Universidade Federal do Rio Grande do Sul

Escola de Educação Física, Fisioterapia e Dança

Programa de Pós-Graduação em Ciências do Movimento Humano

# Is Change in Muscle Strength and Range of Motion Predictive of Change in Quality of Life in Patients with Femoroacetabular Impingement Syndrome? A retrospective cohort study

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**Master of Science Dissertation presented to the Human Movement Sciences Graduate Program as a prerequisite to obtain the title of Master in Human Movement Sciences from the School of Physical Education, Physiotherapy and Dance of the Federal University from Rio Grande do Sul.**

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## PRESENTATION

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Is Change in Muscle Strength and Range of Motion Predictive of Change in Quality of Life in Patients with Femoroacetabular Impingement Syndrome? A retrospective cohort study

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It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.

*Theodore Roosevelt, "Citizenship in a Republic"*

## RESUMO

**Introdução:** A Síndrome do Impacto Femoroacetabular (SIFA) é uma causa comum de dor no quadril em adultos jovens. A SIFA representa o contato prematuro e sintomático entre o fêmur proximal e o acetábulo, causado por morfologias ósseas anormais. A artroscopia de quadril é um procedimento cirúrgico frequentemente proposto para tratamento da SIFA, seguida por um tratamento fisioterapêutico. Medidas de desfechos relatadas pelo paciente (*PROM*) são largamente utilizadas para avaliar a eficácia do tratamento. Nesses questionários, o valor do estado sintomático aceitável pelo paciente *(PASS)* é utilizado para melhor entender se os pacientes estão satisfeitos com seu estado físico. Considerando que programas de reabilitação que visam abordar déficits de força muscular e amplitude de movimento (ADM) de quadril são eficazes no tratamento da SIFA, é plausível supor que o aumento da mobilidade e força muscular do quadril podem desempenhar um papel prognóstico nessa população. **Objetivo:** Avaliar a capacidade preditiva da variação da força muscular e da ADM após quatro meses da artroscopia de quadril em relação à qualidade de vida de paciente com SIFA. **Métodos:** O presente estudo caracteriza-se como coorte retrospectivo. As informações dos pacientes com SIFA foram obtidas de um banco de dados de uma clínica privada de Fisioterapia, em Porto Alegre, Rio Grande do Sul, Brasil. O banco de dados continha prontuários de 99 pacientes com diagnóstico de SIFA, que realizaram avaliação e reavaliação entre os anos de 2013 e 2020. Equações de estimativas generalizadas foram conduzidas visando comparar a ADM de quadril, força muscular isométrica e qualidade de vida no período pré-operatório e após pelo menos três meses de pós-operatório. Regressões lineares múltiplas foram conduzidas visando verificar se a mudança nas variáveis de ADM e força muscular isométrica de quadril constituem preditores da mudança da qualidade de vida após artroscopia. Regressões logísticas binárias foram conduzidas visando verificar se a mudança nas variáveis de ADM e força muscular isométrica de quadril constituem preditores do PASS após artroscopia. **Resultados:** Um total de 69 indivíduos foi incluído no presente estudo. Após a artroscopia, os valores de ADM (rotação externa ativa: 5%, rotação externa passiva: 4% e rotação interna ativa: 30%) e força muscular isométrica de quadril (rotação externa: 17%, rotação interna: 19%, abdução: 6%, adução: 20%, extensão: 12%) foram maiores comparados aos valores pré-cirúrgicos com exceção da ADM de flexão de quadril e força muscular isométrica de flexores de quadril. Após artroscopia, a qualidade de vida autorrelatada foi maior (47%) comparada aos valores pré-cirúrgicos. As alterações nas variáveis de ADM de quadril e força muscular isométrica não foram preditoras da mudança na qualidade de vida e nem do PASS. **Conclusão:** Após a artroscopia, foram observados aumentos na ADM e força muscular isométrica de quadril e qualidade de vida. Os ganhos de ADM e força muscular isométrica de quadril não explicam a melhora na qualidade de vida autorrelatada e não são preditores do PASS.

**Palavras-chave**: Síndrome do impacto femoroacetabular, força muscular, amplitude de movimento, qualidade de vida.

**ABSTRACT**

**Introduction:** Femoroacetabular Impingement Syndrome (FAIS) is a common cause of hip pain in young adults. FAIS represents symptomatic premature contact between the proximal femur and the acetabulum, caused by abnormal bone morphologies. Hip arthroscopy is a common procedure for the treatment of FAIS, followed by physical therapy treatment. Patient-reported Outcome Measures (PROM) are widely used to assess treatment efficacy. In these questionnaires, the Patient Acceptable Symptom State (PASS) value is used to better understand whether patients are satisfied with their physical status. Considering that rehabilitation programs aiming to address muscle strength and hip range of motion (ROM) deficits are effective in the FAIS treatment, it is plausible to assume that increased mobility and hip muscle strength may play a predictive role in this population. **Purpose:** To assess the predictive ability of muscle strength and ROM changes four months after hip arthroscopy for improving the quality of life of patients with FAIS. **Methods:** The present study is characterized as a retrospective cohort study. Information on patients with FAIS was obtained from a database of a private Physiotherapy Clinic in Porto Alegre, Rio Grande do Sul, Brazil. The database contained medical records of 99 patients diagnosed with FAIS, who underwent assessment and reassessment between 2013 and 2020. Generalized estimation equations were conducted to compare hip ROM, isometric muscle strength and quality of life in the preoperative period and after at least three months postoperatively. Multiple linear regressions were conducted to verify whether changes in hip ROM and isometric muscle strength variables are predictors of changes in quality of life after arthroscopy. Binary logistic regressions were conducted to verify whether changes in ROM and isometric hip muscle strength are predictors of PASS after arthroscopy. **Results**: Sixty-nine individuals were included in the present study. After arthroscopy, hip ROM (active external rotation: 5%, passive external rotation: 4% and active internal rotation: 30%) and isometric muscle strength (external rotation: 17%, internal rotation: 19%, abduction: 6%, adduction: 20%, extension: 12%) values were higher compared to pre-surgical values, with the exception of hip flexion ROM and hip flexor isometric muscle strength. After arthroscopy, self-reported quality of life was higher (47%) compared to preoperative values. The change in hip ROM variables and isometric muscle strength were not predictors of changes in quality of life or of the PASS.

**Conclusion:** Gains in hip ROM and isometric muscle strength do not explain gains in self-reported quality of life. Furthermore, gains in ROM and isometric hip muscle strength are not predictors of PASS.

**Keywords**: Femoroacetabular impingement syndrome, muscle strength, range of motion, quality of life.

## LIST OF ABBREVIATIONS

**BMI:** Body Mass Index

**CI:** Confidence Interval

**FAI:** Femoroacetabular Impingement

**FAIS**: Femoroacetabular Impingement Syndrome

**HAGOS:** The Copenhagen Hip and Groin Outcome Score

**HOOS**: Osteoarthritis Outcome Score

**iHOT-33:** International Hip Outcome Tool

**MCID:** Minimal Clinically Important Difference

**MHHS**: Modified Harris Hip Score

**PASS:** Patient Acceptable Symptom State

**PROM:** Patient-reported Outcome Measures

**ROM:** Range of Motion

**VAS**: Visual Analogue Scale

**VIF**: Variance Inflation Factor

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**SUMMARY**

# 1. INTRODUCTION

## 1.1 Femoroacetabular Impingement Syndrome

Femoroacetabular Impingement (FAI) was primarily described by Ganz in 2003 (GANZ *et al.*, 2003), although the impact concept had already been described at least in 1936 (SMITH-PETERSEN, 1936, 2009). Based on the clinical observation of more than six hundred hip surgical dislocations, Ganz (2003) presented FAI as a cause for early development of osteoarthritis in non-dysplastic hips. According to the author, FAI was characterized by abnormal bone morphologies, which would be responsible for the abnormal contact between the proximal femur and the acetabulum in extreme hip joint amplitudes (GANZ *et al.*, 2003). This phenomenon would be more commonly observed in young and physically active patients (GANZ *et al.*, 2003).

In 2016, the Warwick International Agreement was summoned to build the first multidisciplinary consensus on the diagnosis and management of FAI (GRIFFIN *et al.*, 2016). In this consensus, the term "syndrome" was added to FAI (GRIFFIN *et al.*, 2016). The authors now define the Femoroacetabular Impingement Syndrome (FAIS) as a "hip clinical condition related to movement, with a triad of symptoms, clinical signs and imaging findings" (GRIFFIN *et al.*, 2016). The justification for new diagnostic criteria was due to the abnormal bone morphologies being observed in asymptomatic patients (GRIFFIN *et al.*, 2016; MASCARENHAS *et al.*, 2016). Therefore, the Warwick International Agreement was important to differentiate the hip clinical condition related to the bony abnormalities (FAIS) from the asymptomatic presence of these morphological abnormalities (GRIFFIN *et al.*, 2016).

The first impact type to be described by Ganz and the most studied impingement nowadays is the CAM impingement (DIJKSTRA *et al.*, 2021; GANZ *et al.*, 2003). The CAM deformity refer to a cartilage or bone prominence, varying in shape, and localized at the anterior-superior region between the femur's neck and head (DIJKSTRA *et al.*, 2021). The CAM deformity causes a rectification of the head-neck junction, giving it a pistol grip aspect (DIJKSTRA *et al.*, 2021) (FIGURE 1A). In the presence of the CAM deformity, the compression and shear forces increase at the joint (EIJER; HOGERVORST, 2017; GANZ *et al.*, 2003; KUHNS *et al.*, 2015). Therefore, increased forces cause delamination of the acetabular cartilage from the acetabular labrum in its early stage (KUHNS *et al.*, 2015). As the condition progresses, the acetabular labrum may rupture or detach (KUHNS *et al.*, 2015).

The second type of impingement is the Pincer type (GANZ *et al.*, 2003). Pincer morphology refers to excess bone coverage over the femoral head due to focal (acetabular retroversion) or global (hip protrusion or deep hip) alteration of the acetabulum (GANZ *et al.*, 2003) (FIGURE 1B). Patients with the Pincer morphology show damage primarily to the acetabular labrum, consistent with the mechanics of excess bone coverage over the femur (KUHNS *et al.*, 2015). The chondral lesions seen in pincer-type impingement are less severe compared to CAM-type impingement (GANZ *et al.*, 2003; KUHNS *et al.*, 2015). Finally, bone morphologies (CAM and Pincer) may be present in isolation or in combination, the latter called mixed-type impingement (GANZ *et al.*, 2003).

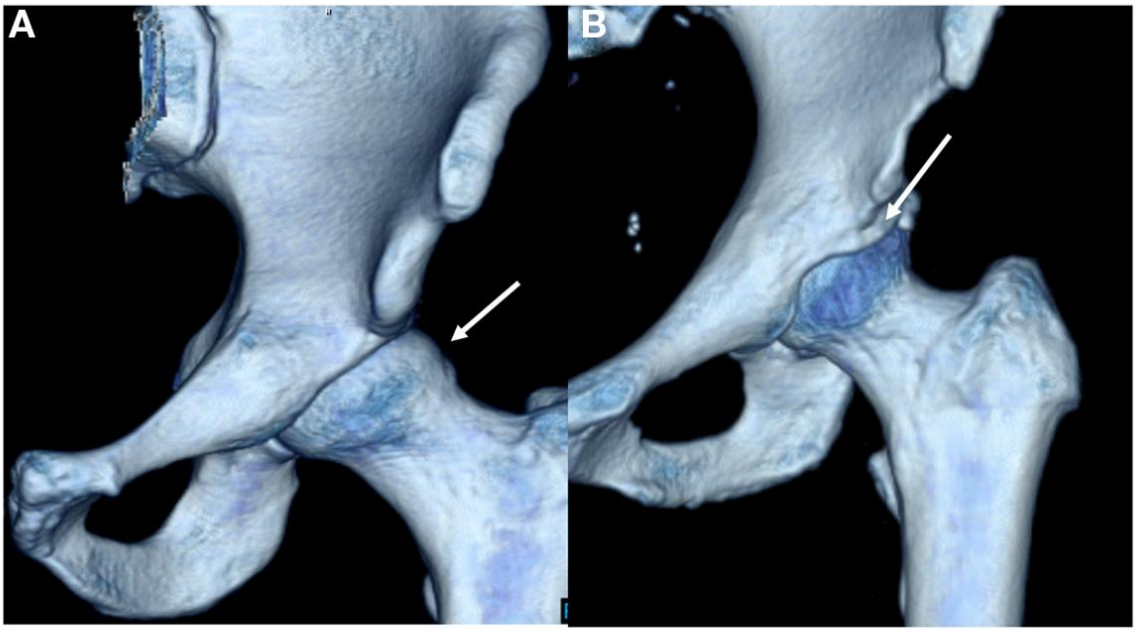


Figure 1. Three-dimensional (3D) computerized tomography showing (A) CAM deformity and (B) Pincer morphology (KUHNS et al., 2015).

A large multicenter study with FAIS patients (CLOHISY *et al.*, 2013) observed that 47.6% of the evaluated hips showed CAM morphology, 44.5% presented combined CAM and Pincer morphology and 7.9% presented Pincer morphology. In contrast, Nepple *et* *al.* (2014) observed greater prevalence of the combine or mixed type morphology compared to isolated CAM and Pincer morphology. Independent of the morphology type (CAM, Pincer or mixed), the anterior impact at the hip is reproduced when the hip joint is subjected to extreme range of motion (ROM) during flexion, adduction and internal rotation performed simultaneously (GRIFFIN *et al.*, 2016). The impact occurs at the limit or close to the ROM limits when the femur's neck contacts the anterosuperior acetabular region (GRIFFIN *et al.*, 2016).

The main FAIS symptom is pain at the hip, or the groin, related to joint position or movement (GRIFFIN *et al.*, 2016). Pain location is usually indicated by the patient in terms of a "C-sign" or a pain going from the anterior to the posterior region of the hip (GRIFFIN *et al.*, 2016) (FIGURE 2a). FAIS clinical symptoms include a positive anterior impingement test, such as the FADIR and FABER tests (FIGURES 2B and 2C) or movement limitations, especially for hip internal rotation during hip flexion (GRIFFIN *et al.*, 2016). In addition, the Warwick International Agreement emphasizes that muscle weakness and dysfunctional movement patterns may be present in FAIS patients (FREKE *et al.*, 2016; GRIFFIN *et al.*, 2016; KING *et al.*, 2018).

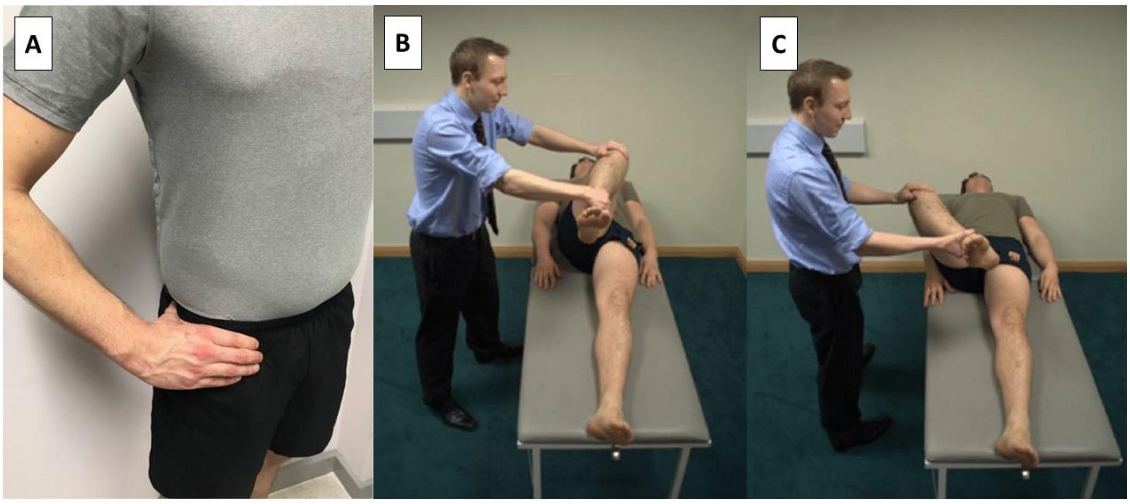


Figure 2. (A) The "C-sign", gesture used by patients to localize the hip pain. (B) The FADIR test (hip flexion, adduction, and internal rotation): the examiner moves the leg passively in total hip flexion and then hip adduction with internal rotation. (C) FABER test (flexion, abduction and external rotation of the hip): after flexing the hip approximately to 45°, the examiner externally rotates and abducts the patient's leg (DICK; HOUGHTON; BANKES, 2018a).

In the last 20 years, FAIS diagnostics have increased in the general population, as well as the interest for this clinical condition (COLVIN; HARRAST; HARNER, 2012; MONTGOMERY *et al.*, 2013). However, FAIS etiology is not totally understood and an association between FAIS and pediatric diseases such as the proximal femoral epiphysiolysis (i.e., dislocation of the proximal femoral epiphysis due to a weakness on the proximal epiphyseal plate) have been suggested (CHAUDHRY; AYENI, 2014). Other conditions such as the Legg-Calve-Perthes disease, avascular necrosis of the femoral head and poor consolidated fractures of the femur's head may predispose patients to developing FAIS (HART *et al.*, 2009). Finally, genetic factors may also play a role in the development of the CAM morphology (POLLARD *et al.*, 2013).

In the pathomechanical model proposed by Cannon et al. (2020), the development and progression of FAIS would be a combination of three factors. First, the bone morphology CAM and/or Pincer (CANNON *et al.*, 2020). Second, abnormal hip and pelvis kinematics that result in impingement between the femur and the acetabulum (CANNON *et al.*, 2020). Third, vigorous sports activities in adolescence during the bone ossification phase, when the epiphyseal growth region (also known as metaphysis or growth cartilage) is open (i.e., has not yet undergone the final ossification process) (CANNON *et al.*, 2020; PALMER *et al.*, 2018; TAK *et al.*, 2015). Although more studies are still needed to clarify the etiology of FAIS, it is widely accepted in the scientific community that FAIS is a multifactorial condition (GRIFFIN *et al.*, 2016).

Currently, FAIS is recognized as the leading cause of hip and/or groin pain in young adults (DICK; HOUGHTON; BANKES, 2018a). In a systematic review, FAIS was responsible for 32% of cases of groin pain requiring surgery in athletes (DE SA *et al.*, 2016). Corroborating these results, Rankin *et al*. (2015) observed that intra-articular causes of hip pain in athletes accounted for 56% of cases, with FAIS being the main cause of intra-articular pain. In addition, the incidence of CAM, Pincer or mixed morphologies is reasonably common in the asymptomatic population (MASCARENHAS *et al.*, 2016). Mascarenhas *et al.* (2016) observed a 22% prevalence of CAM morphology in asymptomatic people and 66% prevalence of CAM morphology (symptomatic or not) in athletes.

Experts agree that FAIS symptoms are likely to get worse over time if left untreated (GRIFFIN *et al.*, 2016). Studies after Ganz's in 2003 confirmed the author's hypothesis that FAIS would be a cause of early hip osteoarthritis (CASARTELLI *et al.*, 2021), and CAM morphology has been associated with hip osteoarthritis in prospective and cross-sectional studies (CASARTELLI *et al.*, 2021), while the association between osteoarthritis and Pincer morphology was observed only in cross-sectional studies (CASARTELLI *et al.*, 2021). Hip osteoarthritis is a condition of suffering and disability for the individual (CIBULKA *et al.*, 2017). In Brazil, osteoarthritis is the fourteenth cause of years lived with disability (MARINHO *et al.*, 2018). Given the above, greater understanding of FAIS may contribute to the development of preventive strategies for early hip osteoarthritis.

## 1.2 Changes in the Musculoskeletal System due to FAIS

### 1.2.1 Hip Motion Limitation

FAIS is a clinical condition associated to motion (GRIFFIN *et al.*, 2016), and, therefore, the biomechanical changes due to this condition may lead to the development and/or persistence of the symptoms, as well as in the intra-articular structures' degeneration. In the sagittal plane, the most consistent findings among the studies is the tendency for the patients to display pelvic kinematic changes compared to control subjects. Smaller hip joint ROM in the sagittal plane and higher pelvic anteversion during the peak hip flexion on a squat were observed in patients with CAM impingement (BAGWELL *et al.*, 2016; LAMONTAGNE; KENNEDY; BEAULÉ, 2009). Higher hip anteversion was also observed in these patients during unipodal stair descent (LEWIS; LOVERRO; KHUU, 2018). Hip anteversion leads to an earlier bony contact between the femur and the acetabulum during hip flexion, thereby increasing FAIS symptoms (CANNON *et al.*, 2020).

A systematic review has reported that patients with CAM impingement showed lower hip ROM in the frontal plane and lower hip abduction ROM in the gait's terminal stance phase compared to controls (YARWOOD *et al.*, 2022). Greater hip adduction was also observed during a restricted squat (movement performed with restriction of trunk inclination) in FAIS patients (DIAMOND *et al.*, 2017). Hip adduction allows approximation of the CAM morphology to the acetabular rim in the hip flexed position, contributing to the FAIS symptoms (CANNON *et al.*, 2020). In the transverse plane, FAIS patients had a lower hip peak internal rotation angle during the gait (KING *et al.*, 2018). Therefore, dysfunctional kinematic changes can be observed in FAIS patients.

Movement limitations are also found during the clinical examination of patients with FAIS (DIAMOND *et al.*, 2015; FREKE *et al.*, 2016). Our research group compared the hip ROM of FAIS patients and healthy controls using a goniometer. Movement limitations during passive flexion, external rotation (active and passive) and internal rotation (active) at 90° of hip flexion were observed in patients with FAIS (FRASSON *et al.*, 2020). Accordingly, two systematic reviews reported hip flexion ROM limitations in patients with FAIS compared to controls (DIAMOND *et al.*, 2015; FREKE *et al.*, 2016).

The hip's internal and external rotation ROM in the clinical examination of FAIS patients show conflicting results in the two previously mentioned reviews (DIAMOND *et al.*, 2015; FREKE *et al.*, 2016). However, experts agree that, in general, FAIS is associated with movement limitations, mainly internal rotation at 90° of hip flexion (GRIFFIN *et al.*, 2016). Restricted hip ROM may increase the risk of injuries in proximal and distal joints of the lower limb kinetic chain (KHAN *et al.*, 2016). In fact, low back pain, sacroiliac pain, pain related to hip flexors and adductors and groin pain are pathologies commonly observed in patients with FAIS (KHAN *et al.*, 2016). In addition, it has already been observed that the limitation of hip internal rotation movement can increase the risk of anterior cruciate ligament injury (BOUTRIS *et al.*, 2018) and pubic pain (BIRMINGHAM *et al.*, 2012).

Wyles *et al*. (2017) noted that movement limitations can have long-term negative consequences. The authors observed that adolescents with limited movement of internal rotation of the hip (< 10°) showed more structural alterations on magnetic resonance (chondrolabral lesions, osteophytes and cysts) compared to adolescents without movement limitations (> 10°) (WYLES *et al.*, 2017). Five years after the initial evaluation, limitations of internal rotation and hip flexion were risk factors for new or progressive MRI findings (WYLES *et al.*, 2017).

Bone impingement, hip capsular ligament stiffness, chondrolabral injuries, musculotendinous shortening and even pain are factors that may play a role in movement limitations in patients with FAIS. Among these factors, structural alterations of the joint capsule have been observed in patients with FAIS. Rakhra *et al*. (2016) observed greater thickness in the anterior-superior region of the joint capsule in patients with FAIS compared to controls. The anterior capsule comprises mainly the illiofemoral ligament, which limits the amplitudes of external rotation and hip extension (FUSS; BACHER, 1991; HEWITT *et al.*, 2002). Therefore, the stiffness of this ligament may limit protective amplitudes against bone impact in the flexed position of the hip. In addition, the rigidity of the joint capsule can limit the existing mobility between the sagittal plane of the pelvis and the transverse plane of the femur (BAGWELL; FUKUDA; POWERS, 2016). Given the above, there seems to be a complex relationship between hip and/or groin pain and movement limitations, which is not fully understood.

**1.2.2 Muscle Weakness**

Two systematic reviews sought to compare hip muscle strength in patients with FAIS and controls (DIAMOND *et al.*, 2015; FREKE *et al.*, 2016). In both reviews, muscle weakness was observed in FAIS patients (DIAMOND *et al.*, 2015; FREKE *et al.*, 2016). Diamond *et al.* (2015) included two studies that evaluated the FAIS patients muscle strength using an isokinetic dynamometer and a manual dynamometer. In the first study, FAIS patients had lower isometric muscle strength of adductors, flexors, external rotators and hip abductors (CARTELLI et al., 2011). No difference was observed in isometric muscle strength of hip extensors and internal rotators in FAIS patients (CASARTELLI *et al.*, 2011). In the second study (CASARTELLI *et al.*, 2012), FAIS patients presented hip flexor weakness (isometric and isokinetic) compared to control participants. However, no differences were observed in any measure of muscle fatigue of the hip flexors between groups (CASARTELLI *et al.*, 2012).

Freke *et al*. (2016) identified generalized muscle weakness of the hip musculature in patients with FAIS and chondrolabral injuries. The review by Freke *et al.* (2016) included six studies that assessed muscle strength isometrically using a manual dynamometer and/or an isokinetic dynamometer. There was moderate evidence of hip adductor and external rotator muscle weakness, limited evidence of hip flexor muscle weakness, and conflicting evidence of hip extensor muscle weakness in patients with FAIS and chondrolabral injuries compared to control participants (FREKE *et al.*, 2016).

Subsequent to these reviews, our research group compared isometric muscle strength using a handhold dynamometer in patients with FAIS and controls (FRASSON *et al.*, 2020). Muscle weaknesses of hip flexors, extensors and adductors were identified in patients with FAIS (FRASSON *et al.*, 2020). In addition, the greatest strength deficits were observed in the hip adductor and extensor muscle groups (FRASSON *et al.*, 2020).

Muscle weakness may be due to decreased muscle mass or the inability to fully activating the musculature (e.g., due to arthrogenic inhibition), two processes already observed in patients with hip pain. The cross-sectional area of the gluteus maximus, gluteus minimus and rectus femoris muscles was significantly smaller in the symptomatic limb compared to the asymptomatic limb in patients with FAIS (MALLOY *et al.*, 2019). Additionally, Dwyer *et al*. (2016) observed decreased activation of the gluteus maximus in patients with labral tears in the deep squat exercise. Inflammation, pain, and muscle atrophy can alter the afferent signal (i.e., information sent by joint receptors to the central nervous system) from the hip joint in FAIS patients (CANNON *et al.*, 2020). The alteration of the afferent signal generates an inhibitory reflex of alpha motor neurons and decreases the recruitment of motor units (FREEMAN; MASCIA; MCGILL, 2013) thereby impeding this musculature of being fully activated.

Although generalized muscle weakness of the hip musculature seems to exist in patients with FAIS (DIAMOND *et al.*, 2015; FRASSON *et al.*, 2020; FREKE *et al.*, 2016), it is important to consider how the gluteal weakness (gluteus maximus and medius) influences the perpetuation of symptoms. The gluteus maximus is an external rotator muscle and primary extensor of the hip (NEUMANN, 2010), in addition to being a pelvic retroversor muscle, while the gluteus medius is the primary hip abductor muscle (NEUMANN, 2010). Anteversion of the pelvis causes early impingement between the femur and acetabulum (BAGWELL; FUKUDA; POWERS, 2016), and, therefore, the weakness of these muscles may decrease the patient's ability to avoid impingement positions (hip flexion, adduction and internal rotation). In addition, the greater the hip flexion, the smaller the lever arm of these muscles, which makes the situation even more problematic (NEUMANN, 2010). Interestingly, many of the activities that patients with FAIS complain about pain involve sustained or repeated hip flexion (GRIFFIN *et al.*, 2016).

Lewis *et al*. (2007) used a musculoskeletal model to determine how muscle weakness could affect the magnitude of anterior forces acting on the hip joint. In this model, muscle weakness of the glutei (maximus, medius and minimus) was simulated. Anterior hip joint forces increased in the presence of gluteal weakness during hip extension (LEWIS; SAHRMANN; MORAN, 2007). Furthermore, anterior forces at the hip joint increased in the presence of iliopsoas muscle weakness during hip flexion (LEWIS; SAHRMANN; MORAN, 2007). Over time, increased anterior forces can contribute to anterior hip pain, instability, and labrum injury (LEWIS; SAHRMANN; MORAN, 2007).

Given the above, it is possible to think that muscle strength and ROM may play a role in the symptoms of patients with FAIS. In this sense, Catelli *et al.* (2018) observed greater hip extensor isometric strength in patients with the CAM morphology (asymptomatic) compared to patients with FAIS (who had the CAM morphology, symptoms and clinical signs). In addition, people with CAM morphology had greater pelvis ROM in the sagittal plane compared to FAIS patients (CATELLI *et al.*, 2018). Therefore, improving the strength and control of these muscles and ensuring good hip and pelvis mobility can have a protective effect. On the other hand, muscle weaknesses and movement limitations can subject joint connective tissues to mechanical overloads, predisposing these structures to degenerative changes (NEUMANN, 2010; WYLES *et al.*, 2017).

### 1.3 FAIS Treatment

The treatment options for FAIS consist of conservative care, physiotherapy-led rehabilitation and surgical treatment (GRIFFIN *et al.*, 2016). Conservative care includes patient education about the condition, lifestyle modification, analgesic medications, intra-articular corticosteroid injection, and “wait and see” (GRIFFIN *et al.*, 2016). Physiotherapy-led rehabilitation aims to reduce FAIS symptoms and improve patient functionality by addressing modifiable factors such as muscle strength, joint ROM, hip stability, neuromuscular control, and movement patterns (GRIFFIN *et al.*, 2016; KEMP *et* *al.*, 2020). Finally, surgery is aimed at remodeling the bone structure to prevent bone impingement (LAVIGNE *et al.*, 2004). Intra-articular injuries, such as at the labrum and cartilage, can be resected, repaired, or reconstructed (KEMP *et al.*, 2012; LAVIGNE *et al.*, 2004). Few studies have compared the effectiveness of available treatment options for FAIS (FERREIRA *et al.*, 2021).

A recent consensus on the FAIS treatment suggested a minimum of twelve weeks of physical therapy treatment without symptom modification before considering surgical treatment (KEMP *et al.*, 2020). Surgical treatments have been recommended not only to relieve symptoms, but also to delay the joint degenerative process (GANZ *et al.*, 2003). Surgical treatment can be performed by arthroscopy or open surgery (GRIFFIN *et al.*, 2016). However, hip arthroscopy is usually preferable since it is a minimally invasive technique and has a faster recovery compared to open surgery (GANZ *et al.*, 2001; SAMPSON, 2008).

Postoperative physiotherapy-led rehabilitation is recommended for patients who underwent surgery for the FAIS treatment (KEMP *et al.*, 2020). Lower hip and trunk isometric strength (FREKE *et al.*, 2016), lower rate of force production (ISHØI *et al.*, 2021c), movement limitations (KEMP *et al.*, 2016b), balance deficits (HATTON *et al.*, 2014), dynamic valgus (CHARLTON *et al.*, 2016), changes in gait (BRISSON *et al.*, 2013) and reduced ability to jump, slow down and change direction (DOMB *et al.*, 2016) have already been observed in patients with FAIS undergoing hip arthroscopy. These deficits can be the target of physiotherapy-led rehabilitation after surgery.

**1.4 Quality of Life in FAIS patients**

In addition to FAIS causing pain in the hip and/or groin, patients with FAIS experience restrictions on participation in activities of daily living and sports activities (FREKE et al., 2016; KEMP et al., 2014). Furthermore, patients with FAIS have worse self-reported quality of life scores when compared to asymptomatic people of the same age (THORBORG *et al.*, 2018a). Arthroscopy has demonstrated a positive effect on the quality of life of patients with FAIS (FERREIRA *et al.*, 2021). However, greater knowledge of the predictors of this improvement is still needed.

In order to monitor the patient's response to treatment, patient-reported outcome measures (PROM) are strongly recommended (IMPELLIZZERI *et al.*, 2020). PROMs are self-report questionnaires that quantify the perception of health, functionality and quality of life of patients with hip and/or groin pain (MOHTADI *et al.*, 2012). Currently, self-reported questionnaires are considered important health assessment instruments (IMPELLIZZERI *et al.*, 2020), since they complement the information from objective assessment measures with a patient-focused perspective (THORBORG *et al.*, 2018b). The minimal clinically important difference (MCID) and the patient acceptable symptomatic state (PASS) have been advocated in the literature to define specific values that represent the clinical improvement of patients (IMPELLIZZERI *et al.*, 2020; ISHØI *et al.*, 2021b).

The PASS can be used to better understand whether patients consider their functionality and pain levels acceptable and how this affects their daily life and was determined by Ishoi *et al.* (2021b). According to the authors, the PASS is equivalent to the patient “feeling good” after treatment and represents the satisfaction of patients with their physical status (ISHØI *et al.*, 2021b). On average, 50% of patients achieve PASS after arthroscopy for the treatment of FAIS (ISHØI *et al.*, 2021b; PALMER *et al.*, 2019).

Favorable results regarding pain reduction and functionality improvement were observed up to ten years after hip arthroscopy (KEMP *et al.*, 2012). Furthermore, 65-85% satisfaction of patients with labral tears was observed after hip arthroscopy forty months postoperatively (BEDI *et al.*, 2008; ROBERTSON; KADRMAS; KELLY, 2007). Thorborg *et al.* (2018b) observed that up to 70% of patients exceed the minimal clinically important change values in the self-reported questionnaires in the first year after arthroscopy. However, most patients with FAIS did not reach the same scores as the asymptomatic population (THORBORG *et al.*, 2018b). With regard to activities of daily living, only 37% of FAIS patients achieved the scores of the asymptomatic population, and only 24% of FAIS patients reached the scores of the asymptomatic population in sports activities (THORBORG *et al.*, 2018b). In this sense, the authors highlighted the difference between improving (i.e., exceeding the minimum clinically important change values) and “returning to normal” (THORBORG *et al.*, 2018b).

Similar physical impairments (reduced strength and muscle cross-sectional area, reduced ROM) are seen in hip osteoarthritis patients (CIBULKA *et al.*, 2017). At the knee, greater knee function (THORSTENSSON *et al*., 2004) and quadriceps strength (ERICSSON *et al.,* 2006) are associated with better quality of life. Therefore, it is likely that similar associations between physical impairments and quality of life could exist at the hip. Importantly, if physical impairments associated with poorer outcomes can be identified in people with FAIS, then rehabilitation programmes that target these modifiable impairments could potentially be established to improve quality of life and to prevent progression to osteoarthritis. In addition, significant improvement in the clinical picture occurs in the first year after arthroscopy, with little or no improvement afterwards (KIERKEGAARD *et al.*, 2017). This fact emphasizes the importance of knowing predictors of better results within the first year after arthroscopy.

## 1.5 Justification

Prognosis is the description of the probable clinical course of a health condition or the prediction of clinical outcomes over time (CROFT; DUNN; RASPE, 2006). Most patients look for health services curious to know when they will be recovered and when they will be able to carry out their daily tasks and sports. Health professionals rely on the prognosis to give these answers. In this way, it is possible to align patients' expectations and plan and direct the conduct to be followed.

A systematic review summarized the prognosis of patients with FAIS who underwent arthroscopy (SOGBEIN *et al.*, 2019). Age, sex, BMI and pain relief with intra-articular injections were able to predict results after arthroscopy (SOGBEIN *et al.*, 2019). That is, younger, male patients with lower BMI had better results after arthroscopy (SOGBEIN *et al.*, 2019). However, we did not find studies that evaluated the prognostic ability of muscle strength and hip ROM on quality of life and PASS of patients with FAIS. Considering that increasing muscle strength and ROM is often a therapeutic target in the treatment of FAIS (KEMP *et al.*, 2020), these variables were considered possible predictors of the quality of life of these patients in the present study.

### 1.6 MAIN OBJECTIVE

The main purpose of the present study was to evaluate the predictive capacity of muscle strength and ROM changes after four months of hip arthroscopy in achieving higher quality of life status in patients with FAIS.

#### 1.6.1 Specific Objectives

1. To describe and compare isometric hip muscle strength before and after 4 months of hip arthroscopy for the treatment of FAIS;
2. To describe and compare active and passive hip ROM before and after 4 months of hip arthroscopy for the treatment of FAIS;
3. To describe and compare quality of life before and after 4 months of hip arthroscopy for FAIS treatment;
4. To describe and compare pain intensity before and after 4 months of hip arthroscopy for FAIS treatment;
5. To investigate the correlation between the changes in isometric muscle strength and hip ROM from the pre to the post hip arthroscopy moment for FAIS treatment with the change in quality of life;
6. To describe the proportion of patients who reached the value corresponding to the PASS of the iHOT-33 questionnaire after hip arthroscopy for the treatment of FAIS;
7. To investigate the correlation between the changes in isometric muscle strength and hip ROM from pre- to post-hip arthroscopy for FAIS treatment with PASS;
8. To evaluate whether the change in isometric muscle strength and hip ROM from pre- to post-hip arthroscopy for FAIS treatment is a predictor of change in quality of life;
9. To assess whether the change in isometric muscle strength and hip ROM from pre- to post-hip arthroscopy for FAIS treatment is a predictor of PASS.

## 1.7 HIPOTHESES

The hypotheses of this study were generated before data analysis, and were as follows:

1. The values of isometric muscle strength and hip ROM and quality of life will be higher after arthroscopy compared to the pre-surgical moment.
2. There will be a positive relationship between the increase in isometric muscle strength and hip ROM with the increase in quality of life after hip arthroscopy, and the most significant relationships will be muscle strength of the adductors and hip extensors with quality of life (FRASSON et al., 2020; FREKE et al., 2016).
3. Increased isometric muscle strength of hip extensors and adductors will be predictors of changes in quality of life.

## 2. MATERIALS AND METHODS

### 2.1 Study Design

The present study is characterized by a quantitative approach with a retrospective cohort design and followed the guidelines of the RECORD Statement (Reporting of Studies Conducted using Observational Routinely-Collected Health Data) for retrospective observational studies that use a database (BENCHIMOL *et al.*, 2015).

### 2.2 Ethical Aspects

The present study was approved by the Research Ethics Committee (CEP) of UFRGS (No. 5.737.155) and is in accordance with Resolution 466/12 of the National Health Council on research involving human beings.

### 2.3 Database Description

The information on patients with FAIS, necessary for carrying out the present study, was obtained from a database of a private physiotherapy clinic. The clinic is located in Porto Alegre, Rio Grande do Sul, Brazil, and is considered a reference in the rehabilitation of musculoskeletal conditions related to the hip. From 365 men and woman with FAIS who were evaluated before surgery in the database, 99 had been re-evaluated between the years 2013 and 2021. The database contains medical records of patients who underwent surgical and non-surgical treatment. In addition, patient assessments were performed at different times. To be included, the patients needed to be evaluated at pre- and post-treatment time points.

### 2.4 Ethical Aspects Involving the Database

All patients at the physiotherapy clinic signed a consent form for evaluation and treatment, agreeing with the use of data in lectures and scientific research (ANNEX 1). The anonymity of all individuals was guaranteed using an identification code in the evaluation forms. Confidentiality was also guaranteed in relation to the individual results obtained by them in the evaluations carried out. The agreement of the physiotherapy clinic with the execution of the study is presented in ANNEX 2. The Data

Use Commitment Term can be found in ANNEX 3. The request for waiver of the Informed Consent Form with the presentation of the due justification can be found in ANNEX 4.

**2.5 Sample obtained from the database**

The sample of the present study consisted of men and women diagnosed with FAIS who underwent arthroscopy for the treatment. Validated codes, algorithms or methods were not used for sample selection from the database (BENCHIMOL *et al.*, 2015). As this is a retrospective study, it was not possible to perform a sample calculation, since the number of people depends on the maximum number of patients who attended the physiotherapy clinic. In addition, retrospective studies often limit their sample based on factors such as data availability (BENCHIMOL et al., 2015). The first author of the study, who had full access to the database without any restrictions, carried out the sample selection.

**2.5.1 Inclusion Criteria**

Patients who had:

- FAIS diagnosed by the orthopedic surgeon based on the triad of signs, symptoms and imaging findings (GRIFFIN et al., 2016);
- Clinical assessments of isometric muscle strength and hip ROM and self-reported quality of life before and after surgery for the treatment of FAIS;
- Age over 18 years at the time of surgery

**2.5.2 Exclusion Criteria**

- Reassessments less than three months or more than one year after surgery;
- Previous hip surgery;
- Neuromuscular diseases;
- Neurological diseases;
- Rheumatological diseases;
- BMI ≥30 $kg/m^2$;

- Localized pain in the lumbar region or sacroiliac joint;
- Any lower limb injury;
- Other hip pathologies, such as osteoarthritis, dysplasia, avascular necrosis of the femoral head, Legg-Calvé-Perthes syndrome and proximal femoral epiphysiolysis.

### 2.6 Data Extraction

The following variables were extracted from the medical records for sample characterization purposes: age, sex, diagnosis of FAIS (right, left or bilateral), most affected side, lower limb dominance, body mass, height, duration of symptoms, and practice of physical activity. The patient answered about the practice of physical activity only as “yes” or “no”. In addition, isometric muscle strength, hip ROM and quality of life before and after surgery for the treatment of FAIS were extracted. The first author of the present study performed data extraction.

### 2.7 Femoroacetabular Impingement Syndrome Diagnosis

The diagnosis of FAIS was based on the triad of symptoms, clinical signs and imaging findings (GRIFFIN *et al.*, 2016). The diagnosis of FAIS and the radiographic evaluations were performed by a team of three physicians specialized in arthroscopic correction of FAIS at the Traumato-Orthopedics Service of Hospital Moinhos de Vento, in Porto Alegre, Rio Grande do Sul, Brazil. To be diagnosed with FAIS, the patient had to present: (1) pain in the hip or groin region related to movement or position; (2) positive FADIR test (flexion-adduction-internal rotation) and (3) anteroposterior radiograph of the pelvis and lateral view of the femoral neck of the symptomatic hip with evidence of CAM morphology and/or Pincer morphology.

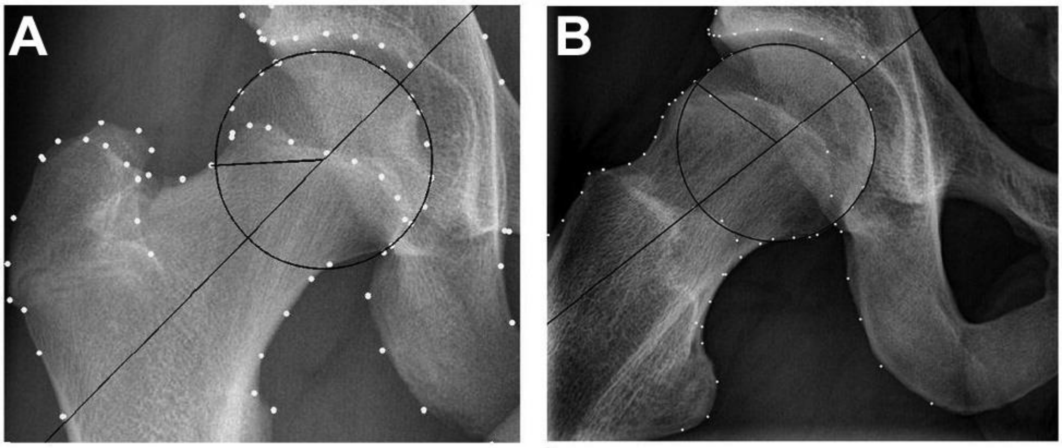


Figure 3. (A) Alpha angle within normal values (42°); (B) Alpha angle of 76° confirming CAM deformity (AGRICOLA et al., 2012).

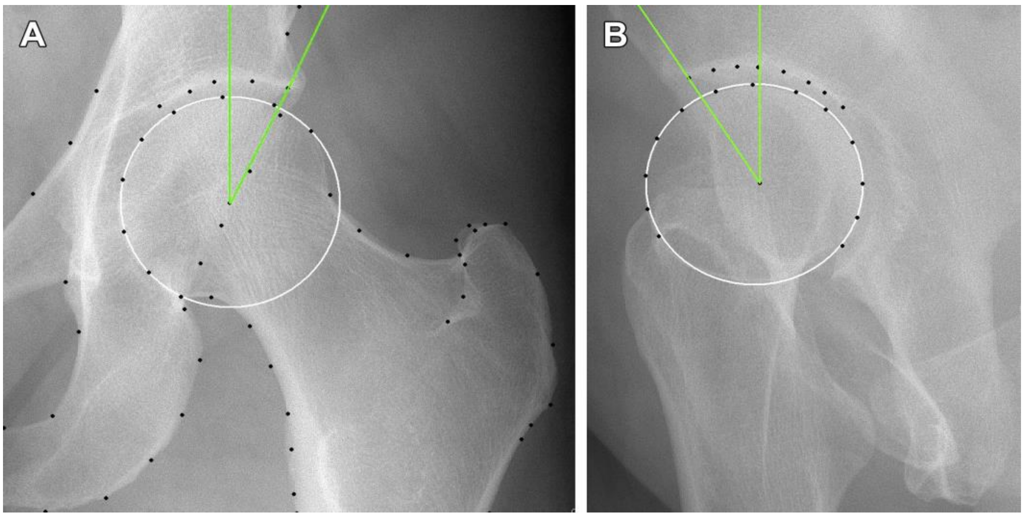


Figure 4. (A) Lateral center-border angle; (B) Anterior center-border angle (AGRICOLA et al., 2013).

The radiological evaluation included anteroposterior view of the pelvis, false profile view, hip lateral view and lateral or cross-table view. The presence of CAM morphology was quantitatively determined using the alpha angle (alpha angle > 60°) in anteroposterior or lateral views (FIGURE 3). The presence of Pincer morphology was quantitatively determined by means of an anterior or lateral center-edge angle >40° in the anteroposterior and false profile views (FIGURE 4). The presence of CAM morphology and/or Pincer morphology per hip was defined when present in any of the radiological views (AGRICOLA *et al.*, 2012, 2013, 2014).

## 2.8 Procedures executed at the Physiotherapy Clinic

Assessments of hip muscle strength, hip ROM and self-reported quality of life were routinely performed as an initial screening in patients with FAIS. Three duly trained physiotherapists who had at least ten years of clinical practice conducted the evaluations and more than five hundred patients with FAIS were evaluated using the methods of the present study.

## 2.9 Pain Intensity

Pain intensity was measured using the visual analogue scale (VAS). The VAS is a 100 mm scale where “0” means “no pain” and “100” indicates “greatest imaginable pain”. Patients were asked to mark on the scale the level of pain they felt in the hip at rest and the worst level of pain they had ever experienced in the hip.

## 2.10 Range of Motion (ROM)

Hip flexion, internal and external rotation ROMs were measured bilaterally in an active and passive way using a digital goniometer (Medigauge, Columbia, USA). This procedure was previously described (FRASSON *et al.*, 2020) (FIGURE 5). Patients were positioned in a way to maximize pelvic stability. For the hip flexion and external rotation movements, the contralateral limb was kept with the hip and knee extended. Internal rotation movement was measured in two different ways, unilaterally and bilaterally. For the unilateral movement, the contralateral leg was kept with the hip and knee extended. For the bilateral movement, the patient kept the hip and knee flexed at 90° and the internal rotation movement was performed simultaneously by both lower limbs. Bilateral internal rotation was performed only actively. Our research group using the same methodology presented in this study previously established the intra-rater and inter-rater reliabilities of the hip ROM of healthy people (TORRESAN & VAZ, 2017). The reliabilities were considered excellent for internal and external rotation and satisfactory for hip flexion (intra-rater ICC values greater than 0.77 and inter-rater greater than 0.84)

(TORRESAN & VAZ, 2017). The ROMs for hip extension, adduction and abduction were not evaluated due to difficulties in stabilizing the pelvis in the testing position, which increases measurement errors. However, hip flexion and rotation amplitudes seem to be representative of hip mobility related to the bone morphologies present in FAIS.

### 2.11 Maximal Isometric Muscle Force

Maximum isometric hip muscle strength was measured bilaterally using a manual dynamometer (MICROFET - Hoggan Scientific, Salt Lake City, United States). In all tests, the dynamometer was positioned distally on the tested lower limb, close to the ankle joint. In this way, the test position provided a large lever arm for the evaluator, maximizing the evaluator's stability. Muscle strength of the hip flexors, extensors, abductors and adductors was measured according to the methodology by Frasson *et al.* (2020) (FIGURE 5). Muscle strength of the internal and external hip rotators was measured with the patient sitting on the edge of a stretcher, with the hip and knee flexed at 90°. The patient was instructed to use his hands resting on the stretcher to help maintain pelvic stability. The dynamometer was positioned 5 cm proximal to the lateral (internal rotators) and medial (external rotators) malleoli.

Patients performed two maximal voluntary isometric contractions of each hip muscle group. When the difference between the two contractions was greater than 10%, a third attempt was performed. The patient was asked to perform maximal contractions in the following sequence: 2 seconds to reach maximum force, 2 seconds of isometric contraction and 2 seconds to relax. Between contractions, an interval of 120 seconds was given. Additional measurements were performed in case of lack of stability during the test by the patient or evaluator or when the patient did not reach the maximum contraction. Patients received verbal encouragement from the evaluator.

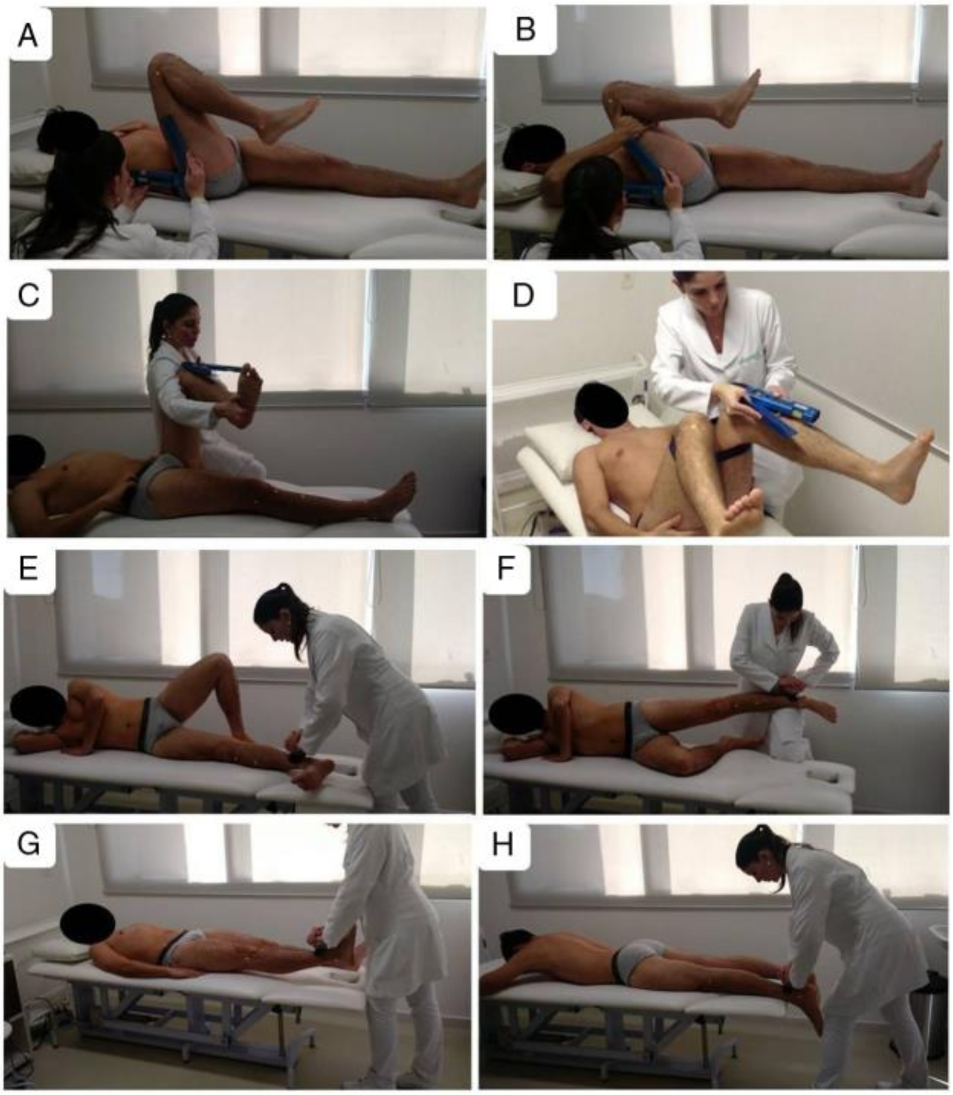


Figure 5. Patient position during ROM assessment (A-D) and isometric muscle strength assessment (E-H). Active hip flexion (A), passive hip flexion (B), passive hip external rotation (C) and active hip internal rotation. Isometric muscle strength of the adductors (E), abductors (F), hip flexors (G) and extensors (H) (FRASSON et al., 2020).

The highest value of the two valid attempts was converted into torque by multiplying the force measured by the dynamometer (in Newtons) by the length of the limb (distance in meters between the axis of rotation of the joint and the point of force application in the dynamometer for each test). Torques were normalized by body mass and were used for data analysis. Data were reported in Newtons meter per kilogram (Nm/kg). The intra-rater and inter-rater reliabilities of hip muscle strength in healthy individuals were previously established in our research group (TORRESAN & VAZ, 2017), and therefore we used the same methodology in the present study. Reliability was considered excellent for all muscle groups (intra-rater ICC values greater than 0.89 and inter-rater greater than 0.90) (TORRESAN & VAZ, 2017).

## 2.12 Quality of Life

Quality of life was quantified using the International Hip Outcome Tool-33 questionnaire (iHOT-33). The iHOT-33 questionnaire assesses four different constructs of hip and/or groin pain, namely: I - symptoms and functional limitations, II - sports and recreational activities, III - considerations related to work and IV - social, emotional and related considerations lifestyle, resulting in a hip-related quality of life score (MOHTADI *et al.*, 2012). The iHOT-33 questionnaire consists of thirty-three questions assessed using the visual analogue scale (VAS). The VAS consists of a line 100 mm long, in which the question is answered by drawing a bar on this line. In this way, each question can be answered from 0 to 100 points. The final score corresponds to the average score of all questions answered. The iHOT-33 questionnaire score ranges from 0 to 100, where higher scores indicate better quality of life (MOHTADI *et al*., 2012).

Recently, the IHOT-33 questionnaire was considered one of the most appropriate self-reported questionnaires to assess physically active in young and middle-aged patients with hip pain in a surgical context (IMPELLIZZERI *et al.*, 2020). In addition, the iHOT-33 questionnaire demonstrates excellent reliability, responsiveness and construct validity for use in patients with surgical indication (KEMP *et al.*, 2013). The PASS cutoff point was set at 67 points according to a recent study (ISHØI *et al.*, 2021b). The iHOT-33 questionnaire can be found in ANNEX 5.

## 2.13 Surgical Procedure

All hip arthroscopies were performed at a local hospital that follows high quality standards in our city using a technique that has been described in the literature (THAUNAT *et al*., 2014). A systematic description of hip arthroscopy was obtained using a conventional optical 30° arthroscope from the surgical records dictated by the surgeons. As the first step, the capsular fatty tissue was cleaned, and a longitudinal capsulotomy was performed using a 3.5 mm, 90° hook electrode, along the femoral neck. The proximal landmark was the reflexed head of the rectus femoris muscle, where a T-shaped capsule extension was added whenever needed. A traction suture was passed through the capsular flaps to facilitate the exposure, preserving the stabilizing function of the iliofemoral ligament. Hip arthroscopy was then conducted in a routine manner by performing femoral ostechondroplasty to remove the CAM morphology, which was carried out on 100% of the patients. The labrum stability was always assessed with a probe. Confirmation of the required resection could be obtained through fluoroscopy and dynamic visual assessment by performing the impingement test. When a pincer morphology was addressed, the labrum was detached to resect the acetabular rim, which was usually at the supra-equatorial portion of the acetabulum. The labrum was then re-attached using 2 or 3 anchors with the simple loop stitch technique, which was carried out on.

**2.14 Post-Surgery Physiotherapy**

For patients who chose to undergo physical therapy treatment at the clinic, physical therapy treatment was performed three times a week for five weeks. The duration of the sessions was approximately one hour and thirty minutes. A team of physiotherapists trained in FAIS rehabilitation was responsible for applying the protocol.

The FAIS postoperative rehabilitation followed the protocol by Frasson *et al.* (2016), which is divided into four phases: (1) immediate rehabilitation phase, which comprises the hospital phase and the initial two weeks of rehabilitation; (2) phase of return to activities of daily living, which covers the first postoperative month; (3) phase of specific muscular reinforcement and proprioceptive training and; (4) final preparation phase for returning to sport. The complete physiotherapy protocol is described in ANNEX 6. After postoperative rehabilitation, each individual was instructed to continue the rehabilitation, through regular physical activity of their choice.

**2.15 Statistical Analysis**

Continuous variables are presented as mean and 95% confidence interval (CI). Categorical variables are presented using absolute and relative frequency. All variables were analyzed for distribution normality using the Shapiro-Wilk test. The symptomatic hip (in patients with unilateral FAIS) or the most symptomatic (in patients with bilateral FAIS) was used for the statistical analysis.

Generalized estimation equations were conducted to verify possible changes over time in muscle strength, hip ROM, pain intensity and quality of life. Bonferroni's complementary test was used.

The change in isometric hip muscle strength was calculated by delta values after arthroscopy and baseline values (delta = value after arthroscopy – baseline value). Changes in hip ROM and quality of life were calculated similarly.

Aiming to verify the correlation between changes in muscle strength, in hip ROM and in quality of life after arthroscopy, Pearson's correlation coefficient was used in the case of parametric data. In case of non-parametric data, Spearman's correlation was used. In order to verify the correlation between changes in muscle strength and hip ROM and the PASS, Spearman's correlation was used.

Aiming to verify whether changes in muscle strength and ROM variables constitute predictors of changes in quality of life after arthroscopy, multiple linear regressions were performed. Prior to the execution of the regressions, the following assumptions were evaluated: 1) normality of the residuals, through graphical analysis (histogram and PP graph of regression of the standardized residues); 2) absence of multicollinearity for each pair of predictors, through tolerance and variance inflation factor (VIF) parameters; 3) testing the independence of residuals (Durbin Watson test); 4) absence of outliers among the residuals; 5) homoscedasticity of residuals (scatter plot of standardized residuals). Two separate models were performed, one for ROM and the other for isometric muscle strength. The hierarchical model was adopted to insert the independent variables in the multiple linear regressions. Considering that 15 individuals are needed for each predictor variable (FIELD, 2009), the number of independent variables inserted in the model was limited to three variables. The inclusion of variables in the model was in accordance with previous studies, which observed associations between physical impairment measurements and quality of life in patients with chondrolabral pathology (KEMP *et al.*, 2016a). The variables that displayed the strongest associations with quality of life were incorporated into the model of the present study (KEMP *et al.*, 2016a). The individual contribution magnitudes in the model were determined by analyzing B and its confidence interval.

Aiming to verify whether changes in muscle strength and hip ROM variables are predictors of PASS after arthroscopy, binary logistic regressions were performed. For the regression analyses, the Likelihood Ratio chi-square test was adopted to verify the significance of the generated model. The significance of the predictors was assessed using the Wald test. The individual contribution magnitudes in the model were determined through the analysis of the Odds Ratio by the parameter (Exp(B)) and its confidence interval. Prior to running the regressions, the assumption of the absence of multicollinearity was tested. Tolerance and VIF parameters were used as criteria for diagnosing multicollinearity. Again, two separate models were performed, one for ROM and the other for isometric muscle strength. The inclusion of independent variables was done in the same way as for multiple linear regression (KEMP *et al.*, 2016a).

A significance level of 0.05 was adopted for all analyses. All analyzes were performed using SPSS statistical software (SPSS 21.0 for Windows, SPSS Inc., Chicago, IL. USA).

The effect size was calculated by comparing pre- and post-hip arthroscopy values according to Cohen's d. The following cutoff points were considered: up to 0.20 = trivial; 0.20-0.49 = small; 0.5-0.79 = moderate; 0.80-1.29 = large; above 1.30 = very large (ROSENTHAL, 1996).

## 3. RESULTS

### 3.1 Participants

A total of 69 individuals, assessed between 2013 and 2018, met the eligibility criteria and were included in the present study (FIGURE 6). The characteristics of the included patients are shown in Table 1. The pre-surgical evaluations were performed on average 21.78 (15.31 - 28.25) days before the surgery. Reassessments were performed on average 128.44 (118.31 - 138.58) days after surgery.

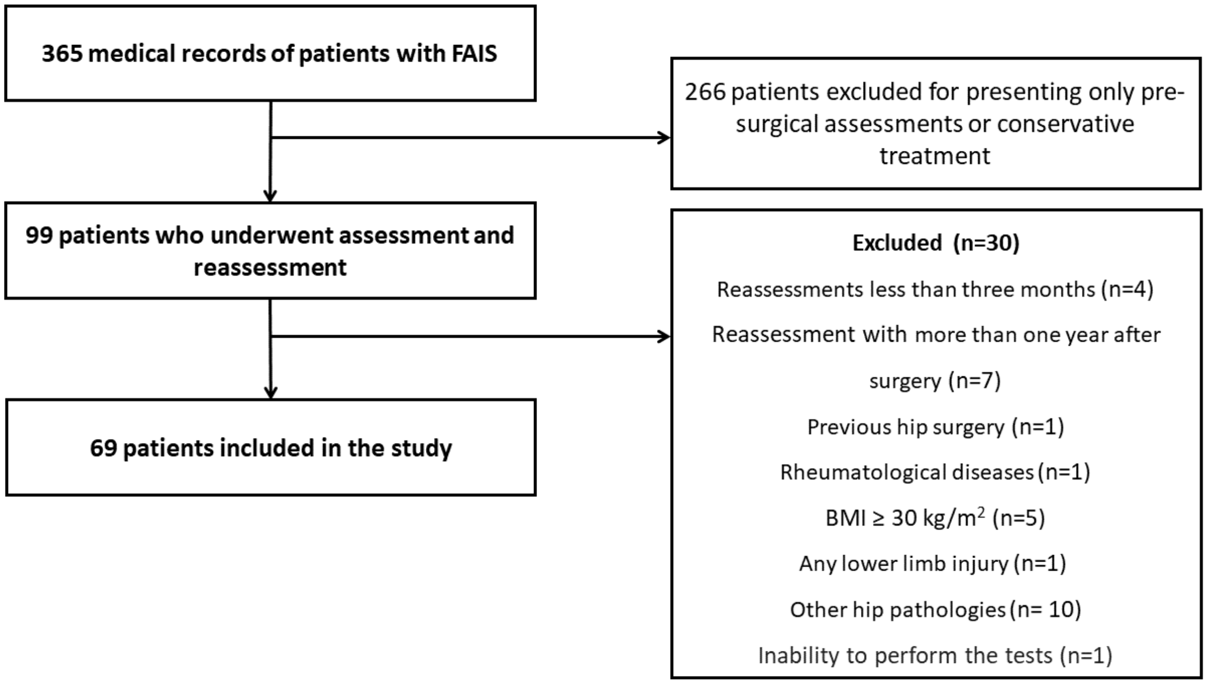


Figure 6. Flowchart of the included patients.

Table 1. Characteristics of the included participants.

| Characteristics | Descriptive Statistics |
|---|---|
| Age, years | 37.26 (34.93 - 39.59) |
| Sex male, Nr. (%) | 53 (76.8%) |
| BMI, kg/m$^2$ | 24.51 (23.88 - 25.13) |
| Symptoms duration, months | 41.98 (26.49 - 57.45) |
| Presence of abnormal morphology, right: left: bilateral, Nr. | 15: 5: 49 |
| Right side symptomatic, Nr. (%) | 52 (75.4%) |
| Right dominant lower limb, Nr. (%) | 57/64 (82.6%) |
| Sedentary, Nr. (%) | 22/65 (31.9%) |

Results are presented as mean (95% CI - confidence interval) or absolute (Nr.) and relative (%) frequency.

### 3.2 Outcomes of interest before and after arthroscopy

Tables 2 to 4 present the results of the comparisons of the outcomes of interest before and after hip arthroscopy. Pain intensity measured by VAS was lower after arthroscopy compared with pre-surgical values (Table 2). After arthroscopy, hip ROM values were higher compared to pre-surgical values, except for active and passive hip flexion ROM (Table 3). After arthroscopy, isometric hip muscle strength values were higher compared to pre-surgical values, except for hip flexor muscle strength (Table 4).

Table 2. Visual-analogue scale (VAS, 0-10) before (Pre) and after (Post) hip arthroscopy.

| | Pre | | Post | | | |
|---|---|---|---|---|---|---|
| Outcome | Mean | 95% CI | Mean | 95% CI | Effect Size | p value |
| VAS at rest | 1.75 | 1.18 - 2.33 | 0.65 | 0.29 - 1.01 | -0.54 (-0.88 to -0.20) | **<0.001** |
| VAS worst pain | 6.64 | 6.04 - 7.23 | 3.56 | 2.78 - 4.33 | -1.04 (-1.40 to -0.69) | **<0.001** |

CI = confidence interval; VAS = visual analogue scale.

Table 3. Hip range of motion (ROM, in degrees) before (Pre) and after (Post) hip arthroscopy.

| | Pre | | Post | | | |
|---|---|---|---|---|---|---|
| Outcome | Mean | 95% CI | Mean | 95% CI | Effect Size | p value |
| FLX active | 116.43 | 113.93 - 118.93 | 116.72 | 114.95 - 118.49 | 0.03 (-0.30 to 0.37) | 0.766 |
| FLX passive | 129.98 | 127.83 - 132.13 | 128.88 | 127.01 - 130.76 | -0.13 (-0.46 to 0.21) | 0.227 |
| ER active | 40.34 | 38.29 - 42.40 | 42.53 | 40.35 - 44.71 | 0.24 (-0.09 to 0.58) | **0.004** |
| ER passive | 53.37 | 50.96 - 55.78 | 55.98 | 53.30 - 58.66 | 0.24 (-0.09 to 0.58) | **0.002** |
| IR active | 22.24 | 20.10 - 24.38 | 28.98 | 26.90 - 31.06 | 0.70 (0.35 to 1.04) | **<0.001** |

CI = confidence interval; ER = external rotation; FLX = flexion; IR= internal rotation.

Table 4. Hip maximal isometric muscle forces normalized to body mass (Nm/kg) before (Pre) and after (Post) hip arthroscopy.

| | Pre | | Post | | | |
|---|---|---|---|---|---|---|
| Outcome | Mean | 95% CI | Mean | 95% CI | Effect size | p value |
| ER | 0.51 | 0.43 - 0.58 | 0.60 | 0.51 - 0.69 | 0.33 (0.00 to 0.67) | **<0.001** |
| IR | 0.56 | 0.48 - 0.63 | 0.67 | 0.57 - 0.76 | 0.43 (0.09 to 0.77) | **<0.001** |
| ABD | 1.32 | 1.23 - 1.41 | 1.41 | 1.31 - 1.50 | 0.23 (-0.11 to 0.56) | **0.011** |
| ADD | 1.03 | 0.91 - 1.14 | 1.24 | 1.11 - 1.38 | 0.40 (0.06 to 0.73) | **<0.001** |
| FLX | 1.44 | 1.28 - 1.60 | 1.41 | 1.27 - 1.57 | -0.03 (0.06 to 0.73) | 0.606 |
| EXT | 1.52 | 1.36 - 1.67 | 1.71 | 1.55 - 1.88 | 0.33 (-0.01 to 0.66) | **0.003** |

ABD = abduction; ADD = adduction; CI = confidence interval; ER = external rotation; EXT = extension; FLX = flexion; IR= internal rotation

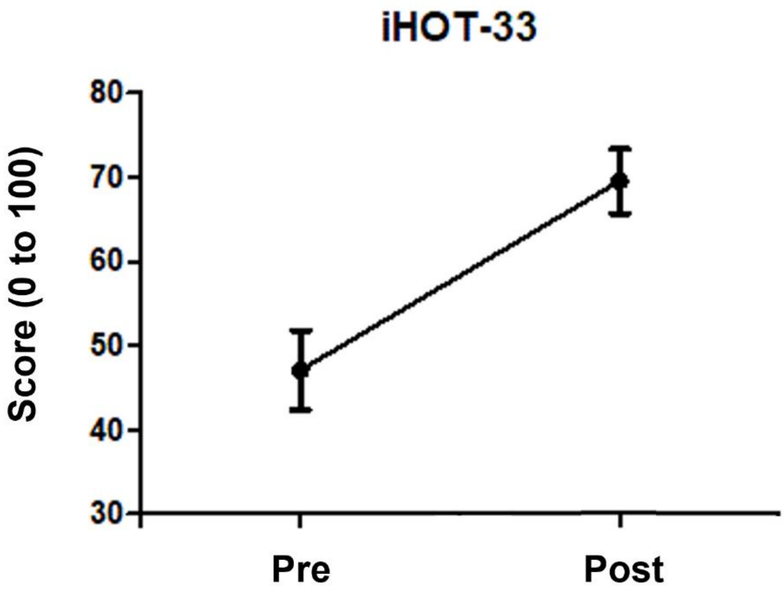


Figure 7. Quality of life assessed using the iHOT-33 questionnaire before and after hip arthroscopy for FAIS treatment.

Finally, hip arthroscopy was able to increase self-reported quality of life (FIGURE 7). Enrolled individuals had a mean score (95% CI) of 47.10 (42.34 - 51.86) on the iHOT-33 questionnaire before arthroscopy and a mean score (95% CI) of 69.57 (65.73 - 73.41) after arthroscopy, with effect size of 1.22 (0.86 to 1.58).

### 3.3 Correlation between change in ROM and isometric muscle strength with change in quality of life

No significant correlations were found between changes in ROM and isometric hip muscle strength and changes in quality of life (Tables 5 and 6).

Table 5. Correlation between the changes in hip range of motion (ROM) (°) and maximal isometric normalized muscle force (Nm/kg) with the iHOT-33 changes.

| | iHOT-33 | |
|---|---|---|
| Outcome | Pearson's r | p-value |
| ROM | | |
| FLX active | -0.008 | 0.945 |
| FLX passive | 0.079 | 0.521 |
| ER active | -0.019 | 0.875 |
| ER passive | -0.190 | 0.117 |
| IR active | -0.001 | 0.995 |
| Normalized Muscle Force | | |
| ER | -0.109 | 0.373 |
| ABD | -0.075 | 0.540 |
| ADD | -0.013 | 0.913 |
| FLX | -0.006 | 0.969 |
| EXT | -0.078 | 0.613 |

ABD = abduction; ADD = adduction; ER = external rotation; EXT = extension; FLX = flexion; IR= internal rotation; ROM = range of motion.

Table 6. Correlation between the changes in hip internal rotators isometric normalized maximal muscle force (Nm/Kg) with the iHOT-33 changes.

| | iHOT-33 | |
|---|---|---|
| Outcome | Spearman's Rhô | p-value |
| IR | -0.123 | 0.313 |

IR = Internal rotation.

### 3.4 Correlation between ROM change and isometric muscle strength with PASS

A total of 41 patients (59.42%) achieved PASS after surgery. No significant correlations were found between change in ROM and isometric hip muscle strength with PASS (Table 7).

Table 7. Correlation between the change in ROM (°) and isometric muscle strength (Nm/Kg) of the hip with the PASS.

| | PASS | |
|---|---|---|
| Variable | Spearman's Rhô | p-value |
| ROM | | |
| FLX active | 0.107 | 0.378 |
| FLX passive | 0.068 | 0.577 |
| ER active | -0.102 | 0.402 |
| ER passive | 0.235 | 0.052 |
| IR active | 0.080 | 0.512 |
| Muscle Force | | |
| ER | -0.147 | 0.229 |
| IR | -0.087 | 0.478 |
| ABD | -0.147 | 0.227 |
| ADD | -0.049 | 0.690 |
| FLX | -0.056 | 0.720 |
| EXT | 0.048 | 0.755 |

ABD = abduction; ADD = adduction; ER = external rotation; EXT = extension; FLX = flexion; IR= internal rotation; PASS = Patient Acceptable Symptom State; ROM = range of motion.

**3.5 Prediction of change in quality of life**

The results of the multiple linear regression containing the hip ROM variables are shown in Table 8. The change in the hip ROM variables was not a predictor of the change in quality of life [F (3.65) = 0.009; p=0.999; $R^2$= 0.0003]. The equation describing this relationship is: (ΔiHOT-33) = 22.579 – 0.012·(Active flexion ROM) – 0.053·(Active external rotation ROM) + 0.001·(Active internal rotation ROM).

The results of the multiple linear regression containing the variables of isometric hip muscle strength are shown in Table 8. The change in the variables of isometric hip muscle strength was not a predictor of change in quality of life [F (3.40) = 0.489; p=0.692; $R^2$=0.035]. The equation that describes this relationship is: (ΔiHOT-33) = 20.612 – 3.077·(muscle strength of adductors) – 12.001·(muscle strength of abductors) + 2.139·(muscle strength of extensors).

Table 8. Prediction of changes in quality of life based on changes in hip ROM (°) and isometric muscle strength (Nm/Kg) of the hip.

| Prediction of changes in quality of life based on changes in hip ROM | | | | | |
|---|---|---|---|---|---|
| Model | Variables | β | p-value | $R^2$ | p-value |
| 1 | FLX active | -0.008 | 0.945 | 0.0001 | 0.945 |
| 2 | FLX active | -0.005 | 0.967 | 0.0004 | 0.884 |
| | ER active | -0.018 | 0.884 | | |
| 3 | FLX active | -0.005 | 0.967 | 0.0004 | 0.996 |
| | ER active | -0.018 | 0.885 | | |
| | IR active | 0.001 | 0.996 | | |
| Prediction of changes in quality of life based on changes in hip isometric muscle strength | | | | | |
| Model | Variables | β | p-value | $R^2$ | p-value |
| 1 | ADD | -0.108 | 0.485 | 0.012 | 0.485 |
| 2 | ADD | -0.045 | 0.787 | 0.034 | 0.335 |
| | ABD | -0.162 | 0.335 | | |
| 3 | ADD | -0.062 | 0.736 | 0.035 | 0.815 |
| | ABD | -0.180 | 0.335 | | |
| | EXT | 0.047 | 0.815 | | |

ER = external rotation; FLX = flexion; IR= internal rotation; ABD = abduction; ADD = adduction; EXT = extension.

**3.6 PASS Prediction**

The change in hip ROM variables was not a predictor of PASS. The model containing the ROM variables of active flexion, active external rotation and active internal rotation was not significant [$X^2$ (3)= 2.490; p=0.477; $R^2$ Negelkerke=0.048]. Active flexion ROM (OR= 1.012; CI 95%= 0.949 - 1.079), active external rotation ROM (OR= 0.964; CI 95%= 0.889 - 1.044) and active hip internal rotation ROM (OR= 1.039; CI= 95%= 0.971 - 1.111) were not significant predictors. The equation describing this relationship is:

$$P\ (pass)= \frac{e\ (0.209 + 0.012\cdot(ROM\ F\ A) - 0.036\cdot(ROM\ ER\ A) + 0.038\cdot(ROM\ IR\ A)}{1+e\ (0.209 + 0.012\cdot(ROM\ F\ A) - 0.036\cdot(ROM\ ER\ A) + 0.038\cdot(ROM\ IR\ A)}$$

Where: $e$ is Euler number, ROM F A is active hip flexion range of motion, ROM ER A is active hip external rotation range of motion and ROM IR A is active hip internal rotation range of motion.

Change in isometric hip muscle strength variables was not predictive of PASS. The model containing the strength variables of adductors, abductors and hip extensors was not significant [$X^2$ (3)= 4.079; p=0.253; $R^2$ Negelkerke=0.118]. The muscle strength of adductors (OR=0.544; CI 95% = 0.065-4.537), abductors (OR=0.068; CI 95% = 0.003-1.469) and hip extensors (OR=4.176; CI 95% = 0.455-38.325) were not significant predictors. The equation describing this relationship is:

$$P\ (pass)= \frac{e\ (-0.046 - 0.608\ (F\ adduction) - 2.686\cdot(F\ abduction) + 1.429\cdot(F\ extension)}{1+e\ (\ -0.046 - 0.608\ (F\ aduction) - 2.686\cdot(F\ abduction) + 1.429\cdot(F\ extension)}$$

Where: $e$ is Euler number, F adduction is hip adduction isometric strength, F abduction is hip abduction isometric strength and F extension is hip extension isometric strength.

## 4. DISCUSSION

Increases in ROM values and isometric hip muscle strength were observed after arthroscopy in the present study. To the best of our knowledge, this was the first study to evaluate the prognostic ability of ROM adaptation and isometric hip muscle strength in relation to the quality of life of patients with FAIS undergoing arthroscopy. However, changes in these variables were not predictors of changes in quality of life. Therefore, we hypothesize that the beneficial effects of the treatment are more ''central'' than local, perhaps involving psychological, neurophysiological or cognitive adaptations. Furthermore, more complex, and non-linear relationships may exist between strength, ROM, and quality of life (BITTENCOURT *et al*., 2016), which were not analyzed in the present study.

### 4.1 Hip range of motion

In the present study, an increase in the hip's external and internal rotation ROMs was observed after arthroscopy. However, no changes in hip flexion ROM were observed after arthroscopy. Our results partially agree with the literature (FILAN; MULLINS; CARTON, 2022). A recent systematic review summarized knowledge about ROM before and on average thirty months after hip arthroscopy for the treatment of FAIS (FILAN; MULLINS; CARTON, 2022). Gains in hip flexion and internal rotation ROM were observed after arthroscopy, with moderate to large effect sizes. The external rotation ROM gains observed were more discreet.

Our baseline values of hip flexion ROM (on average 116° and 129°, respectively) were higher compared to other studies that also used the goniometer as a measurement instrument (CARTON; FILAN, 2020; NUSSBAUMER *et al.*, 2010). The reason why this difference existed is not clear. Furthermore, it is important to point out that, in the study by Frasson *et al*. (2020), no differences were observed in active hip flexion ROM between patients with FAIS and controls, and the values of the present study are similar to those of Frasson *et al.* (2020). In studies that evaluated hip flexion ROM before and after arthroscopy using a goniometer, the gain ranged from 0.1° to 12.2°, according to the previously mentioned systematic review (FILAN; MULLINS; CARTON, 2022). Our above mentioned higher ROM baseline values for hip flexion and the small ROM gain range may explain why we did not observe ROM differences before and after arthroscopy.

Although statistically significant, the increase in active and passive external rotation ROM averaged 2.19° and 2.61°, respectively, with small effect sizes. Nussbaumer *et al.* (2010) determined the standard error of measurement of passive external rotation ROM using the goniometer at 2.53°. In the present study, the passive external rotation gain minimally exceeds this value. Therefore, the observed external rotation gains do not seem to be clinically relevant. Similar increases in external rotation ROM have been previously reported three months after arthroscopy in patients with chondrolabral lesions (FREKE *et al.*, 2019).

The greatest gains were observed in the ROM of internal rotation of the hip, with a moderate effect size, which surpasses the measurement's standard error determined by Nussbaumer *et al* (2010). Surgical removal of bone morphologies may explain this result. According to the previously mentioned systematic review, the greatest gains are observed in the ROM of hip internal rotation, ranging from 5.7° to 21.9° in studies that used the goniometer as a measuring instrument (FILAN; MULLINS; CARTON, 2022). Furthermore, Freke *et al*. (2019) observed similar increases in internal rotation ROM three months after arthroscopy in patients with chondrolabral lesions. However, the patient's positioning for the internal rotation ROM measurement in the present study differs from that used by Freke et al. (2019). Due to bone morphologies, the probability of bone impingement occurring in internal rotation with 90° of hip flexion is greater (GRIFFIN *et al.*, 2016). Therefore, we consider the measurement of the present study more adequate compared to the study by Freke *et al.* (2019), who measured internal rotation with the patient in the prone position.

Goniometry was chosen to assess hip ROM because it is a low-cost measurement instrument widely used in clinical practice (NUSSBAUMER *et al.*, 2010). Furthermore, goniometry is a valid measure to assess hip ROM in patients with FAIS (NUSSBAUMER *et al.*, 2010). Nussbaumer *et al.* (2010) described the positioning during the ROM tests and observed that the goniometry considerably overestimates the ROM of the hip, due to the inclination and rotation of the pelvis. In the present study, an attempt was made to solve some of these problems using a bilateral internal rotation movement. In this way, the patient could not compensate with pelvic rotation or tilt. However, this measure was implemented in the clinic from the 2014 year onwards. Consequently, not all patients in the present study had the bilateral measurement, which may have interfered with the results.

Movement limitations in patients with FAIS are partly explained by bone morphologies (CAM and Pincer) (GANZ *et al*., 2003; GRIFFIN *et al*., 2016). The idea that surgical correction of these bone abnormalities increases hip ROM is partially supported by the literature (FILAN; MULLINS; CARTON, 2022; FREKE *et al.*, 2016). It is important to emphasize that the positioning of the proximal femur in relation to the acetabulum and vice versa and the dynamic interaction between them can be decisive in terms of movement limitations (AGRICOLA; WEINANS, 2016). For example, the CAM morphology in the anterior portion of the femoral neck-head junction may not cause early bone impingement if the acetabulum is anteverted enough to allow a physiological amount of movement. In another situation, the acetabulum may present a lower degree of anteversion and early bone impingement (and consequent movement limitation) may occur (AGRICOLA; WEINANS, 2016). The dynamic interaction between the proximal femur and the acetabulum is difficult to measure. However, it may be partly responsible for the controversial results both when comparing healthy control subjects and FAIS patients and when determining the effectiveness of arthroscopy in increasing ROM (DIAMOND *et al.*, 2015; FILAN; MULLINS; CARTON, 2022; FREKE *et al.*, 2016). In addition, the femoral version also determines the hip ROM (FRASSON *et al.*, 2022), but femoral version was not controlled in the present study.

Finally, the need to standardize and report ROM measurements across studies is urgent in order to have more clarity about the actual ROM gain after arthroscopy. Of the twenty-three studies included in the aforementioned systematic review, twelve do not report the measurement instrument they used (FILAN; MULLINS; CARTON, 2022). Of those studies that report the measurement instrument, six do not describe the patients' positioning during the measurement (FILAN; MULLINS; CARTON, 2022). In addition, some studies did not adequately report statistical significance (FILAN; MULLINS; CARTON, 2022), and from the twenty-three studies, none is a controlled and randomized clinical trial. This makes between-studies' comparisons difficult and limits the conclusions due to limited methodological quality.

**4.2 Hip muscle strength**

Gains in isometric muscle strength of all hip muscle groups after arthroscopy were observed in the present study, except for the hip flexors. Increases in isometric muscle strength ranged from 6% for the hip abductors to 20% for the hip adductors. Removal of bony prominences and correction of chondrolabral lesions performed during the surgical procedure can decrease pain and inflammation in the hip, the latter being a mediator of arthrogenic inhibition (CANNON *et al.*, 2020). In addition, rehabilitation programs after surgery emphasize the need for muscle strengthening due to the period of reduced use of these muscles post-surgery (KEMP *et al*., 2020). Therefore, although statistically significant, we could argue that the gains in strength observed in the present study were lower than expected.

One explanation for the slight increases in muscle strength could be the short follow-up time, which was, on average, four months after surgery. There are divergences regarding the duration of rehabilitation programs after arthroscopy; however, in general, a protocol lasting four to six months is recommended (ANKEM *et al.,* 2020). The goals of the initial period of rehabilitation are to control pain and swelling, slowly and carefully progress the gain of ROM and recover the activation of the pelvic and hip muscles (EDELSTEIN *et al.*, 2012). In addition, the initial rehabilitation period is characterized by restricting weight bearing on the operated limb (EDELSTEIN *et al.*, 2012; REIMAN *et al.,* 2020). Therefore, muscle strengthening during the rehabilitation programs does not start immediately after surgery, which may partly explain the slight increases in muscle strength observed in the present study.

Few studies have evaluated hip muscle strength before and after hip arthroscopy. Increases similar to those of the present study in isometric hip muscle strength six months after arthroscopy (ranging from 13% to 28%) have already been reported in the literature in patients with chondrolabral lesions (FREKE *et al.*, 2019). Kierkegaard *et al.* (2018) used an isokinetic dynamometer to compare the muscle strength of hip flexors and extensors before and one year after hip arthroscopy for the treatment of FAIS. The authors observed increases in concentric (13%), isometric (12%) and eccentric (6%) muscle strength of hip flexors and concentric strength of hip extensors (4%) one year after arthroscopy (KIERKEGAARD *et al., 2018)*. Casartelli *et al.* (2014) reported more significant gains in isometric muscle strength thirty months after arthroscopy in patients with FAIS, ranging from 9 to 59% (hip adductors: 25%, hip abductors: 9%, hip internal rotators: 59%, hip external rotators: 37%, hip flexors: 23%, hip extensors: 43%).

It is difficult to determine gains in muscle strength after hip arthroscopy for the treatment of FAIS. To the best of our knowledge, no randomized controlled clinical trial has investigated hip muscle strength gains after arthroscopy. Among the available studies, there is a variety of follow-up times after arthroscopy. In addition, postoperative rehabilitation is poorly controlled and/or described in all the studies. All these factors can affect the results. The increase in strength observed by Casartelli *et al.* (2014) corroborates the idea that longer follow-up times are needed to observe more expressive gains in muscle strength. However, the low statistical power of the study still limits conclusions.

Cross-sectional studies have observed that patients with FAIS have muscle weakness and movement limitations compared to healthy control subjects even after undergoing surgical procedures and postoperative rehabilitation. A lower rate of hip flexor force production was observed in the operated limb compared to the non-operated side 6 to 30 months after arthroscopy in patients with FAIS (ISHØI et al., 2021c). Accordingly, isometric strength deficits and hip internal rotation movement limitations were observed 12 to 24 months after arthroscopy compared to asymptomatic people (KEMP *et al.*, 2016b). This fact may suggest the need for more ideal rehabilitation programs for patients with FAIS.

Post-operative rehabilitation is considered very important by both surgeons and physical therapists. Yet, there is limited reporting of postoperative rehabilitation for FAIS (REIMAN *et al*., 2020). Based on what has been described in the literature, it is difficult to determine whether the rehabilitation program progression was based on functional criteria and healing times or whether it included the type, dose and progression of exercises needed to generate a meaningful change in strength and function in these patients (REIMAN *et al*., 2020).

In the present study, the hip flexors muscle group was the only one that did not present changes in isometric strength before and after arthroscopy. Muscle weaknesses of hip flexors after arthroscopy have previously been reported in the literature in prospective and cross-sectional studies (ISHØI *et al.*, 2021c; KEMP *et al.*, 2014). Freke *et al.* (2019) did not observe gains in hip flexor strength three months after arthroscopy in patients with chondrolabral lesions. In agreement, Casartelli *et al.* (2014) observed that thirty months after arthroscopy, patients with FAIS had muscle weakness only in the hip flexors compared to the control group.

A possible cause for the non-increase in muscle strength of the hip flexors may be related to the little emphasis that this muscle group receives in rehabilitation protocols after arthroscopy. This may happen because pain in the anterior region of the thigh is common in the postoperative period of hip arthroscopy (EDELSTEIN *et al.*, 2012). Pain in the anterior thigh is believed to be caused by iliopsoas tendinopathy (EDELSTEIN *et al.*, 2012). Thus, for fear from the professionals in exacerbating the patients' symptoms, strengthening the hip flexors is not emphasized. This is problematic as it can affect hip stability over time (RETCHFORD *et al.*, 2013). Furthermore, hip muscle weakness is supposed to be one of the contributing factors to kinematic changes in patients with FAIS (CANNON *et al.*, 2020; KING *et al.*, 2018). Therefore, strategies are needed to make it possible to strengthen the hip flexor musculature without exacerbating symptoms.

A systematic review observed that people with FAIS walk with less hip extension ROM compared to controls (KING *et al.*, 2018). Ng *et al.* (2018) propose that extension reduction is a protective strategy to avoid painful iliopsoas tendon strain in hip extension positions. In agreement, Catelli *et al.* (2019) observed reduced activation of the iliacus and psoas muscles in the final support phases of gait in people with FAIS, when the hip is in extension. It is important to emphasize that even after surgery, FAIS patients persisted with less activation of the iliacus and psoas muscles in the study by Catelli *et al.* (2019). This protective pattern decreases stimuli on this muscle group, and consequently deconditions the musculature, entering a cycle of pain-avoidance and disuse/deconditioning (VLAEYEN; CROMBEZ; LINTON, 2016).

Muscle strengthening is necessary for sports practice, which is of great concern for patients with FAIS, since most patients are young and recreational or professional athletes (DICK; HOUGHTON; BANKES, 2018b). People with FAIS who had greater isometric muscle strength in hip extension (OR = 17.71) and adduction (OR = 16.43) were more likely to practice sports at the pre-injury level 6 to 30 months after arthroscopy (ISHØI *et al.*, 2021c). In addition, the study brings minimum muscle strength values of the hip extensors (3 Nm/kg) and adductors (2.5 Nm/Kg) that were associated with practicing some sport at the pre-injury level, no or little difficulty in "running as fast as possible" and "kick and skate" (ISHØI *et al.*, 2021c). Our patients' muscular strength values were substantially below these values. A systematic review reported an average time to return to sport of four months (O'CONNOR *et al.*, 2018), the average follow-up time of the present study. This indicates that the return to sports should happen with greater caution and better-defined criteria, instead of using only the time after arthroscopy as a criterion.

It was beyond the scope of the present study to control the rehabilitation of patients after arthroscopy, since not all patients chose to undergo physiotherapeutic treatment at the Physique clinic. The role of rehabilitation after hip arthroscopy in relation to changes in muscle strength and ROM is not known. There is consensus in the literature (KEMP *et al.*, 2020) that strengthening the hip muscles is a fundamental part of the treatment of patients with FAIS. However, ROM gain is a controversial point in these patients. Studies of high methodological quality are needed in this area.

### 4.3 Self-reported quality of life

In contrast to the slight gains in ROM and isometric hip muscle strength, the increase in quality of life scores was substantial (mean gains of 46%), with a large effect size. It is worth mentioning that the change in the iHOT-33 questionnaire (on average 22.47 points) exceeds the minimum clinically important change, which is 10 points

(KEMP *et al.*, 2013). In addition, approximately 60% of the sample of the present study reached the PASS value.

Our results corroborate with the literature that indicates positive results regarding self-reported quality of life after arthroscopy (FERREIRA *et al.*, 2021; GO *et al.*, 2021; THORBORG *et al.*, 2018b). The delta of questionnaire scores over time (from pre to post-treatment) is used to assess the effectiveness of a treatment (PALMER *et al.*, 2019). The minimal important detectable change and the PASS help aligning patient expectations for treatment outcome. However, the PASS presents a limitation when it disregards the initial values of the questionnaire. In the present study, thirteen patients had already reached the PASS value in the initial evaluation.

Aligning patients' expectations seems to be important, as patients with FAIS tend to be very optimistic about the result of arthroscopy (JONES *et al.*, 2020). Patients who have undergone arthroscopy are unlikely to reach the physical status of asymptomatic people (THORBORG *et al.*, 2018b). Due to the lack of a control group in the present study, it is not possible to compare the iHOT-33 questionnaire scores of asymptomatic people with characteristics similar to our sample. However, previous studies observed a score of 97 ± 5.9 on the iHOT-33 questionnaire in an asymptomatic sample (KEMP *et al.*, 2013), values much higher compared to the mean post-arthroscopy values of the present study (69.57).

**4.4 Predictors of improvement after arthroscopy**

Our sample was not large enough to assess the relationship between all the variables before and after arthroscopy; therefore, we focused our analysis on the variables for which we had hypotheses a priori. However, our hypothesis that ROM and hip muscle strength would be predictors of clinical improvement was not confirmed by the present study. Furthermore, we did not find PASS predictors in the present study.

To our knowledge, few studies have sought to investigate the predictive role of changes in ROM and muscle strength in patients with FAIS, which makes comparison difficult. Still, our results are in line with the literature. Davis *et al.* (2016) did not observe a relationship between changes in isometric muscle strength of hip abductors and changes in quality of life, as assessed by the HOS (Hip Outcome Score) questionnaire in patients with FAIS. However, the authors observed a moderate relationship between the change in concentric muscle strength (angular velocity of $60°\cdot s^{-1}$) of knee extensors and the change in quality of life (DAVIS *et al*., 2016). In the present study, we did not assess dynamic muscle forces. Since FAIS is a condition associated with movement (GRIFFIN *et al.*, 2016), dynamic muscle forces may be more related to symptoms compared to isometric muscle forces. Furthermore, in the present study we did not assess the muscle strength of the knee extensors, although this muscle group seems to be important in patients with FAIS. In agreement, Gomes *et al.* (2022) compared concentric and eccentric hip and knee muscle strength in patients with FAIS and controls. Interestingly, the authors observed the greatest strength deficits in the knee extensors in these patients (GOMES *et al.*, 2022). Given the above, this muscle group may be the target of future investigations.

In agreement with the present study, Harris-Hayes *et al.* (2018) observed that change in isometric muscle strength of the hip abductors was not associated with change in quality of life, as assessed by the Modified Harris Hip Score (MHHS) and Osteoarthritis Outcome Score (HOOS) questionnaires in patients with chronic hip pain. Baida *et al.* (2021) observed that the change in isometric muscle strength of hip abductors and external rotators explained only 11% of the variance in quality of life, as assessed by the Copenhagen Hip and Groin Outcome Score (HAGOS) questionnaire in athletes with groin pain. The results suggest that other factors should be considered in the rehabilitation of patients with hip and/or groin pain in addition to isometric muscle forces.

It is recommended to clinicians that rehabilitation programs use therapeutic exercises with the aim of improving physical deficits frequently observed in patients with FAIS (ISHØI *et al.*, 2021a; KEMP *et al.*, 2020). It is unclear whether changes in physical performance in patients with musculoskeletal pain are responsible for improvements in pain and disability or whether these two simply occur simultaneously and are mediated by a third factor. In that regard, other factors also may explain the positive effects of exercise on pain and functionality, such as improvement in psychological variables (avoidance beliefs, catastrophizing and self-efficacy in relation to pain control), exercise-induced analgesia, functional and structural changes in the brain and immune system modulation (BOOTH *et al.*, 2017; SLUKA *et al.,* 2018). This fact may explain why, so far, the superiority of some specific exercise to treat musculoskeletal pain, such as chronic low back pain, has not been observed in the literature (DELITTO *et al.*, 2012).

Studies similar to ours are available in the literature addressing different musculoskeletal pain conditions. A systematic review found that change in physical fitness (including mobility, muscle strength and muscle endurance) and change in pain and disability in patients with chronic non-specific low back pain were unrelated or weakly related (STEIGER *et al.*, 2012). Similarly, muscle-strengthening exercises were effective in improving pain and physical activity in patients with patellofemoral pain, even without significant increases in hip and knee muscle strength, according to a systematic review (NASCIMENTO *et al.*, 2018). Based on the findings of the present study and the cited systematic reviews, we suggest that the "side effects" of exercise therapy should be more specifically emphasized and investigated in future rehabilitation programs for patients with FAIS.

**4.5 Limitations**

Because it is a retrospective study, the present study has major limitations compared to prospective studies (BENCHIMOL *et al.*, 2015). An important limitation of the study is the fact that the database used was not collected with the aim of answering an a priori research question. However, the objective and hypotheses of the present study were formulated before accessing the database. In addition, the present study followed the guidelines of the RECORD Statement (Reporting of Studies Conducted using Observational Routinely-Collected Health Data) for the transparent description of observational and retrospective studies (BENCHIMOL *et al.*, 2015).

Another limitation of the present study is the fact that most patients in the database presented only the preoperative evaluation. Therefore, we included in the study only those patients who had pre- and postoperative evaluations, which may constitute a sample selection bias. Finally, the lack of a control group did not allow comparing the results of the clinical evaluations of patients with FAIS with people without hip pain at baseline. Therefore, the results of the present study must be interpreted with caution.

Nevertheless, this was the first study to assess the predictive capacity of adapting isometric muscle strength and ROM after hip arthroscopy in relation to the quality of life of patients with FAIS. A strong point of the study is the significant number of patients, if we compare it with the sample size of clinical studies with a similar objective, which generally does not exceed 40 participants. Another strength of the study is the specific sample of patients with FAIS. Some studies have a non-specific sample, including people with hip dysplasia or isolated chondrolabral lesions. Finally, the measures of isometric muscle strength, ROM and quality of life used in the present study are reliable and can be easily performed in the clinical environment by a single professional (FRASSON *et al.*, 2020).

**4.6 Future Directions**

There is still uncertainty regarding the best treatment approach for patients with FAIS, in part due to the limited evidence available, particularly regarding non-surgical treatment. A recent systematic review observed slightly better results in quality of life in favor of arthroscopy compared with non-surgical treatment after twelve months (FERREIRA *et al.*, 2021). It is noteworthy that the 95% confidence interval ranged from 4.83 to 17.21 points in the iHOT-33 questionnaire, where the lower limit does not exceed the clinically important minimum difference (FERREIRA *et al.*, 2021; KEMP *et al.*, 2013). Low-quality evidence suggests that arthroscopy was similar to non-surgical treatment in the quality of life of patients with FAIS after twenty-four months (FERREIRA *et al.*, 2021). Future studies of high methodological quality should compare the effectiveness of treatments for FAIS, not only in self-reported quality of life, but also in objective variables, for example, return to sport. In addition, it is necessary to determine the profile of patients who would benefit the most from the surgery.

Exercise is often used in the rehabilitation of patients with FAIS. However, there is limited evidence regarding exercise prescription in this patient population. For example, in the treatment of knee osteoarthritis, aerobic exercises of high and low intensity are equally effective in relieving pain (BROSSEAU *et al.*, 2003). Future studies should determine the ideal frequency, intensity, duration, type and volume of exercise for patients with FAIS. Furthermore, the long-term effect of physical exercise in these patients is not known and may be the subject of investigation in future studies.

## 5. CONCLUSION

Patients with FAIS who underwent hip arthroscopy increased ROM and isometric hip muscle strength values and self-reported quality of life. However, gains in ROM and isometric hip muscle strength do not explain gains in self-reported quality of life. Furthermore, gains in ROM and isometric hip muscle strength are unrelated to PASS. The limited predictive ability of ROM and isometric muscle strength measurements suggests that other factors, should be considered in the rehabilitation of these patients. Thus, clinicians should not use only ROM and isometric muscle strength measurements in their evaluations of patients with FAIS. Future studies should seek to identify modifiable factors related to the recovery of patients with FAIS in order to maximize positive results.

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## ANNEX 1 - TERMO DE CONSENTIMENTO UTILIZADO NA CLÍNICA DE FISIOTERAPIA

### TERMO DE CONSENTIMENTO PARA AVALIAÇÃO E TRATAMENTO FISIOTERAPIA

Prezado Paciente,

O presente Termo de Consentimento tem como objetivo informar ao paciente e/ou responsável sobre a avaliação e tratamento fisioterapêutico que será realizado na Physique – Centro de Fisioterapia. A utilização desse termo é prática comum e obrigatória em países da Europa, EUA e Canadá, demonstrando a responsabilidade e comprometimento da nossa empresa com a adoção de padrões elevados de ação profissional na área da saúde.

A fisioterapia envolve várias formas de avaliação e tratamento, com utilização de técnicas manuais, aparelhos e exercícios. Todo tipo de tratamento pode trazer benefícios e riscos aos pacientes. A resposta ao tratamento de cada paciente varia de acordo com a individualidade e não pode ser de todo prevista. Os benefícios da fisioterapia incluem: alívio da dor, diminuição do processo inflamatório, melhora da regeneração tecidual, melhora da força e flexibilidade, e melhora da funcionalidade. Os riscos envolvem essencialmente o surgimento de dor e desconforto após utilização de técnicas específicas. Essa dor e desconforto podem ser causados por técnicas que necessitam ser realizadas para resolução do seu problema, por exemplo, a massagem. A dor e desconforto também podem acontecer em resultado do processo de adaptação dos tecidos esqueléticos aos exercícios propostos. Apesar de a dor ou desconforto serem usuais durante um tratamento fisioterapêutico, esses sintomas devem reduzir gradativamente ao longo do tratamento. Portanto, caso você sinta dor ou desconforto após uma sessão de fisioterapia você deve falar ao fisioterapeuta para que ele possa adaptar seu tratamento e acompanhar de perto esses sintomas.

Durante o tratamento o fisioterapeuta precisará expor a região do seu corpo a ser tratada, bem como necessitará tocar nessa região. Todas as medidas para preservar a sua privacidade serão tomadas. Se você tem algum impedimento neste sentido avise o fisioterapeuta.

Você deve solicitar todas as informações que necessitar para esclarecer quaisquer dúvidas em relação ao seu tratamento. Assinando este termo, você está consentindo a realização de avaliação e tratamento fisioterapêutico sob os cuidados dos profissionais da Physique – Centro de Fisioterapia. Você tem o direito de desistir do tratamento em qualquer momento que desejar. O fisioterapeuta responsável pelo seu tratamento irá lhe explicar sobre a avaliação e o tratamento fisioterapêutico indicado para o seu caso. Você deve seguir todas as orientações e prescrições feitas pelo fisioterapeuta, pois serão determinantes para o sucesso do seu tratamento.

NOME:________________________ASSINATURA:___________________

Assinando abaixo, eu autorizo a Physique – Centro de Fisioterapia a utilizar as informações contidas em meu prontuário, nas pesquisas realizadas na Clínica com fins de auxiliar no desenvolvimento de melhores técnicas de tratamento para os pacientes a partir da Fisioterapia baseada em evidência. Autorizo a publicação do material obtido, **sem identificação pessoal**, em aulas, congressos, palestras, periódicos científicos, trabalhos, dissertações e teses.

NOME: _________________________________

ASSINATURA: _____________________________

DATA: ________________________

**ANNEX 2 - TERMO DE ANUÊNCIA**

**UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL**
ESCOLA DE EDUCAÇÃO FÍSICA, FISIOTERAPIA E DANÇA
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS DO MOVIMENTO HUMANO

TERMO DE ANUÊNCIA DO RESPONSÁVEL PELO SETOR OU INSTITUIÇÃO

ONDE SERÁREALIZADA A PESQUISA

**Título do projeto de Pesquisa**: A Mudança na Força Muscular e Amplitude de Movimento é Preditora da Mudança da Qualidade de Vida em Pacientes com Síndrome do Impacto Femoroacetabular? Um Estudo Coorte Retrospectivo

Eu, VIVIANE BORTOLUZZI FRASSON, responsável pelo setor/instituição PHYSIQUE – CENTRO DE FISIOTERAPIA, tenho ciência do protocolo/projeto de pesquisa acima citado, desenvolvido pelo Prof. MARCO AURÉLIO VAZ, dos objetivos e metodologia a ser utilizada, concordando com a realização da pesquisa neste local.

Porto Alegre, 08 de fevereiro de 2022.

Viviane Frasson

Dra. Viviane Bortoluzzi Frasson

Diretora da Physique Centro de Fisioterapia

Rua Furriel Luiz A Vargas, 250 - 6º andar - Bela Vista, Porto Alegre - RS, 90470-130

ANNEX 3 - TERMO DE COMPROMISSO DE UTILIZAÇÃO DE DADOS (TCUD)

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

## Termo de Compromisso de Utilização de Dados (TCUD)

**Identificação da pesquisa:**

a) Título do Projeto:

   A Mudança na Força Muscular e Amplitude de Movimento é Preditora da Mudança da Qualidade de Vida em Pacientes com Síndrome do Impacto Femoroacetabular? Um Estudo Coorte Retrospectivo

b) Instituição:

   Universidade Federal do Rio Grande do Sul/ Programa de Pós-Graduação em Ciências do Movimento Humano

c) Pesquisador Responsável:

   Marco Aurélio Vaz

**Descrição dos dados:**

As informações necessárias ao presente estudo estão contidas em um banco de dados de uma Clínica Privada de Fisioterapia (Physique- Centro de Fisioterapia). A clínica é localizada em Porto Alegre, Rio Grande do Sul, Brasil, e é considerada referência na reabilitação de condições musculoesqueléticas relacionadas ao quadril. O banco de dados contém os prontuários dos pacientes com diagnóstico de Síndrome do Impacto Femoroacetabular avaliados entre os anos de 2013 e 2020. As informações contidas nos prontuários abrangem avaliações dos níveis de dor e duração dos sintomas, amplitude de movimento e força muscular de quadril, bem como avaliações de qualidade de vida e tratamento escolhido ao paciente (tratamento conservador ou cirúrgico). Nos prontuários também estão contidas informações pessoais dos pacientes (nome, idade, índice de massa corporal).

Os dados acima somente serão coletados após aprovação do projeto de pesquisa pelo Comitê de Ética em Pesquisa da Universidade Federal do Rio Grande do Sul (CEP-UFRGS), e somente serão utilizados para este projeto. Todo e qualquer outro uso que venha a ser planejado, será objeto de novo projeto de pesquisa, que será submetido à apreciação do CEP-UFRGS.

**Declaração dos pesquisadores:**

Nós, pesquisadores abaixo relacionados envolvidos no projeto de pesquisa intitulado "A Mudança na Força Muscular e Amplitude de Movimento é Preditora da Mudança da Qualidade de Vida em Pacientes com Síndrome do Impacto Femoroacetabular? Um Estudo Coorte Retrospectivo", assinaremos esse TCUD para a salvaguarda dos direitos dos participantes de pesquisa devido à impossibilidade de obtenção do Termo de Consentimento Livre e Esclarecido de todos os participantes do estudo.

Nos comprometemos em manter a confidencialidade sobre os dados coletados, como estabelecido na Resolução CNS 466/2012 e suas complementares, e, ao publicar os resultados da pesquisa, manteremos o anonimato das pessoas cujos dados foram pesquisados.

Nos comprometemos a codificar os dados de identificação do participante ao coletar os dados para nosso instrumento de coleta de dados, para aumentar a confidencialidade e assegurar o anonimato do participante.

Declaramos, ainda, estarmos cientes de que é nossa responsabilidade a integridade das informações e a privacidade dos participantes da pesquisa.

Também nos comprometemos que os dados coletados não serão repassados a pessoas não envolvidas na equipe da pesquisa abaixo relacionada.

Estamos cientes do direito do participante da pesquisa a solicitar indenização por dano causado pela pesquisa (por exemplo a perda do anonimato) nos termos da Resolução CNS nº. 466, de 2012, itens IV.3 e V.7; e Código Civil, Lei 10.406, de 2002, artigos 927 a 954, Capítulos I, "Da Obrigação de Indenizar", e II, "Da Indenização", Título IX, "Da Responsabilidade Civil").

Nos comprometemos, ainda, com a guarda, cuidado e utilização das informações apenas para cumprimento dos objetivos previstos na pesquisa citada acima.

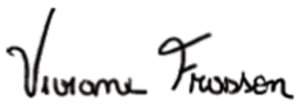
**Identificação de todos os membros do grupo de pesquisa que terão acesso aos dados:**

| Pesquisador | RG | Assinatura |
|---|---|---|
| Luísa Reichert | 5102375358 | Luísa Reichert |
| Viviane Bortoluzzi Frasson | 9052040236 | Viviane Frasson |
| Marco Aurélio Vaz | 1016673756 | Marco Aurélio Vaz |

**Autorização da Instituição**

Declaramos, para os devidos fins, que cederemos aos pesquisadores apresentados neste termo, o acesso aos dados solicitados para serem utilizados nesta pesquisa.

Esta autorização está condicionada ao cumprimento do (a) pesquisador (a) aos requisitos da Resolução 466/12 e suas complementares, comprometendo-se o(a) mesmo(a) a utilizar os dados dos participantes da pesquisa exclusivamente para os fins científicos, mantendo o sigilo e garantindo a não utilização das informações em prejuízo das pessoas e/ou das comunidades.



Dra. Viviane Bortoluzzi Frasson

Diretora da Physique Centro de Fisioterapia

Rua Furriel Luiz A Vargas, 250 - 6º andar - Bela Vista, Porto Alegre - RS, 90470-130

**ANNEX 4 - SOLICITAÇÃO DE DISPENSA DO TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO**

**UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL**

**Escola de Educação Física, Fisioterapia e Dança**

**SOLICITAÇÃO DE DISPENSA DO TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO**

Eu, Marco Aurélio Vaz, Autor e Coordenador do Projeto de Pesquisa intitulado "A Mudança na Força Muscular e Amplitude de Movimento é Preditora da Mudança da Qualidade de Vida em Pacientes com Síndrome do Impacto Femoroacetabular? Um Estudo Coorte Retrospectivo", a ser conduzido na Universidade Federal do Rio Grande do Sul, por este termo, solicito ao Comitê de Ética desta instituição a dispensa do Termo de Consentimento Livre e Esclarecido, em razão desta pesquisa apresentar caráter retrospectivo, por tratar de levantamento de dados junto à prontuários e não ser possível o contato com os sujeitos de pesquisa selecionados. A localização de cada um dos sujeitos que fazem parte da amostra da investigação é inviável, uma vez que os mesmos não frequentam regularmente a clínica de Fisioterapia cujo banco de dados estaremos acessando. Ademais, os pacientes foram atendidos há muito tempo e o endereço e telefone podem não ser mais os mesmos, o que levaria a uma perda amostral significativa impossibilitando a realização do estudo.

Nestes termos, me comprometo a cumprir todas as diretrizes e normas regulamentadoras descritas na Resolução 466/2012 e suas complementares no que diz respeito ao sigilo e confidencialidade dos dados utilizados.

Esperamos ter atendido satisfatoriamente às exigências desse Comitê.

Atenciosamente,

Porto Alegre, 06 de setembro de 2022.

Prof. Marco Aurélio Vaz

## ANNEX 5 - QUESTIONÁRIO iHOT- 33

Questionário de qualidade de vida para pacientes jovens, ativos com problemas de quadril.

INSTRUÇÕES

Estas questões perguntam sobre problemas que você possa estar sentindo no seu quadril, como estes problemas afetam sua vida e quais os sentimentos que estes problemas provocam em você.

Por favor, responda a cada questão considerando a atual condição, função, circunstâncias e opiniões relativas ao seu quadril.

Considere o último mês.

As questões são formatadas de forma que você possa indicar a gravidade do problema marcando a linha abaixo de cada pergunta.

OBSERVAÇÃO:

Por favor, marque um traço no ponto que melhor representa sua situação. Se você marcar um traço no lado extremo da esquerda, significa que você sente que está muito prejudicado. Por exemplo:

Muito prejudicado —/————————————— Nenhum problema

Se você marcar um traço no lado extremo da direita, significa que você sente que não tem nenhum problema no quadril. Por exemplo:

Muito prejudicado —————————————/— Nenhum problema

Se você marcar um traço no meio da linha, significa que você sente que está moderadamente incapacitado ou, em outras palavras, que você está entre os extremos "muito prejudicado" e "sem nenhum problema." É importante que você marque uma das extremidades da linha, quando as descrições extremas reflitam com exatidão a sua situação. Se a pergunta for sobre algo que você não sente, por favor, marque a opção:

☐ Não faço esse movimento em minhas atividades, quando for o caso.

**I: SINTOMAS E LIMITAÇÕES FUNCIONAIS**

As seguintes questões perguntam sobre sintomas que você possa estar sentindo no seu quadril e sobre a função do seu quadril com relação a suas atividades diárias. Por favor, tente lembrar-se de como você tem se sentido durante a maior parte do tempo deste último mês e responda.

Com que frequência você tem dores no quadril/virilha?

Sempre ________________________________________ Nunca

Seu quadril fica rígido (duro) quando senta/descansa durante o dia?

Muito rígido ________________________________________ Nenhuma rigidez

É difícil para você caminhar longas distâncias?

Muito difícil ________________________________________ Nenhuma dificuldade

Quanta dor você sente no quadril/virilha quando está sentado?

Muita dor ______________________________ Nenhuma dor

Qual é a sua dificuldade em ficar em pé por longos períodos?

Muita dificuldade ______________________________ Nenhuma dificuldade

É difícil para você abaixar e levantar-se do chão?

Muito difícil ______________________________ Nenhuma dificuldade

É difícil para você caminhar em superfícies irregulares?

Muito difícil ______________________________ Nenhuma dificuldade

É difícil para você deitar-se do lado do quadril com problema?

Muito difícil ______________________________ Nenhuma dificuldade

Quão difícil é para você para passar por cima de obstáculos?

Muito difícil ______________________________ Nenhuma dificuldade

Você tem dificuldade para subir/descer escadas?

Muita dificuldade ________________________________ Nenhuma dificuldade

Você tem dificuldade para levantar-se quando está sentado?

Muita dificuldade ________________________________ Nenhuma dificuldade

Você tem algum desconforto quando caminha a passos largos?

Muito desconforto ________________________________ Nenhum desconforto

Você tem dificuldade para entrar e/ou sair do carro?

Muita dificuldade ________________________________ Nenhuma dificuldade

Qual é sua dificuldade com rangidos, travadas e estalos no seu quadril?

Muita dificuldade ________________________________ Nenhuma dificuldade

Você tem dificuldade para vestir se e/ou tirar meias ou sapatos?

Muita dificuldade ________________________________ Nenhuma dificuldade

Em geral, você tem dor no quadril/virilha?

Muita dor ______________________________ Nenhuma dor

## II. ATIVIDADES ESPORTIVAS E RECREACIONAIS

As seguintes questões perguntam sobre o que você sente no seu quadril, quando participa de esportes e atividades recreativas. Por favor, tente lembrar-se de como você tem se sentido durante a maior parte do tempo deste último mês e responda.

Quanto você se preocupa sobre a sua capacidade de manter o nível de preparo físico que você deseja?

Muito ______________________________ Não me preocupo

Quanta dor você sente no quadril depois de praticar alguma atividade?

Muita dor ______________________________ Nenhuma dor

Qual é sua preocupação de que a dor no seu quadril aumente, se você praticar esportes ou atividades recreativas?

Muita ______________________________ Não me preocupo

Quanto piorou sua qualidade de vida por não poder praticar esportes ou atividades recreativas?

Muito ______________________________ Não piorou

Quanto você se preocupa em mudanças rápidas de direção nos seus esportes ou atividades recreativas?

Muito ________________________________________ Não me preocupo

☐ **N**ão faço esse movimento em minhas atividades

Quanto diminuiu o seu nível de desempenho ao praticar esportes ou atividades recreativas?

Diminui muito ________________________________________ Não diminuiu

**III. CONSIDERAÇÕES RELACIONADAS AO TRABALHO**

As questões seguintes se referem ao que você sente no seu quadril durante o seu trabalho e suas atividades ocupacionais. Por favor, procure lembrar-se de como você tem se sentido na maior parte do tempo neste último mês e responda.

☐ Sou aposentado (por favor, passe para a próxima seção)

☐ Não trabalho por razões diversas à condição do meu quadril (por favor, passe para a próxima seção)

Qual é sua dificuldade para empurrar, puxar, levantar ou carregar objetos pesados em seu trabalho?

Muita dificuldade ________________________________________ Nenhuma dificuldade

☐ Não faço esse movimento em minhas atividades

Qual é sua dificuldade para abaixar-se/agachar-se?

Muita dificuldade ________________________________________ Nenhuma dificuldade

Qual é sua preocupação de que seu trabalho possa piorar sua dor no quadril?

Muita ________________________________________ Não me preocupo

Quanta dificuldade você tem no seu trabalho devido à mobilidade reduzida no quadril?

Muita dificuldade ________________________________________ Nenhuma dificuldade

**IV CONSIDERAÇÕES SOCIAIS, EMOCIONAIS E DE ESTILO DE VIDA**

As seguintes perguntas se referem a algumas considerações sociais, emocionais e de estilo de vida que você possa estar sentindo com relação a seu problema no quadril. Por favor, tente lembrar-se de como você tem se sentido durante a maior parte do tempo deste último mês e responda.

Quanto o seu problema do quadril o deixa frustrado?

Muito frustrado ______________________________ Nenhuma frustração

Quanto sua atividade sexual é prejudicada por causa do seu quadril?

Muito problema ______________________________ Nenhum problema

☐ Isto não é importante para mim

A sua lesão no quadril o incomoda?

Incomoda muito ______________________________ Não incomoda

É difícil para você relaxar por causa do seu problema no quadril?

Muito difícil ______________________________ Nenhuma dificuldade

Você está desanimado por causa de seu problema no quadril?

Muito desanimado ______________________________ Nenhum desânimo

Quanto você se preocupa em pegar ou carregar uma criança no colo por causa de seu problema no quadril?

Muito ______________________________ Não me preocupo

☐ Não faço esse movimento em minhas atividades

Você se preocupa constantemente com seu problema de quadril?

Constantemente _______________________________________________ Nunca

FIM DO QUESTIONÁRIO! OBRIGADO!

## ANNEX 6 - PROTOCOLO PÓS-OPERATÓRIO DE FISIOTERAPIA

**OBJETIVOS DA FISIOTERAPIA:**

- Restabelecimento das amplitudes de movimento (ADM) do membro operado
- Melhorar a condição muscular
- Redução da inflamação local
- Prevenção de eventos tromboembólicos
- Restabelecimento da marcha funcional
- Independência para atividades de vida diárias (AVDS)
- Treino proprioceptivo
- Combate a dor miofascial

**CONDUTAS:**

**1ª. SEMANA:** (Objetivo: ADM 90° flexão, rotação externa e interna do quadril conforme tolerância, igual às ADMs pré-operatórias)

- Deitado
- Exercícios ativos livres e resistidos de dorsi e plantiflexão do tornozelo
- Exercícios isométricos de quadríceps, isquiotibiais e glúteos
- Isométrico de extensão de joelho em decúbito ventral com rolo sob tornozelos
- Exercícios isométricos de abdução e adução do quadril
- Extensão ativa do joelho com cunha triangular abaixo do joelho
- Flexo-extensão ativo-assistida de quadril e joelho, arrastando o pé
- Flexão de quadril seguida de abdução do quadril ativo-assistida
- Abdução ativo-assistida de quadril em decúbito dorsal, membro inferior estendido
- Exercícios passivos e/ou assistidos de rotação externa e interna do quadril (com quadril em extensão e flexão) em decúbito dorsal e em decúbito ventral
- Isométricos de transverso do abdômen (posição neutra de pelve e lombar) e multífidos

- Rotação interna e externa do quadril passiva com o membro inferior em extensão – "rolinho"
- Utilização do aparelho de movimentação passiva contínua (MPC) por 50 minutos
- Crioterapia
- Sentado
- Exercícios ativos livres de flexão-extensão de joelho
- Em ortostase
- Abdução ativa do quadril (partir de uma extensão de quadril para, durante o exercício, ativar menos o tensor da fáscia lata)
- Exercício ativo de flexão do joelho
- Plantiflexão bilateral dos tornozelos no plano
- Alongamento dos platiflexores, isquiotibiais, quadríceps e flexores de quadril
- Treino de marcha com 2 muletas e apoio conforme tolerância
- Crioterapia e laserterapia de baixa potência na região anterolateral do quadril operado

**2ª. SEMANA:** Manter exercícios e progredir ADM (objetivo: ADM de 110° de flexão e aumentar a abdução e rotações do quadril)

- Deitado
- Abdução ativa do quadril em decúbito lateral;
- Resistidos para extensão de joelho com cunha triangular abaixo do joelho, com caneleira
- Exercícios de flexão de tronco de pequena ADM – abdominais
- Rotação externa em decúbito lateral sem resistência
- Ponte pélvica
- Sentado
- Antero e retroversão; inclinação lateral da pelve na bola
- Flexão do joelho com caneleira
- Alongamento de quadríceps e flexores de quadril em decúbito lateral
- Treino de marcha com 1 muleta

**<u>3ª. SEMANA:</u>** ADM será a máxima indolor. Manter exercícios anteriores e acrescentar

- Bicicleta vertical progressiva até 20 minutos
- Marcha sem muleta
- Deitado
- Rotação externa em decúbito lateral com resistência de faixa elástica
- Exercícios resistidos de dorsiflexão com faixa elástica
- Pranchas estabilizatórias, progredir da posição em 4 apoios com quadril e joelho alinhado, ombro e mão alinhados em 90°, evoluir para ângulos maiores; poderá ser utilizada fita de suspensão (*TRX*)
- Abdução resistida do quadril em decúbito lateral (caneleira)
- Sentado
- Rotação progressiva externa de quadril – ao cruzar a perna
- Flexão e extensão do joelho resistida – com caneleira ou uso das máquinas de musculação
- Em ortostase
- Treino de transferência de peso anteroposterior e látero-lateral
- Equilíbrio unipodal no espaldar ou em frente do espelho: evoluir para o uso da cama elástica se possível
- Exercícios passivos de flexão, abdução e rotação externa e interna do quadril
- Alongamentos em ortostase – quadríceps, flexores de quadril, panturrilha

**<u>4ª. SEMANA:</u>** Manter exercícios anteriores e acrescentar

- Bicicleta progressiva até 30 minutos (progredir resistência)
- Treino proprioceptivo em ortostase bipodal e unipodal (cama elástica e balancinho)
- Treino de deslocamentos progressivos frontal e lateral com resistência elástica
- Abdução e adução do membro operado na prancha deslizante (*Slide Board*)
- Fita de suspensão (*TRX*) – com apoio unipodal
- Mini-agachamento na parede com uso de bola até 45° de flexão de quadril

- Exercícios resistidos progressivos de abdutores, adutores, extensores e rotadores externos do quadril (com caneleira /com aparelhos de musculação)
- Prancha estabilizatória ventral e lateral
- Pode iniciar exercícios nas máquinas: abdutora e adutora de quadril

**5ª. SEMANA**: Exercícios em Aparelhos de Musculação com fisioterapeuta

- Bicicleta com carga progressiva
- Podem ser iniciadas as caminhadas em esteira, sem inclinação, velocidade confortável para o paciente
- Progredir resistência na máquina abdutora, adutora do quadril, extensora e flexora de joelho
- Progredir abdominais e agachamento até 70° de flexão do quadril
- Ponte na bola e/ou unipodal
- Progressão das pranchas estabilizatórias em decúbito ventral e lateral
- Em ortostase
- Abdução-adução de ambas pernas no *slide board*
- Manter alongamentos e exercícios passivos para mobilidade de quadril
- Alongamentos específicos para o esporte do paciente