

Common causes and anatomical principles of knee injury and the treatment of different injuries

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Abstract. A knee injury is a common problem that affects people of all ages and activity levels. This review article outlines the anatomy of some common knee injuries and the effective treatment and rehabilitation for different situations. By studying the causes of a knee injury, such as common ones such as pre-cross ligament cracks, semi-monthly plate wear, and pancreatitis, we can determine that treatment for different injuries depends on the specific injury and may include conservative management with rest, physical therapy, surgery, or surgical intervention. At the same time, rehabilitation is an important part of knee injury management, which can have a bearing on when an athlete can return to play and how rehabilitation can improve sports performance for athletic patients.

Keywords: meniscus, ACL, meditation, physical therapy, rehabilitation.

1. Introduction

Knee injuries may be caused by various factors, including sports-related activities, falls, and automobile accidents. These injuries can lead to significant pain and swelling, which can negatively affect sports performance. As the injury progresses, the condition may become more severe, causing inflammation within the joint like osteoarthritis, and this will decrease muscle strength.

The knee is susceptible to a wide range of injuries that can affect any of these components. Understanding the different types of knee injuries and their associated treatment options is critical for healthcare professionals, athletes, and the public. This review article's goal is to give the reader an overview of common knee injuries. These include ligament sprains and tears, meniscal injuries, knee osteoarthritis, and corresponding effective treatments, all of which will be discussed in this article.

2. Anatomy of knee pain

A lot of factors can cause knee injury. One study estimate with the National Electronic Injury Surveillance System shows that there are 2.29 knee injuries for every 1,000 people. Among these individuals, those between the ages of 15 and 24 had the highest rate of knee injuries (children under the age of 5 had the lowest rate of injuries). The knee is the body's biggest and most intricate joint. There are four major structural components: tendons, ligaments, cartilage, and bone. Femur, tibia, and patella are the bones that make up the knee. At the knee joint, the femur and tibia move with one another. The patella is in front of the joint and slides over the femur during knee motion.

Articular cartilage and meniscal cartilage are the two different kinds of cartilage. In the knee joint, articular cartilage, a shiny, smooth substance, covers the surface of the bone to assist with mobility by reducing friction. Meniscal cartilage serves as a stress absorber and is a C-shaped substance that is located between the femur and tibia.

The ligaments are mainly composed of the cruciate and collateral ligaments. The anterior cruciate ligament (ACL) is in the center of the knee and the posterior cruciate ligament (PCL) is behind the ACL. These two ligaments are the cruciate ligament which are connecting the femur to the tibia and control the motion of the knee. The knee's two collateral ligaments are located on either side. The lateral collateral ligament (LCL) attaches the femur to the greater trochanter, and the medial collateral ligament (MCL) combines the femur with the fibula. They are both used to limit excessive sideward mobility of the knee. The tendons that surround the knee joint give the bones and muscles that make up the joint strength and stability.

3. Injuries

Pain and swelling are the most common symptoms. In addition, the knee may turn to redness and warmth to the touch and may have popping or crunching noises.

3.1. Anterior cruciate ligament injury

ACL injuries can affect more than 200,000 people annually in the US, with athletes and other young, active people accounting for the bulk of instances [1]. ACL injuries happen in association with damage to other knee components such the articular cartilage, meniscus, or other ligaments. Sprains are the medical term for damaged ligaments, and they are divided into 3 severity levels. The ligament suffers only minor injury in a grade 1 sprain. Although slightly stretched, it still aids in maintaining the stability of the knee. The tendon becomes enlarged and lax at grade 2 injury. Partial ligament tear is a term used to describe this condition. 3rd-grade sprain. Most frequently, a complete tear of the ligament is used to describe this kind of sprain. The ligament is either completely severed from the bone or ripped in half.

Several causes can lead to ACL injury. Non-contact injuries account for approximately 70% of ACL injuries [2]. When there is an impact twisted or rotated while the foot is steady on the ground. This can occur in such activities as pivoting or cutting. The contact mechanism occurs with direct contacts with the knee joint, such as in collisions in sports like soccer or field hockey. Also, women are more likely to get ACL injuries compared to men, which may be due to differences in anatomy, hormonal factors, and neuromuscular control [3]. ACL injuries are more common in younger people, possibly due to higher levels of physical activity and sports participation.

3.2. Fractures

Knee fractures can lead to a variety of hazards, including arthritis, nerve damage, blood clots, limb deformities, and infections. The causes of knee fractures can be multifactorial and may include trauma, osteoporosis, sports injuries, age, gender, and previous knee injuries. Based on clinical data, populations at high risk for knee fractures include older adults, women, athletes, and patients with osteoporosis [4]. The study in the Journal of Bone and Mineral Research showed that people with osteoporosis were more likely to suffer knee fractures than those without the condition. Women also have a higher risk of knee fractures due to differences in bone structure and hormonal factors. In addition, high-impact sports can increase the risk of knee fractures, making athletes a high-risk group. It is important to identify and manage these high-risk groups to prevent knee fractures and their associated hazards.

3.3. Meniscus tears

Meniscus tears are a prevalent injury that can affect approximately one million people in the United States each year. A healthy knee contains two menisci, a C-shaped structure made of cartilage. The meniscus is smooth, flexible, and rubbery and provides stability and shock absorption to the precious

knee cartilage (called hyaline cartilage) that lines the joint. The meniscus is vital to the health of the knee joint, especially to prevent arthritis, which can occur if the hyaline cartilage is damaged or lost. Meniscal tears are more common in certain high-risk groups, such as athletes and older adults. In the *Journal of Sports Science*, athletes who participate in sports that involve sudden stops and turns are easier to get meniscal tears than athletes who participate in low-intensity sports [2]. In addition, older adults are also at higher risk for meniscal tears, with a study in the *Journal of Geriatric Physical Therapy* showing that 56% of older adults with knee pain had a meniscal tear. Meniscal tears may be due to trauma, age-related degeneration, and repetitive motion.

3.4. Bursitis

Repetitive motion puts pressure on the bursa, which can cause bursitis. The bursa is a cushion between the bones and soft tissues of the joint. Bursitis of the knee can occur as a normal physiologic response to minor irritation or injury, or it can develop into a pathologic state due to chronic inflammation or repetitive trauma. Under normal physiologic conditions, the bursa of the knee can become inflamed as a protective response to minor injury or irritation. This is referred to as acute bursitis and is usually resolved with rest and conservative treatments.

However, in pathological cases, chronic inflammation or repetitive trauma may cause bursitis to become a persistent or recurrent problem. This is referred to as chronic bursitis. Chronic bursitis can lead to several hazards, including pain, stiffness, decreased mobility, and joint dysfunction. Bursitis is most common in males aged 40-60 years (80%) [5]. Patients require aggressive treatment such as corticosteroid injections or surgery. Identifying the underlying causes and risk factors for knee bursitis, such as age, occupation, and certain medical conditions, can help prevent the development of chronic bursitis and minimize the harms associated with it.

3.5. Patellar tendinitis

Patellar tendonitis is caused by repeated stress on the patellar tendon. Repeated jumping and sprinting movements in sports can push the knee tendon tissue too far, or too fast, which can put stress on the patellar tendon. With the increase in time the tears in tendons can increase, and the large number of minor strains and tiny tears can weaken the tendon tissue and cause pain. Patellar tendinitis is more likely to occur in athletes, the incidence is higher in professional athletes. According to statistics, nearly 40 to 50 percent of professional volleyball players suffer from patellar tendinitis. If left untreated, the pain and soreness may weaken the muscle. This can affect athletic performance.

4. Mechanical injuries

Because the knee joint consists of several tissues working together, there is a high probability of getting mechanical injuries, like ligament sprains, meniscal tears, and patellar dislocations. ACL injuries are often seen in jumping or in sports that suddenly produce a change in direction, such as basketball or football. ACL injuries are seen in a higher percentage of women than men [6]. Meniscal tears, especially among elder people, are usually caused by twisting or hyperextension of the knee joint. 56% of older adults with knee pain were detected to have meniscal tears [7]. Patellar dislocation is less common but can be a serious injury, especially if there is damage to the cartilage or ligaments surrounding the patella [8].

5. Arthritis

Arthritis is swelling and tenderness in one or more joints. Osteoarthritis and rheumatoid arthritis are the main 2 types of arthritis. Osteoarthritis (OA) is primarily caused by the wear and tear of joint cartilage. The role of cartilage is to reduce the friction caused by joint movements. Wear and tear of the cartilage causes the bone to grind directly on the bone, which leads to pain and limited movement. This wear develops slowly, and the pain it causes worsens over time, occurring most often in people over the age of 50. However, it can also be accelerated by joint damage or infection. oa also causes

deterioration of the bones and the connective tissue to which they are attached. Age, obesity, and previous joint damage can all be risk factors for OA [9].

Rheumatoid arthritis (RA) is an autoimmune disease that is more common in women [10]. The immune system begins to attack the capsule surrounding the knee joint, known as the synovium. It causes inflammation of the synovium, which becomes inflamed and swollen. The inflammatory cells release substances that over time destroy the cartilage of the knee joint. Also, RA is symmetrical, which means that RA usually affects the same joint on both sides of the body.

6. Treatment

6.1. Medications

There are several commonly used drugs in the treatment of knee injuries, each with a unique mechanism of action. These drugs are typically used to manage pain, reduce inflammation, and promote healing.

To treat the pain brought on by knee injuries, analgesics are prescribed medications. These medications function by preventing the brain from receiving pain signals sent from the location of the damage. Acetaminophen, tramadol, and opioid painkillers like morphine and oxycodone are a few examples of analgesics that are frequently prescribed for knee injuries. It has also been demonstrated that medications like acetaminophen and opioids are useful in treating knee injury pain [11]. Acetaminophen is beneficial for reducing pain which is caused by osteoarthritis [12]. Research revealed that individuals with knee osteoarthritis who used opioids for their pain saw notable improvements in their pain and functional abilities [13].

NSAIDs, or nonsteroidal anti-inflammatory medicines, are frequently used to treat the pain and swelling brought on by knee injuries. NSAIDs can limit the production of prostaglandins that cause pain and inflammation. Ibuprofen, naproxen, and aspirin are a few NSAIDs that are frequently used for knee problems. NSAIDs like ibuprofen and naproxen are useful for treating knee osteoarthritis patients' pain and enhancing function [13]. According to a study published in the *Annals of Internal Medicine*, patients participating in the study successfully reduced pain and inflammation in osteoarthritis of the knee after up to three months of corticosteroid injections.

Another group of medications that are frequently used to lessen inflammation in knee injuries is corticosteroids. Corticosteroids function by reducing the inflammatory response of the immune system. These medications can be used orally, topically, or intravenously. Prednisone, methylprednisolone, and dexamethasone are among the corticosteroids that are frequently used for knee injuries [14].

Another injection treatment is Platelet-rich plasma. A concentrated mixture of patient growth factors and platelets from the patient's own blood are injected. Injection of the mixture into the knee stimulates the body's natural repair mechanisms to promote healing. Research [15] showed that in the same case of osteoarthritis, patients who received PRP injections were able to effectively reduce the effects of pain compared to those who received placebo injections.

Hyaluronic acid injections are another option for treating knee injuries. Hyaluronic acid is a substance that helps lubricate and cushion the joint. This substance is naturally present in the human body. Hyaluronic acid injections can help lubricate the joint, thereby reducing pain and inflammation. Scientific studies have shown that hyaluronic acid injections can alleviate joint pain and the loss of motor function associated with pain.

6.2. Physical therapy

For knee injuries, particularly those involving ligament, cartilage, and tendon injury, physical therapy is a frequent course of treatment. Reducing pain and inflammation, enhancing range of motion and strengthening muscles that support knee joints are the main objectives of physical therapy for knee injuries. By educating patients on basic body mechanics and strengthening exercises, physical therapy can also aid in the prevention of further injuries.

For individuals with degenerative meniscal tears, PT was found to be just as effective as surgery in a randomized controlled experiment [16]. 321 individuals with a mean age of 56 years who were randomized to either physical therapy or surgery participated in the trial. During the two-year follow-up period, injury pain and motor performance improved significantly in both groups of patients, with no noticeable differences in feedback between the two groups.

A ligament sprain is a frequent knee ailment which can be healed by physical treatment. Exercises that increase knee range of motion, strengthen the muscles that support the knee, and enhance balance and coordination are frequently part of physical therapy for ACL injuries [17]. Leg lifts, squats, and lunges are a few examples of specific exercises. Balance and stability training are also possible with tools like wobble boards or balance balls.

A rehabilitation program combining physical therapy (PT) and at-home exercises was successful in enhancing muscular strength, and functions, according to a randomized controlled trial [18]. 126 individuals with ACL injuries participated in the trial and were randomized to either the rehabilitation program or a control group. The rehabilitation group showed notable increases in muscular strength, function, and quality of life after two years of follow-up.

Physical therapy can also help with cartilage ailments like meniscal tears. Physical therapy can help restore knee function and lessen discomfort following surgery, but in certain circumstances, surgery may be required to replace or remove the damaged cartilage. Exercises that increase the range of motion, strengthen the muscles that support the knee joint, and practice with balance and stability are all common components of physical therapy for meniscal injuries [19].

6.3. *Surgical treatment*

Surgery is often a treatment option for knee injuries, particularly for serious injuries or when conservative treatments such as physical therapy and medication have not been effective.

ACL reconstruction

During an ACL reconstruction, the injured ligament is cut out and replaced with a section of the tendon, a tissue that resembles the ligament that binds muscle to bone. Graft is the name given to this substitute tissue. This transplant could make use of a tendon from another area of the knee or a dead donor's tendon. Successful ACL reconstruction and strict therapy can frequently help the knee regain stability and functionality. Athletes can return to play at any point after an injury. A longer healing time can lessen the chance of re-injury. An athlete cannot often return to play for up to a year or more.

Arthroscopic surgery

Making a few tiny incisions around the knee and inserting a tiny camera to direct the surgical tools are both part of this minimally invasive treatment. It is frequently used to remove loose cartilage fragments or mend the torn meniscus. In individuals with meniscus tears, arthroscopic surgery is successful in reducing discomfort and restoring function [20]. In contrast to non-operative therapy, arthroscopic partial meniscectomy reduced discomfort and increased function in individuals with meniscal tears, according to a randomized controlled trial [21]. 351 individuals with meniscal tears participated in the trial and were randomized to either non-operative or surgical treatment. The surgical group demonstrated noticeably improved results in reduction in pain at the halfway and two-year points in the follow-up.

Total Knee arthroplasty

The impaired surface of the joint was replaced by prosthetic parts composed of metal and plastic. Patients who get severe knee arthritis and other degenerative disorders and who have not responded to non-surgical therapy are frequently advised to have the operation. Total knee replacement is an effective therapy for reducing pain and boosting knee function for patients with osteoarthritis. In comparison to non-surgical options, total knee replacement significantly improved pain, function, and patient satisfaction, according to the research [22].

Cartilage repair or regeneration

Repairing or regenerating damaged cartilage in the knee joint is done surgically and is known as cartilage repair or regeneration. It could entail methods like cell-based therapy, osteochondral

autograft or allograft transplantation, or microfracture. These operations are intended to reduce discomfort and enhance function in people with localized cartilage abnormalities. Studies have shown that using procedures for cartilage repair or regeneration can enhance knee functionality and lessen discomfort. When compared to non-surgical therapies, microfracture, and osteochondral autograft transplantation significantly reduced pain and improved function [23]. Furthermore, compared to microfracture, matrix-induced autologous chondrocyte implantation (MACI) which is a cell-based treatment has been proven that can effectively reduce pain and enhance cartilage function [23].

7. Conclusion

Individuals who sustain knee injuries may experience considerable effects, therefore prompt treatment and ongoing care are essential for the injury's rehabilitation. Physical therapy and other non-surgical therapies are frequently used as the first line of treatment; however, more severe injuries or failures of conservative management may necessitate surgery. The subject of treating and managing knee injuries is now fraught with difficulties and issues. The lack of agreement on the most effective treatment plans for various types of knee injuries, which has caused changes in clinical practice, is one of the main problems. More study is also required to find novel treatments to enhance patient outcomes and better understand the long-term effects of various treatments. Despite these difficulties, technological developments like the creation of minimally invasive surgical methods and novel implant materials may result in improved results and quicker patient recovery periods. Additionally, current studies into the physiology of knee injury pathology and the creation of more individualized therapies may result in better results and a higher quality of life for those who suffer knee injuries.

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