Adolescent Segond Fracture With an Intact Anterior Cruciate Ligament

DEEPAK REDDY, MD; REGINALD ALEXANDER, MD; WAQAS M. HUSSAIN, MD; J. MARTIN LELAND, MD

abstract

Full article available online at Healio.com/Orthopedics. Search: 20120621-33

Segond fractures, or avulsion fractures of the proximal lateral tibial plateau, have been well documented and studied since their original description in 1878. Segond fractures have a widely recognized pathognomonic association with anterior cruciate ligament (ACL) injuries and often prompt orthopedic surgeons to consider reconstruction following radiographic and clinical evaluation. Adolescent patients are particularly vulnerable to these fractures due to the relative weakness of their physeal growth plates compared with the strength of their accompanying ligamentous structures.

This article describes a case of a 13-year-old boy who sustained a Segond fracture that was not coupled with an ACL avulsion or tear. The patient sustained a twisting injury to his knee. He presented to the emergency room with an effusion and radiographic findings consistent with a Segond fracture. On follow-up examination 1 week after injury, the ACL was intact. The patient was followed for 5 months of conservative treatment. At final follow-up, the patient had reestablished his previous level of activity.

This article describes the history, physical examination, and radiographic findings necessary to care for patients who present with a Segond fracture. Although considered pathognomonic for an associated ACL injury, this article describes a Segond fracture that occurred in isolation.

Drs Reddy, Alexander, Hussain, and Leland are from the Department of Orthopaedics, University of Chicago Medical Center, Chicago, Illinois.

Drs Reddy, Alexander, and Hussain have no relevant financial relationships to disclose. Dr Leland is a paid consultant and expert witness for Stryker.

Correspondence should be addressed to: Deepak Reddy, MD, Department of Orthopaedics, University of Chicago Medical Center, 5844 S Maryland Ave, MC 3079, Chicago, IL 60637 (deepak.reddy@uchospitals.edu).

doi: 10.3928/01477447-20120621-33

Figure: Sagittal proton-density–weighted fast spin echo magnetic resonance image using a 1.5 Telsa magnet through the intercondylar notch of the left knee showing an intact anterior cruciate ligament (arrow) with preserved tibial and femoral insertions. No signal change occurred in the substance of the anterior cruciate ligament.
With recent increasing participation in athletic activities, the incidence of sports injuries, ranging from anterior cruciate ligament (ACL) injuries to avulsion fractures, has steadily increased. Although adults may sustain ACL ruptures, or more rarely avulsion fractures, adolescent patients are particularly vulnerable to avulsion fractures due to the relative weakness of their physeal growth plates compared with the strength of their accompanying ligamentous structures. Because of the variable stresses the knee incurs and the number of soft tissue and capsular structures that contribute to its stability, it is particularly vulnerable to this type of injury.

Segond fractures, or avulsion fractures of the proximal lateral tibial plateau, have been well documented and studied since their original description in 1878. These injuries can be reproduced through the mechanism of internal rotation with varus stress and can be a sign of severe internal joint derangement and subsequent rotational instability. Segond fractures have a widely recognized pathognomonic association with ACL injuries and often prompt orthopedic surgeons to consider reconstruction following radiographic and clinical evaluation. This article describes a case in which a 13-year-old boy sustained a Segond fracture that was not coupled with an ACL avulsion or tear. Understanding the mechanism of associated injury and having a strong foundation in a thorough physical examination will provide insight to the overall conservative and operative orthopedic care of these patients.

**Case Report**

A 13-year-old boy presented to the emergency department reporting left knee pain and swelling. Prior to presentation, the patient had sustained a twisting injury to his left knee while wrestling with a friend. After the injury, he noted appreciable swelling and an audible popping or snapping sensation with full weight bearing.

One week following initial injury, the patient presented for repeat clinical examination and MRI review. Physical examination revealed a ROM of 0° to 130° with negative patellar apprehension, grind, and dial tests. The patient had an equivocal Lachman test, with a firm endpoint and negative associated anterior and posterior drawer tests. The knee was stable to varus and valgus stresses, and a palpable lateral collateral ligament was appreciated that was minimally tender with the knee in a figure-4 position. A noncontrast MRI of the left knee revealed an intact ACL with no evidence of associated ligamentous or meniscal pathology (Figure 2). The Segond lesion was visualized on MRI as a lateral plateau capsular avulsion.

The patient was instructed to remain weight bearing as tolerated and was offered physical therapy for a ROM and strengthening program. He was subsequently evaluated in the clinic 5 months after injury. The patient reported no difficulty with his knee, having gradually returned to full activity. On physical examination, the patient had full ROM (range, 0°-130°) and no effusion. No tenderness existed over the medial or lateral joint lines. The patient had a negative patellar apprehension test and a negative Lachman test with a solid endpoint, equal to the contralateral side. In addition, the patient had negative anterior drawer, pivot shift, and posterior drawer tests. The patient was stable to varus–valgus stress, with a dial...
test negative at 30° and 90°. At 5-month follow-up, the patient was unable to recall the side of initial injury and had returned to his preinjury level of sport and, given the clinical picture and full recovery, repeat imaging was not obtained.

**DISCUSSION**

The Segond fracture, also referred to as a lateral capsular sign or a lateral tibial plateau avulsion fracture, implies disruption of the meniscotibial portion of the middle one-third of the lateral capsule and is commonly associated with ACL tears.1-3 The injury was originally described by French surgeon Paul Segond in 1878 through his biomechanical experiments with cadavers.1 The mechanism of this injury is considered the result of varus stress on a partially flexed and internally rotated knee, placing increased strain on the lateral capsular ligaments.2-3 Segond fractures are important because they may be the only radiographic clue to more severe underlying ligamentous injuries, ranging from ACL disruption to avulsion of the fibular collateral ligament or tibiofibular joint sprains.4,6 In addition, this fracture can also be seen in combination with avulsions of the popliteus tendon or iliotibial tract at Gerdy’s tubercle.2,4

The mechanism of these accompanying ACL injuries differs among adults and children. In pediatric populations, these traumas typically involve forced flexion of the knee with internal rotation of the tibia and usually demonstrate no other associated injuries.4 In adults, they are usually the result of joint hyperextension and have a higher incidence of other injuries, such as adjacent bone contusions and tears of the medial collateral and meniscal injuries.2

Segond1 reported that when the knee is flexed to 145° and internally rotated, tension is noted in the lateral and cruciate ligaments. Using 38 cadavers, he reproduced the typical injury pattern, avulsion of the meniscotibial portion of the lateral capsule with complete ACL disruption, in 17 trials. Fourteen of the remaining trials produced incomplete ACL tears.1 Thus, he demonstrated that lateral capsular avulsions are often associated with significant internal ACL derangement.

Falciglia et al5 reported a case of a 14-year-old with a Segond fracture and associated ACL tear in which the patient was injured during a volleyball game. The mechanism was an axial load to a semiflexed knee with a rotational component. He observed knee swelling and a difficult clinical examination secondary to pain. Diagnostic arthroscopy revealed an intrasubstance ACL tear. The patient was placed into a functional knee brace and had a good outcome with no further surgical intervention.5 Sferopoulos et al7 also reported 7 cases of Segond fractures in children and adolescents. However, they reported that the disruption occurred at the intercondylar eminence instead of tears through the ACL.7

The current case is interesting because of the lack of ACL injury. Traditionally, Segond fractures have a high incidence of associated ACL injury. In older patient populations with closed physes, it usually manifests as an intrasubstance tear. This can be attributed to the increase in strength of the bone compared with the surrounding ligamentous structures. In children and adolescents, the usual manifestation is an avulsion fracture. This can be attributed to the ligaments being stronger than the nascent bone in children. However, the current article describes a Segond fracture without an associated ACL tear. It is possible that the normal increase in tension necessary to cause a Segond fracture was dissipated through the physis, sparing the ACL. Thus, with increased stress and strain, the first structure to fail is the bone via the physis because it is the weakest area in the immature skeleton.

In patients who sustain a twisting injury with radiographic findings of a Segond fracture, a high suspicion for ACL rupture should be present. In acutely evaluating these patients, physical examination findings may be hard to illicit. However, the presence or absence of an effusion and neurovascular status should be documented. In addition, provocative tests, such as the Lachman or drawer tests, may be hard to perform in the initial postinjury period. Knee aspiration can be helpful to evaluate for the presence of hematoma indicating intra-articular pathology. In the current patient, given the mild nature of the physical examination findings, no aspiration was performed. In addition, the aspirate can be evaluated for fat droplets. Ficatier8 reported that fat droplets in repeated aspirations from a knee may indicate the presence of intra-articular fracture. Aspiration can be followed by injection of local anesthetic to facilitate patient comfort while performing more aggressive provocative tests. The effusion noted on the current patient’s initial examination was most likely the result of the lateral plateau capsular avulsion. In the setting of Segond fractures, the importance of a thorough physical examination cannot be overstated. However, given this injury’s propensity for associated ACL pathology, MRI is valuable in critically assessing the competence of the crucial intra-articular structures and should be obtained when symptoms or examination findings point toward ligamentous, meniscal, or chondral pathology.

During the initial evaluations of the current patient, the authors noted an equivocal Lachman test with a firm endpoint. However, at final follow-up, the examination revealed a negative Lachman test with a firm endpoint, equal to the contralateral knee. This difference between the acute injury evaluation and the final follow-up is likely secondary to the patient’s decreased discomfort, lack of guarding, and decreased effusion. In addition, on initial evaluation, the patient had a 1 to 2+ effusion. The effusion was most likely due to a hemarthrosis as a result of the lateral plateau capsular avulsion. Alleviation of these
factors at follow-up allowed for a clearer and more precise physical examination that showed a solid endpoint and negative Lachman test that was equal to the contralateral side.

**CONCLUSION**

Segond fractures have a high association with ACL injury. The typical mechanism is a varus force on a partially flexed, internally rotated knee, placing an increased amount of tension on the lateral ligamentous structures. The manifestations of this increase in stress are usually transmitted through the ACL. However, this is not always true. Special consideration should be paid to skeletal maturity and mechanisms of injury that may determine how and where these forces are dissipated. Although Segond fractures are usually associated with ACL ruptures, this is not always the case.

**REFERENCES**