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Diagnosis of Avulsed Anterior Tibial Spine

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Abstract:

Background: Avulsion fractures of the tibial spine (intercondylar eminence) are rare but have clinical significance, especially in children and adolescents. These injuries are commonly seen in conjunction with anterior cruciate ligament (ACL) injuries, and in the early stages, can be missed or incorrectly diagnosed as simple knee sprains. The key components to reaching an accurate diagnosis include looking at a full clinical picture and utilizing a suite of imaging techniques. The consequences of missing a diagnosis can be serious and include ongoing pain, an inability to extend the knee, knee instability, and a decrease in function and the ability to perform activity. This paper reviews the literature on the epidemiology, clinical presentation, and physical examination findings of associated injuries and outlines the contribution of imaging in the diagnosis of tibial spine avulsion fractures.

Keywords: Tibial spine avulsion, Intercondylar eminence fracture, Anterior cruciate ligament, Knee injury, Clinical examination, Radiological diagnosis

Introduction:

With an annual frequency of about 3 per 100,000, isolated tibial spine avulsion fractures are rather rare. The prevalence of these fractures is 60:40% in both adults and children. Adults are more likely than previously believed to sustain these fractures. (1) It is challenging to pinpoint the precise frequency of intercondylar eminence fractures. Originally thought to be uncommon, the prevalence of these injuries seems to be increasing, perhaps as a result of improved imaging methods and increased medical awareness. It might also be connected to a rise in athletic pursuits throughout the early stages of adolescence. (2) Although males accounted for 86% of tibial tubercle fractures, this is less than the 97% recorded by Pretell-Mazzini et al. in their 1970s-era comprehensive review. The sharp rise of female athletes since the 1970s might be the cause of this. (2)

B. Clinical evaluation:

Only a thorough history outlining the mechanism of trauma, a careful clinical examination, and a suitable assessment of the radiography and MRI imaging can yield an accurate diagnosis. (3)

1) History and symptoms:

Tibial spine avulsions are rare but dangerous injuries. After sports injuries, they are frequently misdiagnosed as "sprains" in the triage context, making them easier to overlook. Patients who come with a painful, swelling knee following strong hyperextension injuries should take them into consideration. These occur when teenagers have relatively minor mishaps while biking or skateboarding. X-rays should be examined for disruption or fracture lines at the tibial spine cortex. The attending physician should be made aware of the potential issue by a high index of suspicion combined with a positive medical history. It is critical that these injuries be recognized and taken into account. (4) Hearing or experiencing a "pop" or "snap" is typically linked to the traditional history of an anterior cruciate ligament injury (tear or avulsion). Usually, the patient has fallen to the ground and is unable to get up right away. Walking is frequently challenging, and it is typically not able to resume activities. Initial symptoms include pain and muscular guarding, which worsen over a few hours as knee edema develops and hemarthrosis is discovered during joint suction. (5) Clinical results a few days later (or in cases that were overlooked) include loss of knee extension and knee pain, especially during knee extension, which is brought on by a displacement and impingement of the bone fragment in the intercondylar notch. (5)

2) Clinical examination:

When a patient has a tibial eminence fracture, they usually have a painful knee hemarthrosis, reduced range of motion (the pain should return after it goes away), and trouble carrying their own weight **(6)**

I. **Inspection:** A knee injury should be closely examined for any swelling, bruising, hemarthrosis, scars from prior surgeries, or, in situations that have persisted for a long time, muscle atrophy **(6)**

II. **Palpation:** It is important to thoroughly palpate the joint line, joint effusion, and joint discomfort.d. Additionally, it is necessary to assess the posterior cruciate ligament, lateral collateral ligament, and medial collateral ligament integrity (**6**)

III. **Range of motion:** ought to be evaluated. Lack of motion, which is frequently restricted because to pain, may be a sign of meniscal disease or an entrapped fracture fragment once pain has been managed **(6)**

IV. **Special tests:** Rotatory laxity and anteroposterior tests can be carried out during the acute period if patient compliance permits a secure and efficient assessment of ACL integrity. Evaluation is more successful in the later sub-acute phase, though, once the pain and swelling have decreased.**(6)**

Specific tests for ACL insufficiency:

A) The Lachman test:

On the examination table, the patient is positioned supine, with the affected extremity at the examiner's side. The femur is stabilized with one hand, the affected extremity is positioned in a small external rotation with 30 degrees of flexion, and the posterior side of the proximal tibia is firmly compressed while being raised forward in an effort to translate it anteriorly. Take note of the amount of anterior translation and whether a definite endpoint is present or absent, then contrast it with the opposite side (Fig.1). (7) A positive test result is indicated by anterior translation of the tibia linked to a soft or mushy end point.The patellar tendon slope is completely destroyed by anterior translation of the tibia when the ACL is disrupted. (7)

Fig. (1): The Lachman test, performed at 30° of knee flexion, is the most sensitive test for integrity of the ACL. **(8)**

Grades of Lachman test:

B) A grade of 1–2 mm is considered grade I, 3–5 mm is considered grade II, 6–10 mm is considered grade III, and >10 mm is considered grade IV. The grade is always determined by comparing the amount of increased anterior translation on the injured side to the normal side. Because there may be individual differences, one of the most important factors in identifying whether an ACL rupture is present is the lack of a distinct end point. (7)

C) The anterior drawer test:

This test is carried out with the knee flexed 90 degrees. The ACL cannot be reliably tested in this position because hamstring tone and secondary knee restraints are still present. In this position, an ACL-deficient knee may be restricted, and atypical knees have substantial translation. The anterior drawer test is the least accurate test because of these factors (Fig. 2). **(7)**

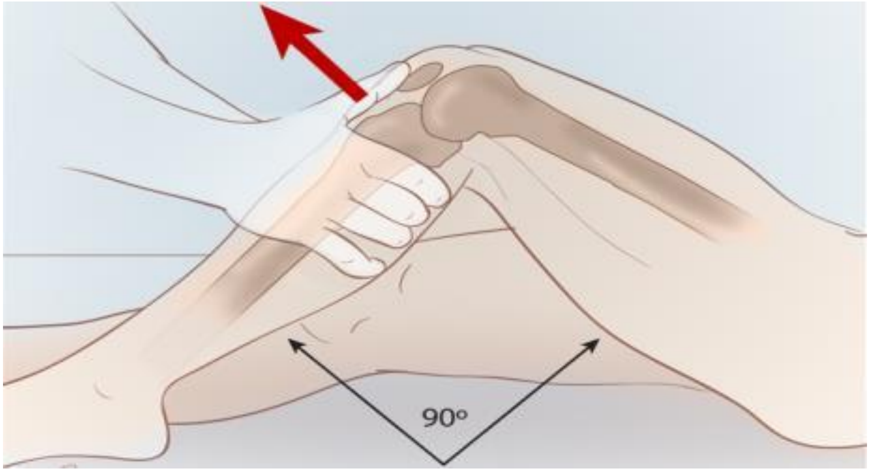

Fig. (2): The anterior drawer test. **(9)**

C) THE PIVOT SHIFT TEST (PST):

The Pivot Shift Test is not frequently utilized in the acute assessment of tibial spine avulsion fractures, despite its high specificity for verifying ACL insufficiency. The maneuver is famously difficult to perform in the clinical setting of a recent injury since it causes the patient great agony, which might conceal the results due to severe muscular guarding. More significantly, the test's dynamic forces of internal rotation and valgus stress present a serious mechanical risk since they have the ability to further displace the fracture fragment, turning a stable Type II injury into a more complicated Type III or IV displaced fracture. The pivot shift is therefore typically postponed in fracture cases until the patient is under general anesthesia in the operating room, where the test can be safely conducted to evaluate the final stability of the fixation without risk of further bony trauma, even though it is still a definitive diagnostic tool for chronic instability. PST carried out the following:

Step 1: Using the ipsilateral hand at heel level, the examiner should provide an internal rotation to the patient's slightly abducted leg.

Step 2: Place the contralateral hand on the lateral side of the joint, placing the thumb slightly below the proximal tibia-fibula joint. Applying a mild valgus tension is necessary. When internal rotation and valgus stress are combined, the knee should naturally flex.

Step 3: Use both hands to advance knee flexion. It is recommended to sustain internal rotation and valgus stress until the knee flexion is about 20 degrees. When shifting, the contralateral hand should guide the proximal tibia into external rotation while the ipsilateral hand should relax its rotational force. Consequently, gravity and the strain of the ITB will cause the lateral side of the proximal tibia to abruptly descend during shifting (Fig. 3). (10)

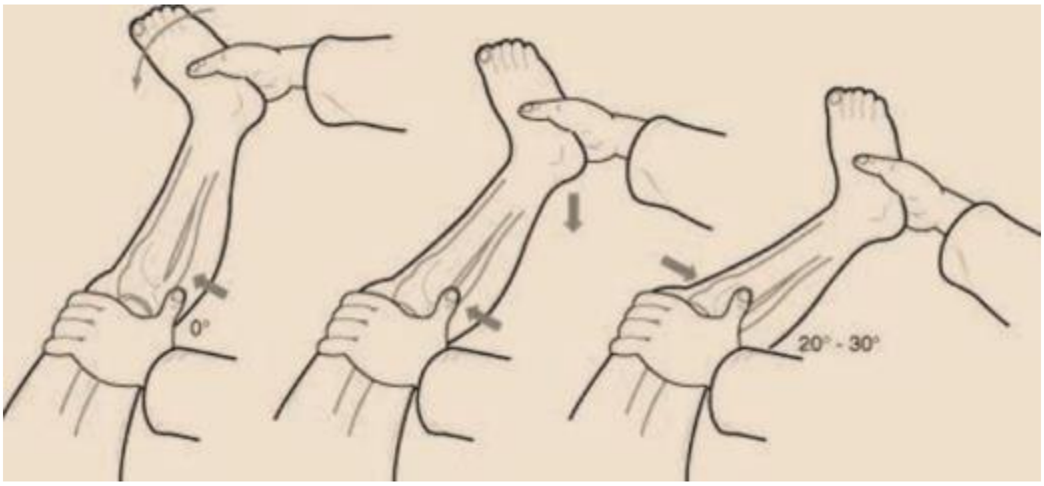

Fig. (3): The pivot shift test is useful in documenting the degree of instability in ACL injuries. The tibia is sublaxed in extension and reduces as the knee is brought into flexion. **(10)**

Grades of pivot shift test:

Pivot shift grade 0: absent pivot shift.

Pivot shift grade I: pivot with smooth glide.

Pivot shift grade II: pivot with an abrupt shift or clunk.

Pivot shift grade III: pivot with momentary locking (impingement of the posterolateral tibial plateau against the femoral condyle). **(10)**

Causes of false-negative results of pivot shift test:

Despite anterior cruciate ligament insufficiency, a pivot shift phenomena has been seen to partially disappear under the following circumstances:

1. Anterior translation or reduction of the tibia may be impeded by a bucket handle rupture of the medial or lateral meniscus.

2. The valgus opening stops force concentration in the lateral compartment when there is a full tear of the medial collateral ligament. In these conditions, subluxation is not possible.

3. Only the subluxation, not the sudden reduction, will be seen when the iliotibial tract is traumatically severed.

4. The formerly convex lateral tibial plateau may develop a concave contour due to increasing osteoarthritis in the lateral compartment with osteophytes. (10)

Other tests:

1. Valgus and Varus Stress Test:

Stress is applied to the collateral ligaments in either the valgus or varus plane when the knee is fully extended and then flexed 30 degrees. The collateral ligament and related posteromedial and posterolateral capsules are tested when the knee is fully extended. The integrity of the cruciate ligaments is also evaluated by testing the knee in full extension. The posterior capsule relaxes when the knee is examined in flexion, enabling the test to demonstrate the collateral ligaments' ability. (11) A primary sprain of a collateral ligament is characterized by localized discomfort and no instability due to straining of the fibers. More fiber damage, loss of function, and mild to moderate instability are characteristics of a second-degree sprain. a third-degree sprain that results in total ligament damage and severe instability. (Figure 4). (11)

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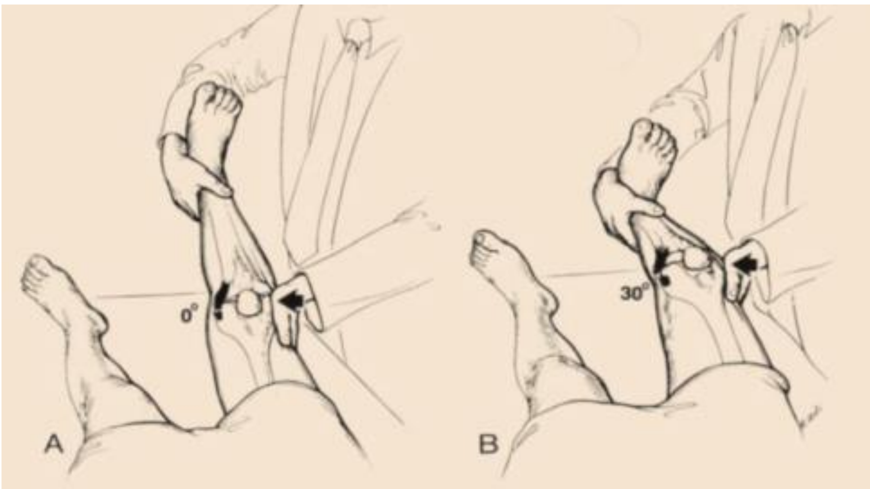

Fig. (4): Test for varus and valgus laxity at 0° and 30° of knee flexion. **(11)**

2. Tests for meniscal pathology:

There have been descriptions of rotation tests for meniscus pathology that try to catch ripped or abnormally movable menisci fragments between the joint surfaces, which can cause clicking or pain. The McMurray test (Fig. 5A), the Apley test (Fig. 5B), and the Steinmann test (Fig. 5C) are the three most popular tests. **(11)**

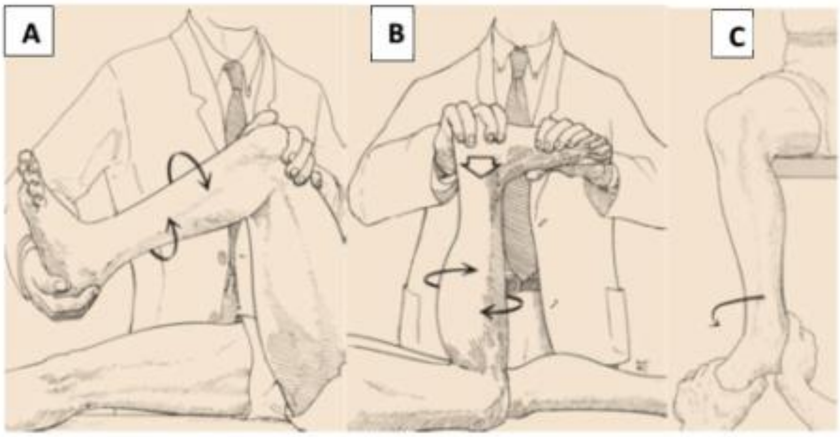

Fig. (5): Tests for meniscus pathology (**A**) The MacMurray test. (**B**) The Apley test. (**C**) The Steinmann test. **(12)**

Associated injuries:

The injuries most frequently linked to tibial intercondylar eminence fractures are meniscus tears. Any combination of bone, chondral, meniscal, or ligamentous injuries may be present in or linked to intercondylar eminence fractures. More complicated tibial plateau fracture patterns, particularly Schatzker type V and VI patterns, are frequently linked to intercondylar eminence avulsion. **(13)**

Radiological evaluation:

A- Plain X-ray:

Anteroposterior (AP) and lateral knee radiographs should be included in the radiographic evaluation; the latter is especially helpful in figuring out how far the fracture fragment has moved. Even while radiographs are used to diagnose conditions, they may not show the full extent of fractures in skeletally immature people because a considerable portion of the fragment may be cartilaginous (Fig.6). **(14)**

Fig. (6): Anteroposterior and lateral radiographs of intercondylar eminence fracture.**(14)**

B- Computed tomography (CT):

Compared to radiography, computed tomographic scanning enables better visualization of the fracture fragment and offers a more accurate evaluation of the fracture and comminution. It aids in determining the tibial plateau's integrity (Fig.7). **(14)**

Fig. (7): (**A**) Sagittal CT scans of an intercondylar eminence fracture. (**B**) Coronal CT scans of an intercondylar eminence fracture. **(15)**

- Magnetic resonance imaging (MRI):

By identifying concurrent knee injuries and the location of the fragment in relation to soft tissue structures that may obstruct reduction, imaging (MRI) can be useful in preoperative planning. Additionally, MRI can be used to detect ACL interstitial injury (Fig.8). **(14)**

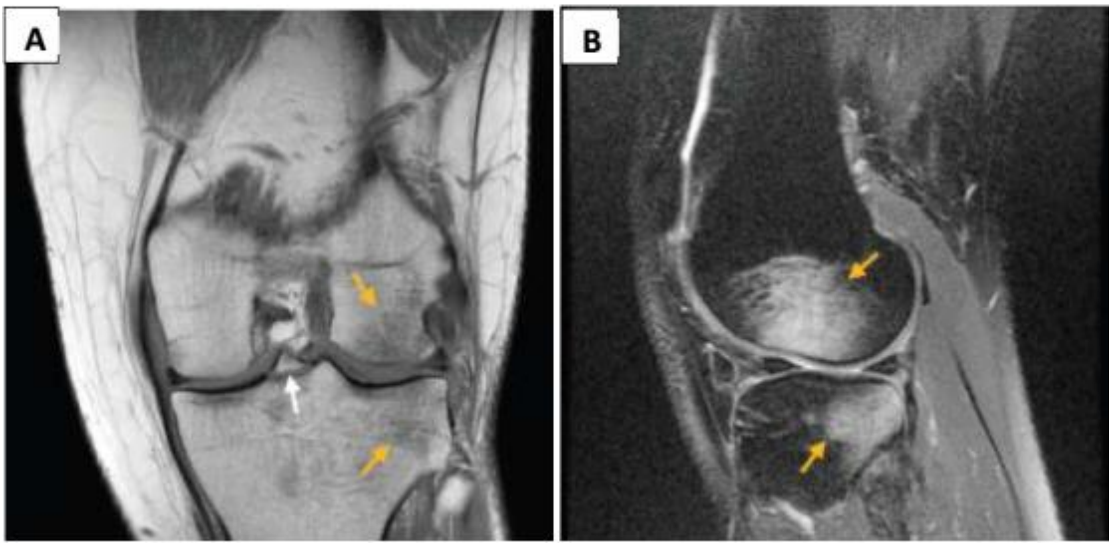

Fig. (8): A: T1-weighted coronal view magnetic resonance image demonstrating a medial tibial spine avulsion fracture (white arrow). Bone marrow edema was also noted in a pivot shift injury pattern involving the lateral femoral condyle and the lateral tibial plateau (orange arrows). B: T2-weighted fat-suppressed sagittal view magnetic resonance image demonstrating bone marrow edema in a pivot shift injury pattern involving the anterior lateral femoral condyle and posterior lateral tibial plateau (arrows). **(16)**

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