Reverse Segond fracture without PCL injury

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This case involves a unique reverse Segond fracture pattern with ACL and MCL tears that does not have the usually involved PCL tear or obvious meniscal tear. It further shows the importance of recognition of the medial tibial avulsion fracture as an indicator of more severe internal derangement and instability of the knee. Early recognition prompts a more thorough evaluation and management of instability, with hope of better patient outcomes.

Introduction

The reverse Segond fracture was first reported by Hall and Hochman [1] in 1997. It is defined as cortical avulsion fracture of the medial tibial plateau of the knee; it is associated with tears of the posterior cruciate ligament (PCL), medial collateral ligament (MCL), and the medical meniscus, and occasionally also with associated anterior cruciate ligament (ACL) injury. The fracture is thought to arise from the avulsion of the MCL's deep fibers that attach to the cortical rim and the meniscal attachment to the tibia. It has been postulated that the presence of this medial tibial cortical avulsion radiographically indicates significant knee internal derangement; this might be similar to the way a Segond fracture [2] (cortical avulsion off the lateral rim of the lateral tibial plateau) indicates associated ACL and lateral meniscal injury. A total of eight similar reported cases followed Hall and Hochman's report (3-7). Each of the nine reported cases of medial cortical fracture included PCL tears; all but two cases included MCL tears, and all but two included medial meniscus tears or meniscal root avulsions. Four cases resulted from knee dislocations, and most were from major trauma.

Case report

A 22-year-old male was brought to the emergency room after suffering a motorcycle-versus-tree accident. On the initial exam in the emergency room, he was diagnosed with a right tibial and fibular fracture (Fig. 1) and then admitted.
for Open Reduction and Internal Fixation (ORIF) and pain control. On the day before the procedure, the patient complained of left knee pain, swelling, and inability to ambulate. Examination revealed a large effusion and tenderness over the medial tibial plateau and MCL. Laxity of the ACL was demonstrated with anterior drawer and Lachman testing, and laxity of the MCL demonstrated with valgus stress at 0 and 30 degrees. Other ligamentous testing was within normal limits, including negative posterior drawer, PCL sag sign, and negative quadriceps active testing.

X-rays performed on admission were interpreted as normal by the radiologist. Further inspection demonstrated an avulsion-type fracture of the medial tibial rim (Fig. 2) consistent with the reverse Segond fracture pattern. MRI was then ordered but was delayed secondary to the ORIF procedure on the contralateral leg. Instead, a CT scan further defined the fracture anatomy (Fig. 3). After an uneventful postoperative period, the patient was discharged home with a hinged knee brace locked in full extension with instructions not to bear weight on either extremity. After followup with the orthopedic surgeon to remove surgical staples, MRI of the left knee confirmed the presence of the ACL and MCL tear that had been suspected on clinical exam; in addition, it demonstrated intact PCL and LCL with no obvious meniscal involvement (Figs. 4-6).

Figure 2. 22-year-old male with reverse Segond fracture. X-ray on admission shows left knee reverse Segond Fracture (yellow arrow in highlighted area for better visibility), indicating significant internal derangement.

Figure 3. 22-year-old male with reverse Segond fracture. CT scan 3D reconstruction shows reverse Segond fracture (yellow arrow).

Figure 4. 22-year-old male with reverse Segond fracture. Sagital T2-weighted MRI shows ACL tear (yellow arrow).

A second orthopedic surgeon was consulted about possible arthroscopy and repair. However, the decision was made to allow the right tibial/fibular fracture to heal first while treating the left knee with the hinged knee brace, allowing a gradual return to flexion of 90 degrees. Once the right-sided fracture was healed sufficiently, an attempt to schedule a surgical evaluation by arthroscopy failed due to insufficient finances. At this point, the patient completed a course of physical therapy and was fitted with a functional ACL brace.
Over the course of treatment, the patient eventually regained full range of motion and strength, but some instability and pain persisted when the brace was not used. Physical examination showed less tenderness over the medial tibial plateau, a decrease in laxity of the MCL, and decreased anterior translation of the tibia. Three-month followup X-rays showed that the avulsed fragment never fully healed to the tibia (Fig. 7). The patient is likely to have continued instability and persistent pain from development of osteoarthritis at a young age.

**Discussion**

The reverse Segond fracture has been shown to have an association with significant internal derangement of the knee, just like the Segond fracture. Most commonly, the reverse Segond pattern involves the PCL, MCL, and medial meniscus. The mechanism of the previously reported cases (1, 3-7) has been postulated to be an injury causing valgus stress with the tibia in external rotation. This case, with MCL and ACL injury, likely resulted from valgus stress with the tibia in internal rotation. It is the first reported case that I am aware of, of the reverse Segond pattern without PCL injury.

One study, by Kaplan et al (8), examined 100 ACL injuries and found 56 occult fractures. Of these 56, all included the original Segond pattern; only five also showed a medial tibial fracture. These five fractures were posteromedial, in

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**Figure 5.** 22-year-old male with reverse Segond fracture. Sagittal T1-weighted MRI shows intact PCL (yellow arrow).

**Figure 6.** 22-year-old male with reverse Segond fracture. Coronal T2-weighted MRI shows reverse Segond fracture and swelling along torn MCL (yellow arrow).

**Figure 7.** 22-year-old male with reverse Segond fracture. Left knee X-ray three months after injury shows reverse Segond fracture fragment unhealed (yellow arrow).
contrast to the anteromedial fractures described in the reverse Segond pattern. This posteriomedial fracture was proposed by Yao et al. (9) to occur by semimembranosus tendon avulsion, but this was then refuted by Vanek (10). Vanek’s alternate theory was based on a case report and cadaveric experiment that showed that the fracture likely occurs after the ACL tear as a crush-type injury from subluxation of the tibia. The Kaplan study helps to demonstrate the rarity of the reverse Segond fracture with ACL tears but without the PCL involvement, as described in the original reverse Segond reported cases.

This patient in this case was never able to have arthroscopy to confirm the injury pattern; however, both physical exam and MRI were consistent with ACL and MCL injury. The meniscus was not noted to be involved on MRI; however, arthroscopy might have shown a tear, root avulsion, or displacement. All but one reported case has involved the meniscus, including the two cases reported by Engelsohn et al. (5); this article proposes development of advanced medial osteoarthritis due to extrusion of the meniscus allowed by the meniscal root tear or displacement of the tibial attachment. This, combined with the known advanced osteoarthritis associated with rotary instability from ACL deficiency, will likely result in advanced osteoarthritis and pain in this 22-year-old patient. Recognition of the reverse Segond fracture pattern allowed prompt diagnosis of internal derangement that had been overlooked in the setting of contralateral tibial/fibular fracture. But sadly, due to financial issues, the patient was not able to get the surgical evaluation and repair that may have decreased the chance of advanced osteoarthritis. Hopefully, increased recognition of the reverse Segond fracture will enable early diagnosis of significant internal derangement in other patients who may get adequate surgical treatment when it is indicated.

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