BACKGROUND
The hip joint and FAI as a cause of groin pain
In recent times the hip joint has been recognised as a significant cause of hip and groin pain in the athletic population. It accounts for approximately 12% of soccer-related injuries and is the third most common injury in the Australian Football League. Groin pain is frequently reported in those with hip pathology attending for arthroscopy, evidenced by 92% of patients with labral tears. The most common site of pain referral in people with labral tears has been reported as the central groin region.

Hip pain often coexists with other groin-related pathologies, including pubic and adductor symptoms, which can make

A CASE STUDY AND RATIONALE FOR TREATMENT

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CASE PRESENTATION: WHAT IS THE PROBLEM?

A 21-year-old male state-level field hockey player presented with a 5 year history of intermittent episodes of right-sided groin pain. He described the onset of pain 5 minutes into a hockey training session or match, which worsened as the session progressed. His pain settled after 48 hours of rest. His pain deteriorated during the season and subsided with rest once the season had ended. During the off-season he swims, jogs and cycles and does not experience pain. For the first 2 years he attended sports medicine clinics where he was diagnosed with adductor tendinopathy and treated with repeated cortisone injections and an adductor strengthening programme. This did not improve his symptoms. His groin pain is now impacting on his ability to pursue a career as a professional hockey player.
definitive diagnosis and appropriate management difficult and often multi-facto-rial. Recent studies have found that 94% of athletes with long-standing adductor-related groin pain have radiological signs of femoroacetabular impingement (FAI)\(^6\)\(^7\).

FAI describes a morphological variant seen in approximately 20% of the general population\(^8\) and has been comprehensively described in recent years\(^9\)-\(^11\). Three types of FAI are commonly described:

1. **Cam lesion** which describes a reduced femoral head-neck offset, resulting in additional bone most commonly seen on the anterior, superior or antero-superior aspect of the femoral head-neck junction\(^11\).

2. **Pincer impingement.** This refers to bony change seen in the acetabulum and can either present as a deep acetabulum which is most commonly seen anteriorly\(^8\)-\(^12\) or as a retroverted acetabulum, which leads to an apparent deeper anterior acetabular wall.

3. **Mixed presentation** where both cam and pincer lesions are seen.

**Where does the pain come from?**

Whilst FAI is not considered to be hip pathology, it is recognised as an anatomical variant within a normal range\(^13\)-\(^14\) that may increases the risk of intra-articular hip pathology, including labral tears and chondropathy\(^15\)-\(^23\) and contribute to the development of groin pain\(^14\)-\(^24\). When the hip joint with FAI is placed into a position of impingement in a repetitive fashion during sporting activities, micro-trauma may occur in the hip. The presence of FAI has been shown to be associated with labral tears, most likely due to impingement of the labrum between the bony components of the hip\(^18\)-\(^22\). Moreover, the presence of FAI and labral pathology may lead to an increased risk of chondropathy and ultimately hip osteoarthritis (OA)\(^22\). This increased risk is possibly due in part to the increased loads placed on the acetabular chondral surfaces when the function of the labrum is compromised\(^25\). Damage to the labrum and the acetabular chondral rim, particularly in the anterior and superior aspect of the joint, may lead to tissue breakdown and ultimately hip and groin pain.

**PHYSICAL IMPAIRMENTS AND HIP JOINT LOADS IN PEOPLE WITH FAI**

An understanding of the physical impairments seen in people with FAI may assist in the development of appropriate rehabilitation programmes. Hip muscle strength and hip range of motion (ROM) have been examined in people with labral pathology\(^26\) and with FAI\(^27\)-\(^29\). These studies all demonstrate reductions in hip muscle strength and hip joint ROM in those with pathology. It is unclear whether this reduction in strength is associated with pain or pathology. There is limited, but emerging, evidence suggesting altered biomechanics of the hip and pelvis are present in people with FAI, which may partially explain the

**CASE PRESENTATION: EXAMINATION FINDINGS**

On examination the patient presented with a normal gait. He had normal range and symmetry in his lumbar spine and pelvis. He had poor control of his right single leg squat with increased femoral internal rotation and a positive Trendelenburg sign. His adductor squeeze test was normal and pain-free. Hip range of motion tests revealed reduced and painful range of right hip flexion (100°) and internal rotation (10°). Flexion, adduction, and internal rotation (FADIR) testing was painful and restricted on the right.

Hand-held dynamometry revealed reduced strength in his right hip extensors, adductors and external rotators (range 16 to 25% weakness compared to the left). He also had pain and overactivity on palpation in his secondary hip stabilisers (adductor longus, gluteus medius, tensor fascial latae and psoas). MRI scans revealed mild subchondral oedema either side of the pubic symphysis and normal hips. Dunn view radiographs showed bilateral femoral neck offset indicating cam-type FAI (Figure 1).
association between FAI and groin pain. Recent studies have demonstrated reduced pelvic and hip movement in the sagittal plane in people with FAI. In addition, a cadaveric study reported that rotational motion at the pubic symphysis is greater in hips with cam impingement, leading to increased opening of the anterior aspect of the pubic symphysis. Combined, these findings may indicate that an increased load through the anterior aspect of the pelvis may be present in those with FAI, with potential to contribute to the development of groin pain.

Physical impairments such as hip muscle strength and ROM may also alter intra-articular hip loads. Hip muscles, including gluteus medius, gluteus maximus, ilioidea and the adductors contribute to forces and impulses in the anterior and superior aspects of the hip, which contributes to hip flexion, internal rotation and abduction moments. Lewis et al reported that such weaknesses may increase load in the anterior aspect of the hip joint. As muscle function is altered in the presence of pain and pathology, resultant changes in hip joint load may increase hip pain. Suitable rehabilitation strategies may have the potential to modify hip joint loads and potentially mitigate the progression of hip and groin pain in FAI.

Similarly, ROM may impact on load within the hip. Hip flexion and hip extension may increase load on the anterior and superior regions of the hip. As the majority of FAI lesions and associated hip pathology occur in the anterior and superior regions of the hip, loads associated with these regions of the hip requires consideration. Reduced hip internal rotation, flexion and abduction ROM have been reported in people with symptomatic FAI. Range of motion may be limited in this group if movement at the end of range loads damaged tissue in a manner that provokes pain. Minimising loads on FAI and damaged labrum and chondral tissue in people with hip pain through the optimisation of hip muscle strength and ROM may enhance outcomes.

MANAGEMENT OF FAI
Cam-type FAI is now commonly treated by femoral osteoplasty via either hip arthroscopy or an open surgical approach. Outcomes for hip arthroscopy with femoral osteoplasty appear to be favourable for up to 3 years post arthroscopy. However, most studies examining outcomes for hip arthroscopy vs conservative management. Furthermore, there is limited evidence as to what constitutes the most effective conservative management for FAI. Current strategies for the conservative management of FAI are based on the knowledge of physical impairments in people with FAI. To date, rehabilitation programmes have been reported in the literature as clinical protocols only, therefore the programme described in Figure 2: The relationship between FAI, hip pain, hip joint forces and load-modification strategies. FAI=femoroacetabular impingement.

Improving hip muscle strength appears to be an important treatment goal.
Rehabilitation programmes for people with symptomatic FAI should include strategies to address the volume and intensity of activity undertaken

in this article is an expert opinion based on clinical experience and in interpretation of the literature in this field. Generally, rehabilitation programmes focus on modifying adverse hip joint forces, created by abnormal hip morphology and pathology. This can be achieved by modifying both hip muscle function and external joint loads, as well as providing appropriate education and advice. Figure 2 outlines the relationship between these factors.

**Hip muscle function**

Modifiable physical impairments such as hip muscle strength may alter hip joint loads, impacting on pain, function and disease progression. Improving hip muscle strength appears to be an important treatment goal in order to optimise hip joint loads. A number of studies have suggested exercises to activate the hip abductors, hip extensors and rotators in healthy people without pain. It has been suggested that improving muscle strength in hip muscles in people with hip pathology may reduce hip joint loads and subsequent progression of hip OA. No studies have directly measured the effect of hip strengthening interventions on outcomes in people with hip pathology such as labral pathology or FAI or following hip arthroscopic surgery.

Recent studies have described the roles of hip muscles, with respect to muscle morphology, primary action of joint movement and lines of pull in relation to the axis of joint movement. Importantly, these studies have described differing roles, with some muscles having greater capacity to generate torque over larger ranges of motion (prime movers), while other muscles are better placed to act as joint stabilisers. These concepts are based on sound principles of kinesiology, examining muscle physiological cross-sectional area in relation to muscle fibre length and lines of pull in relation to the axis of joint movement. The primary stabilisers of the hip are thought to provide a posterior, medial and inferior force on the femur, ensuring the head of the femur is located in a position within the acetabulum to minimise stress on potentially vulnerable structures such as the anterosuperior acetabular labrum and the anterosuperior acetabular rim, while maximising the neuromotor control of the hip. The primary stabilisers of the hip include iliopsoas, gluteus medius, gluteus maximus, quadratus femoris, obturator internus, inferior and superior gemelli and adductor brevis and pectineus.

Once adequate control of the deep hip stabilisers has been attained, a staged hip strengthening programme can be undertaken. Generalised hip strengthening exercises should initially be undertaken with specific activation of the deep stabilisers prior to completing the exercise. This ensures that the athlete has adequate control of the hip prior to placing it under load, which will assist in protecting vulnerable or damaged structures within the hip. Generalised hip strengthening exercises should be undertaken based on clinical assessment. Hand-held dynamometry can be used to reliably assess hip muscle strength. Exercises are frequently commenced in prone (to ensure specificity and isolation of muscle activations) and then progressed into functional/weight-bearing positions. Strengthening exercises need to be targeted to the needs of the individual, progressed according to patient responses and targeted to the sporting/physical requirements.

**External loads**

There is minimal evidence directly examining the influence of type or volume of activity on hip joint loads. However the type of activity undertaken may influence hip joint loads, partially due to the intensity of activity, but also possibly due to hip ROM undertaken during certain activity. Lewis et al reported an increase in anterior hip joint forces when the hip joint extended beyond 10° of ROM. This force increased when weakness in the gluteal muscles or iliopsoas was present. Therefore it appears that hip joint loads can be modulated by the type as well as the amount of activity. The influence of amount of activity undertaken by people with hip pain and pathology on hip joint loads has not been directly measured. However, a greater volume of high impact activity is associated with an increased risk of hip OA. This may indirectly reflect a progression in hip joint degeneration associated with increased hip joint loads. Rehabilitation programmes for people with symptomatic FAI should include strategies to address the volume and intensity of activity undertaken. Moreover, extremes of hip rotation, particularly in combination with hip extension or hip flexion should be reduced in order to minimise potentially pain-inducing loads.
CASE PRESENTATION: WHAT SHOULD WE DO?

The history and examination findings suggest cam-type FAI and possible associated intra-articular pathology such as labral pathology or chondropathy. Dunn view radiographs provide good visualisation of the head-neck junction of the femur and the presence of cam-type defects. The MRI findings of subchondral oedema either side of the pubic symphysis are commonly seen in elite athletes, including those with FAI, possibly due to the increased rotational loads at the anterior aspect of the pelvis that occur with FAI. While the hips appeared normal on MRI, this may not be the case, due to the high number of false negative findings that occur in the hip with MRI. Reduced hip flexion and internal rotation ROM are commonly seen in people with FAI and chondropathy of the hip. Hip muscle strength is often reduced in people with FAI, labral pathology and chondropathy, probably due to pain. Treatment goals should aim to unload the anterior/superior aspect of the hip and therefore reduce symptoms. This can be achieved by:

1. **Restoring strength and neuromotor control of the deep hip stabilisers.**
2. **A graded global hip strength and neuromotor control programme.**
3. **Restoring core and trunk muscle function.**
4. **Reducing overactivity in the secondary hip stabilisers through soft tissue and needle techniques.**
5. **Education regarding provocative positions of hip impingement and strategies to reduce impingement during hockey. This could include (but not be limited to) using a longer hockey stick, playing on the opposite side of the field to minimise right hip internal rotation, ensuring full lumbar and ankle ROM, particularly flexion and rotation.**

SUMMARY

In conclusion, the evidence supporting the best conservative management for FAI is limited. Given the rapid increase in interest in this condition, knowledge of appropriate rehabilitation programmes will most likely grow in the coming years. Conservative management of symptomatic FAI focuses on decreasing adverse hip loads through the implementation of hip muscle strength programmes and modification of external joint loads. This may result in a lessening of symptoms associated with this condition.

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