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Emmanuel Souza da Rocha

TRICEPS SURAE NEUROMECHANICAL PROPERTIES AFTER ACHILLES TENDON SURGICAL REPAIR: FROM REHABILITATION TO TRAINING

Porto Alegre
2020

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Emmanuel Souza da Rocha

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Examination Board

Prof. Dr. Ronei Silveira Pinto
Universidade Federal do Rio Grande do Sul (UFRGS)

Prof. Dr. Bruno Manfredini Baroni
Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA)

Profa. Dra. Rita de Cássia Marqueti Durigan
Universidade de Brasília (UNB)

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PROPRIEDADES NEUROMECÂNICAS DO TRÍCEPS SURAL APÓS REPARO CIRÚRGICO DO TENDÃO DE AQUILES: DA REABILITAÇÃO AO TREINAMENTO

RESUMO

As rupturas do tendão de Aquiles vêm aumentando com o aumento do interesse em práticas esportivas. O programa de reabilitação pós-operatório pode ser realizado com reabilitação tradicional com imobilização, ou acelerada com mobilização e descarga de peso precoce. A abordagem acelerada aumenta a amplitude de movimento (ADM) do tornozelo e aumenta a hipertrofia do músculo tríceps sural. Contudo, apesar da reabilitação acelerada ser mais indicada para uma recuperação rápida, os pacientes apresentam déficit na força muscular mesmo depois de mais de dez anos da cirurgia. Uma das estratégias para diminuir esses efeitos deletérios persistentes no longo prazo é a realização de treinamento excêntrico. Contudo, o exercício excêntrico pode trazer um risco de re-rupturas ou tendinopatia devido às altas cargas se estas não são aplicadas com uma intensidade apropriada. Dessa forma, o objetivo da presente tese de doutorado é identificar os efeitos dos diferentes programas de reabilitação descritos na literatura e verificar os efeitos do exercício excêntrico em pessoas que passaram pelo reparo cirúrgico do tendão de Aquiles. A tese foi dividida em quatro capítulos que correspondem a quatro artigos independentes com objetivos específicos. No capítulo 1, uma revisão sistemática com metanálise foi desenvolvida para comparar os efeitos da reabilitação tradicional com a reabilitação acelerada na força dos plantiflexores, na ADM do tornozelo, na capacidade funcional, na morfologia tendínea e muscular e no desempenho do teste de elevação do calcanhar após ruptura do tendão de Aquiles. Apesar do alto risco de viés encontrado nos estudos, quando os protocolos são comparados não foram encontradas diferenças a favor de nenhum programa para a força muscular. Entretanto, há um efeito em favor da reabilitação acelerada para diminuir déficits de força excêntrica e de ADM. Portanto, o protocolo acelerado, apesar de apresentar bons efeitos relacionados a ADM, não foi superior ao protocolo de imobilização no que se refere à força muscular dos plantiflexores. Esses resultados instigaram a realização de um estudo, com dados do nosso grupo de pesquisa, para tentar entender um pouco mais os efeitos da reabilitação acelerada nas propriedades neuromusculares desses pacientes. Neste segundo capítulo, a proposta foi comparar os efeitos de um protocolo de reabilitação tradicional de imobilização com um protocolo de reabilitação acelerada na ADM, na arquitetura do gastrocnêmio medial e no torque dos plantiflexores logo após a reabilitação (aos 3 meses), e após 6 meses e 30 meses da cirurgia de reconstrução tendínea. Neste estudo, encontramos que a reabilitação acelerada leva a maior ADM de plantiflexão do tornozelo (p=0.007; d=1.61), maior comprimento de fascículo (p=0.043; d=1.10) e maior espessura do músculo gastrocnêmio medial comparado ao grupo tradicional (tanto na perna saudável, p=0.036; d=1.01; quanto na com lesão, p=0.006; d=1.38). Entretanto, independente do protocolo de reabilitação, a perna com ruptura teve menor força de flexão plantar comparada com a perna sem lesão ($p<0.001$; d=1.46), mesmo após o longo prazo decorrente da cirurgia de reconstrução. Esses resultados indicaram a

busca de uma solução para diminuir esses efeitos deletérios relacionados à força muscular. Escolhemos um programa de exercício excêntrico com o objetivo de aumentar a força muscular, o comprimento fascicular, a espessura muscular e remodelar a estrutura tendínea, a fim de tentar diminuir os déficits encontrados nesses pacientes, que parecem ser permanentes mesmo depois de mais de 2 anos da cirurgia. Para isso, no capítulo 3, verificamos o efeito de duas modalidades de treinamento excêntrico, convencional (na academia) e isocinético (no dinamômetro) durante 12 semanas, sobre a massa muscular do tríceps sural, a ativação muscular, o torque dos plantiflexores e a ADM em 28 pacientes que passaram por cirurgia de reconstrução do tendão. O treinamento convencional apresentou maior ativação excêntrica após 8 ($p=0.02$) e 12 semanas ($p=0.001$) de treinamento e maior ativação concêntrica após 12 semanas que o grupo isocinético na perna com lesão ($p=0.04$) e na perna sem lesão ($p=0.01$). O grupo isocinético apresentou maior massa muscular na perna com lesão no momento pré ($p=0.001$) e pós 4 ($p=0.01$) semanas de treinamento e maior massa muscular na perna sem lesão após 8 semanas ($p=0.01$). A perna sem lesão apresentou maior torque e ativação que a perna com lesão. O treinamento convencional foi capaz de diminuir assimetrias de espessura muscular ($p=0.02$) e o treinamento isocinético foi capaz de diminuir assimetrias de torque isométrico ($p=0.009$) após 8 semanas de treinamento. A ativação isométrica aumentou após 8 ($p=0.001$; $d=5.44$) semanas de treinamento excêntrico em ambos os grupos e pernas. O treinamento convencional aumentou a ativação concêntrica após 8 semanas na perna sem lesão ($p<0.001$; $d=6.19$) e após 12 semanas na perna com lesão ($p=0.014$; $d=4.37$) e aumentou a ativação excêntrica nas duas pernas após 8 semanas de treinamento ($p=0.01$; $d=4.4$). O treino convencional aumentou a massa muscular após 8 semanas de treinamento ($p=0.002$; $d=5.2$), enquanto o treinamento excêntrico aumentou após 12 semanas ($p=0.002$; $d=2.56$) na perna com lesão. Ambos os treinamentos aumentaram a amplitude de dorsiflexão após 8 semanas ($p=0.03$; $d=0.83$). O torque máximo de plantiflexão aumentou após 8 semanas [(isométrico, $p=0.001$; $d=2.99$); (concêntrico, $p=0.001$; $d=2.49$); e (excêntrico, $p=0.001$; $d=2.24$)] independente da modalidade de treinamento. Tendo em vista os efeitos positivos do treinamento excêntrico nas propriedades neuromusculares desses pacientes, e a possível complementariedade entre adaptações neuromusculares e tendíneas, no capítulo 4 verificamos os efeitos do treinamento excêntrico no comprimento total e livre do tendão, na área de secção transversa e na ecogeneicidade do tendão em 10 regiões diferentes do tendão. O tendão com ruptura apresentou maior área de secção transversa, menor ecogeneicidade, maior comprimento total e livre que o tendão saudável. Além disso, o tendão lesado apresentou diferentes áreas e ecogeneicidades ao longo de seu comprimento, principalmente no momento pré-treinamento. Essas diferenças entre as áreas diminuíram ao longo do treinamento, indicando uma melhora da estrutura tendínea com o treinamento de força. O treinamento convencional foi capaz de aumentar em 18% a área de secção transversa do tendão com ruptura na região de 5cm da inserção osteotendínea após 8 semanas de treinamento e aumentar o comprimento do tendão na perna sem lesão após 4 semanas, entretanto não foi capaz de causar mudanças na ecogeneicidade do tendão ($p= 0.28$). Os treinamentos

excêntricos (em dinamômetro isocinético) e o convencional (em academias) são igualmente benéficos para pacientes que romperam o tendão de Aquiles, podendo ser utilizados indistintamente na reabilitação após longos períodos da cirurgia de reconstrução tendínea.

Palavras-chaves: tendão de Aquiles, reabilitação precoce, fisioterapia, exercício excêntrico, ruptura.

TRICEPS SURAE NEUROMECHANICAL PROPERTIES AFTER ACHILLES TENDON SURGICAL REPAIR: FROM REHABILITATION TO TRAINING

ABSTRACT

Achilles tendon ruptures have been increasing with increasing interest in sports. Two different Achilles tendon rehabilitation programs have been used in clinical practice: a traditional rehabilitation, in which ankle immobilization of up to 6 weeks occurs; or an early rehabilitation, with early mobilization and early weight-bearing. The accelerated protocol increases the ankle joint range of motion (ROM) and hypertrophies the triceps sural muscle. However, although early rehabilitation is more suitable for fast recovery, patients have muscle strength deficits even after more than ten years post-surgery. One of the strategies to reduce these persistent harmful long-term effects is to perform eccentric training. However, there is a risk of re-rupture or tendinopathy due to the eccentric exercise's high loads if they are not applied at the appropriate intensity. Therefore, the purpose of this doctoral thesis is to identify the effects of different rehabilitation programs described in the literature and verify the impacts of eccentric exercise on patients who have undergone Achilles tendon surgical repair. This thesis was divided into four chapters that correspond to four independent articles with specific goals. In chapter 1, a systematic review with meta-analysis was developed to compare traditional rehabilitation versus early rehabilitation effects on plantarflexion strength, ankle ROM, functional capacity, tendon and muscle morphology, and on the heel raise test after Achilles tendon rupture. Despite the high risk of bias found in the studies, when the protocols are compared, no improvements in muscle force were observed in favour of any program. However, there is an effect in favor of accelerated rehabilitation to reduce eccentric strength and ROM deficits. Thus, despite presenting sound effects related to ROM, early rehabilitation is not superior to the immobilization protocol regarding the plantar flexors' muscle strength. These results instigated a study, with data from our research group, to understand a little better, the early rehabilitation effects at the neuromuscular properties of these patients. In this second chapter, the proposal was to compare the effects of a traditional immobilization protocol with an accelerated one in the ankle joint ROM, in the medial gastrocnemius architecture and the plantar flexor torque shortly after the rehabilitation program (at three months), and at six and 30 months post-surgery. The early rehabilitation led to greater ROM

(p=0.007; d=1.61), greater fascicle length (p=0.043; d=1.10), and greater muscle thickness than the traditional program compared to the traditional group (both at the healthy limb, p=0.036; d=1.01; and at the injury limb, p=0.006; d=1.38). However, regardless of the rehabilitation protocol, the ruptured leg had less plantarflexion strength (p<0.001; d=1.46) than the healthy limb even after the long period after the tendon surgical reconstruction. These results motivated the search for a solution to reduce these deleterious effects related to muscle strength. We chose an eccentric training program aimed at increasing muscle strength, fascicle length, muscle thickness and remodeling the tendinous structure, to reduce the deficits found in these patients, which seems to be permanent even more than two years of the surgery. To achieve this goal, in chapter 3 we verified the effect of two types of eccentric training: conventional (in the gym) and isokinetic (in the dynamometer) during 12 weeks, on the triceps sural muscle mass, muscle activation, plantar flexor torque, and ankle ROM in 28 patients who had undergone tendon reconstructive surgery. The conventional training determined higher eccentric activation after 8 (p=0.02) and 12 (p=0.001) training weeks, and higher concentric activation after 12 weeks compared to the isokinetic at the injured leg (p=0.04) and the healthy leg (p=0.01). The isokinetic group showed higher muscle mass at the injured leg at the pre (p=0.001) and post-4 (p=0.01) weeks of training, and higher muscle mass at the healthy leg post-8 training weeks (p=0.01). The healthy leg showed higher torque and muscle activation compared to the injured leg. Conventional training was able to reduce muscle thickness asymmetries (p=0.02), and the isokinetic training reduced isometric torque asymmetries (p=0.009) post-8 training weeks. Isometric activation increased after 8 (p=0.001; d=5.44) weeks of eccentric training in both groups and legs. Conventional training increased concentric activation after 8 weeks in the uninjured leg (p<0.001; d=6.19) and after 12 weeks in the injured leg (p=0.014; d=4.37) and increased eccentric activation in both legs after 8 training weeks (p=0.01; d=4.4). Conventional training increased muscle mass after 8 weeks of training (p=0.002; d=5.2), while eccentric training increased after 12 weeks (p=0.002; d=2.56) in the injured leg. Both training sessions increased the dorsiflexion ROM after 8 weeks (p=0.03; d=0.83). Plantarflexion torque increased after 8 weeks [(isometric, p=0.001; d=2.99); (concentric, p=0.001; d=2.49); and (eccentric, p= 0.001; d= 2.24)], regardless of the modality of training. Due to the positive effects of eccentric training at the neuromuscular properties of these patients, and to the possible complementarity between neuromuscular and tendinous adaptations, in chapter 4, we verified the eccentric training effects on total and free tendon length, tendon cross-sectional area and echo intensity of 10 different tendon areas. The injured tendon showed a higher cross-sectional area, smaller echo intensity, longer total and free tendon length compared to the healthy tendon. In addition, the injured tendon presented different echo intensity areas along its length, mainly at the pre-training moment. These between-areas differences decreased throughout the training program, indicating an improvement in tendon structure with strength training. Conventional training was able to increase the cross-sectional area of the injured tendon after 8 weeks by 18% in the region of 5 cm of the osteotendinous insertion and to increase tendon length in the

uninjured tendon after 4 weeks, however it was not able to change tendon echogenicity ($p = 0.28$).The eccentric training programs (conventional and isokinetic) equally benefit for patients that ruptured the Achilles tendon and can be used indistinctly in tendon rehabilitation even after long periods after the tendon surgical reconstruction.

Keywords: Achilles tendon, rehabilitation, physical therapy, eccentric exercise, rupture.

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PREFACE

Achilles tendon is the largest and strongest tendon in the human body, and it is especially important in our daily-life activities, such as in the human gait and when sitting on and/or raising from a chair. However, ruptures in this tendon are quite common, mainly in sports’ practice, and its incidence is increasing with the peoples’ increasing interest in sports activities. Despite the unclear etiology, the main mechanism of the Achilles tendon rupture is acceleration and deceleration of the ankle joint movements (SHARMA & MAFFULLI, 2005), such as during the explosive change of directions or sprints. Moreover, the location of the Achilles tendon rupture is within a poorly vascularized zone (CHEN *et al.*, 2009), 2 to 6 cm proximal to the calcaneal insertion (HESS, 2010).

Two types of rehabilitation programs have been used after tendon reconstruction: traditional immobilization or early rehabilitation (early weight-bearing and/or early ankle mobilization). Although early rehabilitation promotes positive results regarding postoperative complications and the level of patient satisfaction compared with traditional immobilization (HUANG *et al.*, 2014; MCCORMACK & BOVARD, 2015; EL-AKKAWI *et al.*, 2018; LU *et al.*, 2019), the effects on muscle strength, ankle functional capacity, ankle joint stiffness are yet unclear (LU *et al.*, 2019), and these are essential variables for clinical decision-making. Patients have morphological and functional deficits years after the surgery (GEREMIA *et al.*, 2015; HEIKKINEN *et al.*, 2017), and these deficits can be related to the early rehabilitation protocol’s focus on the ankle joint range of motion (ROM) improvement, and not on strength gain (ZELLERS *et al.*, 2019a).

In this regard, eccentric contractions are known as muscle actions that have a higher force production compared to both concentric and isometric contractions (HERZOG, 2014), and are used as a strategy that enables faster recovery of the musculoskeletal system (FRIZZIERO *et al.*, 2014). In addition to the contractile component, the participation of the non-contractile elastic components, such as tendons and the muscle’s connective tissue sheets (fascia, epimysium, perimysium, endomysium), which act producing force passively during stretch or during eccentric contractions, adds a substantial amount of force to the total force produced by skeletal muscles (HERZOG, 2014).

Therefore, eccentric exercise also has been extensively used during the rehabilitation process of tendinous injuries (MAFFULLI *et al.*, 2008; FRIZZIERO *et al.*, 2014), because it generates a high mechanical load, which can lead to greater tendinous tissue plasticity. Previous studies showed that eccentric training increased ROM (MAHIEU *et al.*, 2008), increase fascicle length (GEREMIA *et al.*, 2019), increase muscle thickness (GEREMIA *et al.*, 2018b; GEREMIA *et al.*, 2019), increased maximal isometric (DUCLAY *et al.*, 2009; GEREMIA *et al.*, 2018b), eccentric and concentric torques (GEREMIA *et al.*, 2018b), increased tendon cross sectional area (GEREMIA *et al.*, 2018a) and increased tendon stiffness (DUCLAY *et al.*, 2009; GEREMIA *et al.*, 2018a). Training protocols varied from 6 weeks (MAHIEU *et al.*, 2008; MORRISSEY *et al.*, 2011), 7 weeks (DUCLAY *et al.*, 2009) and 12 weeks (GEREMIA *et al.*, 2018a; GEREMIA *et al.*, 2018b; GEREMIA *et al.*, 2019)

The main objective of this doctoral thesis is to understand the mechanisms related to Achilles tendon rehabilitation after surgical repair, mainly in patients who underwent reconstructive surgery several months or years ago, and verify the effects of eccentric training on triceps surae plasticity. To achieve this goal, this thesis is composed by four chapters organized in the form of original papers that will be submitted for publication on international journals.

In Chapter 1, we performed a systematic review with meta-analysis about the effects of early and traditional rehabilitation programs on the ankle joint range of motion and muscle (i.e., plantar flexor) strength after Achilles tendon repair. We aimed to answer if the early rehabilitation is superior to the conservative immobilization protocol in improving the plantar flexors' structure and function, and the ankle ROM and functionality in patients who had Achilles tendon rupture. We included twenty-three studies and observed a high risk of bias in the published studies that compared early rehabilitation with traditional immobilization of the ankle joint. Nevertheless, we found a positive result for the ankle ROM in favor of early rehabilitation, but with no between-group differences for plantar flexor strength. Moreover, traditional rehabilitation programs presented higher deficits of eccentric torque in the injured leg than early rehabilitation. The systematic review results instigated a retrospective study, with data from our research group, aimed at understanding the early rehabilitation effects at the neuromuscular properties of these patients.

After observing these conflicting results regarding the inexistence of a standardized rehabilitation program (ZELLERS *et al.*, 2019a) and the included studies high bias in Chapter 1, in Chapter 2 we compared the effects of a traditional rehabilitation with an early rehabilitation protocol on ankle ROM, gastrocnemius medialis muscle architecture and plantar flexor torque. We found that early rehabilitation presented better results for ankle ROM, and medial gastrocnemius fascicle length and muscle thickness than immobilization. However, the rupture caused lower plantar flexor torque when compared with the uninjured side, independently of which rehabilitation program was performed. Even with a protocol in which strength exercises were periodized, we found strength deficits after two years of the surgery. This lack of muscle force capacity improvement is probably due to the short period of mechanical loading in the muscle-tendon unit. Tendons need a higher training time to generate the expected plasticity compared to muscles, and ruptured tendons definitely need several months to perhaps years of mechanical loading to promote sufficient tendon stimulus, thereby increasing ankle ROM, muscle thickness and torque after the rehabilitation protocol.

In the third chapter (Chapter 3), titled “Can eccentric training minimize the long-term deficits after Achilles tendon repair? A randomized controlled trial of two eccentric training modalities” we aimed to verify the effects of two types of eccentric training [conventional (gym machines) and isokinetic], during twelve weeks, on the triceps surae neuromechanical properties in patients who had Achilles tendon surgical repair several years ago. We found that the injured leg has lower isometric activation, muscle mass and plantarflexion torque than uninjured leg. However, we found that the conventional training had higher concentric and eccentric activation than isokinetic training; and that the isokinetic training had higher muscle mass than conventional training. Conventional training decreased between-limbs asymmetries in muscle thickness, while the isokinetic training decreased asymmetries of isometric toque after 8 weeks of training. Despite that the clinical effects between groups were ambiguous for eccentric muscle activation and muscle mass with favor to CONV, unclear for concentric activation, ROM and dynamic torque, and was trivial for isometric activation and torque. So, the training effect was similar between groups. We found that- muscle activation (isometric and dynamic), ROM and toque increase with high effect size at post-8 in both trainings and muscle mass increased after 8 weeks of training in the CONV and after 12 weeks in the ISO.

Therefore, regardless of the modality, eccentric training improves neuromechanical, morphological and functional properties in people who underwent Achilles tendon rupture with different time courses. Although both programs showed some structural and functional improvements in the plantarflexors, we were not sure if these rehabilitation programs also generated tendon plasticity.

Therefore, in the last chapter (Chapter 4), titled "Eccentric training increases cross-sectional area and echo-intensity in different regions of the ruptured Achilles tendon", we aimed to verify the effects of the same twelve weeks of eccentric training on the cross-sectional area and echo-intensity from different regions of the tendon, and in tendon length in patients that underwent Achilles tendon surgical repair. Despite several years had passed since the Achilles tendon reconstruction, we observed that Achilles tendon rupture patients displayed severe morphological adaptations on the injured tendon (longer tendon length, larger cross sectional area and lower echogenicity in distal regions of the tendon), and that these adaptations were different among different regions of the tendon. However, our main results showed that eccentric training can hypertrophy and increase the echogenicity of the tendon, which suggest that the tendons were healthier after the two strength training programs.

All four chapters will be submitted for publication at international journals with impact factor. At the end of this thesis, we provide supplementary tables and materials to improve the reader’s understanding of the rehabilitation protocols we used, as well as statistical values.

Overall, we can conclude that early rehabilitation is better than traditional immobilization for the ruptured Achilles tendon and for improving functionality, and that both a conventional and an eccentric isokinetic training performed for 12 weeks improve the Achilles tendon structure and triceps surae structure and function.

JUSTIFICATION

The postoperative ankle immobilization, used after an Achilles tendon reconstruction surgery, produces deleterious changes in the muscular and tendinous structure (architecture), which leads to a reduction in the capacity of the muscle and tendon to generate force. This determines functional impairments, as the muscle-tendon unit is incapable of generating force in the entire ankle joint ROM, thereby negatively affecting the patient’s daily life activities. Rehabilitation protocols can minimize the post-operative period deleterious effects by producing a faster structural and functional return of the triceps surae muscle-tendon unit to a healthy condition. Consequently, beneficial anatomical, physiological, and biomechanical adaptations are expected in patients participating in such rehabilitation programs.

We also know that individuals who underwent surgical treatment of acute Achilles tendon rupture have functional plantar flexor deficits and reduced tendon stiffness compared to the non-injured side years after the surgery. In addition, physiotherapy programs for the treatment of Achilles tendon ruptures usually emphasize ankle ROM improvement, and few plantar flexor strengthening exercises have been included in these rehabilitation programs (probably due to a fear of re-rupture).

Therefore, given the clinical importance in leading these patients to a healthier condition and improving the treatment effects and reducing the recovery time of Achilles tendon rupture patients, the studies presented in the next chapters were designed to fill some of the literature gaps. The main questions we want to answer are: Will patients submitted to Achilles tendon surgical reconstruction following an acute rupture, and who have morphological alterations of the affected tendon, respond positively to an eccentric exercise protocol? Will the eccentric rehabilitation protocol produce a return of the affected tendon’s morphology to a condition similar to that of the unaffected tendon? To answer these questions, patients subjected to the surgical correction of acute Achilles tendon rupture were invited from the local community and underwent a 12-week eccentric training protocol.

CHAPTER 1

1. EARLY VERSUS TRADITIONAL REHABILITATION EFFECTS ON RANGE OF MOTION AND STRENGTH AFTER ACHILLES TENDON REPAIR: A SYSTEMATIC REVIEW WITH META-ANALYSIS

ABSTRACT

Objective: To compare the effects of traditional and early rehabilitation on plantar flexor muscle strength, ankle range of motion (ROM), functional capacity, tendon and muscle morphology and heel raise test in subjects who underwent Achilles tendon (AT) surgical repair.

Design: Systematic review and meta-analysis followed the PRISMA Statement and was registered in the PROSPERO (CRD42013004534). **Data sources:** The search included MEDLINE, EMBASE, Cochrane, Scopus, Science Direct, LILACS, PEDro, and manual search until December 2019. **Eligibility criteria for selecting studies:** Randomized and non-randomized clinical trials were included comparing traditional and early rehabilitation protocols after AT surgical repair. Strength and ROM were evaluated in the meta-analysis.

Results: Of the 5,119 manuscripts identified, 23 were included in the systematic review and 14 in the meta-analysis. A high risk of bias was observed. When comparing the different rehabilitation protocols, no significant improvements were observed in muscle strength, but there was a positive effect of early rehabilitation to reestablish ankle ROM and functional capacity. There was no between-groups difference for heel raise, AT and muscle cross-sectional area and tendon stiffness.

Conclusion: The accelerated protocol showed no significant improvement in plantarflexor muscle strength, but improved ankle ROM and functional capacity post-AT surgical repair.

Keywords: Achilles tendon, rehabilitation, systematic review, meta-analysis.

INTRODUCTION

Achilles tendon (AT) is the strongest tendon of the human body (MAFFULLI, 1999b, a). However, this tendon's acute rupture is relatively common, with an estimated incidence of 45/100,000 people (LANTTO *et al.*, 2015b). This incidence has increased in recent years due to an increased number of participants in sports-related activities, mainly male individuals between the third and fourth life's decade during recreational activities (HUTTUNEN *et al.*, 2014; LANTTO *et al.*, 2015b).

From the injury diagnosis, surgical treatment is the most used procedure (MAFFULLI, 1999a; KRAEUTLER *et al.*, 2017). Immediately after surgery, two types of rehabilitation programs can be performed: conservative or accelerated (early rehabilitation). A conservative program consists of the placement of a plaster cast to immobilize the ankle joint complex for four to six weeks (MAFFULLI *et al.*, 2003a) and is based on the idea that cicatrization needs to occur before the sutured tendon receive a load. However, this disuse causes deleterious structural (tendon hypotrophy) and cellular (reduction in collagen synthesis and increased collagen degradation) changes that lead to AT's strength deficits (HEIKKINEN *et al.*, 2017).

An alternative for the conservative treatment is the accelerated treatment, which involves early mobilization and weight-bearing protocols. Accelerated treatments have shown better effects compared to the conservative treatment in terms of increasing ankle range of motion (ROM), triceps-surae muscle morphology (hypertrophy) and functional parameters (muscle strength and endurance, and American Orthopedic Foot and Ankle Society Score - AOFAS) (HUANG *et al.*, 2014; ZHANG *et al.*, 2015). In addition, the accelerated treatment decreased AT re-rupture rate, being a safe treatment that results in higher satisfaction and leads patients to an earlier return to function (work and sports) (HUANG *et al.*, 2014; MCCORMACK & BOVARD, 2015; ZHANG *et al.*, 2015; ZHAO *et al.*, 2017; EL-AKKAWI *et al.*, 2018; LU *et al.*, 2019). However, the effects of early rehabilitation on muscle strength, ankle ROM, ankle joint stiffness and functional capacity are yet unclear (LU *et al.*, 2019), and these are essential variables for clinical decision-making.

Due to this uncertainty, we wanted to answer the following question: is the early rehabilitation superior to the conservative immobilization protocol in improving the plantar flexors structure and function and the ankle ROM and functionality in patients who had Achilles tendon rupture? To answer this question, we evaluated the effects of different physiotherapy interventions: early rehabilitation compared to traditional (immobilization) on the plantar and dorsal flexors muscular strength, on the ankle ROM and functional capacity, on the AT morphology (i.e., cross-sectional area and length) and stiffness, on the plantar flexors' muscle architecture, and heel-rise height, in patients submitted to AT surgical repair, through a systematic review of clinical trials with meta-analysis.

METHODS

Protocol and registration

This systematic review followed the PRISMA Statement recommendations (MOHER *et al.*, 2009), and was registered in the PROSPERO (International prospective register of systematic reviews, CRD42013004534).

Eligibility criteria

Randomized and non-randomized controlled trials that evaluated individuals after AT surgical-repair and compared the post-surgery effects of immobilization (traditional) with early rehabilitation were included. The included outcomes were: (1) strength (or torque) of the plantar and dorsal flexor muscles; (2) ankle ROM; (3) ankle functional capacity, through the American Orthopedic Foot and Ankle Society Score (AOFAS) questionnaire; (4) tendon stiffness; (5) tendon morphology; (6) plantar flexor muscle architecture; (7) heel-rise height and endurance. Studies that did not present data, such as the number of members or mean values per intervention group were excluded from the meta-analysis but were kept in the qualitative analysis.

Information sources

Manuscripts were searched electronically in MEDLINE (using Pubmed), SCOPUS, EMBASE, Physiotherapy Evidence Database (PEDro), Cochrane Central Register of Controlled Trials (Cochrane CENTRAL), LILACS and Science Direct databases. Next, a manual search was made in the reference lists of the selected papers to verify the existence of additional studies not found in the electronic databases. Finally, we performed a search in the Google Scholar database, which allows finding additional manuscripts not indexed in the databases mentioned above.

Search Strategy

The search was performed until December 2019 and included the MESH terms combined using Boolean operators “AND” and “OR”, based on the PRISMA statement (MOHER *et al.*, 2009) regarding participants, interventions, comparisons, outcomes, and study design (PICOS). For the search strategy, we used participants (who had AT rupture), intervention (early rehabilitation) and study design (randomized controlled clinical trials). In Supplementary table 1.1 the MESH terms are described. There was no restriction of language and date of publication in the search.

Study selection

After the search at the electronic databases, the studies’ lists were exported to files that were imported into the EndNote program (EndNote X7, Thomsons Reuters, US) to read the titles and abstracts. We excluded duplicated studies (found in more than one database). Two reviewers independently identified the relevant studies after the selection process. Initially, the reviewers scanned the relevant studies about the titles and abstracts against the inclusion criteria. Next, if sufficient information was not included in the title and abstract to determine inclusion, they examined the full text. A third researcher resolved conflicts.

Data Extraction

Two reviewers independently extracted the meta-analysis data by using a standardized worksheet for each of the studies’ outcomes. Data extracted for both the control group and the intervention group were (in addition to the authors’ name and year of the study) the average post-intervention and standard deviation (SD) values, and the number of participants for all outcomes.

Data outcomes

The study outcomes encompass the plantar and dorsal flexor muscles’ strength (in Newtons, N), or the muscles’ torque (in N.m), the ankle ROM, the clinical outcomes (i.e. AOFAS and heel raise height, heel-rise endurance), tendon parameters (cross-section area, tendon strength, and stiffness), and plantar flexors cross-section area. All outcomes are presented in the results section.

Risk of bias

We assessed the risk of bias by the Cochrane Collaboration assessment tool (RoB 2) for randomized clinical trials (HIGGINS *et al.*, 2011) and by Methodological index for non-randomized studies (MINORS) (SLIM *et al.*, 2003).

Synthesis of results

For the quantitative analysis, the difference between mean values, with a 95% confidence interval, and a random-effects model were used. The values of muscular strength were obtained in force (N) or torque (N.m), while ankle ROM in degrees of dorsal flexion and plantar flexion. We also compared concentric torque in N.m, concentric and eccentric torque deficits (% from the uninjured side), plantar flexion ROM deficit (% from the uninjured side) and total ankle ROM deficit (% from the uninjured side).

Heterogeneity was assessed through the inconsistency test (I^2; low heterogeneity if the value was up to 25%; moderate if the value was between 26% and 50%, and high heterogeneity when greater than 50%). When high heterogeneity between the studies was observed, sensitivity and subgroup analysis (e.g. time of follow-up and study design) were performed. A significance level of 0.05 was considered for the meta-analysis, and the Review Manager program, version 5.3 (Cochrane Collaboration) (HIGGINS *et al.*, 2003) was used for all analyses.

RESULTS

Study selection

The search retrieved 5,119 papers. From these, 23 studies were included in the systematic review and 14 in the meta-analysis (Figure 1). Meta-analysis was performed only for strength and torque and ROM data because there was not enough data from the other outcomes that allowed this analysis.

Study characteristics

The description of the interventions of the included studies is presented in Table 1. Most included studies were randomized controlled trials (16) with early rehabilitation that started in the first two weeks post-surgery. The rehabilitation programs had exercises for ankle mobilization and weight-bearing encouragement. Most patients were male, and the interventions had a maximum duration of six months before the patients' return to sports and physical activities. The patients in the control and/or traditional immobilization groups stayed immobilized from 2 to 6 weeks, and, in most rehabilitation protocols, these patients received exercises with ankle mobilization and weight-bearing post-immobilization.

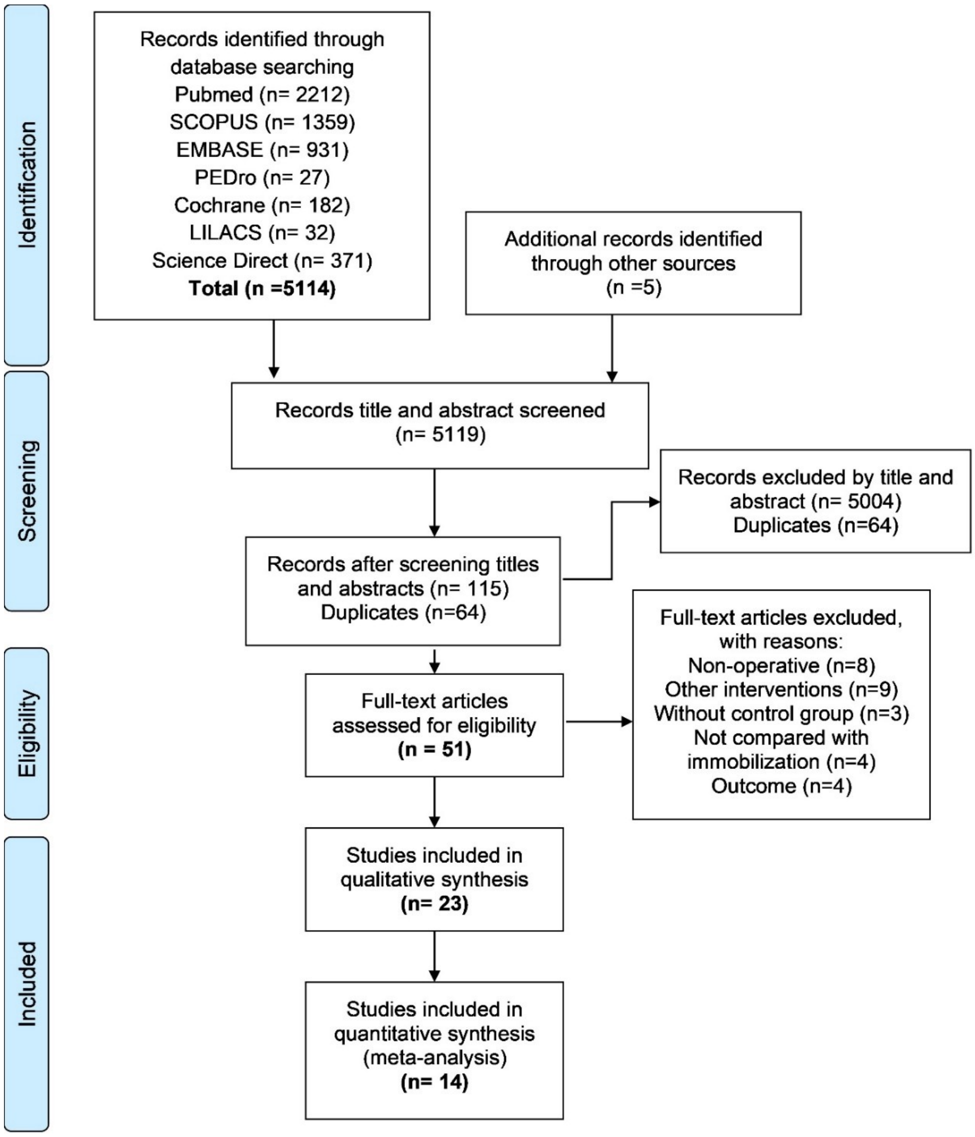


Figure 1-1. PRISMA flow diagram.

Table 1.1. Characteristics of the included studies.

Study	Design	N	Early rehabilitation	Control	N (E/C)	Sex (E/C)	Age (E/C)
BOSTICK *et al.* (2010)	RCT	110	FWB (immediately, discarding the crutches once they were comfortable) AME, HR, and stationary cycling (6th week) Return to activities (6th months)	NWB AME, HR, and stationary cycling (6th week) Return to activities (6th month)	55/55	-	-
BUCHGRABER & PASSLER (1997)	NRS	N=48 38 males 32.7 ±6.3 years old and 10 females 33.4 ±8.4 years old	Immobilization (2.7 days): until the swelling subsided. Special shoe (3-cm heel lift). Patients were encouraged to perform isometric and therapeutic exercises. Isokinetic exercises and electrotherapy (4th week) Exercise program specifically tailored to sports activities (12th week).	Immobilization (2 weeks). PWB (4 weeks with a short walking cast) Patients were encouraged to perform isometric and therapeutic exercises.	30/18	-	-
CETTI *et al.* (1994)	NRS	N=60 37 (20-60) years old	Cast: FWB. EME (6 weeks) 1/2 step on the injured side was started and continued for 14 days (6-8th week). Normal gait (8th week) AME was started immediately after the removal of the cast. A 1 cm HR was used in both shoes during the first 2 weeks after removal of the cast.	Immobilization: NWB (6 weeks) 1/2 step on the injured side was started and continued for 14 days (6-8th week). Normal gait (8th week) AME was started immediately after the removal of the cast. A 1 cm HR was used in both	30/30	25/25 males	-

			4 weeks after removal of the cast, loaded calf muscle exercises were started. 4 months after operation jogging was allowed. Return to activities (6 months)	shoes during the first 2 weeks after removal of the cast. 4 weeks after removal of the cast, loaded calf muscle exercises were started. 4 months after operation jogging was allowed. Return to activities (6 months)			
COSTA *et al.* (2003)	RCT	N=28 (24 males) 41 years old	Early weight-bearing FWB and EME.	Traditional rigid postoperative cast Below-knee gravity equinus cast and mobilized NWB.	9/11	-	-
COSTA *et al.* (2006)	RCT	48	Early weight-bearing Immediate mobilization with orthosis (first day) The orthosis or plaster cast was removed (8 weeks)	Traditional rigid postoperative cast. Plaster cast immobilization (8 weeks)	23/25	18/22 males	42 (28-61)/42 (29-69) years
DE LA FUENTE *et al.* (2016a)	RCT	39	EME and PWB (since the first day). Day 0 to 7: ROM using hinged ankle walking boot protection, PWB (10 kg) with crunches. Day 7 to 14: ROM using hinged ankle walking boot protection, PWB (25 kg) with crunches. Day 14 to 21: ROM using hinged ankle walking boot	Immobilization and NWB (first 28 postoperative days). Day 28 to 84: Strength training with elastic bands, stretching exercises, one-leg HR, postural exercises, locomotion retraining and coordinative exercises.	20/19	20/19 males	41.4 ±8.3/41.7 ±10.7 years

			protection, PWB (40 kg) with one crunch. Day 21 to 28: ROM using hinged ankle walking boot protection and FWB. Day 28 to 84: Strength training with elastic bands, stretching exercises, one-leg HR, postural exercises, locomotion retraining and coordinative exercises.				
DE LA FUENTE *et al.* (2016b)	RCT	26	Active PF with concentric contractions (days 1-7) PF against a yellow elastic band (days 8-14), a red elastic band (days 15-28), a blue elastic band (days 29-56), and against a grey elastic band (days 57-84). HR (days 15-84) Balance Exercises (days 1-84) AME (days 1-28) PWB (days 1-21) FWB (days 22-28) Stretching (days 29-84) Plyometric exercises (days 57-70) Takeoff exercises (days 71 to 84) Controlled running exercise (days 71-84)	Immobilized (days 1-28) NWB (days 1-28) PF against a blue elastic band (days 29-56), and a grey elastic band (days 57-84) HR (days 29-84) Balance exercises (days 29-84) Stretching (days 29-84) Plyometric exercises (days 57-70) Takeoff exercises (days 71 to 84) Controlled running exercise (days 71-84)	13/13	13/13 males	42.7 ±7.8/41.8 ±11.5 years

ELIASSON *et al.* (2018)	RCT	75	EME (3rd week) PWB (7th week) FWB (8th week) The regimen aimed to provide limited mechanical stimulation without any lengthening of the tendon	PWB (7th week) FWB (8th week) The regimen aimed to reduce the tendon lengthening.	25/25	19/19 males	36 ±1.5/36.9 ±2.2 years
			EME (immediate post-surgery) PWB (day 1) FWB (5th week) The regimen aimed to maximize mechanical stimulation.		25/25	22/19 males	38.8 ±1.1/36.9 ±2.2 years
GEREMIA *et al.* (2015)	NRS	18	Immobilization (2 weeks) Week 3: PWB – Crutches (3 points) gait training Week 4-5: PWB – Crutches (2 points) gait training Week 3-5: Active and passive ankle and foot movements; Active and passive hip flexion, adduction, and abduction. Week 5-8: Stretching for the dorsal and plantar flexors; Knee flexion with load (except week 5) Week 6-8: Hip flexion, adduction, and abduction exercises with load; Ankle plantar flexion, dorsiflexion, inversion, and eversion exercises with the load.	Immobilization (equinus) and NWB. 4 weeks: immobilization in the neutral position; PWB was encouraged. 6 weeks: the cast was removed, and the patients received instructions on how to perform a home-exercise program. Week 7-9: Active plantar and dorsal flexion; Bipedal HR; Unipedal HR. Week 10-12: Bipedal squat; Unipedal squat; Stretching exercise.	9/9	9/9 males	45.3 ±2/44.4 ±3.4 years

			Week 6: Gait training (FWB with *robot foot*) Week 7-8: Gait training (FWB) Week 7: Unipodal support training, stair gait training and proprioceptive training Week 8: proprioceptive training with a mini-trampoline; Bipedal squat exercise; Bipedal HR. Week 3-8: Cryotherapy with compression and ankle elevation (20 min) Week 9-12: home-based exercise (same immobilization group)				
GROETELAERS *et al.* (2014)	RCT	N=60 43 (19-65) years	FWB and EME (2nd week) 2-3 weeks: patients had extra heel elevation; 4-6 weeks: normal heel elevation AME. Standardized exercise program immediately after randomization.	2-3 weeks: Immobilised in a fibreglass cast in 10 degrees of PF. 4-6 weeks: immobilized in a neutral position with FWB.	32/28	-	-
JIELILE *et al.* (2016)	RCT	68	Early ankle and knee active motion (from day 1). Day 3: the exercise of tiptoe Week 4: FWB, standing on the toes, and squatting.	Long leg plaster cast immobilization (6 weeks), with the knee in flexion at 60° and the ankle in PF at 45°. Week 7: short leg plaster cast immobilization (2 weeks), with the ankle in quasi-neutral position.	26/31	21/27 males	36 (31-47)/37 (29-45) years

				Week 9: Cast immobilization was removed, and the patients were instructed to perform the same rehabilitation exercises.				
KANGAS *et al.* (2003)	RCT	50	Early weight-bearing. Below-knee dorsal cast (6 weeks). Active free PF with DF restricted to neutral (6 weeks) FWB (3rd week). At 0–6 weeks: Active toes exercises and PF; Isometric knee extension; Active knee flexion; Isometric hip extension. At 6–9 weeks: Active assisted PF and DF; “Rotation” of the ankles (circumduction); Standing on the toes and heels alternately; PF against a rubber strip; Calf muscle stretching. At 9th week: HR; Exercises against a rubber strip for PF, DF, Ankle abduction, and adduction; Calf muscle stretching; standing with the knee somewhat flexed.	Traditional rigid postoperative cast (n=25) Below-knee plaster cast with the ankle in a neutral position (6 weeks). FWB (3rd week). At 0–6 weeks: Active toes exercises; concentric contractions of the PF and DF; isometric knee extension; active knee flexion; isometric hip extension. At 6-9 weeks and 9th week: same of the early group.	25/25	22/24 males	35 (21-55)/37 (23-53) years	
KANGAS *et al.* (2007)	RCT		Same of KANGAS *et al.* (2003)					
KIM *et al.* (2017)	RCT	56 (46 males)	Short leg splint immobilization (2 weeks) PWB – as tolerable (week 2)	Below knee cast immobilization (4 weeks)	32/24	-	-	

		39 (13-69) years old	AME Single leg stance and double HR (if possible) FWB (week 4 - as tolerated) Strengthening exercises Distraction exercise Single HR	PWB – as tolerable (week 4) AME Single leg stance and double HR (if possible) FWB (week 6 - as tolerated) Strengthening exercises Distraction exercise Single HR			
LANTTO *et al.* (2015a)	RCT	50	Below-knee dorsal brace (6 weeks). Active free PF, but DF was restricted to neutral (6 weeks). FWB (after 3 weeks) Standard rehabilitation regimen same KANGAS *et al.* (2003)	Below-knee plaster cast with the ankle at a 90° angle (6 weeks). FWB (after 3 weeks) Standard rehabilitation regimen same KANGAS *et al.* (2003)	25/25	17/17 males	36 ±9/34 ±7 years
MAFFULLI *et al.* (2003a)	NRS		FWB and encouraged to keep the leg elevated (for the first 2 weeks). After 2 weeks: cast removed. PWB as soon as they felt comfortable, and to gradually progress to FWB AME, isometric contraction and gentle concentric contraction. 6 weeks: anterior slab was removed.	NWB and encouraged to keep the leg elevated (for the first 2 weeks) 4 weeks: PWB as soon as they felt comfortable and discarding their crutches as soon as possible. 6 weeks: the cast was removed.	26/27	22/23	44.7 (31-69)/43.8 (30-67) years
MAFFULLI *et al.* (2003b)	NRS	53	Day 0: Synthetic cast without increasing the natural ankle position.	Day 0: Cast was applied with the ankle in full *equinus*.	28/28	21/24 males	44.7 (31-69)/43.8 (30-67) years

			Day 1: Patients were discharged. PWB with crutches. Week 2: the cast was removed. Ankle positioned plantigrade, another cast was applied and increasing the PWB were encouraged, discarding crutches as soon as possible. Week 6: the cast was removed.	Day 1: Patients were discharged. NWB with crutches. Week 2: the cast was removed. Ankle positioned plantigrade, another cast was applied. Week 4: Synthetic cast as close as plantigrade position as possible. PWB was encouraged, discarding crutches as soon as possible. Week 6: the cast was removed.			
MAJEWSKI *et al.* (2008)	NRS	88	Day 1: Splint with 20° of PF. Day 2 – 6: PWB with the shoe Weeks 2-3: Leg-curl treatment within the shoe. Weeks 4 –5: PWB with bare feet Weeks 6 –7: FWB and AME as tolerated Weeks 8 –11: Intensified workout and coordinative performance, without FWB. Months 3 – 12: Shoe no longer required. Proprioceptive training and controlled workout until former activity level in sports is attained	A below-knee splint that holds the foot in 20° of PF (3 weeks). PWB, below-knee walking cast (5 weeks). FWB (at 8^{th} week). Achilles tendon was carefully restricted within a stable working shoe (12 weeks). Proprioceptive training and controlled workout until the patients perceived that sufficient strength and force had been achieved to enable them to return to sports.	14/14	13/13 males	45 (24-61)/45 (25-62) years

MAYER *et al.* (2010)	NRS	24	The removable orthosis in a neutral ankle position. Week 2: Start rehabilitation. Rehabilitation protocol: flexibility exercises and muscle resistance. PWB - gait training with the removable orthosis Week 7: FWB Week 9-12: home-based exercise (same immobilization group)	Immobilization (6 weeks). After removing the cast, they received a form demonstrating the exercises to be done at home. Home-based exercises (6 weeks): Active free ankle PF and DF movement, support exercises tiptoe, with bipedal weight unloading, progressing to unipedal; squat exercises were initially performed with bipedal support, switching to unipedal support after three weeks of rehabilitation. Stretching exercises for the posterior region of the leg on the operated side were performed in the standing position with the operated limb extended and the ankle in dorsiflexion while the healthy side was flexed and the upper limbs were supported on the wall.	13/11	13/11 males	43.5 ±13.7/41.3 ±7.9 years

MCNAIR *et al.* (2013)	RCT	38	Weight-bearing immediately.	NWB - crutches and instructed not to place weight through the injured limb.	16/14	8/7 males	38 ±5/41 ±13 years
			Both groups had a total cast time of 8 weeks and were treated with a set protocol. The first cast was set to “full” *equinus* without manual pressure. After 4 weeks, both groups had their casts changed, and the amount of *equinus* was reduced to a “resting” position of 10–20˚ PF. At 8 weeks: Casts were removed. ROM exercises. PWB as tolerated. At 12 weeks: Raises were removed. At 18 weeks: Graduated strength training. At 3 months: Return to sports.				
MORTENSEN *et al.* (1999)	RCT	71	Below-the-knee dorsal plaster splint applied *equinus* position (2 weeks). At 2nd week: ROM-Walker brace. The patients were instructed to do a small series of DF exercises several times a day. At 4 weeks: PWB as tolerated. AME. At 6 weeks: Brace was removed. Free walk.	Immobilization: below-the-knee plaster cast in *equinus* position. At 6 weeks: Below-the-knee weight-bearing cast applied with the ankle in neutral. At 8 weeks: Cast was removed, PWB as tolerated.	31/30	11/10 males	35 (20-73)/39 (24-63) years
PORTER & SHADBOLT (2015)	RCT	54	EME (immediate post-surgery) PWB (10-14 days postoperative) FWB (4th week) Progressive strengthening work (8-10 week) Passive stretching (12th week) Return to running: When strength and muscle endurance have been restored.	Hanging *equinus* plaster (immediate post-surgery) PWB (6th week) FWB (8th week) Mobilizing and resistance strengthening (10th week) Passive stretching (12th week) Return to running: When strength and muscle	26/28	22/20 males	32.2 (19-45)/36.2 (19-46) years

				endurance have been restored to at least that present on the uninjured side			
VALKERING *et al.* (2017)	RCT	41	EME (first two postoperative weeks) FWB with crutches and ROM exercises were allowed after the application of the orthosis. Recommendation: NWB ROM exercises without orthosis (one-hour daily).	NWB (immediate post-operative) Removable walker (2-4 weeks) FWB with crutches (2nd week). Recommendation: NWB ROM exercises without orthosis (one-hour daily).	27/29	24/26 males	40.8 ±8/39.5 ±8.7 years

RCT: randomized controlled trial; NRS: non-randomized study; EME: early mobilization exercises; PWB: partial weight-bearing; FWB: full weight-bearing; NWB: non-weight bearing; ROM: the range of motion; AME: Ankle mobilization exercises; HR: heel raise; PF: plantarflexion; DF: dorsiflexion.

Analysis of the risk of bias

Of the twenty-three included studies, sixteen were RCT, nine of them (56.25%) met the criteria of random sequence generation, eight (50%) undoubtedly met allocation concealment, and only two studies (12.5%) presented a low risk of bias for blinding of outcome assessment. Most studies (14; 87.5%) mentioned exclusions and losses (incomplete outcomes data) and only in two studies (12.5%) the intent-to-treat analysis was observed (Table 1.2). The other seven studies were NRS, they had high risk of bias for prospective collection of data, unbiased assessment of the study endpoint and prospective calculation of the study size (Table 1.3).

Table 1.2. Risk of bias assessment of randomized clinical trials.

Studies	A	B	C	D	E
BOSTICK *et al.* (2010)	?	?	↑	↓	↑
COSTA *et al.* (2003)	↑	↑	↑	↓	↓
DE LA FUENTE *et al.* (2016b)	↓	?	↑	↓	↓
DE LA FUENTE *et al.* (2016a)	?	?	↑	↓	↑
ELIASSON *et al.* (2018)	?	↑	↓	↓	↑
GROETELAERS *et al.* (2014)	?	↓	↑	↓	?
JIELILE *et al.* (2016)	↓	↓	↑	↓	↑
KANGAS *et al.* (2003)	↓	↓	↑	↓	?
KANGAS *et al.* (2007)	↓	↓	↑	↓	↑
KIM *et al.* (2017)	↑	↑	↑	?	↑
COSTA *et al.* (2006)	↓	↓	↓	↓	↑
LANTTO *et al.* (2015a)	↓	↓	↑	↓	↑
MCNAIR *et al.* (2013)	↑	↑	↑	↓	↑
MORTENSEN *et al.* (1999)	↓	↓	↑	?	↑
PORTER & SHADBOLT (2015)	↓	?	↑	↓	↑
VALKERING *et al.* (2017)	↓	↓	?	↓	↑
	56.25%	**50%**	**12.5%**	**87.5%**	**12.5%**

(A) Random sequence generation; (B) Allocation concealment; (C) Blinding of outcome assessment; (D) Incomplete outcomes data; (E) Intention-to-treat. ? Unclear risk of bias; ↑ High risk of bias; ↓ Low risk of bias.

Table 1.3. Risk of bias assessment of non-randomized clinical trials.

	A	B	C	D	E	F	G	H
BUCHGRABER & PASSLER (1997)	↓	↓	↑	?	↑	↓	↓	↑
CETTI *et al.* (1994)	↓	?	↑	?	↑	↓	?	↑
GEREMIA *et al.* (2015)	↓	↓	↑	?	↑	↓	↓	↓
MAFFULLI *et al.* (2003a)	?	↓	↑	?	↑	↓	↓	?
MAFFULLI *et al.* (2003b)	?	↓	↑	?	↑	↓	↓	?
MAJEWSKI *et al.* (2008)	?	?	↑	?	↑	?	?	↑
MAYER *et al.* (2010)	↓	↓	↑	?	↑	↓	↓	↑
	57%	**71%**	**0%**	**0%**	**0%**	**85%**	**71%**	**0%**

(A) A clearly stated aim; (B) Inclusion of consecutive patients; (C) Prospective collection of data; (D) Endpoints appropriate to the aim of the study; (E) Unbiased assessment of the study endpoint; (F) Follow-up period appropriate to the aim of the study; (G) Loss to follow up less than 5%; (H) Prospective calculation of the study size. ? Unclear risk of bias; ↑ High risk of bias; ↓ Low risk of bias.

Results Synthesis

Results synthesis are presented in table 1.3.

Table 1.4. Results synthesis of the included studies.

Outcomes	Study	Results
Heel raise height	ELIASSON *et al.* (2018)	ACC = IMMO, both ↑
	PORTER & SHADBOLT (2015)	ACC less difference between injured and uninjured leg than IMMO
	VALKERING *et al.* (2017)	ACC = IMMO.
Heel raise endurance	BOSTICK *et al.* (2010)	ACC = IMMO
	BUCHGRABER & PASSLER (1997)	ACC = IMMO
	DE LA FUENTE *et al.* (2016b)	ACC ↑ repetitions than IMMO
	KIM *et al.* (2017)	ACC = IMMO
Range of Motion	BOSTICK *et al.* (2010)	ACC = IMMO
	BUCHGRABER & PASSLER (1997)	ACC less difference between injured and uninjured leg than IMMO
	CETTI *et al.* (1994)	ACC ↑ IMMO
	COSTA *et al.* (2003)	ACC = IMMO
	COSTA *et al.* (2006)	ACC = IMMO
	DE LA FUENTE *et al.* (2016b)	ACC ↑ IMMO
	ELIASSON *et al.* (2018)	ACC = IMMO, both ↑
	KANGAS *et al.* (2003)	ACC = IMMO
	KIM *et al.* (2017)	ACC = IMMO
	LANTTO *et al.* (2015a)	ACC = IMMO
	MAJEWSKI *et al.* (2008)	ACC = IMMO
	MCNAIR *et al.* (2013)	ACC = IMMO
	MORTENSEN *et al.* (1999)	ACC ↑ IMMO
	VALKERING *et al.* (2017)	ACC ↑ DF than IMMO
PF Strength	BOSTICK *et al.* (2010)	ACC = IMMO
	BUCHGRABER & PASSLER (1997)	ACC = IMMO
	COSTA *et al.* (2006)	ACC = IMMO
	DE LA FUENTE *et al.* (2016a)	ACC = IMMO
	ELIASSON *et al.* (2018)	ACC = IMMO

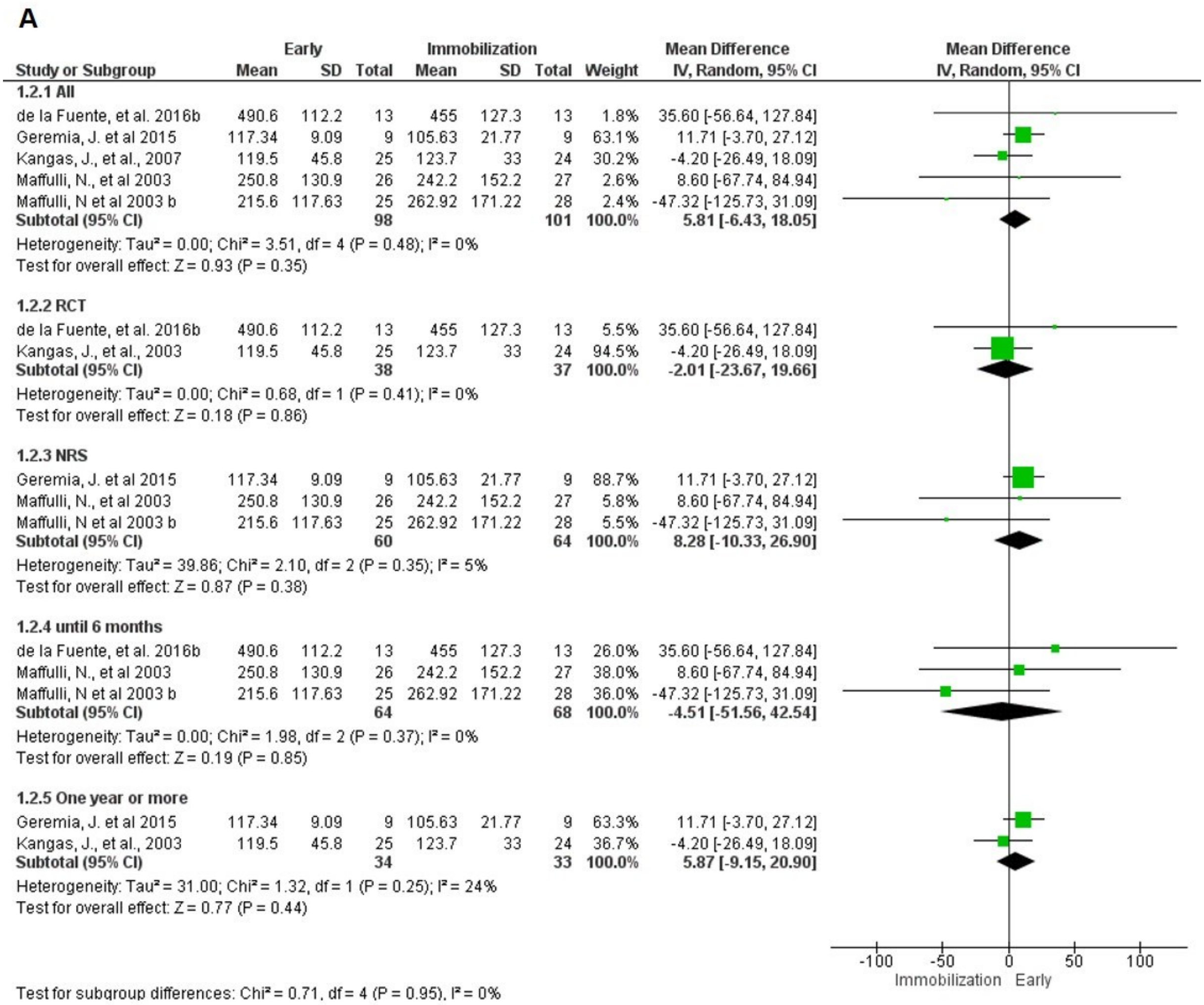
	GROETELAERS *et al.* (2014)	ACC = IMMO
	KANGAS *et al.* (2007)	ACC ↑ IMMO
	LANTTO *et al.* (2015a)	ACC = IMMO
	MAFFULLI *et al.* (2003b)	ACC = IMMO
	MCNAIR *et al.* (2013)	ACC = IMMO
DF strength	KANGAS *et al.* (2003)	ACC = IMMO
Tendon CSA	ELIASSON *et al.* (2018)	ACC = IMMO
	GEREMIA *et al.* (2015)	ACC = IMMO
	JIELILE *et al.* (2016)	ACC ↑ larger size than IMMO
	MAFFULLI *et al.* (2003a)	ACC = IMMO
Tendon length, force and stiffness	DE LA FUENTE *et al.* (2016b)	**AT force:** ACC ↑ than IMMO
	GEREMIA *et al.* (2015)	**Tendon length, force and stiffness:** ACC = IMMO
	MCNAIR *et al.* (2013)	**Stiffness:** ACC = IMMO
Ankle stiffness	LANTTO *et al.* (2015a)	ACC = IMMO
Muscle CSA	ELIASSON *et al.* (2018)	**GM GL →** ↑ ACC = IMMO **SOL →** ↓ ACC = IMMO
Peak torque	CETTI *et al.* (1994)	ACC ↑ IMMO
	COSTA *et al.* (2003)	ACC ↓ torque deficit than the IMMO IMMO ↓ eccentric torque in the injured limb than ACC
	KANGAS *et al.* (2003)	ACC = IMMO
	MAFFULLI *et al.* (2003a)	ACC = IMMO
	MAYER *et al.* (2010)	ACC = IMMO
AOFAS	KIM *et al.* (2017)	ACC ↑ IMMO
	KORKMAZ *et al.* (2015)	ACC ↑ IMMO

HR = heel raise height; ROM = range of motion; ACC = accelerated rehabilitation group; IMMO = immobilization group; HRE = heel raise endurance; ↓ = lower/decrease; ↑ = higher/increase; DF = dorsiflexion; PF = plantar flexion; GM = gastrocnemius medialis; GL = gastrocnemius lateralis; SOL = soleus; CSA = cross sectional area; DF = dorsiflexion.

Effects of early rehabilitation on muscle strength

Five studies (MAFFULLI *et al.*, 2003a; MAFFULLI *et al.*, 2003b; KANGAS *et al.*, 2007; GEREMIA *et al.*, 2015; DE LA FUENTE *et al.*, 2016b) (n=98 for early rehabilitation and 101 for immobilization, respectively) evaluated the isometric plantar flexor muscle strength, in follow-ups of six months and more than one year postoperatively. There were no significant differences (p=0.35) in plantar flexor muscle strength between the immobilization and early rehabilitation groups (Figure 2A). In the subgroup analysis, considering only the RCT (KANGAS *et al.*, 2003; DE LA FUENTE *et al.*, 2016b), there was also no between-groups difference (p=0.86) for plantar flexor strength.

Three studies (BOSTICK *et al.*, 2010; GROETELAERS *et al.*, 2014; ELIASSON *et al.*, 2018) (Figure 2B) evaluated the deficit of the plantar flexor strength to the healthy leg; no differences (p=0.36) were observed between rehabilitation programs for the six months (p=0.42) and twelve months (p=0.54) of follow-up. ELIASSON *et al.* (2018) were presented twice because this study had two early rehabilitation regimes (mobilization with late weight-bearing and with early weight-bearing).



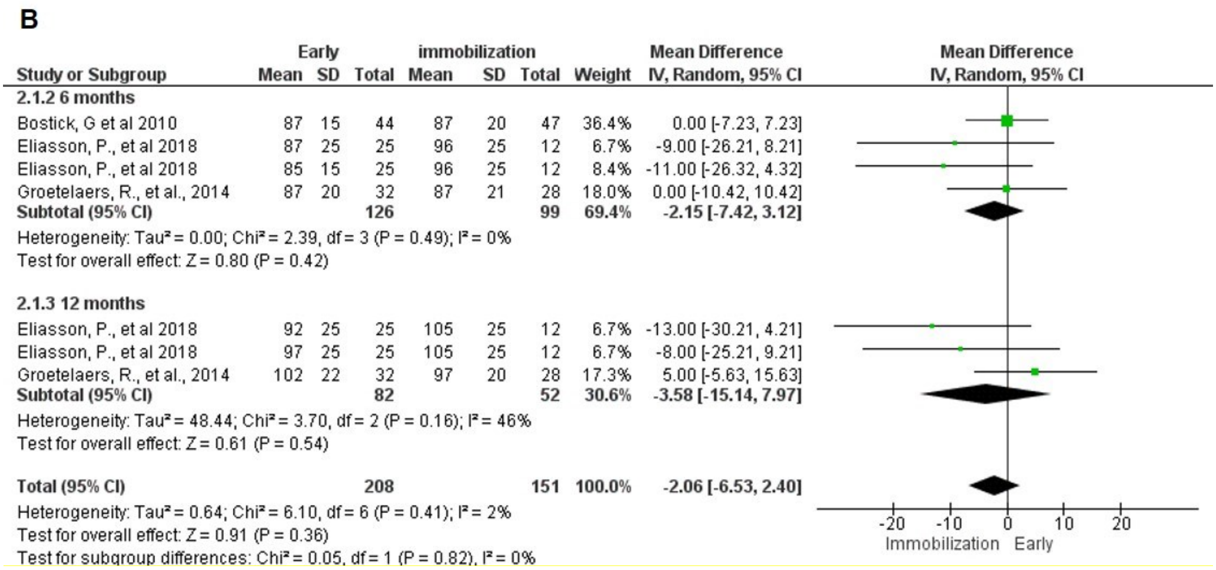


Figure 1-2. Forest plot for the comparison between early rehabilitation and immobilization on (A) plantar flexor muscle strength (Newtons) and on (B) plantarflexion strength percent (%) relative to the healthy side. RCT = randomized clinical trial; NRS = non-randomized study.

Two studies (KANGAS *et al.*, 2003; MAYER *et al.*, 2010) presented concentric torque data (N.m), but also with no between-group differences (p=0.4; Figure 3A). Two studies from the same group (COSTA *et al.*, 2003; COSTA *et al.*, 2006) presented dynamic concentric (Figure 3B) and eccentric (Figure 3C) torque deficits relative (in percent) to the healthy side, without differences between interventions in concentric torque deficit (p=0.09; Figure 3B) and in eccentric torque deficit (p=0.06; Figure 3C).

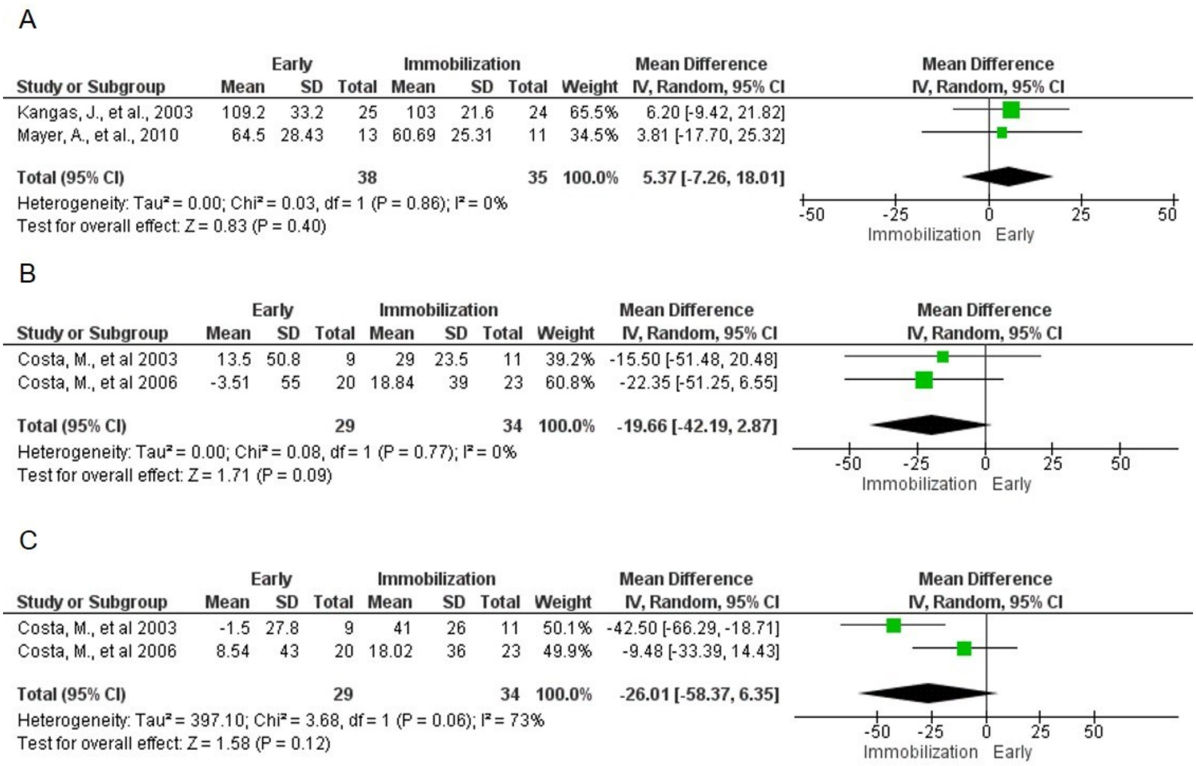


Figure 1-3. Forest plot for the comparison between early rehabilitation and immobilization on (A) concentric plantarflexor torque (N.m) and on (B) concentric plantarflexor torque deficit to healthy side; and (C) eccentric torque deficits in percent relative to the healthy side.

Effects of early rehabilitation on ankle joint range of motion

For ankle dorsiflexion ROM, two studies (DE LA FUENTE *et al.*, 2016a; KIM *et al.*, 2017) evaluated this outcome. We found significant dorsiflexion ROM difference in favor of early rehabilitation (p=0.02; Figure 4A). Most studies (BUCHGRABER & PASSLER, 1997; COSTA *et al.*, 2003; COSTA *et al.*, 2006) presented ROM data in terms of a deficit compared with the healthy limb, in degrees (Figure 4B) to the healthy side. Although the overall effect showed that the immobilization group presented higher deficits (p=0.02; Figure 4B), the subgroup testing did not show between-group differences (p=0.12; Figure 4B).

Three studies (BUCHGRABER & PASSLER, 1997; COSTA *et al.*, 2003; COSTA *et al.*, 2006) evaluated the ankle plantarflexion ROM deficit, in degrees (Figure 4C), to the healthy side. And the metanalysis did not find a difference between groups (p=0.24) nor in the subgroup analysis (p=0.83).

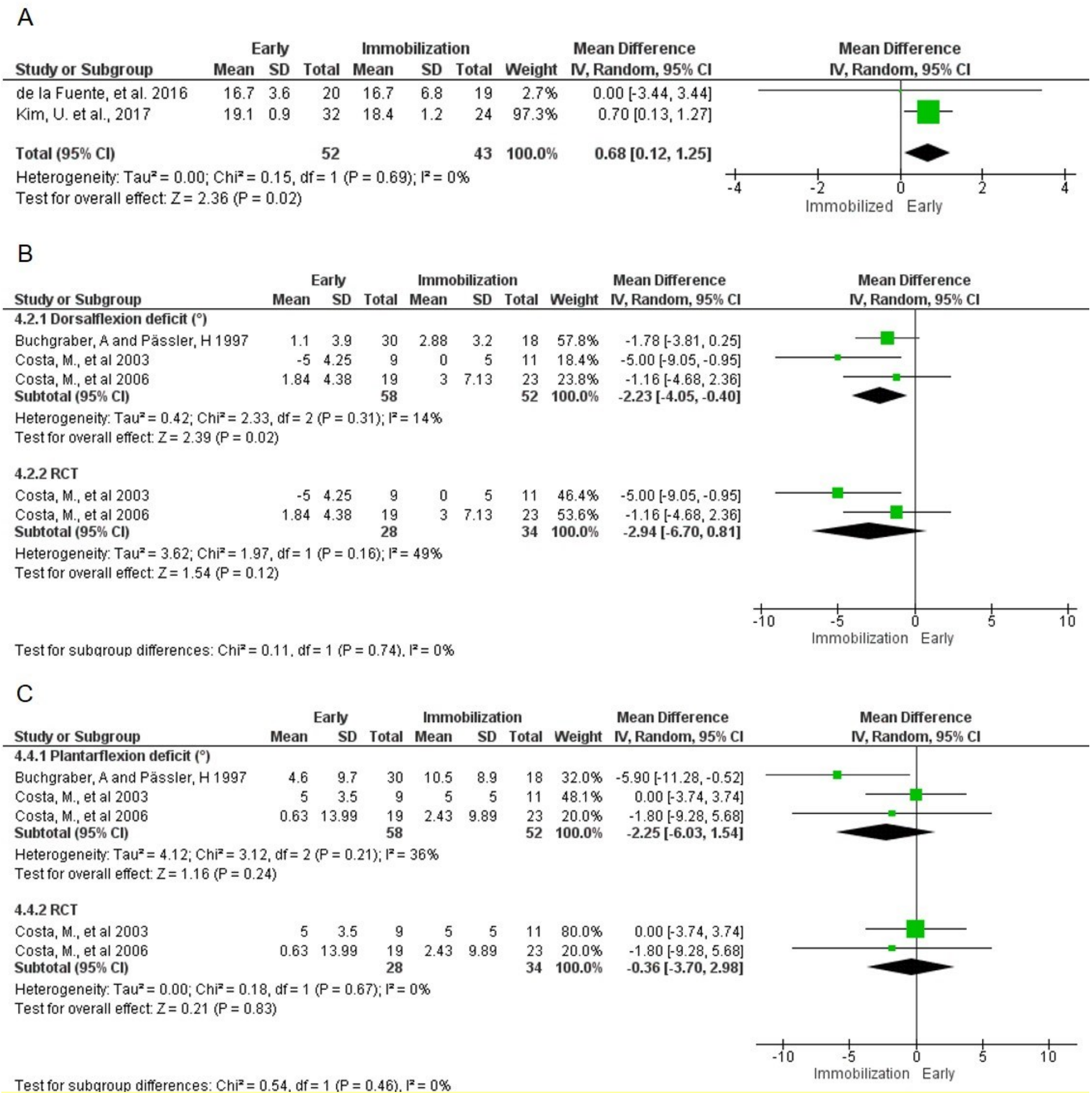


Figure 1-4. Forest plot for the comparison between early rehabilitation and immobilization on the (A) dorsiflexion range of motion (in degrees) and on (B) dorsiflexion and (C) plantarflexion range of motion deficit (in degrees of the healthy side and percent relative).

Functional and Muscular Outcomes

Although we were unable to do a meta-analysis for the functional and muscular outcomes due to insufficient data, the observed results showed important qualitative clinical data. For the heel raise endurance, there was no between-groups difference in one study (BUCHGRABER & PASSLER, 1997) and a positive effect of the accelerated protocol in another one (DE LA FUENTE *et al.*, 2016b). In contrast, for the heel raise height, there was no between-groups difference (BOSTICK *et al.*, 2010; PORTER & SHADBOLT, 2015; VALKERING *et al.*, 2017; ELIASSON *et al.*, 2018). For the AT cross-sectional area, there was no between-groups difference in most studies (MAFFULLI *et al.*, 2003a; GEREMIA *et al.*, 2015; ELIASSON *et al.*, 2018), except for the study by JIELILE *et al.* (2016) that showed a larger cross-sectional area in the accelerated group. Only ELIASSON *et al.* (2018) evaluated the triceps surae cross-sectional area, showing no between-group differences. For tendon stiffness, two studies (MCNAIR *et al.*, 2013; GEREMIA *et al.*, 2015) showed no between-group difference. Finally, for the AOFAS results, there was a positive effect in favor of the early rehabilitation program (KIM *et al.*, 2017).

DISCUSSION

Our main results refer to a high risk of bias in the published studies that compared early rehabilitation with traditional immobilization of the ankle joint. Also, we found a positive result about ankle ROM in favor of early rehabilitation, but with no between-group differences for plantar flexor strength. Traditional rehabilitation programs presented higher eccentric deficits than early rehabilitation. There was an intrinsic relationship between the plantar flexor muscle-tendon unit structure, its function, and the ankle joint functional capacity.

The reduced use process from a period of joint immobilization after a surgical tendon reconstruction may reduce ankle ROM (FREEMAN, 1965). Reducing the ankle joint functionality may lead to a substantial muscle reduced use and atrophy, thereby modifying the immobilized muscles' architecture (CHRISTENSEN *et al.*, 2008; COHEN, 2009; LONGO *et al.*, 2009). One of the structural changes in this process is the reduction in muscle fiber length due to a reduction in the number of serial sarcomeres (NARICI & CERRETELLI, 1998). Another factor that can change the number of sarcomeres in series is the length of the muscle immobilization. A classical study by TABARY *et al.* (1972) found a 40% reduction in the serial number of sarcomeres of the cat soleus muscle immobilized in a shorter position for four weeks. In contrast, they observed a 19% increase in the number of serial sarcomeres for the muscles immobilized in a lengthened position.

Patients after AT surgical repair stay immobilized in the first two weeks at a shorter triceps surae muscle length. In this case, there may be a substantial decrease in serial sarcomeres from this immobilization period (PENG *et al.*, 2017). Therefore, rehabilitation programs should be carefully designed to progressively increase the mechanical load at the muscle-tendon unit to regain the lost muscle structure and function, as well as joint functionality.

Imaging techniques such as ultrasound have been extensively used to measure fascicle length in human studies (GEREMIA *et al.*, 2019). However, a simple measure such as ROM may provide indications of possible muscle shortening due to immobilization, since fiber length reduction limits the ROM of the joint at which the musculature, affected by immobilization, works (TIMMINS *et al.*, 2016). In other words, joint ROM may be an indirect way to measure muscle architecture changes. However, a clear relationship between the ROM changes and the muscle's structural changes has not yet been established for the entire ROM pre- and post-joint immobilization. The ankle joint immobilization in a shortened position, used in previous studies (COSTA *et al.*, 2003; COSTA *et al.*, 2006; BOSTICK *et al.*, 2010), may have caused a reduction in the plantar flexors' serial sarcomere number and, consequently, led to a ROM reduction at the ankle joint, but future studies should address this hypothesis.

Although the studies' early rehabilitation protocols are heterogeneous, they all focus on mobilization exercises. In a recent review, ZELLERS *et al.* (2019a) showed that, although early rehabilitation is often used, it still lacks a consistent definition and standardization. Moreover, they showed that the ankle joint ROM improvement was the most included intervention goal, followed by muscle strengthening, which may reverse the immobilization's process deleterious effects. More specifically, ZELLERS *et al.* (2019a) showed that 38 out of 174 studies used strength as the outcome variable, with only 29 isometric exercises used for the early functional rehabilitation program. However, 114 out of 174 studies used techniques to improve ankle ROM, suggesting that this focus of rehabilitation programs on ROM exercises, and not on strength gain, may explain our findings. More specifically, our meta-analysis showed no significant difference between the accelerated and traditional groups postoperatively for the plantar flexor muscle strength. Ideally, accelerated rehabilitation protocols should aim to reestablish muscle strength, which depends on the interaction of neural and morphological factors. As muscle strength is related to functionality, it will most likely determine changes in joint ROM.

Some limitations regarding the periodization of the accelerated rehabilitation protocols were observed. Although KANGAS *et al.* (2003), which had only 1/5 high risk of bias, performed a 9-week rehabilitation protocol on an accelerated and a traditional group, showing muscle strength gains, it is evident the nonexistence of a rehabilitation protocol periodization. Patients performed three series of 20-25 exercise repetitions in three weekly sessions of physiotherapy at home, without a professional's assistance. In the other two studies (MAFFULLI *et al.*, 2003a; MAFFULLI *et al.*, 2003b), both with 4/5 high risk of bias, data regarding the exercises' weekly frequency, volume and intensity were not reported, only the average number of physiotherapy sessions performed by each group. Although other studies (KANGAS *et al.*, 2003; KANGAS *et al.*, 2007; MAJEWSKI *et al.*, 2008; GEREMIA *et al.*, 2015; LANTTO *et al.*, 2015a; DE LA FUENTE *et al.*, 2016a; DE LA FUENTE *et al.*, 2016b) have a clear description of the physical therapy protocols, only DE LA FUENTE *et al.* (2016a); DE LA FUENTE *et al.* (2016b) and GEREMIA *et al.* (2015) presented clear information about load progression in their physiotherapy protocols. DE LA FUENTE *et al.* (2016b) was the only of these with a low risk of bias.

We need to remember that the neuromuscular system adaptations, characterized by changes in the activation capacity and muscle morphology, are responsible for muscle strength (MORITANI & DEVRIES, 1979). Muscle strength gains during the first four weeks of training occur mainly because of neural adaptations in healthy individuals (FOLLAND & WILLIAMS, 2007a). After this period, muscle force increases are mainly attributed to morphological adaptations (FOLLAND & WILLIAMS, 2007a; GEREMIA *et al.*, 2018b). The fact that the analyzed studies did not find improvement in the plantar flexor strength between the early and traditional rehabilitation protocols may be associated with the accelerated protocol used. The accelerated protocols presented in the studies' meta-analysis do not appear to have enough intensity (i.e., adequate mechanical overload) to generate neuromuscular adaptations like the ones observed in healthy individuals' strength training (GEREMIA *et al.*, 2015; GEREMIA *et al.*, 2019).

Although there was no effect of the early rehabilitation programs on plantar flexor strength, there was a high risk of bias in the include studies, which limits these studies' clinical findings and effects. It indicates the need for the elaboration and execution of better methodological quality studies aimed at providing a larger and more qualified body of evidence in support or against the accelerated rehabilitation protocol. The overall results variability of the evaluated studies may have directly influenced the results' outcomes. This large variability evidences the need for a more significant number of randomized clinical trials on the subject, with a more robust methodological profile that respects the criteria for reducing the risk of bias, besides elucidating which parameters are ideal for accelerating the rehabilitation of AT rupture patients.

Despite the above-mentioned limitations, we corroborate previous systematic reviews' recommendations for the use of early rehabilitation programs after AT surgical repair (HUANG *et al.*, 2014; MCCORMACK & BOVARD, 2015; ZHAO *et al.*, 2017), once early rehabilitation produces similar or superior effects than traditional immobilization protocols. Here we showed that early protocols produced less torque deficit and less ankle ROM deficit. Moreover, early rehabilitation improved patient satisfaction and earlier return to activities without increasing the complication rates (MCCORMACK & BOVARD, 2015; ZHAO *et al.*, 2017). When early weight-bearing was combined with early ankle motion exercises, there was a superior and more rapid functional recovery than traditional immobilization after the surgical repair of acute AT ruptures (HUANG *et al.*, 2014).

However, future studies should improve their methodological designs (both reducing the risk of bias and improving the rehabilitation protocol design) and should apply rehabilitation protocols focusing on plantar flexor strength, not ankle ROM gain, with a progressive increase in mechanical load after AT surgical repair.

CONCLUSION

Early rehabilitation interventions are as effective as traditional physiotherapy interventions in reestablishing the plantar flexor strength. Still, they are more effective at improving ankle joint ROM compared to the traditional immobilization programs. Traditional immobilization program presents higher eccentric torque deficit than early rehabilitation.

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COMPETING INTERESTS

The authors declare that they have no conflicts of interest that are directly relevant to the content of this review.

CHAPTER 2

2. FUNCTIONAL AND MORPHOLOGICAL DEFICITS 2 YEARS AFTER ACHILLES TENDON RUPTURE: TRADITIONAL vs EARLY REHABILITATION

ABSTRACT

Background: Early rehabilitation effectiveness on calf muscle structure and ankle functionality remains unclear in Achilles tendon rupture. Our purpose was to compare the effects of a traditional immobilization rehabilitation protocol with an early rehabilitation protocol on ankle range of motion, gastrocnemius medialis muscle architecture and plantar flexor torque at short (3 months), middle (6 months) and long term (30 months) post-surgery.

Methods: Twenty patients with Achilles tendon rupture and 10 healthy men (control group) participated in this study. After surgery, patients were allocated into two 3-month rehabilitation groups: (1) traditional immobilization group (n=10); or (2) early rehabilitation group (n=10). Comparisons of muscle architecture and parameters of function (i.e. isometric torque and range of motion) were made between groups, between legs and between moments.

Findings: After rehabilitation at short term, the early rehabilitation group had higher active and passive plantarflexion range of motion than in control. In all the other variables we did not find differences between the patients' uninjured leg and the control dominant leg. Early rehabilitation group presented a higher range of motion, muscle thickness and fascicle length than the traditional one. The ruptured side had higher dorsiflexion, but lower plantar flexion, total range of motion, fascicle length, muscle thickness, and torque compared to the healthy side. The ankle range of motion increased at 6 months and decreased at 30 months post-surgery. Fascicle length decreased at 30 months for both groups. Muscle thickness increased after rehabilitation at 6 months and decreased at 30 months. Torque increased at -10° and neutral ankle positions in both groups at 30 months.

Interpretation: Early rehabilitation presented better results for range of motion, fascicle length, and muscle thickness than immobilization. However, rupture

caused lower plantar flexor torque when compared with the uninjured side in both groups.

Keywords: Achilles tendon rupture, early rehabilitation, immobilization, torque, muscle architecture, range of motion.

HIGHLIGHTS

- Achilles tendon ruptures promote structural and functional losses.
- Early rehabilitation is an effective strategy for accelerating functional recovery.
- Early rehabilitation leads a higher range of motion, fascicle length and thickness.
- Rupture leads to deficits independently of the rehabilitation program.

INTRODUCTION

METHODS

Trial design

The retrospective clinical trial (NCT02308618) was conducted according to the Declaration of Helsinki (Protocols 07/04008 and 13202) and evaluated the effects of two ATR postoperative rehabilitation protocols. Participants were admitted to the University Hospital and an orthopedic surgeon, based on clinical examination (positive Thompson test), established the diagnosis of total acute ATR and performed the reconstructive surgery.

Surgical repair occurred within 15 days post-injury, after which patients, matched in age and anthropometric measurements, were allocated into two groups: (1) traditional immobilization group (TRG); or (2) early rehabilitation group (ERG). Evaluations were performed at 3 months, 6 months, and more than 2 years (~30 months) post-surgery. The rehabilitation protocol lasted 3 months for both ATR groups. The control group (CG) was composed by healthy participants, with no history of lower limb injury, matched in age and anthropometric measurements (height and body mass) to the ATR patients. CG was evaluated only at the 3 months evaluation time to check for possible changes at the uninjured (assumed healthy) side. If no differences were observed between the uninjured side and the CG, the uninjured side could be used as a control limb for the injured side and to assess possible changes at the injured side of the ATR groups.

Participants

The sample size calculation was performed in the software G * Power 3.1.9.2 (Kiel University, Germany). Plantar flexion torque values (mean 97.7 Nm vs 95.8 Nm, immobilization, and early group respectively) from a previous study were used as reference values in the calculations (LANTTO *et al.*, 2015a). Considering that the effect size *f* of 0.95, with a 0.05 significance level and power of 0.95, a total of 12 patients was needed for this study. Considering possible sample losses, we evaluated 20 ATR patients divided into two post-operative rehabilitation protocols and 10 healthy participants in the CG. Therefore, thirty participants (CG: n = 10; TRG: n = 10; and ERG: n = 10) were evaluated (Table 2.1).

Table 2.1. Baseline characteristics of the participants.

	CG	TRG	ERG	F	p-value
Age (years old)	44.7 ± 9.7	44.2 ± 9.3	44.1 ± 8.7	0.38	0.68
Height (m)	1.76 ± 0.04	1.72 ± 0.04	1.74 ± 0.06	0.04	0.95
Body mass (kg)	81.6 ± 12.8	82.3 ± 9.0	84.79 ± 7.4	3.12	0.06
Leg length (mm)	408 ± 12.7	407 ± 13.3	407 ± 13.4	-	-

Interventions

Patients were allocated into groups based on participants' limitations. Individuals who were able to attend the physiotherapy program at the university were allocated to the ERG, whereas individuals who were unable, mostly because they lived in other cities, were allocated to the TRG. Both protocols were described in GEREMIA *et al.* (2015).

Traditional immobilization group - TRG

Patients were immobilized with a plaster cast with the ankle in gravitational equine and weight-bearing was not allowed. Two weeks postoperatively, when the swelling was reduced, the cast was removed, and the patient was immobilized in the same position with a new plaster cast. Four weeks postoperatively, the ankle was plastered in neutral position (i.e., with the sole perpendicular to the shank), and weight-bearing was encouraged. Six weeks postoperatively, the plaster cast was removed, and the patients received instructions on how to perform a home-based exercise program for 6 weeks, consisting of active exercises and stretches to improve ankle ROM, and resistance and balance exercises (Supplementary Figure 2.1).

Early rehabilitation group - ERG

Patients in this group were immobilized only by fifteen days. After this period, the plaster cast was removed, and all participants used a removable brace (*Robofoot, Nova Geração, Salvapé, SP, Brazil*) and started an early rehabilitation program for 2 months. They performed physiotherapy sessions three times per week during the six weeks, which included one to two hours of exercises for regaining ankle ROM and muscular endurance (Supplementary Table 2.1). As soon as the early rehabilitation had finished, patients started the same home-based exercise program of the TRG for 1 month.

Outcomes

ROM evaluation

Ankle ROM was measured using a goniometer (SILBERNAGEL *et al.*, 2010), with the participant seated. The ankle neutral position was determined as that when the angle between the foot line and the shank was equal to 90°. From the neutral position, dorsiflexion was measured in negative values and plantar flexion measurements in positive degrees. ROM was measured passively (performed by a physical therapist) and actively. These procedures were executed three times. A one-minute interval was observed between each test. The highest angle values obtained were used for statistical analysis. The total ankle ROM (passive and active) was considered the sum of the maximal plantar-dorsiflexion ROM.

GM muscle architecture evaluation

Muscular architecture was evaluated with a B-mode ultrasonography (US) system (SSD-4000; Aloka Inc., Tokyo, Japan), and a linear array probe operating at 32 Hz (UST-5821, 38 mm, 7.5 MHz, no image filter) was used to determine fascicle length (FL), pennation angle (PA), and muscle thickness (MT) of the GM (Fig 1). The US probe was positioned longitudinally to the GM muscle fibers and perpendicular to the skin, at 30% proximal of the distance between the popliteal fold and the lateral malleolus center (Figure 2.2 A) (KAWAKAMI *et al.*, 1998; GEREMIA *et al.*, 2019). Images were analyzed by Image J software (version 1.48v, National Institutes of Health, Bethesda, MA, United States), in the same methodology as GEREMIA *et al.* (2019) (Figure 2.2 B and C).

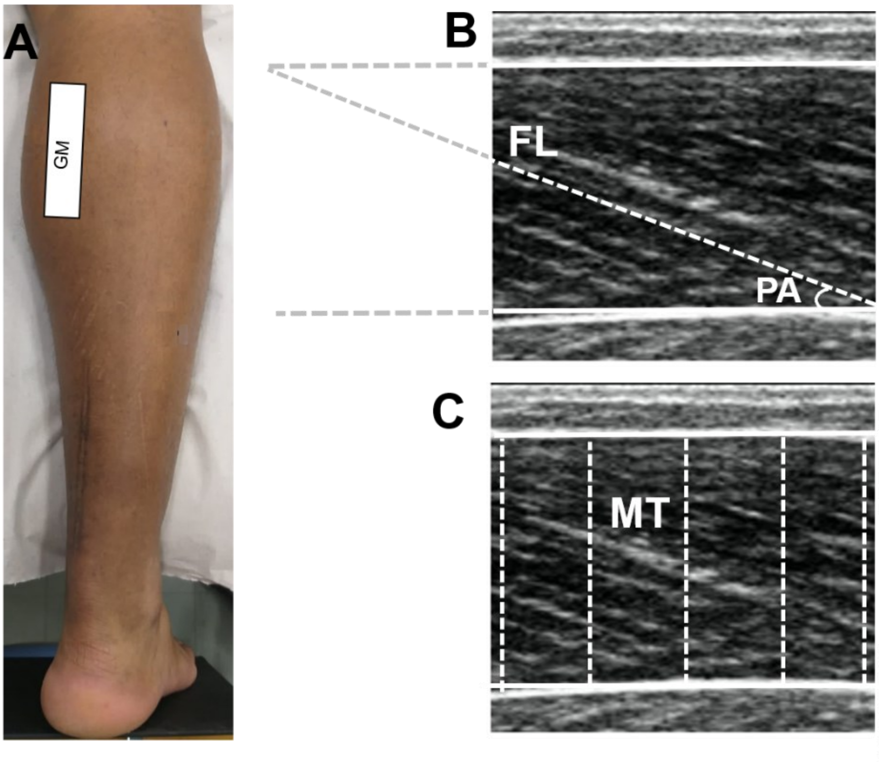

Figure 2-1. Muscle architecture evaluation. (A) Representation of the ultrasound site at the gastrocnemius medialis (GM) muscle. (B) and (C) Ultrasonography images showing GM muscle architecture. Superficial and deep aponeuroses are visualized (continuous horizontal lines). (B) Fascicle length (FL) and pennation angle (PA) analysis. (C) Muscle thickness (MT) is measured as the distance between superficial and deep aponeuroses.

Plantarflexion torque

Participants were seated at the isokinetic dynamometer (Biodex Medical System, Shirley–NY, USA) with the hip flexed at 85°, and the knee fully extended (GEREMIA *et al.*, 2018b). After familiarization, participants performed three plantar flexor maximal voluntary isometric contractions, for 5 seconds each, at -10° of ankle angle (0°= neutral). They were instructed to produce maximum force as quickly as possible and to sustain the contraction for at least 1 second before relaxing. Between each contraction, an interval of 120 seconds was observed. When torque variation was higher than 10% between the three tests, an additional maximal isometric plantar flexor contraction was performed (GEREMIA *et al.*, 2018b).

Statistical analysis

RESULTS

Comparisons between uninjured leg and control group

Active and passive plantarflexion was higher in ERG uninjured leg than in CG. No other differences were observed for all the other variables between the patients' uninjured leg and the CG dominant leg (Table 2.2), suggesting that the uninjured leg could be used as a control limb for the ERG and TRG.

Groups, legs, and moments effects

ROM

All ROM results are presented in Table 2.3.

Table 2.2. Comparison at 3 months after surgery between the uninjured leg of both the intervention groups and the control group.

Variables	**CG (mean ± SD)**	**TRG (mean ± SD)**	**ERG (mean ± SD)**	**F**	**p value**
MT (mm)	13.6 ± 1.4	12.7 ± 1.5	14.0 ± 1.0	2.61	0.09
FL (mm)	49.1 ± 4.8	43.6 ± 7.2	49 ± 9.1	-	-
FL (% of leg)	11.0 ± 0.8	12.2 ± 2.1	12.3 ± 0.8	2.87	0.07
PA (degrees)	18.2 ± 0.7	16.3 ± 3.5	17.8 ± 2.0	1.71	0.19
T 10° (Nm)	127.3 ± 20.9	116.9 ± 36.4	124.6 ± 32.0	0.31	0.73
T 0° (Nm)	160.3 ± 22.0	144.3 ± 37.5	152.7 ± 41.0	0.53	0.59
T -10° (Nm)	190.3 ± 23.3	163.3 ± 48.4	173.6 ± 54.1	0.95	0.39
Active DF (°)	15.0 ± 3.4	12.5 ± 6.0	13.6 ± 4.4	0.70	0.50
Active PF (°)	**48.7 ± 6.0***	52.3 ± 8.1	**57.4 ± 8.1***	3.41	**0.04**
Passive DP (°)	17.4 ± 3.0	17.2 ± 5.6	19.4 ± 4.6	0.72	0.49
Passive PF (°)	**51.3 ± 5.7***	58.0 ± 8.2	**65.0 ± 8.0***	8.63	**0.001**

Data presented in mean ± standard deviation (mean ± SD). CG = Control group; TRG = Traditional immobilization group; ERG = Early rehabilitation group. *p<0.05; MT = muscle thickness; FL = fascicle length; PA = pennation angle; DF = dorsiflexion; PF = plantarflexion.

Active ROM

Both groups were similar in active dorsiflexion ROM ($F_{(1)}$=0.148; *p*=0.709; *d*=0.18), with higher ROM in the injured than the uninjured leg ($F_{(1)}$=11.938; *p*=0.005; *d*=1.37), without effect of the time ($F_{(2)}$=2.28; *p*=0.13, Figure 2.3A).

The ERG showed higher active plantarflexion ROM at 3 months in the injured leg ($t_{(18)}$=-2.86; *p*=0.01; *d=1.2*) and higher in both legs at 6 [uninjured ($t_{(18)}$=-3.85; *p*=0.001; *d=2.9*); injured ($t_{(18)}$= -2.08; *p*=0.05; *d=0.93*)] and 30 months [uninjured ($t_{(18)}$=-3.49; *p*=0.003; *d=1.56*); injured ($t_{(18)}$= -3.65; *p*=0.002; *d=1.63*)] compared to TRG. When the legs were compared, the injured leg had lower active plantarflexion ($t_{(18)}$=2.27; *p*=0.03; *d*=1.01) than the uninjured in the TRG at 3 months (Figure 2.3B). There was no difference between moments in the TRG [uninjured leg ($F_{(2)}$= 2.45; p=0.1); injured leg ($F_{(2)}$= 2.57; p=0.09)] and ERG [uninjured leg ($F_{(2)}$= 3.07; p=0.06); injured leg ($F_{(2)}$= 0.95; p=0.39)].

ERG had higher total active ROM in the injured leg at 3 months ($t_{(18)}$=-2.19; *p*=0.04; *d*=0.98) and uninjured leg at 6 months ($t_{(18)}$=-3.09; *p*=0.06; *d*=1.38), and in both legs [uninjured ($t_{(18)}$=-3.56; *p*=0.002; *d*=1.59) and injured ($t_{(18)}$=-3.24; *p*=0.005; *d*=1.45) at 30 months compared to TRG (Figure 2.3). Both groups presented leg effect with lower total active ROM in the injured leg (F=12.73; *p*=0.006; *d*=1.68) compared to the uninjured leg, but in the post hoc analysis there was no difference between legs for any group and moment. Total active ROM presented time effect with increasing 6 months and decreased at 30 months (F=6.347; *p*=0.008; *d*=1.18) in both legs and groups, however, in the post hoc analysis there was no difference between moments for any group and leg.

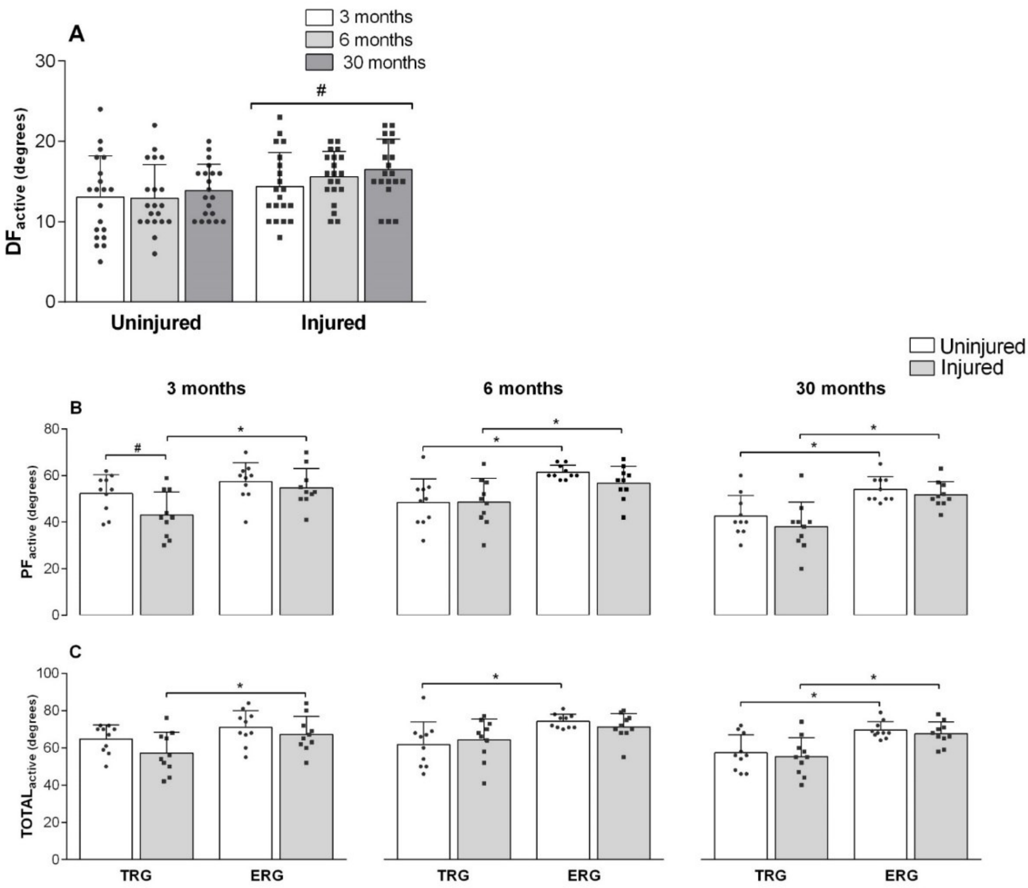

Figure 2-2. Ankle active range of motion. (A) Active dorsiflexion, (B) Active plantarflexion and (C) Active total ankle range of motion. * means difference between groups; # means difference between legs.

Passive ROM

Passive dorsiflexion ROM (Figure 2.4 A) was similar between groups ($F_{(1)}$=0.061; *p*=0.81), legs ($F_{(1)}$=4.338; p=0.067) and among moments ($F_{(2)}$=0.125; p=0.88).

ERG presented higher passive plantarflexion ROM ($F_{(1)}$=21.356; p=0.001) in all moments and both legs (except for the uninjured side at 3 months) when compared to the TRG (Figure 2.4 B). Specifically, ERG has higher passive plantarflexion ROM in the injured leg at 3 months (Z= -2.35; p=0.01; d= 1.14), in both legs at 6 months [uninjured ($t_{(18)}$=-3.55; p= 0.002; d=1.58) and injured ($t_{(18)}$=-

2.25; p= 0.036; d=1.01)] and at 30 months [uninjured ($t_{(18)}$=-3.03; p= 0.007; d=1.35) and injured ($t_{(18)}$=-2.88; p= 0.01; d=1.29)] than the TRG.

The injured leg showed lower passive plantarflexion ROM than the uninjured side ($F_{(1)}$=13.803; p=0.005) in both groups and all moments, however, in the post hoc analysis there was no difference between legs for any group and moment.

Both legs in ERG presented decreased passive plantarflexion ROM at 30 months [uninjured leg ($F_{(2)}$=11.69; p=0.0002) and injured leg ($F_{(2)}$=5.32; p=0.01)] compared with 3 [uninjured leg (p=0.003; d=1.47) and injured leg (p=0.05; d=1.16) and 6 months [uninjured leg (p=0.0002; d=2.67) and injured leg (p=0.01; d=1.49) . In the TRG, only the uninjured leg decreased the passive plantarflexion ROM at 30 months ($F_{(2)}$=8.11; p=0.002) compared with 3 months (*p*=0.006; d=1.42) and 6 months (p=0.004; d=1.62), without changes at the injured leg ($F_{(2)}$=2.47; p=0.1).

ERG showed higher total passive ROM than TRG ($F_{(1)}$=11.794; p=0.007) in all moments and legs [3 months uninjured (p=0.007; d=1.35) and injured (p=0.003; d=0.94); 6 months uninjured (p=0.02; d=1.07) and injured (p=0.05; d=0.91); and 30 months uninjured (p=0.04; d=1.3) and injured (p=0.02; d=1.1).

We found effect of the leg for total passive ROM, where the injured leg presented lower total passive ROM ($F_{(1)}$=9.609; p=0.013; d=1.46) than the uninjured. However, in the post-hoc analysis we did not find differences legs (Figure 2.4 C).

The TRG, at 30 months, presented lower total passive ROM than the other two moments (3 months, p=0.027; d=1.32 and 6 months, p=0.009; d=1.31) in the uninjured leg, without changes in the injured leg (p=0.129). In ERG, both legs decreased at 30 months ($F_{(2)}$=13.12; p=0.0001) compared with 6 months (uninjured, p<0.001; d=2.37 and injured, p=0.045; d=1.32), and only the uninjured leg decreased total passive ROM at 30 months compared to 3 months (p=0.001; d=1.92).

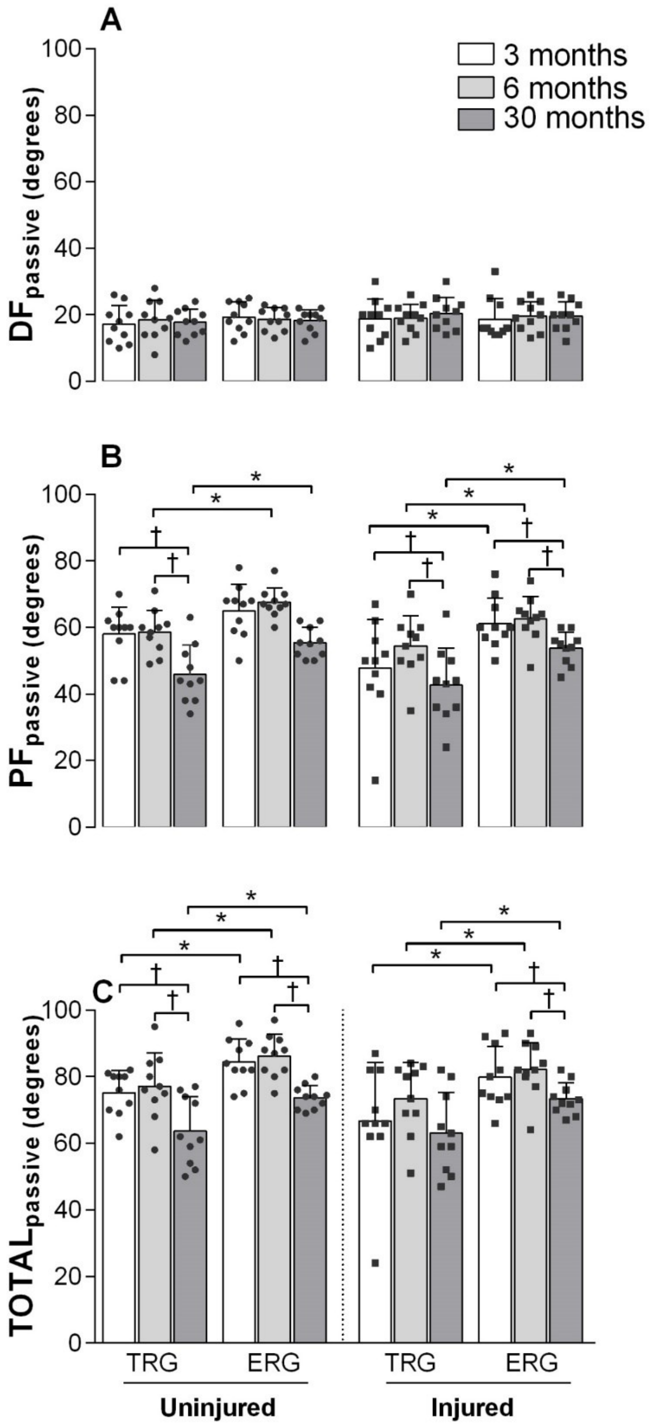

Figure 2-3. Ankle passive range of motion. (A) Passive dorsiflexion, (B) Passive plantarflexion and (C) Passive total ankle range of motion. * means difference between groups; # means difference between legs; and † means difference between moments.

Muscle architecture

Muscle thickness

ERG presented higher MT in both legs (uninjured leg, $t_{(18)}$=-2.269; p=0.036; d=1.01; and injured leg, $t_{(18)}$=-3.088; p=0.006; d=1.38) at 3 months after surgery than TRG (Figure 2.5 A), but without difference between groups at 6 months (uninjured leg, $t_{(18)}$=0.165; p=0.871; d=0.07 and injured leg, $t_{(18)}$=0.038; p=0.97; d=0.01) and at 30 months (uninjured leg, $t_{(18)}$=-0.604; p=0.55; d=0.27 and injured leg, $t_{(18)}$=-0.831; p=0.417; d =0.37).

Moreover, MT was lower in the injured leg at 3 months in the TRG ($t_{(18)}$=2.427; p=0.026; d=1.08) and in both groups after 30 months ($t_{(18)}$=3.457; p=0.003; d=1.54 and $t_{(18)}$=3.075; p=0.007; d=1.37, respectively TRG and ERG) compared to the uninjured leg (Figure 2.5 A), without difference between legs at 6 months ($t_{(18)}$=0.743; p=0.467; d=0.33 and $t_{(18)}$=0.577; p=0.57; d=0.25, TRG and ERG, respectively).

Nevertheless, there was an increase in MT at 6 months compared with 3 months (p=0.001; d=1.74) and a decrease from 6 to 30 months (p=0.003; d=1.64) in the TRG on the injured leg (Figure 2.5 A), without changes in the ERG ($F_{(2)}$= 3.14; p=0.05). On the healthy leg, there was no change among the moments (F=2.66; p=0.08 and F=0.808; p=0.456, TRG and ERG, respectively).

Pennation angle

PA was similar between groups (F=0.048; p=0.831), between legs (F=0.709; p=0.422) and among moments (F=2.217; p=0.138) (Figure 2.5 B).

Fascicle length

ERG presented higher FL in the injured leg (Figure 2.5 C) compared to the TRG (F=5.527; p=0.043) at 6 months (p=0.01; d=1.24), without group differences at 3 months (p=0.26) and at 30 months (p=0.6). TRG had shorter FL (F=8.145; p=0.019) in the injured leg at 6 months (Z=-2.117; p=0.034; d=1.80) compared to the uninjured leg. Both groups showed shorter FL in the injured leg at 30 months than the uninjured leg ($t_{(18)}$=2.185; p=0.042; d=0.97; and $t_{(18)}$=2.642; p=0.017; d=1.18; TRG and ERG, respectively), without difference between legs at 3 months ($t_{(18)}$=1.537; p=0.142; d=0.68; and $t_{(18)}$=0.289; p=0.77; d=0.12; TRG and

ERG, respectively), while at 6 months only the TRG had lower FL in the injured leg (p=0.03 and p=0.93; TRG and ERG, respectively).

On both legs of the TRG, FL decreased at 30 months compared with 3 months [uninjured (p=0,033; d=1.19) and injured (p=0.043; d=1.03)] and without difference compared to 6 months (p=0.6). In ERG, both legs presented shorter FL at 30 months compared with 3 months [uninjured leg (p=0.004; d=1.83) and the injured leg (p=0.009; d=1.57) and 6 months [uninjured leg (p=0.021; d=1.14) and injured leg (p=0.009; d=1.72).

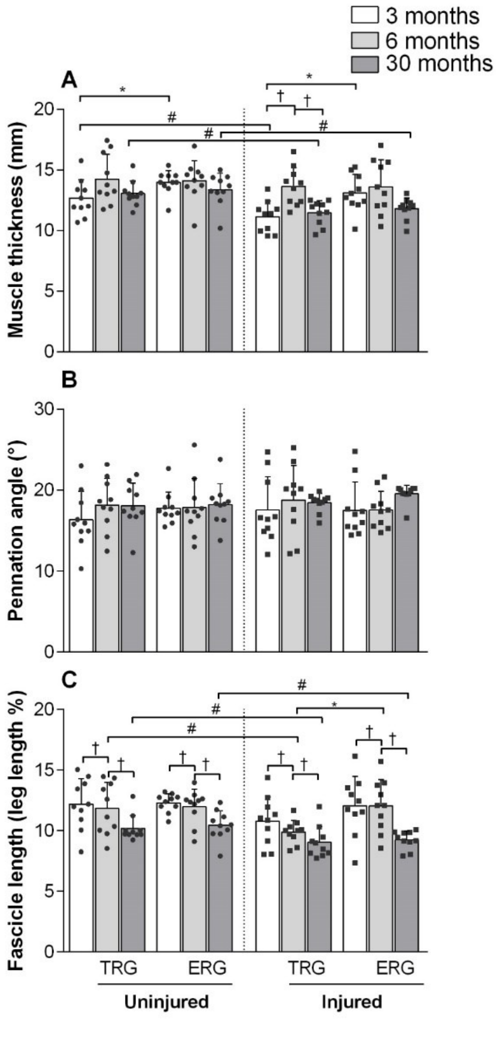

Figure 2-4. Muscle architecture comparisons (groups, legs and moments). TRG: traditional group; ERG: early rehabilitation group. (A) Muscle thickness; (B) Pennation angle; (C) Fascicle length. # indicates the between-legs difference; † indicates the between-moments difference, and * indicates the between-groups difference.

Plantarflexor Torque

Both groups showed similar plantarflexor torque production (F=0.755; p=0.407) in both legs and all moments (Figure 2.6). The injured leg showed lower torque production (F=134.555; p<0.001; d=5.46) than the uninjured leg (Figure 2.6).

The injured leg presented lower plantarflexor torque at 3 months ($t_{(38)}$=4.368; p<0.001; d=1.38) and at 30 months (Z=-5.414; p<0.001; d=1.46) than the uninjured leg, without differences between legs at 6 months ($t_{(38)}$=1.705; p=0.096). There was an increase in plantarflexor torque (p=0.002) of the injured leg at 30 months compared with 3 months.

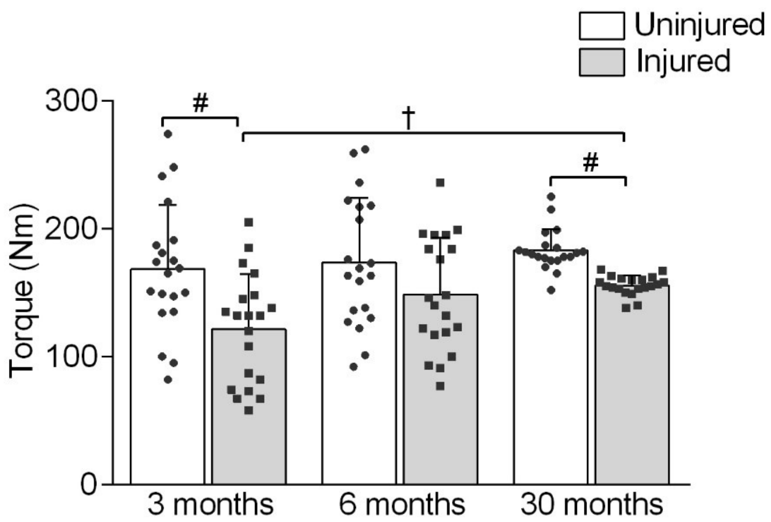

Figure 2-5. Plantar flexion torque in N.m with groups merged. Squares represent ruptured legs and balls represent healthy legs. # indicates the between-legs difference; † indicates the between-moments difference.

DISCUSSION

Our primary findings were that: (1) ERG had higher ankle ROM at all moments, larger FL at 6 months and higher MT at 3 months than TRG; (2) the injured leg had higher active DF ROM and lower PF ROM, lower total ankle ROM, lower FL, MT, and torque compared to the uninjured leg; and (3) ROM and MT were higher at 6 months compared to 3 months, while ankle ROM, GM FL and MT were lower at 30 months compared to 6 months, and active DF and plantarflexor torque in the injured leg were higher at 30 months compared to 3 months.

ERG had higher ankle ROM than TRG. Considering that the early rehabilitation protocol focused on joint mobility, while the TRG had ankle immobilization for several weeks, this result was expected. Ankle ROM exercises are the most commonly included interventions in protocols of early rehabilitation after ATR (ZELLERS *et al.*, 2019a). Despite we had some exercises for muscle strength and endurance, our 12 weeks rehabilitation program consisted mainly of ankle mobility exercises (see supplementary fig 1). Higher ROM is helpful for ATR patients because it allows patients to return to work and sports activities earlier (MAJEWSKI *et al.*, 2008). Exercises for increasing ankle ROM also generate mechanical load at the muscle-tendon unit, which might explain the largest FL in the ERG compared to TRG. Similar results for this larger FL were found in the literature and have been associated with increased joint ROM (FREITAS & MIL-HOMENS, 2015; TIMMINS *et al.*, 2016).

As the FL has been shown to be shorter after the tendon rupture (BAXTER *et al.*, 2018), the increase in the FL caused by our physical therapy program is an important adaptation. FL increases have been explained as being a result from sarcomerogenesis (LIEBER & FRIDEN, 2000). There is evidence that eccentric exercise leads to an increase in plantarflexors FL (GEREMIA *et al.*, 2019), which is a second source of tensile mechanical load to the muscle-tendon unit in addition to the stretching exercises. Our rehabilitation program had exercises with eccentric stimuli such as stair descent training and bipedal heel rise, which may have promoted the necessary stimuli for the increase in FL. In addition, early rehabilitation programs have focused on ankle mobility gains, to assist in tendon gliding and to prevent deep adhesion (ZELLERS *et al.*, 2019a) that are also related to higher FL (TIMMINS *et al.*, 2016).

The FL increase leads to a higher MT (hypertrophy), that we also found in the ERG. Strength exercises associated with hypertrophy are characterized by an increase in sarcomeres arranged in parallel (LIEBER & FRIDEN, 2000), which is related to increases in the PA (LIEBER & FRIDEN, 2000; SCHOENFELD, 2010). However, different from what we expected, we did not find changes in PA. A recent study showed greater PA on the patients’ injured side (NICHOLSON *et* *al.*, 2019). However, in their study the patients were submitted to physiotherapy for 6 months, while ours underwent 3 months of rehabilitation. GEREMIA *et al.* (2019), in their 12-weeks of high loading eccentric training, did not find changes in PA. However, these previous studies showed that PA can be influenced by a limitation in the two-dimensional ultrasonography due to measurement errors that are too close to the pennation adaptive response (GEREMIA *et al.*, 2019; NICHOLSON *et al.*, 2019).

The MT increase usually determines an increase in muscle strength (FOLLAND & WILLIAMS, 2007a). However, we did not find a between-groups difference in torque. Our early rehabilitation focused on ROM gain rather than on strengthening exercises, and probably did not promote sufficient overload to produce strength gains. Strength exercises were included in the last two weeks of the protocol, and a higher MT was observed in the ERG. Although we expected that muscle morphological adaptations would lead to strength gains due to the rehabilitation protocol (i.e. ERG would present a higher torque production than TRG), no between-groups differences in torque were observed, showing that ERG and TRG had similar torque deficits.

Although one could expect that surgical repair and rehabilitation would lead to a healthy and similar condition between legs, asymmetries were observed, as the injured leg had lower ankle ROM than the uninjured leg. Increased joint stiffness, which is common after prolonged periods of immobilization or reduced use (MORTENSEN *et al.*, 1999), may partly explain this impairment in joint motion. Another explanation for the decreased ankle ROM at the injured leg is kinesiophobia (OLSSON *et al.*, 2014), as patients do not feel completely comfortable in moving their joints in a similar way as that of a healthy condition. Finally, the shorter fascicle length observed in the injured leg may also have contributed to the lower ROM (FREITAS & MIL-HOMENS, 2015).

However, it is interesting to mention that we did not find between-legs differences in DF ROM. One possible explanation is that the injured tendon may have increased its total length during the healing process (ZELLERS *et al.*, 2017; OKOROHA *et al.*, 2020), thereby increasing the ankle dorsiflexor ROM. A second possibility would be a smaller tendon stiffness at the injured side (Geremia et al., 2015), which would also allow for a greater deformation of the injured tendon with the same torque applied to the injured and uninjured sides, thereby increasing the Df ROM despite a possible joint stiffness increase.

Another between-limbs asymmetry observed was in muscle architecture. The injured leg showed a shorter FL and lower MT than the uninjured leg, without changes in PA. If in one hand strength training can increase the FL and consequently increase the MT (SCHOENFELD, 2010; GEREMIA *et al.*, 2019), the injury process and temporary disuse after surgery can decrease the FL and consequently decrease the MT, and the PA may remain unchanged, as observed in our study. Shorter fibers are common after ATR (NICHOLSON *et al.*, 2019), and our results agree with previous studies. When immobilized in a shorted position (as was the case of the TRG), muscle belly may change (i.e., decrease), thereby reducing FL. This immobilization at shorter muscle lengths lead the muscle fascicles to experience a continuous shorter length that that experienced during the activities of daily living (MAQUIRRIAIN, 2011), as used in immobilization protocols after the tendon surgical repair (MAFFULLI & ALMEKINDERS, 2007). Our results showed shorter fibers in the ruptured leg, with lower MT and, consequently, lower torque production, showing evidence that the above reasoning seems to be correct.

Plantarflexor torque was lower in the injured compared to the uninjured leg. Previous studies have shown that ATR leads to a reduction of ~6% in plantarflexor peak torque at the injured compared with the uninjured side (LANTTO *et al.*, 2015a). While the lower FL may have shifted the force-length relation leftwards towards shorter muscle lengths due to the smaller serial number of sarcomeres, the reduced MT may have produced a parallel sarcomere loss, which will decrease the maximal capacity of force production due to the smaller number of contractile units in parallel (i.e., smaller number of myofibrils inside each muscle fiber). Although we do not have direct measurements of myofibril content and sarcomere numbers, the reasoning seems correct according to animal studies that have shown these muscle adaptations in models of reduced use (TINKLENBERG *et al.*, 2018).

The fact that ankle ROM was higher at 6 months compared to 3 months post-surgery seems to show evidence that the main goal of our early rehabilitation program was achieved and has been reported in the literature (LU *et al.*, 2019;

ZELLERS *et al.*, 2019a). However, at 30 months both the total ankle ROM and plantarflexor ROM decreased (except for the DF ROM). This smaller ROM after such a long period of time after surgery may be due to the limitations that were not resolved in terms of muscle and tendon lengths, which were different from what is considered a healthy condition. In addition, our TRG and ERG protocols had exercises that were helpful to increase ankle mobility at 6 months, but their short durations probably did not produce the desired long-term structural and functional effects to lead the plantarflexors to a healthy condition. In addition, kinesiophobia on the injured side may have led the patients to reduce their regular ankle ROM during daily living activities, thereby making the uninjured leg (muscle and tendon) to adapt to a shorter ROM in order to maintain a symmetrical movement of the ankle joint. Nevertheless, evidence in support of this idea still needs to be provided.

The higher torque production of the injured leg at 30 months post-surgery compared to 3 months suggest that there should have been an increase in muscle thickness, which we did not observe in both groups. This higher plantar flexor torque production may be due to an increased tendon stiffness, which would improve the tendons ability to transmit muscle forces from 3 months to 30 months post-surgery. Another possibility is that neural changes occurred in the long run and the patients were able to increase plantarflexor activation from the short period to more than two years post-surgery. However, we did not evaluate muscle activation in this study, and this still needs to be determined.

Our study has some limitations. Although our rehabilitation programs followed what has been done in clinical practice for ATR rehabilitation, they were probably short (only six weeks) and our strength exercises only started in the sixth week after the surgery (fourth rehabilitation week). We chose this procedure because of the risk of re-rupture that the early application of load with an elastic band or bodyweight could generate for the sutured tendon. Longer rehabilitation programs and with a temporal progression of load may be more effective for treating this tendon injury. We also were unable to conduct a randomized clinical trial due to the difficulty of some of the patients to participate in our rehabilitation program in our laboratory, as they lived in cities distant from our university, which led us to choose their allocation according to their possibilities. We also did not blind subjects, assessors, physiotherapists, and analyzers to the patients' allocation to the groups. Finally, we used a control group only at 3 months to determine if the uninjured side was similar to the dominant side of healthy participants and used the uninjured side as a control side for the three evaluation moments. However, as we have shown, this was not the correct choice, as adaptations occurred in both injured and uninjured limbs during the follow-up. Therefore, a control group should be used in future studies.

CONCLUSION

Early rehabilitation is more effective than traditional immobilization in increasing the ankle ROM, muscle FL and MT. Regardless of the rehabilitation program, the injured leg showed lower ankle ROM, FL, MT, and torque production than the uninjured leg. Both legs increased ROM and MT at 6 months post-surgery, but in a long follow-up of 30 months, they decreased. However, the torque was higher after 30 months of the surgery.

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Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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CHAPTER 3

3. CAN ECCENTRIC TRAINING MINIMIZE THE LONG-TERM DEFICITS AFTER ACHILLES TENDON REPAIR?

A randomized clinical trial of two eccentric training modalities

ABSTRACT

Background: Achilles tendon rupture promotes deficits on the triceps surae neuromechanical and morphological properties. Eccentric exercise is an alternative to counteract these deficits. However, the effects of different types of eccentric training [conventional (CONV) and isokinetic (ISOK)] on triceps surae properties, after Achilles tendon rupture, remain unclear. **Hypothesis/Purpose:** To verify the effects of two types of eccentric training [CONV (gym machines) and ISOK] on triceps surae mass, activation, torque and ankle range of motion (ROM) in participants with history of Achilles tendon rupture. We hypothesized that ISOK eccentric training would lead to greater increments in all variables than CONV training.

Study Design: Randomized Controlled Clinical Trial (NCT03861572).

Methods: Twenty-eight people with history of Achilles tendon rupture were randomly assigned into two groups: CONV (n=14) and ISOK (n=14) eccentric training programs lasting 12 weeks. Triceps surae muscle mass and activation, isometric and isokinetic plantar flexors torque, and ankle ROM were evaluated every 4 weeks. Effects of training modality (CONV or ISOK), leg (injured or uninjured) and time course (pre, post-4, post-8 and post-12 weeks of training) were tested.

Results: CONV presented higher eccentric activation post-8 and post-12 weeks and higher concentric activation post-12 than ISOK. However, ISOK had larger muscle mass in the injured leg at pre- and post-4 and in the uninjured leg post-8 weeks than CONV. Torque and activation were higher in the uninjured leg than in the injured leg, and muscle mass was higher in the uninjured leg in CONV pre, post-4 and post-12 weeks. Finally, eccentric training was able to increase activation, muscle thickness, ankle ROM, and plantarflexor torque after 8 training weeks. CONV training was able to decrease muscle thickness asymmetries post-

8 weeks and ISOK training decreased isometric torque asymmetries post-8 weeks.

Conclusion: Regardless of the modality, eccentric training improves neuromechanical, morphological and functional properties in people who underwent Achilles tendon rupture.

Clinical Relevance: Considering that isokinetic dynamometers are expensive, conventional eccentric exercise can be a good strategy in sports rehabilitation in patients who underwent Achilles tendon reconstructive surgery.

Key Terms: Achilles tendon rupture, Achilles rehabilitation, eccentric exercise, calf muscle

What is known about the subject:

- Achilles tendon rupture promotes long-term deficits in triceps surae muscle strength, activation, and structure.
- Rehabilitation protocols can minimize strength deficits.
- Eccentric training enables the rapid recovery of the musculoskeletal system.
- Isokinetic eccentric training has been used in rehabilitation programs.
- Isokinetic eccentric training increases the isometric, eccentric and concentric torques, increases the muscle activation and increases the overall triceps surae muscle mass within a short training (4 weeks) period in healthy subjects.

What this study adds to existing knowledge:

- Eccentric training improves muscle thickness, muscle activation, plantarflexion torque and ankle range of motion, regardless of the exercise modality.
- Isokinetic eccentric training decreases plantar flexors torque asymmetries and conventional eccentric training decreases muscle mass asymmetries.
- After 8 weeks, eccentric training improves muscle activation, plantar flexors isometric and isokinetic torque, ankle dorsiflexion range of motion

and muscle mass either if performed with an isokinetic or conventional modality, in participants who have been subjected to Achilles tendon reconstructive surgery.

- Muscle mass increased after 8 weeks of training in the conventional group and after 12 weeks in the isokinetic training group.
- Eccentric training is a good strategy to improve functional and neuromechanical outcomes in patients after Achilles tendon rupture.

INTRODUCTION

Acute Achilles tendon rupture is a multifactorial injury that affects mainly mild aged people (LANTTO *et al.*, 2015b). These factors may be related to poor vascularization, the use of corticosteroids and/or fluoroquinolones antibiotics (used in bacterial infections), hyperthermia, tendon degeneration caused by the ageing process, or due to repetitive tendon micro-injuries and/or tendinopathy (THEVENDRAN *et al.*, 2013). After Achilles tendon rupture, deficits in tendon mechanical properties (i.e stiffness and Young's modulus) (GEREMIA *et al.*, 2015; LANTTO *et al.*, 2015b), triceps surae muscle architecture (BAXTER *et al.*, 2018; NICHOLSON *et al.*, 2019), plantar flexors strength (GROETELAERS *et al.*, 2014; BAXTER *et al.*, 2018) and ankle function (BRORSSON *et al.*, 2017) have been observed. Long-term studies have shown that muscle strength is still reduced, and the functional deficits persist for many years (MOLLER *et al.*, 2002; LANTTO *et al.*, 2015b; HEIKKINEN *et al.*, 2017; BRORSSON *et al.*, 2018).

Eccentric exercise seems to be a good strategy for tendon rehabilitation (BEYER *et al.*, 2015; TUMILTY *et al.*, 2016), since it enables rapid recovery of the musculoskeletal system (FRIZZIERO *et al.*, 2014) and allows for a greater force production than isometric and concentric actions (HERZOG *et al.*, 2015). Previous systematic reviews (FRIZZIERO *et al.*, 2014) showed the positive and beneficial effects of eccentric training for tendinous injuries, which results in a fast recovery in concentric and eccentric plantar flexor muscle strength and resumption of previous running activity (ALFREDSON *et al.*, 1998).

Eccentric training has been found to produce an increase in the plantar flexor isometric, eccentric and concentric strength, and increases in triceps surae muscle activation and mass (GEREMIA *et al.*, 2018b; GEREMIA *et al.*, 2019) within a short training period (4 weeks) (GEREMIA *et al.*, 2018b). Nevertheless, to the best of our knowledge, there is a lack of studies with eccentric training for the rehabilitation of individuals who underwent Achilles tendon reconstructive surgery.

Eccentric exercise of the plantar flexor muscles is usually performed with overload during the movement's eccentric phase in a conventional resistance training (constant load) by isoinertial machines or in a classical heel drop, executed on a step (ALFREDSON *et al.*, 1998; MAHIEU *et al.*, 2008; DUCLAY *et* *al.*, 2009). Another option is to perform the eccentric exercise in the isokinetic dynamometer (GEREMIA *et al.*, 2018a; GEREMIA *et al.*, 2018b; GEREMIA *et al.*, 2019), which enables patients to perform maximal intensity muscle contractions in constant angular velocity and pre-determined ROM, with the dynamometer's resistance equal to the applied muscular force that provides safety when used for rehabilitation (BALTZOPOULOS & BRODIE, 1989).

Therefore, isokinetic exercise has been adopted in rehabilitation regimes to optimize triceps surae muscle strengthening in healthy people (GEREMIA *et al.*, 2019). Moreover, isokinetic eccentric training is more effective than conventional eccentric training to restore quadriceps muscle mass, strength, and functional capacity in recreational athletes who underwent partial meniscectomy (VIDMAR *et al.*, 2019b) and anterior cruciate ligament reconstruction (VIDMAR *et al.*, 2019a). However, there is no evidence available in patients who underwent Achilles tendon reconstructive surgery.

In this study we want to address the following questions: (1) Can isokinetic exercise produce greater or faster morphological and neuromechanical adaptations than a conventional exercise, on plantar flexor muscles, in patients that underwent Achilles tendon reconstructive surgery? (2) Is the time course of neuromechanical and morphological adaptations in the injured leg similar to the uninjured leg? Therefore, our goal was to verify the effects of two types of eccentric training [conventional and isokinetic] on muscle mass, muscle activation, plantar flexor torque and ankle ROM in participants that underwent Achilles tendon reconstructive surgery. We hypothesized that isokinetic eccentric training would lead to greater increments in all variables compared to the conventional training.

MATERIAL AND METHODS

Trial design

This study is characterized by a randomized single-blind controlled clinical trial, registered under the Clinical Trials (NCT03861572). Before the study, participants signed an informed consent form that contains all the information pertinent to this study that was approved by a local ethical committee (#96310118.4.0000.5347) in accordance with the Declaration of Helsinki.

Triceps surae neuromechanical and morphological properties were evaluated four times. These tests were performed (1) before training (Pre-training), (2) after 4 (Post-4), (3) after 8 (Post-8), and (4) after 12 (Post-12) weeks of training.

Sample size

The sample size calculation was performed in the software G * Power 3.1.9.7 (Kiel University, Germany). We selected from a preview study (GEREMIA et al., 2018b) reference peak values of isometric (d=0.39 and r=0.983), concentric (d=0.67 and r=0.991) and eccentric (d =1.16 and r=0.919) torque. From all these values, we selected the value of the highest estimated sample size (i.e., from the isometric torque). Considering the effect size *f* of 0.19, with a 0.05 significance level and power of 0.95 and a correlation among repeated measures of 0.9, a total of 14 patients was needed for this study. Considering possible sample losses, 33 volunteers were invited to participate in the study (Figure 3.2).

Eligibility criteria

Participants were recruited primarily at the university campus, through informative posters about the research project, as well as by social networks and dissemination in print media. Participants were also invited from the local community.

Participants were male and female subjects who suffered total acute Achilles tendon rupture, and which underwent surgical repair. Volunteers that did not have Achilles tendon surgical reconstruction, who participated in strength training programs for the plantar flexors in the last 6 months, patients with diabetic diseases and/or ankle injury, as well as those with difficulty for understanding and/or executing the test and training protocols in the isokinetic dynamometer were excluded.

Randomization

Non-stratified block randomization was used by an author assigning the patient to either the isokinetic eccentric exercise group (ISOK) or the conventional eccentric exercise group (CONV). A computer program was used to generate random numbers in permuted blocks (http://www.randomization.com/). The evaluator was blinded concerning group allocation.

Participants

Participants were randomly assigned into two groups (Figure 3.2): the ISOK [n: 14 (13 men), age: 38.4 ± 6.8 years old, body mass: 87.5 ± 14.8 kg, postoperative follow-up: 5.1 ± 5.2 years]; and the CONV [n: 14 (13 men and 2 women), age: 37.7 ± 4.3 years old, body mass: 87.0 ± 10.0 kg, postoperative follow-up: 4.1 ± 3.5 years].

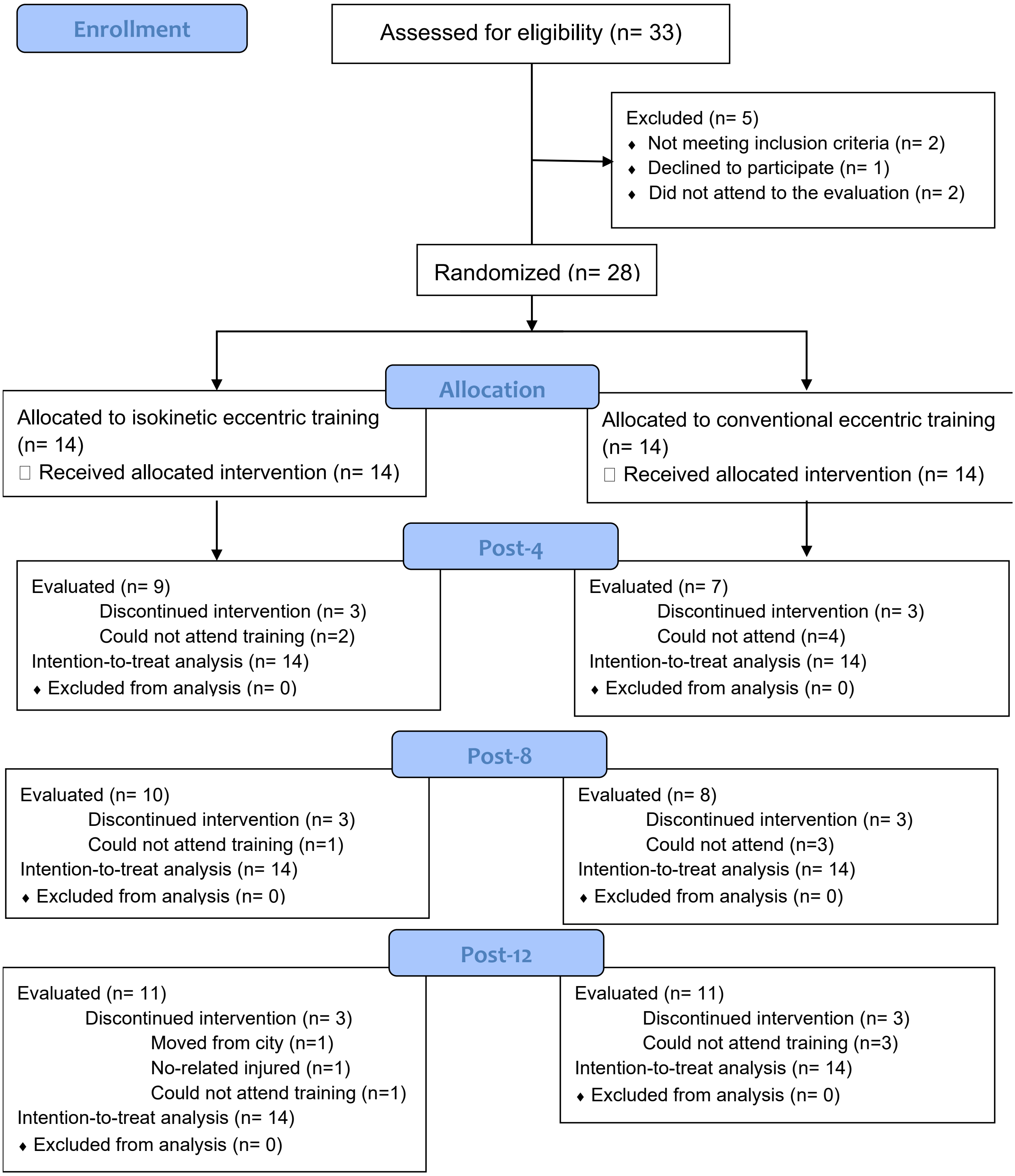


Figure 3.1. CONSORT diagram showing the participants' screening and allocation.

Outcomes

Muscle Thickness

Muscle thickness (MT) was measured by a B-mode ultrasonography system (Logiq P6, GE *Healthcare, Waukesha, Washington, USA*) with a matrixial linear-array probe (60mm *linear array* ML6-15, 5-15MHz – GE *Healthcare, Waukesha, Washington, USA*). Ultrasound (US) images were collected with the subject at rest, before being positioned on the dynamometer. All images were obtained after the participant laid down on a stretcher, in a supine position, for a resting period of 5 to 10 minutes to re-establish body fluids (LOPEZ *et al.*, 2019). After the resting period, US images were obtained with the participants in a prone position, with the ankle in the neutral position. The US probe was covered with a water-soluble transmission gel, which promoted acoustic contact of the probe with the skin. A light pressure was applied by the rater at the probe, but avoiding possible tissue deformation through the exerted pressure (BLAZEVICH, 2006). The US probe was positioned longitudinally to the muscle fibers at 30% (gastrocnemius medialis - GM and gastrocnemius lateralis - GL) and 50% (soleus - SO) of the distance between the popliteal crease and the lateral malleolus (Figure 3.3 A) (KAWAKAMI *et al.*, 1998; GEREMIA *et al.*, 2019).

All US images were collected and analyzed by the same experienced investigator with the Image J software (straight line, line color: yellow, version 1.48v, National Institutes of Health, Bethesda, MA, United States). MT was defined as the distance between the deep and superficial aponeuroses, and was calculated through the mean value of five parallel lines (GEREMIA *et al.*, 2019) drawn at right angles between the superficial and deep aponeuroses along with each ultrasonography image (Figure 3.3 B). A good test-retest reliability has been shown for these US measures (GEREMIA *et al.*, 2018b).

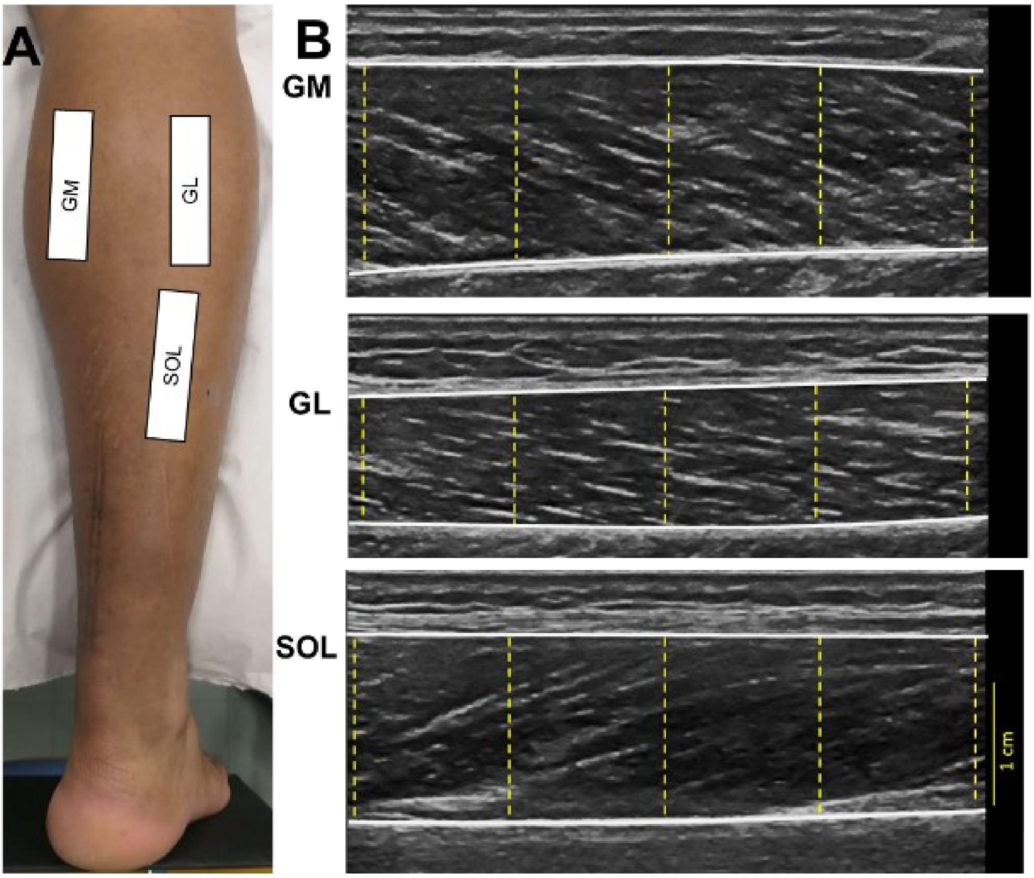


Figure 3.2. Muscle thickness evaluation. (A) Representation of the ultrasound sites in the gastrocnemius medialis (GM), gastrocnemius laterals (GL) and soleus (SOL). (B) Ultrasonography images showing GM, GL and SOL muscles.

Muscle activation

The electrical activity of GM, GL and SOL muscles was evaluated by surface electromyography (EMG) with a 16-channel Delsys EMG system (EMG Trigno Wireless Trigno Base Station, Delsys Inc., Natick, Massachusetts, USA). For each muscle, a superficial individual sensor was used.

Skin preparation and electrode positioning followed standard procedures (SENIAM). For the GM, the electrode was located at the most prominent bulge of the muscle, in the direction of the leg at 30% of the leg length. For the GL, the electrode was placed at 1/3 of the line between the head of the fibula and the lateral malleus. For the SOL, the electrode was placed at 50% of the leg (SENIAM, 2020).

The EMG system was synchronized with the dynamometer, and the EMG signals were obtained during isometric and isokinetic contractions. EMG signals were recorded with a sampling frequency of 2000 Hz per channel. A Butterworth band-pass filter, with cut-off frequencies of 20 and 500 Hz, was used in all evaluations. Root means square (RMS) values were calculated from 1-sec in the middle (plateau) of the EMG signals. The sum of the GM, GL, and SO RMS values in each test (isometric and isokinetic) were used for statistical analysis as representing the triceps surae activation (GEREMIA *et al.*, 2018a). Normalization was performed using the EMG signal of the isomeric contraction at -10° (most stretched position, and plantarflexor optimal muscle length).

Plantarflexion torque

Participants were seated at the isokinetic dynamometer (Biodex System 3 Pro, Biodex Medical System, Shirley – NY, USA) with the hip flexed at 85° (0° = hip fully extended), and the knee fully extended (GEREMIA *et al.*, 2018b). The plantar/dorsiflexion ankle joint axis was aligned with the dynamometer's axis of rotation, and the foot was fixed to the dynamometer's footplate to prevent calcaneus movements. The participants performed a specific warm-up involving 10 submaximal plantar flexion and dorsiflexion concentric contractions at an angular velocity of 120°s^{-1}.

Each participant executed a familiarization session (up to 2 submaximal plantarflexions) with the dynamometer for the plantar flexor torque evaluations. A rest interval (180 seconds) was allowed before the maximal test. After familiarization, participants performed three plantar flexor maximal voluntary isometric contractions (MVIC) for 5 seconds at a neutral ankle position (0° of plantarflexion), followed by three consecutive plantar flexor maximal voluntary isokinetic dynamic contractions: concentric and eccentric at an angular velocity of 30°s^{-1} (GEREMIA *et al.*, 2018b).

For MVIC, patients were instructed to produce maximum force as quickly as possible until they reached their maximum capacity of force generation and to maintain this maximum effort for at least 1 second before relaxing. HERZOG & TER KEURS (1988) proposed this procedure to ensure that all muscle fibers remain at constant length during muscle force (or torque) production. When torque variation was higher than 10% between the three MVIC tests, an additional plantar flexor MVIC was performed (GEREMIA *et al.*, 2018b).

To accommodate interindividual differences in total ankle ROM, a ROM of 50° was used for all patients, initiating at 80% of the each participant's maximal dorsiflexion angle (GEREMIA *et al.*, 2018a). In the concentric test, the dorsiflexion movement was executed by a technician, and participants initiated the active concentric contraction when the ankle reached the start position. For the eccentric isokinetic test, the concentric phase was executed passively, and the participants started the eccentric contraction when the angle was at the start position (i.e., at 50° of plantarflexion) and stopped at 80% of the maximal dorsiflexion. This procedure was used in an attempt to guarantee that all participants performed the isokinetic contraction at the same relative muscle length (GEREMIA *et al.*, 2018a; GEREMIA *et al.*, 2018b; GEREMIA *et al.*, 2019).

Between each contraction, an interval of 120 seconds was used to minimize possible fatigue effects. The highest torque values (i.e., peak values) obtained during the isometric and isokinetic tests were used for statistical analysis.

ROM

The ROM was evaluated using the isokinetic dynamometer. The ankle was passively moved in dorsiflexion by the evaluator until the participant reported a sensation of discomfort. In this position, the maximal dorsiflexion ROM was recorded. Next, the ankle joint was moved to maximal plantarflexion and maximal plantarflexion ROM was registered. Three measures were performed, and the maximal of the three values was used for the analysis.

Interventions

Training sessions were performed twice a week, with a minimum interval of 72 hours between sessions. Both legs were trained. The training program had a total duration of twelve weeks and was divided into three mesocycles of 4 weeks each. In each mesocycle, eight training sessions were performed, leading to a total of 24 sessions. Two to four series of 8 to 12 repetitions were performed (with a one-minute interval between the series) in each training session so that the volume increment (number of series X number of trials per series) occurred gradually over the twelve training weeks (Figure 3.4). In the first mesocycle, the load was set at 60% of maximal effort, followed by 70% in the second and 80% in the last mesocycle.

Isokinetic eccentric training

A systematized isokinetic eccentric training program was performed for both legs (injured and uninjured) using an isokinetic dynamometer (Biodex System Pro 3 Isokinetic, Biodex Medical System, USA). The leg what started the training protocol were randomized for each patient. The eccentric training was carried out with the volunteers positioned seated on the dynamometer, in the same position used during muscle strength and EMG evaluations.

The ankle plantarflexor and dorsiflexor movements were executed in the angular velocity of $30°\cdot s^{-1}$. The same ankle ROM procedure used for testing (50°) was used for the eccentric training program (i.e., participants exercised the plantarflexor muscles from 80% of their maximal dorsiflexion until 50° of ankle ROM). This procedure was used to ensure that all participants were trained on the same plantar flexor muscular lengths, which should promote the same level of muscular demand among participants. In addition, this procedure avoided kinesiophobia while producing a safe maximal eccentric exercise while avoiding maximal eccentric loads at maximal ankle dorsiflexor ROM in the injured tendon. Every four weeks the maximal ankle ROM was evaluated to perform the necessary adjustments in the training sessions. The ROM chosen for strength training was within the ranges used in other plantar flexors eccentric training studies (PENSINI *et al.*, 2002; DUCLAY *et al.*, 2009; GEREMIA *et al.*, 2018a; GEREMIA *et al.*, 2018b; GEREMIA *et al.*, 2019).

Each training session contained a specific warming protocol for the ankle joint performed on the isokinetic dynamometer (1 x 10 concentric repetitions, with an angular velocity of $120°\cdot s^{-1}$). During the eccentric exercise, participants performed just plantar flexor eccentric contractions. The physical therapist manually moved the dynamometer arm to the maximal plantarflexion angle before each eccentric action. The maximal eccentric torque (100%) was used to calculate the training intensity for each mesocycle (60, 70 and 80%).

Conventional resistance eccentric training

Patients on the CONV group participated in a systematized conventional eccentric training program at the university gym for the ankle plantar flexor muscles. Both the injured and uninjured sides were trained focusing in the eccentric phase. The leg that started the eccentric training was also randomized for each patient. The training was carried out with the patients at the gym in a standing position. Participants performed the plantarflexor eccentric contraction with the hip and knee joints at 0° (fully extended). Next, the ankle joint was moved from maximal plantarflexion to maximal dorsiflexion. The concentric phase was executed with both legs and the eccentric one unilaterally.

Each training session contained a standardized 10-min warm-up on a cycle ergometer, with a 100 W constant power output, followed by 10 repetitions of plantar-dorsiflexion in each leg without a load on the gym machine (Figure 3.4). After the standardized warm-up, they performed a one repetition maximum test (1RM) for each leg.

Training progression was similar to that of the ISOK exercise (Figure 3.4). However, due to the difficulty in performing the maximum eccentric repetition test on the gym equipment, we used the maximal concentric and eccentric torques of the pre-training isokinetic evaluation (100%) to estimate the percentage of maximum isokinetic eccentric contraction with respect to the maximal isokinetic concentric contraction (equation 3.1).

In this regard, maximal concentric load at the gym machine (1RM) was determined in a maximum of five trials for each leg and was adjusted by coefficients specific to the number of repetitions performed. This load was considered the concentric load, so we increased the percentage needed for obtaining the eccentric maximal contraction (equation 3.2).

$$\%CONC = \frac{Maximal\ eccentric\ isokinetic\ torque\ x\ 100}{Maximal\ concentric\ isokinetic\ torque}$$

Equation 3.1. The estimation of the percentage of maximum concentric contraction with respect to the maximal eccentric isokinetic torque.

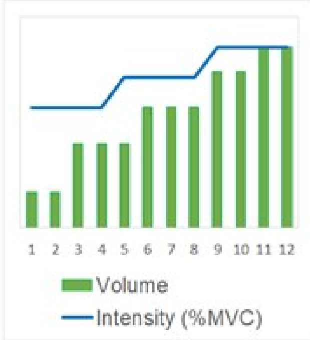
$$1RM\ ECC = \frac{1\ RM\ CONC\ x\ \%CONC}{100}$$

Equation 3.2. The estimation of one maximum eccentric repetition.

An electronic metronome was used to maintain a standard cadence of 35 rpm (~30°s^{-1}) for each movement phase.

Isokinetic eccentric training

Week	Frequency (times/week)	Intensity (%MVC)	Series	Repetions	Volume	Speed (°/s)
1	2	60	2	8	32	30
2	2	60	2	8	32	30
3	2	60	3	8	48	30
4	2	60	3	8	48	30
5	2	70	3	8	48	30
6	2	70	3	10	60	30
7	2	70	3	10	60	30
8	2	70	3	10	60	30
9	2	80	3	12	72	30
10	2	80	3	12	72	30
11	2	80	4	10	80	30
12	2	80	4	10	80	30



Conventional eccentric training

Week	Frequency (times/week)	Intensity (%MVC)	Series	Repetions	Volume	Cadence (rpm)
1	2	60	2	8	32	35
2	2	60	2	8	32	35
3	2	60	3	8	48	35
4	2	60	3	8	48	35
5	2	70	3	8	48	35
6	2	70	3	10	60	35
7	2	70	3	10	60	35
8	2	70	3	10	60	35
9	2	80	3	12	72	35
10	2	80	3	12	72	35
11	2	80	4	10	80	35
12	2	80	4	10	80	35

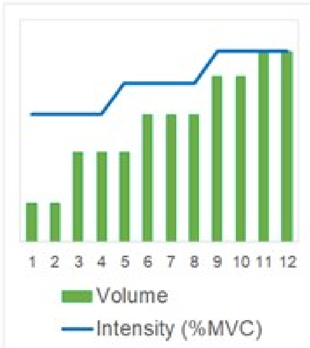


Figure 3.3. Training periodization in both groups of eccentric training. MVC = maximal voluntary contraction.

Statistical analysis

A generalized estimating equation (GEE) method and Bonferroni tests were conducted (group, leg, and moments as factors) for statistical analyses. Moreover, the asymmetry index (AI, equation 3.3) was calculated and compared with GEE analysis for group and moment as factors.

$$AI = \frac{Uninjured - Injured}{Uninjured} \times 100$$

Equation 3.3. Asymmetry index (AI) calculation.

Relative changes to pre-training were also calculated and compared with GEE analysis for group, leg, and moment as factors. We used a significance level of 95% for all analyses. When interactions were identified, post-hoc analysis of Bonferroni was applied. When a training effect was identified, the effect size (Cohen's d) was calculated between pre- and post-12 weeks, and used to classify the training effect as trivial ($d < 0.2$), small ($d > 0.2$), moderate ($d > 0.5$), or large ($d > 0.8$) (COHEN, 1988).

The magnitude of differences between training modalities in the injured leg was calculated and expressed as standardized mean differences (HOPKINS *et al.*, 2009). The absolute difference between pre vs post-12 in each group was used to assess the chances of a possible substantial effect favorable to CONV or ISOK [i.e., greater than the smallest worthwhile change (0.2 multiplied by the between-subject standard deviation)] in a pairwise analysis (i.e., CONV vs ISOK).

RESULTS

One subject declined to participate in the study, two subjects did not meet the inclusion criteria and two other participants did not attend the evaluation. Thus, 28 participants started the training program (Figure 3.2). The effects and interactions of the inferential GEE statistics for all outcomes are presented in Supplementary table 3.1.

Muscle Thickness

Muscle Activation

Isometric activation

Groups did not differ in plantarflexion isometric activation (p=0.24; Figure 3.6A). Regardless of the modality, plantarflexion isometric muscle activation increased at post-8 [compared to pre (202%; p=0.001; 95% CI, -0.43/-0.07; d=0.7)] and post-12 [compared to pre (272%; p<0.001; 95% CI, -0.63/-0.14; d=0.8) and compared to post-4 (p=0.003; 95% CI, -0.52/-0.07; d=0.5]. Therefore, the gains in training were similar between groups (p=0.48) and legs (p=0.2), where gains increase in post-12 [compared with pre (272%; p=0.001) and with post-4 (p=0.04; Figure 3.6 B)].

The injured leg had lower isometric plantarflexion activation (Figure 3.6A) than the uninjured leg (p=0.04; 95% CI, -0.22/-0.0007; MD=-0.11mV).

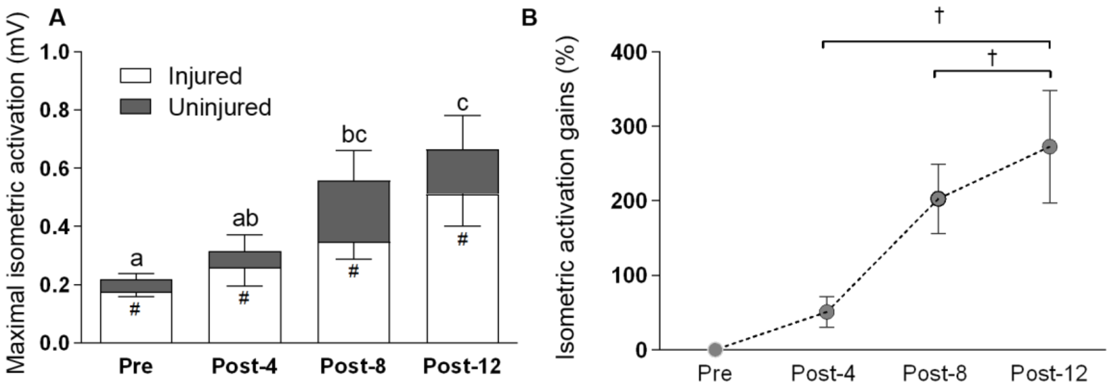


Figure 3.5. Muscle activation (RMS) during maximal isometric plantarflexion. (A) Maximal isometric activation in both legs for each moment (mV) with groups merged, where the different letter means differences between moments; # means differences between legs; (B) Training gains (%) with groups and legs merged, where † means differences between moments.

Concentric activation

CONV training increased the injured leg's plantarflexion concentric activation (Figure 3.7A) post-12 weeks compared to pre (p=0.014; 95% CI, -1.43/-0.1; d=1.16). Also, increases in the uninjured leg activation post-8 weeks (p<0.001; 95% CI, -0.96/-0.25; d=1.6) and post-12 weeks (p<0.001; 95% CI, -1.59/-0.49; d=1.89) compared to pre-training were observed.

After training (post-12) CONV group presented higher concentric muscle activation (Figure 3.7A) in both legs [injured (p=0.04; 95% CI, 0.02/1.06); and uninjured (p=0.01; 95% CI, 0.31/1.23)]. However, the gains in training were similar between groups (p=0.28) and legs (p=0.3), where gains increased in post-8 (411%; p=0.01) compared with post-4 (157%; Figure 3.7 B).

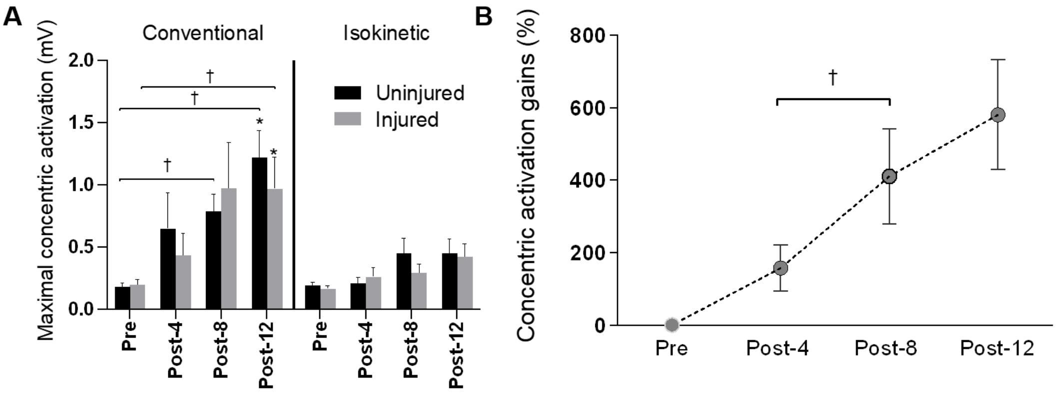


Figure 3.6. Muscle activation (RMS) during maximal concentric plantarflexion. (A) Maximal concentric activation in both legs and groups for each moment (mV); (B) Training gains (%) with groups and legs merged. † means differences between moments. *means differences between groups.

Eccentric activation

CONV training increased plantarflexion eccentric muscle activation post-8 compared to pre-training (p=0.011; 95% CI, -1.13/-0.09; d=1.1) and post-12 compared to pre-training (p<0.001; 95% CI, -1.3/-0.3; d=1.6) and to post-4 (p=0.037; 95% CI, -1.25/-0.02; d=1.0) (Figure 3.8 A). The gains in training were similar between legs (p=0.2), where gains in CONV and ISOK increase in post-12 (CONV=958%; ISOK=235%; p=0.005) compared with post-4 (CONV=165%; ISOK=77%; Figure 3.8 B).

CONV had higher eccentric muscle activation (Figure 3.8A) at post-8 (p=0.02; 95% CI, 0.04-0.86) and at post-12 (p=0.001; 95% CI, 0.26- 1.02) than the ISOK group. CONV had higher eccentric muscle activation gains (p=0.006) than ISOK (Figure 3.6B).

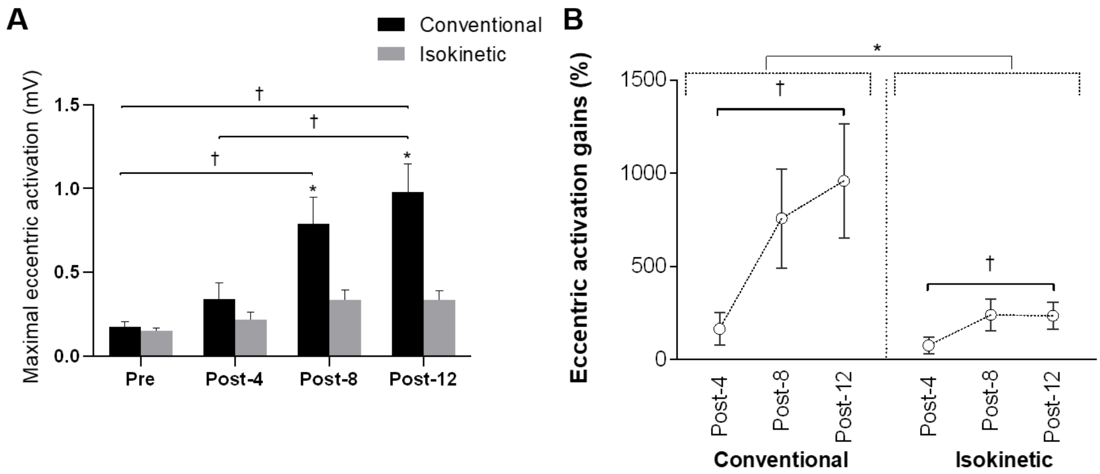


Figure 3.7. Muscle activation (RMS) during maximal eccentric plantarflexion. (A) Maximal eccentric activation in both legs and groups for each moment (mV) with groups and legs merged; (B) Training gains (%) with legs merged. † means differences between moments. *means differences between groups.

Plantarflexion torque

Isometric torque

Training groups did not differ in plantar flexor maximal isometric torque (Figure 3.9A; p=0.57). The uninjured leg had higher isometric torque in both groups [CONV (p<0.001; 95% CI, 29.67/58.9; MD=44.2) and in ISOK (p<0.001; 95% CI, 15.18-36.07; MD=25.6)].

Both groups increased plantar flexor maximal isometric torque (Figure 3.9A) post-8 weeks [compared to pre (p=0.001; 95% CI, -27.59/-4.54; d=0.56) and to post-4 (p=0.001; 95% CI -21.49/-3.54; d=0.44)] and post-12 weeks [compared to pre (p=0.03; 95% CI, -29.69/-0.94; d=0.54) and to post-4 (p=0.03; 95% CI, -22.83/-0.69; d=0.42)]. However, the training gains were similar between groups (p=0.23) and legs (p=0.74; Figure 3.9 B), where gains increased in post-8 (9.8%; p=0.01) and post-12 (9.6%; p=0.01) compared with post-4.

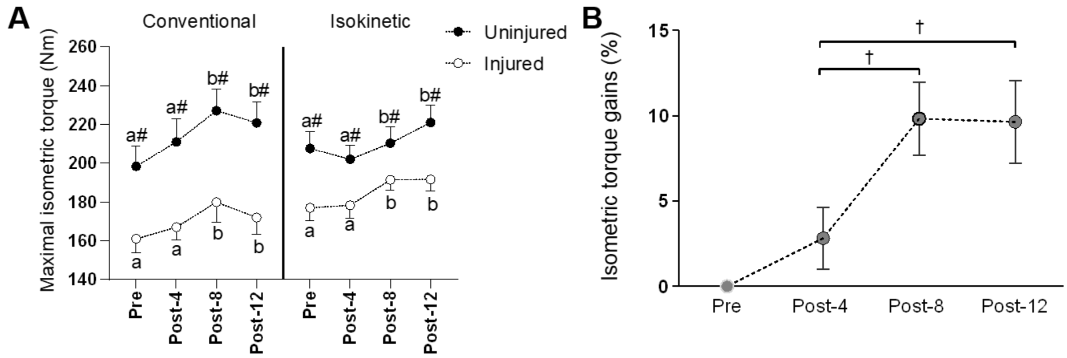


Figure 3.8. Plantar flexors' maximal isometric torque (Nm). In (A) interactions between leg, moment, and group. The different letters mean differences between moments; # means differences between legs. In (B) training gains (%) with groups and legs merged, where † means differences between moments.

CONV had higher AI for isometric torque than ISOK (p=0.006; 95% CI, 3.36- 20.48). Nevertheless, ISOK decreased the AI of isometric torque at post-8 [compared with pre (p=0.009; 95% CI, -10.41/-0.94) and post-4 (p=0.04; 95% CI, -6.01/-0.03)].

Concentric torque

Both groups increased plantar flexor maximal concentric torque (Figure 3.10A) post-8 weeks (p=0.001; 95% CI, -23.23/-4.52; d=0.33) and post-12 weeks (p=0.01; 95% CI, -28.03/-2.26; d=0.38) compared to pre-training. However, the training gains were similar between groups (p=0.68) and legs (p=0.4; Figure 3.10 B), where gains increase in post-8 (12.6%; p=0.04) compared with post-4. The uninjured leg had higher concentric torque than the injured (p=0.013; 95% CI, 1.81/15.13; MD=8.4Nm).

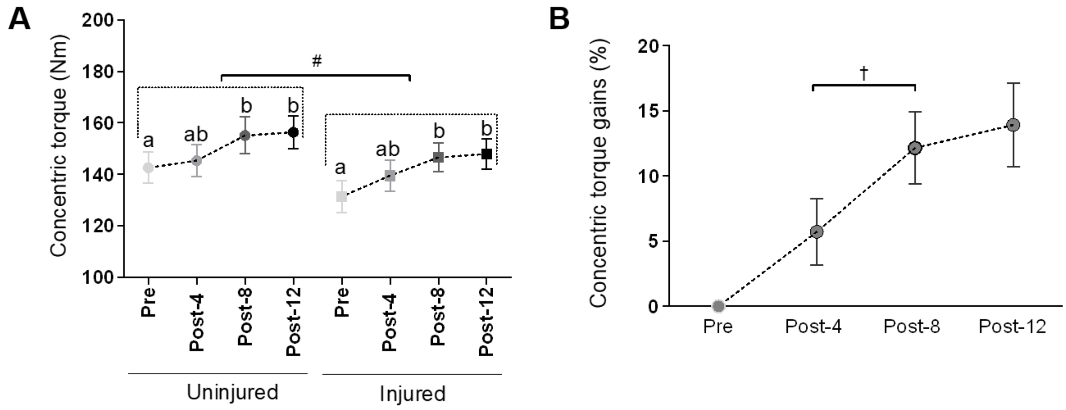


Figure 3.9. Plantar flexor's concentric maximal torque (Nm). In (A) interactions between leg and moment, with groups merged. The different letters mean differences between moments; # means differences between legs. In (B) training gains (%) with groups and legs merged, where † means differences between moments.

Eccentric torque

Both groups increased plantar flexor maximal eccentric torque (Figure 3.11A) post-8 weeks (p=0.001; 95% CI, -28.23/-5.1; d=0.3) and post-12 weeks (p=0.002; 95% CI, -33.8/-5.32; d=0.37) compared to pre-training. The gains in training were similar between groups (p=0.98), legs (p=0.2) and moments (p=0.4) (Figure 3.11 B). The uninjured leg had higher eccentric maximal torque (p=0.001; 95% CI, 8.83/31.77; MD=20.3Nm; Figure 3.11A) compared to the injured leg.

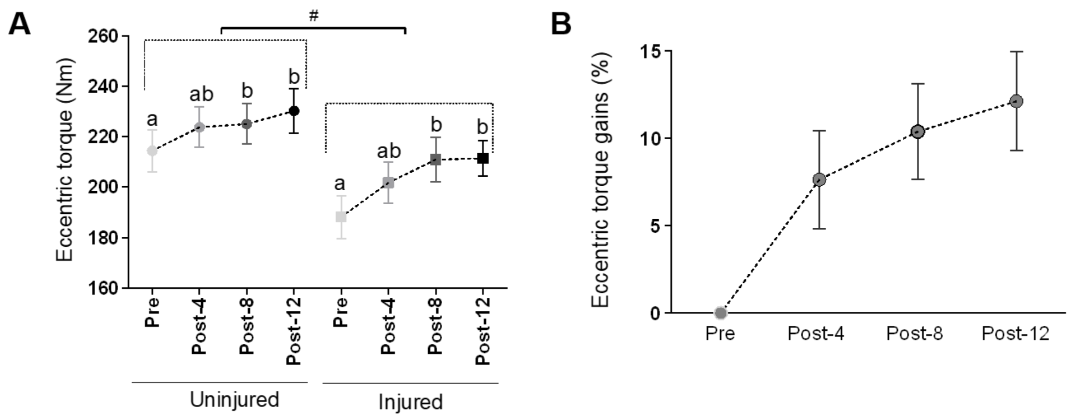


Figure 3.10. Plantar flexor's eccentric maximal torque (Nm). In (A) interactions between leg and moment, with groups merged. The different letter means differences between moments; # means differences between legs. In (B) training gains (%) with groups and legs merged.

ROM

Both training programs increased dorsiflexion ROM at post-8 (p=0.03; 95% CI, -2.57/ -0.06; d=0.11) and post-12 (p=0.05; 95% CI, -3.0/0.02; d=0.13) compared to post-4 (Figure 3.12 A). The training gains were similar between groups (p=0.38) and legs (p=0.052; Figure 3.12 B), where ankle ROM gains increased in post-8 (6.3%; p=0.01) and in post-12 (7.3%; p=0.02) compared with post-4.

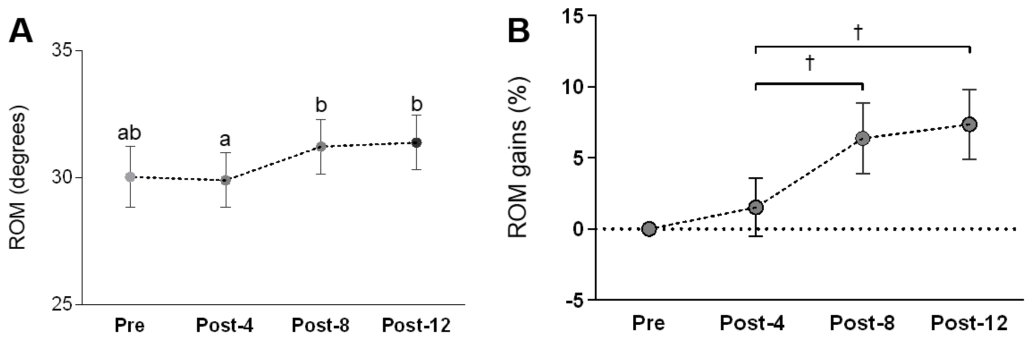


Figure 3.11. Dorsiflexion range of motion (degrees). In (A) the moment effect with groups and legs merged. The different letter means differences between moments. In (B) training gains (%) with groups and legs merged, where † means differences between moments.

DISCUSSION

We had questioned if isokinetic exercise would produce greater or faster neuromechanical and morphological adaptations than a conventional exercise, on triceps surae muscles, in patients that underwent Achilles tendon reconstructive surgery. We hypothesized that isokinetic eccentric training would lead to greater and faster increments on all variables. However, our hypothesis was not confirmed: (1) CONV training produced faster adaptations (increasing) in MT, faster and greater dynamic muscle activation (eccentric and concentric) than ISOK; and (2) isometric muscle activation, plantarflexors torque (isometric and isokinetic) and ankle ROM had similar adaptations between training modalities with increases post-8. So, the answer for the first question is: No, isokinetic training cannot produce greater or faster morphological and neuromechanical adaptations than a conventional exercise, on plantar flexor muscles, in patients that underwent Achilles tendon reconstructive surgery.

We also asked if the time course of neuromechanical and morphological adaptations in the injured leg would be similar to that of the uninjured leg. Our hypothesis was that the uninjured leg would undergo faster adaptations, while the injured leg would undergo greater adaptations, for being in a reduced use condition compared to the healthy limb, probably due to the injury. However, our hypothesis was not confirmed: (1) the injured leg underwent a faster adaptation (post-8) in MT, but the uninjured leg was faster in concentric muscle activation adaptation (post-8); (2) all the other variables underwent a similar adaptation time course, increasing in both legs at post-8.

An interesting result was that ISOK decreased isometric toque asymmetries, while CONV decreased MT asymmetries post-8 weeks of training. This suggests that patients that had history of Achilles tendon reconstructive surgery should perform eccentric training for at least 8 weeks during a rehabilitation program, and clinicians can use a simple and less expensive CONV training to promote neuromechanical adaptations in Achilles tendon ruptured patients.

Different from our results, a previous study (GEREMIA *et al.*, 2018b) showed that triceps surae eccentric training was able to increase force production, muscle activation and muscle thickness after four weeks, while here we found improvements only post-8 weeks of eccentric training. However, their study was with healthy participants in an isokinetic maximal (100% MVC) eccentric training program, whereas we progressively increased the load (starting with 60%). Therefore, the injured patients probably had a slower time course to adapt due to the submaximal load we used, which suggest that Achilles tendon adaptation may need several months (or a longer eccentric rehabilitation protocol) for the needed gains to decrease between-limbs asymmetries to occur.

Isokinetic eccentric training was more effective than conventional eccentric training in patients who underwent partial meniscectomy (VIDMAR *et al.*, 2019b) and anterior cruciate ligament reconstruction (VIDMAR *et al.*, 2019a). However, we did not observe superiority in isokinetic training compared with conventional training, as both groups were able to increase plantar flexor muscle thickness, muscle activation, torque production and ankle ROM.

Strength exercises are an important return-to-play approach in rehabilitation (LORENZ & MORRISON, 2015). Therefore, exercise load (intensity) is the critical component for achieving strength-based adaptations. Previous studies showed that maximal (100% RM) isokinetic eccentric training increases the plantarflexion strength, neural activation and muscle thickness (GEREMIA *et al.*, 2018b), increases tendon stiffness (GEREMIA *et al.*, 2018a) and increases muscle fascicle length (GEREMIA *et al.*, 2019) in healthy individuals. If we think about tendon exercises, an effective training intervention should apply a high loading intensity (BOHM *et al.*, 2015).

However, we trained our Achilles tendon rupture patients in submaximal conditions, as we thought that this would lead to a better enrollment of these patients to a strength training program, due to kinesiophobia, or the fear that most patients have of rupturing the tendon again, which we thought would increase if we used maximal strength training exercises. In addition, we opted to use exercises with a linear periodization similar between both modalities (CONV and ISO) to avoid the development of Achilles tendinopathy that has been related to previous injuries and to the excessive loading of tendons (LONGO *et al.*, 2018).

Therefore, our two training programs had the same periodicity with exercise intensities starting at 60% MVC in the first mesocycle, being increased to 70% MVC in the second, and 80% MVC in the third mesocycle, which gave some safety for all participants during the twelve weeks of training. The recommendation of using loads approximately >80% MVC is for trained individuals (LORENZ & MORRISON, 2015), which was not the case of our participants, which presented low physical activity levels probably due to the undesired effects of an Achilles tendon rupture.

Previous studies that compared ISOK eccentric training with CONV eccentric training in patients with orthopedic problems at the knee showed greater effectiveness with the isokinetic mode (VIDMAR *et al.*, 2019a, b). However, most musculoskeletal adaptations were related to their volume of training and not to exercise modality. The training volume was defined by the exercises' product from the number of repetitions, number of sets and intensity load, and is a strong contributor to muscle adaptations with dose-dependent effects (FIGUEIREDO *et al.*, 2018). In our study, the training volume and relative intensity were equated for both groups, and we did not find a difference in adaptation between the two groups. Functional adaptations have been related to training volume and relative intensity, with no differences in maximal strength when they are equalized (BAKER *et al.*, 1994).

Regardless of the exercise being CONV or ISOK, the eccentric training increased the isometric and isokinetic force production after 8 weeks of training. The mechanism proposed for this increase in force has been attributed to increased muscle thickness and changes in the neural drive. In the traditional theory of strength training adaptations, force production depends first on the neural drive increase, and second on the morphological adaptations (FOLLAND & WILLIAMS, 2007b). We found an increase in neural activation and morphological adaptations after 8 weeks in both groups. This suggests that, in Achilles tendon patients, the time course of the adaptation is slow, and training programs should be at least 8 weeks to observe an increase in the triceps surae morphological aspect.

Although the gains occurred in both legs, the uninjured leg showed higher values in most variables, except for ankle ROM and isokinetic muscle activation. Our training promoted a mechanical load that was specific for each tendon's loading condition, as it is important for tendon development, tendon homeostasis, tendon repair and clinical rehabilitation that we respect the maximal capacity of each limb. However, the mechanobiology in tendons should be hierarchized in the context of healthy and pathological tendons (NOURISSAT *et al.*, 2015). Morphological, mechanical and material adaptations in the ruptured tendon (GEREMIA *et al.*, 2015) may influence the tendons' responses to the exercise. Moreover, eight weeks of CONV training was able to decrease asymmetries related to muscle mass and eight weeks of ISOK training was able to decrease asymmetries related to isometric torque. Therefore, we suggest that if clinicians want to decrease asymmetries related to force production, the training should be performed in the isokinetic dynamometer. However, if they want to decrease asymmetries in muscle mass, they should perform the training at the CONV gym machines.

Our study has some limitations. Our training protocol was not with high intensity (>80%), which may have not produced the expected effects observed in other studies that used high loading. However, we opted to perform a safe submaximal protocol with increasing loads for the participants. We selected patients who had suffered total acute Achilles tendon rupture, who underwent surgical repair and who were released by the surgeon for sports practice. However, the patients were not at the same time after the surgery, which means that they were not probably homogeneous in their tendon structural and functional conditions at the study start. However, we adopted this strategy because we expected to see similar adaptations independent of the time that they were subjected to the reconstructive surgery. Some participants had a low adhesion in the training program and in the follow-up evaluation, and maybe if adherence was greater, the training effect would also be larger. Nevertheless, we performed the intent-to-treat analysis to avoid any treatment bias. Finally, we did not use a control group that did not perform any strength training, and we also did not use a control period before training. Therefore, our results should be interpreted within the inter-groups comparisons we here presented and should not be extrapolated to other conditions. Despite this limitation, our two eccentric rehabilitation protocols were effective to generate neuromuscular and mechanical adaptations, thereby improving the Achilles tendon rupture patients' conditions.

CONCLUSION

Regardless of the training modality, the eccentric training increases the MT, the muscle activation, plantarflexion torque, and the ankle ROM after 8 weeks of training. Conventional eccentric training produces faster muscle thickness and dynamic muscle activation improvement than isokinetic eccentric training. Conventional training should be performed to decrease muscle thickness asymmetries and isokinetic training to decrease isometric torque asymmetries. Both modalities of eccentric training are a good strategy to improve functional and neuromechanical outcomes in patients after Achilles tendon rupture. Moreover, the injured leg has a faster adaptation in concern to muscle thickness, but the uninjured leg was faster in muscle activation adaptation.

CHAPTER 4

4. ECCENTRIC TRAINING INCREASES CROSS-SECTIONAL AREA AND ECHO-INTENSITY IN DIFFERENT REGIONS OF THE ACHILLES TENDON AFTER RUPTURE

ABSTRACT

Background: Achilles tendon rupture determines an increase in tendon cross-sectional area and elongation that affect the plantar flexor function, with deficits persisting years after the surgery. Eccentric training may improve these deleterious changes. Therefore, we verified the effects of twelve weeks of eccentric training at different regions of the tendon's CSA and corresponding echo-intensity along the tendon length in patients that underwent Achilles tendon surgical repair. *Methods:* In this randomized clinical trial (NCT03861572), we evaluated the cross-sectional area, the echo intensity, and the tendon length in twenty-eight patients that had their Achilles tendon reconstructed. They were randomly assigned into two groups of a 12-week eccentric training: conventional (n=14) and isokinetic (n=14). *Findings:* the conventional eccentric training increased the cross-sectional area in the middle region of the injured tendon after eight training weeks and showed lower echo intensity than the isokinetic eccentric training after twelve weeks. The injured tendon had higher CSA, longer tendon length and lower echo intensity than the uninjured tendon in both groups. *Interpretation:* The persistent Achilles tendon morphological adaptations at the injured tendon years after the reconstructive surgery are different among the tendon regions. Eccentric training can correct these changes through tendon hypertrophy and increased tendon echogenicity, thereby being an important intervention for these patient's rehabilitation.

Keywords: Achilles rupture, eccentric training, tendon morphology, echo intensity

Highlights

- Ruptured Achilles tendon had larger CSA, lower echo intensity (mainly at the distal tendon's region), and longer length than the uninjured tendon that persist several years post-surgery.
- Conventional eccentric training increased by 18% the injured tendon's CSA.
- Isokinetic training determined 21-35% increase in tendon CSA post-12 training weeks.
- Conventional training decreased differences in CSA between regions at the injured tendon and increased the echo intensity at proximal regions.

INTRODUCTION

Achilles tendon (AT) morphological properties have gained considerable attention due to this tendon's importance in human locomotion and high injury incidence (LANTTO *et al.*, 2015b). However, the debilitating effects of Achilles tendon rupture have been suggested to be associated with increased tendon cross-sectional area at the injury site (scar tissue) and with tendon elongation (i.e., increased length), which has been negatively correlated to plantar flexor function (KANGAS *et al.*, 2007). It is important to mention that functional deficits have persisted more than one year post-surgical repair (ZELLERS *et al.*, 2019b).

Achilles tendon morphology is an important measure to investigate tendon plasticity in response to training (GEREMIA *et al.*, 2018a), rehabilitation after rupture (GEREMIA *et al.*, 2015) and tendinopathies (ARYA & KULIG, 2010). Patients with tendinopathy, for example, have higher tendon elongation (ARYA & KULIG, 2010), higher cross-sectional area (ARYA & KULIG, 2010; GEREMIA *et al.*, 2015), and lower echogenicity on the tendon (CHIMENTI *et al.*, 2014) than the healthy persons.

Tendon length is an important piece of information to identify the injury severity in tendon rupture patients (KANGAS *et al.*, 2007), and excessive tendon elongation after rupture is associated with the inability to perform a functional task (e.g. heel rise and jumping tasks) after 1 year post-surgery (ZELLERS *et al.*, 2019b). Even long after surgery, independently of which rehabilitation modality the injured leg undergoes, a higher CSA is observed at the injured than the uninjured tendon (GEREMIA *et al.*, 2015; JIELILE *et al.*, 2016), with early rehabilitation producing larger CSA than the conventional immobilization treatment (JIELILE *et al.*, 2016), although no between-groups difference in CSA has also been observed (GEREMIA *et al.*, 2015).

Mechanical loading induces changes in tendon morphology, such CSA and length (HEINEMEIER & KJAER, 2011; GEREMIA *et al.*, 2018a), Therefore, strength training has been associated with a larger tendon CSA (WIESINGER *et al.*, 2015). Although short-term strength training has also been shown to induce tendon hypertrophy (higher CSA), this response is not a consensus (HEINEMEIER & KJAER, 2011). However, high intensity isokinetic eccentric training of twelve weeks increased 15% CSA after 8 weeks but without changes in tendon length (GEREMIA *et al.*, 2018a). Moreover, larger tendon CSA after 12 weeks is associated with improved performance of the heel-rise test at 1 year (ZELLERS *et al.*, 2019b).

Exercises also induces changes in tendon's mechanical and material properties (GEREMIA *et al.*, 2018a). Higher intensity of isometric contractions increases the echogenicity of the tendon in healthy subjects (ISHIGAKI *et al.*, 2016). After 12 weeks of eccentric training increased more than 80% of the tendon stiffness and Young's modulus (GEREMIA *et al.*, 2018a). Theses mechanical stimulus will promote biochemical signals (HEINEMEIER & KJAER, 2011) that elicit tissue adaptation (GUZZONI *et al.*, 2018). Resistance training leads to changes tendon collagen fibril morphology (increased density and area) (KONGSGAARD *et al.*, 2010). This mechanical stimulus is fundamental for tendon development and plasticity, causing collagen fiber alignment changes (NOURISSAT *et al.*, 2015) and collagen synthesis (HEINEMEIER & KJAER, 2011) in the extracellular matrix, thereby increasing the tendon's CSA, echogenicity and length.

In terms of mechanical loading, eccentric contractions are the muscle actions with the highest force production capacity (and thereby tendon loading) due to the recruitment of active (i.e. muscle fibers) and passive (i.e. muscle connective sheets) components (HERZOG, 2014). The eccentric stimulus' high-load intensity has been shown to increase tendon stiffness, Young modulus, and CSA, without changes in tendon length (GEREMIA *et al.*, 2018a). Therefore, eccentric exercise has been extensively used during the rehabilitation process of tendinous injuries (MAFFULLI *et al.*, 2008; FRIZZIERO *et al.*, 2014), because it generates a high mechanical load, which can lead to greater tendinous tissue plasticity. However, tendon properties' adaptation is generally observed in response to large volumes of training (HEINEMEIER & KJAER, 2011), which may become a problem for Achilles tendon rupture patients, as they may experience tendinopathy, which has been related to previous injuries and excessive loading of tendons (LONGO *et al.*, 2018).

Differences in tissue composition have been related to the different mechanical demands that affect the tendon proper in rats (MARQUETI *et al.*, 2014). The Achilles tendon has different collagen fascicles direction, with a twisted pattern that distributes the strain concentrations developed in the tendon to wider areas, leading to stress concentration relief and effective tissue force transmission to bones (SHIM *et al.*, 2018). Therefore, different tendon regions may have different adaptation mechanisms due to their different structure and mechanical loading during eccentric exercise. However, to the best of our knowledge, there is no *in vivo* study that compared different areas of the ruptured Achilles tendon post-surgical repair and eccentric training rehabilitation. Therefore, the purpose of this study was to verify the effects of twelve weeks of eccentric training on the CSA and echo-intensity measured at different regions of the Achilles tendon, as well as in tendon length, in patients that underwent Achilles tendon surgical repair. Two different eccentric training programs were used to determine if different tendon mechanical loadings generated different structural and mechanical tendon adaptations.

MATERIAL AND METHODS

Trial design

This study is a randomized evaluator-blind controlled clinical trial, registered under the Clinical Trials (NCT03861572). Participants signed an informed consent form that contained all the information pertinent to this study that was approved by a local ethical committee (#96310118.4.0000.5347) in accordance with the Declaration of Helsinki.

Achilles tendon morphological and mechanical properties were evaluated at four different moments: (1) before training (Pre-training), (2) after 4 (Post-4); (3) after 8 (Post-8); and (4) after 12 (Post-12) weeks of training (Figure 4.1).

Participants

Participants were recruited primarily at the university campus, through informative posters about the research project, as well as by social networks. Participants were male and female subjects who suffered total acute Achilles tendon rupture, and who underwent surgical repair for at least 6 months before the study start and all had medical clearance for sports.

Sample size calculation was performed in the software G * Power 3.1.9.7 (Kiel University, Germany). Values of CSA (d=-1.03; r=-0.94) from a previous study from our group were used for the sample size calculations (GEREMIA *et al.*, 2018b). Considering an effect size *f* of 0.51, with a 0.05 significance level and power of 0.95, a total of 4 patients was needed for this study. Considering possible sample losses and higher variability in ruptured patients, 33 volunteers were invited to participate in the study. One subject declined to participate, two subjects did not meet the inclusion criteria, and two other participants did not attend the evaluation. Thus, 28 participants were randomized into two eccentric training groups.

Randomization was performed using a computer program to generate random numbers in permuted blocks, and the patients were assigned into two groups: the isokinetic eccentric training [ISOK; n: 14 (13 men and 1 woman), age: 38.4 ± 6.8 years old, body mass: 87.5 ± 14.8 kg, postoperative follow-up: 5.1 ± 5.2 years]; and the conventional eccentric training [CONV; n: 14 (13 men and 2 women), age: 37.7 ± 4.3 years old, body mass: 87.0 ± 10.0 kg, postoperative follow-up: 4.1 ± 3.5 years] group.

Interventions

Volunteers trained twice a week, with a minimum interval of 72 hours between sessions. The training programs had a total duration of twelve weeks,and were divided into three mesocycles of 4 weeks each. Two to four series of 8 to 12 repetitions were performed (with a one-minute interval between the series) in each training session so that the volume increment (number of series X number of trials per series) occurred gradually over the twelve training weeks. In the first mesocycle, the load was established in 60% of the maximal voluntary effort, followed by 70% in the second mesocycle and 80% in the last one. Both legs (injured and uninjured) were trained.

Patients in the ISOK group were trained in an isokinetic dynamometer (Biodex System Pro 3 isokinetic, Biodex Medical System, USA). The eccentric training was carried out with the volunteers positioned seated on the dynamometer. The movement was executed in the angular velocity of $30°\cdot s^{-1}$, in a 50° total ankle ROM, which was used for testing and for the training program.

Participants in the CONV group trained at the university gym, in the standing position, with the hip and knee fully extended, and the ankle moving from maximal plantar flexion to maximal dorsiflexion. The concentric phase was executed with both legs and the eccentric phase unilaterally, changing limb sides between series. After a standardized warm-up, they performed a one repetition maximum test (1RM) for each leg.

Evaluations

Measurement of Tendon Total and Free Lengths

Participants were positioned in ventral decubitus, with the knees fully extended, and the ankle joint in neutral position (heel line at a 90° angle with respect to the longitudinal axis of the leg, considered as 0° of plantarflexion). A customized system was used to secure the ankle at the neutral position, and the ankle joint position was measured with a digital goniometer. Participants rested for 10 minutes before the US tests and were instructed to not engage in any vigorous physical activity for the 48 hours prior to each evaluation.

Tendon length was defined as the distance between the Achilles tendon distal insertion (Figure 4.1A) and the distal myotendinous junction (MTJ) of the medial gastrocnemius muscle for the total tendon length (Figure 4.1B), whereas the free tendon length was measured up to the soleus distal MTJ (Figure 4.1C). The ultrasound (US) probe was placed longitudinally to the tendon to obtain total tendon length and free tendon length. The Achilles tendon insertion into the calcaneus bone was determined by US, and the respective point was marked on the skin. After this, the probe was moved to a proximal position until the visualization of the soleus and medial gastrocnemius MTJs, respectively, to obtain total and free tendon lengths, and the MTJs points were both marked on the skin (Figure 4.1D). The distance between the proximal and distal marked points on the skin was measured with a measuring tape, and these distances were considered representative of the total tendon length and the free tendon length, respectively (BROUWER *et al.*, 2018). Tendon length was normalized by the leg length.

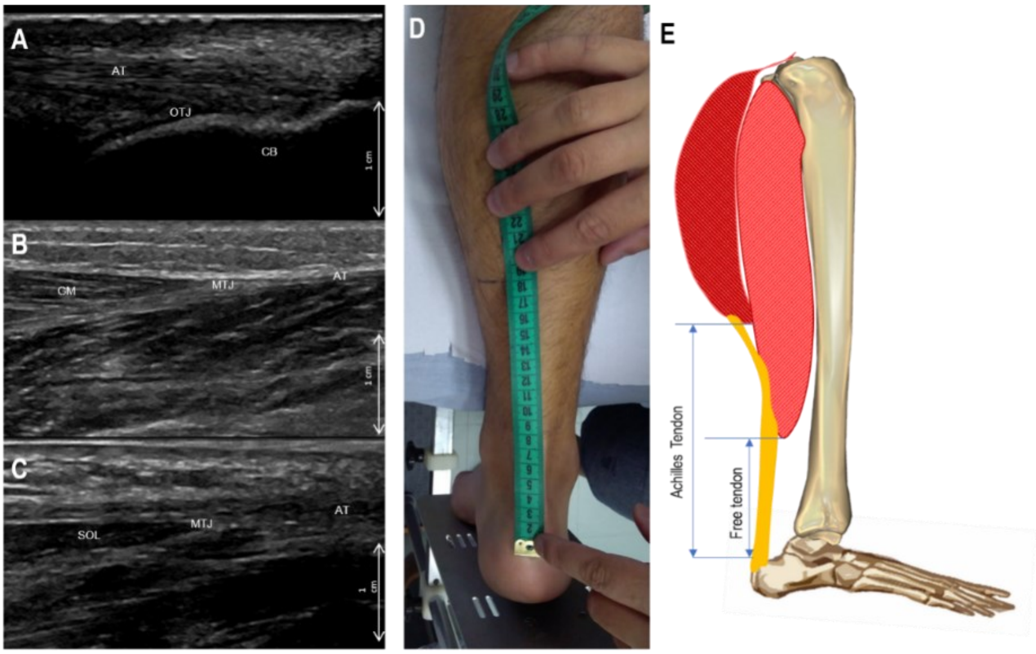


Figure 4.1. Measurement of the tendon length. (A) The most distal portion of the Achilles tendon (AT) inserted into the calcaneus bone (CB); (B) Myotendinous junction (MTJ) of the medial gastrocnemius muscle (GM) and (C) soleus; (D) The distance between the two marked spots on the skin was measured with a measuring tape; (E) a representative image of the measures.

Cross-sectional area (CSA) and Echo intensity

A B-mode US system (LOGIQ P6, GE Healthcare, Waukesha, Washington, United States of America) and a linear matrix array transducer (50mm, 15 MHz - GE Healthcare, Waukesha, Washington, United States of America) were used for the cross-sectional area (CSA) and echo intensity measurements. The frequency was set to 11 MHz, depth at 3.5 cm and focus was dynamically adjusted by the US operator. A four-years expert evaluator in ultrasonography of the Achilles tendon placed the US probe perpendicular to the tendon (Figure 4.2B) and three images were collected in each region in both legs (Figure 4.2C). Transverse images of the tendon were obtained about the distances of 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 cm (Figure 4.2A) from the muscle insertion in the calcaneus bone. Great care was taken to determine the specific sites where the images were collected from.

A blinded evaluator analyzed the images. During the tests, images were saved according to a random-number code to ensure that the image analysts were unaware of the identification of the images and which participants they represented. US images were digitized and analyzed with *ImageJ* version 1.8 software (National Institutes of Health, Bethesda, Maryland). CSA was measured in cm² and tendon echo intensity by gray-scale analysis using the standard histogram function (NADEAU *et al.*, 2016).

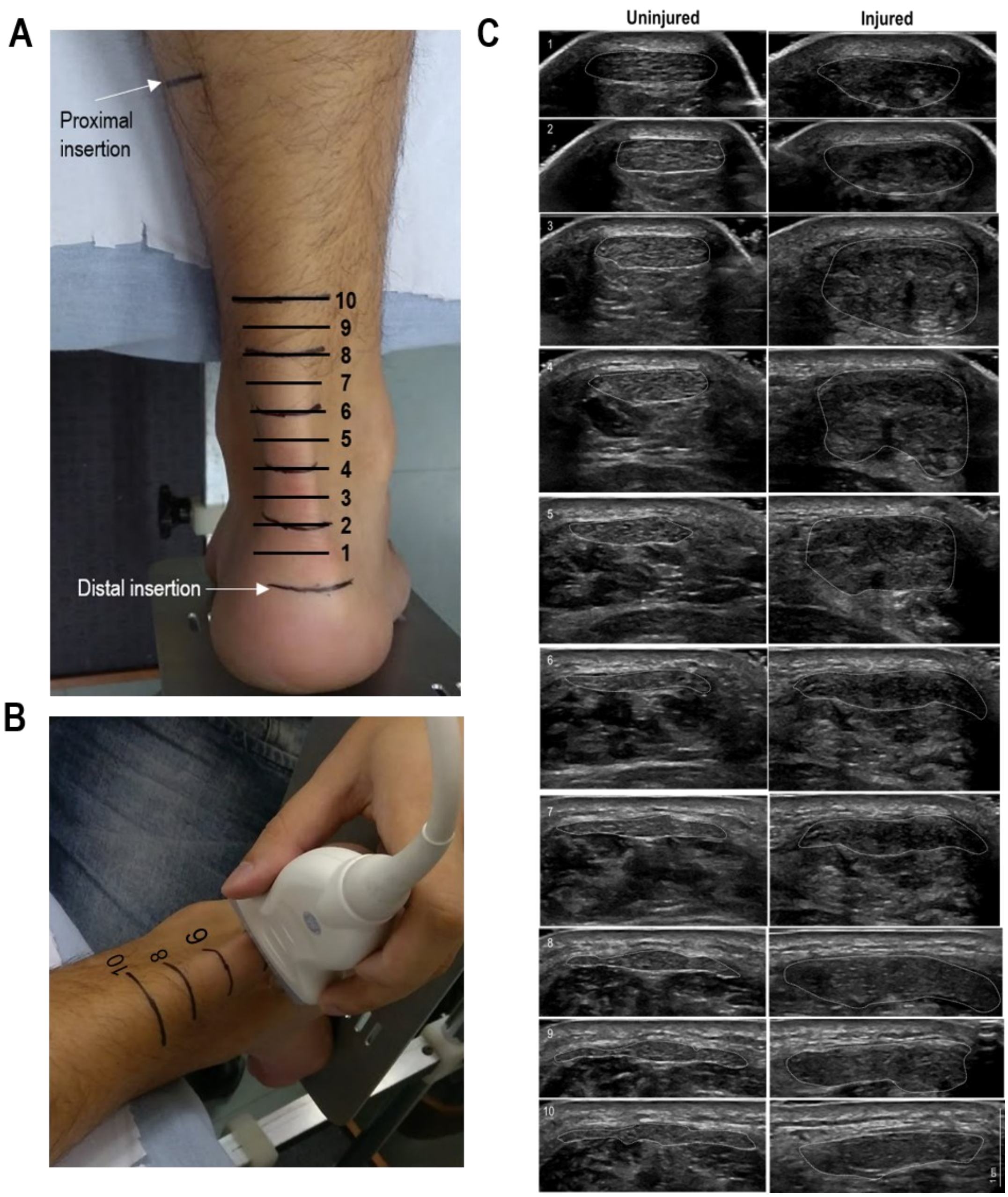


Figure 4.2. Cross-sectional area and echo intensity measurement. (A) The ten regions analyzed; (B) probe position; (C) representative images of the measures in each region for the uninjured and injured leg.

Statistical analysis

Descriptive statistics (mean and standard error) of all included variables are reported. A generalized estimating equation (GEE) method was conducted (group, leg, region and moments as factors, and interactions) with the correction of Bonferroni. All statistical analyses were performed using SPSS 26.0 statistical software (SPSS, Chicago, IL) with significance levels set at $p \leq 0.05$. When a training effect was identified, the effect size (Cohen's d) was calculated between pre- and post-12 weeks, and used to classify the training effect as trivial ($d < 0.2$), small ($d > 0.2$), moderate ($d > 0.5$), or large ($d > 0.8$) (COHEN, 1988).

RESULTS

Total Tendon length

The total tendon length at the injured leg was 6.2% longer than the uninjured leg [in cm ($X^2_{(1)}=25.5$; $p<0.001$) and normalized to the leg length ($X^2_{(1)}=27.4$; $p<0.001$)] (Figure 4.3A).

Free tendon length

After training, the CONV group presented a 12% longer free tendon length at the injured leg than the ISOK [in cm (p= 0.01, 95%CI, 0.2, 2.15) and normalized (p= 0.01, 95%CI, 0.7, 5.7)] (Figure 4.3B).

Free tendon length (Figure 4.3B) was higher at the injured tendon than the uninjured in the CONV group in the pre-training (p=0.004, 95%CI, 0.3, 1.9) and post-training (p=0.001, 95%CI, 0.5, 2.3). In the ISOK group, the injured tendon was longer only at post-8 (p=0.001, 95%CI, 0.6, 2.4) compared to the uninjured tendon.

The CONV training increased the uninjured tendon length at post-4 [in cm (p=0.001, 95%CI, -3, -0.4) and normalized (p=0.004, 95%CI, -7.2, -0.8)], post-8 [in cm (p=0.004, 95%CI, -3.1, -0.3) and normalized (p=0.01, 95%CI, -7.5, -0.5)], and post-12 (in cm, p=0.04, 95%CI, -1.3, -0.007) compared to pre-training.

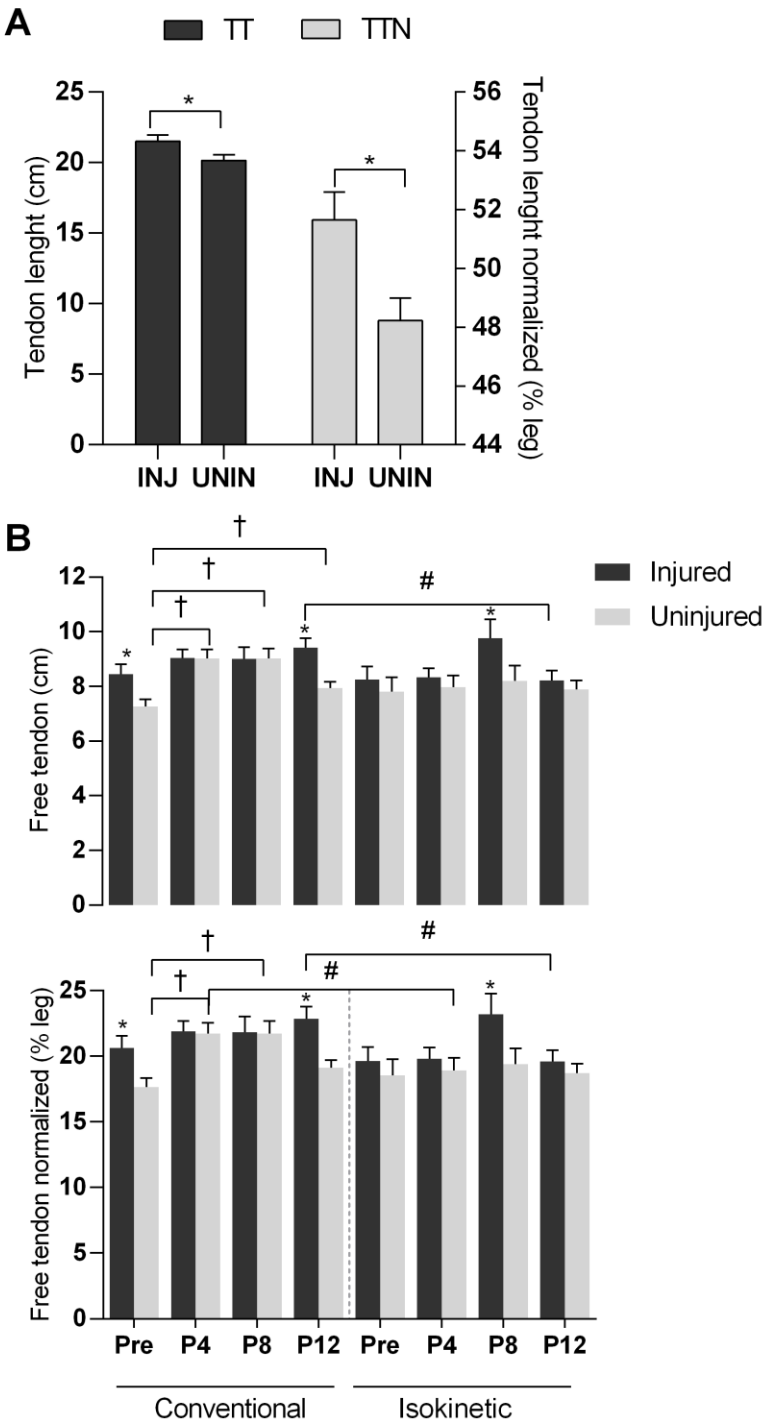


Figure 4.3. Tendon length. (A) Total tendon length; (B) Free tendon length. *difference between legs; # difference between groups; † difference between moments; TT= total tendon; TTN = total tendon normalized.

Cross-sectional area

Eccentric training increased the injured leg's tendon CSA in region 5 (Figure 4.4A) by 18% in the CONV group after 8 weeks of training (p=0.048; 95% CI -0.50, -0,001; d=0.67).

ISOK showed higher CSA at the uninjured leg than CONV at the end of training period (Figure 4.4) in regions 1 (29%; p=0.03; 95% CI, 0.03, 0.91), 3 (20%; p=0.02; 95% CI, 0.04, 0.47), 4 (21%; p=0.02; 95% CI, 0.03, 0.5), 6 (21%; p=0.04; 95% CI 0.009, 0.46), 7 (27%; p=0.011, 95%CI, 0.06, 0.49), 8 (28%; p=0.014, 95%CI, 0.05, 0.44) and 9 (35%; p=0.002, 95%CI, 0.10, 0.48). Patients in ISOK had higher CSA pre-training in region 7 (p=0.025, 95%CI, 0.02, 0.36) of the uninjured tendon compared to CONV.

The injured tendon in the CONV group had higher CSA at post-12 (Figure 4.4) in the regions 1 (p=0.016, 95%CI, 0.067, 0.66), 2 (p=0.008, 95%CI, 0.08, 0.54), 3 (p=0.02, 95%CI, 0.07, 0.84), 4 (p=0.04, 95%CI, 0.01, 0.53), 6 (p=0.02, 95%CI, 0.03, 0.55), 7 (p=0.002, 95%CI, 0.12, 0.53), 8 (p=0.007, 95%CI, 0.08, 0.55) and 9 (p<0.001, 95%CI, 0.24, 0.70). In ISOK, the injured tendon had higher CSA at pre-training in regions 8 (p=0.02, 95%CI, 0.03, 0.43), 9 (p=0.02, 95%CI, 0.02, 0.43) and 10 (p=0.04, 95%CI, 0.009, 0.52), and region 9 also presented between-tendons difference at post-8 (p=0.04, 95%CI, 0.009, 0.51).

Comparisons between regions

In the CONV group, both legs presented differences between the different regions of the tendon at pre-training, although these differences decreased mainly at the injured leg. In ISOK, the injured leg did not show differences between the regions at pre-training, but some differences appeared at post-4 and decreased at post-8 and post-12, being present mainly in region 10. The uninjured tendon presented between-regions differences at pre-training, and these differences decreased probably due to the training. All between-regions comparisons are summarized in figure 4.4B, and all statistical values are presented in supplementary table 4.1.

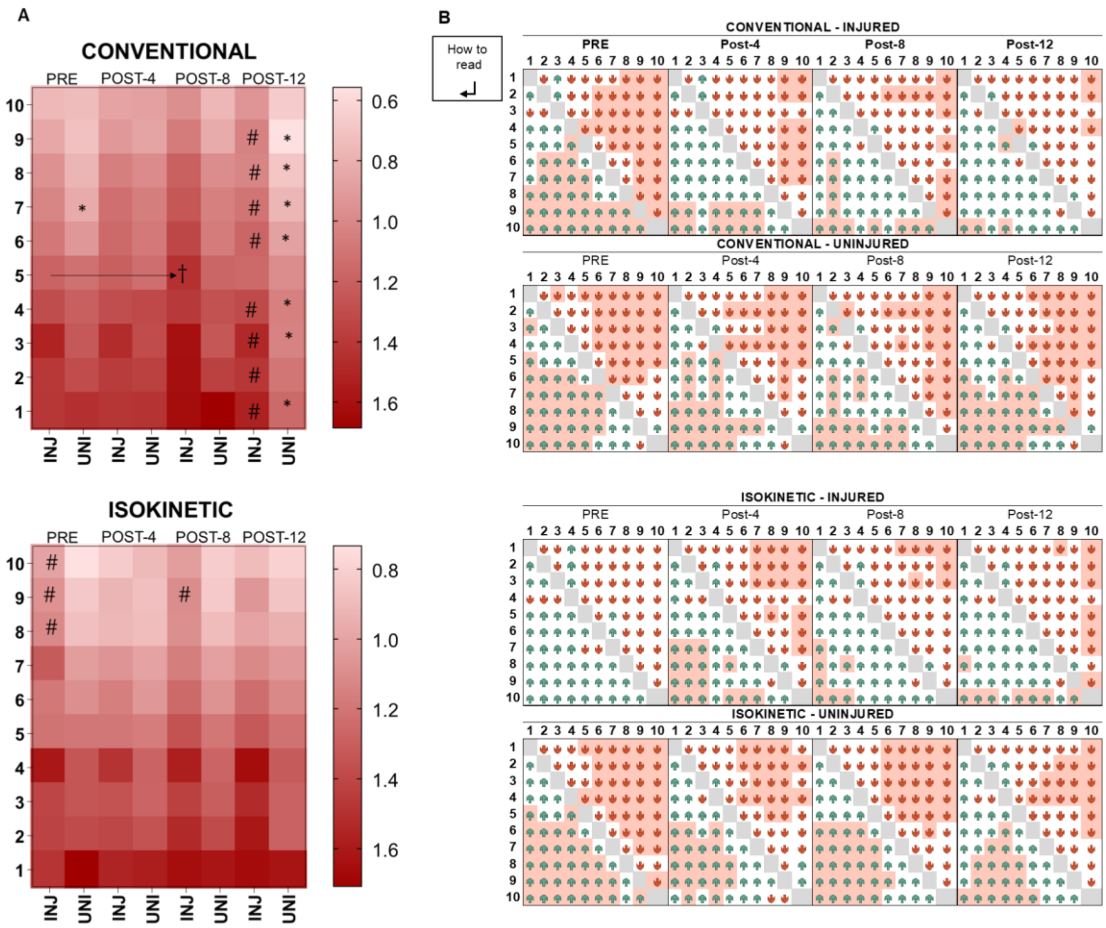


Figure 4.4. Cross-sectional area. (A) Heat map where higher area values are depicted with darker or stronger color. † means training effect; * means differences between groups; # differences between legs; (B) Differences between regions for each group, leg and moment. Arrows up are positive mean difference; arrows down are the negative mean difference. Painted in red present statistical significance (p<0.05).

Echo intensity

There was no training effect on echo intensity in both tendons (p=0.28). In the CONV group, the injured tendon had lower echo intensity in the regions 1, 2, 3, 4, 6, 7 and 8 in all moments, in region 9 at post-4, post-8 and post-12, and in region 10 at post-12 than the uninjured one (Figure 4.5; statistical values are in supplementary table 4.2). In the ISOK group, the injured tendon had also lower echogenicity than the uninjured tendon in the regions 2 and 3 at all moments; in regions 4, 5, 6, 7, 8 and 9 at post-4 and post-8; in region 1 at post-8; and in regions 6 and 10 at post-12 (Figure 4.5; statistical values are in supplementary table 4.1).

The injured tendon of the CONV group had lower echo intensity in region 8 (p=0.045, 95%CI, -23.2, -0.2) at pre-training; higher in region 6 at post-4 (p=0.049, 95%CI, -0.03, 15.9); and lower in region 9 (p=0.027, 95%CI, -19.8, -1.2) and region 10 (p=0.027, 95%CI, -18.3, -1.0) at post-12 than ISOK (Figure 4.5). The uninjured tendon of the CONV group had lower echogenicity only in region 10 (Figure 5, p=0.021, 95%CI, -20.1, -1.6).

Comparisons between regions

All comparisons between regions are summarized in figure 4.6 and all statistical values are presented in supplementary table 4.3.

Conventional group

Injured tendon

At pre-training, region 2 had lower echogenicity than region 5 (p=0.016, 95%CI, -12.3, -0.5).

At post-4, region 2 had lower echogenicity than region 6 (p=0.006, 95%CI, -24.4, -1.9) and 7 (p=0.002, 95%CI, -20.1, -2.1), while region 3 had lower echogenicity than region 6 (p=0.022, 95%CI, -19.3, -0.6).

At post-8, region 2 had lower echogenicity than region 5 (p=0.002, 95%CI, -21.7, -2.4), 6 (p=0.01, 95%CI, -19.1, -1.2), 7 (p=0.02, 95%CI, -17.5, -0.4), 8 (p=0.006, 95%CI, -20.03, -1.6), 9 (p=0.03, 95%CI, -22.9, -0.3) and 10 (p=0.003, 95%CI, -28.1, -2.9).

At post-12, regions 1, 2 and 4 had lower echogenicity than region 7 [region 1 (p=0.02, 95%CI, -21.9, -0.7); region 2 (p=0.04, 95%CI, -23.3, -0.1); region 4 (p=0.002, 95%CI, -12.1, -1.3)] and 8 [region 1 (p=0.01, 95%CI, -19.8, -1.09); region 2 (p=0.003, 95%CI, -19.8, -1.9); region 4 (p=0.01, 95%CI, -11.2, -0.4)].

Uninjured tendon

At post-8, region 9 had higher echogenicity than regions 8 (p=0.04, 95%CI, 0.02, 6.4) and 10 (p=0.04, 95%CI, 0.02, 9.2). At post-12, region 3 had higher echogenicity than regions 1 (p=0.008, 95%CI, 1.4, 19.8), 4 (p=0.006, 95%CI, 0.9, 11.9), 5 (p=0.001, 95%CI, 1.5, 11.8), 7 (p<0.001, 95%CI, 1.9, 12.5), 8 (p<0.001, 95%CI, 3.4, 15.8), 9 (p=0.02, 95%CI, 0.5, 16.3) and 10 (p<0.001, 95%CI, 3.5, 18.1).

Isokinetic group

Injured tendon

At pre-training, region 8 had higher echogenicity than regions 1 (p=0.005, 95%CI, 1.98, 23.06), 2 (p=0.01, 95%CI, 1.3, 21.7), 5 (p=0.04, 95%CI, 0.08, 12.7) and 6 (p=0.03, 95%CI, 0.2, 14.1), while region 10 had higher echogenicity than regions 2 (p=0.03, 95%CI, 0.26, 24.5), 4 (p=0.04, 95%CI, 0.11, 16.8) and 5 (p=0.03, 95%CI, 0.18, 14.3).

At post-4, regions 1 and 2 had lower echogenicity than regions 7 [region 1 (p=0.002, 95%CI, -19.5, -2.2), region 2 (p=0.004, 95%CI, -20.3, -1.8)] and 8 [region 1 (p=0.001, 95%CI, -20.5, -2.7), region 2 (p=0.001, 95%CI, -21, -2.6)]. Region 10 had higher echogenicity than regions 1 (p<0.001, 95%CI, 5.7, 32.7), 2 (p<0.001, 95%CI, 8.0, 30.8), 3 (p<0.001, 95%CI, 5.5, 32.8), 4 (p<0.001, 95%CI, 3.8, 23.2), 5 (p=0.012, 95%CI, 1.2, 23.3) and 6 (p<0.001, 95%CI, 4.1, 24.2).

At post-8, region 1 had lower echogenicity than regions 7 (p<0.001, 95%CI, -12.7, -2.8), 8 (p=0.003, 95%CI, -16.7, -1.7), 9 (p<0.001, 95%CI, -19.9, -4.9) and 10 (p<0.001, 95%CI, -23.5, -6.5). Region 2 had lower echogenicity than regions 9 (p=0.009, 95%CI, -22.4, -1.4) and 10 (p<0.001, 95%CI, -24.5, -4.4). Finally, regions 3 and 4 had lower echogenicity than 10 [region 3 (p=0.04, 95%CI, -24.7, -0.04) and region 4 (p=0.004, 95%CI, -15.8, -1.4)].

Uninjured tendon

At post-4, region 6 had lower echogenicity than region 8 (p=0.01, 95%CI, -9.7, -0.4).

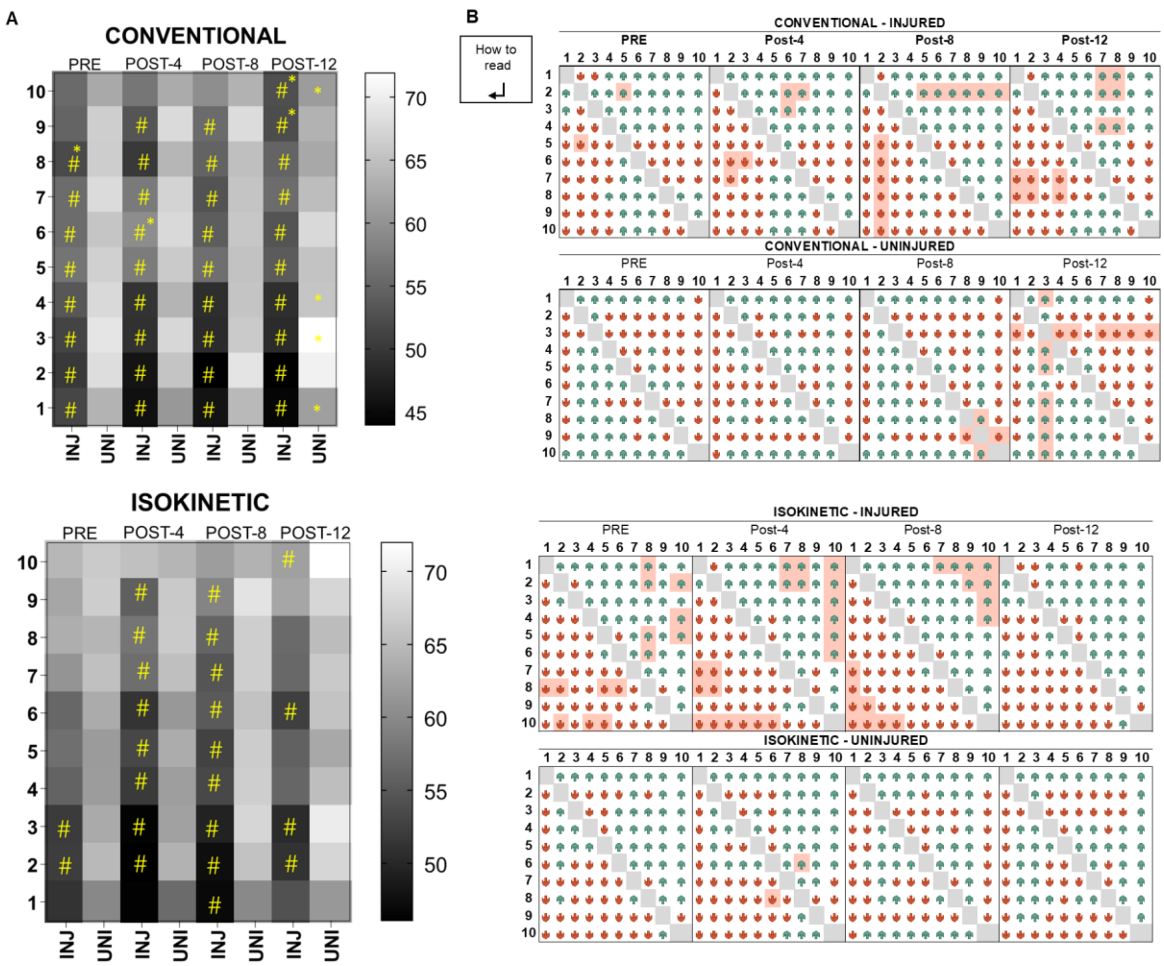


Figure 4.5. Echo intensity. (A) Heat map where lower echointensity values are shown in darker colour; * means differences between groups; # differences between legs (B) Differences between regions for each group, leg, and moment. Arrows up are positive mean difference; arrows down are the negative mean difference. Painted in red are presented the between-regions statistical significance (p<0.05).

DISCUSSION

In this study, we verified the effects of twelve weeks of eccentric training in tendon length, and in CSA and echo-intensity from different regions of the tendon in participants that underwent Achilles tendon surgical repair. Our main results are that: (1) the CONV training was able to increase the CSA of the injured tendon post-8; (2) distal regions presented higher CSA and lower echo intensity than proximal areas; (3) CONV training decreased the CSA differences between regions of the injured tendon and the ISOK decreased the echo intensity differences between regions; (4) CONV had lower echo intensity than ISOK post-12; (5) injured tendon had higher CSA, larger tendon length and lower echo intensity than the uninjured one; (6) CONV had longer free tendon length than ISOK after twelve weeks of training; (7) CONV increased the uninjured tendon length after four weeks of eccentric training.

The CONV training increased in ~18% the CSA at region 5 after eight weeks of training. This region has been described as the narrowest CSA of the whole tendon (KONGSGAARD *et al.*, 2005). Tendon hypertrophy is related to changes in tendon stiffness that also increase post-8 weeks of eccentric training (GEREMIA *et al.*, 2018a). This increase in tendon CSA will yield less strain energy and will reduce the stress in the tendon (KJÆR & MAGNUSSON, 2008), which is beneficial because it reduces the risk of re-ruptures and tendinopathies. Moreover, there is intensity-specific tendon hypertrophy with high-intensity training (BOHM *et al.*, 2015).

Tendon adaptations are not uniform along the tendon. Resistance training for the knee extensors during 12 weeks increased patellar tendon CSA from the proximal to the distal tendon region with smaller increases at the proximal compared to the mid- and distal-tendon regions (KONGSGAARD *et al.*, 2007). In previous studies, the CSA area was evaluated as the mean value from different areas of the tendon (GEREMIA *et al.*, 2015; GEREMIA *et al.*, 2018a). However, for clinical conditions, we should consider different tendon regions, as the location of the Achilles tendon rupture is usually within a poorly vascularized zone, 2 to 6 cm proximal to the calcaneal insertion (HESS, 2010).

Distal regions of the tendon present higher CSA with lower echo-intensity. After rupture, the injured leg presents longer tendons, larger tendons (due to scar tissue) with lower shear modulus than uninjured tendons, and this has been related to plantar flexor function at 1-year after Achilles tendon rupture (ZELLERS *et al.*, 2019b). In addition, in this distal area, we found a lower echo intensity of the injured tendon. This tendon abnormality corresponded with areas of altered collagen fiber structure and increased interfibrillar ground substance (proteoglycans and hydrophilic glycosaminoglycan) (ALFREDSON & COOK, 2007), and can reflect tendons with tendinopathy (VAN SCHIE *et al.*, 2010; GATZ *et al.*, 2020).

We found that the injured tendon is longer than the uninjured tendon. After rupture, the total tendon length to the gastrocnemius myotendinous junction is longer at the ruptured compared to the healthy side (ZELLERS *et al.*, 2017; OKOROHA *et al.*, 2020). We found mean values on the injured side of 21.5 cm compared to 20.1 cm on the uninjured side, similar to the values reported by ZELLERS *et al.* (2017), who found mean values of 22.8 cm on the injured and 21.6 cm on the uninjured sides, respectively. This tendon elongation is a limiting factor in achieving the full return of function, as the degree of tendon elongation correlates with the deficit in heel-rise height in patients with a complete Achilles tendon rupture that has been surgically repaired (SILBERNAGEL *et al.*, 2012). Moreover, patients after Achilles rupture have smaller calf circumference, increased tendon length and decreased heel-rise performance on the injured than the uninjured side (ZELLERS *et al.*, 2017).

Our results showed that the free tendon length of the CONV group was longer in the injured leg at pre-training, and that this training modality increased the uninjured free tendon length after four weeks of training. We also showed that the free tendon length is 12% longer in the injured leg of the CONV group than the ISOK group. Our results for the free tendon length pre training of ~8 cm in the injured tendon and ~7 cm at the uninjured side were higher than KONGSGAARD *et al.* (2005) values who found 4.9 cm in healthy untrained tendons, 7 cm in runner's tendons, 5.2 cm in volleyball players tendons and 5.4 cm in ruptured tendons.

The eccentric training did not increase the total tendon length. Tendon elongation should be avoided if possible, because it has been related to functional deficits (SILBERNAGEL *et al.*, 2012). After surgery, early rehabilitation should apply controlled loading, and the eccentric action can be an option. Previous studies (GEREMIA *et al.*, 2015; OKOROHA *et al.*, 2020) that compared traditional immobilization postoperative regimen with early rehabilitation did not find differences in tendon length between patients undergoing traditional versus early rehabilitation postoperatively.

We evaluated the CSA using ultrasound, and this can be a limitation once this technique has low quality of objectivity, reliability and validity (BOHM *et al.*, 2016). However, we believe that using US to determine CSA was not a severe limitation of our study, because the CSA was determined by the same evaluator in ten different regions of the tendon. Moreover, this technique is widely used due to low cost and clinical applicability (KONGSGAARD *et al.*, 2005; KONGSGAARD *et al.*, 2007; ARYA & KULIG, 2010; VAN SCHIE *et al.*, 2010; GEREMIA *et al.*, 2015; GEREMIA *et al.*, 2018a; ZELLERS *et al.*, 2019b). In a preliminary study from our group (unpublished results), our intra-rater comparisons for the Achilles tendon CSA showed high ICCs (0.986; 95% CI 0.843, 0.964), with the standard error of measurement and minimum detectable change values low for the obtained measurements (2.18 mm^2 and 4.66 mm^2, respectively).

CONCLUSION

Achilles tendon rupture determines a larger tendon CSA and lower echo intensity several years post-surgery, mainly in the distal region of the tendon, and longer length than the uninjured tendon. CONV eccentric training increased by 18% the CSA of the injured tendon, while the ISOK training increased by 21-35% the tendon CSA at the end of the training program (post-12 weeks). CONV decreased between-regions differences in CSA in the injured tendon and increase the echo intensity in proximal regions.

FINAL CONSIDERATIONS

In this thesis, we showed that Achilles tendon rupture happens, and early interventions are as effective as traditional physiotherapy interventions in reestablishing the plantar flexor strength, but there is a high bias and variability between studied protocols. However, the early aggressive protocol is more effective at improving ankle joint ROM and decreasing eccentric torque deficit compared to the traditional immobilization programs. Therefore, early protocols should be better structured and based on training principles that could promote better neuromechanical adaptations to the triceps surae muscle.

Our early rehabilitation program based on training principles (e.g., increased overload) was more effective than the traditional immobilization to increase the ankle ROM, medial gastrocnemius fascicle length and muscle thickness, without modifying pennation angles. However, we showed that, regardless of the rehabilitation program, the injured leg had lower ankle ROM, fascicle length, muscle thickness, and torque production than the uninjured leg, and both programs increased the ROM and muscle thickness. Although one of the beneficial effects of the rehabilitation protocols was a higher capacity of torque production, patients lost ankle ROM and muscle thickness in the long-term of at least 30 months. Thinking in a long term follow up, and return to sports, we proposed to apply eccentric training aimed at promoting more mechanical load at the tendon, thereby avoiding and/or possibly reducing long-term deficits after Achilles tendon rupture.

Preview studies in our group showed the beneficial effects of the high loading isokinetic eccentric training on triceps surae muscle-tendon unit (GEREMIA *et al.*, 2018a; GEREMIA *et al.*, 2018b; GEREMIA *et al.*, 2019) in healthy tendons. However, although Isokinetic eccentric training has been used in rehabilitation programs, the isokinetic dynamometer is an expensive rehabilitation tool, and it is not accessible to most clinicians. Because of that, we compared the isokinetic eccentric training with conventional eccentric training on gym machines in order to see if the conventional training would produce similar or even better adaptations in the surgically repaired Achilles tendon. If so, we would be able to use simpler and less expensive tools to rehabilitate these patients. We found that eccentric training improved muscle thickness, muscle activation, plantarflexion torque and ankle ROM after eight weeks of training, regardless of the exercise modality, in patients who had Achilles tendon surgical reconstruction. Our results showed that eccentric training is a good strategy to improve functional and neuromechanical outcomes in patients after Achilles tendon rupture. Finally, we verified if these improvements caused by the eccentric training would reflect on Achilles tendon morphology and tissue quality.

In regard to tendon plasticity, we verified the effect of twelve weeks of eccentric training on morphology and tendon quality (cross-sectional area and echo intensity) in different regions of the Achilles tendon and in tendon length in patients that had Achilles tendon rupture several years ago. Our main findings were that the injured tendon has a higher CSA, longer tendon length and lower echo intensity than the uninjured one. We also found that the CONV eccentric training increases the CSA in the middle region of the injured tendon after eight weeks of training and has lower echo intensity than the ISOK eccentric training after twelve weeks. Despite the morphological deficits in the injured tendon after years from the surgery, eccentric training can hypertrophy and increase the echogenicity of the tendon.

There is a large interest in early rehabilitation protocols after Achilles tendon rupture, as they may improve clinical practice. Many advances have been achieved with early rehabilitation protocols in that Achilles tendon rupture patients. However, most protocols are conservative in terms of loading the ruptured tendon to avoid re-ruptures, and this may underload the tendon during rehabilitation, thereby creating the observed structural and mechanical deficits. Here we evaluated two different eccentric protocols that produced several structural and functional adaptations both at the injured and the uninjured tendons. Therefore, we should consider applying eccentric exercises in the final rehabilitation of these patients before discharging them. Physical therapists and physical educators should be working in a transdisciplinary model to promote better recovery of these patients and avoiding functional deficits that can lead to re-ruptures and/or tendinopathies.

REFERENCES

ALFREDSON, H.; COOK, J. A treatment algorithm for managing Achilles tendinopathy: new treatment options. **Br J Sports Med**, 41, n. 4, p. 211-216, Apr 2007.

ALFREDSON, H.; PIETILA, T.; JONSSON, P.; LORENTZON, R. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. **Am J Sports Med**, 26, n. 3, p. 360-366, May-Jun 1998.

ARYA, S.; KULIG, K. Tendinopathy alters mechanical and material properties of the Achilles tendon. **J Appl Physiol (1985)**, 108, n. 3, p. 670-675, Mar 2010.

BAKER, D.; WILSON, G.; CARLYON, R. Periodization: The Effect on Strength of Manipulating Volume and Intensity. **J Strength Cond Res**, 8, n. 4, p. 235-242, 1994.

BALTZOPOULOS, V.; BRODIE, D. A. Isokinetic dynamometry. Applications and limitations. **Sports Med**, 8, n. 2, p. 101-116, Aug 1989.

BAXTER, J. R.; HULLFISH, T. J.; CHAO, W. Functional deficits may be explained by plantarflexor remodeling following Achilles tendon rupture repair: Preliminary findings. **J Biomech**, 79, p. 238-242, Oct 5 2018.

BEYER, R.; KONGSGAARD, M.; HOUGS KJAER, B.; OHLENSCHLAEGER, T. *et al.* Heavy Slow Resistance Versus Eccentric Training as Treatment for Achilles Tendinopathy: A Randomized Controlled Trial. **Am J Sports Med**, 43, n. 7, p. 1704-1711, Jul 2015.

BLAZEVICH, A. J. Effects of physical training and detraining, immobilisation, growth and aging on human fascicle geometry. **Sports Medicine**, 36, n. 12, p. 1003-1017, 2006.

BOHM, S.; MERSMANN, F.; ARAMPATZIS, A. Human tendon adaptation in response to mechanical loading: a systematic review and meta-analysis of exercise intervention studies on healthy adults. **Sports Med Open**, 1, n. 1, p. 7, Dec 2015.

BOHM, S.; MERSMANN, F.; SCHROLL, A.; MAKITALO, N. *et al.* Insufficient accuracy of the ultrasound-based determination of Achilles tendon cross-sectional area. **J Biomech**, 49, n. 13, p. 2932-2937, Sep 6 2016.

BOSTICK, G. P.; JOMHA, N. M.; SUCHAK, A. A.; BEAUPRE, L. A. Factors associated with calf muscle endurance recovery 1 year after achilles tendon rupture repair. **J Orthop Sports Phys Ther**, 40, n. 6, p. 345-351, Jun 2010.

BRORSSON, A.; GRAVARE SILBERNAGEL, K.; OLSSON, N.; NILSSON HELANDER, K. Calf Muscle Performance Deficits Remain 7 Years After an Achilles Tendon Rupture. **Am J Sports Med**, 46, n. 2, p. 470-477, Feb 2018.

BRORSSON, A.; WILLY, R. W.; TRANBERG, R.; GRAVARE SILBERNAGEL, K. Heel-Rise Height Deficit 1 Year After Achilles Tendon Rupture Relates to Changes in Ankle Biomechanics 6 Years After Injury. **Am J Sports Med**, 45, n. 13, p. 3060-3068, Nov 2017.

BROUWER, E. F.; MYHRVOLD, S. B.; BENTH, J. S.; HOELSBREKKEN, S. E. Ultrasound measurements of Achilles tendon length using skin markings are more reliable than extended-field-of-view imaging. **Knee Surg Sports Traumatol Arthrosc**, 26, n. 7, p. 2088-2094, Jul 2018.

BUCHGRABER, A.; PASSLER, H. H. Percutaneous repair of Achilles tendon rupture: Immobilization versus functional postoperative treatment. **Clin Orthop Relat Res**, n. 341, p. 113-122, Aug 1997.

CETTI, R.; HENRIKSEN, L. O.; JACOBSEN, K. S. A new treatment of ruptured Achilles tendons. A prospective randomized study. **Clin Orthop Relat Res**, n. 308, p. 155-165, Nov 1994.

CHEN, T. M.; ROZEN, W. M.; PAN, W. R.; ASHTON, M. W. *et al.* The arterial anatomy of the Achilles tendon: anatomical study and clinical implications. **Clin Anat**, 22, n. 3, p. 377-385, Apr 2009.

CHIMENTI, R. L.; FLEMISTER, A. S.; TOME, J.; MCMAHON, J. M. *et al.* Altered tendon characteristics and mechanical properties associated with insertional achilles tendinopathy. **J Orthop Sports Phys Ther**, 44, n. 9, p. 680-689, Sep 2014.

CHRISTENSEN, B.; DYRBERG, E.; AAGAARD, P.; ENEHJELM, S. *et al.* Effects of long-term immobilization and recovery on human triceps surae and collagen turnover in the Achilles tendon in patients with healing ankle fracture. **J Appl Physiol (1985)**, 105, n. 2, p. 420-426, Aug 2008.

CLARK, B. C. In vivo alterations in skeletal muscle form and function after disuse atrophy. **Med Sci Sports Exerc**, 41, n. 10, p. 1869-1875, Oct 2009.

COHEN, J. **Statistical power analysis for the behavioral sciences**. 2nd ed. USA: Lawrence Erlbaum Associates, Publishers, 1988.

COHEN, J. C. Anatomy and biomechanical aspects of the gastrocsoleus complex. **Foot Ankle Clin**, 14, n. 4, p. 617-626, Dec 2009.

COSTA, M.; MACMILLAN, K.; HALLIDAY, D.; CHESTER, R. *et al.* Randomised controlled trials of immediate weight-bearing mobilisation for rupture of the tendo Achillis. **J Bone Joint Surg Am**, 88, n. 1, p. 69-77, 2006.

COSTA, M.; SHEPSTONE, L.; DARRAH, C.; MARSHALL, T. *et al.* Immediate full-weight-bearing mobilisation for repaired Achilles tendon ruptures: a pilot study. **Injury**, 34, n. 11, p. 874-876, 2003. Clinical Trial; Randomized Controlled Trial.

DE LA FUENTE, C.; PENA Y LILLO, R.; CARRENO, G.; MARAMBIO, H. Prospective randomized clinical trial of aggressive rehabilitation after acute Achilles tendon ruptures repaired with Dresden technique. **The Foot**, 26, p. 15-22, 2016a.

DE LA FUENTE, C. I.; LILLO, R. P.; RAMIREZ CAMPILLO, R.; ORTEGA-AURIOL, P. *et al.* Medial gastrocnemius myotendinous junction displacement and plantar-flexion strength in patients treated with immediate rehabilitation after Achilles tendon repair. **J Athl Train**, 51, n. 12, p. 1013-1021, Dec 2016b.

DUCLAY, J.; MARTIN, A.; DUCLAY, A.; COMETTI, G. *et al.* Behavior of fascicles and the myotendinous junction of human medial gastrocnemius following eccentric strength training. **Muscle Nerve**, 39, n. 6, p. 819-827, Jun 2009.

EL-AKKAWI, A. I.; JOANROY, R.; BARFOD, K. W.; KALLEMOSE, T. *et al.* Effect of Early Versus Late Weightbearing in Conservatively Treated Acute Achilles Tendon Rupture: A Meta-Analysis. **J Foot Ankle Surg**, 57, n. 2, p. 346-352, Mar - Apr 2018.

ELIASSON, P.; AGERGAARD, A. S.; COUPPE, C.; SVENSSON, R. *et al.* The Ruptured Achilles Tendon Elongates for 6 Months After Surgical Repair Regardless of Early or Late Weightbearing in Combination With Ankle Mobilization: A Randomized Clinical Trial. **Am J Sports Med**, 46, n. 10, p. 2492-2502, Jun 1 2018.

FIGUEIREDO, V. C.; DE SALLES, B. F.; TRAJANO, G. S. Volume for Muscle Hypertrophy and Health Outcomes: The Most Effective Variable in Resistance Training. **Sports Med**, 48, n. 3, p. 499-505, Mar 2018.

FOLLAND, J. P.; WILLIAMS, A. G. The adaptations to strength training : morphological and neurological contributions to increased strength. **Sports Med**, 37, n. 2, p. 145-168, 2007a.

FOLLAND, J. P.; WILLIAMS, A. G. The adaptations to strength training: morphological and neurological contributions to increased strength. **Sports Med**, 37, n. 2, p. 145-168, 2007b.

FREEMAN, M. A. Treatment of ruptures of the lateral ligament of the ankle. **J Bone Joint Surg Br**, 47, n. 4, p. 661-668, Nov 1965.

FREITAS, S. R.; MIL-HOMENS, P. Effect of 8-week high-intensity stretching training on biceps femoris architecture. **J Strength Cond Res**, 29, n. 6, p. 1737-1740, Jun 2015.

FRIZZIERO, A.; TRAINITO, S.; OLIVA, F.; NICOLI ALDINI, N. *et al.* The role of eccentric exercise in sport injuries rehabilitation. **British Medical Bulletin**, 110, p. 47-75, 2014.

GATZ, M.; BETSCH, M.; DIRRICHS, T.; SCHRADING, S. *et al.* Eccentric and Isometric Exercises in Achilles Tendinopathy Evaluated by the VISA-A Score and Shear Wave Elastography. **Sports Health**, 12, n. 4, p. 373-381, Jul/Aug 2020.

GEREMIA, J. M.; BARONI, B. M.; BINI, R. R.; LANFERDINI, F. J. *et al.* Triceps Surae Muscle Architecture Adaptations to Eccentric Training. **Front Physiol**, 10, p. 1456, 2019.

GEREMIA, J. M.; BARONI, B. M.; BOBBERT, M. F.; BINI, R. R. *et al.* Effects of high loading by eccentric triceps surae training on Achilles tendon properties in humans. **Eur J Appl Physiol**, 118, n. 8, p. 1725-1736, Aug 2018a.

GEREMIA, J. M.; BARONI, B. M.; LANFERDINI, F. J.; BINI, R. R. *et al.* Time course of neuromechanical and morphological adaptations to triceps surae isokinetic eccentric training. **Phys Ther Sport**, 34, p. 84-91, Nov 2018b.

GEREMIA, J. M.; BOBBERT, M. F.; CASA NOVA, M.; OTT, R. D. *et al.* The structural and mechanical properties of the Achilles tendon 2 years after surgical repair. **Clin Biomech (Bristol, Avon)**, 30, n. 5, p. 485-492, Jun 2015.

GONDIN, J.; GUETTE, M.; MAFFIULETTI, N. A.; MARTIN, A. Neural activation of the triceps surae is impaired following 2 weeks of immobilization. **Eur J Appl Physiol**, 93, n. 3, p. 359-365, Dec 2004.

GROETELAERS, R. P.; JANSSEN, L.; VAN DER VELDEN, J.; WIELAND, A. W. *et al.* Functional Treatment or Cast Immobilization After Minimally Invasive Repair of an Acute Achilles Tendon Rupture: Prospective, Randomized Trial. **Foot Ankle Int**, 35, n. 8, p. 771-778, Aug 2014.

GUZZONI, V.; SELISTRE-DE-ARAUJO, H. S.; MARQUETI, R. C. Tendon Remodeling in Response to Resistance Training, Anabolic Androgenic Steroids and Aging. **Cells**, 7, n. 12, Dec 7 2018.

HEIKKINEN, J.; LANTTO, I.; PIILONEN, J.; FLINKKILA, T. *et al.* Tendon Length, Calf Muscle Atrophy, and Strength Deficit After Acute Achilles Tendon Rupture: Long-Term Follow-up of Patients in a Previous Study. **J Bone Joint Surg Am**, 99, n. 18, p. 1509-1515, Sep 20 2017.

HEINEMEIER, K. M.; KJAER, M. In vivo investigation of tendon responses to mechanical loading. **J Musculoskelet Neuronal Interact**, 11, n. 2, p. 115-123, Jun 2011.

HERZOG, W. Mechanisms of enhanced force production in lengthening (eccentric) muscle contractions. **J Appl Physiol (1985)**, 116, n. 11, p. 1407-1417, Jun 01 2014.

HERZOG, W.; POWERS, K.; JOHNSTON, K.; DUVALL, M. A new paradigm for muscle contraction. **Front Physiol**, 6, p. 174, 2015.

HERZOG, W.; TER KEURS, H. E. Force-length relation of in-vivo human rectus femoris muscles. **Pflugers Arch**, 411, n. 6, p. 642-647, 1988.

HESS, G. W. Achilles tendon rupture: a review of etiology, population, anatomy, risk factors, and injury prevention. **Foot Ankle Spec**, 3, n. 1, p. 29-32, Feb 2010.

HIGGINS, J. P.; ALTMAN, D. G.; GOTZSCHE, P. C.; JUNI, P. *et al.* The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. **BMJ**, 343, p. d5928, Oct 18 2011.

HIGGINS, J. P.; THOMPSON, S. G.; DEEKS, J. J.; ALTMAN, D. G. Measuring inconsistency in meta-analyses. **BMJ**, 327, n. 7414, p. 557-560, Sep 6 2003.

HOPKINS, W. G.; MARSHALL, S. W.; BATTERHAM, A. M.; HANIN, J. Progressive statistics for studies in sports medicine and exercise science. **Med Sci Sports Exerc**, 41, n. 1, p. 3-13, Jan 2009.

HUANG, J.; WANG, C.; MA, X.; WANG, X. *et al.* Rehabilitation regimen after surgical treatment of acute Achilles tendon ruptures: a systematic review with meta-analysis. **Am J Sports Med**, 43, n. 4, p. 1008-1016, Apr 2014.

HUTTUNEN, T. T.; KANNUS, P.; ROLF, C.; FELLANDER-TSAI, L. *et al.* Acute achilles tendon ruptures: incidence of injury and surgery in Sweden between 2001 and 2012. **Am J Sports Med**, 42, n. 10, p. 2419-2423, Oct 2014.

ISHIGAKI, T.; KOUNO, M.; IKEBUKURO, T.; KUBO, K. Quantification of collagen fiber orientation in human tendons with the coefficient of variation of echogenicity. **J Biomech**, 49, n. 16, p. 3923-3927, Dec 8 2016.

JIELILE, J.; BADALIHAN, A.; QIANMAN, B.; SATEWALEDE, T. *et al.* Clinical outcome of exercise therapy and early post-operative rehabilitation for treatment of neglected Achilles tendon rupture: a randomized study. **Knee Surg Sports Traumatol Arthrosc**, 24, n. 7, p. 2148-2155, 2016.

KANGAS, J.; PAJALA, A.; OHTONEN, P.; LEPPILAHTI, J. Achilles tendon elongation after rupture repair: a randomized comparison of 2 postoperative regimens. **Am J Sports Med**, 35, n. 1, p. 59-64, Jan 2007.

KANGAS, J.; PAJALA, A.; SIIRA, P.; HAMALAINEN, M. *et al.* Early functional treatment versus early immobilization in tension of the musculotendinous unit after Achilles rupture repair: a prospective, randomized, clinical study. **J Trauma**, 54, n. 6, p. 9, 2003.

KAWAKAMI, Y.; ICHINOSE, Y.; FUKUNAGA, T. Architectural and functional features of human triceps surae muscles during contraction. **J Appl Physiol (1985)**, 85, n. 2, p. 398-404, Aug 1998.

KIM, U.; CHOI, Y. S.; JANG, G. C.; CHOI, Y. R. Early rehabilitation after open repair for patients with a rupture of the Achilles tendon. **Injury**, 48, n. 7, p. 1710-1713, Jul 2017.

KJÆR, M.; MAGNUSSON, S. P. Mechanical Adaptation and Tissue Remodeling. *In*: FRATZL, P. (Ed.). **Collagen: Structure and Mechanics**. Boston, MA: Springer US, 2008. p. 249-267.

KONGSGAARD, M.; AAGAARD, P.; KJAER, M.; MAGNUSSON, S. P. Structural Achilles tendon properties in athletes subjected to different exercise modes and in Achilles tendon rupture patients. **J Appl Physiol (1985)**, 99, n. 5, p. 1965-1971, Nov 2005.

KONGSGAARD, M.; QVORTRUP, K.; LARSEN, J.; AAGAARD, P. *et al.* Fibril morphology and tendon mechanical properties in patellar tendinopathy: effects of heavy slow resistance training. **Am J Sports Med**, 38, n. 4, p. 749-756, Apr 2010.

KONGSGAARD, M.; REITELSEDER, S.; PEDERSEN, T. G.; HOLM, L. *et al.* Region specific patellar tendon hypertrophy in humans following resistance training. **Acta Physiol (Oxf)**, 191, n. 2, p. 111-121, Oct 2007.

KORKMAZ, M.; FATIH ERKOC, M.; YOLCU, S.; BALBALOGLU, O. *et al.* Weight bearing the same day versus non-weight bearing for 4 weeks in Achilles tendon rupture. **J Orthop Sci**, 20, n. 3, p. 513-516, 2015.

KRAEUTLER, M. J.; PURCELL, J. M.; HUNT, K. J. Chronic Achilles Tendon Ruptures. **Foot Ankle Int**, 38, n. 8, p. 921-929, Aug 2017.

LANTTO, I.; HEIKKINEN, J.; FLINKKILA, T.; OHTONEN, P. *et al.* Early functional treatment versus cast immobilization in tension after achilles rupture repair: results of a prospective randomized trial with 10 or more years of follow-up. **Am J Sports Med**, 43, n. 9, p. 2302-2309, 2015a. Comparative Study; Randomized Controlled Trial.

LANTTO, I.; HEIKKINEN, J.; FLINKKILA, T.; OHTONEN, P. *et al.* Epidemiology of Achilles tendon ruptures: increasing incidence over a 33-year period. **Scand J Med Sci Sports**, 25, n. 1, p. e133-138, Feb 2015b.

LIEBER, R. L.; FRIDEN, J. Functional and clinical significance of skeletal muscle architecture. **Muscle Nerve**, 23, n. 11, p. 1647-1666, Nov 2000.

LONGO, U. G.; RONGA, M.; MAFFULLI, N. Acute ruptures of the achilles tendon. **Sports Med Arthrosc Rev**, 17, n. 2, p. 127-138, Jun 2009.

LONGO, U. G.; RONGA, M.; MAFFULLI, N. Achilles Tendinopathy. **Sports Med Arthrosc Rev**, 26, n. 1, p. 16-30, Mar 2018.

LOPEZ, P.; PINTO, M. D.; PINTO, R. S. Does Rest Time before Ultrasonography Imaging Affect Quadriceps Femoris Muscle Thickness, Cross-Sectional Area and Echo Intensity Measurements? **Ultrasound Med Biol**, 45, n. 2, p. 612-616, Feb 2019.

LORENZ, D.; MORRISON, S. Current Concepts in Periodization of Strength and Conditioning for the Sports Physical Therapist. **Int J Sports Phys Ther**, 10, n. 6, p. 734-747, Nov 2015.

LU, J.; LIANG, X.; MA, Q. Early Functional Rehabilitation for Acute Achilles Tendon Ruptures: An Update Meta-Analysis of Randomized Controlled Trials. **J Foot Ankle Surg**, 58, n. 5, p. 938-945, Sep 2019.

MAFFULLI, N. Current Concepts Review - Rupture of the Achilles Tendon*. **J Bone Joint Surg Am**, 81, n. 7, p. 1019--1036, 1999a.

MAFFULLI, N. Rupture of the Achilles tendon. **The Journal of Bone and Joint Surgery. American volume**, 81, n. 7, p. 1019-1036, Jul 1999b.

MAFFULLI, N.; ALMEKINDERS, L. C. **The Achilles Tendon**. Springer, 2007.

MAFFULLI, N.; TALLON, C.; WONG, J.; LIM, K. *et al.* Early weightbearing and ankle mobilization after open repair of acute midsubstance tears of the achilles tendon. **Am J Sports Med**, 31, n. 5, p. 692-700, 2003a.

MAFFULLI, N.; TALLON, C.; WONG, J.; PENG LIM, K. *et al.* No adverse effect of early weight bearing following open repair of acute tears of the Achilles tendon. **J Sports Med Phys Fitness**, 43, n. 3, p. 367-379, Sep 2003b.

MAFFULLI, N.; WALLEY, G.; SAYANA, M. K.; LONGO, U. G. *et al.* Eccentric calf muscle training in athletic patients with Achilles tendinopathy. **Disabil Rehabil**, 30, n. 20-22, p. 1677-1684, 2008.

MAHIEU, N. N.; MCNAIR, P.; COOLS, A.; D'HAEN, C. *et al.* Effect of eccentric training on the plantar flexor muscle-tendon tissue properties. **Med Sci Sports Exerc**, 40, n. 1, p. 117-123, Jan 2008.

MAJEWSKI, M.; SCHAEREN, S.; KOHLHAAS, U.; OCHSNER, P. E. Postoperative rehabilitation after percutaneous Achilles tendon repair: early functional therapy versus cast immobilization. **Disabil Rehabil**, 30, n. 20-22, p. 1726-1732, 2008.

MAQUIRRIAIN, J. Achilles tendon rupture: avoiding tendon lengthening during surgical repair and rehabilitation. **Yale J Biol Med**, 84, n. 3, p. 289-300, Sep 2011.

MARQUETI, R. C.; PAULINO, M. G.; FERNANDES, M. N.; DE OLIVEIRA, E. M. *et al.* Tendon structural adaptations to load exercise are inhibited by anabolic androgenic steroids. **Scand J Med Sci Sports**, 24, n. 1, p. e39-51, Feb 2014.

MAYER, A.; FRASSON, V. B.; OTT, R.; FORTUNA, R. d. O. *et al.* Desequilíbrios musculares entre flexores dorsais e plantares do tornozelo apóstratamento conservador e acelerado da ruptura do tendão calcâneo. **Fisioter pesqui**, 17, n. 2, p. 108-113, 2010/06 2010.

MCCORMACK, R.; BOVARD, J. Early functional rehabilitation or cast immobilisation for the postoperative management of acute Achilles tendon rupture? A systematic review and meta-analysis of randomised controlled trials. **Br J Sports Med**, 49, n. 20, p. 1329-1335, Oct 2015.

MCNAIR, P.; NORDEZ, A.; OLDS, M.; YOUNG, S. W. *et al.* Biomechanical properties of the plantar flexor muscle-tendon complex 6 months post-rupture of the Achilles tendon. **J Orthop Res**, 31, n. 9, p. 1469-1474, Sep 2013.

MOHER, D.; LIBERATI, A.; TETZLAFF, J.; ALTMAN, D. G. *et al.* Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. **PLoS Medicine**, 6, n. 7, p. e1000097, Jul 21 2009.

MOLLER, M.; LIND, K.; MOVIN, T.; KARLSSON, J. Calf muscle function after Achilles tendon rupture. A prospective, randomised study comparing surgical and non-surgical treatment. **Scand J Med Sci Sports**, 12, n. 1, p. 9-16, Feb 2002.

MORITANI, T.; DEVRIES, H. A. Neural factors versus hypertrophy in the time course of muscle strength gain. **Am J Phys Med**, 58, n. 3, p. 115-130, Jun 1979.

MORRISSEY, D.; ROSKILLY, A.; TWYCROSS-LEWIS, R.; ISINKAYE, T. *et al.* The effect of eccentric and concentric calf muscle training on Achilles tendon stiffness. **Clin Rehabil**, 25, n. 3, p. 238-247, Mar 2011.

MORTENSEN, H. M.; SKOV, O.; JENSEN, P. E. Early motion of the ankle after operative treatment of a rupture of the Achilles tendon. A prospective, randomized clinical and radiographic study. **J Bone Joint Surg Am**, 81, n. 7, p. 983-990, Jul 1999.

NADEAU, M. J.; DESROCHERS, A.; LAMONTAGNE, M.; LARIVIERE, C. *et al.* Quantitative ultrasound imaging of Achilles tendon integrity in symptomatic and asymptomatic individuals: reliability and minimal detectable change. **J Foot Ankle Res**, 9, p. 30, 2016.

NARICI, M.; CERRETELLI, P. Changes in human muscle architecture in disuse-atrophy evaluated by ultrasound imaging. **J Gravit Physiol**, 5, n. 1, p. P73-74, Jul 1998.

NEUMAYER, F.; MOUHSINE, E.; ARLETTAZ, Y.; GREMION, G. *et al.* A new conservative-dynamic treatment for the acute ruptured Achilles tendon. **Arch Orthop Trauma Surg**, 130, n. 3, p. 363-368, Mar 2010.

NICHOLSON, G.; WALKER, J.; DAWSON, Z.; BISSAS, A. *et al.* Morphological and functional outcomes of operatively treated Achilles tendon ruptures. **Phys Sportsmed**, p. 1-8, Nov 7 2019.

NOURISSAT, G.; BERENBAUM, F.; DUPREZ, D. Tendon injury: from biology to tendon repair. **Nat Rev Rheumatol**, 11, n. 4, p. 223-233, Apr 2015.

OKOROHA, K. R.; USSEF, N.; JILDEH, T. R.; KHALIL, L. S. *et al.* Comparison of Tendon Lengthening With Traditional Versus Accelerated Rehabilitation After Achilles Tendon Repair: A Prospective Randomized Controlled Trial. **Am J Sports Med**, 48, n. 7, p. 1720-1726, Jun 2020.

OLSSON, N.; KARLSSON, J.; ERIKSSON, B. I.; BRORSSON, A. *et al.* Ability to perform a single heel-rise is significantly related to patient-reported outcome after Achilles tendon rupture. **Scand J Med Sci Sports**, 24, n. 1, p. 152-158, Feb 2014.

PENG, W. C.; CHANG, Y. P.; CHAO, Y. H.; FU, S. N. *et al.* Morphomechanical alterations in the medial gastrocnemius muscle in patients with a repaired Achilles tendon: Associations with outcome measures. **Clin Biomech (Bristol, Avon)**, 43, p. 50-57, Mar 2017.

PENSINI, M.; MARTIN, A.; MAFFIULETTI, N. A. Central versus peripheral adaptations following eccentric resistance training. **Int J Sports Med**, 23, n. 8, p. 567-574, Nov 2002.

PORTER, M.; SHADBOLT, B. Randomized controlled trial of accelerated rehabilitation versus standard protocol following surgical repair of ruptured Achilles tendon. **ANZ J Surg**, 85, n. 5, p. 373-377, 2015. Randomized Controlled Trial.

ROBINSON, K. A.; DICKERSIN, K. Development of a highly sensitive search strategy for the retrieval of reports of controlled trials using PubMed. **Int J Epidemiol**, 31, n. 1, p. 150-153, Feb 2002.

SCHOENFELD, B. J. The mechanisms of muscle hypertrophy and their application to resistance training. **J Strength Cond Res**, 24, n. 10, p. 2857-2872, Oct 2010.

SENIAM. **Recommendations for sensor locations in lower leg or foot muscles**. http://www.seniam.org/, 2020.

SHARMA, P.; MAFFULLI, N. Tendon injury and tendinopathy: healing and repair. **J Bone Joint Surg Am**, 87, n. 1, p. 187-202, Jan 2005.

SHIM, V. B.; HANDSFIELD, G. G.; FERNANDEZ, J. W.; LLOYD, D. G. *et al.* Combining in silico and in vitro experiments to characterize the role of fascicle twist in the Achilles tendon. **Sci Rep**, 8, n. 1, p. 13856, Sep 14 2018.

SILBERNAGEL, K. G.; NILSSON-HELANDER, K.; THOMEE, R.; ERIKSSON, B. I. *et al.* A new measurement of heel-rise endurance with the ability to detect functional deficits in patients with Achilles tendon rupture. **Knee Surg Sports Traumatol Arthrosc**, 18, n. 2, p. 258-264, Feb 2010.

SILBERNAGEL, K. G.; STEELE, R.; MANAL, K. Deficits in heel-rise height and achilles tendon elongation occur in patients recovering from an Achilles tendon rupture. **Am J Sports Med**, 40, n. 7, p. 1564-1571, Jul 2012.

SLIM, K.; NINI, E.; FORESTIER, D.; KWIATKOWSKI, F. *et al.* Methodological index for non-randomized studies (minors): development and validation of a new instrument. **ANZ J Surg**, 73, n. 9, p. 712-716, Sep 2003.

TABARY, J. C.; TABARY, C.; TARDIEU, C.; TARDIEU, G. *et al.* Physiological and structural changes in the cat's soleus muscle due to immobilization at different lengths by plaster casts. **J Physiol**, 224, n. 1, p. 231-244, Jul 1972.

THEVENDRAN, G.; SARRAF, K. M.; PATEL, N. K.; SADRI, A. *et al.* The ruptured Achilles tendon: a current overview from biology of rupture to treatment. **Musculoskelet Surg**, 97, n. 1, p. 9-20, Apr 2013.

TIMMINS, R. G.; SHIELD, A. J.; WILLIAMS, M. D.; LORENZEN, C. *et al.* Architectural adaptations of muscle to training and injury: a narrative review outlining the contributions by fascicle length, pennation angle and muscle thickness. **Br J Sports Med**, 50, n. 23, p. 1467-1472, Dec 2016.

TINKLENBERG, J.; BEATKA, M.; BAIN, J. L. W.; SIEBERS, E. M. *et al.* Use Of Ankle Immobilization In Evaluating Treatments To Promote Longitudinal Muscle Growth In Mice. **Muscle Nerve**, 58, n. 5, p. 718-725, Nov 2018.

TUMILTY, S.; MANI, R.; BAXTER, G. D. Photobiomodulation and eccentric exercise for Achilles tendinopathy: a randomized controlled trial. **Lasers Med Sci**, 31, n. 1, p. 127-135, 2016.

VALKERING, K. P.; AUFWERBER, S.; RANUCCIO, F.; LUNINI, E. *et al.* Functional weight-bearing mobilization after Achilles tendon rupture enhances early healing response: a single-blinded randomized controlled trial. **Knee Surg Sports Traumatol Arthrosc**, 25, n. 6, p. 1807-1816, Jun 2017.

VAN SCHIE, H. T.; DE VOS, R. J.; DE JONGE, S.; BAKKER, E. M. *et al.* Ultrasonographic tissue characterisation of human Achilles tendons: quantification of tendon structure through a novel non-invasive approach. **Br J Sports Med**, 44, n. 16, p. 1153-1159, Dec 2010.

VIDMAR, M. F.; BARONI, B. M.; MICHELIN, A. F.; MEZZOMO, M. *et al.* Isokinetic eccentric training is more effective than constant load eccentric training on the quadriceps rehabilitation following anterior cruciate ligament reconstruction: a randomized controlled trial. **Braz J Phys Ther**, Jul 16 2019a.

VIDMAR, M. F.; BARONI, B. M.; MICHELIN, A. F.; MEZZOMO, M. *et al.* Isokinetic eccentric training is more effective than constant load eccentric training on the quadriceps rehabilitation following partial meniscectomy: A randomized clinical trial. **Phys Ther Sport**, 39, p. 120-125, Sep 2019b.

WIESINGER, H. P.; KOSTERS, A.; MULLER, E.; SEYNNES, O. R. Effects of Increased Loading on In Vivo Tendon Properties: A Systematic Review. **Med Sci Sports Exerc**, 47, n. 9, p. 1885-1895, Sep 2015.

ZELLERS, J. A.; CHRISTENSEN, M.; KJAER, I. L.; RATHLEFF, M. S. *et al.* Defining Components of Early Functional Rehabilitation for Acute Achilles Tendon Rupture: A Systematic Review. **Orthop J Sports Med**, 7, n. 11, p. 2325967119884071, Nov 2019a.

ZELLERS, J. A.; CORTES, D. H.; CORRIGAN, P.; PONTIGGIA, L. *et al.* Side-to-side differences in Achilles tendon geometry and mechanical properties following achilles tendon rupture. **Muscles Ligaments Tendons J**, 7, n. 3, p. 541-547, Jul-Sep 2017.

ZELLERS, J. A.; POHLIG, R. T.; CORTES, D. H.; GRAVARE SILBERNAGEL, K. Achilles tendon cross-sectional area at 12 weeks post-rupture relates to 1-year heel-rise height. **Knee Surg Sports Traumatol Arthrosc**, 28, n. 1, p. 245-252, Jan 2019b.

ZHANG, H.; TANG, H.; HE, Q.; WEI, Q. *et al.* Surgical Versus Conservative Intervention for Acute Achilles Tendon Rupture? A PRISMA-Compliant Systematic Review of Overlapping Meta-Analyses. **Medicine (Baltimore).** 94, n. 45, p. e1951, 2015.

ZHAO, J. G.; MENG, X. H.; LIU, L.; ZENG, X. T. *et al.* Early functional rehabilitation versus traditional immobilization for surgical Achilles tendon repair after acute rupture: a systematic review of overlapping meta-analyses. **Sci Rep**, 7, p. 39871, Jan 5 2017.

APPENDICES

APPENDICE A

Supplementary table 1.1 | Chapter 1

Supplementary table 1.1. The Mesh terms used in the search strategy

Terms for search	***MESH terms used***
Participants	"Achilles Tendon"[Mesh] OR "Achilles Tendon" OR “Tendon, Achilles” OR “Calcaneal Tendon” OR “Calcaneal Tendons” OR “Tendon, Calcaneal” OR “Tendons, Calcaneal” OR “Tendo Calcaneus” OR "Tendon Injuries"[Mesh] OR "Tendon Injuries" OR “Injuries, Tendon” OR “Injury, Tendon” OR “Tendon Injury” OR "Rupture, Spontaneous"[Mesh] OR "Rupture, Spontaneous” OR “Ruptures, Spontaneous” OR “Spontaneous Rupture” OR “Spontaneous Ruptures” OR "Rupture"[Mesh] OR "Rupture” OR "Ruptures" OR “Achilles tendon rupture”
Intervention	"Rehabilitation"[Mesh] OR “Habilitation” OR "Early Ambulation"[Mesh] OR “Accelerated Ambulation” OR “Ambulation, Accelerated” OR “Ambulation, Early” OR “Early Mobilization” OR “Mobilization, Early” OR "Exercise Therapy"[Mesh] OR “Therapy, Exercise” OR “Exercise Therapies” OR “Therapies, Exercise” OR “Rehabilitation Exercise” OR “Exercise, Rehabilitation” OR “Exercises, Rehabilitation” OR “Rehabilitation Exercises” OR “Remedial Exercise” OR “Exercise, Remedial” OR “Exercises, Remedial” OR “Remedial Exercises” OR "Motion Therapy, Continuous Passive"[Mesh] OR “Movement Therapy, Continuous Passive” OR “Passive Movement Therapy, Continuous” OR “Continuous Passive Motion Therapy” OR “Passive Motion Therapy, Continuous” OR “Continuous Passive Movement Therapy” OR “CPM Therapy” OR “CPM Therapies” OR “Therapies, CPM” OR “Therapy, CPM” OR "Immobilization"[Mesh] OR “Hypokinesia, Experimental” OR

	“Experimental Hypokinesia” OR “Experimental Hypokinesias” OR “Hypokinesias, Experimental” OR "Restraint, Physical"[Mesh] OR “Physical Restraints” OR “Restraints, Physical” OR “Physical Restraint” OR “Immobilization, Physical” OR “Physical Immobilization” OR “early rehabilitation”
Study design (ROBINSON & DICKERSIN, 2002)	((randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized controlled trials[mh] OR random allocation[mh] OR double-blind method[mh] OR single-blind method[mh] OR clinical trial[pt] OR clinical trials[mh] OR ("clinical trial"[tw]) OR ((singl*[tw] OR doubl*[tw] OR trebl*[tw] OR tripl*[tw]) AND (mask*[tw] OR blind*[tw])) OR ("latin square"[tw]) OR placebos[mh] OR placebo*[tw] OR random*[tw] OR research design[mh:noexp] OR follow-up studies[mh] OR prospective studies[mh] OR cross-over studies[mh] OR control*[tw] OR prospectiv*[tw] OR volunteer*[tw]) NOT (animal[mh] NOT human[mh]))

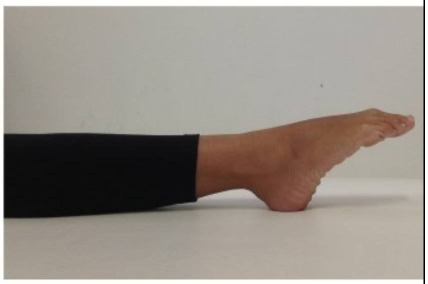
APPENDICE B

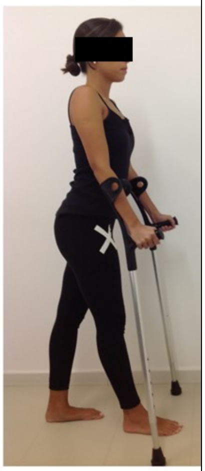
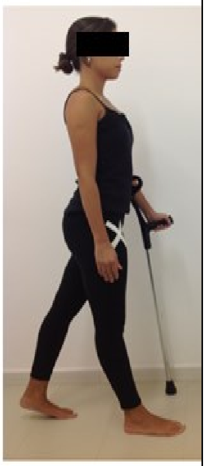
Supplementary Figure 2.1 | CHAPTER 2

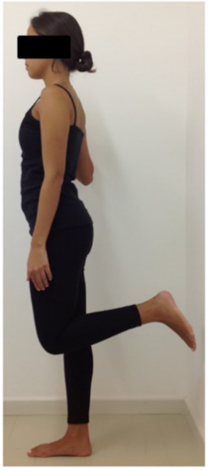
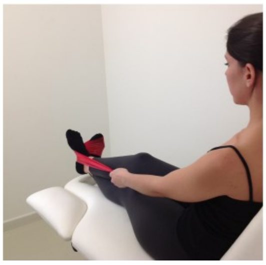
Supplementary Figure 0-1. Traditional rehabilitation program.

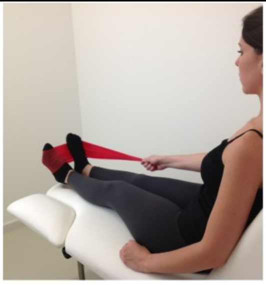
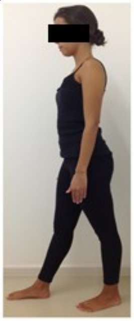
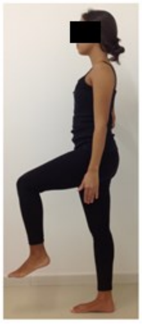
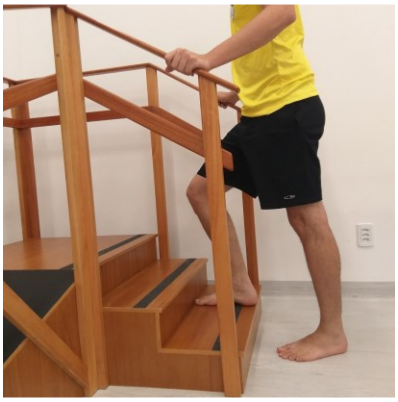
Supplementary Table 2.1 | CHAPTER 2

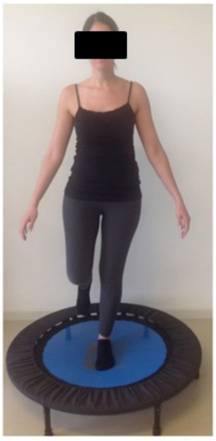
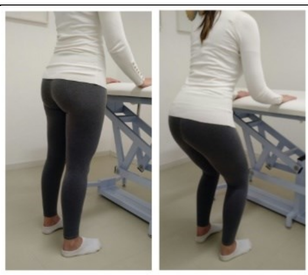
Supplementary table 2. 1. Early rehabilitation program

Exercise	Picture	Weeks					
		1	2	3	4	5	6
Active and passive ankle plantar flexion		2 x 15	2 x 15	2 x 20			
Active and passive ankle dorsal flexion		2 x 15	2 x 15	2 x 20			
Active and passive inversion		2 x 15	3 x 15	2 x 20			
Active and passive eversion		2 x 15	3 x 15	2 x 20			

Crutches gait training with robofoot	 	3 points partial support	2 points partial support	2 points partial support			
Hip flexion		2 x 15	3 x 15	3 x 20	3 x 20 x 1kg	3 x 20 x 2kg	3 x 20 x 3kg
Hip adduction and abduction		2 x 15	3 x 15	3 x 20	3 x 20 x 1kg	3 x 20 x 2kg	3 x 20 x 3kg
Cryotherapy with compression and ankle elevation		20 min	20 min	20 min	20 min	20 min	20 min

Stretching for the dorsal and plantar flexors				3 x 20 s	3 x 20 s	5 x 20 s	5 x 20 s
Knee flexion				2x15	3x15x1 kg	3 x 20 x 2 kg	3 x 20 x 3 kg
Active ankle plantar flexion					2 x 15 x 5 % bm	2 x 15 x 10 % bm	2 x 15 x 20 % bm
Active ankle dorsal flexion					2 x 15 x 5 % bm	2 x 15 x 10 % bm	2 x 15 x 20 % bm
Active inversion					2 x 15 x 5 % bm	2 x 15 x 10 % bm	2 x 15 x 20 % bm

Active eversion					2 x 15 x 5 % bm	2 x 15 x 10 % bm	2 x 15 x 20 % bm
Gait training					Full suport with robofoot	Full suport	Full suport
Unipodal support training: patient raises the weight on the operated side.						Active movement	
Stair gait training Ascent: first the healthy side Descent: first the						Active movement	

operated side							
Proprioceptive training transfer LL, AP and PA to postural imbalances						Active movement	
Proprioceptive training mini trampoline first static, followed by over ball							Active movement
Bipedal squat exercise							2 x 10

Bipedal heel rise							2 x 10

APPENDICE C

Supplementary Table 3.1 | CHAPTER 3

Supplementary table 3. 1. Effects and interactions for group, leg, and time (moments).

	Effects			Interactions			
Variables	Group	Leg	Time	G x L	G x T	L x T	G x P x T
RMS muscle activation							
Isometric	0.24	**0.049**	**<0.001**	0.26	0.7	0.37	0.15
Concentric	**0.001**	0.49	**<0.001**	0.86	**0.007**	0.58	**0.04**
Eccentric	**0.001**	0.32	**<0.001**	0.79	**0.02**	0.12	0.67
MT	**0.01**	**<0.001**	**<0.001**	0.8	0.79	0.62	**0.02**
Torque							
Isometric	0.57	**<0.001**	**<0.001**	**0.04**	0.1	0.42	0.09
Concentric	**0.05**	**0.01**	**0.001**	0.1	0.21	0.59	0.98
Eccentric	0.15	**0.001**	**<0.001**	0.93	0.19	0.21	0.76
ROM	0.22	0.37	**0.01**	0.21	0.71	0.11	0.3

G= group; L= leg; T= time. Bold values mean statistical significance.

APPENDICE D

Supplementary table 4.1| CHAPTER 4

Supplementary table 4.1. Statistical values of cross-sectional area with comparisons between regions.

Pairwise Comparisons - Regions

Group	Leg	Moment	Region		Mean Difference (I-J)	Std. Error	df	Bonferroni Sig.	95% Wald Confidence Interval for Difference	
									Lower	Upper
CONV	Injured	PRE	1	2	0.0043	0.08193	1	1.000	-0.2629	0.2714
				3	-0.1014	0.19091	1	1.000	-0.7239	0.5211
				4	0.1086	0.13242	1	1.000	-0.3232	0.5404
				5	0.2214	0.13206	1	1.000	-0.2092	0.6520
				6	0.3279	0.11971	1	0.278	-0.0625	0.7182
				7	0.3893	0.12397	1	0.076	-0.0150	0.7935
				8	.4514[a]	0.13422	1	0.035	0.0138	0.8891
				9	.5629[a]	0.13982	1	0.003	0.1070	1.0188
				10	.6486[a]	0.13265	1	0.000	0.2160	1.0811
			2	1	-0.0043	0.08193	1	1.000	-0.2714	0.2629
				3	-0.1057	0.14461	1	1.000	-0.5773	0.3658
				4	0.1043	0.07733	1	1.000	-0.1479	0.3564
				5	0.2171	0.07516	1	0.174	-0.0279	0.4622
				6	.3236[a]	0.06141	1	0.000	0.1233	0.5238
				7	.3850[a]	0.07493	1	0.000	0.1407	0.6293
				8	.4471[a]	0.08565	1	0.000	0.1679	0.7264
				9	.5586[a]	0.09730	1	0.000	0.2413	0.8758
				10	.6443[a]	0.09973	1	0.000	0.3191	0.9695
			3	1	0.1014	0.19091	1	1.000	-0.5211	0.7239
				2	0.1057	0.14461	1	1.000	-0.3658	0.5773
				4	0.2100	0.09978	1	1.000	-0.1154	0.5354
				5	0.3229	0.10938	1	0.142	-0.0338	0.6795
				6	.4293[a]	0.11980	1	0.015	0.0387	0.8199
				7	.4907[a]	0.13425	1	0.012	0.0530	0.9285
				8	.5529[a]	0.14881	1	0.009	0.0676	1.0381
				9	.6643[a]	0.15914	1	0.001	0.1454	1.1832
				10	.7500[a]	0.16977	1	0.000	0.1964	1.3036
			4	1	-0.1086	0.13242	1	1.000	-0.5404	0.3232
				2	-0.1043	0.07733	1	1.000	-0.3564	0.1479
				3	-0.2100	0.09978	1	1.000	-0.5354	0.1154
				5	.1129[a]	0.03160	1	0.016	0.0098	0.2159
				6	.2193[a]	0.04942	1	0.000	0.0581	0.3804
				7	.2807[a]	0.07054	1	0.003	0.0507	0.5107
				8	.3429[a]	0.07030	1	0.000	0.1136	0.5721
				9	.4543[a]	0.08721	1	0.000	0.1699	0.7386
				10	.5400[a]	0.09267	1	0.000	0.2378	0.8422

	5	1	-0.2214	0.13206	1	1.000	-0.6520	0.2092
		2	-0.2171	0.07516	1	0.174	-0.4622	0.0279
		3	-0.3229	0.10938	1	0.142	-0.6795	0.0338
		4	-.1129[a]	0.03160	1	0.016	-0.2159	-0.0098
		6	0.1064	0.04204	1	0.511	-0.0306	0.2435
		7	.1679[a]	0.05016	1	0.037	0.0043	0.3314
		8	.2300[a]	0.05583	1	0.002	0.0479	0.4121
		9	.3414[a]	0.06948	1	0.000	0.1149	0.5680
		10	.4271[a]	0.07689	1	0.000	0.1764	0.6779
	6	1	-0.3279	0.11971	1	0.278	-0.7182	0.0625
		2	-.3236[a]	0.06141	1	0.000	-0.5238	-0.1233
		3	-.4293[a]	0.11980	1	0.015	-0.8199	-0.0387
		4	-.2193[a]	0.04942	1	0.000	-0.3804	-0.0581
		5	-0.1064	0.04204	1	0.511	-0.2435	0.0306
		7	0.0614	0.04858	1	1.000	-0.0970	0.2198
		8	0.1236	0.05245	1	0.831	-0.0474	0.2946
		9	.2350[a]	0.07039	1	0.038	0.0055	0.4645
		10	.3207[a]	0.07660	1	0.001	0.0710	0.5705
	7	1	-0.3893	0.12397	1	0.076	-0.7935	0.0150
		2	-.3850[a]	0.07493	1	0.000	-0.6293	-0.1407
		3	-.4907[a]	0.13425	1	0.012	-0.9285	-0.0530
		4	-.2807[a]	0.07054	1	0.003	-0.5107	-0.0507
		5	-.1679[a]	0.05016	1	0.037	-0.3314	-0.0043
		6	-0.0614	0.04858	1	1.000	-0.2198	0.0970
		8	0.0621	0.04110	1	1.000	-0.0719	0.1962
		9	.1736[a]	0.04482	1	0.005	0.0274	0.3197
		10	.2593[a]	0.05270	1	0.000	0.0875	0.4311
	8	1	-.4514[a]	0.13422	1	0.035	-0.8891	-0.0138
		2	-.4471[a]	0.08565	1	0.000	-0.7264	-0.1679
		3	-.5529[a]	0.14881	1	0.009	-1.0381	-0.0676
		4	-.3429[a]	0.07030	1	0.000	-0.5721	-0.1136
		5	-.2300[a]	0.05583	1	0.002	-0.4121	-0.0479
		6	-0.1236	0.05245	1	0.831	-0.2946	0.0474
		7	-0.0621	0.04110	1	1.000	-0.1962	0.0719
		9	.1114[a]	0.02458	1	0.000	0.0313	0.1916
		10	.1971[a]	0.03019	1	0.000	0.0987	0.2956
	9	1	-.5629[a]	0.13982	1	0.003	-1.0188	-0.1070
		2	-.5586[a]	0.09730	1	0.000	-0.8758	-0.2413
		3	-.6643[a]	0.15914	1	0.001	-1.1832	-0.1454
		4	-.4543[a]	0.08721	1	0.000	-0.7386	-0.1699
		5	-.3414[a]	0.06948	1	0.000	-0.5680	-0.1149
		6	-.2350[a]	0.07039	1	0.038	-0.4645	-0.0055
		7	-.1736[a]	0.04482	1	0.005	-0.3197	-0.0274
		8	-.1114[a]	0.02458	1	0.000	-0.1916	-0.0313
		10	.0857[a]	0.02245	1	0.006	0.0125	0.1589
	10	1	-.6486[a]	0.13265	1	0.000	-1.0811	-0.2160

			2	-.6443[a]	0.09973	1	0.000	-0.9695	-0.3191
			3	-.7500[a]	0.16977	1	0.000	-1.3036	-0.1964
			4	-.5400[a]	0.09267	1	0.000	-0.8422	-0.2378
			5	-.4271[a]	0.07689	1	0.000	-0.6779	-0.1764
			6	-.3207[a]	0.07660	1	0.001	-0.5705	-0.0710
			7	-.2593[a]	0.05270	1	0.000	-0.4311	-0.0875
			8	-.1971[a]	0.03019	1	0.000	-0.2956	-0.0987
			9	-.0857[a]	0.02245	1	0.006	-0.1589	-0.0125
	Post-4	1	2	0.0357	0.08457	1	1.000	-0.2401	0.3115
			3	-0.0429	0.20994	1	1.000	-0.7274	0.6417
			4	0.1257	0.15389	1	1.000	-0.3761	0.6275
			5	0.2186	0.14903	1	1.000	-0.2674	0.7045
			6	0.2629	0.13681	1	1.000	-0.1832	0.7090
			7	0.2929	0.15302	1	1.000	-0.2061	0.7918
			8	0.3714	0.14402	1	0.446	-0.0982	0.8410
			9	.4986[a]	0.15152	1	0.045	0.0045	0.9927
			10	.5571[a]	0.15790	1	0.019	0.0423	1.0720
		2	1	-0.0357	0.08457	1	1.000	-0.3115	0.2401
			3	-0.0786	0.16128	1	1.000	-0.6045	0.4473
			4	0.0900	0.09921	1	1.000	-0.2335	0.4135
			5	0.1829	0.09006	1	1.000	-0.1108	0.4765
			6	0.2271	0.08590	1	0.368	-0.0530	0.5072
			7	0.2571	0.11015	1	0.880	-0.1020	0.6163
			8	0.3357	0.10298	1	0.050	-0.0001	0.6715
			9	.4629[a]	0.10791	1	0.001	0.1110	0.8147
			10	.5214[a]	0.12020	1	0.001	0.1295	0.9134
		3	1	0.0429	0.20994	1	1.000	-0.6417	0.7274
			2	0.0786	0.16128	1	1.000	-0.4473	0.6045
			4	0.1686	0.09607	1	1.000	-0.1447	0.4818
			5	0.2614	0.10742	1	0.672	-0.0888	0.6117
			6	0.3057	0.13211	1	0.930	-0.1251	0.7365
			7	0.3357	0.15091	1	1.000	-0.1564	0.8278
			8	0.4143	0.16414	1	0.522	-0.1209	0.9495
			9	0.5414	0.16940	1	0.063	-0.0109	1.0938
			10	0.6000	0.18677	1	0.059	-0.0090	1.2090
		4	1	-0.1257	0.15389	1	1.000	-0.6275	0.3761
			2	-0.0900	0.09921	1	1.000	-0.4135	0.2335
			3	-0.1686	0.09607	1	1.000	-0.4818	0.1447
			5	0.0929	0.03193	1	0.164	-0.0113	0.1970
			6	0.1371	0.05281	1	0.423	-0.0351	0.3094
			7	0.1671	0.08192	1	1.000	-0.1000	0.4343
			8	0.2457	0.09220	1	0.347	-0.0549	0.5464
			9	.3729[a]	0.10448	1	0.016	0.0322	0.7135
			10	.4314[a]	0.11836	1	0.012	0.0455	0.8174
		5	1	-0.2186	0.14903	1	1.000	-0.7045	0.2674
			2	-0.1829	0.09006	1	1.000	-0.4765	0.1108

		3	-0.2614	0.10742	1	0.672	-0.6117	0.0888
		4	-0.0929	0.03193	1	0.164	-0.1970	0.0113
		6	0.0443	0.03271	1	1.000	-0.0624	0.1510
		7	0.0743	0.06042	1	1.000	-0.1227	0.2713
		8	0.1529	0.07154	1	1.000	-0.0804	0.3861
		9	.2800[a]	0.08416	1	0.040	0.0056	0.5544
		10	.3386[a]	0.10189	1	0.040	0.0063	0.6708
	6	1	-0.2629	0.13681	1	1.000	-0.7090	0.1832
		2	-0.2271	0.08590	1	0.368	-0.5072	0.0530
		3	-0.3057	0.13211	1	0.930	-0.7365	0.1251
		4	-0.1371	0.05281	1	0.423	-0.3094	0.0351
		5	-0.0443	0.03271	1	1.000	-0.1510	0.0624
		7	0.0300	0.04149	1	1.000	-0.1053	0.1653
		8	0.1086	0.05222	1	1.000	-0.0617	0.2789
		9	.2357[a]	0.05892	1	0.003	0.0436	0.4278
		10	.2943[a]	0.07474	1	0.004	0.0506	0.5380
	7	1	-0.2929	0.15302	1	1.000	-0.7918	0.2061
		2	-0.2571	0.11015	1	0.880	-0.6163	0.1020
		3	-0.3357	0.15091	1	1.000	-0.8278	0.1564
		4	-0.1671	0.08192	1	1.000	-0.4343	0.1000
		5	-0.0743	0.06042	1	1.000	-0.2713	0.1227
		6	-0.0300	0.04149	1	1.000	-0.1653	0.1053
		8	0.0786	0.03744	1	1.000	-0.0435	0.2007
		9	.2057[a]	0.05523	1	0.009	0.0256	0.3858
		10	.2643[a]	0.06451	1	0.002	0.0539	0.4746
	8	1	-0.3714	0.14402	1	0.446	-0.8410	0.0982
		2	-0.3357	0.10298	1	0.050	-0.6715	0.0001
		3	-0.4143	0.16414	1	0.522	-0.9495	0.1209
		4	-0.2457	0.09220	1	0.347	-0.5464	0.0549
		5	-0.1529	0.07154	1	1.000	-0.3861	0.0804
		6	-0.1086	0.05222	1	1.000	-0.2789	0.0617
		7	-0.0786	0.03744	1	1.000	-0.2007	0.0435
		9	0.1271	0.04928	1	0.445	-0.0336	0.2878
		10	0.1857	0.06373	1	0.160	-0.0221	0.3935
	9	1	-.4986[a]	0.15152	1	0.045	-0.9927	-0.0045
		2	-.4629[a]	0.10791	1	0.001	-0.8147	-0.1110
		3	-0.5414	0.16940	1	0.063	-1.0938	0.0109
		4	-.3729[a]	0.10448	1	0.016	-0.7135	-0.0322
		5	-.2800[a]	0.08416	1	0.040	-0.5544	-0.0056
		6	-.2357[a]	0.05892	1	0.003	-0.4278	-0.0436
		7	-.2057[a]	0.05523	1	0.009	-0.3858	-0.0256
		8	-0.1271	0.04928	1	0.445	-0.2878	0.0336
		10	0.0586	0.03196	1	1.000	-0.0456	0.1628
	10	1	-.5571[a]	0.15790	1	0.019	-1.0720	-0.0423
		2	-.5214[a]	0.12020	1	0.001	-0.9134	-0.1295
		3	-0.6000	0.18677	1	0.059	-1.2090	0.0090

		4	-.4314[a]	0.11836	1	0.012	-0.8174	-0.0455
		5	-.3386[a]	0.10189	1	0.040	-0.6708	-0.0063
		6	-.2943[a]	0.07474	1	0.004	-0.5380	-0.0506
		7	-.2643[a]	0.06451	1	0.002	-0.4746	-0.0539
		8	-0.1857	0.06373	1	0.160	-0.3935	0.0221
		9	-0.0586	0.03196	1	1.000	-0.1628	0.0456
Post-8	1	2	0.0107	0.08617	1	1.000	-0.2703	0.2917
		3	0.0186	0.21284	1	1.000	-0.6755	0.7126
		4	0.2257	0.15948	1	1.000	-0.2943	0.7458
		5	0.1836	0.15946	1	1.000	-0.3364	0.7035
		6	0.2900	0.13257	1	1.000	-0.1423	0.7223
		7	0.3764	0.15280	1	0.619	-0.1218	0.8747
		8	0.4250	0.17308	1	0.633	-0.1394	0.9894
		9	0.5543	0.18879	1	0.150	-0.0613	1.1699
		10	.6564[a]	0.18755	1	0.021	0.0449	1.2680
	2	1	-0.0107	0.08617	1	1.000	-0.2917	0.2703
		3	0.0079	0.16119	1	1.000	-0.5177	0.5335
		4	0.2150	0.09896	1	1.000	-0.1077	0.5377
		5	0.1729	0.09631	1	1.000	-0.1412	0.4869
		6	.2793[a]	0.07359	1	0.007	0.0393	0.5192
		7	.3657[a]	0.09478	1	0.005	0.0567	0.6748
		8	.4143[a]	0.12639	1	0.047	0.0021	0.8264
		9	.5436[a]	0.14530	1	0.008	0.0698	1.0173
		10	.6457[a]	0.14500	1	0.000	0.1729	1.1185
	3	1	-0.0186	0.21284	1	1.000	-0.7126	0.6755
		2	-0.0079	0.16119	1	1.000	-0.5335	0.5177
		4	0.2071	0.09533	1	1.000	-0.1037	0.5180
		5	0.1650	0.12096	1	1.000	-0.2294	0.5594
		6	0.2714	0.13065	1	1.000	-0.1546	0.6974
		7	0.3579	0.14196	1	0.527	-0.1050	0.8208
		8	0.4064	0.17548	1	0.925	-0.1658	0.9786
		9	0.5357	0.18789	1	0.196	-0.0769	1.1484
		10	.6379[a]	0.19351	1	0.044	0.0069	1.2688
	4	1	-0.2257	0.15948	1	1.000	-0.7458	0.2943
		2	-0.2150	0.09896	1	1.000	-0.5377	0.1077
		3	-0.2071	0.09533	1	1.000	-0.5180	0.1037
		5	-0.0421	0.04694	1	1.000	-0.1952	0.1109
		6	0.0643	0.04769	1	1.000	-0.0912	0.2198
		7	0.1507	0.07802	1	1.000	-0.1037	0.4051
		8	0.1993	0.11611	1	1.000	-0.1793	0.5779
		9	0.3286	0.13761	1	0.763	-0.1201	0.7773
		10	0.4307	0.14008	1	0.095	-0.0261	0.8875
	5	1	-0.1836	0.15946	1	1.000	-0.7035	0.3364
		2	-0.1729	0.09631	1	1.000	-0.4869	0.1412
		3	-0.1650	0.12096	1	1.000	-0.5594	0.2294
		4	0.0421	0.04694	1	1.000	-0.1109	0.1952

	6	0.1064	0.04569	1	0.892	-0.0425	0.2554
	7	0.1929	0.06927	1	0.242	-0.0330	0.4187
	8	0.2414	0.11128	1	1.000	-0.1214	0.6043
	9	0.3707	0.13701	1	0.307	-0.0760	0.8175
	10	.4729[a]	0.13916	1	0.031	0.0191	0.9266
6	1	-0.2900	0.13257	1	1.000	-0.7223	0.1423
	2	-.2793[a]	0.07359	1	0.007	-0.5192	-0.0393
	3	-0.2714	0.13065	1	1.000	-0.6974	0.1546
	4	-0.0643	0.04769	1	1.000	-0.2198	0.0912
	5	-0.1064	0.04569	1	0.892	-0.2554	0.0425
	7	0.0864	0.06029	1	1.000	-0.1101	0.2830
	8	0.1350	0.10020	1	1.000	-0.1917	0.4617
	9	0.2643	0.12756	1	1.000	-0.1517	0.6802
	10	0.3664	0.12869	1	0.198	-0.0532	0.7861
7	1	-0.3764	0.15280	1	0.619	-0.8747	0.1218
	2	-.3657[a]	0.09478	1	0.005	-0.6748	-0.0567
	3	-0.3579	0.14196	1	0.527	-0.8208	0.1050
	4	-0.1507	0.07802	1	1.000	-0.4051	0.1037
	5	-0.1929	0.06927	1	0.242	-0.4187	0.0330
	6	-0.0864	0.06029	1	1.000	-0.2830	0.1101
	8	0.0486	0.05371	1	1.000	-0.1266	0.2237
	9	0.1779	0.07742	1	0.972	-0.0746	0.4303
	10	.2800[a]	0.08584	1	0.050	0.0001	0.5599
8	1	-0.4250	0.17308	1	0.633	-0.9894	0.1394
	2	-.4143[a]	0.12639	1	0.047	-0.8264	-0.0021
	3	-0.4064	0.17548	1	0.925	-0.9786	0.1658
	4	-0.1993	0.11611	1	1.000	-0.5779	0.1793
	5	-0.2414	0.11128	1	1.000	-0.6043	0.1214
	6	-0.1350	0.10020	1	1.000	-0.4617	0.1917
	7	-0.0486	0.05371	1	1.000	-0.2237	0.1266
	9	0.1293	0.04465	1	0.170	-0.0163	0.2749
	10	.2314[a]	0.06128	1	0.007	0.0316	0.4312
9	1	-0.5543	0.18879	1	0.150	-1.1699	0.0613
	2	-.5436[a]	0.14530	1	0.008	-1.0173	-0.0698
	3	-0.5357	0.18789	1	0.196	-1.1484	0.0769
	4	-0.3286	0.13761	1	0.763	-0.7773	0.1201
	5	-0.3707	0.13701	1	0.307	-0.8175	0.0760
	6	-0.2643	0.12756	1	1.000	-0.6802	0.1517
	7	-0.1779	0.07742	1	0.972	-0.4303	0.0746
	8	-0.1293	0.04465	1	0.170	-0.2749	0.0163
	10	.1021[a]	0.03064	1	0.039	0.0022	0.2021
10	1	-.6564[a]	0.18755	1	0.021	-1.2680	-0.0449
	2	-.6457[a]	0.14500	1	0.000	-1.1185	-0.1729
	3	-.6379[a]	0.19351	1	0.044	-1.2688	-0.0069
	4	-0.4307	0.14008	1	0.095	-0.8875	0.0261
	5	-.4729[a]	0.13916	1	0.031	-0.9266	-0.0191

		6	-0.3664	0.12869	1	0.198	-0.7861	0.0532
		7	-.2800[a]	0.08584	1	0.050	-0.5599	-0.0001
		8	-.2314[a]	0.06128	1	0.007	-0.4312	-0.0316
		9	-.1021[a]	0.03064	1	0.039	-0.2021	-0.0022
Post-12	1	2	0.1071	0.10601	1	1.000	-0.2385	0.4528
		3	0.0357	0.21381	1	1.000	-0.6615	0.7329
		4	0.2086	0.18449	1	1.000	-0.3930	0.8101
		5	0.3664	0.18984	1	1.000	-0.2526	0.9855
		6	0.3507	0.20229	1	1.000	-0.3089	1.0103
		7	0.4221	0.19968	1	1.000	-0.2290	1.0733
		8	0.5043	0.22476	1	1.000	-0.2286	1.2372
		9	0.4879	0.21949	1	1.000	-0.2279	1.2036
		10	.5871[a]	0.16113	1	0.012	0.0617	1.1125
	2	1	-0.1071	0.10601	1	1.000	-0.4528	0.2385
		3	-0.0714	0.14946	1	1.000	-0.5588	0.4159
		4	0.1014	0.10399	1	1.000	-0.2377	0.4405
		5	0.2593	0.11465	1	1.000	-0.1146	0.6331
		6	0.2436	0.14306	1	1.000	-0.2229	0.7100
		7	0.3150	0.13533	1	0.897	-0.1263	0.7563
		8	0.3971	0.16846	1	0.828	-0.1522	0.9465
		9	0.3807	0.16257	1	0.863	-0.1494	0.9108
		10	.4799[a]	0.11339	1	0.001	0.1102	0.8497
	3	1	-0.0357	0.21381	1	1.000	-0.7329	0.6615
		2	0.0714	0.14946	1	1.000	-0.4159	0.5588
		4	0.1729	0.10736	1	1.000	-0.1772	0.5229
		5	0.3307	0.11935	1	0.252	-0.0585	0.7199
		6	0.3150	0.16170	1	1.000	-0.2123	0.8423
		7	0.3864	0.15933	1	0.688	-0.1331	0.9060
		8	0.4686	0.18670	1	0.544	-0.1402	1.0774
		9	0.4521	0.19375	1	0.883	-0.1796	1.0839
		10	0.5514	0.17737	1	0.085	-0.0270	1.1297
	4	1	-0.2086	0.18449	1	1.000	-0.8101	0.3930
		2	-0.1014	0.10399	1	1.000	-0.4405	0.2377
		3	-0.1729	0.10736	1	1.000	-0.5229	0.1772
		5	.1579[a]	0.03745	1	0.001	0.0358	0.2800
		6	0.1421	0.09307	1	1.000	-0.1613	0.4456
		7	0.2136	0.07613	1	0.226	-0.0347	0.4618
		8	0.2957	0.11897	1	0.582	-0.0922	0.6836
		9	0.2793	0.12079	1	0.935	-0.1146	0.6732
		10	.3785[a]	0.11554	1	0.047	0.0018	0.7553
	5	1	-0.3664	0.18984	1	1.000	-0.9855	0.2526
		2	-0.2593	0.11465	1	1.000	-0.6331	0.1146
		3	-0.3307	0.11935	1	0.252	-0.7199	0.0585
		4	-.1579[a]	0.03745	1	0.001	-0.2800	-0.0358
		6	-0.0157	0.07598	1	1.000	-0.2635	0.2320
		7	0.0557	0.06638	1	1.000	-0.1607	0.2722

	8	0.1379	0.09753	1	1.000	-0.1802	0.4559
	9	0.1214	0.11111	1	1.000	-0.2409	0.4837
	10	0.2207	0.11372	1	1.000	-0.1501	0.5915
6	1	-0.3507	0.20229	1	1.000	-1.0103	0.3089
	2	-0.2436	0.14306	1	1.000	-0.7100	0.2229
	3	-0.3150	0.16170	1	1.000	-0.8423	0.2123
	4	-0.1421	0.09307	1	1.000	-0.4456	0.1613
	5	0.0157	0.07598	1	1.000	-0.2320	0.2635
	7	0.0714	0.05871	1	1.000	-0.1200	0.2629
	8	0.1536	0.05599	1	0.274	-0.0290	0.3362
	9	0.1371	0.07748	1	1.000	-0.1155	0.3898
	10	0.2364	0.09801	1	0.715	-0.0832	0.5560
7	1	-0.4221	0.19968	1	1.000	-1.0733	0.2290
	2	-0.3150	0.13533	1	0.897	-0.7563	0.1263
	3	-0.3864	0.15933	1	0.688	-0.9060	0.1331
	4	-0.2136	0.07613	1	0.226	-0.4618	0.0347
	5	-0.0557	0.06638	1	1.000	-0.2722	0.1607
	6	-0.0714	0.05871	1	1.000	-0.2629	0.1200
	8	0.0821	0.06342	1	1.000	-0.1247	0.2890
	9	0.0657	0.05952	1	1.000	-0.1284	0.2598
	10	0.1649	0.09134	1	1.000	-0.1329	0.4628
8	1	-0.5043	0.22476	1	1.000	-1.2372	0.2286
	2	-0.3971	0.16846	1	0.828	-0.9465	0.1522
	3	-0.4686	0.18670	1	0.544	-1.0774	0.1402
	4	-0.2957	0.11897	1	0.582	-0.6836	0.0922
	5	-0.1379	0.09753	1	1.000	-0.4559	0.1802
	6	-0.1536	0.05599	1	0.274	-0.3362	0.0290
	7	-0.0821	0.06342	1	1.000	-0.2890	0.1247
	9	-0.0164	0.05568	1	1.000	-0.1980	0.1651
	10	0.0828	0.10775	1	1.000	-0.2685	0.4341
9	1	-0.4879	0.21949	1	1.000	-1.2036	0.2279
	2	-0.3807	0.16257	1	0.863	-0.9108	0.1494
	3	-0.4521	0.19375	1	0.883	-1.0839	0.1796
	4	-0.2793	0.12079	1	0.935	-0.6732	0.1146
	5	-0.1214	0.11111	1	1.000	-0.4837	0.2409
	6	-0.1371	0.07748	1	1.000	-0.3898	0.1155
	7	-0.0657	0.05952	1	1.000	-0.2598	0.1284
	8	0.0164	0.05568	1	1.000	-0.1651	0.1980
	10	0.0992	0.08379	1	1.000	-0.1740	0.3725
10	1	-.5871[a]	0.16113	1	0.012	-1.1125	-0.0617
	2	-.4799[a]	0.11339	1	0.001	-0.8497	-0.1102
	3	-0.5514	0.17737	1	0.085	-1.1297	0.0270
	4	-.3785[a]	0.11554	1	0.047	-0.7553	-0.0018
	5	-0.2207	0.11372	1	1.000	-0.5915	0.1501
	6	-0.2364	0.09801	1	0.715	-0.5560	0.0832
	7	-0.1649	0.09134	1	1.000	-0.4628	0.1329

			8	-0.0828	0.10775	1	1.000	-0.4341	0.2685
			9	-0.0992	0.08379	1	1.000	-0.3725	0.1740
Uninju red	PRE	1	2	0.1400	0.06564	1	1.000	-0.0741	0.3541
			3	.2050[a]	0.06072	1	0.033	0.0070	0.4030
			4	0.2407	0.08078	1	0.130	-0.0227	0.5041
			5	.3271[a]	0.07835	1	0.001	0.0717	0.5826
			6	.5164[a]	0.09823	1	0.000	0.1961	0.8367
			7	.6121[a]	0.09727	1	0.000	0.2950	0.9293
			8	.6664[a]	0.08931	1	0.000	0.3752	0.9577
			9	.7250[a]	0.08910	1	0.000	0.4345	1.0155
			10	.7021[a]	0.09370	1	0.000	0.3966	1.0077
		2	1	-0.1400	0.06564	1	1.000	-0.3541	0.0741
			3	0.0650	0.02602	1	0.563	-0.0199	0.1499
			4	0.1007	0.05228	1	1.000	-0.0698	0.2712
			5	0.1871	0.06637	1	0.216	-0.0293	0.4036
			6	.3764[a]	0.08535	1	0.000	0.0981	0.6547
			7	.4721[a]	0.08567	1	0.000	0.1928	0.7515
			8	.5264[a]	0.07765	1	0.000	0.2732	0.7796
			9	.5850[a]	0.09073	1	0.000	0.2892	0.8808
			10	.5621[a]	0.11143	1	0.000	0.1988	0.9255
		3	1	-.2050[a]	0.06072	1	0.033	-0.4030	-0.0070
			2	-0.0650	0.02602	1	0.563	-0.1499	0.0199
			4	0.0357	0.05521	1	1.000	-0.1443	0.2157
			5	0.1221	0.06641	1	1.000	-0.0944	0.3387
			6	.3114[a]	0.09047	1	0.026	0.0164	0.6064
			7	.4071[a]	0.09120	1	0.000	0.1098	0.7045
			8	.4614[a]	0.08298	1	0.000	0.1909	0.7320
			9	.5200[a]	0.09230	1	0.000	0.2190	0.8210
			10	.4971[a]	0.10961	1	0.000	0.1397	0.8545
		4	1	-0.2407	0.08078	1	0.130	-0.5041	0.0227
			2	-0.1007	0.05228	1	1.000	-0.2712	0.0698
			3	-0.0357	0.05521	1	1.000	-0.2157	0.1443
			5	0.0864	0.03462	1	0.564	-0.0265	0.1993
			6	.2757[a]	0.06818	1	0.002	0.0534	0.4980
			7	.3714[a]	0.06771	1	0.000	0.1506	0.5922
			8	.4257[a]	0.06456	1	0.000	0.2152	0.6362
			9	.4843[a]	0.07800	1	0.000	0.2299	0.7386
			10	.4614[a]	0.09058	1	0.000	0.1661	0.7568
		5	1	-.3271[a]	0.07835	1	0.001	-0.5826	-0.0717
			2	-0.1871	0.06637	1	0.216	-0.4036	0.0293
			3	-0.1221	0.06641	1	1.000	-0.3387	0.0944
			4	-0.0864	0.03462	1	0.564	-0.1993	0.0265
			6	0.1893	0.05953	1	0.066	-0.0048	0.3834
			7	.2850[a]	0.05866	1	0.000	0.0937	0.4763
			8	.3393[a]	0.05571	1	0.000	0.1576	0.5209
			9	.3979[a]	0.06851	1	0.000	0.1745	0.6212

	10	.3750[a]	0.08095	1	0.000	0.1110	0.6390
6	1	-.5164[a]	0.09823	1	0.000	-0.8367	-0.1961
	2	-.3764[a]	0.08535	1	0.000	-0.6547	-0.0981
	3	-.3114[a]	0.09047	1	0.026	-0.6064	-0.0164
	4	-.2757[a]	0.06818	1	0.002	-0.4980	-0.0534
	5	-0.1893	0.05953	1	0.066	-0.3834	0.0048
	7	.0957[a]	0.01564	1	0.000	0.0447	0.1467
	8	.1500[a]	0.02489	1	0.000	0.0688	0.2312
	9	.2086[a]	0.04812	1	0.001	0.0517	0.3655
	10	0.1857	0.07925	1	0.860	-0.0727	0.4441
7	1	-.6121[a]	0.09727	1	0.000	-0.9293	-0.2950
	2	-.4721[a]	0.08567	1	0.000	-0.7515	-0.1928
	3	-.4071[a]	0.09120	1	0.000	-0.7045	-0.1098
	4	-.3714[a]	0.06771	1	0.000	-0.5922	-0.1506
	5	-.2850[a]	0.05866	1	0.000	-0.4763	-0.0937
	6	-.0957[a]	0.01564	1	0.000	-0.1467	-0.0447
	8	0.0543	0.02182	1	0.579	-0.0169	0.1254
	9	0.1129	0.04236	1	0.347	-0.0253	0.2510
	10	0.0900	0.07569	1	1.000	-0.1568	0.3368
8	1	-.6664[a]	0.08931	1	0.000	-0.9577	-0.3752
	2	-.5264[a]	0.07765	1	0.000	-0.7796	-0.2732
	3	-.4614[a]	0.08298	1	0.000	-0.7320	-0.1909
	4	-.4257[a]	0.06456	1	0.000	-0.6362	-0.2152
	5	-.3393[a]	0.05571	1	0.000	-0.5209	-0.1576
	6	-.1500[a]	0.02489	1	0.000	-0.2312	-0.0688
	7	-0.0543	0.02182	1	0.579	-0.1254	0.0169
	9	0.0586	0.03098	1	1.000	-0.0425	0.1596
	10	0.0357	0.06759	1	1.000	-0.1847	0.2561
9	1	-.7250[a]	0.08910	1	0.000	-1.0155	-0.4345
	2	-.5850[a]	0.09073	1	0.000	-0.8808	-0.2892
	3	-.5200[a]	0.09230	1	0.000	-0.8210	-0.2190
	4	-.4843[a]	0.07800	1	0.000	-0.7386	-0.2299
	5	-.3979[a]	0.06851	1	0.000	-0.6212	-0.1745
	6	-.2086[a]	0.04812	1	0.001	-0.3655	-0.0517
	7	-0.1129	0.04236	1	0.347	-0.2510	0.0253
	8	-0.0586	0.03098	1	1.000	-0.1596	0.0425
	10	-0.0229	0.05384	1	1.000	-0.1984	0.1527
10	1	-.7021[a]	0.09370	1	0.000	-1.0077	-0.3966
	2	-.5621[a]	0.11143	1	0.000	-0.9255	-0.1988
	3	-.4971[a]	0.10961	1	0.000	-0.8545	-0.1397
	4	-.4614[a]	0.09058	1	0.000	-0.7568	-0.1661
	5	-.3750[a]	0.08095	1	0.000	-0.6390	-0.1110
	6	-0.1857	0.07925	1	0.860	-0.4441	0.0727
	7	-0.0900	0.07569	1	1.000	-0.3368	0.1568
	8	-0.0357	0.06759	1	1.000	-0.2561	0.1847
	9	0.0229	0.05384	1	1.000	-0.1527	0.1984

Post-4	1	2	0.0664	0.06595	1	1.000	-0.1486	0.2815
		3	0.1279	0.07015	1	1.000	-0.1009	0.3566
		4	0.1129	0.10144	1	1.000	-0.2179	0.4436
		5	0.2950	0.09512	1	0.087	-0.0152	0.6052
		6	0.3543	0.11104	1	0.064	-0.0078	0.7164
		7	0.3779	0.12866	1	0.149	-0.0417	0.7974
		8	.4443[a]	0.11314	1	0.004	0.0754	0.8132
		9	.5700[a]	0.12479	1	0.000	0.1631	0.9769
		10	.5507[a]	0.10318	1	0.000	0.2143	0.8872
	2	1	-0.0664	0.06595	1	1.000	-0.2815	0.1486
		3	0.0614	0.02493	1	0.617	-0.0198	0.1427
		4	0.0464	0.06570	1	1.000	-0.1678	0.2607
		5	.2286[a]	0.06948	1	0.045	0.0020	0.4551
		6	.2879[a]	0.07126	1	0.002	0.0555	0.5202
		7	.3114[a]	0.09131	1	0.029	0.0137	0.6092
		8	.3779[a]	0.08003	1	0.000	0.1169	0.6388
		9	.5036[a]	0.08942	1	0.000	0.2120	0.7952
		10	.4843[a]	0.08655	1	0.000	0.2021	0.7665
	3	1	-0.1279	0.07015	1	1.000	-0.3566	0.1009
		2	-0.0614	0.02493	1	0.617	-0.1427	0.0198
		4	-0.0150	0.06864	1	1.000	-0.2388	0.2088
		5	0.1671	0.07317	1	1.000	-0.0714	0.4057
		6	0.2264	0.07881	1	0.183	-0.0305	0.4834
		7	0.2500	0.09743	1	0.463	-0.0677	0.5677
		8	.3164[a]	0.08969	1	0.019	0.0240	0.6089
		9	.4421[a]	0.09471	1	0.000	0.1333	0.7510
		10	.4229[a]	0.09140	1	0.000	0.1248	0.7209
	4	1	-0.1129	0.10144	1	1.000	-0.4436	0.2179
		2	-0.0464	0.06570	1	1.000	-0.2607	0.1678
		3	0.0150	0.06864	1	1.000	-0.2088	0.2388
		5	.1821[a]	0.02879	1	0.000	0.0883	0.2760
		6	.2414[a]	0.03212	1	0.000	0.1367	0.3462
		7	.2650[a]	0.04708	1	0.000	0.1115	0.4185
		8	.3314[a]	0.06197	1	0.000	0.1293	0.5335
		9	.4571[a]	0.05997	1	0.000	0.2616	0.6527
		10	.4379[a]	0.06659	1	0.000	0.2207	0.6550
	5	1	-0.2950	0.09512	1	0.087	-0.6052	0.0152
		2	-.2286[a]	0.06948	1	0.045	-0.4551	-0.0020
		3	-0.1671	0.07317	1	1.000	-0.4057	0.0714
		4	-.1821[a]	0.02879	1	0.000	-0.2760	-0.0883
		6	0.0593	0.03826	1	1.000	-0.0655	0.1840
		7	0.0829	0.05745	1	1.000	-0.1045	0.2702
		8	0.1493	0.07245	1	1.000	-0.0870	0.3855
		9	.2750[a]	0.06823	1	0.003	0.0525	0.4975
		10	.2557[a]	0.06145	1	0.001	0.0553	0.4561
	6	1	-0.3543	0.11104	1	0.064	-0.7164	0.0078

		2	-.2879[a]	0.07126	1	0.002	-0.5202	-0.0555
		3	-0.2264	0.07881	1	0.183	-0.4834	0.0305
		4	-.2414[a]	0.03212	1	0.000	-0.3462	-0.1367
		5	-0.0593	0.03826	1	1.000	-0.1840	0.0655
		7	0.0236	0.03406	1	1.000	-0.0875	0.1346
		8	0.0900	0.05000	1	1.000	-0.0730	0.2530
		9	.2157[a]	0.05661	1	0.006	0.0311	0.4003
		10	0.1964	0.07173	1	0.278	-0.0375	0.4303
	7	1	-0.3779	0.12866	1	0.149	-0.7974	0.0417
		2	-.3114[a]	0.09131	1	0.029	-0.6092	-0.0137
		3	-0.2500	0.09743	1	0.463	-0.5677	0.0677
		4	-.2650[a]	0.04708	1	0.000	-0.4185	-0.1115
		5	-0.0829	0.05745	1	1.000	-0.2702	0.1045
		6	-0.0236	0.03406	1	1.000	-0.1346	0.0875
		8	0.0664	0.04583	1	1.000	-0.0830	0.2159
		9	.1921[a]	0.03661	1	0.000	0.0728	0.3115
		10	0.1729	0.07240	1	0.763	-0.0632	0.4089
	8	1	-.4443[a]	0.11314	1	0.004	-0.8132	-0.0754
		2	-.3779[a]	0.08003	1	0.000	-0.6388	-0.1169
		3	-.3164[a]	0.08969	1	0.019	-0.6089	-0.0240
		4	-.3314[a]	0.06197	1	0.000	-0.5335	-0.1293
		5	-0.1493	0.07245	1	1.000	-0.3855	0.0870
		6	-0.0900	0.05000	1	1.000	-0.2530	0.0730
		7	-0.0664	0.04583	1	1.000	-0.2159	0.0830
		9	0.1257	0.05345	1	0.840	-0.0486	0.3000
		10	0.1064	0.06971	1	1.000	-0.1209	0.3337
	9	1	-.5700[a]	0.12479	1	0.000	-0.9769	-0.1631
		2	-.5036[a]	0.08942	1	0.000	-0.7952	-0.2120
		3	-.4421[a]	0.09471	1	0.000	-0.7510	-0.1333
		4	-.4571[a]	0.05997	1	0.000	-0.6527	-0.2616
		5	-.2750[a]	0.06823	1	0.003	-0.4975	-0.0525
		6	-.2157[a]	0.05661	1	0.006	-0.4003	-0.0311
		7	-.1921[a]	0.03661	1	0.000	-0.3115	-0.0728
		8	-0.1257	0.05345	1	0.840	-0.3000	0.0486
		10	-0.0193	0.05866	1	1.000	-0.2106	0.1720
	10	1	-.5507[a]	0.10318	1	0.000	-0.8872	-0.2143
		2	-.4843[a]	0.08655	1	0.000	-0.7665	-0.2021
		3	-.4229[a]	0.09140	1	0.000	-0.7209	-0.1248
		4	-.4379[a]	0.06659	1	0.000	-0.6550	-0.2207
		5	-.2557[a]	0.06145	1	0.001	-0.4561	-0.0553
		6	-0.1964	0.07173	1	0.278	-0.4303	0.0375
		7	-0.1729	0.07240	1	0.763	-0.4089	0.0632
		8	-0.1064	0.06971	1	1.000	-0.3337	0.1209
		9	0.0193	0.05866	1	1.000	-0.1720	0.2106
Post-8	1	2	0.3293	0.22998	1	1.000	-0.4206	1.0792
		3	0.4421	0.23394	1	1.000	-0.3207	1.2050

	4	0.4086	0.24848	1	1.000	-0.4017	1.2188
	5	0.5171	0.25668	1	1.000	-0.3198	1.3541
	6	0.6200	0.24744	1	0.550	-0.1869	1.4269
	7	0.6464	0.23973	1	0.315	-0.1353	1.4281
	8	0.7064	0.26747	1	0.372	-0.1657	1.5786
	9	.8607[a]	0.26045	1	0.043	0.0114	1.7100
	10	.9250[a]	0.25004	1	0.010	0.1097	1.7403
2	1	-0.3293	0.22998	1	1.000	-1.0792	0.4206
	3	.1129[a]	0.03174	1	0.017	0.0094	0.2164
	4	0.0793	0.07332	1	1.000	-0.1598	0.3184
	5	0.1879	0.07242	1	0.427	-0.0483	0.4240
	6	.2907[a]	0.06925	1	0.001	0.0649	0.5165
	7	.3171[a]	0.09636	1	0.045	0.0029	0.6313
	8	.3771[a]	0.10589	1	0.017	0.0318	0.7224
	9	.5314[a]	0.10315	1	0.000	0.1951	0.8678
	10	.5957[a]	0.09178	1	0.000	0.2964	0.8950
3	1	-0.4421	0.23394	1	1.000	-1.2050	0.3207
	2	-.1129[a]	0.03174	1	0.017	-0.2164	-0.0094
	4	-0.0336	0.06232	1	1.000	-0.2368	0.1696
	5	0.0750	0.06227	1	1.000	-0.1280	0.2780
	6	0.1779	0.06824	1	0.412	-0.0446	0.4004
	7	0.2043	0.09814	1	1.000	-0.1157	0.5243
	8	0.2643	0.11412	1	0.925	-0.1078	0.6364
	9	.4186[a]	0.10920	1	0.006	0.0625	0.7746
	10	.4829[a]	0.09730	1	0.000	0.1656	0.8001
4	1	-0.4086	0.24848	1	1.000	-1.2188	0.4017
	2	-0.0793	0.07332	1	1.000	-0.3184	0.1598
	3	0.0336	0.06232	1	1.000	-0.1696	0.2368
	5	0.1086	0.03891	1	0.237	-0.0183	0.2355
	6	.2114[a]	0.03736	1	0.000	0.0896	0.3333
	7	.2379[a]	0.06261	1	0.007	0.0337	0.4420
	8	0.2979	0.10766	1	0.255	-0.0532	0.6489
	9	.4521[a]	0.08962	1	0.000	0.1599	0.7444
	10	.5164[a]	0.07986	1	0.000	0.2560	0.7768
5	1	-0.5171	0.25668	1	1.000	-1.3541	0.3198
	2	-0.1879	0.07242	1	0.427	-0.4240	0.0483
	3	-0.0750	0.06227	1	1.000	-0.2780	0.1280
	4	-0.1086	0.03891	1	0.237	-0.2355	0.0183
	6	0.1029	0.05894	1	1.000	-0.0893	0.2950
	7	0.1293	0.09242	1	1.000	-0.1721	0.4307
	8	0.1893	0.12627	1	1.000	-0.2225	0.6010
	9	0.3436	0.11535	1	0.130	-0.0326	0.7197
	10	.4079[a]	0.10611	1	0.005	0.0618	0.7539
6	1	-0.6200	0.24744	1	0.550	-1.4269	0.1869
	2	-.2907[a]	0.06925	1	0.001	-0.5165	-0.0649
	3	-0.1779	0.06824	1	0.412	-0.4004	0.0446

		4	-.2114[a]	0.03736	1	0.000	-0.3333	-0.0896
		5	-0.1029	0.05894	1	1.000	-0.2950	0.0893
		7	0.0264	0.04420	1	1.000	-0.1177	0.1706
		8	0.0864	0.08028	1	1.000	-0.1754	0.3482
		9	.2407[a]	0.06636	1	0.013	0.0243	0.4571
		10	.3050[a]	0.05131	1	0.000	0.1377	0.4723
	7	1	-0.6464	0.23973	1	0.315	-1.4281	0.1353
		2	-.3171[a]	0.09636	1	0.045	-0.6313	-0.0029
		3	-0.2043	0.09814	1	1.000	-0.5243	0.1157
		4	-.2379[a]	0.06261	1	0.007	-0.4420	-0.0337
		5	-0.1293	0.09242	1	1.000	-0.4307	0.1721
		6	-0.0264	0.04420	1	1.000	-0.1706	0.1177
		8	0.0600	0.07388	1	1.000	-0.1809	0.3009
		9	.2143[a]	0.04544	1	0.000	0.0661	0.3625
		10	.2786[a]	0.04206	1	0.000	0.1414	0.4157
	8	1	-0.7064	0.26747	1	0.372	-1.5786	0.1657
		2	-.3771[a]	0.10589	1	0.017	-0.7224	-0.0318
		3	-0.2643	0.11412	1	0.925	-0.6364	0.1078
		4	-0.2979	0.10766	1	0.255	-0.6489	0.0532
		5	-0.1893	0.12627	1	1.000	-0.6010	0.2225
		6	-0.0864	0.08028	1	1.000	-0.3482	0.1754
		7	-0.0600	0.07388	1	1.000	-0.3009	0.1809
		9	0.1543	0.06250	1	0.610	-0.0495	0.3581
		10	.2186[a]	0.05255	1	0.001	0.0472	0.3899
	9	1	-.8607[a]	0.26045	1	0.043	-1.7100	-0.0114
		2	-.5314[a]	0.10315	1	0.000	-0.8678	-0.1951
		3	-.4186[a]	0.10920	1	0.006	-0.7746	-0.0625
		4	-.4521[a]	0.08962	1	0.000	-0.7444	-0.1599
		5	-0.3436	0.11535	1	0.130	-0.7197	0.0326
		6	-.2407[a]	0.06636	1	0.013	-0.4571	-0.0243
		7	-.2143[a]	0.04544	1	0.000	-0.3625	-0.0661
		8	-0.1543	0.06250	1	0.610	-0.3581	0.0495
		10	0.0643	0.03328	1	1.000	-0.0442	0.1728
	10	1	-.9250[a]	0.25004	1	0.010	-1.7403	-0.1097
		2	-.5957[a]	0.09178	1	0.000	-0.8950	-0.2964
		3	-.4829[a]	0.09730	1	0.000	-0.8001	-0.1656
		4	-.5164[a]	0.07986	1	0.000	-0.7768	-0.2560
		5	-.4079[a]	0.10611	1	0.005	-0.7539	-0.0618
		6	-.3050[a]	0.05131	1	0.000	-0.4723	-0.1377
		7	-.2786[a]	0.04206	1	0.000	-0.4157	-0.1414
		8	-.2186[a]	0.05255	1	0.001	-0.3899	-0.0472
		9	-0.0643	0.03328	1	1.000	-0.1728	0.0442
Post-12	1	2	0.0571	0.05974	1	1.000	-0.1377	0.2519
		3	0.1264	0.06943	1	1.000	-0.1000	0.3528
		4	0.1157	0.08513	1	1.000	-0.1619	0.3933
		5	0.1750	0.09158	1	1.000	-0.1236	0.4736

	6	.2786[a]	0.08341	1	0.038	0.0066	0.5506
	7	.3871[a]	0.09677	1	0.003	0.0716	0.7027
	8	.4600[a]	0.08780	1	0.000	0.1737	0.7463
	9	.5943[a]	0.08679	1	0.000	0.3113	0.8773
	10	.4907[a]	0.10814	1	0.000	0.1380	0.8433
2	1	-0.0571	0.05974	1	1.000	-0.2519	0.1377
	3	0.0693	0.02530	1	0.278	-0.0132	0.1518
	4	0.0586	0.05404	1	1.000	-0.1176	0.2348
	5	0.1179	0.06100	1	1.000	-0.0810	0.3168
	6	0.2214	0.06951	1	0.065	-0.0052	0.4481
	7	.3300[a]	0.08535	1	0.005	0.0517	0.6083
	8	.4029[a]	0.07155	1	0.000	0.1696	0.6362
	9	.5371[a]	0.07377	1	0.000	0.2966	0.7777
	10	.4335[a]	0.08799	1	0.000	0.1466	0.7204
3	1	-0.1264	0.06943	1	1.000	-0.3528	0.1000
	2	-0.0693	0.02530	1	0.278	-0.1518	0.0132
	4	-0.0107	0.05423	1	1.000	-0.1876	0.1661
	5	0.0486	0.05784	1	1.000	-0.1400	0.2372
	6	0.1521	0.07473	1	1.000	-0.0915	0.3958
	7	0.2607	0.09017	1	0.173	-0.0333	0.5547
	8	.3336[a]	0.07564	1	0.000	0.0869	0.5802
	9	.4679[a]	0.07903	1	0.000	0.2102	0.7255
	10	.3642[a]	0.09025	1	0.002	0.0699	0.6585
4	1	-0.1157	0.08513	1	1.000	-0.3933	0.1619
	2	-0.0586	0.05404	1	1.000	-0.2348	0.1176
	3	0.0107	0.05423	1	1.000	-0.1661	0.1876
	5	0.0593	0.02130	1	0.242	-0.0102	0.1287
	6	.1629[a]	0.04864	1	0.037	0.0043	0.3215
	7	.2714[a]	0.07077	1	0.006	0.0407	0.5022
	8	.3443[a]	0.06515	1	0.000	0.1318	0.5567
	9	.4786[a]	0.07271	1	0.000	0.2415	0.7157
	10	.3749[a]	0.08420	1	0.000	0.1004	0.6495
5	1	-0.1750	0.09158	1	1.000	-0.4736	0.1236
	2	-0.1179	0.06100	1	1.000	-0.3168	0.0810
	3	-0.0486	0.05784	1	1.000	-0.2372	0.1400
	4	-0.0593	0.02130	1	0.242	-0.1287	0.0102
	6	0.1036	0.04435	1	0.879	-0.0410	0.2482
	7	.2121[a]	0.06319	1	0.035	0.0061	0.4182
	8	.2850[a]	0.06128	1	0.000	0.0852	0.4848
	9	.4193[a]	0.06909	1	0.000	0.1940	0.6446
	10	.3157[a]	0.07483	1	0.001	0.0717	0.5597
6	1	-.2786[a]	0.08341	1	0.038	-0.5506	-0.0066
	2	-0.2214	0.06951	1	0.065	-0.4481	0.0052
	3	-0.1521	0.07473	1	1.000	-0.3958	0.0915
	4	-.1629[a]	0.04864	1	0.037	-0.3215	-0.0043
	5	-0.1036	0.04435	1	0.879	-0.2482	0.0410

				7	.1086[a]	0.02957	1	0.011	0.0122	0.2050
				8	.1814[a]	0.04265	1	0.001	0.0423	0.3205
				9	.3157[a]	0.04899	1	0.000	0.1560	0.4754
				10	0.2121	0.06523	1	0.052	-0.0006	0.4248
			7	1	-.3871[a]	0.09677	1	0.003	-0.7027	-0.0716
				2	-.3300[a]	0.08535	1	0.005	-0.6083	-0.0517
				3	-0.2607	0.09017	1	0.173	-0.5547	0.0333
				4	-.2714[a]	0.07077	1	0.006	-0.5022	-0.0407
				5	-.2121[a]	0.06319	1	0.035	-0.4182	-0.0061
				6	-.1086[a]	0.02957	1	0.011	-0.2050	-0.0122
				8	0.0729	0.03839	1	1.000	-0.0523	0.1980
				9	.2071[a]	0.03784	1	0.000	0.0837	0.3305
				10	0.1035	0.05956	1	1.000	-0.0907	0.2977
			8	1	-.4600[a]	0.08780	1	0.000	-0.7463	-0.1737
				2	-.4029[a]	0.07155	1	0.000	-0.6362	-0.1696
				3	-.3336[a]	0.07564	1	0.000	-0.5802	-0.0869
				4	-.3443[a]	0.06515	1	0.000	-0.5567	-0.1318
				5	-.2850[a]	0.06128	1	0.000	-0.4848	-0.0852
				6	-.1814[a]	0.04265	1	0.001	-0.3205	-0.0423
				7	-0.0729	0.03839	1	1.000	-0.1980	0.0523
				9	.1343[a]	0.03254	1	0.002	0.0282	0.2404
				10	0.0307	0.07108	1	1.000	-0.2011	0.2624
			9	1	-.5943[a]	0.08679	1	0.000	-0.8773	-0.3113
				2	-.5371[a]	0.07377	1	0.000	-0.7777	-0.2966
				3	-.4679[a]	0.07903	1	0.000	-0.7255	-0.2102
				4	-.4786[a]	0.07271	1	0.000	-0.7157	-0.2415
				5	-.4193[a]	0.06909	1	0.000	-0.6446	-0.1940
				6	-.3157[a]	0.04899	1	0.000	-0.4754	-0.1560
				7	-.2071[a]	0.03784	1	0.000	-0.3305	-0.0837
				8	-.1343[a]	0.03254	1	0.002	-0.2404	-0.0282
				10	-0.1036	0.06625	1	1.000	-0.3197	0.1124
			10	1	-.4907[a]	0.10814	1	0.000	-0.8433	-0.1380
				2	-.4335[a]	0.08799	1	0.000	-0.7204	-0.1466
				3	-.3642[a]	0.09025	1	0.002	-0.6585	-0.0699
				4	-.3749[a]	0.08420	1	0.000	-0.6495	-0.1004
				5	-.3157[a]	0.07483	1	0.001	-0.5597	-0.0717
				6	-0.2121	0.06523	1	0.052	-0.4248	0.0006
				7	-0.1035	0.05956	1	1.000	-0.2977	0.0907
				8	-0.0307	0.07108	1	1.000	-0.2624	0.2011
				9	0.1036	0.06625	1	1.000	-0.1124	0.3197
ISO	Injured	PRE	1	2	0.0631	0.08629	1	1.000	-0.2183	0.3445
				3	0.0738	0.09100	1	1.000	-0.2229	0.3706
				4	-0.1292	0.26040	1	1.000	-0.9783	0.7199
				5	0.2723	0.12285	1	1.000	-0.1283	0.6729
				6	0.2938	0.14447	1	1.000	-0.1772	0.7649
				7	0.1700	0.24912	1	1.000	-0.6423	0.9823

	8	0.3669	0.23780	1	1.000	-0.4085	1.1423
	9	0.4092	0.25036	1	1.000	-0.4071	1.2256
	10	0.4785	0.29798	1	1.000	-0.4932	1.4501
2	1	-0.0631	0.08629	1	1.000	-0.3445	0.2183
	3	0.0108	0.03070	1	1.000	-0.0893	0.1109
	4	-0.1923	0.26174	1	1.000	-1.0458	0.6612
	5	0.2092	0.07036	1	0.132	-0.0202	0.4387
	6	0.2308	0.09255	1	0.569	-0.0710	0.5326
	7	0.1069	0.20510	1	1.000	-0.5619	0.7757
	8	0.3038	0.17229	1	1.000	-0.2579	0.8656
	9	0.3462	0.19222	1	1.000	-0.2806	0.9729
	10	0.4154	0.23267	1	1.000	-0.3433	1.1741
3	1	-0.0738	0.09100	1	1.000	-0.3706	0.2229
	2	-0.0108	0.03070	1	1.000	-0.1109	0.0893
	4	-0.2031	0.26906	1	1.000	-1.0804	0.6743
	5	0.1985	0.06326	1	0.077	-0.0078	0.4047
	6	0.2200	0.08592	1	0.470	-0.0602	0.5002
	7	0.0962	0.19775	1	1.000	-0.5487	0.7410
	8	0.2931	0.17470	1	1.000	-0.2766	0.8627
	9	0.3354	0.19368	1	1.000	-0.2962	0.9669
	10	0.4046	0.23393	1	1.000	-0.3582	1.1674
4	1	0.1292	0.26040	1	1.000	-0.7199	0.9783
	2	0.1923	0.26174	1	1.000	-0.6612	1.0458
	3	0.2031	0.26906	1	1.000	-0.6743	1.0804
	5	0.4015	0.24391	1	1.000	-0.3938	1.1969
	6	0.4231	0.23751	1	1.000	-0.3514	1.1976
	7	0.2992	0.30768	1	1.000	-0.7040	1.3025
	8	0.4962	0.27999	1	1.000	-0.4168	1.4091
	9	0.5385	0.28700	1	1.000	-0.3974	1.4743
	10	0.6077	0.33434	1	1.000	-0.4825	1.6979
5	1	-0.2723	0.12285	1	1.000	-0.6729	0.1283
	2	-0.2092	0.07036	1	0.132	-0.4387	0.0202
	3	-0.1985	0.06326	1	0.077	-0.4047	0.0078
	4	-0.4015	0.24391	1	1.000	-1.1969	0.3938
	6	0.0215	0.02907	1	1.000	-0.0732	0.1163
	7	-0.1023	0.18773	1	1.000	-0.7144	0.5098
	8	0.0946	0.15160	1	1.000	-0.3997	0.5890
	9	0.1369	0.17211	1	1.000	-0.4243	0.6981
	10	0.2062	0.21671	1	1.000	-0.5005	0.9128
6	1	-0.2938	0.14447	1	1.000	-0.7649	0.1772
	2	-0.2308	0.09255	1	0.569	-0.5326	0.0710
	3	-0.2200	0.08592	1	0.470	-0.5002	0.0602
	4	-0.4231	0.23751	1	1.000	-1.1976	0.3514
	5	-0.0215	0.02907	1	1.000	-0.1163	0.0732
	7	-0.1238	0.17474	1	1.000	-0.6936	0.4459
	8	0.0731	0.15236	1	1.000	-0.4237	0.5699

		9	0.1154	0.17360	1	1.000	-0.4507	0.6815
		10	0.1846	0.21739	1	1.000	-0.5242	0.8935
	7	1	-0.1700	0.24912	1	1.000	-0.9823	0.6423
		2	-0.1069	0.20510	1	1.000	-0.7757	0.5619
		3	-0.0962	0.19775	1	1.000	-0.7410	0.5487
		4	-0.2992	0.30768	1	1.000	-1.3025	0.7040
		5	0.1023	0.18773	1	1.000	-0.5098	0.7144
		6	0.1238	0.17474	1	1.000	-0.4459	0.6936
		8	0.1969	0.22093	1	1.000	-0.5235	0.9173
		9	0.2392	0.22436	1	1.000	-0.4924	0.9708
		10	0.3085	0.24949	1	1.000	-0.5051	1.1220
	8	1	-0.3669	0.23780	1	1.000	-1.1423	0.4085
		2	-0.3038	0.17229	1	1.000	-0.8656	0.2579
		3	-0.2931	0.17470	1	1.000	-0.8627	0.2766
		4	-0.4962	0.27999	1	1.000	-1.4091	0.4168
		5	-0.0946	0.15160	1	1.000	-0.5890	0.3997
		6	-0.0731	0.15236	1	1.000	-0.5699	0.4237
		7	-0.1969	0.22093	1	1.000	-0.9173	0.5235
		9	0.0423	0.04343	1	1.000	-0.0993	0.1839
		10	0.1115	0.07516	1	1.000	-0.1336	0.3566
	9	1	-0.4092	0.25036	1	1.000	-1.2256	0.4071
		2	-0.3462	0.19222	1	1.000	-0.9729	0.2806
		3	-0.3354	0.19368	1	1.000	-0.9669	0.2962
		4	-0.5385	0.28700	1	1.000	-1.4743	0.3974
		5	-0.1369	0.17211	1	1.000	-0.6981	0.4243
		6	-0.1154	0.17360	1	1.000	-0.6815	0.4507
		7	-0.2392	0.22436	1	1.000	-0.9708	0.4924
		8	-0.0423	0.04343	1	1.000	-0.1839	0.0993
		10	0.0692	0.05828	1	1.000	-0.1208	0.2593
	10	1	-0.4785	0.29798	1	1.000	-1.4501	0.4932
		2	-0.4154	0.23267	1	1.000	-1.1741	0.3433
		3	-0.4046	0.23393	1	1.000	-1.1674	0.3582
		4	-0.6077	0.33434	1	1.000	-1.6979	0.4825
		5	-0.2062	0.21671	1	1.000	-0.9128	0.5005
		6	-0.1846	0.21739	1	1.000	-0.8935	0.5242
		7	-0.3085	0.24949	1	1.000	-1.1220	0.5051
		8	-0.1115	0.07516	1	1.000	-0.3566	0.1336
		9	-0.0692	0.05828	1	1.000	-0.2593	0.1208
Post-4	1	2	0.1546	0.07326	1	1.000	-0.0843	0.3935
		3	0.2115	0.07983	1	0.362	-0.0488	0.4718
		4	0.0700	0.28826	1	1.000	-0.8699	1.0099
		5	0.3669	0.13795	1	0.352	-0.0829	0.8168
		6	0.4031	0.15737	1	0.469	-0.1101	0.9162
		7	.4923[a]	0.13030	1	0.007	0.0674	0.9172
		8	.6454[a]	0.13717	1	0.000	0.1981	1.0927
		9	.6354[a]	0.12053	1	0.000	0.2423	1.0284

	10	.7323[a]	0.12399	1	0.000	0.3280	1.1366
2	1	-0.1546	0.07326	1	1.000	-0.3935	0.0843
	3	0.0569	0.03220	1	1.000	-0.0481	0.1619
	4	-0.0846	0.27684	1	1.000	-0.9873	0.8181
	5	0.2123	0.08611	1	0.615	-0.0685	0.4931
	6	0.2485	0.10599	1	0.858	-0.0972	0.5941
	7	.3377[a]	0.09089	1	0.009	0.0413	0.6341
	8	.4908[a]	0.10436	1	0.000	0.1505	0.8311
	9	.4808[a]	0.10381	1	0.000	0.1423	0.8193
	10	.5777[a]	0.09517	1	0.000	0.2674	0.8880
3	1	-0.2115	0.07983	1	0.362	-0.4718	0.0488
	2	-0.0569	0.03220	1	1.000	-0.1619	0.0481
	4	-0.1415	0.27920	1	1.000	-1.0519	0.7689
	5	0.1554	0.07447	1	1.000	-0.0875	0.3982
	6	0.1915	0.09780	1	1.000	-0.1274	0.5105
	7	.2808[a]	0.08556	1	0.046	0.0018	0.5598
	8	.4338[a]	0.09776	1	0.000	0.1151	0.7526
	9	.4238[a]	0.09493	1	0.000	0.1143	0.7334
	10	.5208[a]	0.08124	1	0.000	0.2559	0.7857
4	1	-0.0700	0.28826	1	1.000	-1.0099	0.8699
	2	0.0846	0.27684	1	1.000	-0.8181	0.9873
	3	0.1415	0.27920	1	1.000	-0.7689	1.0519
	5	0.2969	0.25183	1	1.000	-0.5242	1.1181
	6	0.3331	0.24570	1	1.000	-0.4681	1.1343
	7	0.4223	0.24252	1	1.000	-0.3685	1.2131
	8	0.5754	0.22894	1	0.538	-0.1711	1.3219
	9	0.5654	0.22928	1	0.615	-0.1822	1.3130
	10	0.6623	0.24400	1	0.299	-0.1333	1.4579
5	1	-0.3669	0.13795	1	0.352	-0.8168	0.0829
	2	-0.2123	0.08611	1	0.615	-0.4931	0.0685
	3	-0.1554	0.07447	1	1.000	-0.3982	0.0875
	4	-0.2969	0.25183	1	1.000	-1.1181	0.5242
	6	0.0362	0.04752	1	1.000	-0.1188	0.1911
	7	0.1254	0.06296	1	1.000	-0.0799	0.3307
	8	.2785[a]	0.07728	1	0.014	0.0265	0.5305
	9	0.2685	0.08500	1	0.071	-0.0087	0.5456
	10	.3654[a]	0.06492	1	0.000	0.1537	0.5771
6	1	-0.4031	0.15737	1	0.469	-0.9162	0.1101
	2	-0.2485	0.10599	1	0.858	-0.5941	0.0972
	3	-0.1915	0.09780	1	1.000	-0.5105	0.1274
	4	-0.3331	0.24570	1	1.000	-1.1343	0.4681
	5	-0.0362	0.04752	1	1.000	-0.1911	0.1188
	7	0.0892	0.04322	1	1.000	-0.0517	0.2302
	8	0.2423	0.07468	1	0.053	-0.0012	0.4858
	9	0.2323	0.08925	1	0.416	-0.0587	0.5233
	10	.3292[a]	0.08687	1	0.007	0.0460	0.6125

	7	1	-.4923[a]	0.13030	1	0.007	-0.9172	-0.0674
		2	-.3377[a]	0.09089	1	0.009	-0.6341	-0.0413
		3	-.2808[a]	0.08556	1	0.046	-0.5598	-0.0018
		4	-0.4223	0.24252	1	1.000	-1.2131	0.3685
		5	-0.1254	0.06296	1	1.000	-0.3307	0.0799
		6	-0.0892	0.04322	1	1.000	-0.2302	0.0517
		8	0.1531	0.06137	1	0.568	-0.0470	0.3532
		9	0.1431	0.06168	1	0.916	-0.0580	0.3442
		10	.2400[a]	0.07122	1	0.034	0.0078	0.4722
	8	1	-.6454[a]	0.13717	1	0.000	-1.0927	-0.1981
		2	-.4908[a]	0.10436	1	0.000	-0.8311	-0.1505
		3	-.4338[a]	0.09776	1	0.000	-0.7526	-0.1151
		4	-0.5754	0.22894	1	0.538	-1.3219	0.1711
		5	-.2785[a]	0.07728	1	0.014	-0.5305	-0.0265
		6	-0.2423	0.07468	1	0.053	-0.4858	0.0012
		7	-0.1531	0.06137	1	0.568	-0.3532	0.0470
		9	-0.0100	0.04489	1	1.000	-0.1564	0.1364
		10	0.0869	0.06840	1	1.000	-0.1361	0.3100
	9	1	-.6354[a]	0.12053	1	0.000	-1.0284	-0.2423
		2	-.4808[a]	0.10381	1	0.000	-0.8193	-0.1423
		3	-.4238[a]	0.09493	1	0.000	-0.7334	-0.1143
		4	-0.5654	0.22928	1	0.615	-1.3130	0.1822
		5	-0.2685	0.08500	1	0.071	-0.5456	0.0087
		6	-0.2323	0.08925	1	0.416	-0.5233	0.0587
		7	-0.1431	0.06168	1	0.916	-0.3442	0.0580
		8	0.0100	0.04489	1	1.000	-0.1364	0.1564
		10	0.0969	0.04851	1	1.000	-0.0613	0.2551
	10	1	-.7323[a]	0.12399	1	0.000	-1.1366	-0.3280
		2	-.5777[a]	0.09517	1	0.000	-0.8880	-0.2674
		3	-.5208[a]	0.08124	1	0.000	-0.7857	-0.2559
		4	-0.6623	0.24400	1	0.299	-1.4579	0.1333
		5	-.3654[a]	0.06492	1	0.000	-0.5771	-0.1537
		6	-.3292[a]	0.08687	1	0.007	-0.6125	-0.0460
		7	-.2400[a]	0.07122	1	0.034	-0.4722	-0.0078
		8	-0.0869	0.06840	1	1.000	-0.3100	0.1361
		9	-0.0969	0.04851	1	1.000	-0.2551	0.0613
Post-8	1	2	0.1154	0.08127	1	1.000	-0.1496	0.3804
		3	0.2192	0.12406	1	1.000	-0.1853	0.6238
		4	0.0700	0.28497	1	1.000	-0.8592	0.9992
		5	0.2977	0.13168	1	1.000	-0.1317	0.7271
		6	0.3969	0.15354	1	0.438	-0.1037	0.8976
		7	.4854[a]	0.14052	1	0.025	0.0272	0.9436
		8	.5585[a]	0.14183	1	0.004	0.0960	1.0209
		9	.5508[a]	0.14807	1	0.009	0.0680	1.0336
		10	.6200[a]	0.10502	1	0.000	0.2775	0.9625
	2	1	-0.1154	0.08127	1	1.000	-0.3804	0.1496

	3	0.1038	0.07374	1	1.000	-0.1366	0.3443
	4	-0.0454	0.28022	1	1.000	-0.9591	0.8684
	5	0.1823	0.10021	1	1.000	-0.1444	0.5091
	6	0.2815	0.12186	1	0.939	-0.1158	0.6789
	7	0.3700	0.12214	1	0.110	-0.0283	0.7683
	8	0.4431	0.13625	1	0.052	-0.0012	0.8874
	9	0.4354	0.15620	1	0.239	-0.0739	0.9447
	10	.5046[a]	0.11778	1	0.001	0.1206	0.8887
3	1	-0.2192	0.12406	1	1.000	-0.6238	0.1853
	2	-0.1038	0.07374	1	1.000	-0.3443	0.1366
	4	-0.1492	0.27609	1	1.000	-1.0495	0.7510
	5	0.0785	0.08194	1	1.000	-0.1887	0.3457
	6	0.1777	0.08853	1	1.000	-0.1110	0.4664
	7	0.2662	0.08344	1	0.064	-0.0059	0.5382
	8	.3392[a]	0.10330	1	0.046	0.0024	0.6761
	9	0.3315	0.13132	1	0.521	-0.0967	0.7597
	10	.4008[a]	0.10628	1	0.007	0.0542	0.7473
4	1	-0.0700	0.28497	1	1.000	-0.9992	0.8592
	2	0.0454	0.28022	1	1.000	-0.8684	0.9591
	3	0.1492	0.27609	1	1.000	-0.7510	1.0495
	5	0.2277	0.25971	1	1.000	-0.6192	1.0746
	6	0.3269	0.24372	1	1.000	-0.4678	1.1216
	7	0.4154	0.23622	1	1.000	-0.3549	1.1856
	8	0.4885	0.23628	1	1.000	-0.2820	1.2589
	9	0.4808	0.24257	1	1.000	-0.3102	1.2717
	10	0.5500	0.26269	1	1.000	-0.3066	1.4066
5	1	-0.2977	0.13168	1	1.000	-0.7271	0.1317
	2	-0.1823	0.10021	1	1.000	-0.5091	0.1444
	3	-0.0785	0.08194	1	1.000	-0.3457	0.1887
	4	-0.2277	0.25971	1	1.000	-1.0746	0.6192
	6	0.0992	0.03964	1	0.553	-0.0300	0.2285
	7	0.1877	0.07307	1	0.459	-0.0506	0.4259
	8	0.2608	0.09964	1	0.399	-0.0641	0.5857
	9	0.2531	0.10366	1	0.658	-0.0849	0.5911
	10	0.3223	0.10136	1	0.066	-0.0082	0.6528
6	1	-0.3969	0.15354	1	0.438	-0.8976	0.1037
	2	-0.2815	0.12186	1	0.939	-0.6789	0.1158
	3	-0.1777	0.08853	1	1.000	-0.4664	0.1110
	4	-0.3269	0.24372	1	1.000	-1.1216	0.4678
	5	-0.0992	0.03964	1	0.553	-0.2285	0.0300
	7	0.0885	0.05393	1	1.000	-0.0874	0.2643
	8	0.1615	0.08076	1	1.000	-0.1018	0.4249
	9	0.1538	0.09317	1	1.000	-0.1499	0.4576
	10	0.2231	0.10148	1	1.000	-0.1078	0.5540
7	1	-.4854[a]	0.14052	1	0.025	-0.9436	-0.0272
	2	-0.3700	0.12214	1	0.110	-0.7683	0.0283

		3	-0.2662	0.08344	1	0.064	-0.5382	0.0059
		4	-0.4154	0.23622	1	1.000	-1.1856	0.3549
		5	-0.1877	0.07307	1	0.459	-0.4259	0.0506
		6	-0.0885	0.05393	1	1.000	-0.2643	0.0874
		8	0.0731	0.05301	1	1.000	-0.0998	0.2459
		9	0.0654	0.07951	1	1.000	-0.1939	0.3246
		10	0.1346	0.09435	1	1.000	-0.1730	0.4423
	8	1	-.5585[a]	0.14183	1	0.004	-1.0209	-0.0960
		2	-0.4431	0.13625	1	0.052	-0.8874	0.0012
		3	-.3392[a]	0.10330	1	0.046	-0.6761	-0.0024
		4	-0.4885	0.23628	1	1.000	-1.2589	0.2820
		5	-0.2608	0.09964	1	0.399	-0.5857	0.0641
		6	-0.1615	0.08076	1	1.000	-0.4249	0.1018
		7	-0.0731	0.05301	1	1.000	-0.2459	0.0998
		9	-0.0077	0.05367	1	1.000	-0.1827	0.1673
		10	0.0615	0.07636	1	1.000	-0.1874	0.3105
	9	1	-.5508[a]	0.14807	1	0.009	-1.0336	-0.0680
		2	-0.4354	0.15620	1	0.239	-0.9447	0.0739
		3	-0.3315	0.13132	1	0.521	-0.7597	0.0967
		4	-0.4808	0.24257	1	1.000	-1.2717	0.3102
		5	-0.2531	0.10366	1	0.658	-0.5911	0.0849
		6	-0.1538	0.09317	1	1.000	-0.4576	0.1499
		7	-0.0654	0.07951	1	1.000	-0.3246	0.1939
		8	0.0077	0.05367	1	1.000	-0.1673	0.1827
		10	0.0692	0.08470	1	1.000	-0.2070	0.3454
	10	1	-.6200[a]	0.10502	1	0.000	-0.9625	-0.2775
		2	-.5046[a]	0.11778	1	0.001	-0.8887	-0.1206
		3	-.4008[a]	0.10628	1	0.007	-0.7473	-0.0542
		4	-0.5500	0.26269	1	1.000	-1.4066	0.3066
		5	-0.3223	0.10136	1	0.066	-0.6528	0.0082
		6	-0.2231	0.10148	1	1.000	-0.5540	0.1078
		7	-0.1346	0.09435	1	1.000	-0.4423	0.1730
		8	-0.0615	0.07636	1	1.000	-0.3105	0.1874
		9	-0.0692	0.08470	1	1.000	-0.3454	0.2070
Post-12	1	2	0.0485	0.06682	1	1.000	-0.1694	0.2663
		3	0.1354	0.12007	1	1.000	-0.2561	0.5269
		4	0.0054	0.28530	1	1.000	-0.9249	0.9357
		5	0.3315	0.15036	1	1.000	-0.1588	0.8218
		6	0.4262	0.16553	1	0.452	-0.1136	0.9659
		7	0.5454	0.17534	1	0.084	-0.0264	1.1171
		8	.6585[a]	0.18767	1	0.020	0.0465	1.2704
		9	0.6023	0.20694	1	0.162	-0.0725	1.2771
		10	.7631[a]	0.20873	1	0.012	0.0825	1.4437
	2	1	-0.0485	0.06682	1	1.000	-0.2663	0.1694
		3	0.0869	0.08939	1	1.000	-0.2046	0.3784
		4	-0.0431	0.28951	1	1.000	-0.9871	0.9010

	5	0.2831	0.13884	1	1.000	-0.1697	0.7358
	6	0.3777	0.15696	1	0.725	-0.1341	0.8895
	7	0.4969	0.17033	1	0.159	-0.0585	1.0523
	8	0.6100	0.19441	1	0.077	-0.0239	1.2439
	9	0.5538	0.21339	1	0.425	-0.1420	1.2496
	10	.7146[a]	0.21201	1	0.034	0.0233	1.4059
3	1	-0.1354	0.12007	1	1.000	-0.5269	0.2561
	2	-0.0869	0.08939	1	1.000	-0.3784	0.2046
	4	-0.1300	0.27904	1	1.000	-1.0399	0.7799
	5	0.1962	0.10003	1	1.000	-0.1300	0.5223
	6	0.2908	0.13152	1	1.000	-0.1381	0.7196
	7	0.4100	0.13785	1	0.132	-0.0395	0.8595
	8	0.5231	0.16994	1	0.094	-0.0311	1.0772
	9	0.4669	0.19402	1	0.725	-0.1657	1.0996
	10	.6277[a]	0.17963	1	0.021	0.0420	1.2134
4	1	-0.0054	0.28530	1	1.000	-0.9357	0.9249
	2	0.0431	0.28951	1	1.000	-0.9010	0.9871
	3	0.1300	0.27904	1	1.000	-0.7799	1.0399
	5	0.3262	0.25535	1	1.000	-0.5065	1.1588
	6	0.4208	0.24515	1	1.000	-0.3786	1.2201
	7	0.5400	0.23795	1	1.000	-0.2359	1.3159
	8	0.6531	0.24523	1	0.348	-0.1466	1.4527
	9	0.5969	0.26049	1	0.987	-0.2525	1.4463
	10	0.7577	0.26706	1	0.205	-0.1131	1.6285
5	1	-0.3315	0.15036	1	1.000	-0.8218	0.1588
	2	-0.2831	0.13884	1	1.000	-0.7358	0.1697
	3	-0.1962	0.10003	1	1.000	-0.5223	0.1300
	4	-0.3262	0.25535	1	1.000	-1.1588	0.5065
	6	0.0946	0.05236	1	1.000	-0.0761	0.2653
	7	0.2138	0.07823	1	0.282	-0.0412	0.4689
	8	0.3269	0.11243	1	0.164	-0.0397	0.6935
	9	0.2708	0.12072	1	1.000	-0.1229	0.6644
	10	.4315[a]	0.11065	1	0.004	0.0707	0.7923
6	1	-0.4262	0.16553	1	0.452	-0.9659	0.1136
	2	-0.3777	0.15696	1	0.725	-0.8895	0.1341
	3	-0.2908	0.13152	1	1.000	-0.7196	0.1381
	4	-0.4208	0.24515	1	1.000	-1.2201	0.3786
	5	-0.0946	0.05236	1	1.000	-0.2653	0.0761
	7	0.1192	0.04584	1	0.418	-0.0302	0.2687
	8	0.2323	0.07547	1	0.094	-0.0138	0.4784
	9	0.1762	0.08319	1	1.000	-0.0951	0.4474
	10	.3369[a]	0.07694	1	0.001	0.0860	0.5878
7	1	-0.5454	0.17534	1	0.084	-1.1171	0.0264
	2	-0.4969	0.17033	1	0.159	-1.0523	0.0585
	3	-0.4100	0.13785	1	0.132	-0.8595	0.0395
	4	-0.5400	0.23795	1	1.000	-1.3159	0.2359

			5	-0.2138	0.07823	1	0.282	-0.4689	0.0412
			6	-0.1192	0.04584	1	0.418	-0.2687	0.0302
			8	0.1131	0.05028	1	1.000	-0.0509	0.2770
			9	0.0569	0.07562	1	1.000	-0.1897	0.3035
			10	.2177[a]	0.06110	1	0.016	0.0185	0.4169
		8	1	-.6585[a]	0.18767	1	0.020	-1.2704	-0.0465
			2	-0.6100	0.19441	1	0.077	-1.2439	0.0239
			3	-0.5231	0.16994	1	0.094	-1.0772	0.0311
			4	-0.6531	0.24523	1	0.348	-1.4527	0.1466
			5	-0.3269	0.11243	1	0.164	-0.6935	0.0397
			6	-0.2323	0.07547	1	0.094	-0.4784	0.0138
			7	-0.1131	0.05028	1	1.000	-0.2770	0.0509
			9	-0.0562	0.04555	1	1.000	-0.2047	0.0924
			10	0.1046	0.03917	1	0.341	-0.0231	0.2323
		9	1	-0.6023	0.20694	1	0.162	-1.2771	0.0725
			2	-0.5538	0.21339	1	0.425	-1.2496	0.1420
			3	-0.4669	0.19402	1	0.725	-1.0996	0.1657
			4	-0.5969	0.26049	1	0.987	-1.4463	0.2525
			5	-0.2708	0.12072	1	1.000	-0.6644	0.1229
			6	-0.1762	0.08319	1	1.000	-0.4474	0.0951
			7	-0.0569	0.07562	1	1.000	-0.3035	0.1897
			8	0.0562	0.04555	1	1.000	-0.0924	0.2047
			10	.1608[a]	0.03853	1	0.001	0.0351	0.2864
		10	1	-.7631[a]	0.20873	1	0.012	-1.4437	-0.0825
			2	-.7146[a]	0.21201	1	0.034	-1.4059	-0.0233
			3	-.6277[a]	0.17963	1	0.021	-1.2134	-0.0420
			4	-0.7577	0.26706	1	0.205	-1.6285	0.1131
			5	-.4315[a]	0.11065	1	0.004	-0.7923	-0.0707
			6	-.3369[a]	0.07694	1	0.001	-0.5878	-0.0860
			7	-.2177[a]	0.06110	1	0.016	-0.4169	-0.0185
			8	-0.1046	0.03917	1	0.341	-0.2323	0.0231
			9	-.1608[a]	0.03853	1	0.001	-0.2864	-0.0351
Uninjured	PRE	1	2	0.3307	0.14811	1	1.000	-0.1523	0.8136
			3	0.3753	0.14125	1	0.355	-0.0852	0.8359
			4	0.3767	0.15019	1	0.547	-0.1131	0.8664
			5	.5187[a]	0.14950	1	0.023	0.0312	1.0061
			6	.6233[a]	0.13973	1	0.000	0.1677	1.0790
			7	.6860[a]	0.13152	1	0.000	0.2571	1.1149
			8	.8333[a]	0.16794	1	0.000	0.2857	1.3809
			9	.8707[a]	0.16570	1	0.000	0.3304	1.4110
			10	.9747[a]	0.16625	1	0.000	0.4326	1.5168
		2	1	-0.3307	0.14811	1	1.000	-0.8136	0.1523
			3	0.0447	0.05389	1	1.000	-0.1311	0.2204
			4	0.0460	0.07183	1	1.000	-0.1882	0.2802
			5	0.1880	0.06876	1	0.281	-0.0362	0.4122
			6	.2927[a]	0.06973	1	0.001	0.0653	0.5200

	7	.3553[a]	0.06470	1	0.000	0.1444	0.5663
	8	.5027[a]	0.07433	1	0.000	0.2603	0.7450
	9	.5400[a]	0.05494	1	0.000	0.3608	0.7192
	10	.6440[a]	0.05972	1	0.000	0.4493	0.8387
3	1	-0.3753	0.14125	1	0.355	-0.8359	0.0852
	2	-0.0447	0.05389	1	1.000	-0.2204	0.1311
	4	0.0013	0.05560	1	1.000	-0.1800	0.1826
	5	0.1433	0.05653	1	0.505	-0.0410	0.3277
	6	.2480[a]	0.06733	1	0.010	0.0285	0.4675
	7	.3107[a]	0.05455	1	0.000	0.1328	0.4885
	8	.4580[a]	0.06478	1	0.000	0.2468	0.6692
	9	.4953[a]	0.05289	1	0.000	0.3229	0.6678
	10	.5993[a]	0.04714	1	0.000	0.4456	0.7530
4	1	-0.3767	0.15019	1	0.547	-0.8664	0.1131
	2	-0.0460	0.07183	1	1.000	-0.2802	0.1882
	3	-0.0013	0.05560	1	1.000	-0.1826	0.1800
	5	.1420[a]	0.03996	1	0.017	0.0117	0.2723
	6	.2467[a]	0.05988	1	0.002	0.0514	0.4419
	7	.3093[a]	0.04685	1	0.000	0.1566	0.4621
	8	.4567[a]	0.04327	1	0.000	0.3156	0.5978
	9	.4940[a]	0.04331	1	0.000	0.3528	0.6352
	10	.5980[a]	0.05581	1	0.000	0.4160	0.7800
5	1	-.5187[a]	0.14950	1	0.023	-1.0061	-0.0312
	2	-0.1880	0.06876	1	0.281	-0.4122	0.0362
	3	-0.1433	0.05653	1	0.505	-0.3277	0.0410
	4	-.1420[a]	0.03996	1	0.017	-0.2723	-0.0117
	6	0.1047	0.04362	1	0.738	-0.0376	0.2469
	7	.1673[a]	0.04263	1	0.004	0.0283	0.3064
	8	.3147[a]	0.04799	1	0.000	0.1582	0.4712
	9	.3520[a]	0.04794	1	0.000	0.1957	0.5083
	10	.4560[a]	0.04945	1	0.000	0.2948	0.6172
6	1	-.6233[a]	0.13973	1	0.000	-1.0790	-0.1677
	2	-.2927[a]	0.06973	1	0.001	-0.5200	-0.0653
	3	-.2480[a]	0.06733	1	0.010	-0.4675	-0.0285
	4	-.2467[a]	0.05988	1	0.002	-0.4419	-0.0514
	5	-0.1047	0.04362	1	0.738	-0.2469	0.0376
	7	0.0627	0.03464	1	1.000	-0.0503	0.1756
	8	.2100[a]	0.04397	1	0.000	0.0666	0.3534
	9	.2473[a]	0.05408	1	0.000	0.0710	0.4237
	10	.3513[a]	0.05497	1	0.000	0.1721	0.5306
7	1	-.6860[a]	0.13152	1	0.000	-1.1149	-0.2571
	2	-.3553[a]	0.06470	1	0.000	-0.5663	-0.1444
	3	-.3107[a]	0.05455	1	0.000	-0.4885	-0.1328
	4	-.3093[a]	0.04685	1	0.000	-0.4621	-0.1566
	5	-.1673[a]	0.04263	1	0.004	-0.3064	-0.0283
	6	-0.0627	0.03464	1	1.000	-0.1756	0.0503

		8	0.1473	0.04562	1	0.056	-0.0014	0.2961
		9	.1847[a]	0.04703	1	0.004	0.0313	0.3380
		10	.2887[a]	0.04907	1	0.000	0.1287	0.4487
	8	1	-.8333[a]	0.16794	1	0.000	-1.3809	-0.2857
		2	-.5027[a]	0.07433	1	0.000	-0.7450	-0.2603
		3	-.4580[a]	0.06478	1	0.000	-0.6692	-0.2468
		4	-.4567[a]	0.04327	1	0.000	-0.5978	-0.3156
		5	-.3147[a]	0.04799	1	0.000	-0.4712	-0.1582
		6	-.2100[a]	0.04397	1	0.000	-0.3534	-0.0666
		7	-0.1473	0.04562	1	0.056	-0.2961	0.0014
		9	0.0373	0.03250	1	1.000	-0.0686	0.1433
		10	0.1413	0.04398	1	0.059	-0.0021	0.2847
	9	1	-.8707[a]	0.16570	1	0.000	-1.4110	-0.3304
		2	-.5400[a]	0.05494	1	0.000	-0.7192	-0.3608
		3	-.4953[a]	0.05289	1	0.000	-0.6678	-0.3229
		4	-.4940[a]	0.04331	1	0.000	-0.6352	-0.3528
		5	-.3520[a]	0.04794	1	0.000	-0.5083	-0.1957
		6	-.2473[a]	0.05408	1	0.000	-0.4237	-0.0710
		7	-.1847[a]	0.04703	1	0.004	-0.3380	-0.0313
		8	-0.0373	0.03250	1	1.000	-0.1433	0.0686
		10	.1040[a]	0.02587	1	0.003	0.0197	0.1883
	10	1	-.9747[a]	0.16625	1	0.000	-1.5168	-0.4326
		2	-.6440[a]	0.05972	1	0.000	-0.8387	-0.4493
		3	-.5993[a]	0.04714	1	0.000	-0.7530	-0.4456
		4	-.5980[a]	0.05581	1	0.000	-0.7800	-0.4160
		5	-.4560[a]	0.04945	1	0.000	-0.6172	-0.2948
		6	-.3513[a]	0.05497	1	0.000	-0.5306	-0.1721
		7	-.2887[a]	0.04907	1	0.000	-0.4487	-0.1287
		8	-0.1413	0.04398	1	0.059	-0.2847	0.0021
		9	-.1040[a]	0.02587	1	0.003	-0.1883	-0.0197
Post-4	1	2	0.2320	0.15082	1	1.000	-0.2598	0.7238
		3	0.3153	0.14550	1	1.000	-0.1591	0.7898
		4	0.3033	0.15037	1	1.000	-0.1870	0.7937
		5	0.4160	0.15703	1	0.363	-0.0960	0.9280
		6	.5300[a]	0.15468	1	0.028	0.0256	1.0344
		7	.5787[a]	0.15198	1	0.006	0.0831	1.0742
		8	.6933[a]	0.18903	1	0.011	0.0769	1.3097
		9	.7033[a]	0.19246	1	0.012	0.0758	1.3309
		10	0.6773	0.21624	1	0.078	-0.0278	1.3824
	2	1	-0.2320	0.15082	1	1.000	-0.7238	0.2598
		3	0.0833	0.04795	1	1.000	-0.0730	0.2397
		4	0.0713	0.05951	1	1.000	-0.1227	0.2654
		5	0.1840	0.06921	1	0.353	-0.0417	0.4097
		6	.2980[a]	0.07491	1	0.003	0.0537	0.5423
		7	.3467[a]	0.08273	1	0.001	0.0769	0.6164
		8	.4613[a]	0.09306	1	0.000	0.1579	0.7648

	9	.4713[a]	0.09290	1	0.000	0.1684	0.7743
	10	.4453[a]	0.13381	1	0.039	0.0090	0.8817
3	1	-0.3153	0.14550	1	1.000	-0.7898	0.1591
	2	-0.0833	0.04795	1	1.000	-0.2397	0.0730
	4	-0.0120	0.03268	1	1.000	-0.1186	0.0946
	5	0.1007	0.04782	1	1.000	-0.0553	0.2566
	6	0.2147	0.06879	1	0.081	-0.0096	0.4390
	7	.2633[a]	0.06953	1	0.007	0.0366	0.4901
	8	.3780[a]	0.07753	1	0.000	0.1252	0.6308
	9	.3880[a]	0.08693	1	0.000	0.1045	0.6715
	10	0.3620	0.12401	1	0.158	-0.0424	0.7664
4	1	-0.3033	0.15037	1	1.000	-0.7937	0.1870
	2	-0.0713	0.05951	1	1.000	-0.2654	0.1227
	3	0.0120	0.03268	1	1.000	-0.0946	0.1186
	5	0.1127	0.03789	1	0.132	-0.0109	0.2362
	6	.2267[a]	0.05194	1	0.001	0.0573	0.3960
	7	.2753[a]	0.05334	1	0.000	0.1014	0.4493
	8	.3900[a]	0.06116	1	0.000	0.1906	0.5894
	9	.4000[a]	0.06747	1	0.000	0.1800	0.6200
	10	.3740[a]	0.11271	1	0.041	0.0065	0.7415
5	1	-0.4160	0.15703	1	0.363	-0.9280	0.0960
	2	-0.1840	0.06921	1	0.353	-0.4097	0.0417
	3	-0.1007	0.04782	1	1.000	-0.2566	0.0553
	4	-0.1127	0.03789	1	0.132	-0.2362	0.0109
	6	0.1140	0.04646	1	0.637	-0.0375	0.2655
	7	0.1627	0.05523	1	0.145	-0.0174	0.3428
	8	.2773[a]	0.06266	1	0.000	0.0730	0.4817
	9	.2873[a]	0.06950	1	0.002	0.0607	0.5139
	10	0.2613	0.10765	1	0.684	-0.0897	0.6123
6	1	-.5300[a]	0.15468	1	0.028	-1.0344	-0.0256
	2	-.2980[a]	0.07491	1	0.003	-0.5423	-0.0537
	3	-0.2147	0.06879	1	0.081	-0.4390	0.0096
	4	-.2267[a]	0.05194	1	0.001	-0.3960	-0.0573
	5	-0.1140	0.04646	1	0.637	-0.2655	0.0375
	7	0.0487	0.03414	1	1.000	-0.0627	0.1600
	8	0.1633	0.05469	1	0.127	-0.0150	0.3417
	9	0.1733	0.05952	1	0.162	-0.0208	0.3674
	10	0.1473	0.11702	1	1.000	-0.2342	0.5289
7	1	-.5787[a]	0.15198	1	0.006	-1.0742	-0.0831
	2	-.3467[a]	0.08273	1	0.001	-0.6164	-0.0769
	3	-.2633[a]	0.06953	1	0.007	-0.4901	-0.0366
	4	-.2753[a]	0.05334	1	0.000	-0.4493	-0.1014
	5	-0.1627	0.05523	1	0.145	-0.3428	0.0174
	6	-0.0487	0.03414	1	1.000	-0.1600	0.0627
	8	0.1147	0.04803	1	0.763	-0.0419	0.2713
	9	0.1247	0.05789	1	1.000	-0.0641	0.3134

		10	0.0987	0.11679	1	1.000	-0.2821	0.4795
	8	1	-.6933[a]	0.18903	1	0.011	-1.3097	-0.0769
		2	-.4613[a]	0.09306	1	0.000	-0.7648	-0.1579
		3	-.3780[a]	0.07753	1	0.000	-0.6308	-0.1252
		4	-.3900[a]	0.06116	1	0.000	-0.5894	-0.1906
		5	-.2773[a]	0.06266	1	0.000	-0.4817	-0.0730
		6	-0.1633	0.05469	1	0.127	-0.3417	0.0150
		7	-0.1147	0.04803	1	0.763	-0.2713	0.0419
		9	0.0100	0.03361	1	1.000	-0.0996	0.1196
		10	-0.0160	0.09473	1	1.000	-0.3249	0.2929
	9	1	-.7033[a]	0.19246	1	0.012	-1.3309	-0.0758
		2	-.4713[a]	0.09290	1	0.000	-0.7743	-0.1684
		3	-.3880[a]	0.08693	1	0.000	-0.6715	-0.1045
		4	-.4000[a]	0.06747	1	0.000	-0.6200	-0.1800
		5	-.2873[a]	0.06950	1	0.002	-0.5139	-0.0607
		6	-0.1733	0.05952	1	0.162	-0.3674	0.0208
		7	-0.1247	0.05789	1	1.000	-0.3134	0.0641
		8	-0.0100	0.03361	1	1.000	-0.1196	0.0996
		10	-0.0260	0.09111	1	1.000	-0.3231	0.2711
	10	1	-0.6773	0.21624	1	0.078	-1.3824	0.0278
		2	-.4453[a]	0.13381	1	0.039	-0.8817	-0.0090
		3	-0.3620	0.12401	1	0.158	-0.7664	0.0424
		4	-.3740[a]	0.11271	1	0.041	-0.7415	-0.0065
		5	-0.2613	0.10765	1	0.684	-0.6123	0.0897
		6	-0.1473	0.11702	1	1.000	-0.5289	0.2342
		7	-0.0987	0.11679	1	1.000	-0.4795	0.2821
		8	0.0160	0.09473	1	1.000	-0.2929	0.3249
		9	0.0260	0.09111	1	1.000	-0.2711	0.3231
Post-8	1	2	0.2353	0.15867	1	1.000	-0.2820	0.7527
		3	0.3200	0.14724	1	1.000	-0.1601	0.8001
		4	0.3467	0.15142	1	0.993	-0.1471	0.8404
		5	0.4193	0.15471	1	0.302	-0.0851	0.9238
		6	.5487[a]	0.14727	1	0.009	0.0685	1.0289
		7	.6040[a]	0.14767	1	0.002	0.1225	1.0855
		8	.7233[a]	0.18081	1	0.003	0.1337	1.3129
		9	.7807[a]	0.19031	1	0.002	0.1601	1.4012
		10	.7953[a]	0.19006	1	0.001	0.1756	1.4151
	2	1	-0.2353	0.15867	1	1.000	-0.7527	0.2820
		3	0.0847	0.06935	1	1.000	-0.1415	0.3108
		4	0.1113	0.07942	1	1.000	-0.1476	0.3703
		5	0.1840	0.07053	1	0.409	-0.0460	0.4140
		6	.3133[a]	0.07086	1	0.000	0.0823	0.5444
		7	.3687[a]	0.08127	1	0.000	0.1037	0.6337
		8	.4880[a]	0.07570	1	0.000	0.2412	0.7348
		9	.5453[a]	0.09348	1	0.000	0.2405	0.8502
		10	.5600[a]	0.09584	1	0.000	0.2475	0.8725

3	1	-0.3200	0.14724	1	1.000	-0.8001	0.1601
	2	-0.0847	0.06935	1	1.000	-0.3108	0.1415
	4	0.0267	0.02149	1	1.000	-0.0434	0.0968
	5	0.0993	0.03960	1	0.545	-0.0298	0.2284
	6	.2287[a]	0.05393	1	0.001	0.0528	0.4045
	7	.2840[a]	0.05664	1	0.000	0.0993	0.4687
	8	.4033[a]	0.06089	1	0.000	0.2048	0.6019
	9	.4607[a]	0.07284	1	0.000	0.2231	0.6982
	10	.4753[a]	0.08582	1	0.000	0.1955	0.7552
4	1	-0.3467	0.15142	1	0.993	-0.8404	0.1471
	2	-0.1113	0.07942	1	1.000	-0.3703	0.1476
	3	-0.0267	0.02149	1	1.000	-0.0968	0.0434
	5	0.0727	0.03361	1	1.000	-0.0369	0.1823
	6	.2020[a]	0.05411	1	0.009	0.0255	0.3785
	7	.2573[a]	0.05036	1	0.000	0.0931	0.4216
	8	.3767[a]	0.05853	1	0.000	0.1858	0.5675
	9	.4340[a]	0.06650	1	0.000	0.2172	0.6508
	10	.4487[a]	0.08854	1	0.000	0.1600	0.7374
5	1	-0.4193	0.15471	1	0.302	-0.9238	0.0851
	2	-0.1840	0.07053	1	0.409	-0.4140	0.0460
	3	-0.0993	0.03960	1	0.545	-0.2284	0.0298
	4	-0.0727	0.03361	1	1.000	-0.1823	0.0369
	6	0.1293	0.04133	1	0.079	-0.0054	0.2641
	7	.1847[a]	0.04346	1	0.001	0.0430	0.3264
	8	.3040[a]	0.05406	1	0.000	0.1277	0.4803
	9	.3613[a]	0.05959	1	0.000	0.1670	0.5557
	10	.3760[a]	0.09092	1	0.002	0.0795	0.6725
6	1	-.5487[a]	0.14727	1	0.009	-1.0289	-0.0685
	2	-.3133[a]	0.07086	1	0.000	-0.5444	-0.0823
	3	-.2287[a]	0.05393	1	0.001	-0.4045	-0.0528
	4	-.2020[a]	0.05411	1	0.009	-0.3785	-0.0255
	5	-0.1293	0.04133	1	0.079	-0.2641	0.0054
	7	0.0553	0.02815	1	1.000	-0.0365	0.1471
	8	0.1747	0.05563	1	0.076	-0.0067	0.3561
	9	.2320[a]	0.06350	1	0.012	0.0249	0.4391
	10	0.2467	0.09436	1	0.403	-0.0610	0.5544
7	1	-.6040[a]	0.14767	1	0.002	-1.0855	-0.1225
	2	-.3687[a]	0.08127	1	0.000	-0.6337	-0.1037
	3	-.2840[a]	0.05664	1	0.000	-0.4687	-0.0993
	4	-.2573[a]	0.05036	1	0.000	-0.4216	-0.0931
	5	-.1847[a]	0.04346	1	0.001	-0.3264	-0.0430
	6	-0.0553	0.02815	1	1.000	-0.1471	0.0365
	8	0.1193	0.05959	1	1.000	-0.0750	0.3136
	9	0.1767	0.06555	1	0.317	-0.0371	0.3904
	10	0.1913	0.10415	1	1.000	-0.1483	0.5309
8	1	-.7233[a]	0.18081	1	0.003	-1.3129	-0.1337

		2	-.4880[a]	0.07570	1	0.000	-0.7348	-0.2412
		3	-.4033[a]	0.06089	1	0.000	-0.6019	-0.2048
		4	-.3767[a]	0.05853	1	0.000	-0.5675	-0.1858
		5	-.3040[a]	0.05406	1	0.000	-0.4803	-0.1277
		6	-0.1747	0.05563	1	0.076	-0.3561	0.0067
		7	-0.1193	0.05959	1	1.000	-0.3136	0.0750
		9	0.0573	0.02699	1	1.000	-0.0307	0.1453
		10	0.0720	0.07854	1	1.000	-0.1841	0.3281
	9	1	-.7807[a]	0.19031	1	0.002	-1.4012	-0.1601
		2	-.5453[a]	0.09348	1	0.000	-0.8502	-0.2405
		3	-.4607[a]	0.07284	1	0.000	-0.6982	-0.2231
		4	-.4340[a]	0.06650	1	0.000	-0.6508	-0.2172
		5	-.3613[a]	0.05959	1	0.000	-0.5557	-0.1670
		6	-.2320[a]	0.06350	1	0.012	-0.4391	-0.0249
		7	-0.1767	0.06555	1	0.317	-0.3904	0.0371
		8	-0.0573	0.02699	1	1.000	-0.1453	0.0307
		10	0.0147	0.09199	1	1.000	-0.2853	0.3146
	10	1	-.7953[a]	0.19006	1	0.001	-1.4151	-0.1756
		2	-.5600[a]	0.09584	1	0.000	-0.8725	-0.2475
		3	-.4753[a]	0.08582	1	0.000	-0.7552	-0.1955
		4	-.4487[a]	0.08854	1	0.000	-0.7374	-0.1600
		5	-.3760[a]	0.09092	1	0.002	-0.6725	-0.0795
		6	-0.2467	0.09436	1	0.403	-0.5544	0.0610
		7	-0.1913	0.10415	1	1.000	-0.5309	0.1483
		8	-0.0720	0.07854	1	1.000	-0.3281	0.1841
		9	-0.0147	0.09199	1	1.000	-0.3146	0.2853
Post-12	1	2	0.3427	0.21325	1	1.000	-0.3527	1.0380
		3	0.3427	0.21113	1	1.000	-0.3458	1.0311
		4	0.3153	0.22320	1	1.000	-0.4125	1.0431
		5	0.4153	0.23213	1	1.000	-0.3416	1.1722
		6	0.5153	0.22715	1	1.000	-0.2253	1.2560
		7	0.5780	0.22474	1	0.455	-0.1548	1.3108
		8	0.6853	0.23400	1	0.153	-0.0777	1.4483
		9	0.7713	0.23693	1	0.051	-0.0012	1.5439
		10	.8293[a]	0.23674	1	0.021	0.0574	1.6013
	2	1	-0.3427	0.21325	1	1.000	-1.0380	0.3527
		3	0.0000	0.05541	1	1.000	-0.1807	0.1807
		4	-0.0273	0.08865	1	1.000	-0.3164	0.2617
		5	0.0727	0.09469	1	1.000	-0.2361	0.3814
		6	0.1727	0.09126	1	1.000	-0.1249	0.4703
		7	0.2353	0.09024	1	0.410	-0.0589	0.5296
		8	.3427[a]	0.06944	1	0.000	0.1162	0.5691
		9	.4287[a]	0.07289	1	0.000	0.1910	0.6663
		10	.4867[a]	0.07184	1	0.000	0.2524	0.7209
	3	1	-0.3427	0.21113	1	1.000	-1.0311	0.3458
		2	0.0000	0.05541	1	1.000	-0.1807	0.1807

	4	-0.0273	0.03970	1	1.000	-0.1568	0.1021
	5	0.0727	0.05641	1	1.000	-0.1113	0.2566
	6	0.1727	0.06632	1	0.415	-0.0436	0.3889
	7	.2353[a]	0.07186	1	0.048	0.0010	0.4697
	8	.3427[a]	0.07021	1	0.000	0.1137	0.5716
	9	.4287[a]	0.09189	1	0.000	0.1290	0.7283
	10	.4867[a]	0.08567	1	0.000	0.2073	0.7660
4	1	-0.3153	0.22320	1	1.000	-1.0431	0.4125
	2	0.0273	0.08865	1	1.000	-0.2617	0.3164
	3	0.0273	0.03970	1	1.000	-0.1021	0.1568
	5	0.1000	0.03563	1	0.225	-0.0162	0.2162
	6	.2000[a]	0.05803	1	0.026	0.0108	0.3892
	7	.2627[a]	0.07361	1	0.016	0.0226	0.5027
	8	.3700[a]	0.08321	1	0.000	0.0987	0.6413
	9	.4560[a]	0.11040	1	0.002	0.0960	0.8160
	10	.5140[a]	0.10225	1	0.000	0.1806	0.8474
5	1	-0.4153	0.23213	1	1.000	-1.1722	0.3416
	2	-0.0727	0.09469	1	1.000	-0.3814	0.2361
	3	-0.0727	0.05641	1	1.000	-0.2566	0.1113
	4	-0.1000	0.03563	1	0.225	-0.2162	0.0162
	6	0.1000	0.03423	1	0.157	-0.0116	0.2116
	7	0.1627	0.05636	1	0.176	-0.0211	0.3465
	8	.2700[a]	0.07651	1	0.019	0.0205	0.5195
	9	.3560[a]	0.10280	1	0.024	0.0208	0.6912
	10	.4140[a]	0.09893	1	0.001	0.0914	0.7366
6	1	-0.5153	0.22715	1	1.000	-1.2560	0.2253
	2	-0.1727	0.09126	1	1.000	-0.4703	0.1249
	3	-0.1727	0.06632	1	0.415	-0.3889	0.0436
	4	-.2000[a]	0.05803	1	0.026	-0.3892	-0.0108
	5	-0.1000	0.03423	1	0.157	-0.2116	0.0116
	7	0.0627	0.03479	1	1.000	-0.0508	0.1761
	8	0.1700	0.06148	1	0.256	-0.0305	0.3705
	9	0.2560	0.08869	1	0.175	-0.0332	0.5452
	10	.3140[a]	0.09097	1	0.025	0.0174	0.6106
7	1	-0.5780	0.22474	1	0.455	-1.3108	0.1548
	2	-0.2353	0.09024	1	0.410	-0.5296	0.0589
	3	-.2353[a]	0.07186	1	0.048	-0.4697	-0.0010
	4	-.2627[a]	0.07361	1	0.016	-0.5027	-0.0226
	5	-0.1627	0.05636	1	0.176	-0.3465	0.0211
	6	-0.0627	0.03479	1	1.000	-0.1761	0.0508
	8	0.1073	0.05139	1	1.000	-0.0603	0.2749
	9	0.1933	0.07326	1	0.374	-0.0456	0.4322
	10	0.2513	0.08243	1	0.103	-0.0175	0.5201
8	1	-0.6853	0.23400	1	0.153	-1.4483	0.0777
	2	-.3427[a]	0.06944	1	0.000	-0.5691	-0.1162
	3	-.3427[a]	0.07021	1	0.000	-0.5716	-0.1137

		4	-.3700[a]	0.08321	1	0.000	-0.6413	-0.0987
		5	-.2700[a]	0.07651	1	0.019	-0.5195	-0.0205
		6	-0.1700	0.06148	1	0.256	-0.3705	0.0305
		7	-0.1073	0.05139	1	1.000	-0.2749	0.0603
		9	0.0860	0.04366	1	1.000	-0.0564	0.2284
		10	0.1440	0.05612	1	0.463	-0.0390	0.3270
	9	1	-0.7713	0.23693	1	0.051	-1.5439	0.0012
		2	-.4287[a]	0.07289	1	0.000	-0.6663	-0.1910
		3	-.4287[a]	0.09189	1	0.000	-0.7283	-0.1290
		4	-.4560[a]	0.11040	1	0.002	-0.8160	-0.0960
		5	-.3560[a]	0.10280	1	0.024	-0.6912	-0.0208
		6	-0.2560	0.08869	1	0.175	-0.5452	0.0332
		7	-0.1933	0.07326	1	0.374	-0.4322	0.0456
		8	-0.0860	0.04366	1	1.000	-0.2284	0.0564
		10	0.0580	0.04433	1	1.000	-0.0865	0.2025
	10	1	-.8293[a]	0.23674	1	0.021	-1.6013	-0.0574
		2	-.4867[a]	0.07184	1	0.000	-0.7209	-0.2524
		3	-.4867[a]	0.08567	1	0.000	-0.7660	-0.2073
		4	-.5140[a]	0.10225	1	0.000	-0.8474	-0.1806
		5	-.4140[a]	0.09893	1	0.001	-0.7366	-0.0914
		6	-.3140[a]	0.09097	1	0.025	-0.6106	-0.0174
		7	-0.2513	0.08243	1	0.103	-0.5201	0.0175
		8	-0.1440	0.05612	1	0.463	-0.3270	0.0390
		9	-0.0580	0.04433	1	1.000	-0.2025	0.0865

Pairwise comparisons of estimated marginal means based on the original scale of dependent variable AST

a. The mean difference is significant at the .05 level.

APPENDICE E

Supplementary table 4.2| CHAPTER 4

Supplementary table 4.2. Statistical values of echo-intensity with comparisons between legs.

Pairwise Comparisons - Legs

Group	Region	Moment	Leg		Mean Difference (I-J)	Std. Error	df	Bonferroni Sig.	95% Wald Confidence Interval for Difference	
									Lower	Upper
CONV	1	PRE	Injured	Uninjured	-11.8850[a]	5.73227	1	0.038	-23.1200	-0.6500
			Uninjured	Injured	11.8850[a]	5.73227	1	0.038	0.6500	23.1200
		Post-4	Injured	Uninjured	-14.9157[a]	4.12404	1	0.000	-22.9987	-6.8327
			Uninjured	Injured	14.9157[a]	4.12404	1	0.000	6.8327	22.9987
		Post-8	Injured	Uninjured	-18.1579[a]	4.31155	1	0.000	-26.6083	-9.7074
			Uninjured	Injured	18.1579[a]	4.31155	1	0.000	9.7074	26.6083
		Post-12	Injured	Uninjured	-16.8764[a]	4.48799	1	0.000	-25.6727	-8.0801
			Uninjured	Injured	16.8764[a]	4.48799	1	0.000	8.0801	25.6727
	2	PRE	Injured	Uninjured	-17.9214[a]	5.29376	1	0.001	-28.2970	-7.5458
			Uninjured	Injured	17.9214[a]	5.29376	1	0.001	7.5458	28.2970
		Post-4	Injured	Uninjured	-19.3007[a]	4.86774	1	0.000	-28.8413	-9.7601
			Uninjured	Injured	19.3007[a]	4.86774	1	0.000	9.7601	28.8413
		Post-8	Injured	Uninjured	-24.9150[a]	3.19882	1	0.000	-31.1846	-18.6454
			Uninjured	Injured	24.9150[a]	3.19882	1	0.000	18.6454	31.1846
		Post-12	Injured	Uninjured	-26.2757[a]	3.54068	1	0.000	-33.2153	-19.3361
			Uninjured	Injured	26.2757[a]	3.54068	1	0.000	19.3361	33.2153
	3	PRE	Injured	Uninjured	-17.7336[a]	4.99377	1	0.000	-27.5212	-7.9460
			Uninjured	Injured	17.7336[a]	4.99377	1	0.000	7.9460	27.5212
		Post-4	Injured	Uninjured	-18.1193[a]	4.01551	1	0.000	-25.9895	-10.2490
			Uninjured	Injured	18.1193[a]	4.01551	1	0.000	10.2490	25.9895
		Post-8	Injured	Uninjured	-17.4029[a]	3.62260	1	0.000	-24.5030	-10.3027
			Uninjured	Injured	17.4029[a]	3.62260	1	0.000	10.3027	24.5030
		Post-12	Injured	Uninjured	-23.2486[a]	3.23263	1	0.000	-29.5844	-16.9127
			Uninjured	Injured	23.2486[a]	3.23263	1	0.000	16.9127	29.5844
	4	PRE	Injured	Uninjured	-14.2393[a]	4.03965	1	0.000	-22.1569	-6.3217
			Uninjured	Injured	14.2393[a]	4.03965	1	0.000	6.3217	22.1569
		Post-4	Injured	Uninjured	-14.1207[a]	2.62710	1	0.000	-19.2697	-8.9717
			Uninjured	Injured	14.1207[a]	2.62710	1	0.000	8.9717	19.2697

	Post-8	Injured	Uninjured	-16.4814a	3.09104	1	0.000	-22.5398	-10.4231
		Uninjured	Injured	16.4814a	3.09104	1	0.000	10.4231	22.5398
	Post-12	Injured	Uninjured	-16.4364a	3.37911	1	0.000	-23.0594	-9.8135
		Uninjured	Injured	16.4364a	3.37911	1	0.000	9.8135	23.0594
5	PRE	Injured	Uninjured	-10.1314a	4.43094	1	0.022	-18.8159	-1.4469
		Uninjured	Injured	10.1314a	4.43094	1	0.022	1.4469	18.8159
	Post-4	Injured	Uninjured	-8.5671a	2.81222	1	0.002	-14.0790	-3.0553
		Uninjured	Injured	8.5671a	2.81222	1	0.002	3.0553	14.0790
	Post-8	Injured	Uninjured	-9.0843a	3.92715	1	0.021	-16.7814	-1.3872
		Uninjured	Injured	9.0843a	3.92715	1	0.021	1.3872	16.7814
	Post-12	Injured	Uninjured	-11.4100a	4.44987	1	0.010	-20.1316	-2.6884
		Uninjured	Injured	11.4100a	4.44987	1	0.010	2.6884	20.1316
6	PRE	Injured	Uninjured	-9.8336a	4.04068	1	0.015	-17.7532	-1.9140
		Uninjured	Injured	9.8336a	4.04068	1	0.015	1.9140	17.7532
	Post-4	Injured	Uninjured	-8.3957a	2.92712	1	0.004	-14.1328	-2.6587
		Uninjured	Injured	8.3957a	2.92712	1	0.004	2.6587	14.1328
	Post-8	Injured	Uninjured	-11.5450a	3.52439	1	0.001	-18.4527	-4.6373
		Uninjured	Injured	11.5450a	3.52439	1	0.001	4.6373	18.4527
	Post-12	Injured	Uninjured	-14.5429a	3.93451	1	0.000	-22.2544	-6.8314
		Uninjured	Injured	14.5429a	3.93451	1	0.000	6.8314	22.2544
7	PRE	Injured	Uninjured	-12.1779a	3.67985	1	0.001	-19.3902	-4.9655
		Uninjured	Injured	12.1779a	3.67985	1	0.001	4.9655	19.3902
	Post-4	Injured	Uninjured	-9.7643a	3.63618	1	0.007	-16.8911	-2.6375
		Uninjured	Injured	9.7643a	3.63618	1	0.007	2.6375	16.8911
	Post-8	Injured	Uninjured	-12.3957a	3.71096	1	0.001	-19.6691	-5.1224
		Uninjured	Injured	12.3957a	3.71096	1	0.001	5.1224	19.6691
	Post-12	Injured	Uninjured	-8.8443a	2.78154	1	0.001	-14.2960	-3.3926
		Uninjured	Injured	8.8443a	2.78154	1	0.001	3.3926	14.2960
8	PRE	Injured	Uninjured	-14.4321a	5.10959	1	0.005	-24.4467	-4.4175
		Uninjured	Injured	14.4321a	5.10959	1	0.005	4.4175	24.4467
	Post-4	Injured	Uninjured	-13.7300a	5.52775	1	0.013	-24.5642	-2.8958
		Uninjured	Injured	13.7300a	5.52775	1	0.013	2.8958	24.5642
	Post-8	Injured	Uninjured	-10.0507a	2.33078	1	0.000	-14.6190	-5.4825
		Uninjured	Injured	10.0507a	2.33078	1	0.000	5.4825	14.6190
	Post-12	Injured	Uninjured	-7.3757a	2.45599	1	0.003	-12.1894	-2.5621
		Uninjured	Injured	7.3757a	2.45599	1	0.003	2.5621	12.1894
9	PRE	Injured	Uninjured	-11.6086	6.18272	1	0.060	-23.7265	0.5093
		Uninjured	Injured	11.6086	6.18272	1	0.060	-0.5093	23.7265

		Post-4	Injured	Uninjured	-14.5786[a]	5.28083	1	0.006	-24.9288	-4.2283
			Uninjured	Injured	14.5786[a]	5.28083	1	0.006	4.2283	24.9288
		Post-8	Injured	Uninjured	-12.4714[a]	2.50054	1	0.000	-17.3724	-7.5705
			Uninjured	Injured	12.4714[a]	2.50054	1	0.000	7.5705	17.3724
		Post-12	Injured	Uninjured	-11.0929[a]	4.21070	1	0.008	-19.3457	-2.8400
			Uninjured	Injured	11.0929[a]	4.21070	1	0.008	2.8400	19.3457
	10	PRE	Injured	Uninjured	-6.8936	5.05818	1	0.173	-16.8074	3.0203
			Uninjured	Injured	6.8936	5.05818	1	0.173	-3.0203	16.8074
		Post-4	Injured	Uninjured	-5.7550	4.94451	1	0.244	-15.4461	3.9361
			Uninjured	Injured	5.7550	4.94451	1	0.244	-3.9361	15.4461
		Post-8	Injured	Uninjured	-3.9736	4.07363	1	0.329	-11.9577	4.0106
			Uninjured	Injured	3.9736	4.07363	1	0.329	-4.0106	11.9577
		Post-12	Injured	Uninjured	-8.5171[a]	2.95064	1	0.004	-14.3003	-2.7340
			Uninjured	Injured	8.5171[a]	2.95064	1	0.004	2.7340	14.3003
ISO	1	PRE	Injured	Uninjured	-8.6157	6.41080	1	0.179	-21.1806	3.9492
			Uninjured	Injured	8.6157	6.41080	1	0.179	-3.9492	21.1806
		Post-4	Injured	Uninjured	-10.6425	6.58689	1	0.106	-23.5526	2.2676
			Uninjured	Injured	10.6425	6.58689	1	0.106	-2.2676	23.5526
		Post-8	Injured	Uninjured	-12.9893[a]	4.65599	1	0.005	-22.1149	-3.8638
			Uninjured	Injured	12.9893[a]	4.65599	1	0.005	3.8638	22.1149
		Post-12	Injured	Uninjured	-7.2063	5.57286	1	0.196	-18.1289	3.7163
			Uninjured	Injured	7.2063	5.57286	1	0.196	-3.7163	18.1289
	2	PRE	Injured	Uninjured	-12.6073[a]	4.09744	1	0.002	-20.6381	-4.5764
			Uninjured	Injured	12.6073[a]	4.09744	1	0.002	4.5764	20.6381
		Post-4	Injured	Uninjured	-17.9753[a]	3.45108	1	0.000	-24.7393	-11.2113
			Uninjured	Injured	17.9753[a]	3.45108	1	0.000	11.2113	24.7393
		Post-8	Injured	Uninjured	-18.3114[a]	3.95434	1	0.000	-26.0618	-10.5611
			Uninjured	Injured	18.3114[a]	3.95434	1	0.000	10.5611	26.0618
		Post-12	Injured	Uninjured	-16.6868[a]	5.94184	1	0.005	-28.3326	-5.0410
			Uninjured	Injured	16.6868[a]	5.94184	1	0.005	5.0410	28.3326
	3	PRE	Injured	Uninjured	-11.2993[a]	5.26842	1	0.032	-21.6252	-0.9734
			Uninjured	Injured	11.2993[a]	5.26842	1	0.032	0.9734	21.6252
		Post-4	Injured	Uninjured	-16.0871[a]	3.77853	1	0.000	-23.4929	-8.6813
			Uninjured	Injured	16.0871[a]	3.77853	1	0.000	8.6813	23.4929
		Post-8	Injured	Uninjured	-18.2800[a]	3.41759	1	0.000	-24.9784	-11.5816
			Uninjured	Injured	18.2800[a]	3.41759	1	0.000	11.5816	24.9784
		Post-12	Injured	Uninjured	-19.5584[a]	6.18617	1	0.002	-31.6830	-7.4337
			Uninjured	Injured	19.5584[a]	6.18617	1	0.002	7.4337	31.6830

4	PRE	Injured	Uninjured	-5.7312	3.57064	1	0.108	-12.7296	1.2671
		Uninjured	Injured	5.7312	3.57064	1	0.108	-1.2671	12.7296
	Post-4	Injured	Uninjured	-10.1113[a]	3.97890	1	0.011	-17.9098	-2.3128
		Uninjured	Injured	10.1113[a]	3.97890	1	0.011	2.3128	17.9098
	Post-8	Injured	Uninjured	-13.6143[a]	4.07402	1	0.001	-21.5992	-5.6293
		Uninjured	Injured	13.6143[a]	4.07402	1	0.001	5.6293	21.5992
	Post-12	Injured	Uninjured	-8.8813	5.86995	1	0.130	-20.3862	2.6236
		Uninjured	Injured	8.8813	5.86995	1	0.130	-2.6236	20.3862
5	PRE	Injured	Uninjured	-4.5052	4.12211	1	0.274	-12.5844	3.5740
		Uninjured	Injured	4.5052	4.12211	1	0.274	-3.5740	12.5844
	Post-4	Injured	Uninjured	-10.3037[a]	4.39532	1	0.019	-18.9184	-1.6891
		Uninjured	Injured	10.3037[a]	4.39532	1	0.019	1.6891	18.9184
	Post-8	Injured	Uninjured	-14.0778[a]	4.05818	1	0.001	-22.0317	-6.1240
		Uninjured	Injured	14.0778[a]	4.05818	1	0.001	6.1240	22.0317
	Post-12	Injured	Uninjured	-7.2050	5.46458	1	0.187	-17.9154	3.5054
		Uninjured	Injured	7.2050	5.46458	1	0.187	-3.5054	17.9154
6	PRE	Injured	Uninjured	-6.8337	3.77104	1	0.070	-14.2248	0.5574
		Uninjured	Injured	6.8337	3.77104	1	0.070	-0.5574	14.2248
	Post-4	Injured	Uninjured	-10.1292[a]	3.44140	1	0.003	-16.8742	-3.3842
		Uninjured	Injured	10.1292[a]	3.44140	1	0.003	3.3842	16.8742
	Post-8	Injured	Uninjured	-10.5001[a]	4.09724	1	0.010	-18.5305	-2.4697
		Uninjured	Injured	10.5001[a]	4.09724	1	0.010	2.4697	18.5305
	Post-12	Injured	Uninjured	-13.4034[a]	6.35997	1	0.035	-25.8687	-0.9381
		Uninjured	Injured	13.4034[a]	6.35997	1	0.035	0.9381	25.8687
7	PRE	Injured	Uninjured	-4.4545	4.07235	1	0.274	-12.4362	3.5271
		Uninjured	Injured	4.4545	4.07235	1	0.274	-3.5271	12.4362
	Post-4	Injured	Uninjured	-8.2862[a]	3.14280	1	0.008	-14.4459	-2.1264
		Uninjured	Injured	8.2862[a]	3.14280	1	0.008	2.1264	14.4459
	Post-8	Injured	Uninjured	-12.2495[a]	4.61174	1	0.008	-21.2884	-3.2107
		Uninjured	Injured	12.2495[a]	4.61174	1	0.008	3.2107	21.2884
	Post-12	Injured	Uninjured	-9.8735	6.64419	1	0.137	-22.8959	3.1489
		Uninjured	Injured	9.8735	6.64419	1	0.137	-3.1489	22.8959
8	PRE	Injured	Uninjured	-0.6491	4.07466	1	0.873	-8.6353	7.3371
		Uninjured	Injured	0.6491	4.07466	1	0.873	-7.3371	8.6353
	Post-4	Injured	Uninjured	-8.6421[a]	3.08252	1	0.005	-14.6837	-2.6004
		Uninjured	Injured	8.6421[a]	3.08252	1	0.005	2.6004	14.6837
	Post-8	Injured	Uninjured	-10.7754[a]	4.62798	1	0.020	-19.8461	-1.7047
		Uninjured	Injured	10.7754[a]	4.62798	1	0.020	1.7047	19.8461

	Post-12	Injured	Uninjured	-8.3009	6.41873	1	0.196	-20.8814	4.2795
		Uninjured	Injured	8.3009	6.41873	1	0.196	-4.2795	20.8814
9	PRE	Injured	Uninjured	-3.9497	4.25094	1	0.353	-12.2814	4.3819
		Uninjured	Injured	3.9497	4.25094	1	0.353	-4.3819	12.2814
	Post-4	Injured	Uninjured	-10.7734[a]	4.61594	1	0.020	-19.8205	-1.7264
		Uninjured	Injured	10.7734[a]	4.61594	1	0.020	1.7264	19.8205
	Post-8	Injured	Uninjured	-9.7285[a]	3.74439	1	0.009	-17.0674	-2.3897
		Uninjured	Injured	9.7285[a]	3.74439	1	0.009	2.3897	17.0674
	Post-12	Injured	Uninjured	-4.8087	4.63576	1	0.300	-13.8946	4.2772
		Uninjured	Injured	4.8087	4.63576	1	0.300	-4.2772	13.8946
10	PRE	Injured	Uninjured	-1.9953	3.79269	1	0.599	-9.4288	5.4382
		Uninjured	Injured	1.9953	3.79269	1	0.599	-5.4382	9.4288
	Post-4	Injured	Uninjured	1.0570	3.78807	1	0.780	-6.3675	8.4815
		Uninjured	Injured	-1.0570	3.78807	1	0.780	-8.4815	6.3675
	Post-8	Injured	Uninjured	-2.1376	3.75462	1	0.569	-9.4966	5.2213
		Uninjured	Injured	2.1376	3.75462	1	0.569	-5.2213	9.4966
	Post-12	Injured	Uninjured	-9.7217[a]	4.91162	1	0.048	-19.3483	-0.0951
		Uninjured	Injured	9.7217[a]	4.91162	1	0.048	0.0951	19.3483

Pairwise comparisons of estimated marginal means based on the original scale of dependent variable eco

a. The mean difference is significant at the ,05 level.

APPENDICE F

Supplementary table 4.3| CHAPTER 4

Supplementary table 4.3. Statistical values of echo-intensity with comparisons between regions.

Pairwise Comparisons - Region

Grupo	Leg	Moment	Region		Mean Difference (I-J)	Std. Error	df	Bonferroni Sig.	95% Wald Confidence Interval for Difference Lower	Upper
CONV	Injured	PRE	1	2	1.4614	2.12038	1	1.000	-5.4526	8.3755
				3	0.2971	3.98810	1	1.000	-12.7071	13.3014
				4	-1.7879	2.99237	1	1.000	-11.5453	7.9696
				5	-4.9964	2.74639	1	1.000	-13.9518	3.9589
				6	-4.0893	3.40442	1	1.000	-15.1903	7.0117
				7	-4.0843	3.55998	1	1.000	-15.6925	7.5240
				8	-0.3443	5.87138	1	1.000	-19.4895	18.8009
				9	-3.2593	6.23721	1	1.000	-23.5974	17.0788
				10	-3.9293	6.79846	1	1.000	-26.0975	18.2389
			2	1	-1.4614	2.12038	1	1.000	-8.3755	5.4526
				3	-1.1643	2.72649	1	1.000	-10.0547	7.7261
				4	-3.2493	2.11772	1	1.000	-10.1547	3.6561
				5	-6.4579[a]	1.81041	1	0.016	-12.3612	-0.5545
				6	-5.5507	2.44594	1	1.000	-13.5264	2.4249
				7	-5.5457	3.11941	1	1.000	-15.7174	4.6260
				8	-1.8057	6.09571	1	1.000	-21.6824	18.0710
				9	-4.7207	6.21469	1	1.000	-24.9854	15.5440
				10	-5.3907	6.76478	1	1.000	-27.4491	16.6676
			3	1	-0.2971	3.98810	1	1.000	-13.3014	12.7071
				2	1.1643	2.72649	1	1.000	-7.7261	10.0547
				4	-2.0850	2.33713	1	1.000	-9.7058	5.5358
				5	-5.2936	2.58957	1	1.000	-13.7376	3.1504
				6	-4.3864	2.73091	1	1.000	-13.2913	4.5184
				7	-4.3814	2.88595	1	1.000	-13.7918	5.0290
				8	-0.6414	6.41786	1	1.000	-21.5686	20.2857

	9	-3.5564	6.43480	1	1.000	-24.5388	17.4260
	10	-4.2264	6.69733	1	1.000	-26.0649	17.6120
4	1	1.7879	2.99237	1	1.000	-7.9696	11.5453
	2	3.2493	2.11772	1	1.000	-3.6561	10.1547
	3	2.0850	2.33713	1	1.000	-5.5358	9.7058
	5	-3.2086	1.52679	1	1.000	-8.1871	1.7699
	6	-2.3014	2.23473	1	1.000	-9.5884	4.9855
	7	-2.2964	2.15272	1	1.000	-9.3159	4.7231
	8	1.4436	5.34078	1	1.000	-15.9715	18.8586
	9	-1.4714	5.68688	1	1.000	-20.0150	17.0722
	10	-2.1414	6.02506	1	1.000	-21.7877	17.5049
5	1	4.9964	2.74639	1	1.000	-3.9589	13.9518
	2	6.4579[a]	1.81041	1	0.016	0.5545	12.3612
	3	5.2936	2.58957	1	1.000	-3.1504	13.7376
	4	3.2086	1.52679	1	1.000	-1.7699	8.1871
	6	0.9071	1.87704	1	1.000	-5.2135	7.0277
	7	0.9121	2.59771	1	1.000	-7.5584	9.3827
	8	4.6521	5.73910	1	1.000	-14.0617	23.3660
	9	1.7371	6.09979	1	1.000	-18.1529	21.6272
	10	1.0671	6.41022	1	1.000	-19.8351	21.9694
6	1	4.0893	3.40442	1	1.000	-7.0117	15.1903
	2	5.5507	2.44594	1	1.000	-2.4249	13.5264
	3	4.3864	2.73091	1	1.000	-4.5184	13.2913
	4	2.3014	2.23473	1	1.000	-4.9855	9.5884
	5	-0.9071	1.87704	1	1.000	-7.0277	5.2135
	7	0.0050	1.55878	1	1.000	-5.0778	5.0878
	8	3.7450	5.42336	1	1.000	-13.9393	21.4293
	9	0.8300	5.77378	1	1.000	-17.9970	19.6570
	10	0.1600	6.11230	1	1.000	-19.7708	20.0908
7	1	4.0843	3.55998	1	1.000	-7.5240	15.6925
	2	5.5457	3.11941	1	1.000	-4.6260	15.7174
	3	4.3814	2.88595	1	1.000	-5.0290	13.7918
	4	2.2964	2.15272	1	1.000	-4.7231	9.3159

		5	-0.9121	2.59771	1	1.000	-9.3827	7.5584
		6	-0.0050	1.55878	1	1.000	-5.0878	5.0778
		8	3.7400	4.65854	1	1.000	-11.4504	18.9304
		9	0.8250	5.17021	1	1.000	-16.0339	17.6839
		10	0.1550	5.46095	1	1.000	-17.6519	17.9619
	8	1	0.3443	5.87138	1	1.000	-18.8009	19.4895
		2	1.8057	6.09571	1	1.000	-18.0710	21.6824
		3	0.6414	6.41786	1	1.000	-20.2857	21.5686
		4	-1.4436	5.34078	1	1.000	-18.8586	15.9715
		5	-4.6521	5.73910	1	1.000	-23.3660	14.0617
		6	-3.7450	5.42336	1	1.000	-21.4293	13.9393
		7	-3.7400	4.65854	1	1.000	-18.9304	11.4504
		9	-2.9150	2.11550	1	1.000	-9.8132	3.9832
		10	-3.5850	2.58672	1	1.000	-12.0197	4.8497
	9	1	3.2593	6.23721	1	1.000	-17.0788	23.5974
		2	4.7207	6.21469	1	1.000	-15.5440	24.9854
		3	3.5564	6.43480	1	1.000	-17.4260	24.5388
		4	1.4714	5.68688	1	1.000	-17.0722	20.0150
		5	-1.7371	6.09979	1	1.000	-21.6272	18.1529
		6	-0.8300	5.77378	1	1.000	-19.6570	17.9970
		7	-0.8250	5.17021	1	1.000	-17.6839	16.0339
		8	2.9150	2.11550	1	1.000	-3.9832	9.8132
		10	-0.6700	1.60619	1	1.000	-5.9074	4.5674
	10	1	3.9293	6.79846	1	1.000	-18.2389	26.0975
		2	5.3907	6.76478	1	1.000	-16.6676	27.4491
		3	4.2264	6.69733	1	1.000	-17.6120	26.0649
		4	2.1414	6.02506	1	1.000	-17.5049	21.7877
		5	-1.0671	6.41022	1	1.000	-21.9694	19.8351
		6	-0.1600	6.11230	1	1.000	-20.0908	19.7708
		7	-0.1550	5.46095	1	1.000	-17.9619	17.6519
		8	3.5850	2.58672	1	1.000	-4.8497	12.0197
		9	0.6700	1.60619	1	1.000	-4.5674	5.9074
POST-4	1	2	-0.4350	2.28604	1	1.000	-7.8893	7.0193

	3	-3.6171	3.75567	1	1.000	-15.8635	8.6292
	4	-3.7879	3.48883	1	1.000	-15.1641	7.5884
	5	-11.7564	4.46109	1	0.378	-26.3030	2.7901
	6	-13.6300	4.53138	1	0.118	-28.4058	1.1458
	7	-11.5786	3.94575	1	0.150	-24.4447	1.2876
	8	-4.4743	6.19534	1	1.000	-24.6759	15.7273
	9	-7.5236	6.92280	1	1.000	-30.0972	15.0501
	10	-11.1771	7.46098	1	1.000	-35.5057	13.1514
2	1	0.4350	2.28604	1	1.000	-7.0193	7.8893
	3	-3.1821	2.33098	1	1.000	-10.7829	4.4187
	4	-3.3529	2.88860	1	1.000	-12.7719	6.0662
	5	-11.3214	3.59465	1	0.074	-23.0428	0.3999
	6	-13.1950[a]	3.45313	1	0.006	-24.4548	-1.9352
	7	-11.1436[a]	2.75300	1	0.002	-20.1205	-2.1667
	8	-4.0393	6.17142	1	1.000	-24.1629	16.0843
	9	-7.0886	6.67623	1	1.000	-28.8582	14.6811
	10	-10.7421	7.32511	1	1.000	-34.6276	13.1433
3	1	3.6171	3.75567	1	1.000	-8.6292	15.8635
	2	3.1821	2.33098	1	1.000	-4.4187	10.7829
	4	-0.1707	2.21309	1	1.000	-7.3871	7.0456
	5	-8.1393	3.15072	1	0.440	-18.4130	2.1345
	6	-10.0129[a]	2.86772	1	0.022	-19.3638	-0.6619
	7	-7.9614	2.55638	1	0.083	-16.2972	0.3743
	8	-0.8571	6.45542	1	1.000	-21.9068	20.1925
	9	-3.9064	6.69847	1	1.000	-25.7486	17.9357
	10	-7.5600	7.16359	1	1.000	-30.9188	15.7988
4	1	3.7879	3.48883	1	1.000	-7.5884	15.1641
	2	3.3529	2.88860	1	1.000	-6.0662	12.7719
	3	0.1707	2.21309	1	1.000	-7.0456	7.3871
	5	-7.9686	2.86385	1	0.243	-17.3069	1.3698
	6	-9.8421	3.28832	1	0.124	-20.5646	0.8803
	7	-7.7907	2.76230	1	0.216	-16.7979	1.2165
	8	-0.6864	5.70630	1	1.000	-19.2934	17.9205

	9	-3.7357	6.31346	1	1.000	-24.3224	16.8510
	10	-7.3893	6.77059	1	1.000	-29.4666	14.6880
5	1	11.7564	4.46109	1	0.378	-2.7901	26.3030
	2	11.3214	3.59465	1	0.074	-0.3999	23.0428
	3	8.1393	3.15072	1	0.440	-2.1345	18.4130
	4	7.9686	2.86385	1	0.243	-1.3698	17.3069
	6	-1.8736	2.18351	1	1.000	-8.9935	5.2463
	7	0.1779	2.97036	1	1.000	-9.5078	9.8635
	8	7.2821	5.79979	1	1.000	-11.6296	26.1939
	9	4.2329	5.77448	1	1.000	-14.5964	23.0621
	10	0.5793	6.56435	1	1.000	-20.8255	21.9841
6	1	13.6300	4.53138	1	0.118	-1.1458	28.4058
	2	13.1950[a]	3.45313	1	0.006	1.9352	24.4548
	3	10.0129[a]	2.86772	1	0.022	0.6619	19.3638
	4	9.8421	3.28832	1	0.124	-0.8803	20.5646
	5	1.8736	2.18351	1	1.000	-5.2463	8.9935
	7	2.0514	2.00001	1	1.000	-4.4702	8.5730
	8	9.1557	5.21178	1	1.000	-7.8387	26.1501
	9	6.1064	4.98138	1	1.000	-10.1367	22.3496
	10	2.4529	5.61582	1	1.000	-15.8590	20.7647
7	1	11.5786	3.94575	1	0.150	-1.2876	24.4447
	2	11.1436[a]	2.75300	1	0.002	2.1667	20.1205
	3	7.9614	2.55638	1	0.083	-0.3743	16.2972
	4	7.7907	2.76230	1	0.216	-1.2165	16.7979
	5	-0.1779	2.97036	1	1.000	-9.8635	9.5078
	6	-2.0514	2.00001	1	1.000	-8.5730	4.4702
	8	7.1043	4.45135	1	1.000	-7.4105	21.6191
	9	4.0550	4.75828	1	1.000	-11.4606	19.5706
	10	0.4014	5.50597	1	1.000	-17.5522	18.3551
8	1	4.4743	6.19534	1	1.000	-15.7273	24.6759
	2	4.0393	6.17142	1	1.000	-16.0843	24.1629
	3	0.8571	6.45542	1	1.000	-20.1925	21.9068
	4	0.6864	5.70630	1	1.000	-17.9205	19.2934

		5	-7.2821	5.79979	1	1.000	-26.1939	11.6296
		6	-9.1557	5.21178	1	1.000	-26.1501	7.8387
		7	-7.1043	4.45135	1	1.000	-21.6191	7.4105
		9	-3.0493	2.64978	1	1.000	-11.6896	5.5910
		10	-6.7029	3.37142	1	1.000	-17.6963	4.2906
	9	1	7.5236	6.92280	1	1.000	-15.0501	30.0972
		2	7.0886	6.67623	1	1.000	-14.6811	28.8582
		3	3.9064	6.69847	1	1.000	-17.9357	25.7486
		4	3.7357	6.31346	1	1.000	-16.8510	24.3224
		5	-4.2329	5.77448	1	1.000	-23.0621	14.5964
		6	-6.1064	4.98138	1	1.000	-22.3496	10.1367
		7	-4.0550	4.75828	1	1.000	-19.5706	11.4606
		8	3.0493	2.64978	1	1.000	-5.5910	11.6896
		10	-3.6536	2.01827	1	1.000	-10.2347	2.9275
	10	1	11.1771	7.46098	1	1.000	-13.1514	35.5057
		2	10.7421	7.32511	1	1.000	-13.1433	34.6276
		3	7.5600	7.16359	1	1.000	-15.7988	30.9188
		4	7.3893	6.77059	1	1.000	-14.6880	29.4666
		5	-0.5793	6.56435	1	1.000	-21.9841	20.8255
		6	-2.4529	5.61582	1	1.000	-20.7647	15.8590
		7	-0.4014	5.50597	1	1.000	-18.3551	17.5522
		8	6.7029	3.37142	1	1.000	-4.2906	17.6963
		9	3.6536	2.01827	1	1.000	-2.9275	10.2347
POST-8	1	2	2.0471	2.61168	1	1.000	-6.4689	10.5632
		3	-2.6679	4.20009	1	1.000	-16.3634	11.0276
		4	-2.9564	3.56495	1	1.000	-14.5809	8.6680
		5	-10.0886	3.70151	1	0.289	-22.1583	1.9812
		6	-8.1464	4.38119	1	1.000	-22.4325	6.1396
		7	-6.9943	4.21014	1	1.000	-20.7226	6.7340
		8	-8.7700	3.91992	1	1.000	-21.5519	4.0119
		9	-9.5864	4.17195	1	0.971	-23.1902	4.0173
		10	-13.4621	4.20085	1	0.061	-27.1601	0.2359
	2	1	-2.0471	2.61168	1	1.000	-10.5632	6.4689

	3	-4.7150	2.26659	1	1.000	-12.1058	2.6758
	4	-5.0036	2.31228	1	1.000	-12.5434	2.5362
	5	-12.1357[a]	2.95969	1	0.002	-21.7866	-2.4849
	6	-10.1936[a]	2.75743	1	0.010	-19.1849	-1.2022
	7	-9.0414[a]	2.62464	1	0.026	-17.5998	-0.4831
	8	-10.8171[a]	2.82536	1	0.006	-20.0300	-1.6043
	9	-11.6336[a]	3.46208	1	0.035	-22.9226	-0.3445
	10	-15.5093[a]	3.86199	1	0.003	-28.1024	-2.9162
3	1	2.6679	4.20009	1	1.000	-11.0276	16.3634
	2	4.7150	2.26659	1	1.000	-2.6758	12.1058
	4	-0.2886	2.44809	1	1.000	-8.2712	7.6941
	5	-7.4207	3.37491	1	1.000	-18.4255	3.5841
	6	-5.4786	2.80347	1	1.000	-14.6200	3.6629
	7	-4.3264	3.07882	1	1.000	-14.3657	5.7129
	8	-6.1021	3.47726	1	1.000	-17.4407	5.2364
	9	-6.9186	3.56337	1	1.000	-18.5379	4.7007
	10	-10.7943	3.44877	1	0.079	-22.0399	0.4514
4	1	2.9564	3.56495	1	1.000	-8.6680	14.5809
	2	5.0036	2.31228	1	1.000	-2.5362	12.5434
	3	0.2886	2.44809	1	1.000	-7.6941	8.2712
	5	-7.1321	3.26994	1	1.000	-17.7946	3.5304
	6	-5.1900	2.97135	1	1.000	-14.8789	4.4989
	7	-4.0379	3.00669	1	1.000	-13.8420	5.7663
	8	-5.8136	2.98166	1	1.000	-15.5361	3.9089
	9	-6.6300	3.41626	1	1.000	-17.7696	4.5096
	10	-10.5057	4.12268	1	0.487	-23.9488	2.9374
5	1	10.0886	3.70151	1	0.289	-1.9812	22.1583
	2	12.1357[a]	2.95969	1	0.002	2.4849	21.7866
	3	7.4207	3.37491	1	1.000	-3.5841	18.4255
	4	7.1321	3.26994	1	1.000	-3.5304	17.7946
	6	1.9421	2.98770	1	1.000	-7.8001	11.6844
	7	3.0943	3.33678	1	1.000	-7.7862	13.9747
	8	1.3186	4.09392	1	1.000	-12.0307	14.6679

	9	0.5021	3.56830	1	1.000	-11.1332	12.1375
	10	-3.3736	4.04595	1	1.000	-16.5665	9.8193
6	1	8.1464	4.38119	1	1.000	-6.1396	22.4325
	2	10.1936[a]	2.75743	1	0.010	1.2022	19.1849
	3	5.4786	2.80347	1	1.000	-3.6629	14.6200
	4	5.1900	2.97135	1	1.000	-4.4989	14.8789
	5	-1.9421	2.98770	1	1.000	-11.6844	7.8001
	7	1.1521	1.88220	1	1.000	-4.9853	7.2895
	8	-0.6236	2.78203	1	1.000	-9.6951	8.4480
	9	-1.4400	2.61495	1	1.000	-9.9667	7.0867
	10	-5.3157	4.55506	1	1.000	-20.1687	9.5373
7	1	6.9943	4.21014	1	1.000	-6.7340	20.7226
	2	9.0414[a]	2.62464	1	0.026	0.4831	17.5998
	3	4.3264	3.07882	1	1.000	-5.7129	14.3657
	4	4.0379	3.00669	1	1.000	-5.7663	13.8420
	5	-3.0943	3.33678	1	1.000	-13.9747	7.7862
	6	-1.1521	1.88220	1	1.000	-7.2895	4.9853
	8	-1.7757	2.45825	1	1.000	-9.7915	6.2401
	9	-2.5921	3.09652	1	1.000	-12.6892	7.5049
	10	-6.4679	4.74955	1	1.000	-21.9550	9.0193
8	1	8.7700	3.91992	1	1.000	-4.0119	21.5519
	2	10.8171[a]	2.82536	1	0.006	1.6043	20.0300
	3	6.1021	3.47726	1	1.000	-5.2364	17.4407
	4	5.8136	2.98166	1	1.000	-3.9089	15.5361
	5	-1.3186	4.09392	1	1.000	-14.6679	12.0307
	6	0.6236	2.78203	1	1.000	-8.4480	9.6951
	7	1.7757	2.45825	1	1.000	-6.2401	9.7915
	9	-0.8164	3.29855	1	1.000	-11.5722	9.9394
	10	-4.6921	4.39718	1	1.000	-19.0303	9.6460
9	1	9.5864	4.17195	1	0.971	-4.0173	23.1902
	2	11.6336[a]	3.46208	1	0.035	0.3445	22.9226
	3	6.9186	3.56337	1	1.000	-4.7007	18.5379
	4	6.6300	3.41626	1	1.000	-4.5096	17.7696

		5	-0.5021	3.56830	1	1.000	-12.1375	11.1332
		6	1.4400	2.61495	1	1.000	-7.0867	9.9667
		7	2.5921	3.09652	1	1.000	-7.5049	12.6892
		8	0.8164	3.29855	1	1.000	-9.9394	11.5722
		10	-3.8757	3.33364	1	1.000	-14.7459	6.9945
	10	1	13.4621	4.20085	1	0.061	-0.2359	27.1601
		2	15.5093[a]	3.86199	1	0.003	2.9162	28.1024
		3	10.7943	3.44877	1	0.079	-0.4514	22.0399
		4	10.5057	4.12268	1	0.487	-2.9374	23.9488
		5	3.3736	4.04595	1	1.000	-9.8193	16.5665
		6	5.3157	4.55506	1	1.000	-9.5373	20.1687
		7	6.4679	4.74955	1	1.000	-9.0193	21.9550
		8	4.6921	4.39718	1	1.000	-9.6460	19.0303
		9	3.8757	3.33364	1	1.000	-6.9945	14.7459
POST-12	1	2	0.3979	2.95178	1	1.000	-9.2272	10.0229
		3	-4.2414	4.25613	1	1.000	-18.1197	9.6368
		4	-4.6164	2.80161	1	1.000	-13.7518	4.5190
		5	-9.3986	4.79119	1	1.000	-25.0215	6.2244
		6	-8.6914	5.36854	1	1.000	-26.1970	8.8141
		7	-11.3650[a]	3.24270	1	0.021	-21.9387	-0.7913
		8	-10.4721[a]	2.87701	1	0.012	-19.8534	-1.0909
		9	-7.9429	3.62606	1	1.000	-19.7666	3.8809
		10	-8.1164	3.58708	1	1.000	-19.8131	3.5802
	2	1	-0.3979	2.95178	1	1.000	-10.0229	9.2272
		3	-4.6393	3.05331	1	1.000	-14.5954	5.3168
		4	-5.0143	2.97007	1	1.000	-14.6990	4.6704
		5	-9.7964	4.08951	1	0.747	-23.1314	3.5385
		6	-9.0893	5.06178	1	1.000	-25.5946	7.4160
		7	-11.7629[a]	3.56451	1	0.044	-23.3859	-0.1398
		8	-10.8700[a]	2.74705	1	0.003	-19.8275	-1.9125
		9	-8.3407	4.14077	1	1.000	-21.8428	5.1614
		10	-8.5143	4.71005	1	1.000	-23.8727	6.8441
	3	1	4.2414	4.25613	1	1.000	-9.6368	18.1197

	2	4.6393	3.05331	1	1.000	-5.3168	14.5954
	4	-0.3750	2.74737	1	1.000	-9.3335	8.5835
	5	-5.1571	3.26933	1	1.000	-15.8177	5.5034
	6	-4.4500	3.49318	1	1.000	-15.8404	6.9404
	7	-7.1236	2.94420	1	0.699	-16.7239	2.4768
	8	-6.2307	2.59209	1	0.730	-14.6829	2.2215
	9	-3.7014	3.69901	1	1.000	-15.7630	8.3602
	10	-3.8750	4.01348	1	1.000	-16.9620	9.2120
4	1	4.6164	2.80161	1	1.000	-4.5190	13.7518
	2	5.0143	2.97007	1	1.000	-4.6704	14.6990
	3	0.3750	2.74737	1	1.000	-8.5835	9.3335
	5	-4.7821	2.50812	1	1.000	-12.9605	3.3962
	6	-4.0750	3.02387	1	1.000	-13.9351	5.7851
	7	-6.7486[a]	1.66483	1	0.002	-12.1772	-1.3199
	8	-5.8557[a]	1.64434	1	0.017	-11.2175	-0.4939
	9	-3.3264	2.64156	1	1.000	-11.9400	5.2871
	10	-3.5000	3.10773	1	1.000	-13.6336	6.6336
5	1	9.3986	4.79119	1	1.000	-6.2244	25.0215
	2	9.7964	4.08951	1	0.747	-3.5385	23.1314
	3	5.1571	3.26933	1	1.000	-5.5034	15.8177
	4	4.7821	2.50812	1	1.000	-3.3962	12.9605
	6	0.7071	2.70950	1	1.000	-8.1279	9.5422
	7	-1.9664	3.08589	1	1.000	-12.0288	8.0959
	8	-1.0736	3.36165	1	1.000	-12.0351	9.8880
	9	1.4557	4.67188	1	1.000	-13.7782	16.6896
	10	1.2821	4.84674	1	1.000	-14.5220	17.0862
6	1	8.6914	5.36854	1	1.000	-8.8141	26.1970
	2	9.0893	5.06178	1	1.000	-7.4160	25.5946
	3	4.4500	3.49318	1	1.000	-6.9404	15.8404
	4	4.0750	3.02387	1	1.000	-5.7851	13.9351
	5	-0.7071	2.70950	1	1.000	-9.5422	8.1279
	7	-2.6736	3.45454	1	1.000	-13.9380	8.5909
	8	-1.7807	3.03463	1	1.000	-11.6759	8.1145

	9	0.7486	4.13164	1	1.000	-12.7237	14.2209
	10	0.5750	4.95634	1	1.000	-15.5865	16.7365
7	1	11.3650[a]	3.24270	1	0.021	0.7913	21.9387
	2	11.7629[a]	3.56451	1	0.044	0.1398	23.3859
	3	7.1236	2.94420	1	0.699	-2.4768	16.7239
	4	6.7486[a]	1.66483	1	0.002	1.3199	12.1772
	5	1.9664	3.08589	1	1.000	-8.0959	12.0288
	6	2.6736	3.45454	1	1.000	-8.5909	13.9380
	8	0.8929	2.36291	1	1.000	-6.8121	8.5978
	9	3.4221	2.89027	1	1.000	-6.0024	12.8466
	10	3.2486	2.37366	1	1.000	-4.4914	10.9885
8	1	10.4721[a]	2.87701	1	0.012	1.0909	19.8534
	2	10.8700[a]	2.74705	1	0.003	1.9125	19.8275
	3	6.2307	2.59209	1	0.730	-2.2215	14.6829
	4	5.8557[a]	1.64434	1	0.017	0.4939	11.2175
	5	1.0736	3.36165	1	1.000	-9.8880	12.0351
	6	1.7807	3.03463	1	1.000	-8.1145	11.6759
	7	-0.8929	2.36291	1	1.000	-8.5978	6.8121
	9	2.5293	2.33689	1	1.000	-5.0908	10.1493
	10	2.3557	3.55065	1	1.000	-9.2221	13.9336
9	1	7.9429	3.62606	1	1.000	-3.8809	19.7666
	2	8.3407	4.14077	1	1.000	-5.1614	21.8428
	3	3.7014	3.69901	1	1.000	-8.3602	15.7630
	4	3.3264	2.64156	1	1.000	-5.2871	11.9400
	5	-1.4557	4.67188	1	1.000	-16.6896	13.7782
	6	-0.7486	4.13164	1	1.000	-14.2209	12.7237
	7	-3.4221	2.89027	1	1.000	-12.8466	6.0024
	8	-2.5293	2.33689	1	1.000	-10.1493	5.0908
	10	-0.1736	2.88405	1	1.000	-9.5778	9.2307
10	1	8.1164	3.58708	1	1.000	-3.5802	19.8131
	2	8.5143	4.71005	1	1.000	-6.8441	23.8727
	3	3.8750	4.01348	1	1.000	-9.2120	16.9620
	4	3.5000	3.10773	1	1.000	-6.6336	13.6336

			5	-1.2821	4.84674	1	1.000	-17.0862	14.5220
			6	-0.5750	4.95634	1	1.000	-16.7365	15.5865
			7	-3.2486	2.37366	1	1.000	-10.9885	4.4914
			8	-2.3557	3.55065	1	1.000	-13.9336	9.2221
			9	0.1736	2.88405	1	1.000	-9.2307	9.5778
Uninjured	PRE	1	2	-4.5750	3.56923	1	1.000	-16.2134	7.0634
			3	-5.5514	3.08276	1	1.000	-15.6036	4.5007
			4	-4.1421	2.81032	1	1.000	-13.3060	5.0217
			5	-3.2429	2.34484	1	1.000	-10.8888	4.4031
			6	-2.0379	1.97031	1	1.000	-8.4626	4.3869
			7	-4.3771	2.12623	1	1.000	-11.3103	2.5560
			8	-2.8914	2.35717	1	1.000	-10.5776	4.7948
			9	-2.9829	2.17947	1	1.000	-10.0896	4.1239
			10	1.0621	3.81659	1	1.000	-11.3829	13.5071
		2	1	4.5750	3.56923	1	1.000	-7.0634	16.2134
			3	-0.9764	2.25705	1	1.000	-8.3361	6.3833
			4	0.4329	2.23267	1	1.000	-6.8474	7.7131
			5	1.3321	3.02546	1	1.000	-8.5332	11.1975
			6	2.5371	3.05628	1	1.000	-7.4287	12.5030
			7	0.1979	3.39900	1	1.000	-10.8855	11.2812
			8	1.6836	3.52882	1	1.000	-9.8231	13.1902
			9	1.5921	3.67642	1	1.000	-10.3958	13.5801
			10	5.6371	3.71350	1	1.000	-6.4717	17.7460
		3	1	5.5514	3.08276	1	1.000	-4.5007	15.6036
			2	0.9764	2.25705	1	1.000	-6.3833	8.3361
			4	1.4093	1.93753	1	1.000	-4.9086	7.7271
			5	2.3086	2.29904	1	1.000	-5.1881	9.8052
			6	3.5136	2.41707	1	1.000	-4.3679	11.3951
			7	1.1743	3.03474	1	1.000	-8.7213	11.0699
			8	2.6600	3.38788	1	1.000	-8.3871	13.7071
			9	2.5686	3.36894	1	1.000	-8.4168	13.5539
			10	6.6136	3.95538	1	1.000	-6.2840	19.5111
		4	1	4.1421	2.81032	1	1.000	-5.0217	13.3060

	2	-0.4329	2.23267	1	1.000	-7.7131	6.8474
	3	-1.4093	1.93753	1	1.000	-7.7271	4.9086
	5	0.8993	1.70043	1	1.000	-4.6454	6.4440
	6	2.1043	1.75509	1	1.000	-3.6186	7.8272
	7	-0.2350	1.96005	1	1.000	-6.6263	6.1563
	8	1.2507	2.36969	1	1.000	-6.4763	8.9777
	9	1.1593	2.67771	1	1.000	-7.5721	9.8907
	10	5.2043	3.25192	1	1.000	-5.3995	15.8080
5	1	3.2429	2.34484	1	1.000	-4.4031	10.8888
	2	-1.3321	3.02546	1	1.000	-11.1975	8.5332
	3	-2.3086	2.29904	1	1.000	-9.8052	5.1881
	4	-0.8993	1.70043	1	1.000	-6.4440	4.6454
	6	1.2050	1.23109	1	1.000	-2.8093	5.2193
	7	-1.1343	1.87833	1	1.000	-7.2591	4.9905
	8	0.3514	2.56475	1	1.000	-8.0116	8.7145
	9	0.2600	2.53595	1	1.000	-8.0091	8.5291
	10	4.3050	3.48845	1	1.000	-7.0700	15.6800
6	1	2.0379	1.97031	1	1.000	-4.3869	8.4626
	2	-2.5371	3.05628	1	1.000	-12.5030	7.4287
	3	-3.5136	2.41707	1	1.000	-11.3951	4.3679
	4	-2.1043	1.75509	1	1.000	-7.8272	3.6186
	5	-1.2050	1.23109	1	1.000	-5.2193	2.8093
	7	-2.3393	1.11485	1	1.000	-5.9746	1.2960
	8	-0.8536	2.15814	1	1.000	-7.8908	6.1836
	9	-0.9450	1.80753	1	1.000	-6.8389	4.9489
	10	3.1000	2.80913	1	1.000	-6.0599	12.2599
7	1	4.3771	2.12623	1	1.000	-2.5560	11.3103
	2	-0.1979	3.39900	1	1.000	-11.2812	10.8855
	3	-1.1743	3.03474	1	1.000	-11.0699	8.7213
	4	0.2350	1.96005	1	1.000	-6.1563	6.6263
	5	1.1343	1.87833	1	1.000	-4.9905	7.2591
	6	2.3393	1.11485	1	1.000	-1.2960	5.9746
	8	1.4857	1.65867	1	1.000	-3.9228	6.8942

		9	1.3943	1.61373	1	1.000	-3.8677	6.6563
		10	5.4393	2.75190	1	1.000	-3.5340	14.4126
	8	1	2.8914	2.35717	1	1.000	-4.7948	10.5776
		2	-1.6836	3.52882	1	1.000	-13.1902	9.8231
		3	-2.6600	3.38788	1	1.000	-13.7071	8.3871
		4	-1.2507	2.36969	1	1.000	-8.9777	6.4763
		5	-0.3514	2.56475	1	1.000	-8.7145	8.0116
		6	0.8536	2.15814	1	1.000	-6.1836	7.8908
		7	-1.4857	1.65867	1	1.000	-6.8942	3.9228
		9	-0.0914	1.32300	1	1.000	-4.4054	4.2226
		10	3.9536	2.87086	1	1.000	-5.4076	13.3148
	9	1	2.9829	2.17947	1	1.000	-4.1239	10.0896
		2	-1.5921	3.67642	1	1.000	-13.5801	10.3958
		3	-2.5686	3.36894	1	1.000	-13.5539	8.4168
		4	-1.1593	2.67771	1	1.000	-9.8907	7.5721
		5	-0.2600	2.53595	1	1.000	-8.5291	8.0091
		6	0.9450	1.80753	1	1.000	-4.9489	6.8389
		7	-1.3943	1.61373	1	1.000	-6.6563	3.8677
		8	0.0914	1.32300	1	1.000	-4.2226	4.4054
		10	4.0450	2.37404	1	1.000	-3.6962	11.7862
	10	1	-1.0621	3.81659	1	1.000	-13.5071	11.3829
		2	-5.6371	3.71350	1	1.000	-17.7460	6.4717
		3	-6.6136	3.95538	1	1.000	-19.5111	6.2840
		4	-5.2043	3.25192	1	1.000	-15.8080	5.3995
		5	-4.3050	3.48845	1	1.000	-15.6800	7.0700
		6	-3.1000	2.80913	1	1.000	-12.2599	6.0599
		7	-5.4393	2.75190	1	1.000	-14.4126	3.5340
		8	-3.9536	2.87086	1	1.000	-13.3148	5.4076
		9	-4.0450	2.37404	1	1.000	-11.7862	3.6962
POST-4	1	2	-4.8200	3.76173	1	1.000	-17.0861	7.4461
		3	-6.8207	3.48271	1	1.000	-18.1770	4.5356
		4	-2.9929	4.30566	1	1.000	-17.0326	11.0469
		5	-5.4079	4.46903	1	1.000	-19.9803	9.1646

	6	-7.1100	3.80246	1	1.000	-19.5089	5.2889
	7	-6.4271	3.19177	1	1.000	-16.8348	3.9805
	8	-3.2886	2.43863	1	1.000	-11.2404	4.6632
	9	-7.1864	3.91830	1	1.000	-19.9631	5.5903
	10	-2.0164	4.01825	1	1.000	-15.1190	11.0861
2	1	4.8200	3.76173	1	1.000	-7.4461	17.0861
	3	-2.0007	2.18596	1	1.000	-9.1286	5.1272
	4	1.8271	3.48263	1	1.000	-9.5289	13.1832
	5	-0.5879	3.95054	1	1.000	-13.4697	12.2939
	6	-2.2900	3.14539	1	1.000	-12.5464	7.9664
	7	-1.6071	3.13943	1	1.000	-11.8441	8.6298
	8	1.5314	3.71573	1	1.000	-10.5847	13.6476
	9	-2.3664	3.47392	1	1.000	-13.6941	8.9612
	10	2.8036	2.89015	1	1.000	-6.6205	12.2277
3	1	6.8207	3.48271	1	1.000	-4.5356	18.1770
	2	2.0007	2.18596	1	1.000	-5.1272	9.1286
	4	3.8279	2.73096	1	1.000	-5.0772	12.7329
	5	1.4129	3.11908	1	1.000	-8.7577	11.5835
	6	-0.2893	2.40863	1	1.000	-8.1433	7.5647
	7	0.3936	2.59398	1	1.000	-8.0648	8.8519
	8	3.5321	3.62309	1	1.000	-8.2819	15.3462
	9	-0.3657	3.24424	1	1.000	-10.9444	10.2130
	10	4.8043	2.79333	1	1.000	-4.3041	13.9127
4	1	2.9929	4.30566	1	1.000	-11.0469	17.0326
	2	-1.8271	3.48263	1	1.000	-13.1832	9.5289
	3	-3.8279	2.73096	1	1.000	-12.7329	5.0772
	5	-2.4150	2.85188	1	1.000	-11.7143	6.8843
	6	-4.1171	2.39918	1	1.000	-11.9403	3.7060
	7	-3.4343	2.78453	1	1.000	-12.5140	5.6454
	8	-0.2957	3.56799	1	1.000	-11.9301	11.3387
	9	-4.1936	2.74026	1	1.000	-13.1289	4.7418
	10	0.9764	2.91117	1	1.000	-8.5162	10.4691
5	1	5.4079	4.46903	1	1.000	-9.1646	19.9803

	2	0.5879	3.950 54	1	1.000	-12.2939	13.4697
	3	-1.4129	3.119 08	1	1.000	-11.5835	8.7577
	4	2.4150	2.851 88	1	1.000	-6.8843	11.7143
	6	-1.7021	1.470 27	1	1.000	-6.4964	3.0921
	7	-1.0193	1.821 14	1	1.000	-6.9576	4.9190
	8	2.1193	4.055 65	1	1.000	-11.1052	15.3438
	9	-1.7786	2.604 17	1	1.000	-10.2702	6.7130
	1 0	3.3914	2.684 78	1	1.000	-5.3630	12.1459
6	1	7.1100	3.802 46	1	1.000	-5.2889	19.5089
	2	2.2900	3.145 39	1	1.000	-7.9664	12.5464
	3	0.2893	2.408 63	1	1.000	-7.5647	8.1433
	4	4.1171	2.399 18	1	1.000	-3.7060	11.9403
	5	1.7021	1.470 27	1	1.000	-3.0921	6.4964
	7	0.6829	0.989 52	1	1.000	-2.5437	3.9095
	8	3.8214	3.549 84	1	1.000	-7.7538	15.3966
	9	-0.0764	2.464 95	1	1.000	-8.1141	7.9612
	1 0	5.0936	2.359 08	1	1.000	-2.5989	12.7860
7	1	6.4271	3.191 77	1	1.000	-3.9805	16.8348
	2	1.6071	3.139 43	1	1.000	-8.6298	11.8441
	3	-0.3936	2.593 98	1	1.000	-8.8519	8.0648
	4	3.4343	2.784 53	1	1.000	-5.6454	12.5140
	5	1.0193	1.821 14	1	1.000	-4.9190	6.9576
	6	-0.6829	0.989 52	1	1.000	-3.9095	2.5437
	8	3.1386	3.030 76	1	1.000	-6.7440	13.0212
	9	-0.7593	2.288 71	1	1.000	-8.2223	6.7037
	1 0	4.4107	2.571 55	1	1.000	-3.9745	12.7959
8	1	3.2886	2.438 63	1	1.000	-4.6632	11.2404
	2	-1.5314	3.715 73	1	1.000	-13.6476	10.5847
	3	-3.5321	3.623 09	1	1.000	-15.3462	8.2819
	4	0.2957	3.567 99	1	1.000	-11.3387	11.9301
	5	-2.1193	4.055 65	1	1.000	-15.3438	11.1052
	6	-3.8214	3.549 84	1	1.000	-15.3966	7.7538
	7	-3.1386	3.030 76	1	1.000	-13.0212	6.7440

		9	-3.8979	2.42356	1	1.000	-11.8005	4.0048
		10	1.2721	3.23767	1	1.000	-9.2851	11.8294
	9	1	7.1864	3.91830	1	1.000	-5.5903	19.9631
		2	2.3664	3.47392	1	1.000	-8.9612	13.6941
		3	0.3657	3.24424	1	1.000	-10.2130	10.9444
		4	4.1936	2.74026	1	1.000	-4.7418	13.1289
		5	1.7786	2.60417	1	1.000	-6.7130	10.2702
		6	0.0764	2.46495	1	1.000	-7.9612	8.1141
		7	0.7593	2.28871	1	1.000	-6.7037	8.2223
		8	3.8979	2.42356	1	1.000	-4.0048	11.8005
		10	5.1700	2.16323	1	0.758	-1.8838	12.2238
	10	1	2.0164	4.01825	1	1.000	-11.0861	15.1190
		2	-2.8036	2.89015	1	1.000	-12.2277	6.6205
		3	-4.8043	2.79333	1	1.000	-13.9127	4.3041
		4	-0.9764	2.91117	1	1.000	-10.4691	8.5162
		5	-3.3914	2.68478	1	1.000	-12.1459	5.3630
		6	-5.0936	2.35908	1	1.000	-12.7860	2.5989
		7	-4.4107	2.57155	1	1.000	-12.7959	3.9745
		8	-1.2721	3.23767	1	1.000	-11.8294	9.2851
		9	-5.1700	2.16323	1	0.758	-12.2238	1.8838
POST-8	1	2	-4.7100	2.64348	1	1.000	-13.3298	3.9098
		3	-1.9129	2.87745	1	1.000	-11.2956	7.4698
		4	-1.2800	2.73622	1	1.000	-10.2022	7.6422
		5	-1.0150	2.77841	1	1.000	-10.0747	8.0447
		6	-1.5336	1.99524	1	1.000	-8.0396	4.9724
		7	-1.2321	2.23637	1	1.000	-8.5244	6.0601
		8	-0.6629	3.42178	1	1.000	-11.8205	10.4948
		9	-3.9000	3.94505	1	1.000	-16.7639	8.9639
		10	0.7221	4.01848	1	1.000	-12.3812	13.8255
	2	1	4.7100	2.64348	1	1.000	-3.9098	13.3298
		3	2.7971	1.88424	1	1.000	-3.3469	8.9412
		4	3.4300	2.09550	1	1.000	-3.4029	10.2629
		5	3.6950	3.11851	1	1.000	-6.4737	13.8637

	6	3.1764	2.26261	1	1.000	-4.2014	10.5543
	7	3.4779	2.80250	1	1.000	-5.6604	12.6162
	8	4.0471	3.17749	1	1.000	-6.3139	14.4082
	9	0.8100	3.69000	1	1.000	-11.2222	12.8422
	10	5.4321	3.59917	1	1.000	-6.3039	17.1682
3	1	1.9129	2.87745	1	1.000	-7.4698	11.2956
	2	-2.7971	1.88424	1	1.000	-8.9412	3.3469
	4	0.6329	2.02393	1	1.000	-5.9667	7.2324
	5	0.8979	2.87257	1	1.000	-8.4689	10.2647
	6	0.3793	2.42147	1	1.000	-7.5166	8.2751
	7	0.6807	2.67832	1	1.000	-8.0527	9.4141
	8	1.2500	3.08035	1	1.000	-8.7943	11.2943
	9	-1.9871	3.50238	1	1.000	-13.4076	9.4333
	10	2.6350	3.37615	1	1.000	-8.3738	13.6438
4	1	1.2800	2.73622	1	1.000	-7.6422	10.2022
	2	-3.4300	2.09550	1	1.000	-10.2629	3.4029
	3	-0.6329	2.02393	1	1.000	-7.2324	5.9667
	5	0.2650	1.80040	1	1.000	-5.6057	6.1357
	6	-0.2536	1.75305	1	1.000	-5.9699	5.4627
	7	0.0479	2.03544	1	1.000	-6.5892	6.6849
	8	0.6171	2.42676	1	1.000	-7.2959	8.5302
	9	-2.6200	2.78504	1	1.000	-11.7014	6.4614
	10	2.0021	3.06229	1	1.000	-7.9833	11.9876
5	1	1.0150	2.77841	1	1.000	-8.0447	10.0747
	2	-3.6950	3.11851	1	1.000	-13.8637	6.4737
	3	-0.8979	2.87257	1	1.000	-10.2647	8.4689
	4	-0.2650	1.80040	1	1.000	-6.1357	5.6057
	6	-0.5186	1.66797	1	1.000	-5.9574	4.9203
	7	-0.2171	1.65808	1	1.000	-5.6238	5.1895
	8	0.3521	2.36043	1	1.000	-7.3447	8.0489
	9	-2.8850	2.56883	1	1.000	-11.2614	5.4914
	10	1.7371	2.87867	1	1.000	-7.6495	11.1238
6	1	1.5336	1.99524	1	1.000	-4.9724	8.0396

	2	-3.1764	2.26261	1	1.000	-10.5543	4.2014
	3	-0.3793	2.42147	1	1.000	-8.2751	7.5166
	4	0.2536	1.75305	1	1.000	-5.4627	5.9699
	5	0.5186	1.66797	1	1.000	-4.9203	5.9574
	7	0.3014	0.85246	1	1.000	-2.4783	3.0811
	8	0.8707	1.76370	1	1.000	-4.8803	6.6217
	9	-2.3664	2.27791	1	1.000	-9.7942	5.0613
	10	2.2557	2.37731	1	1.000	-5.4962	10.0076
7	1	1.2321	2.23637	1	1.000	-6.0601	8.5244
	2	-3.4779	2.80250	1	1.000	-12.6162	5.6604
	3	-0.6807	2.67832	1	1.000	-9.4141	8.0527
	4	-0.0479	2.03544	1	1.000	-6.6849	6.5892
	5	0.2171	1.65808	1	1.000	-5.1895	5.6238
	6	-0.3014	0.85246	1	1.000	-3.0811	2.4783
	8	0.5693	1.67959	1	1.000	-4.9075	6.0460
	9	-2.6679	2.04629	1	1.000	-9.3403	4.0046
	10	1.9543	2.16359	1	1.000	-5.1007	9.0092
8	1	0.6629	3.42178	1	1.000	-10.4948	11.8205
	2	-4.0471	3.17749	1	1.000	-14.4082	6.3139
	3	-1.2500	3.08035	1	1.000	-11.2943	8.7943
	4	-0.6171	2.42676	1	1.000	-8.5302	7.2959
	5	-0.3521	2.36043	1	1.000	-8.0489	7.3447
	6	-0.8707	1.76370	1	1.000	-6.6217	4.8803
	7	-0.5693	1.67959	1	1.000	-6.0460	4.9075
	9	-3.2371[a]	0.98638	1	0.046	-6.4535	-0.0208
	10	1.3850	1.57722	1	1.000	-3.7579	6.5279
9	1	3.9000	3.94505	1	1.000	-8.9639	16.7639
	2	-0.8100	3.69000	1	1.000	-12.8422	11.2222
	3	1.9871	3.50238	1	1.000	-9.4333	13.4076
	4	2.6200	2.78504	1	1.000	-6.4614	11.7014
	5	2.8850	2.56883	1	1.000	-5.4914	11.2614
	6	2.3664	2.27791	1	1.000	-5.0613	9.7942
	7	2.6679	2.04629	1	1.000	-4.0046	9.3403

		8	3.2371[a]	0.98638	1	0.046	0.0208	6.4535
		10	4.6221[a]	1.41000	1	0.047	0.0245	9.2198
	10	1	-0.7221	4.01848	1	1.000	-13.8255	12.3812
		2	-5.4321	3.59917	1	1.000	-17.1682	6.3039
		3	-2.6350	3.37615	1	1.000	-13.6438	8.3738
		4	-2.0021	3.06229	1	1.000	-11.9876	7.9833
		5	-1.7371	2.87867	1	1.000	-11.1238	7.6495
		6	-2.2557	2.37731	1	1.000	-10.0076	5.4962
		7	-1.9543	2.16359	1	1.000	-9.0092	5.1007
		8	-1.3850	1.57722	1	1.000	-6.5279	3.7579
		9	-4.6221[a]	1.41000	1	0.047	-9.2198	-0.0245
POST-12	1	2	-9.0014	3.77513	1	0.770	-21.3112	3.3084
		3	-10.6136[a]	2.82265	1	0.008	-19.8176	-1.4096
		4	-4.1764	3.31837	1	1.000	-14.9969	6.6440
		5	-3.9321	2.99157	1	1.000	-13.6870	5.8227
		6	-6.3579	3.63594	1	1.000	-18.2138	5.4981
		7	-3.3329	3.51195	1	1.000	-14.7845	8.1188
		8	-0.9714	3.65010	1	1.000	-12.8736	10.9307
		9	-2.1593	3.99136	1	1.000	-15.1742	10.8556
		10	0.2429	4.47025	1	1.000	-14.3336	14.8193
	2	1	9.0014	3.77513	1	0.770	-3.3084	21.3112
		3	-1.6121	2.23346	1	1.000	-8.8949	5.6706
		4	4.8250	2.18936	1	1.000	-2.3140	11.9640
		5	5.0693	1.58377	1	0.062	-0.0950	10.2336
		6	2.6436	1.69521	1	1.000	-2.8841	8.1713
		7	5.6686	2.52448	1	1.000	-2.5632	13.9003
		8	8.0300	3.04549	1	0.377	-1.9006	17.9606
		9	6.8421	3.73066	1	1.000	-5.3227	19.0070
		10	9.2443	3.72336	1	0.587	-2.8967	21.3853
	3	1	10.6136[a]	2.82265	1	0.008	1.4096	19.8176
		2	1.6121	2.23346	1	1.000	-5.6706	8.8949
		4	6.4371[a]	1.68550	1	0.006	0.9411	11.9332
		5	6.6814[a]	1.58777	1	0.001	1.5041	11.8588

	6	4.2557	1.42846	1	0.130	-0.4022	8.9136
	7	7.2807[a]	1.61956	1	0.000	1.9997	12.5617
	8	9.6421[a]	1.91112	1	0.000	3.4104	15.8739
	9	8.4543[a]	2.41908	1	0.021	0.5662	16.3423
	10	10.8564[a]	2.23971	1	0.000	3.5532	18.1596
4	1	4.1764	3.31837	1	1.000	-6.6440	14.9969
	2	-4.8250	2.18936	1	1.000	-11.9640	2.3140
	3	-6.4371[a]	1.68550	1	0.006	-11.9332	-0.9411
	5	0.2443	1.69269	1	1.000	-5.2752	5.7638
	6	-2.1814	1.59734	1	1.000	-7.3900	3.0271
	7	0.8436	1.90054	1	1.000	-5.3536	7.0408
	8	3.2050	2.35739	1	1.000	-4.4819	10.8919
	9	2.0171	2.99832	1	1.000	-7.7597	11.7940
	10	4.4193	3.05433	1	1.000	-5.5402	14.3787
5	1	3.9321	2.99157	1	1.000	-5.8227	13.6870
	2	-5.0693	1.58377	1	0.062	-10.2336	0.0950
	3	-6.6814[a]	1.58777	1	0.001	-11.8588	-1.5041
	4	-0.2443	1.69269	1	1.000	-5.7638	5.2752
	6	-2.4257	1.28330	1	1.000	-6.6103	1.7588
	7	0.5993	1.93758	1	1.000	-5.7187	6.9173
	8	2.9607	2.33890	1	1.000	-4.6659	10.5873
	9	1.7729	2.90390	1	1.000	-7.6961	11.2418
	10	4.1750	3.41445	1	1.000	-6.9587	15.3087
6	1	6.3579	3.63594	1	1.000	-5.4981	18.2138
	2	-2.6436	1.69521	1	1.000	-8.1713	2.8841
	3	-4.2557	1.42846	1	0.130	-8.9136	0.4022
	4	2.1814	1.59734	1	1.000	-3.0271	7.3900
	5	2.4257	1.28330	1	1.000	-1.7588	6.6103
	7	3.0250	1.35482	1	1.000	-1.3927	7.4427
	8	5.3864	2.05455	1	0.394	-1.3130	12.0858
	9	4.1986	2.83201	1	1.000	-5.0359	13.4331
	10	6.6007	2.66300	1	0.593	-2.0827	15.2841
7	1	3.3329	3.51195	1	1.000	-8.1188	14.7845

	2	-5.6686	2.52448	1	1.000	-13.9003	2.5632
	3	-7.2807[a]	1.61956	1	0.000	-12.5617	-1.9997
	4	-0.8436	1.90054	1	1.000	-7.0408	5.3536
	5	-0.5993	1.93758	1	1.000	-6.9173	5.7187
	6	-3.0250	1.35482	1	1.000	-7.4427	1.3927
	8	2.3614	1.27956	1	1.000	-1.8109	6.5338
	9	1.1736	2.02734	1	1.000	-5.4371	7.7843
	10	3.5757	2.07563	1	1.000	-3.1924	10.3439
8	1	0.9714	3.65010	1	1.000	-10.9307	12.8736
	2	-8.0300	3.04549	1	0.377	-17.9606	1.9006
	3	-9.6421[a]	1.91112	1	0.000	-15.8739	-3.4104
	4	-3.2050	2.35739	1	1.000	-10.8919	4.4819
	5	-2.9607	2.33890	1	1.000	-10.5873	4.6659
	6	-5.3864	2.05455	1	0.394	-12.0858	1.3130
	7	-2.3614	1.27956	1	1.000	-6.5338	1.8109
	9	-1.1879	1.11653	1	1.000	-4.8286	2.4529
	10	1.2143	2.38238	1	1.000	-6.5541	8.9827
9	1	2.1593	3.99136	1	1.000	-10.8556	15.1742
	2	-6.8421	3.73066	1	1.000	-19.0070	5.3227
	3	-8.4543[a]	2.41908	1	0.021	-16.3423	-0.5662
	4	-2.0171	2.99832	1	1.000	-11.7940	7.7597
	5	-1.7729	2.90390	1	1.000	-11.2418	7.6961
	6	-4.1986	2.83201	1	1.000	-13.4331	5.0359
	7	-1.1736	2.02734	1	1.000	-7.7843	5.4371
	8	1.1879	1.11653	1	1.000	-2.4529	4.8286
	10	2.4021	2.68509	1	1.000	-6.3533	11.1576
10	1	-0.2429	4.47025	1	1.000	-14.8193	14.3336
	2	-9.2443	3.72336	1	0.587	-21.3853	2.8967
	3	-10.8564[a]	2.23971	1	0.000	-18.1596	-3.5532
	4	-4.4193	3.05433	1	1.000	-14.3787	5.5402
	5	-4.1750	3.41445	1	1.000	-15.3087	6.9587
	6	-6.6007	2.66300	1	0.593	-15.2841	2.0827
	7	-3.5757	2.07563	1	1.000	-10.3439	3.1924

				8	-1.2143	2.38238	1	1.000	-8.9827	6.5541
				9	-2.4021	2.68509	1	1.000	-11.1576	6.3533
ISO	Injured	PRE	1	2	-0.9831	3.45368	1	1.000	-12.2447	10.2786
				3	-0.8231	4.26090	1	1.000	-14.7169	13.0707
				4	-4.9185	3.48101	1	1.000	-16.2692	6.4323
				5	-6.0938	3.16627	1	1.000	-16.4183	4.2306
				6	-5.3300	3.21171	1	1.000	-15.8026	5.1426
				7	-9.8738	3.99803	1	0.609	-22.9105	3.1628
				8	-12.5246[a]	3.23313	1	0.005	-23.0671	-1.9821
				9	-11.7146	4.17913	1	0.228	-25.3418	1.9125
				10	-13.3831	4.40147	1	0.106	-27.7353	0.9691
			2	1	0.9831	3.45368	1	1.000	-10.2786	12.2447
				3	0.1600	2.34153	1	1.000	-7.4752	7.7952
				4	-3.9354	2.83769	1	1.000	-13.1884	5.3177
				5	-5.1108	2.39406	1	1.000	-12.9172	2.6957
				6	-4.3469	2.26155	1	1.000	-11.7213	3.0275
				7	-8.8908	3.68397	1	0.711	-20.9033	3.1218
				8	-11.5415[a]	3.14032	1	0.011	-21.7814	-1.3017
				9	-10.7315	3.47127	1	0.090	-22.0505	0.5875
				10	-12.4000[a]	3.72287	1	0.039	-24.5394	-0.2606
			3	1	0.8231	4.26090	1	1.000	-13.0707	14.7169
				2	-0.1600	2.34153	1	1.000	-7.7952	7.4752
				4	-4.0954	3.61099	1	1.000	-15.8700	7.6792
				5	-5.2708	3.80221	1	1.000	-17.6689	7.1274
				6	-4.5069	3.16891	1	1.000	-14.8400	5.8262
				7	-9.0508	4.40256	1	1.000	-23.4065	5.3049
				8	-11.7015	4.32115	1	0.305	-25.7918	2.3887
				9	-10.8915	4.60449	1	0.810	-25.9057	4.1226
				10	-12.5600	4.81770	1	0.411	-28.2694	3.1494
			4	1	4.9185	3.48101	1	1.000	-6.4323	16.2692
				2	3.9354	2.83769	1	1.000	-5.3177	13.1884
				3	4.0954	3.61099	1	1.000	-7.6792	15.8700
				5	-1.1754	1.66099	1	1.000	-6.5915	4.2407

	6	-0.4115	2.22876	1	1.000	-7.6790	6.8559
	7	-4.9554	2.44421	1	1.000	-12.9254	3.0146
	8	-7.6062	2.36050	1	0.057	-15.3032	0.0909
	9	-6.7962	2.19070	1	0.086	-13.9395	0.3472
	10	-8.4646[a]	2.56154	1	0.043	-16.8172	-0.1120
5	1	6.0938	3.16627	1	1.000	-4.2306	16.4183
	2	5.1108	2.39406	1	1.000	-2.6957	12.9172
	3	5.2708	3.80221	1	1.000	-7.1274	17.6689
	4	1.1754	1.66099	1	1.000	-4.2407	6.5915
	6	0.7638	1.84496	1	1.000	-5.2521	6.7798
	7	-3.7800	2.15759	1	1.000	-10.8154	3.2554
	8	-6.4308[a]	1.94508	1	0.043	-12.7732	-0.0883
	9	-5.6208	1.75470	1	0.061	-11.3424	0.1009
	10	-7.2892[a]	2.17902	1	0.037	-14.3945	-0.1840
6	1	5.3300	3.21171	1	1.000	-5.1426	15.8026
	2	4.3469	2.26155	1	1.000	-3.0275	11.7213
	3	4.5069	3.16891	1	1.000	-5.8262	14.8400
	4	0.4115	2.22876	1	1.000	-6.8559	7.6790
	5	-0.7638	1.84496	1	1.000	-6.7798	5.2521
	7	-4.5438	1.89808	1	0.750	-10.7331	1.6454
	8	-7.1946[a]	2.12416	1	0.032	-14.1210	-0.2682
	9	-6.3846	2.53589	1	0.532	-14.6536	1.8843
	10	-8.0531	3.23102	1	0.571	-18.5887	2.4825
7	1	9.8738	3.99803	1	0.609	-3.1628	22.9105
	2	8.8908	3.68397	1	0.711	-3.1218	20.9033
	3	9.0508	4.40256	1	1.000	-5.3049	23.4065
	4	4.9554	2.44421	1	1.000	-3.0146	12.9254
	5	3.7800	2.15759	1	1.000	-3.2554	10.8154
	6	4.5438	1.89808	1	0.750	-1.6454	10.7331
	8	-2.6508	2.02352	1	1.000	-9.2490	3.9475
	9	-1.8408	1.74471	1	1.000	-7.5298	3.8483
	10	-3.5092	2.68201	1	1.000	-12.2546	5.2362
8	1	12.5246[a]	3.23313	1	0.005	1.9821	23.0671

		2	11.5415[a]	3.14032	1	0.011	1.3017	21.7814
		3	11.7015	4.32115	1	0.305	-2.3887	25.7918
		4	7.6062	2.36050	1	0.057	-0.0909	15.3032
		5	6.4308[a]	1.94508	1	0.043	0.0883	12.7732
		6	7.1946[a]	2.12416	1	0.032	0.2682	14.1210
		7	2.6508	2.02352	1	1.000	-3.9475	9.2490
		9	0.8100	1.90697	1	1.000	-5.4082	7.0282
		10	-0.8585	2.56940	1	1.000	-9.2367	7.5198
	9	1	11.7146	4.17913	1	0.228	-1.9125	25.3418
		2	10.7315	3.47127	1	0.090	-0.5875	22.0505
		3	10.8915	4.60449	1	0.810	-4.1226	25.9057
		4	6.7962	2.19070	1	0.086	-0.3472	13.9395
		5	5.6208	1.75470	1	0.061	-0.1009	11.3424
		6	6.3846	2.53589	1	0.532	-1.8843	14.6536
		7	1.8408	1.74471	1	1.000	-3.8483	7.5298
		8	-0.8100	1.90697	1	1.000	-7.0282	5.4082
		10	-1.6685	1.28040	1	1.000	-5.8436	2.5066
	10	1	13.3831	4.40147	1	0.106	-0.9691	27.7353
		2	12.4000[a]	3.72287	1	0.039	0.2606	24.5394
		3	12.5600	4.81770	1	0.411	-3.1494	28.2694
		4	8.4646[a]	2.56154	1	0.043	0.1120	16.8172
		5	7.2892[a]	2.17902	1	0.037	0.1840	14.3945
		6	8.0531	3.23102	1	0.571	-2.4825	18.5887
		7	3.5092	2.68201	1	1.000	-5.2362	12.2546
		8	0.8585	2.56940	1	1.000	-7.5198	9.2367
		9	1.6685	1.28040	1	1.000	-2.5066	5.8436
POST-4	1	2	0.2008	3.26721	1	1.000	-10.4529	10.8544
		3	-0.0254	4.47184	1	1.000	-14.6070	14.5562
		4	-5.6692	3.84052	1	1.000	-18.1923	6.8538
		5	-6.9208	3.22157	1	1.000	-17.4256	3.5840
		6	-5.0600	3.64301	1	1.000	-16.9390	6.8190
		7	-10.8877[a]	2.65476	1	0.002	-19.5443	-2.2311
		8	-11.6485[a]	2.73384	1	0.001	-20.5629	-2.7341

	9	-9.4031	5.31018	1	1.000	-26.7183	7.9122
	10	-19.2315[a]	4.14891	1	0.000	-32.7602	-5.7029
2	1	-0.2008	3.26721	1	1.000	-10.8544	10.4529
	3	-0.2262	2.42800	1	1.000	-8.1433	7.6910
	4	-5.8700	3.42845	1	1.000	-17.0494	5.3094
	5	-7.1215	3.44863	1	1.000	-18.3667	4.1236
	6	-5.2608	3.26881	1	1.000	-15.9196	5.3981
	7	-11.0885[a]	2.82807	1	0.004	-20.3101	-1.8668
	8	-11.8492[a]	2.82669	1	0.001	-21.0664	-2.6321
	9	-9.6038	5.02543	1	1.000	-25.9906	6.7829
	10	-19.4323[a]	3.50257	1	0.000	-30.8534	-8.0112
3	1	0.0254	4.47184	1	1.000	-14.5562	14.6070
	2	0.2262	2.42800	1	1.000	-7.6910	8.1433
	4	-5.6438	2.98204	1	1.000	-15.3676	4.0799
	5	-6.8954	4.62867	1	1.000	-21.9884	8.1976
	6	-5.0346	3.42633	1	1.000	-16.2071	6.1378
	7	-10.8623	3.57584	1	0.107	-22.5223	0.7977
	8	-11.6231	3.56686	1	0.050	-23.2538	0.0076
	9	-9.3777	4.80322	1	1.000	-25.0399	6.2845
	10	-19.2062[a]	4.19627	1	0.000	-32.8892	-5.5231
4	1	5.6692	3.84052	1	1.000	-6.8538	18.1923
	2	5.8700	3.42845	1	1.000	-5.3094	17.0494
	3	5.6438	2.98204	1	1.000	-4.0799	15.3676
	5	-1.2515	3.91695	1	1.000	-14.0238	11.5207
	6	0.6092	2.47762	1	1.000	-7.4697	8.6882
	7	-5.2185	2.72243	1	1.000	-14.0957	3.6588
	8	-5.9792	2.66822	1	1.000	-14.6797	2.7212
	9	-3.7338	4.62602	1	1.000	-18.8182	11.3505
	10	-13.5623[a]	2.97604	1	0.000	-23.2665	-3.8581
5	1	6.9208	3.22157	1	1.000	-3.5840	17.4256
	2	7.1215	3.44863	1	1.000	-4.1236	18.3667
	3	6.8954	4.62867	1	1.000	-8.1976	21.9884
	4	1.2515	3.91695	1	1.000	-11.5207	14.0238

	6	1.8608	2.81228	1	1.000	-7.3094	11.0309
	7	-3.9669	2.15179	1	1.000	-10.9834	3.0496
	8	-4.7277	3.07911	1	1.000	-14.7679	5.3126
	9	-2.4823	6.22376	1	1.000	-22.7766	17.8119
	10	-12.3108[a]	3.37696	1	0.012	-23.3223	-1.2993
6	1	5.0600	3.64301	1	1.000	-6.8190	16.9390
	2	5.2608	3.26881	1	1.000	-5.3981	15.9196
	3	5.0346	3.42633	1	1.000	-6.1378	16.2071
	4	-0.6092	2.47762	1	1.000	-8.6882	7.4697
	5	-1.8608	2.81228	1	1.000	-11.0309	7.3094
	7	-5.8277	2.12070	1	0.270	-12.7428	1.0874
	8	-6.5885	3.23238	1	1.000	-17.1285	3.9516
	9	-4.3431	6.24570	1	1.000	-24.7089	16.0227
	10	-14.1715[a]	3.08731	1	0.000	-24.2385	-4.1046
7	1	10.8877[a]	2.65476	1	0.002	2.2311	19.5443
	2	11.0885[a]	2.82807	1	0.004	1.8668	20.3101
	3	10.8623	3.57584	1	0.107	-0.7977	22.5223
	4	5.2185	2.72243	1	1.000	-3.6588	14.0957
	5	3.9669	2.15179	1	1.000	-3.0496	10.9834
	6	5.8277	2.12070	1	0.270	-1.0874	12.7428
	8	-0.7608	1.61357	1	1.000	-6.0223	4.5007
	9	1.4846	5.19984	1	1.000	-15.4708	18.4401
	10	-8.3438	3.29306	1	0.508	-19.0817	2.3940
8	1	11.6485[a]	2.73384	1	0.001	2.7341	20.5629
	2	11.8492[a]	2.82669	1	0.001	2.6321	21.0664
	3	11.6231	3.56686	1	0.050	-0.0076	23.2538
	4	5.9792	2.66822	1	1.000	-2.7212	14.6797
	5	4.7277	3.07911	1	1.000	-5.3126	14.7679
	6	6.5885	3.23238	1	1.000	-3.9516	17.1285
	7	0.7608	1.61357	1	1.000	-4.5007	6.0223
	9	2.2454	4.21288	1	1.000	-11.4918	15.9826
	10	-7.5831	3.29104	1	0.955	-18.3144	3.1482
9	1	9.4031	5.31018	1	1.000	-7.9122	26.7183

		2	9.6038	5.02543	1	1.000	-6.7829	25.9906
		3	9.3777	4.80322	1	1.000	-6.2845	25.0399
		4	3.7338	4.62602	1	1.000	-11.3505	18.8182
		5	2.4823	6.22376	1	1.000	-17.8119	22.7766
		6	4.3431	6.24570	1	1.000	-16.0227	24.7089
		7	-1.4846	5.19984	1	1.000	-18.4401	15.4708
		8	-2.2454	4.21288	1	1.000	-15.9826	11.4918
		10	-9.8285	6.36122	1	1.000	-30.5709	10.9140
	10	1	19.2315[a]	4.14891	1	0.000	5.7029	32.7602
		2	19.4323[a]	3.50257	1	0.000	8.0112	30.8534
		3	19.2062[a]	4.19627	1	0.000	5.5231	32.8892
		4	13.5623[a]	2.97604	1	0.000	3.8581	23.2665
		5	12.3108[a]	3.37696	1	0.012	1.2993	23.3223
		6	14.1715[a]	3.08731	1	0.000	4.1046	24.2385
		7	8.3438	3.29306	1	0.508	-2.3940	19.0817
		8	7.5831	3.29104	1	0.955	-3.1482	18.3144
		9	9.8285	6.36122	1	1.000	-10.9140	30.5709
POST-8	1	2	-0.4992	4.05636	1	1.000	-13.7261	12.7276
		3	-2.6100	4.85158	1	1.000	-18.4299	13.2099
		4	-6.4031	2.45093	1	0.404	-14.3950	1.5888
		5	-5.7862	3.43893	1	1.000	-16.9997	5.4274
		6	-8.2992	4.33984	1	1.000	-22.4505	5.8520
		7	-7.7885[a]	1.51896	1	0.000	-12.7414	-2.8355
		8	-9.2246[a]	2.30089	1	0.003	-16.7273	-1.7219
		9	-12.4762[a]	2.29365	1	0.000	-19.9552	-4.9971
		10	-15.0277[a]	2.60336	1	0.000	-23.5166	-6.5388
	2	1	0.4992	4.05636	1	1.000	-12.7276	13.7261
		3	-2.1108	2.29033	1	1.000	-9.5790	5.3575
		4	-5.9038	3.06390	1	1.000	-15.8945	4.0868
		5	-5.2869	4.05918	1	1.000	-18.5230	7.9491
		6	-7.8000	3.60865	1	1.000	-19.5670	3.9670
		7	-7.2892	4.18114	1	1.000	-20.9230	6.3445
		8	-8.7254	3.75221	1	0.902	-20.9605	3.5097

	9	-11.9769[a]	3.22685	1	0.009	-22.4989	-1.4549
	10	-14.5285[a]	3.08149	1	0.000	-24.5765	-4.4805
3	1	2.6100	4.85158	1	1.000	-13.2099	18.4299
	2	2.1108	2.29033	1	1.000	-5.3575	9.5790
	4	-3.7931	3.15015	1	1.000	-14.0650	6.4788
	5	-3.1762	3.82158	1	1.000	-15.6374	9.2851
	6	-5.6892	2.48403	1	0.990	-13.7891	2.4106
	7	-5.1785	4.52404	1	1.000	-19.9303	9.5734
	8	-6.6146	4.41751	1	1.000	-21.0191	7.7899
	9	-9.8662	3.84903	1	0.467	-22.4170	2.6846
	10	-12.4177[a]	3.79566	1	0.048	-24.7945	-0.0409
4	1	6.4031	2.45093	1	0.404	-1.5888	14.3950
	2	5.9038	3.06390	1	1.000	-4.0868	15.8945
	3	3.7931	3.15015	1	1.000	-6.4788	14.0650
	5	0.6169	2.01882	1	1.000	-5.9660	7.1998
	6	-1.8962	2.96864	1	1.000	-11.5762	7.7839
	7	-1.3854	2.47378	1	1.000	-9.4518	6.6810
	8	-2.8215	2.47923	1	1.000	-10.9057	5.2626
	9	-6.0731	2.08814	1	0.163	-12.8820	0.7359
	10	-8.6246[a]	2.20179	1	0.004	-15.8041	-1.4451
5	1	5.7862	3.43893	1	1.000	-5.4274	16.9997
	2	5.2869	4.05918	1	1.000	-7.9491	18.5230
	3	3.1762	3.82158	1	1.000	-9.2851	15.6374
	4	-0.6169	2.01882	1	1.000	-7.1998	5.9660
	6	-2.5131	3.03440	1	1.000	-12.4076	7.3814
	7	-2.0023	3.15556	1	1.000	-12.2919	8.2872
	8	-3.4385	2.72452	1	1.000	-12.3225	5.4456
	9	-6.6900	2.80199	1	0.763	-15.8267	2.4467
	10	-9.2415	3.12286	1	0.139	-19.4244	0.9414
6	1	8.2992	4.33984	1	1.000	-5.8520	22.4505
	2	7.8000	3.60865	1	1.000	-3.9670	19.5670
	3	5.6892	2.48403	1	0.990	-2.4106	13.7891
	4	1.8962	2.96864	1	1.000	-7.7839	11.5762

	5	2.5131	3.03440	1	1.000	-7.3814	12.4076
	7	0.5108	3.63605	1	1.000	-11.3455	12.3671
	8	-0.9254	3.57347	1	1.000	-12.5777	10.7269
	9	-4.1769	3.51348	1	1.000	-15.6336	7.2797
	10	-6.7285	4.11357	1	1.000	-20.1418	6.6849
7	1	7.7885[a]	1.51896	1	0.000	2.8355	12.7414
	2	7.2892	4.18114	1	1.000	-6.3445	20.9230
	3	5.1785	4.52404	1	1.000	-9.5734	19.9303
	4	1.3854	2.47378	1	1.000	-6.6810	9.4518
	5	2.0023	3.15556	1	1.000	-8.2872	12.2919
	6	-0.5108	3.63605	1	1.000	-12.3671	11.3455
	8	-1.4362	2.38490	1	1.000	-9.2128	6.3405
	9	-4.6877	2.17060	1	1.000	-11.7655	2.3901
	10	-7.2392	3.07271	1	0.831	-17.2586	2.7802
8	1	9.2246[a]	2.30089	1	0.003	1.7219	16.7273
	2	8.7254	3.75221	1	0.902	-3.5097	20.9605
	3	6.6146	4.41751	1	1.000	-7.7899	21.0191
	4	2.8215	2.47923	1	1.000	-5.2626	10.9057
	5	3.4385	2.72452	1	1.000	-5.4456	12.3225
	6	0.9254	3.57347	1	1.000	-10.7269	12.5777
	7	1.4362	2.38490	1	1.000	-6.3405	9.2128
	9	-3.2515	1.45994	1	1.000	-8.0121	1.5090
	10	-5.8031	2.32440	1	0.564	-13.3824	1.7762
9	1	12.4762[a]	2.29365	1	0.000	4.9971	19.9552
	2	11.9769[a]	3.22685	1	0.009	1.4549	22.4989
	3	9.8662	3.84903	1	0.467	-2.6846	22.4170
	4	6.0731	2.08814	1	0.163	-0.7359	12.8820
	5	6.6900	2.80199	1	0.763	-2.4467	15.8267
	6	4.1769	3.51348	1	1.000	-7.2797	15.6336
	7	4.6877	2.17060	1	1.000	-2.3901	11.7655
	8	3.2515	1.45994	1	1.000	-1.5090	8.0121
	10	-2.5515	1.54919	1	1.000	-7.6031	2.5000
10	1	15.0277[a]	2.60336	1	0.000	6.5388	23.5166

		2	14.5285[a]	3.08149	1	0.000	4.4805	24.5765
		3	12.4177[a]	3.79566	1	0.048	0.0409	24.7945
		4	8.6246[a]	2.20179	1	0.004	1.4451	15.8041
		5	9.2415	3.12286	1	0.139	-0.9414	19.4244
		6	6.7285	4.11357	1	1.000	-6.6849	20.1418
		7	7.2392	3.07271	1	0.831	-2.7802	17.2586
		8	5.8031	2.32440	1	0.564	-1.7762	13.3824
		9	2.5515	1.54919	1	1.000	-2.5000	7.6031
POST-12	1	2	3.1238	3.65959	1	1.000	-8.8092	15.0569
		3	3.8354	3.41898	1	1.000	-7.3131	14.9839
		4	-2.1577	2.96984	1	1.000	-11.8416	7.5263
		5	-1.6346	2.54110	1	1.000	-9.9205	6.6513
		6	1.8031	4.50233	1	1.000	-12.8780	16.4841
		7	-2.3162	3.68501	1	1.000	-14.3321	9.6998
		8	-2.5854	3.62648	1	1.000	-14.4105	9.2397
		9	-8.6723	5.41638	1	1.000	-26.3339	8.9892
		10	-8.0046	5.43780	1	1.000	-25.7360	9.7268
	2	1	-3.1238	3.65959	1	1.000	-15.0569	8.8092
		3	0.7115	1.95990	1	1.000	-5.6793	7.1023
		4	-5.2815	3.11575	1	1.000	-15.4413	4.8782
		5	-4.7585	2.42667	1	1.000	-12.6713	3.1543
		6	-1.3208	3.85455	1	1.000	-13.8895	11.2480
		7	-5.4400	4.09411	1	1.000	-18.7899	7.9099
		8	-5.7092	4.17819	1	1.000	-19.3333	7.9149
		9	-11.7962	5.30359	1	1.000	-29.0899	5.4976
		10	-11.1285	5.91001	1	1.000	-30.3996	8.1427
	3	1	-3.8354	3.41898	1	1.000	-14.9839	7.3131
		2	-0.7115	1.95990	1	1.000	-7.1023	5.6793
		4	-5.9931	2.68940	1	1.000	-14.7626	2.7764
		5	-5.4700	2.31609	1	0.819	-13.0222	2.0822
		6	-2.0323	3.58144	1	1.000	-13.7106	9.6459
		7	-6.1515	3.94330	1	1.000	-19.0097	6.7066
		8	-6.4208	4.03048	1	1.000	-19.5632	6.7217

	9	-12.5077	4.94706	1	0.516	-28.6389	3.6235
	10	-11.8400	5.78931	1	1.000	-30.7176	7.0376
4	1	2.1577	2.96984	1	1.000	-7.5263	11.8416
	2	5.2815	3.11575	1	1.000	-4.8782	15.4413
	3	5.9931	2.68940	1	1.000	-2.7764	14.7626
	5	0.5231	1.46627	1	1.000	-4.2581	5.3042
	6	3.9608	2.15402	1	1.000	-3.0630	10.9845
	7	-0.1585	2.21820	1	1.000	-7.3915	7.0746
	8	-0.4277	2.06823	1	1.000	-7.1717	6.3163
	9	-6.5146	4.30092	1	1.000	-20.5389	7.5097
	10	-5.8469	5.74138	1	1.000	-24.5682	12.8744
5	1	1.6346	2.54110	1	1.000	-6.6513	9.9205
	2	4.7585	2.42667	1	1.000	-3.1543	12.6713
	3	5.4700	2.31609	1	0.819	-2.0822	13.0222
	4	-0.5231	1.46627	1	1.000	-5.3042	4.2581
	6	3.4377	2.80656	1	1.000	-5.7138	12.5892
	7	-0.6815	2.47305	1	1.000	-8.7456	7.3825
	8	-0.9508	2.07160	1	1.000	-7.7058	5.8042
	9	-7.0377	4.15933	1	1.000	-20.6003	6.5249
	10	-6.3700	4.82178	1	1.000	-22.0927	9.3527
6	1	-1.8031	4.50233	1	1.000	-16.4841	12.8780
	2	1.3208	3.85455	1	1.000	-11.2480	13.8895
	3	2.0323	3.58144	1	1.000	-9.6459	13.7106
	4	-3.9608	2.15402	1	1.000	-10.9845	3.0630
	5	-3.4377	2.80656	1	1.000	-12.5892	5.7138
	7	-4.1192	2.58408	1	1.000	-12.5453	4.3068
	8	-4.3885	2.43728	1	1.000	-12.3359	3.5590
	9	-10.4754	4.01772	1	0.411	-23.5762	2.6255
	10	-9.8077	5.96828	1	1.000	-29.2689	9.6535
7	1	2.3162	3.68501	1	1.000	-9.6998	14.3321
	2	5.4400	4.09411	1	1.000	-7.9099	18.7899
	3	6.1515	3.94330	1	1.000	-6.7066	19.0097
	4	0.1585	2.21820	1	1.000	-7.0746	7.3915

			5	0.6815	2.47305	1	1.000	-7.3825	8.7456
			6	4.1192	2.58408	1	1.000	-4.3068	12.5453
			8	-0.2692	2.00127	1	1.000	-6.7949	6.2564
			9	-6.3562	4.59397	1	1.000	-21.3360	8.6237
			10	-5.6885	5.61509	1	1.000	-23.9980	12.6210
		8	1	2.5854	3.62648	1	1.000	-9.2397	14.4105
			2	5.7092	4.17819	1	1.000	-7.9149	19.3333
			3	6.4208	4.03048	1	1.000	-6.7217	19.5632
			4	0.4277	2.06823	1	1.000	-6.3163	7.1717
			5	0.9508	2.07160	1	1.000	-5.8042	7.7058
			6	4.3885	2.43728	1	1.000	-3.5590	12.3359
			7	0.2692	2.00127	1	1.000	-6.2564	6.7949
			9	-6.0869	4.12799	1	1.000	-19.5473	7.3735
			10	-5.4192	5.01024	1	1.000	-21.7564	10.9180
		9	1	8.6723	5.41638	1	1.000	-8.9892	26.3339
			2	11.7962	5.30359	1	1.000	-5.4976	29.0899
			3	12.5077	4.94706	1	0.516	-3.6235	28.6389
			4	6.5146	4.30092	1	1.000	-7.5097	20.5389
			5	7.0377	4.15933	1	1.000	-6.5249	20.6003
			6	10.4754	4.01772	1	0.411	-2.6255	23.5762
			7	6.3562	4.59397	1	1.000	-8.6237	21.3360
			8	6.0869	4.12799	1	1.000	-7.3735	19.5473
			10	0.6677	3.57433	1	1.000	-10.9874	12.3228
		10	1	8.0046	5.43780	1	1.000	-9.7268	25.7360
			2	11.1285	5.91001	1	1.000	-8.1427	30.3996
			3	11.8400	5.78931	1	1.000	-7.0376	30.7176
			4	5.8469	5.74138	1	1.000	-12.8744	24.5682
			5	6.3700	4.82178	1	1.000	-9.3527	22.0927
			6	9.8077	5.96828	1	1.000	-9.6535	29.2689
			7	5.6885	5.61509	1	1.000	-12.6210	23.9980
			8	5.4192	5.01024	1	1.000	-10.9180	21.7564
			9	-0.6677	3.57433	1	1.000	-12.3228	10.9874
Uninjured	PRE	1	2	-4.9747	2.65591	1	1.000	-13.6350	3.6856

	3	-3.5067	2.48319	1	1.000	-11.6038	4.5904
	4	-2.0340	3.18637	1	1.000	-12.4240	8.3560
	5	-1.9833	4.10372	1	1.000	-15.3646	11.3979
	6	-3.5480	3.54028	1	1.000	-15.0920	7.9960
	7	-5.7127	4.22918	1	1.000	-19.5030	8.0777
	8	-4.5580	4.17097	1	1.000	-18.1586	9.0426
	9	-7.0487	4.19439	1	1.000	-20.7256	6.6283
	10	-6.7627	4.09228	1	1.000	-20.1067	6.5813
2	1	4.9747	2.65591	1	1.000	-3.6856	13.6350
	3	1.4680	1.73934	1	1.000	-4.2036	7.1396
	4	2.9407	2.10802	1	1.000	-3.9331	9.8144
	5	2.9913	2.72683	1	1.000	-5.9002	11.8829
	6	1.4267	2.23071	1	1.000	-5.8471	8.7005
	7	-0.7380	2.45182	1	1.000	-8.7328	7.2568
	8	0.4167	2.54110	1	1.000	-7.8693	8.7026
	9	-2.0740	2.54220	1	1.000	-10.3635	6.2155
	10	-1.7880	2.16879	1	1.000	-8.8599	5.2839
3	1	3.5067	2.48319	1	1.000	-4.5904	11.6038
	2	-1.4680	1.73934	1	1.000	-7.1396	4.2036
	4	1.4727	2.52145	1	1.000	-6.7492	9.6945
	5	1.5233	3.48089	1	1.000	-9.8270	12.8737
	6	-0.0413	2.78735	1	1.000	-9.1302	9.0476
	7	-2.2060	3.54165	1	1.000	-13.7545	9.3425
	8	-1.0513	3.65511	1	1.000	-12.9698	10.8671
	9	-3.5420	3.71010	1	1.000	-15.6398	8.5558
	10	-3.2560	3.24642	1	1.000	-13.8418	7.3298
4	1	2.0340	3.18637	1	1.000	-8.3560	12.4240
	2	-2.9407	2.10802	1	1.000	-9.8144	3.9331
	3	-1.4727	2.52145	1	1.000	-9.6945	6.7492
	5	0.0507	1.70770	1	1.000	-5.5178	5.6191
	6	-1.5140	1.43258	1	1.000	-6.1853	3.1573
	7	-3.6787	2.08569	1	1.000	-10.4796	3.1223
	8	-2.5240	2.08837	1	1.000	-9.3337	4.2857

	9	-5.0147	2.80671	1	1.000	-14.1667	4.1374
	10	-4.7287	2.60987	1	1.000	-13.2388	3.7815
5	1	1.9833	4.10372	1	1.000	-11.3979	15.3646
	2	-2.9913	2.72683	1	1.000	-11.8829	5.9002
	3	-1.5233	3.48089	1	1.000	-12.8737	9.8270
	4	-0.0507	1.70770	1	1.000	-5.6191	5.5178
	6	-1.5647	1.28774	1	1.000	-5.7637	2.6344
	7	-3.7293	2.10695	1	1.000	-10.5996	3.1409
	8	-2.5747	2.02644	1	1.000	-9.1824	4.0331
	9	-5.0653	3.10768	1	1.000	-15.1988	5.0681
	10	-4.7793	2.86531	1	1.000	-14.1225	4.5638
6	1	3.5480	3.54028	1	1.000	-7.9960	15.0920
	2	-1.4267	2.23071	1	1.000	-8.7005	5.8471
	3	0.0413	2.78735	1	1.000	-9.0476	9.1302
	4	1.5140	1.43258	1	1.000	-3.1573	6.1853
	5	1.5647	1.28774	1	1.000	-2.6344	5.7637
	7	-2.1647	1.72640	1	1.000	-7.7940	3.4647
	8	-1.0100	2.02231	1	1.000	-7.6043	5.5843
	9	-3.5007	2.69247	1	1.000	-12.2802	5.2789
	10	-3.2147	2.39922	1	1.000	-11.0380	4.6086
7	1	5.7127	4.22918	1	1.000	-8.0777	19.5030
	2	0.7380	2.45182	1	1.000	-7.2568	8.7328
	3	2.2060	3.54165	1	1.000	-9.3425	13.7545
	4	3.6787	2.08569	1	1.000	-3.1223	10.4796
	5	3.7293	2.10695	1	1.000	-3.1409	10.5996
	6	2.1647	1.72640	1	1.000	-3.4647	7.7940
	8	1.1547	1.35119	1	1.000	-3.2513	5.5606
	9	-1.3360	1.66185	1	1.000	-6.7549	4.0829
	10	-1.0500	1.41537	1	1.000	-5.6652	3.5652
8	1	4.5580	4.17097	1	1.000	-9.0426	18.1586
	2	-0.4167	2.54110	1	1.000	-8.7026	7.8693
	3	1.0513	3.65511	1	1.000	-10.8671	12.9698
	4	2.5240	2.08837	1	1.000	-4.2857	9.3337

		5	2.5747	2.02644	1	1.000	-4.0331	9.1824
		6	1.0100	2.02231	1	1.000	-5.5843	7.6043
		7	-1.1547	1.35119	1	1.000	-5.5606	3.2513
		9	-2.4907	1.34884	1	1.000	-6.8889	1.9076
		10	-2.2047	1.56309	1	1.000	-7.3015	2.8922
	9	1	7.0487	4.19439	1	1.000	-6.6283	20.7256
		2	2.0740	2.54220	1	1.000	-6.2155	10.3635
		3	3.5420	3.71010	1	1.000	-8.5558	15.6398
		4	5.0147	2.80671	1	1.000	-4.1374	14.1667
		5	5.0653	3.10768	1	1.000	-5.0681	15.1988
		6	3.5007	2.69247	1	1.000	-5.2789	12.2802
		7	1.3360	1.66185	1	1.000	-4.0829	6.7549
		8	2.4907	1.34884	1	1.000	-1.9076	6.8889
		10	0.2860	1.11296	1	1.000	-3.3431	3.9151
	10	1	6.7627	4.09228	1	1.000	-6.5813	20.1067
		2	1.7880	2.16879	1	1.000	-5.2839	8.8599
		3	3.2560	3.24642	1	1.000	-7.3298	13.8418
		4	4.7287	2.60987	1	1.000	-3.7815	13.2388
		5	4.7793	2.86531	1	1.000	-4.5638	14.1225
		6	3.2147	2.39922	1	1.000	-4.6086	11.0380
		7	1.0500	1.41537	1	1.000	-3.5652	5.6652
		8	2.2047	1.56309	1	1.000	-2.8922	7.3015
		9	-0.2860	1.11296	1	1.000	-3.9151	3.3431
POST-4	1	2	-7.1320	3.40991	1	1.000	-18.2509	3.9869
		3	-5.4700	3.04899	1	1.000	-15.4120	4.4720
		4	-5.1380	3.94716	1	1.000	-18.0088	7.7328
		5	-6.5820	4.40824	1	1.000	-20.9562	7.7922
		6	-4.5467	4.53015	1	1.000	-19.3184	10.2251
		7	-8.5313	4.35568	1	1.000	-22.7342	5.6715
		8	-9.6480	4.37165	1	1.000	-23.9029	4.6069
		9	-9.5340	5.44570	1	1.000	-27.2911	8.2231
		10	-7.5320	5.49510	1	1.000	-25.4502	10.3862
	2	1	7.1320	3.40991	1	1.000	-3.9869	18.2509

	3	1.6620	1.87984	1	1.000	-4.4677	7.7917
	4	1.9940	2.18844	1	1.000	-5.1420	9.1300
	5	0.5500	2.97066	1	1.000	-9.1366	10.2366
	6	2.5853	2.85664	1	1.000	-6.7295	11.9002
	7	-1.3993	2.01891	1	1.000	-7.9825	5.1839
	8	-2.5160	2.28263	1	1.000	-9.9591	4.9271
	9	-2.4020	3.10051	1	1.000	-12.5120	7.7080
	10	-0.4000	3.30000	1	1.000	-11.1605	10.3605
3	1	5.4700	3.04899	1	1.000	-4.4720	15.4120
	2	-1.6620	1.87984	1	1.000	-7.7917	4.4677
	4	0.3320	2.25053	1	1.000	-7.0065	7.6705
	5	-1.1120	3.17218	1	1.000	-11.4558	9.2318
	6	0.9233	3.19332	1	1.000	-9.4893	11.3360
	7	-3.0613	2.96006	1	1.000	-12.7134	6.5907
	8	-4.1780	2.98807	1	1.000	-13.9214	5.5654
	9	-4.0640	4.01852	1	1.000	-17.1675	9.0395
	10	-2.0620	4.22864	1	1.000	-15.8506	11.7266
4	1	5.1380	3.94716	1	1.000	-7.7328	18.0088
	2	-1.9940	2.18844	1	1.000	-9.1300	5.1420
	3	-0.3320	2.25053	1	1.000	-7.6705	7.0065
	5	-1.4440	1.72289	1	1.000	-7.0620	4.1740
	6	0.5913	2.49353	1	1.000	-7.5395	8.7221
	7	-3.3933	2.21626	1	1.000	-10.6200	3.8334
	8	-4.5100	2.47325	1	1.000	-12.5747	3.5547
	9	-4.3960	4.08508	1	1.000	-17.7165	8.9245
	10	-2.3940	4.15671	1	1.000	-15.9481	11.1601
5	1	6.5820	4.40824	1	1.000	-7.7922	20.9562
	2	-0.5500	2.97066	1	1.000	-10.2366	9.1366
	3	1.1120	3.17218	1	1.000	-9.2318	11.4558
	4	1.4440	1.72289	1	1.000	-4.1740	7.0620
	6	2.0353	1.67217	1	1.000	-3.4172	7.4879
	7	-1.9493	2.02373	1	1.000	-8.5483	4.6496
	8	-3.0660	1.96526	1	1.000	-9.4742	3.3422

	9	-2.9520	3.79460	1	1.000	-15.3253	9.4213
	10	-0.9500	3.74134	1	1.000	-13.1497	11.2497
6	1	4.5467	4.53015	1	1.000	-10.2251	19.3184
	2	-2.5853	2.85664	1	1.000	-11.9002	6.7295
	3	-0.9233	3.19332	1	1.000	-11.3360	9.4893
	4	-0.5913	2.49353	1	1.000	-8.7221	7.5395
	5	-2.0353	1.67217	1	1.000	-7.4879	3.4172
	7	-3.9847	1.75381	1	1.000	-9.7034	1.7341
	8	-5.1013[a]	1.41781	1	0.014	-9.7245	-0.4782
	9	-4.9873	2.74224	1	1.000	-13.9291	3.9545
	10	-2.9853	2.71470	1	1.000	-11.8373	5.8667
7	1	8.5313	4.35568	1	1.000	-5.6715	22.7342
	2	1.3993	2.01891	1	1.000	-5.1839	7.9825
	3	3.0613	2.96006	1	1.000	-6.5907	12.7134
	4	3.3933	2.21626	1	1.000	-3.8334	10.6200
	5	1.9493	2.02373	1	1.000	-4.6496	8.5483
	6	3.9847	1.75381	1	1.000	-1.7341	9.7034
	8	-1.1167	1.21576	1	1.000	-5.0810	2.8477
	9	-1.0027	2.60473	1	1.000	-9.4961	7.4907
	10	0.9993	2.62946	1	1.000	-7.5747	9.5734
8	1	9.6480	4.37165	1	1.000	-4.6069	23.9029
	2	2.5160	2.28263	1	1.000	-4.9271	9.9591
	3	4.1780	2.98807	1	1.000	-5.5654	13.9214
	4	4.5100	2.47325	1	1.000	-3.5547	12.5747
	5	3.0660	1.96526	1	1.000	-3.3422	9.4742
	6	5.1013[a]	1.41781	1	0.014	0.4782	9.7245
	7	1.1167	1.21576	1	1.000	-2.8477	5.0810
	9	0.1140	2.02912	1	1.000	-6.5025	6.7305
	10	2.1160	2.18876	1	1.000	-5.0211	9.2531
9	1	9.5340	5.44570	1	1.000	-8.2231	27.2911
	2	2.4020	3.10051	1	1.000	-7.7080	12.5120
	3	4.0640	4.01852	1	1.000	-9.0395	17.1675
	4	4.3960	4.08508	1	1.000	-8.9245	17.7165

		5	2.9520	3.79460	1	1.000	-9.4213	15.3253
		6	4.9873	2.74224	1	1.000	-3.9545	13.9291
		7	1.0027	2.60473	1	1.000	-7.4907	9.4961
		8	-0.1140	2.02912	1	1.000	-6.7305	6.5025
		10	2.0020	1.59516	1	1.000	-3.1995	7.2035
	10	1	7.5320	5.49510	1	1.000	-10.3862	25.4502
		2	0.4000	3.30000	1	1.000	-10.3605	11.1605
		3	2.0620	4.22864	1	1.000	-11.7266	15.8506
		4	2.3940	4.15671	1	1.000	-11.1601	15.9481
		5	0.9500	3.74134	1	1.000	-11.2497	13.1497
		6	2.9853	2.71470	1	1.000	-5.8667	11.8373
		7	-0.9993	2.62946	1	1.000	-9.5734	7.5747
		8	-2.1160	2.18876	1	1.000	-9.2531	5.0211
		9	-2.0020	1.59516	1	1.000	-7.2035	3.1995
POST-8	1	2	-5.8213	1.93588	1	0.119	-12.1338	0.4911
		3	-7.9007	2.53083	1	0.081	-16.1531	0.3518
		4	-7.0280	4.27934	1	1.000	-20.9819	6.9259
		5	-6.8747	4.20695	1	1.000	-20.5926	6.8432
		6	-5.8100	3.18150	1	1.000	-16.1841	4.5641
		7	-7.0487	4.09638	1	1.000	-20.4060	6.3087
		8	-7.0107	3.69327	1	1.000	-19.0536	5.0322
		9	-9.2153	4.22517	1	1.000	-22.9926	4.5619
		10	-4.1760	3.47810	1	1.000	-15.5173	7.1653
	2	1	5.8213	1.93588	1	0.119	-0.4911	12.1338
		3	-2.0793	1.89424	1	1.000	-8.2560	4.0973
		4	-1.2067	3.43088	1	1.000	-12.3940	9.9807
		5	-1.0533	3.37828	1	1.000	-12.0691	9.9624
		6	0.0113	2.76836	1	1.000	-9.0156	9.0383
		7	-1.2273	3.48030	1	1.000	-12.5758	10.1211
		8	-1.1893	2.85187	1	1.000	-10.4886	8.1100
		9	-3.3940	3.35510	1	1.000	-14.3342	7.5462
		10	1.6453	2.95728	1	1.000	-7.9977	11.2883
	3	1	7.9007	2.53083	1	0.081	-0.3518	16.1531

	2	2.0793	1.89424	1	1.000	-4.0973	8.2560
	4	0.8727	2.92495	1	1.000	-8.6649	10.4102
	5	1.0260	2.64538	1	1.000	-7.6000	9.6520
	6	2.0907	2.05780	1	1.000	-4.6194	8.8007
	7	0.8520	3.06382	1	1.000	-9.1384	10.8424
	8	0.8900	2.66050	1	1.000	-7.7853	9.5653
	9	-1.3147	3.24481	1	1.000	-11.8952	9.2659
	10	3.7247	3.45083	1	1.000	-7.5277	14.9770
4	1	7.0280	4.27934	1	1.000	-6.9259	20.9819
	2	1.2067	3.43088	1	1.000	-9.9807	12.3940
	3	-0.8727	2.92495	1	1.000	-10.4102	8.6649
	5	0.1533	1.00227	1	1.000	-3.1148	3.4215
	6	1.2180	2.62733	1	1.000	-7.3491	9.7851
	7	-0.0207	2.33859	1	1.000	-7.6463	7.6049
	8	0.0173	2.15035	1	1.000	-6.9945	7.0291
	9	-2.1873	2.93826	1	1.000	-11.7683	7.3936
	10	2.8520	4.57111	1	1.000	-12.0533	17.7573
5	1	6.8747	4.20695	1	1.000	-6.8432	20.5926
	2	1.0533	3.37828	1	1.000	-9.9624	12.0691
	3	-1.0260	2.64538	1	1.000	-9.6520	7.6000
	4	-0.1533	1.00227	1	1.000	-3.4215	3.1148
	6	1.0647	2.17549	1	1.000	-6.0291	8.1584
	7	-0.1740	2.63535	1	1.000	-8.7673	8.4193
	8	-0.1360	2.35313	1	1.000	-7.8090	7.5370
	9	-2.3407	3.29364	1	1.000	-13.0805	8.3991
	10	2.6987	4.51973	1	1.000	-12.0391	17.4365
6	1	5.8100	3.18150	1	1.000	-4.5641	16.1841
	2	-0.0113	2.76836	1	1.000	-9.0383	9.0156
	3	-2.0907	2.05780	1	1.000	-8.8007	4.6194
	4	-1.2180	2.62733	1	1.000	-9.7851	7.3491
	5	-1.0647	2.17549	1	1.000	-8.1584	6.0291
	7	-1.2387	2.32596	1	1.000	-8.8231	6.3457
	8	-1.2007	2.07950	1	1.000	-7.9814	5.5801

	9	-3.4053	3.02434	1	1.000	-13.2670	6.4563
	10	1.6340	3.52543	1	1.000	-9.8616	13.1296
7	1	7.0487	4.09638	1	1.000	-6.3087	20.4060
	2	1.2273	3.48030	1	1.000	-10.1211	12.5758
	3	-0.8520	3.06382	1	1.000	-10.8424	9.1384
	4	0.0207	2.33859	1	1.000	-7.6049	7.6463
	5	0.1740	2.63535	1	1.000	-8.4193	8.7673
	6	1.2387	2.32596	1	1.000	-6.3457	8.8231
	8	0.0380	1.22288	1	1.000	-3.9495	4.0255
	9	-2.1667	1.26919	1	1.000	-6.3052	1.9719
	10	2.8727	3.45738	1	1.000	-8.4011	14.1464
8	1	7.0107	3.69327	1	1.000	-5.0322	19.0536
	2	1.1893	2.85187	1	1.000	-8.1100	10.4886
	3	-0.8900	2.66050	1	1.000	-9.5653	7.7853
	4	-0.0173	2.15035	1	1.000	-7.0291	6.9945
	5	0.1360	2.35313	1	1.000	-7.5370	7.8090
	6	1.2007	2.07950	1	1.000	-5.5801	7.9814
	7	-0.0380	1.22288	1	1.000	-4.0255	3.9495
	9	-2.2047	1.49893	1	1.000	-7.0923	2.6830
	10	2.8347	2.96862	1	1.000	-6.8453	12.5146
9	1	9.2153	4.22517	1	1.000	-4.5619	22.9926
	2	3.3940	3.35510	1	1.000	-7.5462	14.3342
	3	1.3147	3.24481	1	1.000	-9.2659	11.8952
	4	2.1873	2.93826	1	1.000	-7.3936	11.7683
	5	2.3407	3.29364	1	1.000	-8.3991	13.0805
	6	3.4053	3.02434	1	1.000	-6.4563	13.2670
	7	2.1667	1.26919	1	1.000	-1.9719	6.3052
	8	2.2047	1.49893	1	1.000	-2.6830	7.0923
	10	5.0393	3.02721	1	1.000	-4.8317	14.9104
10	1	4.1760	3.47810	1	1.000	-7.1653	15.5173
	2	-1.6453	2.95728	1	1.000	-11.2883	7.9977
	3	-3.7247	3.45083	1	1.000	-14.9770	7.5277
	4	-2.8520	4.57111	1	1.000	-17.7573	12.0533

		5	-2.6987	4.51973	1	1.000	-17.4365	12.0391
		6	-1.6340	3.52543	1	1.000	-13.1296	9.8616
		7	-2.8727	3.45738	1	1.000	-14.1464	8.4011
		8	-2.8347	2.96862	1	1.000	-12.5146	6.8453
		9	-5.0393	3.02721	1	1.000	-14.9104	4.8317
POST -12	1	2	-6.3567	2.99193	1	1.000	-16.1127	3.3993
		3	-8.5167	5.55982	1	1.000	-26.6459	9.6126
		4	-3.8327	4.67499	1	1.000	-19.0767	11.4114
		5	-1.6333	4.36854	1	1.000	-15.8781	12.6115
		6	-4.3940	4.92538	1	1.000	-20.4545	11.6665
		7	-4.9833	5.06184	1	1.000	-21.4888	11.5221
		8	-3.6800	4.45491	1	1.000	-18.2064	10.8464
		9	-6.2747	4.77622	1	1.000	-21.8488	9.2995
		10	-10.5200	6.63876	1	1.000	-32.1674	11.1274
	2	1	6.3567	2.99193	1	1.000	-3.3993	16.1127
		3	-2.1600	3.71764	1	1.000	-14.2824	9.9624
		4	2.5240	3.41574	1	1.000	-8.6139	13.6619
		5	4.7233	2.84511	1	1.000	-4.5539	14.0006
		6	1.9627	3.21681	1	1.000	-8.5266	12.4519
		7	1.3733	2.99353	1	1.000	-8.3879	11.1345
		8	2.6767	2.78783	1	1.000	-6.4138	11.7671
		9	0.0820	2.71138	1	1.000	-8.7592	8.9232
		10	-4.1633	4.16509	1	1.000	-17.7447	9.4180
	3	1	8.5167	5.55982	1	1.000	-9.6126	26.6459
		2	2.1600	3.71764	1	1.000	-9.9624	14.2824
		4	4.6840	2.36512	1	1.000	-3.0281	12.3961
		5	6.8833	2.28146	1	0.115	-0.5560	14.3227
		6	4.1227	2.26390	1	1.000	-3.2594	11.5047
		7	3.5333	1.99875	1	1.000	-2.9841	10.0508
		8	4.8367	2.77523	1	1.000	-4.2127	13.8861
		9	2.2420	3.24185	1	1.000	-8.3289	12.8129
		10	-2.0033	4.15530	1	1.000	-15.5528	11.5461
	4	1	3.8327	4.67499	1	1.000	-11.4114	19.0767

	2	-2.5240	3.41574	1	1.000	-13.6619	8.6139
	3	-4.6840	2.36512	1	1.000	-12.3961	3.0281
	5	2.1993	1.25727	1	1.000	-1.9003	6.2990
	6	-0.5613	1.47200	1	1.000	-5.3612	4.2385
	7	-1.1507	2.04547	1	1.000	-7.8205	5.5191
	8	0.1527	2.48973	1	1.000	-7.9658	8.2711
	9	-2.4420	3.45744	1	1.000	-13.7159	8.8319
	10	-6.6873	4.42333	1	1.000	-21.1108	7.7361
5	1	1.6333	4.36854	1	1.000	-12.6115	15.8781
	2	-4.7233	2.84511	1	1.000	-14.0006	4.5539
	3	-6.8833	2.28146	1	0.115	-14.3227	0.5560
	4	-2.1993	1.25727	1	1.000	-6.2990	1.9003
	6	-2.7607	1.09567	1	0.529	-6.3334	0.8121
	7	-3.3500	2.20628	1	1.000	-10.5442	3.8442
	8	-2.0467	2.58004	1	1.000	-10.4596	6.3663
	9	-4.6413	3.35968	1	1.000	-15.5965	6.3138
	10	-8.8867	4.05352	1	1.000	-22.1042	4.3309
6	1	4.3940	4.92538	1	1.000	-11.6665	20.4545
	2	-1.9627	3.21681	1	1.000	-12.4519	8.5266
	3	-4.1227	2.26390	1	1.000	-11.5047	3.2594
	4	0.5613	1.47200	1	1.000	-4.2385	5.3612
	5	2.7607	1.09567	1	0.529	-0.8121	6.3334
	7	-0.5893	1.79587	1	1.000	-6.4453	5.2666
	8	0.7140	2.34285	1	1.000	-6.9255	8.3535
	9	-1.8807	3.05416	1	1.000	-11.8396	8.0782
	10	-6.1260	3.76409	1	1.000	-18.3998	6.1478
7	1	4.9833	5.06184	1	1.000	-11.5221	21.4888
	2	-1.3733	2.99353	1	1.000	-11.1345	8.3879
	3	-3.5333	1.99875	1	1.000	-10.0508	2.9841
	4	1.1507	2.04547	1	1.000	-5.5191	7.8205
	5	3.3500	2.20628	1	1.000	-3.8442	10.5442
	6	0.5893	1.79587	1	1.000	-5.2666	6.4453
	8	1.3033	1.31590	1	1.000	-2.9875	5.5942

	9	-1.2913	1.77286	1	1.000	-7.0722	4.4896
	10	-5.5367	3.28608	1	1.000	-16.2518	5.1785
8	1	3.6800	4.45491	1	1.000	-10.8464	18.2064
	2	-2.6767	2.78783	1	1.000	-11.7671	6.4138
	3	-4.8367	2.77523	1	1.000	-13.8861	4.2127
	4	-0.1527	2.48973	1	1.000	-8.2711	7.9658
	5	2.0467	2.58004	1	1.000	-6.3663	10.4596
	6	-0.7140	2.34285	1	1.000	-8.3535	6.9255
	7	-1.3033	1.31590	1	1.000	-5.5942	2.9875
	9	-2.5947	1.52854	1	1.000	-7.5789	2.3895
	10	-6.8400	3.48169	1	1.000	-18.1930	4.5130
9	1	6.2747	4.77622	1	1.000	-9.2995	21.8488
	2	-0.0820	2.71138	1	1.000	-8.9232	8.7592
	3	-2.2420	3.24185	1	1.000	-12.8129	8.3289
	4	2.4420	3.45744	1	1.000	-8.8319	13.7159
	5	4.6413	3.35968	1	1.000	-6.3138	15.5965
	6	1.8807	3.05416	1	1.000	-8.0782	11.8396
	7	1.2913	1.77286	1	1.000	-4.4896	7.0722
	8	2.5947	1.52854	1	1.000	-2.3895	7.5789
	10	-4.2453	3.22135	1	1.000	-14.7494	6.2587
10	1	10.5200	6.63876	1	1.000	-11.1274	32.1674
	2	4.1633	4.16509	1	1.000	-9.4180	17.7447
	3	2.0033	4.15530	1	1.000	-11.5461	15.5528
	4	6.6873	4.42333	1	1.000	-7.7361	21.1108
	5	8.8867	4.05352	1	1.000	-4.3309	22.1042
	6	6.1260	3.76409	1	1.000	-6.1478	18.3998
	7	5.5367	3.28608	1	1.000	-5.1785	16.2518
	8	6.8400	3.48169	1	1.000	-4.5130	18.1930
	9	4.2453	3.22135	1	1.000	-6.2587	14.7494

Pairwise comparisons of estimated marginal means based on the original scale of dependent variable eco
a. The mean difference is significant at the .05 level.