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Patient characteristics and function among patients with femoroacetabular impingement syndrome eligible for hip arthroscopy compared to those eligible for conservative treatment

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PREFACE

This Master`s thesis is a part of a master in the field of Sports Physiotherapy at the Norwegian School of Sport Sciences. The work with the thesis has been an exciting process. It has been a mix of personal and scientific development and maturation.

I would like to give a special thanks to my supervisor May Arna Risberg representing the Norwegian School of Sport Sciences, and Joanne Kemp and Kay Crossley representing La Trobe University, who made it possible to spend June and July 2016 in Melbourne where I was connected to La Trobe University. The aim of the study trips was to practice English and be in a research environment where FAI syndrome was of high priority. Being a part of a research environment was something else than just being a master student, and it gave me a lot of inspiration for my future physiotherapy career. And Joanne, you are fantastic!! Thank you very much for your inspiration, involvement and access to the data which made this thesis possible. Thank you very much May Arna for your knowledge and advice throughout the process!

I would like to thank the PHD-students at La Trobe University for taking good care of me during the stay in Melbourne!

I am thankful for all the nice fellow students who have made the last two years great!

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SUMMARY

Introduction: Femoroacetabular impingement (FAI) syndrome is recognized as a cause of hip ailments in young and middle aged adults, and the number of hip arthroscopies treating FAI syndrome has increased. There is no evidence for better results after hip arthroscopy compared to conservative treatment. There is a large heterogeneity in diagnostic criteria and criteria for hip arthroscopy treating FAI syndrome.

Purpose: The purpose of this thesis was to compare patient characteristics and function among patients with FAI syndrome eligible for hip arthroscopy to those eligible for conservative treatment.

Method: This is a cross sectional study including female and male participants who were diagnosed with FAI syndrome and eligible for either hip arthroscopy (N=19) or conservative treatment (N=24). Baseline data from a hip arthroscopy cohort study and a conservative pilot RCT treating FAI syndrome were used. Patient characteristics, symptoms (pain), function, clinical signs and diagnostic imaging were compared between groups.

Results: We found no significant differences in patient characteristics, hip range of motion (ROM) or hip muscle strength between groups for involved leg. The arthroscopy group revealed significantly lower HOOS sport and recreational score, and performed worse on single leg hop distance.

Conclusion: Patient characteristics do not differ between patients with FAI syndrome eligible for hip arthroscopy and those eligible for conservative treatment. Patients eligible for hip arthroscopy have somewhat impaired function compared to the conservative group. In order to improve knowledge of those eligible for hip arthroscopy and conservative treatment, larger studies and qualitative research need to address the differences in characteristics and function.

CONTENTS

1. INTRODUCTION

The main motivation to immerse into FAI syndrome was that it is a relative new research field and applies to young and middle aged people. A study trip to Melbourne in Australia the summer 2016 made the basis of this Master`s thesis. Basically, I was involved in a multicentre randomized controlled trial (RCT) on the effect of hip arthroscopy on patients with FAI syndrome and/or labral tears (HIPARTI study (Clinical Trials ID: NCT02692807)) in Norway. During the study trip to Australia I was involved in two different FAI syndrome research studies. These were the HARP study which is a hip arthroscopy prospective cohort study including those not willing to take part into the HIPARTI study, and the FIRST study – Australia, which is a pilot RCT on conservative treatment of FAI syndrome. Data from these two Australian studies made the basis for this Master`s thesis.

For a long time, I have had a desire to improve my English language skills, and when I got the opportunity to travel to Melbourne and use data from the Australian studies, I felt that I had to write the Master`s thesis in English. I knew this would be challenging, but important for further career.

Hip and groin pain is reported to be the most common injury in young male soccer players (33% of all injuries) (Nilsson, Ostenberg, & Alricsson, 2016). In general populations, estimates of hip and groin pain are 14% in older adults (Christmas et al., 2002) and 6,5% in younger populations (Spahn, Schiele, Langlotz, & Jung, 2005).

Joint-related hip pain refers to a number of intra-articular pathologies, and femoroacetabular impingement is s a common cause of hip pain in young and middle-aged adults (Clohisy et al., 2013; Kemp et al., 2014). As a result of inconsistent use of symptoms, clinical signs and diagnostic imaging to diagnose FAI syndrome (Ayeni et al., 2012), a consensus meeting was held in 2016. FAI syndrome was then described as a motion-related clinical disorder of the hip, were a triad of symptoms, clinical signs and imaging findings must be present to be

diagnosed (Griffin et al., 2016). The imaging findings are related to morphological variations in the bony structures in the hip joint, either a non-spherical head of femur (cam type) or a deep acetabulum (pincer type), as may result in repetitively and prematurely abutment against each other when moving the hip (Ganz et al., 2003). The impact of the proximal femur against the acetabular rim may over time cause damage of the soft tissue structures acetabular labrum and/or cartilage, leading to pain and difficulty participating in physical activity (Ganz et al., 2003; Kemp et al., 2014).

In the healthy population, the prevalence of imaging findings related to cam or pincer are found to vary between 7%-100% (Frank et al., 2015; Gosvig, Jacobsen, Sonne-Holm, & Gebuhr, 2008; Kang, Hwang, & Cha, 2009; Mascarenhas et al., 2016). People participating in soccer and ice hockey many times a week in early adolescence seems to have higher imaging prevalence of cam morphology than those who did not (Nepple, Vigdorchik, & Clohisy, 2015; Packer & Safran, 2015; Tak et al., 2015). There is limited prevalence data of FAI syndrome in the general population (Dickenson et al., 2016).

Treatment strategies for FAI syndrome includes hip surgery and conservative treatment. The number of hip arthroscopies treating FAI syndrome and acetabular labral tears has increased dramatically (Bozic, Chan, Valone, Feeley, & Vail, 2013; Lee, Ha, Yoon, & Koo, 2014; Montgomery et al., 2013). There is no evidence for better results from surgical treatment compared to conservative treatment in patients with FAI syndrome (Wall et al., 2014). The diagnostic criteria are imprecise and the utility of those is unclear (Griffin et al., 2016), and it seems to be random who receive what treatment (Ayeni et al., 2012; Wall, Fernandez, Griffin, & Foster, 2013). A hip surgery is also more comprehensive than conservative treatment.

Health and health related conditions may be classified based on the International Classification of Function, Disability and Health (ICF), which categorize function into body structure and function, activity, and participation (World Health Organization, 2003). A systematic review has reported that healthy people have better function in hip muscle strength (ICF body function) and dynamic balance on one leg (ICF activity) compared to people with

FAI syndrome, but no differences in range of motion (ICF body function) (Freke et al., 2016). To our knowledge no previous studies have identified patient characteristics, symptoms, function, clinical signs and diagnostic imaging among those eligible for hip arthroscopy compared to those eligible for conservative treatment, and this was the main motivation for this Master`s thesis.

Therefore, the purpose of this Master's thesis was to identify patient characteristics, symptoms (pain), function, clinical signs and diagnostic imaging characteristics of people with FAI syndrome eligible for hip arthroscopy, and compare them to those eligible for conservative treatment. This Master`s thesis is based on baseline data from two mentioned research projects including patients with FAI syndrome; the arthroscopy HARP study and the conservative FIRST study – Australia.

1.2 Question and hypotheses

Question

To compare patient characteristics, symptoms (pain), function, clinical signs and diagnostic imaging among patients with FAI syndrome eligible for hip arthroscopy to those eligible for conservative treatment.

Hypotheses

I. Patients with FAI syndrome eligible for hip arthroscopy are younger and in greater extent men than women compared to those eligible for conservative treatment.

II. Patients with FAI syndrome eligible for hip arthroscopy have worse function (hip range of motion, hip muscle strength, functional task performance and sport participation) compared to those eligible for conservative treatment.

III. Patients with FAI syndrome eligible for hip arthroscopy display more hip-related symptoms and reduced quality of life compared to those eligible for conservative treatment.

2. THEORY

In this part of the Master`s thesis, the theory underlying the question is presented. In the first part, the concepts FAI and FAI syndrome are presented. Further, diagnostic criteria for FAI syndrome and hip function among people with FAI syndrome are presented. The last part addresses treatment of FAI syndrome.

2.1 Hip function and anatomy

The hips main function is to allow mobility of the lower limb and to be a stable base during weight bearing activities, in both static and dynamic situations (Kemp, Crossley, Agricola, Schache, & Pritchard, 2017). The hip joint is the articulation connecting the pelvis and the femur. It has a socket and ball shape, where the acetabulum refers to the socket and the spherical head of femur is the ball. The acetabulum is normally anteverted by approximately 23° and faces inferiorly and laterally (Stem, O'Connor, Kransdorf, & Crook, 2006). The anteverted head of the femur faces superiorly and medially (Kemp et al., 2017). Joint capsule, muscles and ligaments encircle the hip joint, and help keeping it stable (Kemp et al., 2017). The acetabular labrum, consisting of fibrocartilage and dense connective tissue, is attached to the acetabular rim (Petersen, Petersen, & Tillmann, 2003). Deviations from the normal hip morphology can result in inexpedient stress on the hip joint and soft tissue around the hip (Kemp et al., 2017).

2.3 FAI and FAI syndrome

FAI is deviations from the normal hip morphology. The concept of FAI was described and treated by open surgery in the US as early as 1936 (Smith-Petersen, 2009). In 2001 Ganz et al. (2001) reported a new surgical technique which gave better insight into the hip joint. FAI was then described as an abnormal contact between the acetabulum and the femoral head-neck junction, from either abnormal morphology or excessive range of motions (Ganz et al., 2003).

During hip motions, particularly internal rotation and flexion, this can cause hip pain and impaired performance (Beck, Kalhor, Leunig, & Ganz, 2005).

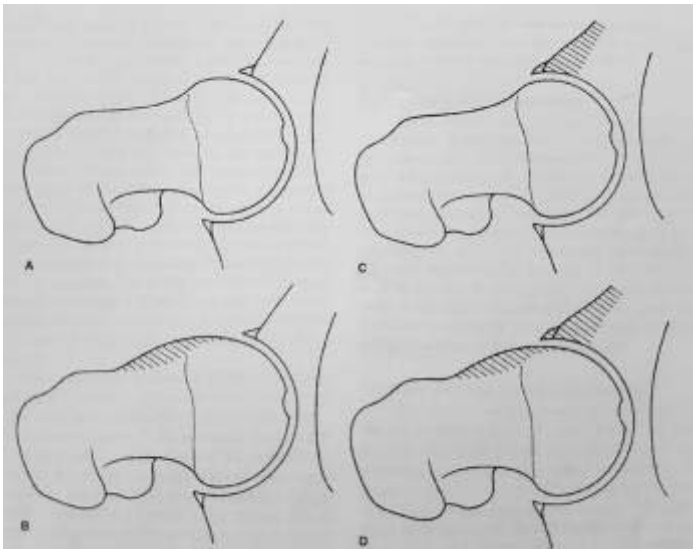

Figure 1: Different types of FAI morphology. Normal clearance of the hip (A), cam morphology (B), pincer morphology (C) and a mix of both cam and pincer morphology (D). From "Anterior Femoroacetabular Impingement. Part I. Techniques of Joint Preserving Surgery", Lavinge, M., Parvizi, J., Beck, M., Siebenrock, K., Ganz, R. and Leunig, M., 2004, *Clinical Orthopaedics and Related Research, 418,* p. 62. Reprinted with permission from Michael Leunig (appendix 1).

There are three types of morphology typically described when referred to FAI; cam, pincer and a mixed presentation where both cam and pincer are seen (Figure 1) (Beck et al., 2005; Ganz et al., 2003). Cam impingement refers to the morphology of femur with a non-spherical femoral head, and are most commonly seen in the anterior, superior or anteriosuperior aspect of the femoral head-neck junction (Beaule, Zaragoza, Motamedi, Copelan, & Dorey, 2005; Beck et al., 2005). Pincer impingement either refers to a deep or a retroverted acetabulum. A deep acetabulum, caused by coxa protrusion or coxa profunda, leads to a more global over coverage of the caput femur, and because flexion is the main movement in the hip, the impingement is often seen in the anteriosuperior part of the acetabulum (Beck et al., 2005; Ganz et al., 2003). Retroverted acetabulum leads to an excessive focal over coverage of the caput femur caused by a deeper anterior-laterally wall of the acetabulum (Reynolds, Lucas, & Klaue, 1999; Siebenrock, Schoeniger, & Ganz, 2003).

Sankar et al. (2013) developed and added some elements to Ganz` definition of femoroacetabular impingement from 2003; abnormal morphology of the femur and/or acetabulum; abnormal contact between these structures; vigorous supraphysiological motions that results in such abnormal contact and collision; repetitive motion resulting in the continuous insult; presence of soft-tissue damage. Also these definitions included only the morphology disorder and did not include the patient's symptoms if present. Since this morphology was also observed in those without symptoms (Laborie et al., 2011), the terms "asymptomatic" and "symptomatic" femoroacetabular impingement was randomly used in the literature and led to confusion. In 2016 a consensus meeting was held to make an agreement on the terminology used to define femoroacetabular impingement as a clinical disorder; FAI syndrome (Griffin et al., 2016). The diagnostic criteria of FAI syndrome include both symptoms, clinical signs and imaging findings (Griffin et al., 2016).

2.4 Prevalence of FAI and FAI syndrome

Studies report different prevalence data of the cam and pincer morphology related to hip joints, and imaging findings are seen in people with and without a clinical diagnosed FAI syndrome. Heterogeneity in what definitions and methods used to define cam and pincer morphology may explain some of the wide variability of prevalence of FAI (Dickenson et al., 2016; Mascarenhas et al., 2016).

In the general healthy population, the prevalence imaging findings related to cam are found to vary between 7% to 100% (Frank et al., 2015). Cam morphology have a high prevalence in athletes performing on a high level in football, ice hockey and basketball during adolescence compared to non-athletes (Frank et al., 2015; Packer & Safran, 2015). The prevalence of cam morphology in cross sectional studies on male soccer players from different ethnicities and male elite ice hockey players was estimated to 60% and 70% (Brunner et al., 2016; Lerebours et al., 2016; Mosler et al., 2016). Imaging studies suggest that cam morphology is more

common among men (17-58%) than women (4-35%) (Dickenson et al., 2016; Gosvig et al., 2008; Leunig et al., 2013).

The prevalence of imaging findings of pincer type FAI in the general healthy population has been reported to vary between 20% to 67 % (Frank et al., 2015; Gosvig et al., 2008; Kang et al., 2009). The prevalence of mixed FAI among people diagnosed with FAI syndrome is more common among men (51-56%) than women (40-42%) (Clohisy et al., 2013; Nepple, Riggs, Ross, & Clohisy, 2014). A deep acetabulum is more frequent in healthy women than men (Leunig et al., 2013). Whether or not pincer deformity is more common in athletes is unknown (Kemp et al., 2017). There is limited prevalence data of FAI syndrome in the general population (Dickenson et al., 2016).

2.5 Consequence of FAI

Most people who has imaging findings of cam or pincer morphology have no symptoms (Agricola, Heijboer, et al., 2014; Allen, Beaule, Ramadan, & Doucette, 2009). Acetabular labral tears commonly co-exist with FAI (Nepple, Carlisle, Nunley, & Clohisy, 2011; Tijssen, van Cingel, de Visser, Holmich, & Nijhuis-van der Sanden, 2016). The pincer morphology directly compress the acetabular labrum between the femoral head and the acetabulum and may cause labral lesions (Beck et al., 2005; Ganz et al., 2003). Pincer impingement appears to result less-severe chondral lesions than cam impingement (Beck et al., 2005). Compared to pincer, cam impingement is more associated to acetabular cartilage damage, and a theory is that the acetabular cartilage over time is ripped off the labrum and leads to a separation of these structures (Beck et al., 2005).

Among a young-to-middle-aged population there are some evidence suggesting a 40 % higher risk of having chondropathy concomitant to FAI syndrome and labral pathology (Kemp et al., 2014). The results of a cohort has shown an association with early osteoarthritis (OA) and cam deformities on later total hip arthroplasty (Agricola et al., 2012). An alpha angle >60º are

associated with an odds ratio (OR) of 3.67 of developing end-stage OR. An alpha angle >83º has been associated with an OR of 9.66 developing an end-stage OA (Agricola et al., 2013). This relationship was not found between pincer and OA. On the other hand, in a cross sectional population-study the authors found that both cam and pincer morphology were significant risk factors for the development of OA (risk ratio 2.4 and 2.2 respectively) (Gosvig, Jacobsen, Sonne-Holm, Palm, & Troelsen, 2010). OA is a chronic condition and is a significant cause of pain, reduced range of motion and function in those involved (Abhishek & Doherty, 2013; Rydevik, Fernandes, Nordsletten, & Risberg, 2010).

2.6 Aetiology of FAI

The question of cam and pincer morphology development has not been finally discussed. So far, no long term prospective cohort studies focusing on the ethology of development of imaging cam or pincer have been published. However, there are studies suggesting a variety of factors linked to the development of cam morphology.

There is evidence for higher prevalence of cam morphology among athletes participating in sports which require high level of hip flexion and rotations (basketball, ice hockey and soccer) compared to non-athletes (Nepple, Vigdorchik, et al., 2015). It is suggested that bone structure adapts to the mechanical load and change structure before the growth plates have been closed, which may result in cam morphology. Forty percent of those attending football ≤3 times a week before the age of 12 had developed cam morphology later in life, compared to about 60 % of those attending football ≥4 times a week (Tak et al., 2015). A cohort study over 2 years of pre-professional male soccer players in the middle of teens, showed from pre- to post-test an increased cam morphology among those with open growth plates compared those who had closed growth plates in their proximal caput femur (Agricola, Heijboer, et al., 2014).

A systematic review summarize that in the teenage, the levels of growth hormone, testosterone and IGF-1 increase, and bone modelling are on high level and may contribute to the development of the cam morphology as a result of focal loading (MacKelvie, Khan, & McKay, 2002). Current research into finite element models also show that the development of cam lesions may be due to stress and loading of the growth plate of the hip in flexed and external rotated positions (Roels et al., 2014).

2.7 Diagnostic criteria

2.7.1 Symptoms and pain localization

The primary symptom of FAI syndrome is motion-related or position-related pain (Ganz et al., 2003; Griffin et al., 2016; Philippon, Maxwell, Johnston, Schenker, & Briggs, 2007). There are wide variations in the location, nature and severity of the pain. Groin pain is the main localisation of pain, but pain is also reported in low back regions, greater trochanter regions, buttock and thigh (Clohisy et al., 2009; Emara, Samir, Motasem el, & Ghafar, 2011; Griffin et al., 2016; Tijssen et al., 2016). Most patients presenting buttock pain have corresponding groin pain (Clohisy et al., 2009). In a group of patients with FAI syndrome, recruited to hip surgery, the pain was described as moderate, severe or disabling in 81%, activity-related in 71%, and exacerbated with sitting in 65% (Ayeni, Naudie, et al., 2013; Clohisy et al., 2009). Clicking, catching, locking, stiffness and/ or giving have also been described (Clohisy et al., 2009; Griffin et al., 2016).

2.7.2 Clinical signs

To diagnose FAI syndrome or acetabular labral pathology, the impingement tests FADIR (hip in 90° flexion, adduction, and internal rotation) (Freehill & Safran, 2011), FABER (hip in 90° flexion, abduction and external rotation, or test sides ankle rests on the contralateral distal part

of femur in supine position), and anterior hip impingement test (90° hip flexion and internal rotation) are suggested (Griffin et al., 2016; Kivlan & Martin, 2012). The impingement tests are positive if the tests reproduce the patients familiar pain (Griffin et al., 2016).

The FADIR test is reported to be sensitive but not specific (Reiman, Goode, Cook, Holmich, & Thorborg, 2015). In retrospective cohort studies including patients with FAI syndrome, >88% had a positive FADIR and FABER test (Clohisy et al., 2009). Comparison of clinical signs and diagnostic findings from surgery illustrate that combining the presence of groin pain and a positive FABER test, or a positive FADIR and FABER test, was most sensitive of FAI syndrome and/ or acetabular labral pathology (Tijssen et al., 2016). Image-guided local anaesthetic injection should be used to support a FAI syndrome diagnose when other clinical signs are met (Griffin et al., 2016).

2.7.3 Diagnostic imaging

The imaging findings related to FAI syndrome refers to variations in hip joint morphology, where the normal sphericity of the head of femur or acetabulum are altered (Ganz et al., 2003). Different radiographic measures and cut-off criteria identifying cam and pincer are found in the literature (Ayeni et al., 2012; Peters et al., 2017).

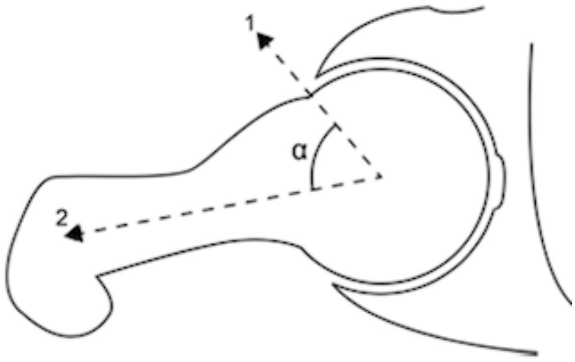

Figure 2: Illustrate how to measure the alpha angle in a hip with a cam deformity. The alpha angle is the angle between a line drawn along the centre femoral neck to the centre of the caput of femur (line 2) and a line drawn from the centre of the caput of femur to the point where the sphericity of the head of femur contour (line 1). From "Prevalence of cam hip shape morphology: a systematic review", Dickenson, E., Wall, P. D. H., Robinson, B., Fernandez. M., Parsons, H., Buchbinder, R. and Griffin, D. R., 2016, *Osteoarthritis Research Society International, 24,* p. 949-961. Reprinted with permission from Damian Griffin (appendix 2).

Different parameters are used identifying cam morphology including an increased alpha angle, decreased head-neck offset, pistol grip deformity of the femoral head-neck offset and a no-spherical femoral head (Mascarenhas et al., 2016). The alpha angle is the angle between a line drawn along the centre femoral neck to the centre of the caput of femur and a line drawn from the centre of the caput of femur to the point where the a sphericity of the head of femur contour (figure 2) (Notzli et al., 2002). An alpha angle threshold >60° has been proposed for defining the presence of cam morphology, while an alpha angle threshold >78° has been proposed for pathological cam deformity of development of OA (Agricola, Waarsing, et al., 2014). "Pistol grip" refers to when the normally spherical caput has lost its spherical form at the head-neck junction (Notzli et al., 2002). Head-neck offset refers to the distance between two parallel lines; a constructed line along the femoral neck which pass where the caput femur merges into the femoral neck and a line through the anteriormost aspect of the femoral head.

Pincer morphology is identified looking at the cross-over sign, posterior wall sign and lateral centre edge angle (Sierra, Trousdale, Ganz, & Leunig, 2008). Cross-over sign is seen on an anterior posterior radiograph, characterized by the anterior rim of the acetabulum crossing the

posterior rim, visible more laterally than the posterior rim (Reynolds et al., 1999). Posterior wall sign are seen on anterior posterior view referred to when the posterior wall of acetabulum is medial to center of the femoral head (Reynolds et al., 1999). Seen in an anterior-posteriorly direction, lateral centre edge (LCE) angle is defined as the angle between a vertical line through the center of the femoral head and the most lateral aspect of the acetabulum (Wiberg, 1939).

At the Warwick agreement on FAI syndrome, they agreed that a anterior posterior radiograph of the pelvis and a lateral femoral neck view initially should be performed to identify cam or pincer morphology or other causes of hip pain (Griffin et al., 2016). To evaluate cartilage and labral lesions, cross-sectional imaging should be used (Griffin et al., 2016).

To summarize, the combination of symptoms, clinical signs and imaging findings must be present to diagnose FAI syndrome (Griffin et al., 2016).

2.8 Hip function and FAI syndrome

ICF categorize function into body structure and function, activity, and participation. Body structures refers to the body` anatomical parts of the body; body function refers to the body` physiological (and mental) functions; activity refers to functional activities in daily activity; and participation refers to participation in sport, job or social settings in daily living (WHO, 2003). Hence, hip function comprise aspects which include both body structure and – function, and activities and participation (World Health Organization, 2003). In this Master`s thesis on patients with FAI syndrome, it is relevant to evaluate hip ROM (ICF body function), hip muscle strength (ICF body function), symptoms (ICF body function), diagnostic imaging (body structure), clinical signs (body structure and body function), functional task performance (ICF activity), hip related symptoms and quality of life (ICF body function, activity and participation), physical activities and sport participation (ICF participation).

Knowledge on hip function of patients with FAI syndrome is limited. To our knowledge, no studies have compared hip function between people with FAI syndrome eligible for arthroscopy to those eligible for conservative treatment.

2.8.1 Active hip ROM

There is limited evidence on between-group differences of ROM for people with FAI syndrome and healthy people (Freke et al., 2016). There are inconsistent findings if people with FAI syndrome have reduced hip ROM in all planes of movement compared to healthy people or to their unaffected hip (Diamond et al., 2015; Freke et al., 2016). A systematic review which combined both clinical and laboratory-based biomechanical data, reported less hip ROM in flexion, internal rotation, external rotation, adduction, abduction and extension, sagittal plane hip ROM during stair climbing, altered sagittal and frontal plane hip ROM during gait among people with FAI syndrome (Diamond et al., 2015). Freke et al. (2016) did not find any difference in hip ROM either when active and passive hip ROM measured with a goniometer or 3D CT motion analysis were included. Significant lower hip flexion ROM in affected hip compared to unaffected hip are found among patients with FAI syndrome (Nepple, Goljan, et al., 2015). Studies investigating the presence of cam morphology and hip ROM in soccer and hockey players, did not find any significant hip rotation ROM impairments (Brunner et al., 2016; Tak et al., 2016) or in other hip ROM (Brunner et al., 2016) among those with cam morphology compared to those without.

2.8.2 Hip muscle strength

Evidence of hip muscle strength ratio between people with FAI syndrome and healthy controls are also limited to case-control studies. Healthy people have better hip muscle strength in hip abduction, adduction, flexion, extension, internal rotation, external rotation and dynamic balance on one leg compared to people with FAI syndrome (Diamond et al., 2016;

Freke et al., 2016). In two studies, hip extension muscle strength has been reported to be lower in the control group (Casartelli, Maffiuletti, Item-Glatthorn, Impellizzeri, & Leunig, 2014; Casartelli et al., 2011).

2.8.3 Hip-related symptoms and quality of life

The patient reported outcomes measurements (PROs) Hip Osteoarthritis and Disability Outcome Score (HOOS) (Kemp, Collins, Roos, & Crossley, 2013) and International Hip Outcome Tool-33 (iHOT-33) (Kemp, Collins, et al., 2013; Thorborg et al., 2015) appear to be the most appropriate measures of outcome in people with FAI syndrome undergoing hip arthroscopy.

There are studies evaluating the PROs scores HOS, NAHS, iHOT-12 and WOMAC-12 on patients presenting articular and musculoskeletal hip pain, labral tears and FAI syndrome at clinical visit and pre- and/or postoperative (Dippmann et al., 2014; Kemp et al., 2014; Krych, Thompson, Knutson, Scoon, & Coleman, 2013; Larson & Giveans, 2008; Smeatham, Powell, Moore, Chauhan, & Wilson, 2016; Thorborg et al., 2015; Wall et al., 2016; Wright, Hegedus, Taylor, Dischiavi, & Stubbs, 2016). After what we have found, there is limited published data on the PROs HOOS and iHOT-33 before treatment on patients with FAI syndrome. Hinman, Dobson, Takla, O'Donnell, and Bennell (2014) evaluated test-retest reliability of the HOOS and iHOT-33 in a group of patients with clinical signs and symptoms of FAI. Nepple et al. (2014) have reported HOOS sub scores for female and male patients with clinical findings of FAI scheduled for surgery.

People with moderate and severe chondropathy 12-24 months after hip arthroscopy had significantly poorer results in all subscales of HOOS and iHOT-33, compared to those who had no or mild chondropathy (Kemp et al., 2014).

2.9 Treatment

The treatment alternative for patients with FAI syndrome is either surgical or conservative management. There are currently no absolute cut-off criteria for either conservative or surgery treatment for patients with FAI syndrome, and the diagnostic criteria reported in the published literature are inconsistent (Ayeni, Naudie, et al., 2013; Ayeni et al., 2012; Peters et al., 2017; Wall et al., 2013).

2.9.1 Arthroscopy and conservative treatment

Hip surgery, either arthroscopic or open, aims to correct hip morphology to achieve impingement free hip joint motions and reduce the symptoms (Griffin et al., 2016; Wall et al., 2014). The conservative treatment includes both conservative care and physiotherapist-led rehabilitation (Griffin et al., 2016). Conservative care aims to reduce symptoms using activity modification, patient education, intra-articular steroid injection and non-steroidal anti-inflammatory drugs (Wall et al., 2013). Physiotherapist-led rehabilitation aims to reduce the patients symptoms by improving hip muscles strength, hip range of motion and the neuromuscular control (Wall et al., 2013). Both arthroscopic and conservative management are intended to reduce patients´ symptoms and improve function, but the evidence is not unanimous (Clohisy, St John, & Schutz, 2010; Freke et al., 2016; Wall et al., 2013).

The number of hip arthroscopies treating cam and pincer morphology and labrum tears has risen sharply the last decade. This applies to the United States, where the FAI-surgery rate has increased six-fold between 2006-2010 (Bozic et al., 2013; Montgomery et al., 2013) and in Asia (Lee et al., 2014). There is no evidence for a better result of a surgical intervention compared to non-surgical intervention in patients with FAI syndrome (Wall et al., 2014), and the lack of evidence includes also best conservative treatment. The evidence is limited to case series in both surgery and conservative management (Wall et al., 2014; Wall et al., 2013). Included to the mentioned HIPARTI and HARP study, there are currently 3 registered RCTs

at https://clinicaltrials.gov/ (NCT01893034, NCT01993615 and NCT01623843) comparing hip arthroscopic surgery lavage or best conservative treatment. There is one registered RCT at http://www.anzctr.org.au/ (ACTRN12615001177549) and one registered RCT at www.isrctn.com (ISRCTN64081839) comparing arthroscopic surgery with conservative care. I addition to the FIRST study – Australia, there is one registered RCT comparing different conservative treatment strategies (NCT02706756).

Because of the uncertainty of epidemiology and prevalence, and lack of high evidence how to best treat patients with FAI syndrome, clinicians have signalled concern (Kemp & Beasley, 2016; Reiman & Thorborg, 2015). The Australian government has newly decided to cut funding for hip arthroscopy in managing FAI syndrome, and it is calculated to save $51.4 million during a four-year period (Australian Government: Department of Health, 2017).

2.9.2 Indications for surgical and conservative treatment of patients with FAI syndrome

A newly published scoping review of specific surgical criteria for FAI syndrome reported major inconsistencies across the studies (Peters et al., 2017). Fifty six percent of the studies included the combination of symptoms, clinical signs and diagnostic imaging, according to the Warwick agreement on diagnosing FAI syndrome (Griffin et al., 2016). Failed conservative management were a criterion for surgery in 42 % of the studies, diagnostic imaging in 92 %, symptoms in 75 % and clinical signs in 70 % (Peters et al., 2017). Appendix 3 contains an overview over prospective studies and pilot RCTs including participants with FAI syndrome eligible for either arthroscopy (Brisson, Lamontagne, Kennedy, & Beaule, 2013; Dippmann et al., 2014; Krych et al., 2013; Larson & Giveans, 2008; Rylander, Shu, Andriacchi, & Safran, 2011; Rylander, Shu, Favre, Safran, & Andriacchi, 2013) or conservative treatment (Bennell et al., 2014; Emara et al., 2011; Smeatham et al., 2016; Wall et al., 2016; Wright et al., 2016).

The studies listed in appendix 3 includes only baseline data for the different studies, as it is relevant for this Master`s thesis. The studies in appendix 3 confirm the findings from Peters et al. (2017). The studies have used a combination of different diagnostic imaging identifying FAI morphology and labral tears: radiographic techniques (anterior posterior view of pelvis, cross-table lateral view of pelvis, frog-leg lateral view), magnetic resonance imaging (MRI) with and without arthrography, and some did not specify diagnostic imaging. Some studies have cut-off values for identifying cam and pincer morphology, and in both the arthroscopy and conservative studies it is variable if symptoms and clinical signs and have been used to establish FAI syndrome

3. METHOD

3.1 Access to data

On my study trip to Melbourne summer 2016 I was involved in different FAI syndrome research studies. I observed and assisted in the research projects “FORCe” and “FIRST”. I also measured muscle volume on MRI scans on data from the FORCe research. The study coordinator for both the HARP study (in Australia) and FIRST study, and I, practiced a lot on the clinical assenssments presented in the method chapter. The experiences I made doing the reliability testing with the study coordinator, were very important for the baseline testing and 3 months follow up testing in the HIPARTI study I was involved in in Norway. Unfortunately, all the planned baseline testing of the HARP study during my stay in Melbourne were cancelled. On the basis of the study trip to Australia I got the permission to use data from the Australian HARP and FIRST studies in my Master`s thesis.

3.2 Study design

This Master`s thesis is a cross sectional study including female and male patients who were diagnosed with FAI syndrome and were eligible for either hip arthroscopy or conservative treatment. To evaluate differences in patient characteristics, symptoms, function, clinical signs and diagnostic imaging between those eligible for hip arthroscopy or conservative treatment, baseline data from the mentioned HARP (arthroscopy) and FIRST (conservative) studies were used. The HARP study is a clinical prospective longitudinal cohort study; "Arthroscopic surgery for patients with femoroacetabular impingement and/ or labral tears". The aim was to establish modifiable risk factors associated with pain, function, work participation and quality of life over 12 months in people aged 18-50 years with early-onset hip OA diagnosed at hip arthroscopy (Clinical Trials ID: NCT02692807). The FIRST study is a pilot RCT; "A pilot double-blinded randomised controlled trial comparing two physiotherapy interventions to treat femoroacetabular impingement", where the aim was to investigate

the feasibility of a study to reduce pain and improve function in people with FAI syndrome. Both studies were ongoing studies and located in Australia, Melbourne and Ballarat respectively.

Hereafter, the patients in the HARP study are called "arthroscopy group", and the patients in the FIRST study are called "conservative group".

3.3 Participants

The number of patients in this Master's Thesis were restricted to available data at the end of my stay in Australia. Women and men aged 18-50 years were included in both studies.

3.3.1 Arthroscopy group

Inclusion criteria: (i) Aged 18 to 50 years; (ii) hip pain during daily and/ or sporting activities; (iii) intra-articular hip pain with radiological signs of FAI and/ or labral tears eligible for hip arthroscopy; (vi) able to give written informed consent and to participate fully in the interventions and follow-up procedures. The orthopedic surgeon had a pragmatic approach including patients to hip arthroscopy based on clinical examination and imaging. Alpha angle, ischial-spine sign, crossover sign and lateral center-edge was determined for the presence of FAI (radiographs: anterior posterior pelvic view and Dunn view).

Exclusion criteria: (i) Pain that is not confirmed by physical examination of the hip; (ii) evidence of pre-existing osteoarthritis, defined as Tonnis grade >1, or less than 3 mm superior joint space width on anterior posterior pelvic radiography; (iii) center edge angle on radiograph <25°; (iv) previous known hip pathology such as Perthes` disease, slipped upper femoral epiphysis or avascular necrosis; (v) previous hip injury; (iv)

medical conditions complicating surgery (ASA 3), (vii) inflammatory joint disease (RA, Bechterew, etc.); (viii) physical inability to undertake testing procedures; (ix) expected lack of compliance such as cognitive impairment; (x) drug abuse or similar; (xi) inability to understand the written and spoken language of the treatment centre; (xii) contra-indications to placebo surgery, which will include large loose body, chondral flap >1cm^2 detached at 3 sides, complete labral radial flap tear and labral bucklet-handle tear with complete avulsion >1.5cm long.

3.3.2 Conservative group

Inclusion criteria: (i) Symptomatic FAI (pain on at least one impingement test: FABER, FADIR, hip internal rotation pain) >3/10 on VAS; (ii) radiographic FAI (alpha angle >60° on anterior posterior standard X-ray of hips), (iii) pain for >6 weeks duration.

Exclusion criteria: (i) Physiotherapy treatment for hip pain in the past 3 months; (ii) pain for <6 weeks duration; (iii) pain <3/10 VAS on impingement; (iv) alpha angle <60°; (v) past hip surgery, (vi) other musculoskeletal conditions including rheumatoid arthritis; (vii) not able to perform testing procedures; (viii) not able to commit to 12 weeks of treatment, or both follow-up assessments; (ix) contra-indications to baseline X-ray (including pregnancy).

3.4 Recruitment

Arthroscopy group

All patients were recruited from two different surgeons in Melbourne, Victoria. If the patients had hip pain considered to be associated with hip impingement and/or acetabular labral pathology, and the consultant orthopaedic surgeon determined a patient`s eligibility for hip arthroscopy, they were informed about the study and

introduced to the study coordinator for more information. The coordinator screened the patients via phone for eligibility.

Conservative group

Patients were recruited through advertisements in clinic waiting rooms, at gymnasiums and sporting clubs in Ballarat and via social media. Volunteers were invited to contact the project coordinator and then screened via telephone interview. A clinical examination at the Federation University, Ballarat, was then organized to eventually confirm eligibility.

3.5 Assessments

The assessments in this Master`s thesis were based on the available common baseline assessments in the arthroscopy and conservative groups. Only the common assessments for the two groups are listed in the following paragraphs.

3.5.1 Patient characteristics

Sex, age, height (cm), weight (kg), body mass index (BMI (kg/m^2)).

3.5.2 Function

Active hip range of motion

ROM was measured in flexion, using an inclinometer (Plurimeter V Gravity Inclinometer) based on previous protocols, which demonstrate high reliability (intraclass correlation coefficient (ICC) 0.82 to 0.92) (Hatton, Kemp, Brauer, Clark, & Crossley, 2014). The patients were positioned in supine position with both legs

extended at rest. Arms crossed over the chest. Contralateral leg was fixed with a seat belt distal on the distal part of femur. The inclinometer was placed on testing thigh 5 cm above superior pole of patella. Patient instructions: "keep the arms folded and bend the knee towards the chest as far as possible". End range of motion was at firm end feel or pain restriction. Maximum angle was noted on each of three trials, and the mean of three trials was collected. Range of motion endpoints were determined by detecting motion through the pelvis rather than hip.

Isometric maximal voluntary hip muscle strength

Hip muscle strength was measured for the following hip muscles: abduction, adduction, flexion, extension, internal rotation and external rotation. Muscle strength was assessed using a Commander Power track II handheld dynamometer (JTECH Medical, Midvale, UT), which previously has shown excellent reliability (ICC 0.87 to 0.95) (Kemp, Schache, Makdissi, Sims, & Crossley, 2013). Peak torque was calculated by multiplying the force (Newton (N)) by the length of the moment arm (meters (m)), and then normalized by dividing on body weight (kg) (i.e. Nm/kg) (Kemp, Schache, et al., 2013). The length from distal grater trochanter to lateral knee joint line (m) were measured to find maximum torque for hip abduction and adduction, while the length from distal grater trochanter to distal tip of lateral malleolus (m) were used to find maximum torque hip flexion, extension, internal rotation and external rotation.

All strength measurements in both groups were conducted with the hands were folded on the chest when testing in supine position, and folded under the forehead when testing in prone position, contralateral thigh was fixed with a belt across the distal tight and the best of three trials were collected. The arthroscopy group were asked to push as hard as possible for five seconds. The conservative group were asked to build up to the maximum force for 2 seconds and then push maximum performance for 3 seconds. The

tester matched the force generated by the participant performing an isometric muscle contraction.

Hip abduction: Patient positioned in supine position. Force plate placed 5 cm above lateral malleolus.
Hip adduction: Patient positioned in supine position. Force plate placed 5 cm above medial malleolus.
Hip flexion: Patient seated at the end of the test bench. Force plate placed 5 cm proximal to the superior pole of patella.
Hip extension: Patient positioned in prone. Test leg with knee at 90° flexion. Force plate placed on the heel. Patient was instructed to "push foot straight up to the ceiling".
Hip internal rotation: Patient in prone position. Test leg with knee at 90° flexion. Force plate placed 5 cm above lateral malleolus. Knees were kept together at the test.
Hip external rotation: Patient in prone position. Test leg with knee at 90° flexion. Force plate placed 5 cm above medial malleolus. Knees were kept together at the test.

Functional task performance

Functional tasks assessed included the single-leg hop test (Kemp et al., 2016) and side bridge test (Kemp et al., 2016). The single-leg hop test`s reliability and validity has not been established in young people with hip dysfunction (Kivlan & Martin, 2012). However, it has been measured as a reliable measure of functional task performance in people with patellar tendinopathy (Crossley et al., 2007) and in healthy people (Kemp, Schache, et al., 2013). The side bridge test (Kemp et al., 2016) has been assumed to be a measure of trunk muscle strength endurance in healthy people (Kemp, Schache, et al., 2013). The side bridge test has shown good reliability (ICC=0.87, SEM=9.44) (Kemp, Schache, et al., 2013).

Single leg hop for distance test: The test was performed barefoot, hands were held behind the back in the start position. They were instructed to stand on one foot, hopping as far as possible forward, landing stable on the same foot. Distance was measured from a starting line to the heel of the landing foot. The patients were given one practice trial followed by three alternating trials for each leg, with the greatest distance (m) recorded. *Side bridge test:* The patients were positioned in side lying on the bench without shoes. The test side was the side nearest the bench. One ankle rested on top of the other. The lowermost elbow was placed in a straight line under the shoulder and the resting hand were folded on the chest. The hips were lifted up from the bench and patient was asked to hold this position for as long as possible. Encouragement was given at 30 seconds' intervals throughout the test. The test finished when the hip touched into the bench.

Hip-related symptoms and quality of life

Hip-related symptoms and quality of life was measured using the HOOS and the iHOT-33. HOOS determine patients' perception of their hip function and associated problem (Nilsdotter, Lohmander, Klassbo, & Roos, 2003). The HOOS has been measured to be reliable (ICC >0.90 in all five subscales), and has shown excellent discriminative ability when comparing people who has undergone a hip arthroscopic surgery with healthy people (Kemp, Collins, et al., 2013). Each of the five HOOS subscale symptoms stiffness, pain, activities of daily living, sport and recreation and quality of life were calculated independently. Each of these questions were ranged on a Likert scale from 0-4, where 0 indicated no problems, 4 indicated extreme problems. When HOOS subscale were calculated, 0 indicated the worst possible outcome, 100 indicated no problems for each subscale (Nilsdotter et al., 2003).

The iHOT-33 is a composite score, developed for active patients with hip pathology (Mohtadi et al., 2012). The iHOT-33 includes 33 questions, where each question are scored on VAS from 0-100 (a score of 0 is the worst possible outcome) (Mohtadi et al.,

2012). iHOT-33 has found to be a reliable (ICC=0.93; 95% CI: 0.87 to 0.96), valid and responsive outcome measure, with low SEM of 6 points out of 100 (Kemp, Collins, et al., 2013). The iHOT33 total score was calculated by adding all scores on the answered items and divided by the numbers of answered items (Mohtadi et al., 2012).

Clinical signs

Hip provocation pain was measured using the FADIR (Freehill & Safran, 2011) and FABER tests (Tijssen, van Cingel, Willemsen, & de Visser, 2012).

Physical activity

HUNT data questions related to physical activity (weekly frequency, intensity and duration pre-injury and when eligible for treatment) was recorded (HUNT forskningssenter, n.d.) (Table 1).

Table 1: HUNT 3 questions related to physical activity (HUNT forskningssenter, n.d.)

Exercise frequency
How often on average do you undertake leisure time sports? (Leisure time sports means, e.g., walking, cross-country skiing, swimming, other physical activities).
Never; Less than 1 time per week; 1 time per week; 2-3 times per week; Almost every day.
Exercise intensity
If you undertake leisure time sports, on which intensity level do you exercise on average?
Light activity, without "losing" breath or sweating; So hard that I "loose breath" or sweat; Almost exhausted.
Exercise duration
How long time do you exercise every time on average?
Less than 15 minutes; 15-29 minutes; 30 minutes – 1 hour; More than 1 hour.
Physical activity >30 minutes
Are you physically active at least 30 minutes every day during work and/or in your leisure time?
Yes; No.

Type of sport

Patients were asked what type of sport they participated in. To categorize the sports the Hip Sports Activity Scale (HSAS) (Naal et al., 2013) was used as a base when processing the data. This questionnaire has been designed to measure sports participation in people undergoing hip arthroscopy for FAI syndrome. Originally categorizes sport participation into 4 different activity levels and gather different sports into different groups at each activity level (Naal et al., 2013). In this Master`s thesis, only *what type of sport the* patients *participated in* were available, and not on what specific level patients were doing their sports. I choose to use the recreational level in the HSAS as a base, and used the 6 divisions listed there to categorize the sports. Many of the patients had listed more than one activity, and in lack of information of the main activity, the first listed activity was considered as their main activity. The HSAS used in

this Master`s thesis is validated for people from Switzerland and the US (Naal et al., 2013). Some sports are quite similar in Australia, Switzerland and the US, but has some different rules. Therefore, Aussie rules football, AFL football and Australian Football are equated with American football / rugby. The patients had also listed some sports which were not included in the HSAS. These activities were matched with activities with similar movement patterns and grouped then. This included the five listed activities: *Walking* ≈ Nordic walking (group 2); *Running* ≈ Jogging (group 4); *Gym* ≈ Aerobics or lower extremity weight training (group 4); *Foot biking* ≈ Bicycle racing/ cross-country skiing (group 3); *Triathlon* ≈ Bicycle racing/ swimming (group 3). Table 2 present the categorizing of different sports used in this Master`s thesis.

Table 2: Illustrates different sports categorized into different groups. The Hip Sports Activity Score (HSAS) is applied to allocate the patients into different sport groups (Naal et al., 2013).

Group categorized	**Sports included**
Group 1	No sports
Group 2	Swimming, cycling, hiking, Nordic walking (quick walking with ski-poles), walking
Group 3	Golf, bicycle racing, mountain biking, swimming, rowing, cross-country skiing / biathlon, dancing, inline skating, foot biking, triathlon
Group 4	Aerobics, jogging, lower extremity weight-training, horseback riding, cricket, running, gym
Group 5	Tennis, downhill skiing, snowboarding, indoor sports (basketball, squash, racket ball, handball, badminton, volleyball)
Group 6	Soccer, ice hockey, field hockey, American football/Rugby, track-and-field, beach-volleyball, Lacrosse

Diagnostic imaging

Data from the diagnostic imaging at baseline were not available for either the arthroscopy or the conservative group when writing this thesis. The diagnostic imaging inclusion criteria for each group will be discussed in discussion.

3.6 Test procedure

Baseline data from both the arthroscopy and conservative group were obtained by the same examiner (J.L.K.). The questionnaires were completed by the patient the same day, but prior to the baseline assessments. The HUNT 3 questions and the question of which type of sport the patients were participating in, were not included in the conservative study protocol. The patients answered these questions after the baseline testing by e-mail. The uninvolved leg was tested first. The conservative group had 5 minutes warm up prior to the testing, which was different from the arthroscopy group which did not.

3.7 Statistical analyses

The statistical analysis were processed in IBM SPSS Statistics for Mac 2015 (version 23), and all tables and figures were made in Microsoft Office for Mac 2016 (version 15.30).

Normal distribution of the continuous data was assessed using frequency tables and comparing the mean and median (if small differences between the mean and median, the data were normally distributed). The level of significance was set to $p<0.05$, 95% confidence interval (CI) for all tests.

Gender was presented as frequency and percent. The continuous descriptive data age, height, weight and BMI were presented as mean and standard deviation if criteria for parametric tests were fulfilled. If not, median and range for non-parametric data were

present (O´Donoghue, 2012). In the assumptions using parametric tests were fulfilled, independent sample t-tests were used to investigate the difference in age, height, weight, BMI, isometric maximal voluntary hip muscle strength, hip ROM, single leg hop for distance test, side bridge test, iHOT-33 and HOOS between the groups (O´Donoghue, 2012). If not, the non-parametric Mann Whitney U test were used (O´Donoghue, 2012).

Effect size differences with a confidence interval conveys the same information as a test of statistical significance, but has the emphasis of the effect, rather than the sample size (O´Donoghue, 2012). Effect size measured with Cohen`s d was determined for differences in involved leg between the groups for hip flexion ROM, hip muscle strength, the side bridge test and single leg hop for distance test, and HOOS and iHOT-33. Mean and standard deviation for each group were used calculating the effect size. The effect sizes were categorised into; ≥0.2 small, ≥0.5 moderate and ≥0.8 large (O´Donoghue, 2012). A 95% confidence interval for the effect size were presented.

Crosstab analyses were used to measure the between-group difference of the categorical variables; activity pre-injury and when eligible for treatment, >30 daily minutes activity when eligible for treatment, type of sport, and the clinical provocation tests FADIR and FABER (O´Donoghue, 2012). The chi square goodness of fit test was used. Pearson Chi Square test was valid if there were an expected frequency of at least five for at least 80 per cent of the values of the categorical variable. If this assumption was not fulfilled, the Fisher´s Exact test was used. If there were too few patients in each group to use a Chi-Square test, it was more appropriate to presented the data only as frequency and percent. Categorical results were presented without decimals, and total score might therefore be >100%.

3.8 Ethics

The studies were performed according to the Helsinki Declaration. The arthroscopy study was approved by the Human Research Ethics Committee (appendix 4), and are registered in Clinical Trials.gov with number NCT02692807. The La Trobe University Human Ethics Committee (appendix 5) approved the conservative study. It was also sought for an ethics amendment for the HUNT questions (appendix 6). Before start up the patients received oral and written information of the studies purpose and procedure: arthroscopy study (appendix 7) and conservative study (appendix 8). Informed consent was sought form eligible people before baseline testing for arthroscopy (appendix 9) and the conservative (appendix 10) groups.

Data from the arthroscopy study were saved in the CheckWare program and were available for a limited number of persons. CheckWare is an online programme constructed to obtain, treat and save sensitive information. The FIRST study data were saved on password-encrypted excel spreadsheets, that were held on a password secured university server.

4. RESULTS

All the continuous data were normally distributed.

4.1 Patient characteristics

Table 3 presents descriptive characteristics of the arthroscopy group and the conservative group. No significant differences between the arthroscopy group and the conservative group were found for gender, age, height, weight or BMI.

Table 3: Descriptive characteristics of the arthroscopy group and the conservative group. Gender distribution is presented as numbers (n) and percent (%) of women. Age, height in meters, weight in kilos and body mass index (BMI, kg/m^2) are presented as mean and standard deviation.

Group	**Women** n (%)	**Age** (year)	**Height** (meter)	**Weight** (kilo)	**BMI** (kg/m^2)
Arthroscopy (N=19)	10 (53)	36±9	1.75±0.08	76.5±14.2	24.9±3.5
Conservative (N=24)	16 (67)	37±8	1.71±0.08	74.7±10.7	25.6±3.2

4.2 Function

4.2.1 Active hip flexion ROM and isometric hip muscle strength

There were no significant differences between the arthroscopy group and the conservative group for any of the ROM measures (Table 4). Between-group differences for hip muscle strength are presented in Table 3. No significant between-group differences were found for hip strength for any muscle groups in involved leg. The arthroscopy group exhibited significantly greater muscle strength than the conservative group for hip adduction (mean difference = 0.17 Nm/kg) and abduction (mean difference = 0.43 Nm/kg) of uninvolved leg.

Table 4: Mean and standard deviation in the arthroscopy group and the conservative group for hip range of motion (ROM) in degrees (°) and hip muscle strength (normalized peak torque (Nm/kg)), and mean between-group differences. Number of patients (N), confidence interval (CI) and p-value are presented.

Test	**Art** (N=19)	**Cons** (N=24)	**Mean difference** (Nm/kg and %)	**95 % CI**	**p-value**
Active hip range of motion (°)					
Flexion I	105±11	107±16	-1.6 (2%)	-10 to 7	0.720
Flexion UI	112±3	113±10	-1.4 (1%)	-8 to 5	0.670
Hip muscle strength (Nm/kg)					
Adduction I	0.90±0.32	0.88±0.21	0.02 (2%)	-0.14 to 0.18	0.790
Adduction UI	1.01±0.32	0.83±0.16	0.17 (18%)	0.00 to 0.34	0.044*
Abduction I	1.12±0.44	0.90±0.26	0.22 (20%)	-0.01 to 0.45	0.064
Abduction UI	1.33±0.41	0.89±0.31	0.43 (33%)	0.21 to 0.65	<0.000*
Extension I	0.86±0.46	0.83±0.25	0.03 (3%)	-0.21 to 0.28	0.779
Extension UI	0.96±0.46	0.76±0.22	0.19 (21%)	-0.03 to 0.41	0.082
Flexion I	1.14±1.12	0.72±0.17	0.41 (37%)	-0.13 to 0.96	0.130
Flexion UI	1.24±1.08	0.66±0.14	0.58 (47%)	0.06 to 1.10	0.320
ER I	0.49±0.19	0.48±0.17	0.01 (2%)	-0.10 to 0.12	0.865
ER UI	0.53±0.19	0.48±0.16	0.04 (9%)	-0.07 to 0.15	0.437
IR I	0.49±0.22	0.40±0.14	0.10 (18%)	-0.01 to 0.21	0.078
IR UI	0.49±0.18	0.41±0.12	0.08 (16%)	-0.02 to 0.17	0.098

ER = external rotation; I = involved leg; IR = internal rotation; UI = uninvolved leg.
* Significant difference between the groups.

4.2.2 Functional task performance

Differences between the arthroscopy group and the conservative group for the functional tasks are presented in Table 5. The single leg hop for distance test, involved leg, was excluded for one participant in the arthroscopy group because of an unlikely result (200 meters). The conservative group revealed significantly longer hop distance for the single leg hop test than the arthroscopy group for both legs (mean difference involved leg = 0.27 m; mean difference uninvolved leg = 0.44 m).

Table 5: Mean and standard deviation in the arthroscopy group (Art) and the conservative group (Cons) for functional task performance, and mean between-group differences. Number of patients (N), confidence interval (CI) and p-value are presented.

Test	Art (N=19)	Cons (N=24)	Mean difference	95% CI	p-value
Side bridge I (s)	71±40	58±46	13	-15 to 40	0.358
Side bridge UI (s)	66±39	59±47	6	-21 to 34	0.633
SLHFD I (m)	0.89±0.44	1.16±0.28	-0.27	-0.50 to -0.04	0.020∗
SLHFD UI (m) #	0.77±0.47	1.22±0.36	-0.44	-0.70 to -0.19	0.001∗

I = involved leg; m = meters; s = seconds; SLHFD = single leg hop for distance test; UI = uninvolved leg.
∗ Significant difference between the groups.
Arthroscopy group (N=18).

4.2.3 Hip-related symptoms and quality of life

Differences between the arthroscopy group and the conservative group for PROs hip-related to symptoms and quality of life are presented in Figure 3. The mean HOOS sport and recreation score was significant lower in the arthroscopy group (43±24) compared to the conservative group (65±21) (p=0.003; mean difference 22 points (CI -35 to -8)).

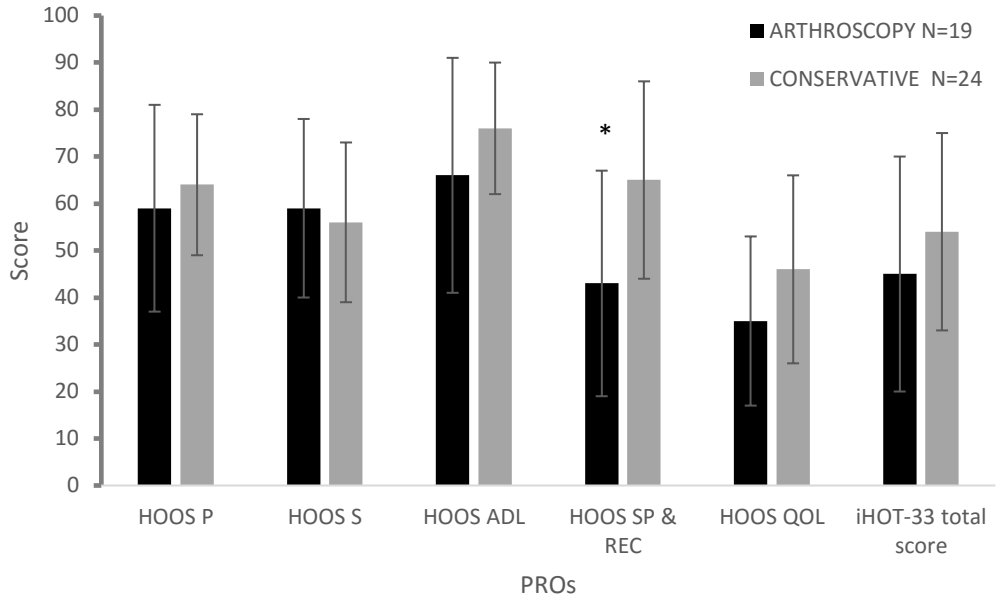

Figure 3: Patient reported outcome measurements (PROs) for the arthroscopy group and the conservative group are presented as mean and standard deviation. ADL = activity of daily living; HOOS = Hip Osteoarthritis and Disability Outcome Score; iHOT-33 = International Hip Outcome Tool -33; P = pain; S = symptoms; SP & REC = sport and recreation; QOL = quality of life.
∗ p=0.003.

4.2.4 Hip provocation pain

Table 6 illustrate frequency distribution of the pain provocation tests FADIR and FABER in the arthroscopy and the conservative groups. There were no significant differences between the two groups for positive FADIR or FABER tests in involved leg. There were significantly fewer positive FABER tests in arthroscopy group compared to conservative group in uninvolved leg (14 of 19 versus 10 of 24).

Table 6: Frequency distribution of the FADIR and FABER pain provocation tests for the arthroscopy group and the conservative group. Frequency and percent of the total number of patients in each group are presented. N = number of patients in each group.

Test	**Arthroscopy** (N=19)		**Conservative** (N=24)	
	No pain	Pain	No pain	Pain
FADIR involved leg	2 (11%)	17 (89%)	7 (29%)	17 (71%)
FADIR uninvolved leg	10 (53%)	9 (47%)	13 (54%)	11 (46%)
FABER involved leg	9 (47%)	10(53%)	8 (33%)	16 (67%)
FABER uninvolved leg	14 (74%)∗	5 (26%)	10 (42%)	14 (58%)

∗ Significant difference between the groups (p=0.036).

4.2.5 Physical activity

One third (N=8) of the patients in the conservative group and all of the patients in the arthroscopy group answered the HUNT questions. No patients increased either frequency, intensity or duration of the activities from pre-injury to the time they were eligible for either hip arthroscopy or conservative treatment.

There were no significant differences between the arthroscopy group and the conservative group for activity frequency, intensity and duration from pre-injury to baseline testing. The distribution of the number of patients who reduced their activity frequency pre-injury to baseline testing were: arthroscopy group, 11 of 19 (58%) versus conservative group, 3 of 8 (38%). The number of those who reduced the frequency from "almost every day" or "2-3 times per week" to "never", were 4 of 19 (21%) in the arthroscopy group compared to 0 of 8 (0%) in the conservative group.

The number of those who reduced the activity intensity from pre-injury to baseline testing were 9 of 19 (47%) in the arthroscopy group versus 2 of 8 (25%) in the conservative group. The number of those who reduced the activity duration from pre-

injury to baseline testing were 12 of 19 (63%) in the arthroscopy group versus 2 of 8 (25%) in the conservative group.

There was no significant difference between the groups reporting >30 minutes' activity per day (arthroscopy group 79% versus conservative group 88%).

4.2.6 Type of sport

One of the responders in the conservative group failed to answer the question of what type of sport he or she was doing, and not all patients in conservative group responded on the e-mail they received in aftermath of the baseline testing (N=19 patients in the arthroscopy group; N=7 patients in the conservative group). Frequency and percent of the sport type distribution in both groups are presented in Table 7. In arthroscopy group, most patients participated in sports in group 4 and 6.

Table 7: Percent (%) and number (N) of patients participating in sports categorized from 1 to 6 in the arthroscopy and the conservative group.

Group	**1** % (N)	**2** % (N)	**3** % (N)	**4** % (N)	**5** % (N)	**6** % (N)	**Total** %
Arthroscopy (N=19)	5(1)	11(2)	1(2)	32(6)	11(2)	32(6)	102%
Conservative (N=7)	29(2)	0(0)	14(1)	14(1)	14(1)	29(2)	100%

1 = no sports; 2 = swimming, cycling, hiking, Nordic walking (quick walking with ski-poles); 3 = golf, bicycle racing, mountain biking, swimming, rowing, cross-country skiing / biathlon, dancing, inline skating; 4 = aerobics, jogging, lower extremity weight-training, horseback riding, cricket; 5 = tennis, downhill skiing, snowboarding, indoor sports (basketball, squash, racket ball, handball, badminton, volleyball); 6 = soccer, ice hockey, field hockey, American football/Rugby, track-and-field, beach-volleyball, Lacrosse.

4.2.7 Effect size

The effect size differences for involved leg between the arthroscopy and the conservative group are presented in Table 8. The only large between-group effect size was the HOOS sport and recreation sub score (effect size 0.97), in favour the conservative group.

Table 8: Effect sizes (ES) between the arthroscopy group and the conservative group for hip range of motion (ROM), hip muscle strength and functional performance tasks, involved leg, and patient reported outcome measurements (PROs). Positive ES favour the arthroscopy group. Lower and upper confidence interval (CI) are presented. Red = large ES (>0.80); green = moderate ES (>0.50); blue = small (>0.20).

Outcome	ES	Lower 95% CI	Upper 95% CI
Flexion ROM	-0.15	-0.27	-0.02
Adduction strength	0.07	-0.05	0.19
Abduction strength	0.59	0.46	0.71
Extension strength	0.08	-0.05	0.20
Flexion strength	0.50	0.36	0.61
ER strength	0.06	-0.07	0.59
IR strength	0.48	0.34	0.42
Side bridge	0.30	0.18	0.18
SLHFD	-0.71	-0.83	-0.57
HOOS P	-0.26	-0.38	-0.13
HOOS S	0.17	0.04	0.29
HOOS ADL	-0.48	-0.59	-0.35
HOOS SP & REC	-0.97	-1.08	-0.82
HOOS QOL	-0.53	-0.64	-0.39
iHOT-33	-0.39	-0.50	-0.25

ADL = activity of daily living; ER = external rotation; HOOS = Hip Osteoarthritis and Disability Outcome Score; iHOT-33 = International Hip Outcome Tool -33; IR = internal rotation; P = pain; S = symptoms; SLHFD = single leg hop for distance test; SP & REC = sport & recreation; QOL = quality of life.

5. DISCUSSION

In this Master`s thesis patient characteristics, symptoms (pain), function, clinical signs and diagnostic imaging among patients with FAI syndrome eligible for hip arthroscopy, were compared to those eligible for conservative treatment. The checklist of cross sectional studies from The National Institute of Health Services will be used considering the thesis` internal and external validity and measurement validity and reliability (National Institute of Health Services, 2006). The results will be discussed in light of other literature when it is possible. The discussion is divided into 1) results, 2) methods, and 3) further research and clinical relevance.

5.1 Results

Main results

We found no significant differences in patient characteristics between the arthroscopy group and the conservative group. The arthroscopy group revealed significantly lower HOOS sport and recreational score, performed worse on the single leg hop for distance test, and had reduced hip abduction strength in uninvolved leg compared to the conservative group. Hence, it seems like those who were eligible for hip arthroscopy have somewhat impaired function compared to the conservative group, however, our sample size is small and larger trials need to confirm these results.

Hypothesis I: *Patients with FAI syndrome eligible for hip arthroscopy are younger and in greater extent men than women compared to those eligible for conservative treatment.* The first hypothesis was not supported. We found no significant differences in any patient characteristics between the arthroscopy group and the conservative group.

Hypothesis II: *Patients with FAI syndrome eligible for hip arthroscopy have worse function (hip range of motion, hip muscle strength, functional task performance and sport participation) compared to those eligible for conservative treatment.* The second

hypothesis was partly supported. We found no significant differences in hip ROM or hip muscle strength in involved leg between the arthroscopy group and the conservative group. Moderate between-groups effect size differences were found for hip muscle strength for abduction and flexion in involved leg, in favour the arthroscopy group. The arthroscopy group performed significant worse on single leg hop distance compared to the conservative group. We found no significant differences in the hip provocation tests FADIR and FABER in involved leg between the groups.

Hypothesis III: *Patients with FAI syndrome eligible for hip arthroscopy display more hip-related symptoms and reduced quality of life compared to those eligible for conservative treatment.* The third hypothesis was partly supported. The arthroscopy group revealed significantly lower HOOS sport and recreational score compared to the conservative group. Moderate between-groups effect size differences were found for HOOS quality of life, in favour the conservative group.

5.1.1 Patient characteristic

Age, height, weight and BMI did not differ significantly between the groups. Mean age of 36±9 years in arthroscopy group and 37±8 years in conservative group do not differ from other prospective arthroscopy or conservative studies on FAI syndrome listed in appendix 3. Both groups in this Master`s thesis included people between 18-50 years, which represent the population of FAI patients. Many prospective hip arthroscopy studies on FAI syndrome have not reported upper or lover age limit, but still mean age were similar to mean age in this study (Brisson et al., 2013; Dippmann et al., 2014; Larson & Giveans, 2008; Rylander et al., 2011; Rylander et al., 2013). There were not more men in the arthroscopy group versus the conservative group. If we had a larger study population, it could be interesting to subgroup the patients into general population, athletes, women and men.

5.1.2 Function

Active hip ROM

Active hip flexion ROM did not differ significantly between the arthroscopy group and the conservative group (Table 4). The effect size was also low (0.15 in favour the conservative group). Generally, there are inconsistent findings whether FAI patients in general have reduced ROM compared to healthy people (Diamond et al., 2015; Freke et al., 2016). Two prospective studies on patients with FAI syndrome have reported hip ROM for involved leg before conservative treatment. Wright et al. (2016) reported 108º±23º, which is similar to our results. Emara et al. (2011) reported 95º±0.4º, which is worse hip ROM compared to our results. This may indicate that hip ROM among patients with FAI syndrome eligible for conservative treatment also varies. None of these studied specified if the hip ROM were measured as active or passive motions, whether ROM was measured with or without motion in the pelvis, or what type of measurement tool which was used. Nepple et al. (2014) reported passive hip flexion ROM for involved leg measured with a goniometer before hip arthroscopy of 97.6º±5.6º for women and 94.4º±4.5º for male, which differ from our results. The selection sample were too small doing separate analysis for women and men in our study, and we cannot say anything about gender differences.

Hip muscle strength

Hip muscle strength did not differ significantly between groups for involved leg. No other studies have compared hip muscle strength between those eligible for hip arthroscopy and those eligible for conservative treatment. Neither of the prospective studies listed in appendix 3 have measured hip muscle strength. Compared to healthy peoples` hip strength (Kemp, Schache, et al., 2013), both the arthroscopy and the conservative group seems to be weaker than healthy people.

Small and moderate between-group effect sizes were seen for hip abduction, flexion and internal rotation in involved leg, in favour the arthroscopy group. No significant differences were found between the two groups for these hip strength measures, but maybe the results differed significantly if we had included more patients in each group.

We should have had data on how many in the arthroscopy group who had gone through and failed conservative treatment. Even though most of the between-group difference for hip muscle strength were not significant, there was a tendency that the arthroscopy group was stronger for almost all hip muscle strength measures compared to conservative group (Table 4).

Hip peak torque (Nm/kg) data in the arthroscopy group had generally larger variation compared to the conservative group. Eight of twelve strength measures in the arthroscopy group compared to one of twelve in the conservative group had a standard deviation >0.30 Nm/kg. One explanation of this variation for hip muscle strength within the arthroscopy group may be large variations in hip muscle strengthening prior to arthroscopy, or there were larger variations in activity level within the group compared to conservative group.

The arthroscopy group was significantly stronger in hip adduction (mean difference 0.17 Nm/kg) and abduction (mean difference 0.43 Nm/kg) for uninvolved leg compared to conservative group. The conservative group might have had more bilateral problems which affected hip muscle strength for hip adduction and abduction in uninvolved leg. Another theory is that the arthroscopy group during physiotherapy-led rehabilitation had strengthened hip adductor and abductor muscles in uninvolved legs largely compared to other muscle groups.

Functional task performance

The arthroscopy group revealed significantly shorter hop distance for the single leg hop distance test than the conservative group for both legs (mean difference 0.27 meters in involved leg; mean difference 0.44 meters in uninvolved leg). The between-group effect size for the single leg hop for distance test, involved leg, was moderate, in favour the conservative group. There was no between-group difference for the side bridge test. We have not found other studies on FAI syndrome patients including these functional tasks.

Hip-related symptoms and quality of life

The arthroscopy group had significantly lower HOOS sport and recreation sub score than the conservative group (mean difference 22 points), and the effect size were large (0.97). Also HOOS activity of daily living and HOOS quality of life sub score were lower in the arthroscopy group, but did not differ significantly between the groups. However, the effect sizes were calculated to be moderate, in favour the conservative group.

No other studies have compared the HOOS or iHOT-33 questionnaires between the two groups, but a few other studies have included these measurements before treatment of FAI syndrome. Hinman et al. (2014) reported HOOS sub scores and iHOT-33 total score in a group of patients with clinical signs and symptoms of FAI syndrome (diagnostic imaging was missing). These results were in general almost the same as our results, but they had higher score on HOOS pain, symptoms and activity of daily living than the conservative group in our study. In a pilot RCT of general people ≥16 years with FAI syndrome eligible for either arthroscopy or conservative treatment, mean iHOT-33 total score before randomisation was 31.4±15.2 (Wall et al., 2016). Those patients had worse hip-related symptoms and quality of life compared to our results (arthroscopy 45±25; conservative 54±21). Nepple et al. (2014) reported separate results for women and men with FAI syndrome eligible for hip surgery, and the arthroscopy group in our study reported HOOS and iHOT-33 scores somewhere between the scores for women and men. They found that women had more symptoms, but less radiographic

evidence of cam or pincer compared to men. It would be relevant to do in our study if the sample size was larger.

The minimal clinical relevant difference of HOOS sport and recreation sub score among adults undergoing hip arthroscopy has been reported to be 17 points (Kemp, Collins, et al., 2013). The mean difference of 22 points between the groups in this study may therefore be considered as clinical relevant. Minimal clinical important difference for iHOT-33 among young, active patients undergoing hip arthroscopy has been reported to be 6 points (Mohtadi et al., 2012), and 10 points among adults undergoing hip arthroscopy (Kemp, Collins, et al., 2013). The mean difference of 9 points between the arthroscopy and the conservative group were not significant. Larger sample size would be needed to draw any firm conclusions.

Clinical signs

The sensitivity and specificity of the FADIR test for labral tears and FAI (arthroscopy and MRI as reference standard) has been reported to be between 94-99 and 5-9 respectively (Reiman et al., 2015). The FABER test has shown to be less sensitive (42-81), but more specific (18-75) than the FADIR test (Reiman, Goode, Hegedus, Cook, & Wright, 2013). Most of the patients in both groups had a positive FADIR test for involved leg (71% and 89%), but more than 50% (67% and 53%) in each group had a positive FADIR test for uninvolved leg. However, with no information on bilateral hip pain, the uninvolved FADIR and FABER test results are highly uncertain. Studies have reported bilateral hip morphology, which may or may not be symptomatic (Mascarenhas et al., 2016). The low specificity of the FADIR test might also be the reason for the high number of positive FADIR tests in uninvolved leg (46% and 47%).

In both groups, less patients had a positive FABER test (53% and 67%) compared to FADIR test in involved leg. It is interesting that there were significantly fewer positive

FABER tests in uninvolved leg in the arthroscopy group versus the conservative group, which differed from the FADIR test. One explanation may be that less patients in the arthroscopy group had bilateral intra-articular hip problems. The studies listed in appendix 3 showed inconsistent use of the FADIR and FABER tests, and our results showed that within a group eligible for either hip arthroscopy or conservative treatment, not all had a positive FADIR and FABER test.

Physical activity and type of sport

No patients in either the arthroscopy group (N=19) or the conservative group (N=8) increased frequency, intensity or duration of the physical activity (sports) from pre-injury to the time they were eligible for hip arthroscopy or conservative treatment (baseline testing). There was a tendency that the patients in the arthroscopy group in greater extent than conservative group had a decrease in both frequency, intensity and duration pre-injury to baseline testing. Firstly, 11 of 19 (58%) in the arthroscopy group and 3 out of 8 (38%) in conservative group reduced activity frequency pre-injury to post-injury. Secondly, 4 out of 19 (21%) in the arthroscopy group and 0 out of 8 (0%) in the conservative group reduced frequency from "almost every day" or "2-3 times per week" to "never" pre-injury to baseline testing. Thirdly, almost half of the arthroscopy group compared to one fourth in conservative group reduced activity intensity pre-injury to baseline testing. Fourthly, 12 out of 19 (63%) in the arthroscopy group and 2 out of 8 (25%) in conservative group reduced activity duration pre-injury to baseline testing. A cross sectional study cannot draw conclusions of causality, but the reduced activity in the arthroscopy group may be a driver for hip arthroscopy.

One third of both groups were participating in sports which places the hips into internal rotation, adduction and flexion (soccer, ice hockey, American football/ rugby), but the low number of patients in conservative group makes it less relevant to compare type of sport in percent

between the groups.

Diagnostic imaging

The alpha angle was the only diagnostic imaging data that was included in both studies. Hence, cam deformity using an alpha angle cut-off is the only imaging data that will be discussed.

The arthroscopy group had a pragmatic approach defining cam. Cam deformity was the only measure used as diagnostic imaging inclusion criteria in the conservative study (alpha angle >60 º), which means that these patients may also have had pincer and/or labral tears, but they did not have diagnostic imaging to confirm this. It is reported that almost 50% of people with FAI syndrome have a combination of cam and pincer morphology (Clohisy et al., 2013), where gender distribution are reported to be 32% for women versus 62% for males (Nepple et al., 2014). In a systematic review by Nepple et al. (2014) including people treated with hip surgery for their FAI syndrome, 6% of women and 0% of males had isolated pincer morphology. Referred to these findings, it is relevant to compare the arthroscopy group and the conservative group even though they had different diagnostic imaging inclusion criteria. Referred to these findings, the conservative group did not differ largely from the arthroscopy group and FAI syndrome population in general when only including patients on base of cam deformities.

Radiographic evaluation of FAI syndrome is limited by a lack of consensus regarding criteria, and thresholds defining cam are inconsistent. Agricola, Waarsing, et al. (2014) have suggested to define cam as an alpha angle >60º. In a systematic review including people who have had surgery for FAI (or FAI syndrome), they found a significant difference (<0.001) of mean alpha angle between females and males (Nepple et al., 2014). Patients with an alpha angle >50º were included in those analyses, and females mean alpha angle were just below 60º versus 70º among males. Among all who have had a hip surgery in that study, two thirds of the females versus one third of the males had an alpha angle <60º. The women had milder morphologic abnormalities, despite more symptoms and functional limitation than males. According to Agricola, Waarsing, et al. (2014) some patients with hip symptoms and clinical signs of FAI in our arthroscopy group might have had an alpha angle <60 º, and who by definition did not have FAI syndrome.

The Australian healthcare system is to a greater extent, compared to Norway, driven by health care and insurance based. This may lead to a lower threshold for offering hip arthroscopy, and the cut-off alpha angle diagnosing cam morphology may be less interesting. It is likely that the surgeons are less concerned to what extent conservative treatment, including physiotherapist-led rehabilitation and conservative care, have been tried before a hip surgery.

5.2 Method

In this part of the thesis, methodological considerations which is of importance for the interpretation of the results will be discussed. A suited design, a reliable method and implementation, and a representative population with sufficient sample size are important to draw conclusions (Laake, Olsen, & Benestad, 2013).

5.2.1 Study design

The study design was chosen on basis of the main purpose of the study which was to compare patient characteristics, symptoms (pain), function, clinical signs and diagnostic imaging between two independent groups at a given time, before receiving either arthroscopy or conservative treatment for FAI syndrome. Cross sectional studies are preferred when the goal is to investigate a population at a specific time, which was applicable to this thesis (Laake et al., 2013). A cross sectional study is not designed to address causalities, and that is beyond the scope of this thesis. We have not found similar studies to ours, and this thesis may be considered a pilot.

5.2.2 Sample

Patients in the arthroscopy group were recruited from two different surgeons in Melbourne. The conservative group were volunteers who on their own initiative contacted the study coordinator, and these might differ from those who do not take

contact to participate into a research project. The arthroscopy group were already in contact with an orthopaedic surgeon when they were recruited, and this can be considered as a representative selection of the population at a given point. We have not received information whether this were a special clinic which operated a specific population or not. The selection of patients with FAI syndrome in this study may differ from other countries, which may affect the external validity and generalization of our results.

FAI syndrome have been reported to hit most young and middle aged people, and the included population in both studies may be considered as representative (18-50 years) for the population. It is a weakness that the arthroscopy and conservative study did not include patients with the same hip pathology. The arthroscopy group included people with FAI syndrome (cam, pincer or both) and/or labral tears. Cam morphology (alpha angle >60) was the only inclusion criteria for the conservative group. It is unknown whether these people also had pincer and/or labral tears. When the results from diagnostic imaging of patients are missing in this Master`s thesis, there is a chance that some of the patients included in the arthroscopy group did not have imaging findings of FAI syndrome, but only labral tears. We should have had data on whether the patients had bilateral hip symptoms, because bilateral problems might have affected our results.

Both women and men were included in both studies, but perhaps the conservative study missed some women because of the requirement of cam morphology. Cam deformities occurs most frequently among men (Dickenson et al., 2016; Gosvig et al., 2008; Leunig et al., 2013), and prevalence seems to be especially high among athletes taking part in sports like hockey, soccer and basketball (Frank et al., 2015; Packer & Safran, 2015). A deep acetabulum (pincer morphology) is more frequent among females (Leunig et al., 2013).

The arthroscopy group did not have a VAS cut-off score for a positive FADIR and FABER test, while the conservative group approved >3 on VAS as a positive test. Pain

scored on VAS is a subjective score, and many factors may influence the score, which may have affected the inclusion. Neither of the studies listed in appendix 3 have described in what circumstance the VAS scores were conducted, and is therefore difficult to compare these results with other studies.

The published literature until 2016 illustrates that there is a high heterogeneity regarding diagnostic criteria of FAI, and who have received hip surgery for their hip problems. The pragmatic approach including HARP patients in fact represent todays practice, but perhaps the selection would be different if other surgeons in Australia or other countries were responsible for the inclusion. According to the Warwick agreement on FAI syndrome, diagnostic criteria for patients with FAI syndrome should include positive symptoms, clinical signs and imaging findings (Griffin et al., 2016). Patients in the arthroscopy group were included if they had hip pain during daily/ and or sporting activities. Pain >6 weeks was an inclusion criteria in the conservative study. Both studies fulfilled criteria of symptoms, but the criteria for being eligible for hip arthroscopy had a more pragmatic approach to duration of symptoms compared to the conservative group. Other prospective conservative studies on FAI (FAI syndrome) have in some way included symptoms (Emara et al., 2011; Larson & Giveans, 2008; Rylander et al., 2011; Rylander et al., 2013; Smeatham et al., 2016; Wall et al., 2016; Wright et al., 2016).

5.2.3 Sample size

The number of patients is crucial deducting reliable conclusions. If few patients are included, individual differences have bigger impact on the group result (Laake et al., 2013). The statistical analyses in this Master`s thesis were based on available data from the HARP and FIRST studies. We did not calculate the number needed to be included in each group to get reliable results in priori. This calculation includes a chosen power (reject the null hypothesis when it is wrong), a chosen significant level (the probability to reject the null hypothesis when it is true), and a clinically relevant difference between the groups. In clinical research and hypothesis

testing there are two types of error the researcher and reader should be aware of when drawing conclusions. Type 1 error is when the null hypothesis is rejected when it is true in reality. Type 2 error is when the null hypothesis is accepted when it is false in reality. The results in this thesis may have been affected by a type-2 error because of the low number of patients (Laake et al., 2013). Some of the results shows a clinical relevant difference, but are not significant. If we included more patients from the exactly same population, the difference would perhaps be significant.

5.2.4 Assessments

The same highly trained examiner did all the testing in both studies, with the same test equipment in the same time period. This strengthens the reliability of our results. To achieve a low grade of random variation of the assessments, both groups should have the same standardized test procedures. It is a weakness that test procedures to some extent are different. The conservative group had 5 minutes warm up prior to the functional testing as compared to non for the arthroscopy group, both groups did tests that the other group did not, and both groups got different instructions when doing the muscle isometric hip muscle strength testing. It is unknown to what extent this have influenced the results and contributed to random variation. We have no control whether the patients met refreshed or not to the baseline testing which may have influenced the test results.

Hip range of motion and muscle strength

The inclinometer used to measure hip ROM has demonstrated high intra-rater reliability on healthy people (Hatton et al., 2014), but has not been tested among people with FAI syndrome. Active hip ROM reflects ROM required in functional activity, and is therefore a good measure on hip ROM.

A handheld dynamometer is a portable, clinic friendly and a relatively cheap option for measuring peak isometric hip muscle strength, which previously have shown excellent intra-rater (ICC 0.80 to 0.96) and inter-rater reliability (ICC 0.82-0.94) (Kemp, Schache, et al., 2013). The reliability testing has been conducted on heathy people, but may vary when conducted on people with hip pathology. Shoulder pain may influence the side bridge test results. We have no information whether this affected our results, but this may have affected the results if there was a between group difference present. Normalising of torque measures for body weight is important, heavier patients are able to generate higher peak torques than lighter patients. Normalised peak torque measures are therefore likely to reflect real differences in strength, and this strengthen our results internal validity.

Functional task performance

Single leg hop for distance test have not been tested for reliability and validity in patients with FAI syndrome (Kivlan & Martin, 2012). However, it has been described as a reliable measure of functional task performance in people with patellar tendinopathy (Crossley et al., 2007), in healthy people (Kemp, Schache, et al., 2013) and in people following anterior cruciate ligament reconstruction (Bryant, Newton, & Steele, 2009). Ability to hop a greater distance is associated with better iHOT-33 scores 12-24 months following hip arthroscopy in a group with chondrolabral pathology (Kemp et al., 2016), and it is relevant to investigate single leg hop for distance test in the FAI syndrome population before treatment.

The side bridge test have been assumed to be a measure of trunk muscle endurance and has shown good reliability (ICC=0.87, SEM=9.44) in healthy people (Kemp, Schache, et al., 2013), but have not been evaluated in patients with FAI syndrome. Side bridge test score has been reported to be lower in a group with chondropathy compared to healthy people (Kemp et al., 2016), and it may be a relevant measurement of function for the groups in our study.

Hip-related symptoms and quality of life

iHOT-33 is designed to measure hip-related symptoms and quality of life in a young, active population (18-60 years) with hip pathology. Is found reliable (ICC=0.93) and to a large extent face - and content valid (Mohtadi et al., 2012). HOOS are also found reliable for test-retest reliability (ICC=0.93-0.96) (Kemp, Collins, et al., 2013). Both iHOT-33 and HOOS appear to be the most appropriate PROs measuring hip-related symptoms and quality of life in people with FAI syndrome undergoing hip arthroscopy (Kemp, Collins, et al., 2013; Thorborg et al., 2015), and it is very relevant including patients own perceptions when evaluating difference in function between those eligible for hip arthroscopy and those eligible for conservative treatment.

Physical activity and type of sport

It is a weakness of this thesis that data of physical activity and sports were gathered after the baseline testing, and may therefore be influenced of selection bias. The conservative group received these questions by e-mail weeks after the baseline testing, and only 8 of 24 patients returned the questionnaires. We do not know the difference between the responders and the non-responders, and it may also be a risk that the patients who had gotten started with the conservative treatment answered in retrospective.

The results of type of sport was widely spread in the conservative group. Because of the low number of responders in conservative group, it is not appropriate to compare type of sport between the groups. It is also a weakness that we only suggested that the sport the patients had listed up first were their main sport. Referred to the knowledge of higher prevalence of cam deformities in some population sub groups, a question of level of participation in sport would be useful and strengthen this study.

When the HUNT questions were translated from Norwegian to English, physical activity was translated to “sports”. This difference is good to be aware of if the results shall be compared to other research, and some patients may not take part in sports, but are physically active

nevertheless.

5.3 Further research and clinical relevance

Further research

This study contributes with knowledge regarding differences in hip function among patients with FAI syndrome eligible for hip arthroscopy compared to those eligible for conservative treatment. We have not found similar studies, and very few studies have evaluated function among patients with FAI syndrome. Because of general inclusion criteria and no information whether the patient were athletes, the patients in the arthroscopy and the conservative group were assumed as "general population". Further research is required to evaluate hip function among athletes, differences between women and men, and include patients with the same hip morphologies in both groups (cam, pincer, a mix of cam and pincer or labrum tears). It is suggested to include larger samples to report more valid results. We did not have information whether the arthroscopy group had gone through conservative treatment, or if the patients had bilateral hip pathologies. This would strengthen the results in further studies.

Clinical signs and imaging used diagnose FAI syndrome suffer from great uncertainly. Further research to provide high-quality evidence on diagnosing FAI syndrome is needed. Larger studies and qualitative research would need to address differences in characteristics and function between those who go through hip arthroscopy compared to those conservatively treated.

Clinical relevance

The number of FAI-related publications have increased the last decade (Ayeni, Chan, et al., 2013). The published literature is characterized by large heterogeneity when it

comes to diagnosing FAI and FAI syndrome, and there is still a lack of high-quality studies of FAI syndrome treatment. In many cases, orthopaedic surgeons seem to have a pragmatic approach recommending hip surgery. Our results complement the knowledge of FAI syndrome by presenting the difference in function between those eligible for hip arthroscopy and those eligible for conservative treatment. There are many limitations regarding this study, mentioned here is the small sample size, different inclusion criteria in the arthroscopy and conservative studies, and lack of knowledge of activity level and bilateral hip pathology. Still, the results may be considered to complement the knowledge of FAI syndrome.

The scale-free between-groups effect size differences indicated that the arthroscopy group had higher hip muscle strength in involved leg. However, the statistical significant testing which is more conservative when small sample size did not report significant differences in hip muscle strength. Larger studies may investigate this further.

The decision on whether some patients with FAI syndrome should have hip arthroscopy and some should not, seems to be complex and is not based on any specific criteria (Ayeni, Naudie, et al., 2013; Ayeni et al., 2012; Peters et al., 2017; Wall et al., 2013). In Australia, the decision of choosing hip arthroscopy is often based on whether the patients can afford hip arthroscopy, as well as a whole lot of personal factors and beliefs. This may include how well they understand their condition, how much they think the hip surgery will "fix" them, whether they think they have exhausted all other treatment options, including conservative treatment with a physiotherapist, and whether the physiotherapy they have had has been sufficient. In Australia, a hip arthroscopy can cost up to $15,000, and a large portion of the hip arthroscopies are paid by the patients themselves. Also the Australian Government uses a lot of money on hip arthroscopies, but because of the low evidence on whether a hip arthroscopy is preferable over any other treatment, they have newly decided to cut funding for hip arthroscopy in managing FAI syndrome (Australian Government: Department of Health, 2017).

6. CONCLUSION

Patient characteristics do not differ between patients with FAI syndrome eligible for hip arthroscopy and those eligible for conservative treatment. Patients eligible for hip arthroscopy have somewhat impaired function compared to the conservative group. The hip arthroscopy group display more hip-related symptoms and worse functional task performance than those eligible for conservative treatment. Hip muscle strength does not differ significantly between groups in involved leg. However, effect size calculations show small to moderate between-group differences in involved leg, in favour to the arthroscopy group.

Larger studies and qualitative research need to address the differences in characteristics and function between patients with FAI syndrome eligible for hip arthroscopy compared to those eligible for conservative treatment.

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TABLE OVERVIEW

FIGURE OVERVIEW

APPENDIX

Appendix 1: Permission from Michael Leunig to reprint figure 1

Karianne Gåsland Bjellånes <bjellaanes@gmail.com> 17:52 (for 15 timer siden)

til Michael.leunig

Hi Michael,

I am contacting you in conjunction with my work om a Mastes' Thesis at The Norwegian School of Sport Science. I am writing about FAI syndrome, and compare range of motion, muscle strength and hip-related symptoms and quality of life in a group eligible for arthroscopy with people eligible for conservative treatment.

My question to you, is if I may reprint Figure 1 in an article from 2004:
Anterior Femoroacetabular Impingement
Part I. Techniques of joint Preserving Surgery

Hope to hear from you.

Best wishes from Karianne Bjellånes.

Leunig Michael (Schulthess Klinik) 18:24 (for 14 timer siden)

til meg

engelsk > norsk Oversett e-posten Slå av for: engelsk

No problem, good luck

Appendix 2: Permission from Damian Griffin to reprint figure 2

Permission to reprint figure 2 in the article " Prevalence of cam hip shape morphology: a systematic review" (2016) Innboks

Griffin, Damian
damian.griffin@warwick.ac.uk

Karianne Gåsland Bjellånes <bjellaanes@gmail.com> 13. mai (for 2 dager siden)
til damian.griffin

Hi Dr. Griffin,

I am writing a Master´s Thesis at The Norwegian School of Sport Science. I am writing about FAI syndrome, and compare hip range of motion, hip muscle strength and hip-related symptoms and quality of life in a group eligible for hip arthroscopy with people eligible for conservative treatment.

In that connection, I am asking to reprint figure 2 in "Prevalence of cam hip shape morphology: a systematic review (2016). http://dx.doi.org/10.1016/j.joca.2015.12.020

I will not publish the the thesis as an article.

Hope to hear from you soon.

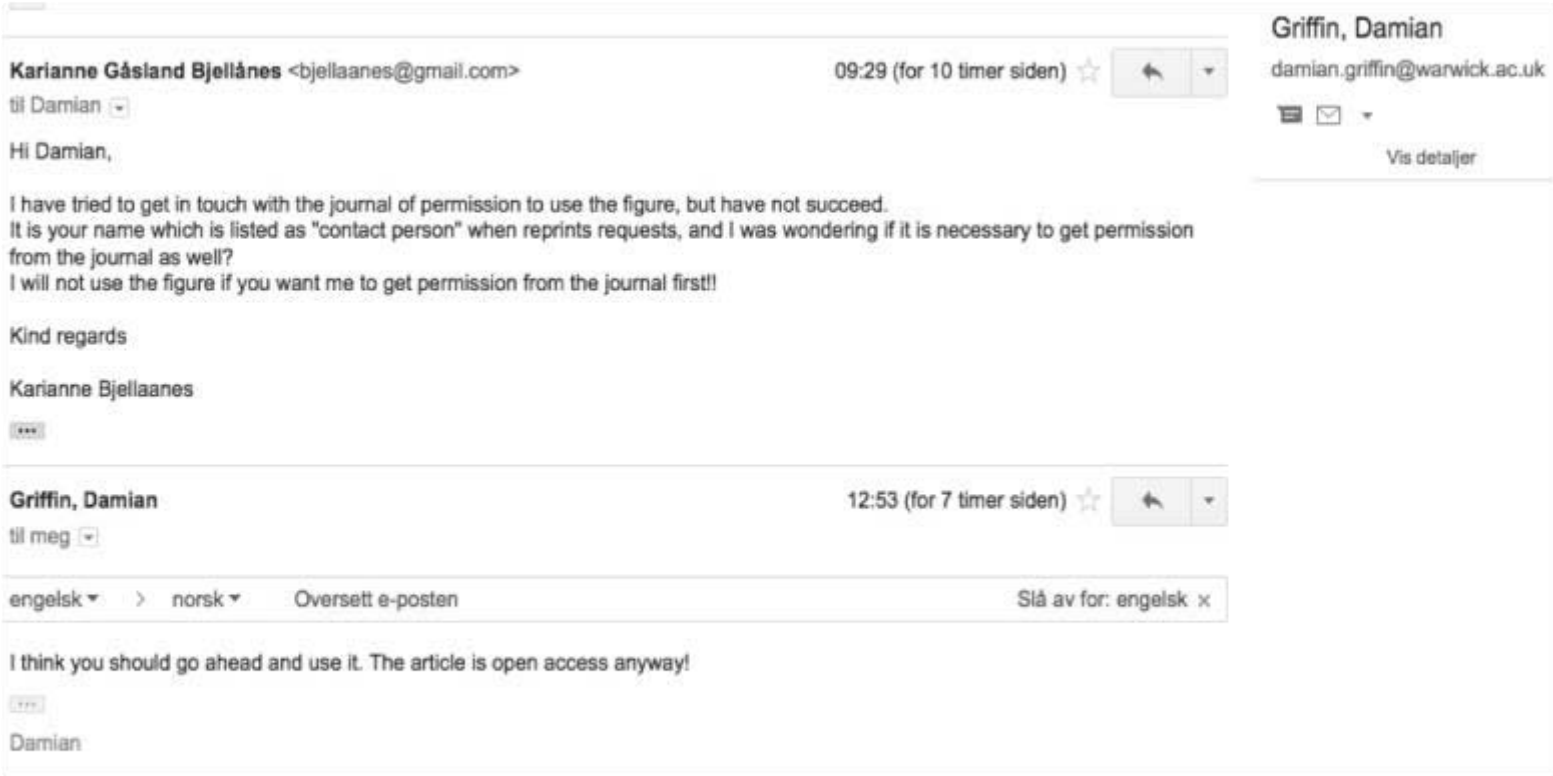
Best wishes from Karianne Bjellaanes

Griffin, Damian 13. mai (for 2 dager siden)
til meg

engelsk > norsk Oversett e-posten Slå av for: engelsk

Dear Karianne
You are most welcome to use our figure. May I suggest that you also seek permission from the journal?
I would love to see your thesis!
Kind regards

Damian



Griffin, Damian
damian.griffin@warwick.ac.uk
Vis detaljer

Karianne Gåsland Bjellånes <bjellaanes@gmail.com> 09:29 (for 10 timer siden)
til Damian

Hi Damian,

I have tried to get in touch with the journal of permission to use the figure, but have not succeed.
It is your name which is listed as "contact person" when reprints requests, and I was wondering if it is necessary to get permission from the journal as well?
I will not use the figure if you want me to get permission from the journal first!!

Kind regards

Karianne Bjellaanes

Griffin, Damian 12:53 (for 7 timer siden)
til meg

engelsk › norsk Oversett e-posten Slå av for: engelsk

I think you should go ahead and use it. The article is open access anyway!

Damian

Appendix 3: Table A of prospective case studies and pilot RCT studies including people with FAI syndrome treated either with arthroscopy or conservative treatment.

Table A: Prospective studies and pilot RCTs illustrating patient characteristics, inclusion criteria and function for patients with FAI syndrome eligible for either hip surgery or conservative treatment.

Study	Population/ inclusion criteria/ exclusion criteria	Outcome measured	Method of measurement	Sample size	Gender W/M	Mean age BMI (kg/m^2) Assessments at baseline
SURGERY STUDIES						
Rylander et al., 2011 Prospective case series	Morphology: all. General population. Imaging: AP, cross-table lateral, MRA. *Cam*: not specified. *Pincer*: Crossover sign and center-edge angle. Pain F and IR manoeuvre; Positive impingement + labral stress test; Intra-articular injection. *Exclusion*: trauma to the hip.	ROM Pain Activity level	3D motion during gait VAS TAS	N=11	0/11	Age: 33.1±7.8, VAS: 4.6± 2.2, TAS: 4.1±1.7 ROM (overall hip sagittal plane): involved leg: 27.6°±5.0°; Uninvolved leg: 29.1°±4.7°.
Rylander et al., 2013 Prospective case series	Morphology: all types. General population. Imaging: AP, cross-table lateral, MRI/MRA. *Cam*: Alpha angle >54°. *Pincer*: Center-edge angle >35°, crossover, positive wall, ischial spine sign. Pain F + IR manoeuvre; Positive impingement test; Labral stress test; Intra-articular injection. *Exclusion*: Not specified.	ROM Pain Activity level	3D motion during gait VAS TAS	FAI group: N=17 Controls: N=17	Both groups: 3/14	*FAI group*: Age: 34.9±9.7, BMI: 25.9 ± 4.6, TAS: 3.7±1.7, VAS: 4.9, ROM: not specified *Control*: Age: 34.9±9.7, BMI: 24.7 ± 3.2, TAS: 5.2 ± 1.9, VAS: not specified
Brisson et al., 2013 Prospective case series	Morphology: cam. Imaging: AP and Dunn. *Cam*: Alpha angle >50.5°. Positive impingement test. *Exclusion*: Hip OA (Tönnis grade >1).	ROM Pain/stiffness/ function	3D motion analyses WOMAC	FAI group: N=10 Controls: N=13	FAI: 3/7 Control: 5/8	FAI group: Age: 29.9±7.2, BMI: 23.3±2.7 Controls: Age: 34.2±9.9, BMI: 23.1±2.4
Dippmann et al., 2014 Prospective case series	Morphology: all types. Imaging: AP and cross-table of pelvis. *Cam*: alpha angle >55°. *Pincer*: Positive crossover sign. Pain; Positive impingement test; Intra-articular injection. *Exclusion*: Not specified.	Symptoms Pain	mHHS VAS	N=87	55/32	Age: W: median 38 (15-59). M: median 38 (17-63). mHHS: 59.9±1.9 VAS: 57.9±2.6

Bennell et al., 2014 Protokol RCT surgery with/without rehabilitation	Morphology: all types. Not professional athlete; 16-35 years. Imaging: not specified. *Cam/pincer:* not specified. Symptomatic FAI scheduled for surgery: Hip/groin symptoms ≥3 months; Symptoms, clinical signs and imaging findings. *Exclusion:* OA Tönnis >grade 1.	Symptoms Function Activity	iHOT-33 HOS HAGOS HAS Modified TAS	N=100 1:1	W and M	Age: 16-35 Study not started.
Larson et al., 2008 Prospective case series	Morphology: all. Imaging: AP, frog-leg lateral, cross-table lateral and MRA. *Cam*: Alpha angle, cut-off not specified. *Pincer*: Not specified. Groin pain related to activity/ prolonged sitting. Intraarticular injection. *Exclusion:* Tönnis grade ≥3	Symptoms Impingement Pain	mHHS SF-12 Impingement test; E + ER VAS (0-10 cm)	N=100	42/58	Age: 34.7 (16-64 years) mHHS: 60.8 SF-12: 60.2 VAS: 6,74 Positive impingement test: 100%
Krych et al., 2013	Morphology: Labral and pincer, or pincer and cam. General population, females >17 years. Imaging: AP and MRI. *Cam*: alpha angle >45°. *Pincer*: acetabular retroversion, coxa profunda, acetabular protrusion. History and positive impingement test. *Exclusion:* hip surgery; OA Tönnis grade >2.	Function	ADL HOS Sport HOS	18/18		*Repair:* Age: 38 (range, 20-59) ADL HOS: 68.2 (26.6-92.6) Sport HOS: 47.5 (0-80.6) *Debridement:* Age: 39 (19-55) ADL HOS: 60.2 (23.5-91.2) Sport HOS: 40.6 (28.6-100)
Nepple et al., 2014 Prospective case series	Morphology: all. General population <50 years, both gender. Imaging: not used. Failure conservative treatment, Tönnis grade ≤1. *Exclusion*: acetabular dysplasia, hip surgery, pediatric hip disease.	Function Passive ROM Morphology	mHHS WOMAC HOOS SF-12 Goniometer	N=100	50/50	*Hip flexion ROM:* W/M: 97.6°±5.6°/94.4°±4.5° *HOOS: Pain*: W/M: 49.3±19.5/ 62.3±4.5° *Symptoms*: W/M:49.0±19.1/ 61.5±22.5 *ADL*: W/M: 60.9±21.6/71.9±20.6 *Sports*: W/M: 40.5±24/ 49.1±26.1 *QOL*: W/M: 29.2±16.9/32.6±20.9
CONSERVATIVE STUDIES						

Wright et al., 2016 Conservative Pilot RCT	Morphology: all. General population 18-55 years. Imaging: not specified. *Cam*: alpha angle >55°. *Pincer*: coxa profunda, acetabular over coverage (lateral center-edge angle >35°), acetabular retroversion. ≥2 clinical signs: hip pain, hip F <95°, IR<10°, positive FADIR and FABER. *Exclusion:* Hip surgery; manual therapy; OA.	Function Pain ROM	HOS: ADL VAS ROM: Not specified	N=15	11/4	Age: 33.7±9.5 BMI: 24.8±5.8 Pain: 39.5±20.6 ROM: hip flexion 108±23 HOS ADL: 74.0±11.7 HOS Sport: 55.1±16.9
Smeatham et al., 2016. Conservative Pilot RCT	Morphology: not specified. General population 18-50 years. Imaging: AP and lateral pelvis. *Cam/ pincer:* not specified. Groin or anterolateral hip pain; mechanical symptoms; positive FADIR. *Exclusion:* Surgery hip/ pelvis; back pain.	General health Function Pain	EQ-5D-3L LEFS VAS (0-10)	Intervention: N=15 Normal care: N=15	FAI group: 8/7 Control: 10/5	*Intervention:* Age: 35.9 (18.6-48.8); VAS: 4.5±2.5; HOS ADL: 69±39 HOS sport: 51.5±19.7 *Normal care:* Age: 32.6 (18.5-50.3); VAS: 4.5; HOS ADL: 75±25; HOS sport: 59.0±24.5
Emara et al., 2011 Prospective case series. Activity anti-inflammatory/ activity	Morphology: all. Athletic population <55 years. Imaging: AP and frog-leg lateral. *Cam*: Alpha angle <60°. *Pincer*: Centre-edge angle, acetabular retroversion. Positive impingement test. Hip pain secondary to FAI. *Exclusion:* History of hip disease or surgery; alpha angle >60°; OA, no-spherical femoral head.	Symptoms ROM Pain	HHS ROM: not specified VAS (0-10)	N=37	N= 10 W	Age: 33±5 *ROM involved leg:* ABD 37.0°±0.4; ADD 17.0°±7.0; F 95.0°±0.4; E 4.0°±1.6°; IR in E 15.8°±0.4; ER in E 25.3°±0.3. *ROM uninvolved leg:* ABD 43.0°±3.3°; ADD 19.0°±8.0°; F 103.0°±2.6; E 4.3°±1.7°; IR in E 19.0°±3.2°; ER in E 29.7°±3.2. VAS: 6±1. HHS: 72.6
Wall et al., 2016 Protocol RCT (surgery vs conservative care) and pilot conservative	Morphology: all. General population ≥16 years. Imaging: AP and cross sectional. *Cam*: Alpha angle >55°. *Pincer*: Lateral centre-edge angle >40°, crossover sign. Clicking, catching, giving way; Surgery appropriate. *Exclusion:* OA Tönnis grade >1; Other hip pathology.	Hip-related quality of life, general, health, health economics	iHOT-33 SF-12 EQ5D	N=42 The same participants in both treatment groups	12/30	Age: 33.4±6.4 iHOT-33: 31.4±15.2 SF-12 Physical: 31.1±15.2 SF-12 Mental: 46.4±15.0

ABD = abduction; ADD = adduction; AP = anterior-posterior pelvic view; BMI = body mass index; E = extension; ER = external rotation; HAS = Heidelberg's Sports Activity Score; HAGOS = Copenhagen Hip and Groin Outcome Score; F = flexion; HHS = Harris Hips Score; HOS = Hip Outcome score; LEFS = Lower extremity Functional Score; M = male; mHHS = modified Harris Hip Score; MRI/MRA = magnetic resonance imaging/arthrography; ROM = range of motion; SF-12 = Short Physical; TAS = Tegner Activity Score; VAS = visual analogue scale; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; W = women.

Appendix 4: HARP study approval from Human Research Ethics Committee.

Approval

Human Research Ethics Committee

Federation UNIVERSITY • AUSTRALIA

Principal Researcher:	Joanne Kemp
Other/Student Researcher/s:	Caroline Finch Kay Crossley
School/Section:	**ACRISP**
Project Number:	**A15-052**
Project Title:	**Risk factors for early hip osteoarthritis: A longitudinal cohort study.**
For the period:	08/05/2015 **to** 30/06/2017

Quote the Project No.A15-052 in all correspondence regarding this application.

Please note: Ethics Approval is contingent upon the submission of annual progress reports and a final report upon completion of the project. It is the responsibility of researchers to make a note of the following dates and submit these reports in a timely manner, as reminders may not be sent out. Failure to submit reports will result in your ethics approval lapsing.

REPORTS TO HREC:

Annual reports for this project must be submitted to the Ethics Officer on:
8 May 2016
8 May 2017

A final report for this project must be submitted to the Ethics Officer on:
30 July 2017

These report forms can be found at:
http://federation.edu.au/research-and-innovation/research-support/ethics/human-ethics/human-ethics3

Fiona Koop

Ethics Officer
8 May 2015

Please see attached 'Conditions of Approval'.

CONDITIONS OF APPROVAL

1. The project must be conducted in accordance with the approved application, including any conditions and amendments that have been approved. You must comply with all of the conditions imposed by the HREC, and any subsequent conditions that the HREC may require.

2. You must report immediately anything which might affect ethical acceptance of your project, including:

   - Adverse effects on participants;
   - Significant unforeseen events;
   - Other matters that might affect continued ethical acceptability of the project.

3. Where approval has been given subject to the submission of copies of documents such as letters of support or approvals from third parties, these must be provided to the Ethics Office before the research may commence at each relevant location.

4. Proposed changes or amendments to the research must be applied for, using a '**Request for Amendments**' form, and approved by the HREC before these may be implemented.

5. If an extension is required beyond the approved end date of the project, a '**Request for Extension**' should be submitted, allowing sufficient time for its consideration by the committee. Extensions cannot be granted retrospectively.

6. If changes are to be made to the project's personnel, a '**Changes to Personnel**' form should be submitted for approval.

7. An '**Annual Report**' must be provided by the due date specified each year for the project to have continuing approval.

8. A '**Final Report**' must be provided at the conclusion of the project.

9. If, for any reason, the project does not proceed or is discontinued, you must advise the committee in writing, using a '**Final Report**' form.

10. You must advise the HREC immediately, in writing, if any complaint is made about the conduct of the project.

11. You must notify the Ethics Office of any changes in contact details including address, phone number and email address.

12. The HREC may conduct random audits and / or require additional reports concerning the research project.

Failure to comply with the *National Statement on Ethical Conduct in Human Research* (2007) and with the conditions of approval will result in suspension or withdrawal of approval.

Appendix 5: FIRST study approval from La Trobe University Human Ethics Committee.

LA TROBE UNIVERSITY

University Human Ethics Committee

RESEARCH OFFICE

MEMORANDUM

To: **Professor Kay Crossley, School of Allied Health, College of SHE**

From: **Senior Human Ethics Officer, La Trobe University Human Ethics Committee**

Subject: **Review of Human Ethics Committee Application No. 15-076**

Title: **A pilot double-blind randomised controlled trial comparing two physiotherapy interventions to treat femoroacetabular impingement (Femoroacetabular Impingement Rehabilitation STudy-FIRST).**

Date: **2 November 2015**

Thank you for your recent correspondence in relation to the research project referred to above. The project has been assessed as complying with the *National Statement on Ethical Conduct in Human Research*. I am pleased to advise that your project has been granted ethics approval and you may commence the study now.

The project has been approved from the date of this letter until 31 December 2016.

Please note that your application has been reviewed by a sub-committee of the University Human Ethics Committee (UHEC) to facilitate a decision before the next Committee meeting. This decision will require ratification by the UHEC and it reserves the right to alter conditions of approval or withdraw approval at that time. You will be notified if the approval status of your project changes. The UHEC is a fully constituted ethics committee in accordance with the National Statement under Section 5.1.29.

The following standard conditions apply to your project:

- **Limit of Approval.** Approval is limited strictly to the research proposal as submitted in your application while taking into account any additional conditions advised by the UHEC.

- **Variation to Project.** Any subsequent variations or modifications you wish to make to your project must be formally notified to the UHEC for approval in advance of these modifications being introduced into the project. This can be done using the appropriate

form: *Modification to Project – Human Ethics* which is available on the Human Ethics website at http://www.latrobe.edu.au/researchers/ethics/human-ethics If the UHEC considers that the proposed changes are significant, you may be required to submit a new application form for approval of the revised project.

- **Adverse Events.** If any unforeseen or adverse events occur, including adverse effects on participants, during the course of the project which may affect the ethical acceptability of the project, the Chief Investigator must immediately notify the Senior Human Ethics Officer. An *Adverse Event Form – Human Ethics* is available at the Research Office website (see above address). Any complaints about the project received by the researchers must also be referred immediately to the Senior Human Ethics Officer.

- **Withdrawal of Project.** If you decide to discontinue your research before its planned completion, you must advise the UHEC and clarify the circumstances.

- **Monitoring.** All projects are subject to monitoring at any time by the University Human Ethics Committee.

- **Annual Progress Reports.** If your project continues for more than 12 months, you are required to submit a Progress Report annually, **on or just prior to 12 February**. The form is available on the Research Office website (see above address). Failure to submit a Progress Report will mean approval for this project will lapse.

- **Auditing**. An audit of the project may be conducted by members of the UHEC.

- **Final Report.** A Final Report (see above address) is required within six months of the completion of the project or by **30 June 2017.**

If you have any queries on the information above or require further clarification please email: **humanethics@latrobe.edu.au** or contact me by phone.

On behalf of the University Human Ethics Committee, best wishes with your research!

Kind regards,

Ms Sara Paradowski
Senior Human Ethics Officer
Executive Officer – University Human Ethics Committee
Ethics and Integrity / Research Office
La Trobe University Bundoora, Victoria 3086
P: (03) 9479 – 1443 / F: (03) 9479 - 1464
http://www.latrobe.edu.au/researchers/ethics/human-ethics

Appendix 6: Approval letter for the ethics amendment FIRST study

Amendment Approval

Human Research Ethics Committee

Federation UNIVERSITY • AUSTRALIA

Principal Researcher:	Dr Joanne Kemp
Other/Student Researcher/s:	Prof Caroline Finch Prof Kay Crossley
School/Section:	**ACRISP**
Project Number:	**A15-052**
Project Title:	**Risk factors for early hip osteoarthritis: A longitudinal cohort study**
For the period:	29/07/2015 **to** 30/06/2017

Quote the Project No **A15-052** *in all correspondence regarding this application.*

Please note: Ethics Approval is contingent upon the submission of a ***Final Project Report*** upon the completion/discontinuation of the project. ***Annual Project Reports*** must also be submitted if the duration of the project exceeds twelve months. It is the responsibility of researchers to make a note of the following dates and submit these reports in a timely manner, as reminders may not be sent out. Failure to submit reports will result in your ethics approval lapsing.

REPORTS TO HREC:

An annual report for this project must be submitted to the Ethics Officer on:
8/05/2016
8/05/2017

A final report for this project must be submitted to the Ethics Officer on:
30/07/2017

These report forms can be found at:
http://federation.edu.au/research-and-innovation/research-support/ethics/human-ethics/human-ethics3

Irene Hall
Ethics Officer
4/08/2016

Please see attached 'Conditions of Approval'.

Amendment Approval

Human Research Ethics Committee

Federation UNIVERSITY • AUSTRALIA

Principal Researcher:	Dr Joanne Kemp
Other/Student Researcher/s:	Prof Caroline Finch Prof Kay Crossley
School/Section:	**ACRISP**
Project Number:	**A15-052**
Project Title:	**Risk factors for early hip osteoarthritis: A longitudinal cohort study**
For the period:	29/07/2015 **to** 30/06/2017

Quote the Project No **A15-052** *in all correspondence regarding this application.*

Please note: Ethics Approval is contingent upon the submission of a ***Final Project Report*** upon the completion/discontinuation of the project. ***Annual Project Reports*** must also be submitted if the duration of the project exceeds twelve months. It is the responsibility of researchers to make a note of the following dates and submit these reports in a timely manner, as reminders may not be sent out. Failure to submit reports will result in your ethics approval lapsing.

REPORTS TO HREC:

An annual report for this project must be submitted to the Ethics Officer on:
8/05/2016
8/05/2017

A final report for this project must be submitted to the Ethics Officer on:
30/07/2017

These report forms can be found at:
http://federation.edu.au/research-and-innovation/research-support/ethics/human-ethics/human-ethics3

Irene Hall
Ethics Officer
4/08/2016

Please see attached 'Conditions of Approval'.

Appendix 7: Written information HARP study.

Plain Language Information Statement

AUSTRALIAN CENTRE FOR RESEARCH INTO INJURY IN SPORT AND ITS PREVENTION (ACRISP)

PROJECT TITLE:	**Risk factors for early hip osteoarthritis: A longitudinal cohort study**
PRINCIPAL RESEARCHER:	**Dr Joanne Kemp (Federation University Australia)**
OTHER RESEARCHERS:	**Professor Caroline Finch (Federation University Australia),** **Professor Kay Crossley (La Trobe University)**

Background and purpose

This is an invitation for you to participate in a research study of people with hip pain, which involves testing of patients undergoing hip arthroscopy for impingement and labral tears. Patients who consult an orthopaedic surgeon for hip pain to have hip arthroscopy surgery for hip impingement and/or labral tears, will be invited to take part in the study. Hip arthroscopy is a relatively new surgical procedure for patients with hip pain to reduce pain and improve function. This study is designed to determine the natural progression and recovery for hip arthroscopy, particularly with respect to reducing pain and improving function for people with hip pain and hip impingement and/or labral tears.

The research team

Dr Joanne Kemp is a post-doctoral research fellow and clinical sports physiotherapist of 22 years' experience. She has extensive experience in research and clinical treatment of hip pain and pathology, and hip arthroscopy rehabilitation. Professor Caroline Finch is a sports injury and sports medicine professor of >30 years' experience. She has extensive experience in studies examining sports injury and sports medicine. Professor Kay Crossley is a physiotherapy professor and sports physiotherapist of >30 years' experience. She has extensive experience in studies of musculoskeletal injury. She has extensive experience with clinical studies and rehabilitation for musculoskeletal pain and osteoarthritis in the hip and knee.

What does the study involve?

If you agree to take part in the study, you will undergo a baseline assessment prior to surgery. In this appointment, you will complete some questionnaires and perform some physical tests. The questionnaires ask about your hip pain and its impact on your ability to participate in daily and sporting activities. The physical tests include hip movement, hip muscle strength and balance tests. In addition, you will be asked to attend a radiology clinic in Melbourne (Imaging at Olympic Park) to have magnetic resonance imaging (MRI) scans of your hip. If you have a pacemaker, metal implants, are pregnant or claustrophobic, or prefer not to for any other reason, you will not undergo the scans of your hip. You will then undergo your hip arthroscopic surgery as planned. The same questionnaires and physical tests (that were performed at baseline) will be repeated at 12 and 24 months following the surgery. The tests will be conducted at the surgeon's rooms at a convenient time to you. A fully qualified physiotherapist will undertake the testing procedures. We will also access your medical records to obtain information about your scans taken of your hip prior to surgery, and details of your surgical procedure.

In addition, you may also be asked for additional consent to be contacted five years and ten years after surgery for further follow-up.

Potential advantages, disadvantages and serious adverse events

The main advantage is potential for future patients with hip pain who are in your position and are considering undergoing hip arthroscopy surgery. We will have a better understanding of the condition, the risk factors for reducing pain and improving function.

There are small/minor benefits to your taking part in this study: You will obtain a full physical assessment of hip function at no financial cost.

The main disadvantage of participation is your time commitment. This includes 3 assessment sessions each of 30-60 minutes duration at baseline, 12 and 24 months follow-up. Serious adverse events are very unlikely, although they are possible, including moderate discomfort in physical hip testing. Other complications are related to your planned surgical procedure and include risks of undergoing anaesthesia, and the risk of post-operative infection. The risk will be reduced by following standard care clinical pathways.

What will happen to your personal information?

The samples and data that are registered about you will only be used in accordance with the purpose of the study as described above. Your data will be re-identifiable. This means that the information is processed without your name, personal identification number or other directly recognisable type of information. Instead a code number links you to your data. This code list is stored at the clinic/hospital only, and only the authorised study staff will have access to this list. Confidentiality of your personal information is a priority, subject to legal limitations. Data from this and any follow-up studies will be destroyed 5 years after the final report is published. It will not be possible to identify you in the results of the study when these are published.

Voluntary participation

Participation in the study is voluntary. Choosing to participate or not has no impact on the treatment provided by your surgeon. You can withdraw your consent to participate in the study at any time and without stating any particular reason. It confirms that involvement in the project is voluntary and that participants are free to withdraw at any time, or withdraw any unprocessed data previously supplied. This will not have any consequences for your further treatment. If you complete the follow-up phases of the study, you will be eligible for a small gift voucher to thank you for your participation.

Additional Information

This study has received funding from the Physiotherapy Research Foundation (Australian Physiotherapy Association). If requested, participants will be provided with a copy of the results of the study at its conclusion via email. In addition, participants will be able to discuss their individual results at any time with the researchers. The results of this study will be presented at national and international sports medicine and rheumatology conferences and will be published in international peer-reviewed journals.

If you have any questions, or you would like further information regarding the project titled
Risk factors for early hip osteoarthritis: A longitudinal cohort study,
please contact the Principal Researcher, ***(Dr Joanne Kemp)*** of the
AUSTRALIAN CENTRE FOR RESEARCH INTO INJURY IN SPORT AND ITS PREVENTION
(ACRISP):
PH: 03 53 279 587
EMAIL: j.kemp@federation.edu.au

Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia,
P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842.
Telephone: (03) 5327 9765, (03) 5122 6446
Email: research.ethics@federation.edu.au

CRICOS Provider Number 00103D

Appendix 8: Written information FIRST study

LA TROBE UNIVERSITY

A pilot double-blind randomised controlled trial comparing two physiotherapy interventions to treat femoracetabular impingement.

La Trobe Sports and Exercise Medicine Research Centre

Participant Information Statement

We invite you to participate in our project "A pilot double-blind randomised controlled trial comparing two physiotherapy interventions to treat femoroacetabular impingement." We would like to give you some background information to explain why we think this project is important and describe what we would like you to do if you decide to join us in this research.

What is the purpose of this study?

Femoroacetabular (hip) impingement is a painful condition that commonly affects healthy active younger adults. It can limit their ability to continue playing sport and perform normal daily activities. It can be related to extra bone formation at the hip joint known as a cam deformity. Physiotherapy is one treatment people may use to reduce their symptoms and improve their function. However there are many different techniques that physiotherapists use to treat this condition. We would like to compare the benefits of two different treatments to find the best way to manage this condition. We are also testing the methods we are using to conduct this pilot study. If we find a difference between the physiotherapy treatments we could use the same study methods to run a much larger project. Funding for this project has been provided by La Trobe Sports and Exercise Medicine Research Centre and La Trobe University.

Who can participate in this study?

You can participate in this study if:

- You are aged 18 to 50 years
- You have had moderate hip or groin pain for more than 6 weeks
- You have signs of hip impingement when your hip is tested by a physiotherapist
- Your x-ray shows you have a cam deformity

You are not eligible to participate in this study if:

- You cannot understand written or spoken English
- You have had physiotherapy for your hip in the past three months
- You have had hip surgery before
- You are not able to commit to a twelve week physiotherapy program, baseline (beginning) or follow-up assessment (at twelve weeks-after treatment)
- You are unable to have an x-ray of your pelvis (both hips at once) eg. You are pregnant/unwilling

What does the project involve?

You will be invited to attend the physiotherapy clinic at Lake Health Group, Ballarat, to undergo a physiotherapy assessment to ensure you are eligible for the study. You will be asked to bring any previous x-rays of your sore hip. If you don't have x-rays we will test you movements first before organising a hip (pelvic) x-ray for you at Lake Imaging, Ballarat (if you are willing and able). This assessment will take about half an hour.

If your movement tests and x-rays indicate you are eligible, we will ask you to attend an appointment at a mutually convenient time at Federation University, Ballarat, to undergo baseline measurement of your hip movements and strength. These baseline tests will also take about half an hour.

Following the assessment you will receive several questionnaires to complete, either online or hardcopy. The questionnaires will ask you questions about your hip/groin pain, other hip-related symptoms and your levels of physical activity.

After the first assessment and completion of the questionnaires, you will be randomly allocated to one of the treatment groups. You will have an equal chance of receiving either of the two treatments. Both treatments are used regularly by physiotherapists. You will then be asked to attend the physiotherapy clinic at Lake Health Group in Ballarat for eight physiotherapy treatments over a period of twelve weeks. The first four treatments are once per week for four weeks, then once per fortnight over the remaining eight weeks. Each treatment will last 30 minutes and will be performed by an experienced, titled Sports Physiotherapist. You will also be asked to perform a gym-based exercise program once per week at the same clinic. There are also exercises to complete at home. All treatments and any use of gym equipment will be provided at no cost to you.

You will then complete the same (follow-up) assessment at twelve weeks, with the same examiner physiotherapist at Federation University. This will take approximately the same amount of time as the first assessment (about 30 minutes). The examiner physiotherapist will not know which treatment you have received. We ask you not to discuss your treatment with the examiner. We will also provide the same follow-up questionnaires for you to complete again, in hardcopy, or online.

You will not receive any payment for your participation, however you will have free assessment of your hip problem and free physiotherapy if you are eligible and choose to participate. You may ask for a copy of your assessment results.

Are there any potential side-effects?

The impingement and movement tests represent usual examination by a physiotherapist. You may experience a small amount of discomfort in the joints or tiredness in the muscles during the movement and strength testing and interventions. Please report any undue discomfort or pain experienced during the testing. If the pain or discomfort is deemed to be excessive by yourself or the examiner, testing will cease.

If required, emergency procedures will be used to deal with any medical event that arises during testing or physiotherapy treatments. The Federation University and Lake Health Group have documented procedures for emergencies. This includes annual St John's ambulance and CPR training and appropriate management of fire for all staff.

What if I have any concerns during the study?

This study is funded La Trobe Sports and Exercise Medicine Research Centre at La Trobe University, Bundoora. This study adheres to the La Trobe University Human Ethics Guidelines and National Statement on Ethical Conduct in Human Research. Whilst you are free to discuss your participation in this study with the project coordinator (Sally Coburn ph:???), you may want to an officer of the University not involved with the study. If so, you may contact the Ethics Coordinator, Sara Paradowski on ph: (03) 9479 1443

Can I withdraw from the study if I wish?

Your participation in the study is voluntary. If you do not wish to take part you are under no obligation to do so. If you decide to take part and later change your mind, you are free to withdraw from the study at any stage. You may also withdraw any unprocessed data previously supplied by you. You have 4 weeks after data is collected to withdraw data from the study.

If you are a patient of the investigating physiotherapists, your decision whether to take part or not to take part, or to withdraw, will **not** affect your treatment or care at any health clinic you are associated with at any time in any way.

Will my details be kept confidential?

Our procedures require allocation of a code number to identify you and any data associated with your participation. This assures your anonymity as your name will not be used. No findings that identify you will be published and access to individual results is restricted to the investigators. Video data of you will be de-identified through obscuring of facial features. Video data will only be accessible to the researchers, and individual video data will not be published. Coded data will be stored for at least 5 years. All data and results will be handled in a strictly confidential manner, under guidelines set out by the National Health and Medical Research Council. Data may be used for future studies including this one, however the researchers will obtain your consent prior to doing so. The chief investigator is responsible for maintaining this confidentiality. This project is subject to the requirements of the La Trobe University Human Ethics Guidelines. However, you must be aware that there are legal limitations to data confidentiality.

What will happen to the results of the study?

Summaries of the study results will be sent to participants, if requested on consent form. The results of the study will be presented at national and/or international conferences and may be published in peer-reviewed publications. Results may also be used for teaching purposes and web-based translational material. All results are de-identified.

How do I get more information?

You should ask for any information you want. If you would like more information about the study, or if there is any matter that concerns you, either now or in the future, do not hesitate to ask one of the investigators or project coordinator. Before deciding whether or not you should take part you may wish to discuss the matter with a relative or friend or with your local doctor. You should feel free to

do this. A newsletter will be sent to update you during the project. A project summary will be available, on request via email/post at the conclusion of the study and will include no identifiable information.

About the investigators:

Dr Kay Crossley is a sports physiotherapist and professor at La Trobe Sports and Exercise Medicine Research Centre at La Trobe University, Bundoora.

Dr Joanne Kemp is a sports physiotherapist and post-doctoral researcher at Australian Centre for Research into Injury in Sport and its Prevention, Federation University, Ballarat.

Denise Jones is a physiotherapist and research assistant at Australian Centre for Research into Injury in Sport and its Prevention, Federation University.

Sally Coburn is a physiotherapist and research assistant at La Trobe Sports and Exercise Medicine Research Centre at La Trobe University, Bundoora.

To contact any of the investigators, please contact:

Sally Coburn:

Mobile: 0457 311 203

Email: S.Coburn@latrobe.edu.au.

Appendix 9: Informed consent HARP study

Consent Form

PROJECT TITLE:	**Risk factors for early hip osteoarthritis: A longitudinal cohort study**
RESEARCHERS:	**Dr Joanne Kemp, Professor Kay Crossley, Ms Denise Jones**

Consent – Please complete the following information:

I, ... of . . . . . .
. . . . . .
hereby consent to participate as a subject in the above research study.

The research program in which I am being asked to participate has been explained fully to me, verbally and in writing, and any matters on which I have sought information have been answered to my satisfaction.

I understand that: all information I provide (including questionnaires) will be treated with the strictest confidence and data will be stored separately from any listing that includes my name and address.

- aggregated results will be used for research purposes and may be reported in scientific and academic journals
- ***I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and any information obtained from it will not be used.***
- ***once information has been aggregated it is unable to be identified, and from this point it is not possible to withdraw consent to participate***

SIGNATURE: . . . . . **DATE**: . . . . . .

Appendix 10: Informed consent FIRST study

LA TROBE UNIVERSITY

La Trobe Sports and Exercise Medicine Research Centre

Consent form for persons participating in research projects

Name of participant: _____

Project title: A pilot double-blind randomised controlled trial of two physiotherapy interventions for femoroacetabular impingement.

Investigators: Dr Kay Crossley, and Dr Joanne Kemp

1. I consent to participate in the above project, the particulars of which (including details of tests or procedures) have been explained to me to my satisfaction.
2. I authorise the investigator or his or her assistant to use the tests, which includes procedures referred to above.
3. I acknowledge that:
   a) The possible effects of the tests or procedures have been explained to me to my satisfaction;
   b) My participation is voluntary and I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied;
   c) I will not gain financial benefit from participation;
   d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements;
   e) My participation will not affect my current or future physiotherapy management at Lake Health Group physiotherapy clinic;

I, _____ consent to participate in the above project.

Signature (Participant):_____ Date: ___ /___ /___

Signature (Witness):_____ Date: ___ /___ /___

I am willing to have videos taken during the testing session and consent for these videos to be used solely for education and research purposes at physiotherapy schools at other universities in Australia and when presentations are made at conferences/workshops in national and international settings:

Yes □ No □

I consent to de-identified data to be used for comparison with other projects: Yes □ No □

I request a project summary be sent to me at the conclusion of the study: Yes □ No □