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Adductor Magnus Injury: Bridging Diagnostic Challenges with Therapeutic Advancements in Groin Pain

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Abstract: ***An often overlooked but important source of groin pain is damage to the adductor magnus, especially in athletes who participate in high-intensity lower-limb sports. Despite significant research on other adductor muscles, the adductor magnus remains largely ignored due to its deep location in the body and its complex role in hip adduction and extension. This narrative review aims to bridge the gap between diagnosis and treatment by examining the anatomy, biomechanics, injury causes, clinical presentation, imaging techniques, and treatment options related to adductor magnus strain. Injuries usually result from excessive eccentric loading, quick changes in direction, or overstretching, which can damage the muscle fibres to varying degrees. Non-specific symptoms and the presence of other groin issues complicate diagnosis. Accurate evaluation often needs advanced imaging, such as MRI. Effective treatments, including surgical options, are reserved for severe or resistant cases. Meanwhile, rest, rehabilitation, and a gradual return to activity are key parts of a structured conservative approach. To improve patient outcomes, reduce recurrence, and promote functional recovery, it is essential to address gaps in early diagnosis, tailored rehabilitation, and team-based care.***

Keywords: Groin pain, Hip adduction**,** Eccentric contraction, Musculotendinous injury, MRI imaging, Rehabilitation

1. Introduction

According to current studies, adductor-related groin pain should be seen as a complex issue. It involves interactions between muscle, tendon, and nerve components. This mix of anatomical parts sometimes creates treatment challenges and diagnostic confusion. The adductor magnus may be an important yet poorly understood part of groin pain (1). This narrative review aims to bring together existing knowledge to clarify the anatomical, biomechanical, and clinical importance of adductor magnus strain. It will also highlight its role as a unique and sometimes overlooked cause of groin pain. Groin pain makes up a large part of musculoskeletal injuries in athletes, especially in sports that involve fast running, frequent kicking, and sudden changes in direction. Among the various causes, strains of the adductor muscle group are often the most common. These strains frequently lead to extended time away from sports and reduced athletic performance. While there has been a lot of research on the adductor longus, the adductor magnus has been studied much less. This is largely due to its deep location and its dual role in hip adduction and extension (2).

2. Anatomy of Adductor Magnus Muscle

Hip adduction and extension depend on the adductor magnus, the largest and most anatomically complex muscle in the medial compartment of the thigh. Its two distinct but related anatomical and functional components are the hamstring (posterior or ischiocondylar) and adductor (anterior or pubofemoral) portions. The anterior segment, which arises from the inferior pubic ramus, primarily facilitates hip adduction and serves to dynamically stabilise the pelvis during single-limb posture and transitional motions. In contrast, the posterior segment functions similarly to the hamstring muscles and arises from the ischial tuberosity. Hip extension is crucial, particularly for powerful movements like sprint acceleration and propulsion (3).

The adductor Magnus's dual configuration allows it to integrate force transmission across the pelvis and lower limbs by functionally connecting the anterior and posterior kinetic chains. In addition to creating movement, the muscle aids in pelvic stabilisation and femoral alignment control in high-demand sports including sprinting, cutting, and sudden deceleration. Its biomechanical relevance is further shown by its participation in eccentric and concentric contractions under various loads (4).

This specific innervation system necessitates complex neuromuscular coordination, which may increase the muscle's susceptibility to asynchronous activation and sensitivity in cases of neuromuscular imbalance or fatigue. This anatomical architecture results in region-specific loading patterns, especially at the musculotendinous junctions, which are known to be common sites of strain injury as shown as figure no. 01 (5).

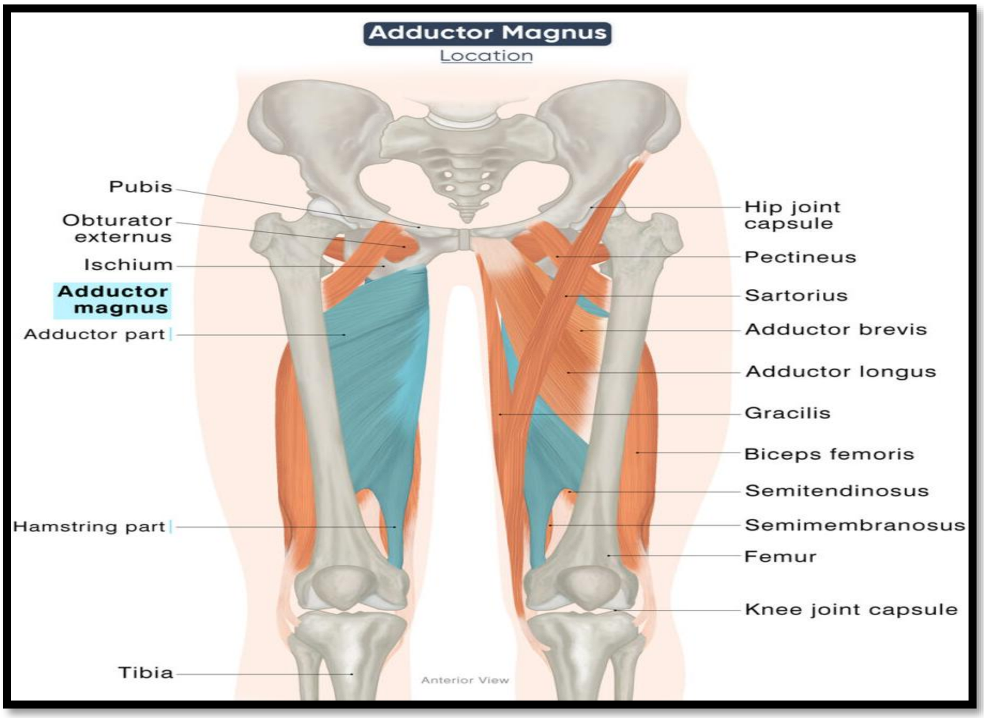

Fig. No. 01 (Anatomy of Adductor Magnus Muscle)

3. Symptoms of Adductor Magnus injury

3.1 Inner Thigh Pain

The most typical sign of an adductor magnus injury is inner thigh soreness. Depending on how severe the strain is, it can vary in intensity and is often felt along the medial side of the thigh. In extreme situations, the pain is frequently abrupt and intense, particularly while sprinting, kicking, or making quick direction changes. In chronic illnesses, the pain may start off as a dull, ongoing aching that gets worse with sustained exercise and may even be felt even at rest.

3.2 Pain During Leg Movement (Adduction)

One of the most common signs of an adductor magnus injury is pain during leg movement, especially during adduction. Any action involving this motion might cause discomfort because this muscle is mostly responsible for moving the thigh toward the midline. It can hurt to execute exercises like side lunges, pressing the thighs together, or crossing the legs. Even everyday tasks like turning while walking or getting in and out of a car might be noticeably uncomfortable.

3.3 Tenderness on Palpation

Pain felt when pressure is applied to the afflicted location is referred to as tenderness on palpation. When an adductor magnus injury occurs, the inner thigh becomes sensitive to touch, and applying pressure to the muscle may cause localised discomfort. The degree of muscle injury is frequently indicated by the degree of soreness. A distinct sensitive patch may be visible in moderate to severe strains, which aids in the clinical identification of the injury location.

3.4 Swelling or Bruising

Due to internal bleeding and inflammation, swelling and bruising are typical symptoms of muscle damage. As fluid builds up in the injured tissues, swelling happens, making the afflicted region appear larger. Ecchymosis, another name for bruising, is a blue or purple discolouration caused by the bursting of tiny blood vessels under the skin. After the accident, these symptoms might not show up right away and can take hours or days to manifest.

3.5 Muscle Weakness

Another significant indicator of injury to the muscular fibres is muscle weakness. The inner thigh becomes weaker as a result of the adductor magnus losing its capacity to provide normal force. People may have trouble doing things like jogging, jumping, pressing their legs together, or climbing stairs. In more extreme situations, the muscle may feel unsteady, which might impair general performance and mobility.

3.6 Limited Range of Motion (ROM)

A restricted range of motion at the hip joint is frequently the consequence of an adductor magnus injury. The leg's range of motion is restricted by pain and stiffness, particularly while stretching or abduction. Joint stiffness may be exacerbated by the person's deliberate avoidance of particular motions in order to avoid discomfort. Both regular everyday tasks and sports performance may be hampered by this restriction.

3.7 Pain Radiating to Nearby Areas

An adductor magnus injury may cause pain that spreads to other areas rather than staying localised. Owing to its wide anatomical connection, the pain may occasionally resemble a

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hamstring injury and radiate to the groin or even the posterior thigh. This transferred pain may worsen with extended movement or physical exertion, making diagnosis difficult.

3.8 Pain During Sitting or Squatting

People with adductor magnus injuries frequently experience pain when sitting or crouching. Sitting for extended periods of time can compress the muscle, causing pain and stiffness. Similar to this, deep bending or squatting stretches the muscle fibres, which can exacerbate discomfort, especially in cases of moderate to severe strains. Daily tasks including relaxing, lifting items, and using stairs might be severely impacted by this ailment (6,7,8).

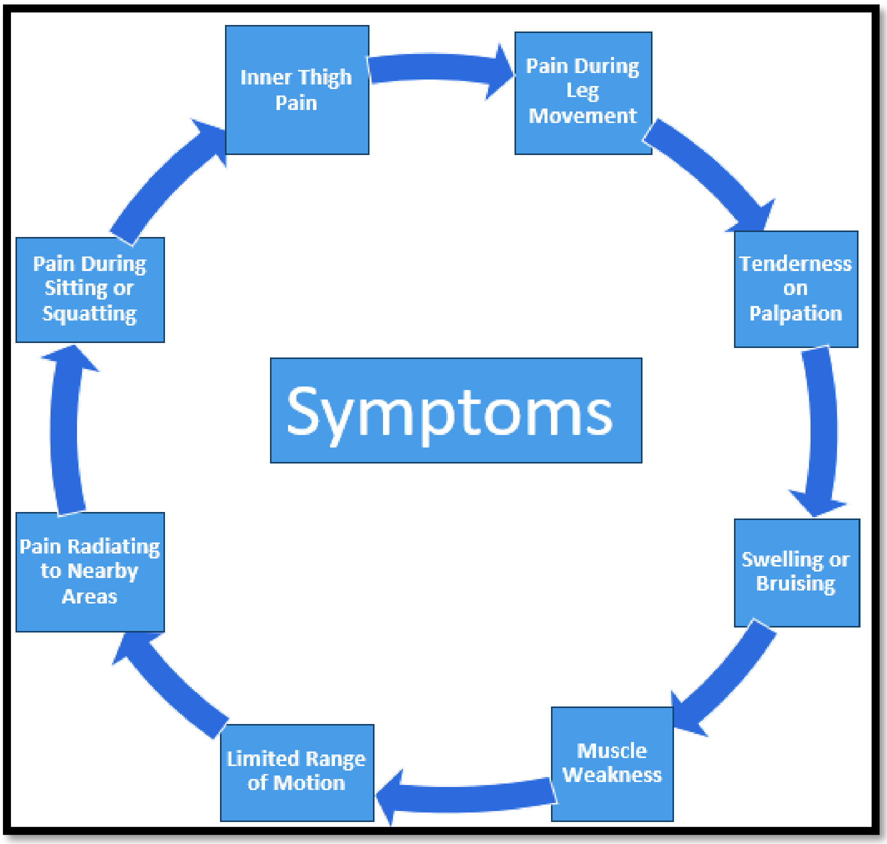

Figure 2: Symptoms of Adductor Magnus injury

4. Mechanism of Injury of Adductor Magnus injury

Excessive mechanical loading during dynamic lower-limb motions, especially when eccentric muscle contraction is present, is the main cause of adductor magnus damage. This usually happens when the muscle is vigorously contracting and lengthening at the same time, causing the muscle fibres to experience significant tensile stress. Athletic activity including running, abrupt direction changes, cutting manoeuvres, and hard kicks frequently include such circumstances. In an effort to stabilise the pelvis and regulate limb motion, the hip is frequently positioned in an abduction and external rotation posture during these motions, stretching the adductor magnus. Microtears or partial to total rupture occur when the applied force surpasses the muscle-tendon unit's tensile capability, most frequently near the musculotendinous junction, where stress concentration is highest. Rapid acceleration and deceleration motions also contribute significantly to the development of injuries. The adductor magnus must produce significant force to decelerate the limb and preserve balance when an athlete suddenly changes direction or pace. This abrupt loading raises the risk of strain, particularly if there is insufficient neuromuscular control or preparation. Similar to this, during the backswing and follow-through phases of kicking sports, the adductor magnus is subjected to simultaneous stretching and contraction stresses, which puts it at risk for injury. Another important contributing mechanism is overstretching beyond physiological limits, which can occur during slips, splits, or forced movements.

4.1 Grade I: Microtears and Edema

The mildest type of adductor magnus strain, known as grade I damage, is characterised by tiny muscle fibre tearing without appreciable structural integrity loss. Only a few muscle fibres are impacted at this point, which causes oedema (fluid buildup) and localised inflammation in the muscle tissue. Clinically, patients report minor tightness or soreness in the medial thigh, particularly during activity, but range of motion and muscular strength are usually maintained or just slightly diminished. Stretching or resisted adduction of the muscle typically causes pain. There is little to no obvious bruising or swelling. Even if it's a small injury, it might get worse if you don't get enough sleep or keep doing things. Recovery is typically rapid, often within 1–3 weeks, with appropriate rest and gradual rehabilitation.

4.2 Grade II: Partial Tear with Functional Impairment

Compared to Grade I injuries, Grade II injuries cause a more substantial structural disturbance due to a partial rupture of the muscle fibres. Moderate discomfort, oedema, and functional impairment result from a significant number of damaged fibres. Patients frequently describe experiencing a sudden, intense pain at the time of the injury, which is followed by trouble jogging, walking, or engaging in activities that call for hip adduction. Due to localised bleeding, the afflicted area may exhibit apparent swelling, pain, and even bruising. Range of motion is limited and muscle strength is substantially diminished. Both passive stretching and aggressive contraction of the adductor magnus exacerbate pain. This grade often requires a more structured rehabilitation program, and recovery may take 4–8 weeks, depending on the severity and adherence to treatment.

4.3 Grade III: Complete Rupture or Tendon Avulsion

The most severe type of damage is grade III, which is defined by an avulsion from the muscle's bony attachment or a total rupture of the muscle or its tendon. The muscle-tendon unit completely loses continuity as a result. When an injury occurs, patients usually feel abrupt, intense pain that is frequently followed by a popping feeling. Significant bruising, swelling, and even a palpable flaw or gap in the muscle are all present. Without support, walking may be extremely difficult or impossible. The muscle may retract in tendon avulsion situations, making healing even more difficult. Long-term therapy is frequently required for many injuries, and in certain situations, surgery may be required to restore function. Recovery time can extend from several months to even longer, depending on the severity and treatment approach (9,10,11,12).

Table 1: Mechanism of Injury of Adductor Magnus injury

Grade	Pathology	Clinical Features	Functional Impact	Recovery Time
Grade I (Mild)	Microtears of muscle fibres with edema	Mild pain, tightness, minimal/no swelling, pain on resisted adduction or stretch	Strength and ROM mostly preserved	1–3 weeks
Grade II (Moderate)	Partial tear of muscle fibres	Moderate pain, swelling, tenderness, possible bruising, sharp pain at onset	Reduced strength, limited ROM, difficulty in walking/running	4–8 weeks
Grade III (Severe)	Complete rupture or tendon avulsion	Severe pain, possible “popping” sensation, significant swelling, bruising, palpable defect	Severe functional loss, inability to adduct hip, difficulty walking	Several months (may require surgery)

5. Pathophysiology of Adductor Magnus Injury

A coordinated series of inflammatory, regenerative, and remodelling processes accompany mechanical stress, which causes structural disruption of muscle fibres. The pathophysiology of adductor magnus damage is a complicated, multi-stage process. When the muscle experiences high tensile stress, especially during eccentric contraction—a contraction in which the muscle lengthens while producing force- the first injury usually takes place. This causes muscle fibres to rupture either micro or macro, usually at the musculotendinous junction, which is the weakest and most stress-prone area in terms of biomechanics. Sarcomere disruption results in minor blood vessel rupture, loss of structural integrity, and injury to surrounding connective tissue, all of which cause localised bleeding and the development of haematomas. The body starts an acute inflammatory reaction right after damage, which is what makes up the destruction phase. Necrosis occurs in damaged muscle fibres, and prostaglandins and cytokines are produced as inflammatory mediators. Neutrophils and macrophages infiltrate the damaged tissue as a result, and they are essential for phagocytosing necrotic material and releasing growth factors that promote tissue healing. Clinically, this stage is linked to decreased muscular function, discomfort, and oedema (13).

6. Imaging Techniques for Adductor Magnus Damage

6.1 X-ray

When a patient presents with groin discomfort, an X-ray is typically the first imaging modality used, mainly to rule out bone abnormalities rather than to directly see muscle damage. X-rays are helpful in ruling out disorders such fractures, avulsion injuries, stress fractures, or degenerative changes in the hip joint and pelvis because they offer great visualisation of bone structures. However, soft tissue injuries, such as adductor magnus strains, are difficult to detect using X-rays. Despite this drawback, they are a crucial initial step in the diagnostic procedure to rule out significant skeletal anomalies that might resemble or coexist with muscle injuries.

6.2 Magnetic Resonance Imaging (MRI)

Due to its exceptional capacity to see soft tissues in great detail, magnetic resonance imaging (MRI) is regarded as the gold standard for assessing adductor magnus injuries. Muscle oedema, bleeding, fibre disruption, and tendon involvement may all be reliably seen by MRI, which is essential for verifying the diagnosis and determining the extent of the damage. Since most strains occur at the musculotendinous junction, it offers high-resolution pictures that enable accurate localisation of the injury. Additionally, by evaluating the degree of tissue damage and the involvement of nearby structures, MRI results can aid in the prediction of recovery time.

6.3 Ultrasound

A popular imaging method for evaluating soft tissue injuries, particularly those of the adductor magnus, is ultrasound, which is dynamic and reasonably priced. Clinicians can evaluate muscle rips, haematoma development, and fibre discontinuity during movement thanks to its real-time visualisation of muscle anatomy and function. The capacity of ultrasonography to conduct dynamic exams, which allow the muscle to be assessed during contraction and relaxation, is one of its main benefits. It is nonetheless very helpful for follow-up evaluations to track healing progress, despite being operator-dependent and less sensitive than MRI for deep muscle damage (14,15).

7. Diagnostic complications of Adductor Magnus Injury

7.1 Deep Anatomical Location

Above more superficial adductor muscles like the adductor longus and adductor brevis, in the medial compartment of the thigh, is the massive, deep-seated adductor magnus. It is sometimes difficult to palpate directly during a clinical examination because of its depth, which makes it difficult to precisely localise discomfort. In contrast to superficial muscle injuries, symptoms like swelling or obvious deformity are typically missing, which might result in an incorrect diagnosis or misinterpretation of symptoms.

7.2 Overlap with Other Groin Pathologies (e.g., Sports Hernia, Hip Joint Disorders)

The substantial overlap of symptoms between adductor magnus injury and other groin-related disorders is one of the main diagnostic obstacles. Patients frequently report groin discomfort that might be mistaken for hip joint pathologies (such as labral tears or femoroacetabular impingement), sports hernias (athletic pubalgia), or other adductor muscle injuries. Similar clinical characteristics, such as discomfort during movement, decreased range of motion, and functional restrictions, are shared by several disorders. Because of this, medical professionals may first mistake the symptoms for more well-known ailments, which might result in ineffective or delayed treatment.

7.3 Non-Specific Symptoms

Generalised groin pain, discomfort while movement, and decreased athletic performance are common non-specific signs of adductor magnus injuries. Numerous musculoskeletal and neurological disorders can cause these symptoms, which are not exclusive to this muscle. It is challenging to make a firm diagnosis based only on history and physical examination when there are no clear clinical indicators. Clinicians may be misled by the fact that pain might vary in intensity and not necessarily correspond with the severity of the damage. A high index of suspicion is required for this non-specific presentation, and an appropriate diagnosis frequently needs imaging confirmation.

7.4 Differential Diagnoses of Adductor Magnus Injury

7.4.1 Osteitis Pubis

Athletes who engage in repeated lower limb exercises frequently develop osteitis pubis, an inflammatory disorder that affects the pubic symphysis and associated tissues. It manifests as persistent groin discomfort, pubic soreness, and pain during running or kicking. Similar to an adductor magnus injury, the discomfort may spread to the medial thigh. Osteitis pubis, on the other hand, usually develops more gradually and is linked to bone discomfort as opposed to isolated muscle involvement. By detecting inflammation at the pubic symphysis rather than injury to muscle fibres, imaging—especially magnetic resonance imaging (MRI)- helps distinguish between these disorders.

7.4.2 Hip Impingement (Femoroacetabular Impingement)

Hip impingement is a structural abnormality of the hip joint when the femoral head and acetabulum make incorrect contact. This condition causes groin pain, stiffness, and restricted range of motion, especially during hip flexion and rotation. The symptoms may be similar to those of an adductor magnus injury, especially in athletes. However, joint-related pain and mechanical symptoms like clicking or locking are typically associated with hip impingement. Certain clinical techniques (like impingement tests) and imaging investigations (like MRIs or CT scans) are essential to establish the diagnosis and distinguish it from muscle injuries.

7.4.3 Iliopsoas Pathology

Similar to an adductor magnus injury, iliopsoas muscle pathologies including strain, tendinitis, or bursitis can also cause groin pain. One of the main hip flexors is the iliopsoas, and when it malfunctions, hip flexion-related actions like ascending stairs or getting up from a seated posture can cause discomfort. The discomfort is typically more anterior than medial, in contrast to adductor magnus injuries.

7.4.4 Lumbar Radiculopathy

Nerve root compression in the lumbar spine is known as lumbar radiculopathy, and it can result in referred pain to the groin or medial thigh. When pain spreads across the nerve distribution, it might resemble the signs of an adductor magnus injury. However, neurological symptoms including tingling, numbness, or weakness in the lower leg are frequently linked to radiculopathy. Instead of hip-specific exercises, spine motions may exacerbate pain. To distinguish this syndrome from a basic muscle damage, a thorough neurological examination and lumbar spine imaging are essential (16,17,18).

8. Management Strategies

8.1 Conservative Management of Adductor Magnus Injuries

The majority of adductor magnus injuries may be successfully treated with non-surgical (conservative) methods, especially in mild to moderate instances. In order to guarantee appropriate healing, restore function, and avoid recurrence, treatment is usually organised into phases.

8.1.1 Acute Phase: Immediately following an injury, the acute phase aims to reduce pain, inflammation, and further tissue damage. During this phase, rest and activity reduction are crucial because they help keep the damaged muscle fibres from getting worse. It is recommended that patients stay away from high-intensity physical exercise, hip adduction, and abrupt direction changes. By reducing local blood flow and tissue oedema, the use of ice (cryotherapy) and compression can reduce swelling, manage inflammation, and ease discomfort. Additionally, analgesics—especially non-steroidal anti-inflammatory medicines, or NSAIDs- are frequently administered to control pain and inflammation, allowing for improved patient comfort and an earlier start to rehabilitation.

8.1.2 Rehabilitation Phase: Once acute symptoms subside, a structured rehabilitation program is initiated to restore muscle flexibility, strength, and coordination. Progressive stretching exercises are introduced gradually to improve the flexibility of the adductor muscles without causing re-injury. These stretches are performed within pain-free limits and are advanced over time. Strengthening exercises play a critical role in recovery, targeting not only the adductor magnus but also surrounding muscle groups such as the core, hip flexors, and extensors to enhance overall pelvic stability. Neuromuscular training is also incorporated to improve muscle coordination, balance, and proprioception, which are essential for preventing future injuries.

8.1.3 Return to Sport: Rather than following a set schedule, return to sport is focused on functional rehabilitation. As long as they restore complete strength, flexibility, and pain-free mobility, athletes with minor injuries may usually return to sports activities in 4–8 weeks. However, the healing time may be much longer in situations of persistent injury or severe muscular strain. To make sure the athlete can safely perform without running the danger of re-injury, a progressive return-to-play protocol is followed, which includes sport-specific drills. A thorough evaluation by a medical expert is essential prior to a complete return to competitive activity.

8.2 Advanced Non-Surgical Therapies

Advanced non-surgical treatments may be taken into consideration if adductor magnus injuries become chronic or do not improve with conventional conservative treatment. In refractory situations, these treatments are usually utilised to encourage healing, lessen chronic pain, and restore function, particularly in athletes or those who need a quicker recovery.

8.2.1 Platelet-Rich Plasma (PRP) Injections: A concentrated preparation of the patient's own platelets is injected into the site of damage as part of platelet-rich plasma treatment. Growth factors and bioactive proteins included in PRP are essential for tissue regeneration and repair. By promoting collagen synthesis, boosting angiogenesis (the creation of new blood vessels), and lowering inflammation, PRP is thought to hasten the healing process when injected into the injured adductor magnus muscle or its tendon. When partial muscle rips or persistent tendinopathies have not healed with traditional treatment, this technique is very helpful.

8.2.2 Corticosteroid Injections: The main reason corticosteroid injections are utilised is because of their strong anti-inflammatory properties, which help lessen chronic inflammation-related persistent discomfort. These injections can be given around the injured tendon or muscle in the case of adductor magnus injury in order to reduce pain and increase range of motion. They can quickly relieve pain, enabling patients to take part in rehabilitation programs more successfully. However, because frequent corticosteroid injections may weaken soft tissues and raise the risk of tendon degeneration or rupture, their usage must be careful and restricted.

8.2.3 Prolotherapy: An irritating solution, usually hypertonic dextrose, is injected into the damaged or weakened tissue as part of the regenerative injection procedure known as prolotherapy. Prolotherapy aims to induce a localised inflammatory response, which increases fibroblast activity and collagen formation, hence promoting tissue repair and strengthening. Prolotherapy may help improve ligament and tendon integrity, lessen discomfort, and eventually restore function in cases with chronic adductor injuries. Prolotherapy, in contrast to corticosteroids, attempts to treat the underlying tissue weakening as opposed to merely relieving symptoms.

8.3 Surgical Management

Adductor magnus injuries are seldom treated surgically, and when they are, it is usually saved for severe instances that don't improve with conservative or sophisticated non-surgical treatments. Certain clinical indicators, such as the degree of tissue damage, functional impairment, and the patient's activity needs, especially in athletes, are taken into consideration while deciding whether to proceed with surgery.

8.3.1 Indications

Surgery is typically advised when the adductor magnus tendon is totally torn from its attachment, causing a significant loss of muscle strength and function. Another important indicator is a severe tendon avulsion, which is often defined as a retraction more than 2 cm from its insertion point and commonly involves a bony fragment. Such injuries are unlikely to heal enough with conservative treatment alone and may result in long-term weakening or instability if left untreated. Additionally, surgery may be considered if long-term conservative therapy is unsuccessful.

8.3.2 Procedures

The kind and extent of the damage determine the surgical technique to be used. When various therapies fail to relieve persistent discomfort or contracture, adductor tenotomy- which entails the surgical release of the afflicted tendon- is usually carried out. Although this technique can ease discomfort and stress, muscular strength may be slightly compromised. Conversely, tendon repair is used for severe or acute injuries such avulsions or total ruptures. In order to restore anatomical continuity and function, the ripped tendon is reattached to its original insertion point, frequently with the use of sutures or anchors. Following both surgeries, postoperative rehabilitation is crucial, with an emphasis on the progressive restoration of strength, range of motion, and functional performance (19,20).

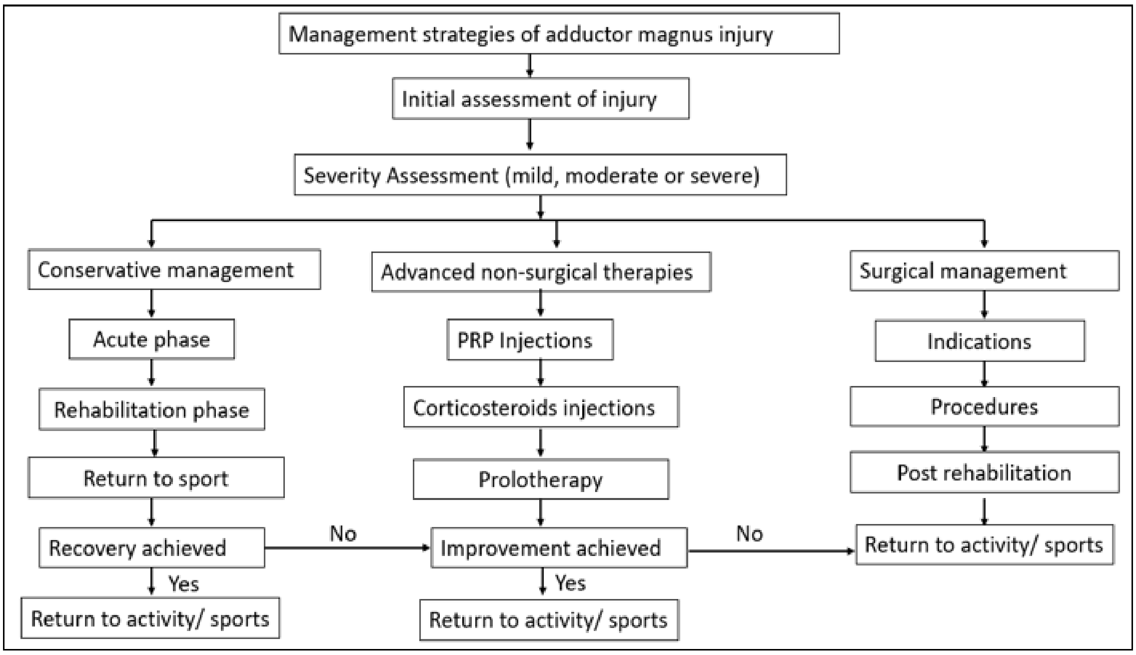

Figure 3: Management Strategies of Adductor Magnus injury

9. The Gap between Diagnosis to Management

Recovery and long-term results may be jeopardised by a number of interconnected elements that frequently cause the gap between diagnosis and efficient treatment of adductor magnus injuries.

9.1 Delayed or Missed Diagnosis

Missed or delayed diagnosis is one of the main causes of this disparity. Because the adductor magnus is a deep muscle, injuries to it can cause vague or nonspecific groin pain that can be mistaken for other musculoskeletal disorders including hip joint pathology or other adductor strains. Inadequate clinical evaluation or an excessive dependence on physical examination in the absence of suitable imaging, such an MRI, may lead to an inability to precisely identify the injury or estimate its severity. Treatment may therefore be postponed or ineffective, enabling the illness to develop and raising the possibility of persistent pain and functional impairment.

9.2 Inadequate Rehabilitation Protocols

The application of insufficient rehabilitative methods is another significant aspect. Rehabilitation may not always be well planned, gradual, or tailored to the patient's requirements and the extent of the damage. Incomplete healing and long-lasting muscle weakness can result from a lack of focus on regaining strength, flexibility, and neuromuscular control. Furthermore, neglecting related issues like biomechanical abnormalities and core stability worsens healing results and raises the risk of recurrence.

9.3 Premature Return to Activity

Another significant problem is an early return to exercise, especially for athletes who might feel under pressure to start training or competition right away. Re-injury or the development of a chronic disease may occur if exercise is resumed before full healing, which is defined by pain-free mobility, sufficient muscular strength, and appropriate functional performance. In addition to lengthening the recovery period overall, this might result in recurrent injury cycles and insufficient healing, which would ultimately impair performance and quality of life (21,22,23).

10. Strategies to Bridge the Gap Between Diagnosis and Management

10.1 Early Use of MRI in Unclear Cases

Improving diagnostic accuracy is greatly aided by the early application of Magnetic Resonance Imaging (MRI) in clinically unclear or complicated patients. Because adductor magnus injuries can be challenging to identify with a physical examination alone, magnetic resonance imaging (MRI) offers a thorough visualisation of soft tissue structures that enables doctors to pinpoint the precise site and degree of the injury as well as identify muscle oedema and fibre damage. Timely and adequate treatment planning is made possible by early imaging, which helps avoid misdiagnosis or underestimate of the problem. This method lowers the risk of consequences related to delayed or inaccurate diagnosis while also facilitating focused care.

10.2 Standardized Clinical Assessment Protocols

A methodical and uniform approach to assessing patients with suspected adductor injuries is ensured by the use of standardised clinical evaluation techniques. A thorough history, a physical examination, tests for strength and flexibility, and a functional evaluation are usually included in these procedures. Healthcare professionals may reduce diagnostic variability, increase accuracy, and make sure that no important component of evaluation is missed by adhering to a standardised framework.

10.3 Individualized Rehabilitation Programs

To maximise healing and meet patient-specific demands, customised rehabilitation programs are crucial. Every injury is different in terms of its location, severity, and the patient's physical state, degree of activity, and objectives. A safe and progressive progression of exercises emphasising neuromuscular control, strength, flexibility, and endurance can be achieved by customising rehabilitation programs. In order to improve functional recovery and lower the chance of re-injury, personalised programs also take into account elements like pain tolerance, healing response, and sport-specific demands. This strategy guarantees that rehabilitation is both successful and in line with the person's needs for returning to their previous activities.

10.4 Multidisciplinary Care (Physicians, Physiotherapists, Trainers)

The overall therapy of adductor magnus injuries is greatly improved by a multidisciplinary approach to care. Physicians, physiotherapists, and sports trainers working together guarantees thorough assessment, care, and recovery. Trainers help with conditioning and safe return-to-sport activities, physiotherapists create and oversee rehabilitation programs, and doctors are in charge of precise diagnosis and medical care. This concerted effort guarantees that every facet of the patient's rehabilitation is taken care of, encourages continuity of care, and enables professional communication. In the end, multidisciplinary treatment improves functional performance, lowers recurrence rates, and produces superior clinical results (24,25,26).

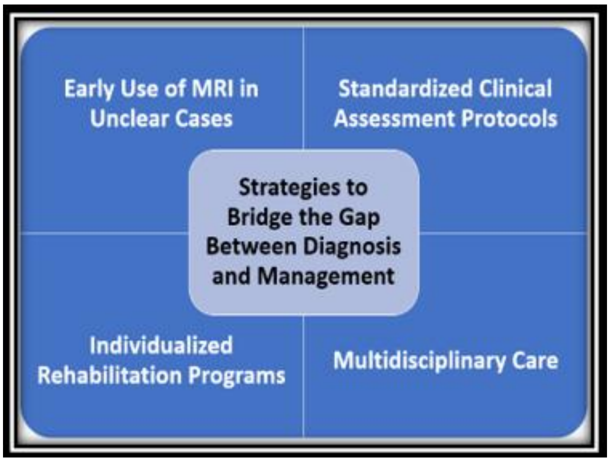

Figure 4: Strategies to Bridge the Gap Between Diagnosis and Management

11. Rehabilitation and Prevention of Adductor Magnus Injury

11.1 Effective Rehabilitation Focus in Adductor Magnus Injury

11.1.1 Restoring Muscle Strength Balance: A key objective of rehabilitation is to restore muscular strength balance since imbalances between the adductor muscles and their opposing muscle groups, such the hip stabilisers and abductors, can make people more vulnerable to injury and prolong their recuperation. Due to discomfort, inactivity, or compensatory mechanisms, adductor magnus injuries frequently result in weakening in both the damaged muscle and the surrounding musculature. The goal of rehabilitation is to progressively strengthen the adductors while also enhancing the strength of antagonistic and synergistic muscle groups, such as the hip, gluteal, and core muscles.

11.1.2 Improving Flexibility: Enhancing flexibility is yet another essential element of successful recovery. Adductor magnus injuries frequently result in decreased range of motion and stiff muscles, which can hinder movement patterns and put more stress on the healing tissue. In order to restore normal muscle length and flexibility, controlled and gradual stretching activities are implemented. As the healing process advances, these workouts are progressively increased in intensity while remaining pain-free. In addition to helping to restore complete functional mobility, increased flexibility also helps avoid compensatory movement patterns that could put more strain on nearby structures.

11.1.3 Enhancing Neuromuscular Control: Regaining efficient and coordinated movement patterns requires improving neuromuscular control. The body's capacity to regulate joint stability, timing, and muscle activation may be weakened after an injury. To retrain the neuromuscular system, rehabilitation regimens include activities that emphasise balance, proprioception, and coordination. This comprises exercises that mimic real-life functional demands, such as dynamic movements, stability training, and sport-specific drills. Better neuromuscular control is essential for safely reintroducing the person to physical exercise or sports, improving joint stabilisation, and lowering the risk of aberrant movement patterns (27,28,29).

12. Preventive Strategies for Adductor Magnus Injuries

12.1 Pre-season Strengthening Programs

Particularly for athletes participating in high-intensity sports, pre-season strengthening regimens are essential in lowering the likelihood of adductor magnus injuries. These exercises are intended to enhance the adductor muscles' strength, stamina, and coordination as well as those of the surrounding muscle groups, including the hip stabilisers, gluteal, and core. Athletes are better equipped to handle the physical demands of their sport by correcting muscular imbalances and improving overall pelvic stability before to the start of the competitive season.

12.2 Proper Warm-up Routines

In order to prevent injuries, it is crucial to do appropriate warm-up exercises before to physical activity. A well-planned warm-up improves muscular flexibility, boosts tissue temperature, and increases blood flow to the muscles, increasing their resistance to strain. The adductor muscles are better prepared for abrupt contractions and quick direction shifts through dynamic stretching, mobility exercises, and mild sport-specific activities. Additionally, a correct warm-up enhances neuromuscular activation and coordination, both of which are essential for sustaining appropriate movement patterns and lowering the risk of injury.

12.3 Load Management

To avoid overuse injuries, effective load management is closely monitoring and controlling the amount, frequency, and intensity of physical activity. The adductor magnus may be overworked and more prone to injury as a result of abrupt increases in training load or insufficient rest times. Periodisation techniques, rest days, and a gradual increase in training intensity all contribute to maintaining peak performance while lowering the chance of strain. Because early exposure to high loads can lead to recurrence, load control is especially crucial for athletes recovering from injuries.

12.4 Flexibility and Mobility Training

Preventing undue tension on the adductor muscles requires maintaining sufficient flexibility and joint mobility. Frequent mobility exercises and stretching assist maintain the hip joint's natural range of motion and avoid tense muscles. Increased flexibility lowers the risk of abrupt overstretching or tearing by enabling the muscles to perform effectively during dynamic motions.

12.5 Neuromuscular and Balance Training

Enhancing proprioception, balance, and coordination- all essential for preserving joint stability during intricate movements- is the core goal of neuromuscular training. Exercises that improve the body's capacity to adapt to abrupt changes in direction or load include single-leg balancing, agility exercises, and controlled dynamic movements. This lessens the possibility of inappropriate movement patterns that might cause harm.

12.6 Sport-specific Conditioning

The athlete is prepared for the particular physical demands of their sport through sport-specific conditioning. This involves exercises like running, cutting, and kicking that replicate real-world game scenarios. Athletes can increase their functional strength and resilience and lower their risk of injury during real performance by strengthening their adductor muscles under conditions unique to their sport (30,31,32).

13. Complications of Adductor Magnus Injuries

13.1 Chronic Groin Pain

One of the most frequent side effects of an adductor magnus injury is chronic groin discomfort, especially if the initial injury is not properly treated or healed. Long-term discomfort in the groin area may result from insufficient healing, persistent inflammation, or the formation of scar tissue. Exercise, extended sitting, or certain motions like hip adduction and rotation may make this discomfort worse. Chronic pain can eventually have a major impact on day-to-day activities and restrict engagement in physical activity or sports.

13.2 Recurrent Injury (~20% Cases)

Studies indicate that about 20% of people may get another injury after resuming their activities, which raises serious concerns. Inadequate rehabilitation, untreated muscular weakness, or an early return to athletics are common causes of this. Recurrent strains are sometimes more severe and may take longer to heal. Furthermore, cumulative damage from repeated traumas might raise the likelihood of chronic illnesses and long-term functional impairment.

13.3 Reduced Athletic Performance

Studies indicate that about 20% of people may get another injury after resuming their activities, which raises serious concerns. Inadequate rehabilitation, untreated muscular weakness, or an early return to athletics are common causes of this. Recurrent strains are sometimes more severe and may take longer to heal. Furthermore, cumulative damage from repeated traumas might raise the likelihood of chronic illnesses and long-term functional impairment.

13.4 Muscle Weakness and Imbalance

Residual muscular weakness and imbalance between the adductor muscles and opposing muscle groups, such the abductors and hip stabilisers, may occur after an injury. Normal biomechanics may be altered by this imbalance, putting more strain on nearby structures and raising the possibility of future injuries. These deficiencies may last for a long time if they are not appropriately treated through rehabilitation.

13.5 Decreased Range of Motion and Stiffness

Adductor magnus injuries can cause joint stiffness and decreased flexibility, especially in the hip area. The natural range of motion may be limited by the development of scar tissue and tight muscles, resulting in less fluid and more constrained motions. Both functional tasks and sports performance may suffer as a result.

13.6 Tendinopathy or Chronic Degeneration

In certain instances, the damage may develop into tendinopathy or chronic tendon degeneration, particularly if there is repetitive strain or insufficient recovery. This syndrome is characterised by persistent discomfort, decreased tensile strength, and compromised tendon healing ability, which makes treatment more difficult and time-consuming.

13.7 Psychological Impact

There may be psychological repercussions in addition to physical ones, such as concern about returning to sports, diminished confidence, and fear of re-injury. If not appropriately handled, these variables may affect the results of therapy and postpone complete functional recovery (33,34,35).

14. Conclusion

Due to its deep anatomical location, intricate functional role, and non-specific clinical appearance, adductor magnus damage is an important but frequently underdiagnosed cause of groin discomfort. This study emphasises how crucial it is to comprehend its distinct anatomy and biomechanics in order to recognise damage processes and direct efficient treatment. In order to distinguish it from other groin disorders, accurate diagnosis is still difficult and frequently requires sophisticated imaging methods, especially MRI. The mainstay of therapy is still conservative care, with systematic rehabilitation being essential for regaining neuromuscular coordination, strength, and flexibility. Gaps between diagnosis and treatment, however, can have a detrimental effect on recovery and raise the chance of recurrence. Examples of these gaps include delayed detection, insufficient rehabilitation, and an early return to activities. Optimal results require a multidisciplinary and customised strategy that includes early imaging, standardised evaluation, and focused rehabilitation techniques. Additionally, a focus on preventative strategies including neuromuscular conditioning, load control, and strength training can greatly lower the chance of injury. Future studies should concentrate on increasing the precision of diagnoses and creating evidence-based rehabilitation plans that are especially suited to injuries to the adductor magnus.

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