Why Women are more prone to Knee Injuries than Men?

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Abstract

Objective:-

This is a literature review regarding the numerous types of knee injuries, the most common being the injury of the Anterior Cruciate Ligament (ACL). Moreover, it specifies the gender differences. It discusses the anatomy, various types and the reason for women being more prone to these knee injuries.

Data Collection:-

The resources used to compile this literature review include journals articles, text/reference books, and internet website.

Results:-

The key words that were used are anatomy of the knee joint, knee injuries, women more prone to knee injuries than men, sprain and strains, chiropractics, ACL injuries in women, sport injuries. These key words/phrases pulled up numerous websites, journal articles and references. Some of them were beyond the requirement of this paper or published a long time ago. The ones most relevant to this review were selected and used.

Conclusion:-

The numerous articles showed a number of reason why women are more prone to knee injuries than men. Even after a wide research area the reason is still unclear. Although, suggestions include the differences in hormone levels, shape of the anterior cruciate ligament (ACL), difference in the width of the pelvis, and neuromuscular and habitual differences in women. Numerous preventive measures have suggested to avoid more female athletes of getting knee injuries.

Key Words:-

Anterior cruciate ligament (ACL), Q-angle, estrogen, musculoskeletal problems in females, neuromuscular differences.

Introduction

To understand the knee injuries, it is important to clearly understand the anatomy of the knee joint first. Knee joint is the largest and one of the most important joints of the body. The knee joint provides flexibility and stability to your body while walking, running, climbing stairs, and sitting or about any activity of your daily routine. It is a synovial joint of 'hinge' variety and made up of bones, cartilages, muscles, ligaments and tendons.

Discussion

Anatomy of the Knee Joint

The knee joint comprises of three bones: femur, tibia and patella. Femur is the thigh bone sitting on top of tibia, the shin bone. Patella, the small triangular bone, is for protection. These articular surfaces are characterized by their large size and complicated, distinct shapes. Femur slants medially while the tibia is almost vertical.

The ends of bones are covered by articular capsules. It is thin and delicate and deficient in some areas. The strong fibrous capsule attaches itself on the posterior surface of the femur and to the intercondylar fossa posteriorly. The fibrous capsule is deficient on the lateral condyles to provide a passage for the tendon of the popliteus muscle to pass through and attach itself on the tibia.

The articular cartilage covers the femur and the patella. The main function of these articular cartilages is to provide a cushion to the joint. These cushions are important for prevent the grinding and damaging of bones. Extra cushioning is provided by bursae and menisci. There are two menisci for the knee joint; medial and lateral. These menisci function to absorb body's weight during an activity.

Although, a complicated joint, mechanically it is considered weak. This is due to the peculiar arrangement of it articular surfaces. Although weak the knee joint has a great deal of stability. This stability of the joint is provided by the strength and actions of the surrounding muscles and the ligaments connecting the two bones; femur and tibia.

Of these supports, the muscles are more important. Thus, many sports injuries can be avoided if appropriate conditioning and training is given. There are two muscles acting on the knee joint. One of them is the large quadriceps femoris muscle lying in the front of the thigh. Particularly, the inferior and lateral fibers of quadriceps femoris are more important. Following a ligament strain, knee joints function surprisingly well if the quadriceps femoris muscle is well conditioned. The other muscle is the bicep femoris muscle or the hamstrings. It is located at the back of the thigh. The quadriceps femoris muscle is used in straightening and extending you knee, whereas, hamstring are used in bending and flexing the knee joint.

The other second support is the tendons and the ligaments associated with the knee joint. Tendons are strong bands of fibrous tissue that connects bones to muscles. The two tendon of knee joint are the quadriceps tendon and the patellar tendon. As the name indicates, the quadriceps tendon connects quadriceps femoris muscle to anterior surface of the patella. It is somewhat separated from the patella by suprapatellar (quadriceps) bursa and subcutaneous (prepatellar) bursa. The bursae reduce friction between the tendon and the bone. This tendon enables the knee joint to be extended. The patellar tendon connects the anterior and inferior surface of the patella to the anterior surface of tibia. These tough bands join the bones of the upper and lower legs, as well as, they keep the patella in place.

The ligaments, on the other hand, are thick and very strong cables connecting bone to bone or cartilage to bone. The five ligaments providing the stability to the knee joint are the patellar ligament, fibular collateral ligament, tibial collateral ligament, oblique popliteal ligament and arcuate popliteal ligament. Collectively, they are called external or extra capsular ligaments in order to differentiate them from the internal or intracapsular ligaments.

The patellar ligament is continuous with the distal part of the quadriceps femoris muscle passing the patella and attaching to the tibial tuberosity. It is the anterior ligament of the knee joint. On the medial and lateral sides, it blends with medial and lateral patellar retinacula. Patellar retinacula are aponeurotic expansion of the two parts of quadriceps femoris muscle. The retinacula functions to support the articular capsule laterally.

The fibular collateral ligament is the lateral ligament of the knee joint. This rounded, cord-like structure strongly attaches the lateral surface of the femur with the head of the fibula. This tendon is separated from the lateral meniscus by the tendon of the popliteus muscle passing deep to it. It also splits the tendon of the biceps femoris muscle into two parts.

The tibial collateral ligament is the medial ligament of the knee joint extending from the medial surface of the femur to the medial surface of the tibia. In its central part, this ligament attaches itself to the medial meniscus. It is comparatively a weaker tendon than the fibular collateral ligament. As a result, it is more often damaged. Frequently, the tibial collateral ligament and the medial meniscus are torn during contact sports like football.

The oblique popliteal ligament strengthens the fibrous capsule posteriorly. It passes obliquely and it attached to central part of the posterior aspect of the fibrous capsule.

The arcuate popliteal ligament also strengthens the joint posteriorly. It arises from the posterior aspect of the fibula, passes obliquely and spread itself on the posterior surface of the knee joint.

The intracapsular ligaments are present within the knee joint. It consists of the cruciate ligaments. The cruciate ligaments join the femur and the tibia within the articular capsule of the joint but outside the synovial cavity. The two ligaments, anterior and posterior, are located in the center of the joint crisscrossing each other obliquely forming the letter 'X', and providing greater stability and strength.

The anterior cruciate ligament is weaker between the two. Relatively, anterior cruciate ligament has a poor blood supply. "It is slack when the knee is flexed and taut when it is fully extended, preventing posterior displacement of the femur on the tibia and hyperextension of the knee joint." (Moore, 1999, p.620) At right angle, while the knee is flexed, anterior displacement is prevented by the anterior cruciate ligament.

The posterior cruciate ligament is stronger than the anterior. It prevents "anterior displacement of the femur on the tibia or posterior displacement of the tibia on the femur. It also helps prevent hyperextension o f the knee joint." (Moore, 1999, p.620) Femur's main stabilizing factor during the weight bearing flexed knee is provided by this posterior cruciate ligament.

The main movements performed at the knee joint are extension and flexion; however, some rotation occurs in the flexed knee. In a fully extended foot, the medial

rotation of the femur on the tibia "locks" the knee joint. This locking mechanism adapts the knee joint for greater weight bearing. The popliteus muscle contracts and rotates the femur laterally producing flexion of the knee joint. This "unlocks" the knee joint.

The blood supply of the knee joint comes from the genicular anastomosis around the knee joint. The anastomosis is formed by the genicular branches of the femoral, popliteal, and anterior and posterior recurrent branches of the anterior tibial recurrent and circumflex fibular arteries.

The nerves supplying the knee joint are branches of the obturator, femoral, tibial, and common fibular nerve.

Knee Injuries

The knee joint is the most important joint of the body. It functions as a shock absorber in all the daily routine activities such as walking, climbing, running, and jogging. Although, as mentioned above, the ligaments, tendons and the muscles provide great stability to the join, it is structurally a weak joint. This explains the reason for the knee joint being the most commonly injured and most prone to get injured joint.

There are three particular ways to injure any joint of the body. Generally, injuries occur due to excessive use of the particular joint, abrupt stops or twists, or direct trauma to the joint. "The most common knee injuries are sprains, cartilage tears, arthritis, and overuse." Some of these injuries are explained below. (Knee Injuries: Health Topics: University of Iowa Health Care)

Sprain and Strains

Knee sprain and strain patients are one of the most frequent visitors at the chiropractor's clinic. Knee sprains strains are caused by damage to the musculoskeletal

system of the joint. More often it is seen during a physical or a sport activity, but it takes place in a weight bearing activities where the muscle is stretched more than it can afford. A direct blow or a sudden twist ruptures the ligaments surrounding the joint or the muscles involved.

The four ligaments providing the stability to the joint are very strong yet not flexible. They are easily torn apart either totally or partially. The torn ligaments causes knee sprain. Knee strains are a bit different. Strains mainly refer to the muscles surrounding the joint or the area where the muscle becomes a tendon. Strains cause a slight tear in the muscle fibers. Sometimes, sprains and strains occur together. This produces great pain and may cause immobilization to the patient

Strains and Sprains are cured with RICE: rest, ice, density, and elevation. It is advisable to rest your knee. Apply ice wrapped in a towel or cloth, ice reduces internal bleeding, pain and swelling or inflammation. The affected area should be compressed with a slightly tight bandage. And, it should be elevated. RICE should be applied as long as needed. Over-the-counter analgesics and anti-inflammatory drug like aspirin, ibuprofen, and acetaminophen are recommended by physicists.

However, chiropractors treat the sprains and strains with extreme pain and decreased function. Their way of practice is a bit different. Their basic mode is the spinal manipulation or joint manipulation. "In addition to joint manipulation, applications of ice and heat, the use of ultrasound or electrical muscle stimulation are some of the ways chiropractors treat sprains and strains." And, advise "stretching and strengthening exercises" for the recovery period. (Chiropractic)

Researchers have compared the chiropractor's joint manipulation method with the physicians' ant-inflammatory medications. According to the results, both methods prove to be effective in the same manner where pain and flexibility was concerned. However, for improving the range of motion, joint manipulation was more effective.

Tendon injuries (tendonitis)

An irritation or inflammation of a tendon is known as Tendonitis. "Athletes — especially runners, skiers and cyclists — are prone to develop inflammation in the patellar tendon." The patellar tendon joins the quadriceps femoris muscle to the tibia. "This is part of the 'extensor mechanism' of the knee, and together with the quadriceps muscle and the quadriceps tendon. This system allows the extension of the knee and provides strength to this motion. Like any other tendon, patellar tendon is also made up of though band surrounded by vascular tissue lining which provides nutrition to the tendon.

The patellar tendonitis is caused by the inflammation or irritation of the surrounding tissue. Usually, it is caused by the overuse especially due to jumping activities. This is the reason patellar tendonitis if often called "jumper's knee." When overuse is the cause of patellar tendonitis, patients are usually active participants of jumping-types of sports such as basketball or volleyball.

Patellar tendonitis may also be seen with sports such as running and soccer. Also, some patients develop patellar tendonitis after sustaining an acute injury to the tendon, and not allowing adequate healing. This type of traumatic patellar tendonitis is much less common than overuse syndromes". (Patellar Tendonitis - Jumper's Knee).

Tendonitis causes pain and swelling on the anterior aspect of the knee. It is not a continuous pain but appears during an activity. In case of a complete rupture of the patellar or quadriceps tendon, straightening or extension of the knee is not viable. (Anonymous. September, 2006. Knee pain.)

Meniscus injuries

Meniscus injuries are very common sport injury. As described above, meniscus is a wedge-like rubbery cushion. Meniscal cartilage is a C-shaped cartilage. It is a strong stabilizing tissue which helps the joint in carrying weight, glide and turn in many directions. It also prevents the gliding forces acting between the femur and tibia.

It is usually observed in sports where menisci are torn apart due sudden change of speed or side-to-side movement such as football. Football players tear the meniscus by twisting the knee, pivoting, cutting or decelerating. More often, meniscal tear is appears in combination with some other injury. The tear may appear anywhere in its arrangement.

This type of injury is presented with pain and swelling within 24 to 48 hours. There might be a 'popping' sensation felt. Fluid may also get collected within the knee, known as the 'water on the knee'.

"Meniscal tears that don't cause locking, including those of a degenerative nature, can usually be managed nonsurgically." (Anonymous. September, 2006. Knee pain.)

Though, without treatment, a fragment of the meniscus can loosen and slip in the cavity of the joint. This fragment can lock the knee and the knee joint can get stuck, often in a forty-five degree angle. It can only move back to its place manually. Meniscal tear should be treated immediately to avoid any further damage.

The most favorable treatment is to follow RICE; rest the knee, apply ice wrapped in a towel or cloth, compress it with bandage and elevate it above your heart level especially while lying down. A combination of non-steroidal anti-inflammatory analgesics can help relieve pain. Though, this treatment is only efficient if the knee is stable and not locked. Blood vessels surrounding the knee are able to provide the natural environment which helps the knee in healing itself.

However, if the healing process is slowed or not taking place surgery is the next option. More often it is performed when the knee is very painful, stiff or locked. Surgeries are based on the type of tear one have and whether it involves the anterior cruciate ligament or not. Other factor such as your age is also considers.

An arthroscope is sometimes used to trim of the damaged pieces of cartilage present in the joint. After the surgery, a cast or brace is applied and this immobilizes the knee for sometime. A complete course of rehabilitation exercises is necessary before resuming the usual activities. This is done gradually and not suddenly.

Bursitis

Inflammation of the bursae associated with the knee joint produces Bursitis. Bursae are the small fluid filled sac that cushions the knee cap. This cushioning is important to prevent the damage that results due to friction between the bone and the tendon, during any movement. "Bursitis can lead to warmth, swelling and redness over the inflamed area, aching or stiffness when you walk, and considerable pain when you kneel." Infection can also take place in the prepatellar bursa causing fever, and pain and swelling in the surrounding area. (Anonymous. September, 2006. Knee pain)

Fractures and Dislocations

A cracked or a broken bone is known as a fracture. Whereas, dislocations particularly the patellar (knee-cap) dislocation, is the displacement of the bone to one side. Fracture is extremely painful and causes immobility. On the other hand, dislocations are comparatively less painful. Common cause of dislocation is a direct impact on front of the knee displacing the patella out of its place. There will be swelling and pain at the front of the knee with the patella bulging out on one side. It generally moves back to its original place naturally, but sometimes help is required.

Unfortunately, risk for having a dislocated knee increases if you had any one previously. "Although you may not experience as much swelling or discomfort with subsequent episodes, repeated dislocations can lead to chronic knee pain. But good rehabilitation, with a focus on strength training of the muscles that control your kneecap, can help prevent dislocation." (Anonymous, September, 2006. Knee pain.)

Osgood-Schlatter Disease

Osgood-Schlatter Disease affects the younger group. It is mostly affiliated with athletic teens overusing their knee joint. It produces a swelling on the tibial tuberosity-a bony prominence at the front of the bone. Pain is constant during an activity such as jumping or running and disappears at rest. The associated pain and swelling last from weeks to months and keeps recurring till the bone growth has stopped.

Iliotibial Band Syndrome

Iliotibial band is thick bank of ligament extending from the lateral side of the pelvis to the tibia. Generally, affecting the distance runners, it causes the iliotibial tract to

become tight. The tract then rubs itself against the femur producing burning pain. In the initial stages pain goes away with rest, however, later it persists.

Hyperextended Knee

Extending the knee beyond the normal position causes Hyperextended knee. Mostly, the damage is minor with little pain and swelling, though it can involve ligaments which can tear partially or completely.

Septic Arthritis

An infection in the knee joint causes septic arthritis. Its symptoms include pain, swelling, redness and fever.

Osteoarthritis

Osteoarthritis is the most general type of arthritis. It is a physiological disorder occurring with age and use, also known as a wear-and-tear condition. The cartilage in the knee joint deteriorates. It produces pain and rigidity with loss of flexibility.

Difference between Men and Women Knee Injuries

Various researches and studies have been conducted on the different knee injuries occurring throughout the United States. The basis of these studies is to prevent the many younger, college students from having serious knee injuries. According to a study, Hewett observed that "Female athletes who participate in jumping and cutting sports are 4 to 6 times more likely to sustain a serious knee injury than male athletes participating in the same sports." The record disclosed the facts that in the United States female intercollegiate and high school student's athletics suffer more than 30,000 serious knee injuries per annum.

More often it is the anterior cruciate ligament that is injured in women. As previously mentioned, anterior cruciate ligament is an intracapsular ligament which is relatively a weak ligament. Moreover, it has a low blood supply. It connects the femur to the tibia and is used in the extension and flexion of the knee.

The anterior cruciate ligament is injured when there is a rapid change of speed, or a direct trauma while supporting the weight of the body. Athletes of sports which place a major load on the anterior cruciate ligament such as basketball, soccer, cheerleading etc, are more likely to injure the anterior cruciate ligament. And although the musculoskeletal system is same in both the genders, women are up to ten times more prone to suffer the injury as compared to men.

"Data collected since 1995 finds that the incidence of ACL injuries among women basketball players is twice that for men, and that female soccer players are four times more likely to experience an ACL tear than their male counterparts." (Quinn, 2005) Continuous researches are been progressed to understand the cause of this difference so that painful injuries are prevented. Despite of these researches the cause is still not clear. Yet, some theories are presented which are described below.

Presented Theories

Hormone Cycles

Although the studies on the hormonal effects on the anterior cruciate ligament have been inconclusive, it is still known to have an influence. As a general rule, women bear a greater laxity in their ligaments as compared to men. The major female hormones are estrogen and progesterone.

Estrogen and progesterone function together to have a proper hormonal cycle. Estrogen, mainly, relaxes soft tissues in the body. And in combination with other hormone influences the functions of nerves, muscles, and ligament. In some studies it has been suggested that increase concentration of estrogen levels in the blood decreases the muscle strength. It also reduces the synthesis of collagen and fibroblast proliferation causing weaker ligaments and greater laxity. Fibroblasts proliferation and procollagen synthesis, mainly type 1, vary according the estrogen concentrations in the blood. Furthermore, it diminishes the fine motor skills of the knee joint by affecting the nervous system and thus decreases the normal protective neuromuscular function of the knee joint.

Anterior cruciate ligament is known to have both estrogen and progesterone receptors on its surface. This indicates and confirms the hormonal influence. Influence can be on the surface cells of the anterior cruciate ligament, cells making up the fibers of the ligament and the blood vessels that supply the anterior cruciate ligament.

Estrogen levels peak during the middle of the menstrual cycle. Also known as the ovulatory phase occurring somewhere between day 10 and 14. As a result, during the midcycle the tensile strength of the anterior cruciate ligament is decreased. The ligament is more laxed and thus more prone to overstretching, increasing the incidence of anterior cruciate ligament tear.

This relationship between the menstrual phase and the knee injuries was studied using a KT2000 (MEDmetric Corp, San Diego) arthrometer. KT2000 (MEDmetric Corp, San Diego) arthrometer is a device that measures anterior and posterior tibial displacement and so was used to measure the clinical affect of estrogen.

Shape of Anterior Cruciate Ligament

The Anterior Cruciate Ligament is enclosed in the intercondylar notch while passing through the knee joint. On average, the intercondylar notch and the length of the anterior cruciate ligament is smaller in women than in males. The studies of the anatomical differences between the size of intercondylar notch and the anterior cruciate ligament have been uncertain. However, it is the combination of "increased body mass, generalized joint laxity, and decreased intercondylar notch width significantly increased the risk of ACL injury."

(Anonymous. Musculoskeletal Problems in the Female Athlete. ACP Medicine)

Wide Female Pelvis

There are certain skeletal differences that persist between the female and male pelvises. Although the male have wide shoulders, the females have pelvis which is wider than the male pelvis. The difference exists because of the child bearing period.

The wider pelvis is stabilized by ligaments of the pelvis. The two ligaments are the sacroiliac ligament at the back and the pubic ligament in the front. These ligaments are stretched during pregnancy which causes the back pain in fifty percent of the women.

The wider pelvis creates a prominent angle between the two bones; femur and tibia. Because of this inward slant, this angle is called the 'Q' angle by scientists and anatomists. The angled is measured between a line created from anterior superior iliac spine and the patella, and the line from the tibial tubercle and the patella. The increased Q-angles increase the lateral force on the quadriceps and the increased inward pressure. It also causes the female thigh to slant inward. In addition, "the resulting increased inward

pressure on the knee with external rotation of the tibia may place excessive stress on the ACL." (Orthopedic and Trauma Surgery)

Men have narrower pelvises. This makes the angle between their hips and knees a little straighter. This anatomical differences, provides the knee's of men stability and makes women's knee more prone to anterior cruciate ligament injuries.

Neuromuscular and Habitual Differences in Women

The neuromuscular differences between men and women are the most interesting. Female athletes misbalance the two muscles of the thigh- the quadriceps femoris and the biceps femoris or the hamstrings. Although this imbalance develops quadriceps femoris to be strong and the hamstrings muscles to be relatively weak "the hamstring muscles decrease anterior tibial force…which is protective to the ACL. In contrast, the quadriceps pulls the tibia forward, thus placing additional stress on the ACL." (Creighton, Alexander 2004).

In contrast, men flex their knee during any sport. The injuries to anterior cruciate ligament occur during an upright position which lacks in women.

"Some of the most interesting, and possibly most helpful findings have been looking at the neuromuscular differences between women and men. Some female athletes have a tendency to fire their quadriceps first before their hamstrings in response to the lower leg moving forward called anterior tibial translation." (Creighton, Alexander 2004).

Conclusion

Even though, there are so many theories that has been proposed, the real reason of why women are more prone to knee injuries is still unclear. The knee injuries continue to take place where no one knows what the real cause is. Investigations continue to be carried out to prevent these knee injuries. However, it has been suggested that proper training and studies prevents serious kinds of knee injuries to numerous female athletes of the Unites States.

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