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Treatment and Rehabilitation of Femoral Acetabular Impingement

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Treatment and Rehabilitation of Femoral Acetabular Impingement

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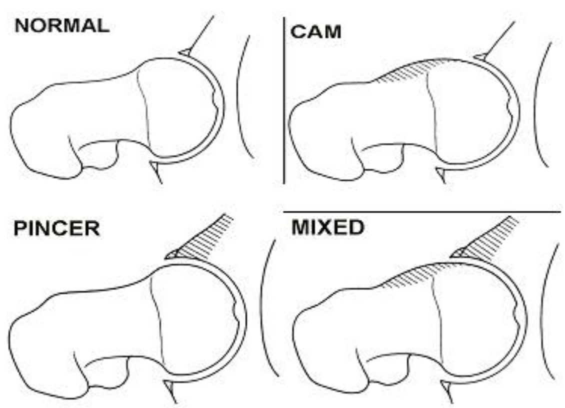
Overview-

Femoral acetabular impingement (FAI) is a complex disorder of the hip that involves damage to the bones of the coxofemoral joint typically as a result of repetitive movements near the end range of the hip. The etiology, pathology, and prognosis of the disorder will be discussed in addition to clinical techniques used to recognize and diagnose the injury. Treatment options will also be examined including both a conservative treatment and a surgical intervention. The rehabilitation protocol will follow a step-by-step progression which will start immediately post-operation and progress through the months that follow all the way until the individual returns to competitive athletics. This rehabilitation protocol will be highly individualized therefore it is important to focus on clinical goals and patient goals while designing the progression.

Introduction-

The hip is a ball-and-socket joint which consists of the femoral head of the femur and the acetabulum of the innominate bone. Typically the articulation between the femoral head and the acetabulum is smooth, however at the end range of the joint repetitive bony impingement can result in articular cartilage or acetabular labrum damage. There are three types of femoral acetabular impingement: cam, pincer, and mixed. The risk of FAI is especially prevalent in sports which involve the hip in movements of extreme flexion and internal rotation.[1] Perhaps the athlete most commonly found in this position is ice hockey goaltenders dropping down to their knees with their hips flexed and internally rotated in order to save a shot in what is called the "butterfly position."[2] One such goaltender impacted by FAI was Niklas Bäckström who played ten seasons for the Minnesota Wild in

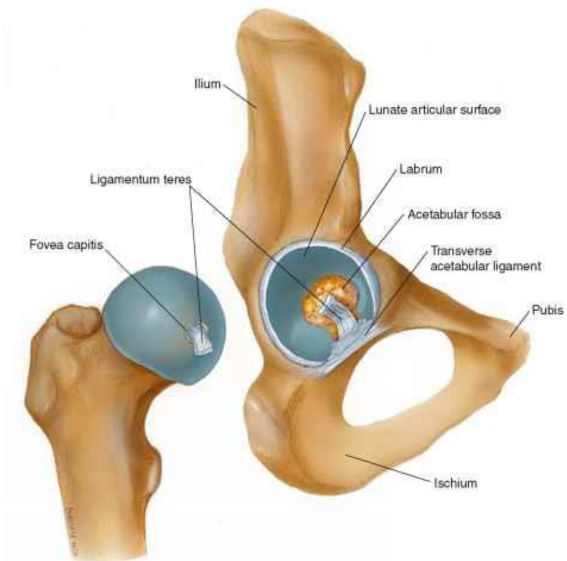
the National Hockey League. Bäckström states that the NHL's regulations which decreased knee pad thickness is what caused the injury, due to increased flexion and internal rotation when dropping forcefully into the butterfly position. Another goaltender who was diagnosed with FAI was Jean-Sebastien Giguere, who played for the Mighty Ducks of Anaheim when they won the Stanley Cup in 2007. Each of the goalies underwent hip surgery to repair a damaged labrum, however Giguere presented with a considerable femoral head lesion which required "shaving on the top of the femur".[3] The source does not state directly the type of FAI each goalie had, however the brief descriptions from the article would indicate that Bäckström had a pincer type impingement, while Giguere presented with a cam lesion. Both goaltenders did return to play after their treatment and rehabilitation and perform at an elite level. Due to the chronic nature of



FAI, often surgery is postponed and athletes attempt to play through their injuries, however studies have shown that 82-93% of athletes returned to professional play following surgical repair of the hip.[4,5] The discrepancy between these percentages is likely due to the size of the case studies performed and the athletes studied. While McDonald et al[4] studied only 17 professional hockey players, Phillippon et al[5] studied 45 professional athletes from a variety of different sports. It is interesting to note that of the 45 athletes studied by Phillippon et al[5], only three did not return to play and each of those three athletes had osteoarthritis at the time of surgery. In fact, FAI has been linked to early onset osteoarthritis[1,6,7,8] and some surgeons will only consider surgical treatment of FAI if their patients present with minimal or no osteoarthritis.[8]

Anatomy-

The coxofemoral joint is the ball-and-socket hip articulation which consists of the femoral head and the acetabulum of the innominate bone. The innominate bone is formed by

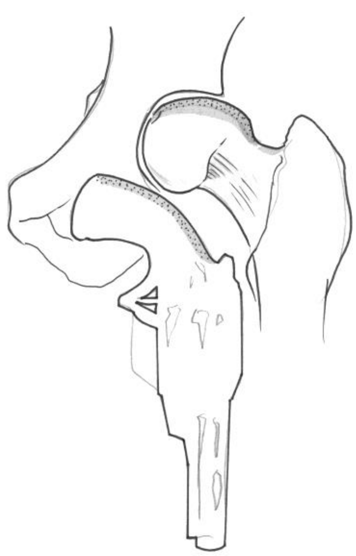


three fused bones, the ilium, ischium, and pubis. Each of these three bones forms the wall of the acetabulum, the depression in which the femoral head lies. The femur is a long bone with a rounded head at the proximal end where it articulates with the acetabulum. The femur also has two projections toward the proximal end of the bone, the greater trochanter and the lesser trochanter. The greater trochanter is a lateral projection of the femur, which can be palpated on the proximal thigh. The bony alignment of the coxofemoral joint allows for the body weight to be transmitted through the hip when standing, walking or jogging. The ligaments and musculature surrounding the joint also work to stabilize it, however at the end range of the hip's range of motion, the ligaments and muscles cannot help to disperse the weight of the body, thus resulting in extreme bone-on-bone impingement. Both the femoral head and the acetabular rim are lined with articular cartilage, and the acetabulum is deepened by the labrum. The labrum, a thick fibrocartilaginous ring, lines the acetabular rim with the exception of the inferior edge of the depression. The transverse ligament is present at the inferior rim and completes the circular labrum. Together, the labrum and transverse ligament work to create a suctioning effect to stabilize the hip and lubricate, which is known as negative intra-articular pressure. After repetitive movement into extreme flexion and inversion of the hip, the labrum and articular cartilage may become pinched and tear. This will result in decreased hip stability and decreased nourishment due to loss of the negative intra-articular pressure and articular fluid within the joint space. In addition to the transverse ligament, several other ligaments help to stabilize the hip. The ligamentum teres, which joins the femoral head to the acetabulum, plays a minor role in joint stability, supports the medial femoral circumflex artery, and plays a role in joint nociception. Additionally, there are three major ligaments which surround the hip joint. The iliofemoral ligament lies anteriorly and helps to limit hip extension. The pubofemoral ligament lies anterior and slightly inferior and medial to the iliofemoral ligament. The pubofemoral ligament helps to restrict extension and abduction of the hip. Finally, the triangular-shaped ischiofemoral ligament lies posterior and horizontally. This ligament is tightens with hip extension and internal rotation. It is important to note that none of the main supporting ligaments of the hip help to restrict hip flexion and only the ischiofemoral ligament restricts internal rotation. This means that when the hip is found in the position where the most bone-on-bone impingement occurs, there is minimal ligamentous support.

While there is not much evidence that links the musculature of the hip to the occurrence of FAI, it is imperative to have a firm grasp of the muscles and their locations, as the surgical repair of FAI requires specific routes through the muscles to gain access to the hip joint. There are four main groups of muscles that support the hip: anterior, medial, lateral, and posterior. The anterior musculature is composed rectus femoris of the quadriceps group, the sartiorius, and the iliopsoas group. The iliopsoas group, composed of the psoas major, psoas minor, and iliacus are the primary muscles responsible for hip flexion. The medial muscles are formed by the adductor group. The adductor longus, adductor brevis, and adductor magnus are assisted by the pectineus and gracilis in order to adduct and internally rotate the hip. The superficial lateral musculature group is comprised of the tensor fascia lata (TFL), which inserts as the iliotibial band at Gerdy's tubercle on the tibia, and the gluteus medius. There are also six muscles which are just deep to the TFL and gluteus medius which serve to externally rotate the hip. These are the piriformis, quadratus femoris, obturator internus and obturator externus, and the gemellus superior and gemellus inferior. The posterior musculature is formed by the hamstring musculature and the gluteus maximus which assists with hip extension. Due to the increased strength of the hip flexors compared to the hip extenders, forceful contraction of the hip flexors at the end range could result in greater forces placed on the joint where the bones make contact.[1,9]

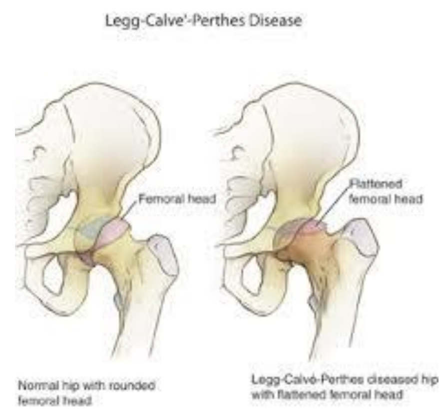
Etiology, Pathology, Prognosis-

The etiology of a condition is the mechanism which commonly creates the injury. The pathology is defined simply as the damage that occurs to the tissues as a result of the injury. The prognosis is defined as the projected outlook of the injury taking into account both the nature of the injury and the treatment and rehabilitation methods. As mentioned previously, the hip joint is a relatively strong joint, however when placed in internal rotation and flexion particularly at the end range of motion, the muscular and ligamentous protection are lacking. This results in chronic



bone-on-bone contact. This repetitive contact between the femoral head and the acetabular rim creates a vicious cycle resulting in pinching of the soft tissue and outgrowth of the bones which in turn creates increased impingement. The outgrowth of the bone can be attributed to Wolff's Law which states that "a bone remodels itself in response to forces placed on it."[9] The repetitive abutment of the femoral neck against the acetabular rim results in a lesion either upon the femoral neck, the superior rim of the acetabulum, or a mixture of both. A cam lesion is an outgrowth of bone at the femoral head-neck junction. This results in a "pistol grip deformity"[1,6,7] in which the femoral head and neck are more rounded much like the shape of an old revolver. This type of impingement, which is more common in young athletic males, results in delamination of the acetabular cartilage and in turn may cause labral tears.[9] A pincer lesion, on the other hand, is an outgrowth of the rim of the acetabulum. This bone formation essentially deepens the acetabulum which decreases the available range of motion in the hip. As a result, the femoral head is pinched in the acetabulum which results in damage to the acetabular rim, the labrum, and the articular cartilage. More commonly found in middle-aged women, pincer lesions are often associated with labral tears. The deepened acetabulum results in entrapment of the femoral head which in turn results in a "crossover sign" which can be seen on a radiograph.[10] The most common presentation of femoral acetabular impingement is a mixed type, which involves the both the cam and pincer lesions. Athletes who present with mixed impingement nearly always have labral tearing and damage to articular cartilage as well. Some studies show that slipped capital femoral epiphysis (SCFE) may be a predisposing factor to FAI.[1,6,7,11]

SCFE is the most common hip disorder in adolescents, particularly young boys. This condition is caused by the femoral neck moving from the femoral head at the epiphysis resulting in anterior displacement of the femoral neck. Due to the radiographic imaging of SCFE, the condition is sometimes likened to a melting ice cream cone because the femoral head appears to be sliding off the cone-like femoral neck.[9] Another predisposing condition thought to lead to FAI is Legg-Calve-Perthes disease.[1,6,7,11] This condition is an avascular necrosis of the femoral head due to compromise of the integrity of the blood flow to the femoral head via the medial femoral circumflex artery. In patients with Legg-Calve-Perthes disease, a lack of blood flow to the femoral head results in ischemia and eventually results in avascular necrosis. It is well established that mal-union of femoral neck fractures are commonly seen in athletes who present with FAI.[1,5,6,7,8] In all of the above conditions, the continuity of the femoral head-neck junction is compromised, therefore the resulting likelihood of the formation of cam lesions is understandably increased. The prognosis of femoral acetabular impingement varies largely from one athlete to the next. Typically a conservative approach is the initial route of treatment for FAI, however for the driven, athletic population this method is not highly successful due to the bony nature of the injury.[1,5,9,10] Since FAI is also a chronic injury, the risk of osteoarthritis in the joint is highly increased.[1,6,7,8] However, for those athletes who opt for surgery to address the cause of the impingement, the prognosis is much better than those who simply try to alleviate the signs and symptoms. As mentioned previously, 82-93% of athletes studied returned to elite performance following surgical treatment of their FAI.[4,5] The overall condition of the hip joint at the time of surgery also has a large impact upon the prognosis of treatment. As was stated by Phillippon et al[5] the three athletes who were not able to return to athletic play presented with osteoarthritic hip joints. The other 45 athletes were successfully



treated and followed a rehabilitation protocol and returned to play at an elite level. Even professional ice hockey goaltenders, such as Niklas Bäckström and Jean-Sebastien Giguere, who drop forcefully into the butterfly position with extreme hip flexion and internal rotation were able to return to play after surgery and continued to excel in their sport.[3] As mentioned previously, the prognosis of femoral acetabular impingement is markedly improved when comparing surgical intervention to conservative treatment. Therefore early recognition of the signs and symptoms of FAI is also key in an improved prognosis during treatment and rehabilitation.

Signs and Symptoms-

The insidious nature of femoral acetabular impingement often makes the signs and symptoms hard to recognize. However, there are distinguishing characteristics that present with FAI. First, due to the chronic repetitive action which causes the condition, often the athlete will follow a progression of pain. Initially, the athlete will only have intermittent pain which is exacerbated by certain activities. Examples of these activities are prolonged periods of sitting, squatting, moving up and down stairs, planting and cutting on the injured leg, and as mentioned formerly, movements at the end range of motion of the hip. This list of activities is neither definitive nor all-inclusive. As a result of these signs and symptoms, FAI is often misdiagnosed as hip or groin pain of soft-tissue origin. Pain levels then progress to constant pain during activities that improve after the activity stops. Then the pain progresses to pain that does not recede after activities until eventually activities of daily living are significantly impaired and the patient has constant, unrelenting pain.[1,9]

Diagnosis-

While early signs and symptoms of femoral acetabular impingement are sometimes hard to recognize, a thorough clinical examination and patient history can provide solid evidence that suggests the presence of impingement. However, the only definitive diagnosis of FAI is radiographic imaging. Occasionally, further imaging with magnetic resonance arthrography is used to fully assess the extent of soft tissue damage. Magnetic resonance arthrography involves the use of injected dye into the joint space to analyze the soft tissue impacted by the bony impingement.[1] Clinical evaluation should involve a thorough history of the patient's subjective symptoms and selective tissue tests to determine clinical signs of FAI. As mentioned previously, the patient will describe pain characteristics that develop gradually and following a progression until the pain becomes constant. Upon physical examination, the patient will present with limited internal rotation, particularly when the hip is flexed to 90^o, both with active and passive range of motion. Manual muscle testing of each of the four major muscle groups of the hip will reveal weak hip external rotators. Inspection of the hip will typically be unremarkable, as the injury occurs deep in the hip joint and does not show physical signs of injury. In addition, vascular and neurological screens will commonly be within normal limits. The area of the clinical examination that will produce clinical findings associated with femoral acetabular impingement is the selective tissue tests. One diagnostic test that can be used to determine the presence of FAI is Patrick's test, which is commonly called the FABER test. In this test, the patient is lying supine with the foot of the involved side crossed onto the opposite knee, in the figure-4 position. The examiner will then apply downward pressure on the knee of the involved side and the anterior superior iliac spine of the uninvolved hip. This pressure will elicit the sharp pain felt during exacerbating physical activities by the patient. It is crucial to ask the patient whether the pain felt is a reproduction of symptoms of injury, as the FABER test can also produce a positive result for sacroiliac joint dysfunction, if the pain is elicited in the posterior pelvis. Another test that can be used to ascertain the presence of FAI is the Anterior Impingement test, also referred

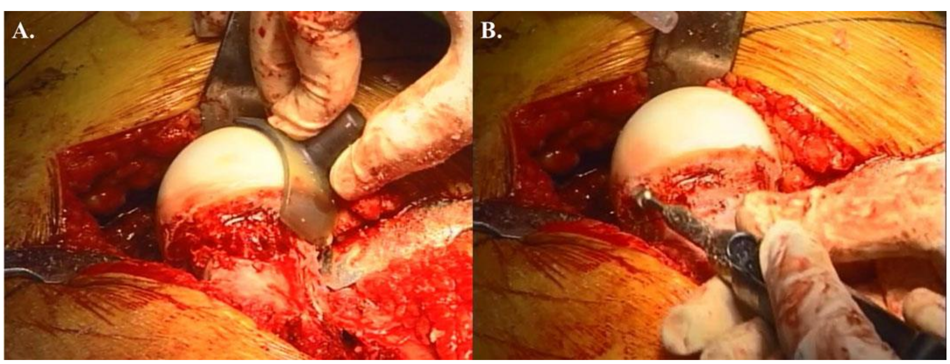
to as the Hip Impingement test. The patient will be lying supine with the examiner standing beside the impacted hip. The examiner passively flexes and internally rotates the hip then slowly adducts it. This will reproduce the pain and symptoms felt by the patient, as it places the femoral head in a position to entrap the labrum. The Impingement test has a sensitivity of 0.90 out of 1.0 and is, therefore, very effective at identifying individuals with FAI or labral tears.[9] Another article by Phillippon et al[12] revealed that the Impingement test was positive in 99% of athletes and the FABER test was positive in 97% of athletes with FAI. Although these selective tissue tests most often yield accurate results, the only definitive diagnosis of FAI can be produced via radiograph. Radiographs of the hip joint will reveal the bony abnormalities present as a result of FAI and will also give the examiner an opportunity to view the uninvolved side as well. The femoral head and the acetabular rim will create the “crossover sign” in patients with pincer lesions. This is measured by noting the anterior and posterior edges of the acetabular rim in reference with the positioning of the femoral head.[10] This gives the examiner the best opportunity to correctly view and identify the presence of cam, pincer, or both lesions. As mentioned previously, sometimes a magnetic resonance arthrogram is used in order to inject a dye into joint. This allows a physician to determine the full extent of soft tissue damage that will need to be repaired surgically.

Treatment-

Typically, the treatment of FAI begins with conservative measures. This is often due to misdiagnosis of the signs and symptoms as a muscle strain or soft tissue damage. The conservative treatment of FAI consists of modification of activities which irritate the hip, prescription of non-steroidal anti-inflammatory drugs (NSAIDs), and rehabilitation in order to strengthen the hip musculature. This course of treatment, however, is only effective until the patient returns to the activity which was initially causing the pain. Some doctors may give the patient a corticosteroid injection into the hip joint, though this usually only masks the symptoms for a short period. The conservative treatment may be sufficient to treat individuals who are not regularly physically active, however for the driven, physically active population this method usually only provides temporary relief of the pain.

Due to the bony lesions causing impingement, typically the only successful route of treatment is surgical intervention. It is crucial to fully ascertain the extent of bone and soft tissue damage, as the surgery involves an in-depth process. There are two main styles of open surgery, the straight lateral Gibson-style approach and the Kocher-Langenbeck approach.[10]The Gibson style is considered to be the "gold standard" in accessing the postero-lateral hip joint.[13] The Kocher-Langenbeck approach is slightly preferred for the obese population, particularly women, as it reduces the risk of postoperative saddlebag deformity. This refers to layers of fat protruding from the sides of a person's thighs. In both surgical techniques, the patient is side-lying in a

lateral decubitus position and is stabilized to the table with side posts positioned so as not to interfere with the surgery. The lower extremity of the operative side is then disinfected from the toes to the most inferior rib and a sterile bag is placed upon the knee in order to position the hip during surgery. The Kocher-Langenbeck approach splits the anterior fibers of the gluteus maximus which greatly reduces the risk of damage to the inferior gluteal nerve. Again the Kocher-Langenbeck approach is also more beneficial in obese women to decrease the risk of saddlebag deformities. However, the Gibson approach is much preferred due to the direction of the approach which provides the best exposure to the hip joint. For the purpose of this paper, we will focus on the Gibson approach, as it is preferred for the young, physically active population. The Gibson approach begins with a longitudinal incision along the anterior aspect of the greater trochanter that is approximately 20-25 centimeters long. The Gibson style splits the gluteus maximus and the tensor fascia lata. By carefully separating the fascia between these two muscles, the greater trochanter becomes exposed when the leg is internally rotated. Fascinatingly, the greater trochanter is removed in order to gain full access to the femoral head and neck during the surgery. The surgeon must take great care not to disrupt the insertion point of the gluteus medius muscle on the greater trochanter. The surgeon is then able to access the joint capsule which is opened up in order to view the femoral head and acetabulum in addition to the soft tissue of the joint. Because the involved leg is mobile during the surgery, the site of impingement can be clearly identified by moving the hip into flexion and internal rotation. The surgeon will then have the hip placed into flexion and external rotation and will use a bone hook to firmly grasp around the femoral neck and will completely dislocate the femoral head from the



acetabulum. The dislocation of the hip joint allows for full observation of the femoral head as well as the entire rim of the acetabulum. Cam lesions are then able to be trimmed fairly easily using an oscillating saw or curved chisels to reshape the femoral head-neck junction. Pincer overhang is not as easily rectified as the labrum must carefully be detached before the rim of the acetabulum is trimmed. The labrum then has to be reattached to the acetabular rim using bone anchors. In the event of labral tearing, the surgeon will take time to ensure the labral tear is either trimmed or anchored to the rim of the acetabulum securely to avoid future impingement. As would be expected, patients with mixed FAI often require a longer surgery in order to address the cam and pincer lesions. Often the surgeon will reduce the dislocated hip and move the leg throughout the range of motion of the hip in order to view the femoral head articulating with the acetabulum after the corrections have been made. After the surgeon has finished removing the lesions and repairing any additional soft tissue damage, the femur is reduced into the acetabulum and blood flow is assessed to ensure there is no risk of avascular necrosis as a result of diminished blood flow to the femur. The surgeon will then seal the exposed bone with bone wax in order to reduce excessive osteoblast activity where the bone has been shaved. The joint capsule is then closed with stitches and the greater trochanter is replaced into its original position with cortical screws aiming toward the lesser trochanter. Finally, the surgeon will work meticulously to realign and suture the gluteus maximus and tensor fascia lata muscles together. Carefully performed, this will avoid any herniation of muscle or fat through the fascia which could result in saddlebag deformities.[10]

Due to the highly invasive nature of the open surgery, a combined arthroscopic and modified open approach is gaining popularity. This method, however, is mostly beneficial for those patients with cam lesions only, as the arthroscopic approach does not allow for dislocation of the coxofemoral joint and therefore full examination of the femoral head and acetabulum is not available. A study by Lincoln et al[15] viewed 16 hips with FAI that had been repaired by a combination of hip arthroscopy and an open approach. The study stated "we believe the limited anterior surgical approach with open osteoplasty provides a reasonable means of treating cam pathoanatomy with minimal drawbacks…" Out of the 16 hips studied, one patient had to have a total hip arthroplasty and another patient had a repeat arthroscopy to address the return of the mechanical symptoms associated with cam lesions. Seven of the patients studied experienced transient anesthesia, which results in numbness, tingling, weakness, or in some cases no feeling in the proximal lateral hip. However each of the seven cases of transient anesthesia resolved on its own within a timeframe of two weeks to three months. Again, due to the "minimal drawbacks" and the general lack of evidence-based science associated with the combined arthroscopic-open surgical approach, the Gibson-style open approach remains the "gold standard" in surgical intervention of FAI.[10,15]

Rehabilitation-

Rehabilitation is a progression that must take a "tightrope" approach. The progression must be aggressive enough to return the athlete to play in an efficient manner, however it cannot be too aggressive as to reinjure the healing tissues and subsequently cause a delay in return to play. The rehabilitation will also require close interaction and communication between the patient, the treating physician, the athletic trainer and the coach. The athletic trainer must be certain to account for the variability of recovery progression from one individual to the next. For this reason, it is important that rehabilitation is set up in phases with approximate ranges rather than exact time frames. Some individuals may progress through the phases quicker than others, however rehabilitation should always be effective and timely, but most importantly safe. If the athlete experiences severe pain, swelling, laxity, a loss or plateau in strength or range of motion these are signs that too much stress is being applied on the joint. Rehabilitation should be altered accordingly in order to allow proper healing of the tissue. The athletic trainer will work closely with the athlete and the treating physician, but ultimately the physician will make the return to play decision.[16] Due to the high prevalence of femoral acetabular impingement in this athletic population, for the purpose of this paper the rehabilitation protocol will be designed in phases to return a male, collegiate ice hockey goaltender to competitive play following open surgical correction of FAI. Each phase will have specific goals that must be attained before the athlete can progress to the next phase.

Phase I (0-4 weeks post-operative)-

The main goal of the first phase is to allow for pain management, tissue healing, and most importantly incision care. Initially, the patient will remain in the hospital for up to 4-6 days after the surgery. This time allows nurses and hospital staff to closely monitor the site of incision from the Gibson-style approach, which due to its large size greatly increases the risk of infection. Signs of infection include redness, swelling, warmth to the touch, and potentially discharge from the incision. If any of these symptoms are present, the patient should be immediately referred to the treating physician.[17] In addition, the patient must be instructed in proper personal hygiene in order to reduce the risk of infection or reinjuring the wound. A night splint should be worn consistently for one week post-operation. Immediately post-operation, the patient may begin touch-down weight bearing, but should be using two crutches until approximately week 3. Beginning at week 2, the patient may progress to 50% weight bearing. Following that, every 2-3 days the patient may increase 25% weight bearing. Full weight bearing should only occur when pain is controlled, the patient has a non-antalgic gait, and the mechanics of the coxofemoral joint are normal. Pain when progressing back to full weight bearing should remain at or below a 3/10. In addition, during the return to full weight bearing, the use of one crutch should be discouraged, as it often results in uneven mechanics and increased forces being placed upon the hip. While the patient may slowly progress to full weight bearing by week 3, it is important that hip flexion is limited to less than 90^{o} in the first week then slowly increase range of motion. The patient should also avoid excessive internal and external rotation of the hip as this could cause damage to the healing tissues. In the first week after surgery, the patient should begin isometric strengthening twice a day at least six days a week. This includes quadriceps sets, heel digs, isometric adduction, abduction, and external rotation, and pelvic tilts. The athlete may use a stationary bike with no resistance and the seat high enough so the hip does not reach 90^{o} of flexion. The athletic trainer should work with the athlete to move the hip through passive range of motion with hip circumduction. To do this, the athlete will lie supine with the hip and knee fully extended. The athletic trainer will grasp the leg at the ankle and slowly move the leg in small circles, both clockwise and counter-clockwise. In addition to these exercises, it is important for the athlete to complete at least two hours a day of prone lying in order to prevent hip flexion contractures. Beginning around week 2, the athlete may begin to flex the hip past 90^{o}. Quadruped rocking, where the athlete is on all fours and shifts his weight in order to stress different areas of the joint may be beneficial in helping the athlete to increase his hip flexion, by leaning backwards. Weight bearing is still progressing around this time, therefore some strengthening exercises will be isotonic, but the athlete should continue the isometric as well. In order to progress the rehabilitation, it is imperative to overload the tissues. This is according to the Specific Adaptations to Imposed Demands (SAID) principle, which states that the body has an ability to adapt to stresses placed upon it.[16] It is important to note that a majority of the exercises completed from weeks 2-4 are closed kinetic chain as well. Closed kinetic chain exercises allow for increased joint compression which promotes increased joint congruency and stability. The athlete may begin mini squats, clamshells with no resistance, calf raises, bridges, bird dogs, and active internal and external rotation of the hip while lying prone. In addition, the athlete should perform a kneeling hip flexor stretch and gentle figure-4 stretches. As mentioned previously, the figure-4 position is used in the FABER test which was used in the clinical examination to determine the presence of FAI. Therefore, the figure-4 stretch should be initiated very gently before increasing the amount of stretch felt. Straight leg raises, front planks, side-lying abduction with weights, or squatting patterns below parallel are strictly prohibited. Due to the shear forces placed on the hip during those exercises, it is crucial that they are not performed before the treating physician has approved of them. Once the athlete is fully weight bearing, without the use of crutches and maintains a pain level at or below 3/10, progression to Phase II may begin.

Phase II (5-11 weeks post-operative)-

The main priorities in Phase II are to return the athlete to his activities of daily living, to regain full range of motion, and to begin strengthening. Once the athlete is at full weight bearing without any complaints for over one week, he may begin to use the elliptical and may begin to lower the seat on the stationary bike and slowly increase resistance. Range of motion should progress as tolerated around week 5 and should focus on preventing hip flexion contractures along with external rotation tightness. When possible, the athlete should try to avoid prolonged periods of sitting. Rehabilitation exercises for Phase II will be broken up into two days, each to be performed three times per week. This should help to reduce the monotony experienced by many athletes while progressing through their rehabilitation. One day of the rehabilitation should focus more on hip mechanics and gait normalization, while the other can focus on strengthening.

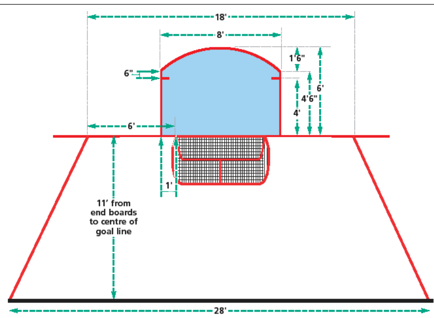
The break between strengthening rehabilitation days will also allow the athlete to recover from delayed onset muscle soreness (DOMS). The athlete will begin to complete clock steps, single leg deadlifts, side planks, 4-way hip machine, body weight squats, and leg extensions using hamstring curl weight machines. Introducing a slide-board during this phase will also allow the athlete to begin to regain the feeling of being on the unstable surface of the ice. Some examples

of exercises to be performed on the slide-board, are clock steps, bridges, and slides. The athletic trainer can also incorporate stick work with indoor pucks in order to improve the athlete's demeanor and maintain basic hockey skills. In addition to these exercises to be performed regularly, the athletic trainer will also coordinate with the athlete to begin aquatic therapy. Aquatic therapy can be very beneficial in rehabilitation as it allows the athlete to perform some exercises earlier on in the rehabilitative phases and it helps to bolster the athlete's mood by increasing his confidence with his progress in his rehabilitation.[18] The second half of Phase II, which is approximately weeks 8-11, will begin to focus more heavily on strengthening and also on returning to skating. It is important to have full strength recovery, if not improved strength, before progressing to Phase III. New strengthening exercises to be incorporated can include step ups and step downs, side steps with therabands, leg press, and increasing weight with squats. In addition, variations may be made to exercises in order to increase the difficulty. For example, adding therabands to increase resistance to exercises such as clock steps or clamshells works not only to improve strength, but to exercise the joint in multiple planes of stress as well. Exercises may be performed on the single leg of the involved side, or with reactive feedback introduced by the athletic trainer to increase the difficulty as well. For example, while the athlete is balancing on one foot, introduce an air-ex pad and toss a ball to him to catch and throw back for increased difficulty. The return to skating protocol may appear to be very elementary to the athlete, however it is crucial that he does not overdo the exercises simply because he is well-experienced with skating. In addition, care should be taken that the strengthening and on-ice rehabilitation do not overstress the tissues and cause damage to the healing process. Ideally, strengthening days should be performed on alternating days from on-ice exercises. To begin, the athlete will skate without pads then progress to skating with pads. Simple hip abduction with a skate on the ice is a great way to introduce the early range of motion of the hip when dropping into the butterfly position. From there, the athlete may progress to side-steps along the boards and downhill skiing from one end of the rink to the other. With both these exercises the athlete should pay careful attention not to fully extend the hip when pushing off. Then to stress the hip under control in full extension, the athlete should perform single-leg long strides and slow backward skating. In addition to these skating exercises, it is important for the goaltender to begin butterfly stretches and exercises in order to appropriately progress back into the well-known butterfly position. When the athlete has full range of motion and strength and has begun his return to skate protocol, he may progress to Phase III of his rehabilitation.

Phase III (12-24+ weeks post-operative)-

The third and final phase of FAI rehabilitation will be broken up into three sub-phases. These phases will include: Preparation of Functional Return, Graduated Return to Sport Progression, and Return to Play. A key focus of all of these phases is to continue strengthening while adding agility, speed, and sport specific drills. The first sub-phase, Preparation of

Functional Return, will begin around weeks 12-14. The main goal of this sub-phase is to complete a jogging progression. The running progression should be designed to improve endurance and speed by incorporating intervals of increasing effort and distance. The on-ice exercises will also continue to increase in difficulty at this sub-phase and should consist of average goaltender workouts intended to improve speed but do not require him to enter the butterfly position quickly. Examples of these exercises include crease slides, 5-puck shuffles, and goal net transitions. Crease slides allow the goaltender to follow the lines of the goal crease



ALL LINES ARE 2" IN WIDTH

CREASE DIMENSIONS

and incorporate cuts and shuffles into their skating. The 5-puck shuffle is quite similar to the crease slides, however the athletic trainer will point to a puck and the athlete will move to that puck using one stride. This helps to work on the athlete's reaction time and explosiveness moving towards the designated puck. Goal net transitions are simply skating in a circular pattern around the goal with changes from skating forwards and backwards while the athlete uses one leg to propel his body and the other to balance and direct himself.[2] The second sub-phase, Graduated Return to Sport Progression, will incorporate agility programs both on and off the ice. The agility program off the ice will aim to improve the athlete's reaction and quickness. The athlete can complete ladder drills, box drills, sprinting and cutting drills, and reaction drills. On the ice, he will begin to incorporate explosive goaltender movements which include moving into and out of butterfly position quickly. The athlete should begin on-ice exercises with butterfly stretches and glides. This will help prepare himself for the quick, explosive movements. Then the athlete will complete X-drills which are similar to crease slides, however he will drop into the butterfly position at each corner of the crease and return to a standing position in order to skate to the next position. Similarly, the 5-puck shuffle can be adjusted in order for the athlete to enter into the butterfly position at each puck designated by the athletic trainer. Additionally, the athletic trainer may stand at the face-off circle and slowly send pucks to the athlete for him to make saves by dropping down into the butterfly position in order to deflect the shot with his stick or pad as directed by the athletic trainer. An excellent exercise to work on the athlete's endurance and skating is the dump and chase. In this exercise, the athletic trainer will pass the puck behind the goal and the goalie will practice coming out of the goal to retrieve it. The athlete will then pass the puck back to the athletic trainer and return to the front of the net and then repeat the whole process.[2] Finally, the last sub-phase of Phase III which will begin around 17-24+ weeks will be Return to Play. When the athletic trainer considers the athlete to be fully prepared to return to play, the athlete may return to practice with consent from the treating physician. During this sub-phase, the athlete will resume practices as he would have prior to his injury. He should face shots and engage in play against his teammates as he normally would in practice. Regardless of being cleared by the treating physician, it is still highly important for the athlete to remain in communication with the athletic trainer and his coach. Returning to play in game-like situations is extremely demanding upon the athlete, so he should be properly informed on how to perform within his limits. The athlete should understand fully that even though he is returning to play, he should continue to perform his rehabilitative exercises in order to maintain his strength and endurance.

Conclusion-

The treatment and rehabilitation for femoral acetabular impingement may appear to be long and daunting, however with early recognition of the signs and symptoms and early diagnosis of the condition, the treatment can be successfully managed. Due to the chronic nature and insidious onset of the pain characteristics, patients often undergo conservative measures in order to correct their signs and symptoms; however the bony nature of the injury leads to high recurrence of injury if the disorder is not treated surgically.[1,5,9,10] The rehabilitation process may seem like a monotonous, uphill battle, however when given attainable goals separated into smaller phases, athletes can be successfully rehabilitated and returned to play in roughly six months. It is vital for the athlete, athletic trainer, and treating physician to be in constant communication throughout the process to ensure that the athlete is progressing in a safe but efficient manner.

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