A common sport causing an uncommon injury: Isolated avulsion fracture of the medial head of the gastrocnemius muscle during standing broad jump.

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Purpose

Purpose of this exhibit is:

1. Report a rare case of isolated avulsion fracture of the medial head of gastrocnemius during an exercise called the standing broad jump.

2. Explain the bio-mechanism of medial head of gastrocnemius injury in context of standing broad jump
Methods and Materials

Methods and materials:

- A 16 year male athlete developed acute severe pain and swelling along the medial and posteromedial aspect of the left knee immediately after performing a standing broad jump.
- The patient was examined by a sports surgeon who suspected acute ACL and MCL partial tear/sprain, and a medial meniscal tear.
- Radiographs on the (L) knee were performed in two orthogonal views.
- Non-enhanced MRI of left knee was performed with following sequences.

(1) Coronal T1W
(2) Coronal Proton Density (PD) Fat Saturated (FS)
(3) Sagittal PD thin slice 1.5 mm
(4) Sagittal GRE T2*
(5) Axial PD
(6) Sagittal PD for anterior cruciate ligament
(7) Axial T2FS
(8) Sagittal T2FS
(9) 3D- Double Echo Steady State (DESS)-T2W (0.6 mm)

- Published literature on avulsion fracture of the medial head of the gastrocnemius was reviewed.

- Published literature of the biomechanics of the standing broad jump was also reviewed.
Results

Results:

• The lateral radiograph of the left knee reveals a 1.5cm curvilinear fracture fragment in the popliteal fossa, projected along the posterior aspect of the distal femoral metaphysis, approximately 1 cm away from the cortex and just above the physis (Figure 1). Another irregular osseous fragment is seen at same location, closely related to the posterior femoral metaphyseal cortex (Figure 1). The anteroposterior radiograph of the left knee is unremarkable.

• MRI shows complete avulsion of the medial head of gastrocnemius with a large bony fragment attached to the retracted tendon (Figure 2 and Figure 3). There is associated soft tissue oedema, minimal effusion (figure 2 and Figure 3). Focal marrow oedema is seen in the femoral metaphysis, at the avulsion site (Figure 3). The musculotendinous junction of the medial head of gastrocnemius is normal (figure 4). No meniscal tear or ligamentous tear or acute osteochondral defect or joint effusion is seen.

Discussion:

The medial head gastrocnemius injury is quite common as a part of tennis leg syndrome. Avulsion of the medial head of gastrocnemius muscle is uncommon and most often occurs in combination of other injuries. It is very rare to have isolated avulsion fracture of the medial head of gastrocnemius.

• **Functional anatomy:**

  • The medial head of the gastrocnemius muscle originates from the posterior aspect of the medial femoral condyle (Figure 5), and as it courses distally, the medial head merges with the lateral head of the gastrocnemius. The main function of the gastrocnemius muscle is to plantar flex the ankle, but it also provides some knee flexion, as well as contributes to the posterior stability of the knee and partially to the motion of the menisci with flexion/extension of the knee. Throughout the belly of the muscle, the medial gastrocnemius has several origins of tendinous formation.

  • A tendinous sling of the semimembranosus insertion onto the posteromedial tibia also elevates the medial head of the gastrocnemius from the tibia during active knee flexion and passive external rotation (Figure 6).

• **Biomechanics of Medial gastrocnemius injury:**
The medial gastrocnemius often gets injured at two locations.

1. Most commonly at musculotendinous junction and in the bulk of muscle belly as part of the 'tennis leg' syndrome. This injury occurs when an eccentric force is applied to the gastrocnemius muscle, which usually happens when the knee is extended, the ankle is dorsiflexed, and the gastrocnemius attempts to contract in the already lengthened state. This is the common position of the back leg in a tennis stroke, and it results in the greatest force to the muscle unit.

2. The femoral origin of the medial head of the gastrocnemius get stressed during a combination of planter flexion of the ankle with extension of knee on a forcible externally rotated tibia.

• **Possible biomechanism of medial gastrocnemius head avulsion during a standing broad jump:**

1. During a well-executed standing broad jump, the foot is plantar flexed and the knee is extended simultaneously during the mid-part of the jump, before making the landing. At the time of a well-executed landing, the foot is getting in to dorsiflexion and the knee is getting flexed with most of the body with being transferred on back side (Figure 7 a to i and j1 & k2). However, it is unlikely to get medial head avulsion fracture during the mid-part of the jump as the tibia is not fixed and externally rotated.

2. In our case, it possible that the landing of the jump had gone wrong. It is possible that after touching the ground, the athlete fell forward and the whole weight was transferred anteriorly which lead to forcible planter flexion of the ankle and simultaneous forced extension of the knee while the tibia was fixed and forcibly externally rotated (Figure 7- j2 and k2).
Fig. 1: Figure 1: Lateral radiograph of the left knee reveals a curvilinear displaced avulsion fracture fragment in the popliteal fossa (thick white arrow). Another non-displaced fracture fragment is also seen along the posterior cortex of the femoral metaphysis (thin arrow).

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Fig. 2: Sagittal PD image of the left knee shows avulsion fracture of medial head of gastrocnemius tendon (black arrow) with an attached fracture fragment (white arrow).

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Fig. 3: Axial T2FS MRI image of the left knee shows avulsion fracture of medial head of gastrocnemius tendon (curved arrow) with an attached fracture fragment (thick white arrow). Marrow oedema is seen at the avulsion fracture site (thin white arrow).

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Fig. 4: Figure 4: The sagittal PD MRI image of the left knee reveals normal musculo-tendinous junction of the medial head of gastrocnemius (arrow).

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**Fig. 5:** Figure 5: Sagittal PD MRI image of the left knee reveals sling of semimebranosus tendon (short arrow) and the medial head of the gastrocnemius (long arrow). The former acts as sling and lifts the later during knee flexion.

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**Fig. 6:** Figure 6: Origin of the medial head of gastrocnemius (arrow)

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Fig. 7: Figure 7. Image 'a' to 'h' show a normal execution of a standing broad jump. Image 'i', 'j1' and 'k1' show normal landing of a standing broad jump in which the foot is in neutral position and the knees are getting flexed and the body weight is transferred backward. The image 'j2' and 'k2' show incorrect landing in which the athlete's body weight is fallen forward which leads to forced planter flexion of the ankle and simultaneous forced extension of the knee.

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Conclusion

Isolated avulsion fracture of the medial head of gastrocnemius is extremely rare. It may result from combination of forcible planter flexion of the foot and extension of knee and external rotation of tibia during a standing broad jump.
References

Avulsion Fracture of the Medial Head of the Gastrocnemius Muscle - A case report. H Mahera and Y Sakaguchi. THE JOURNAL OF BONE & JOINT SURGERY · JBJS.ORG VOLUME 86-A · NUMBER 2 · FEBRUARY 2004


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