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Segond Fractures: Not Necessarily Pathognemonic of Anterior Cruciate Ligament Injury in the Pediatric Population

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Initially described following cadaveric studies in the late 19th century by Dr. Paul Segond, the Segond fracture is now widely accepted as a pathognemonic radiographic marker of anterior cruciate ligament injury. This fracture in a skeletally immature 16-year-old was not seen with an anterior cruciate ligament injury, but with a Salter-Harris type IV fracture of the tibial plateau. A nonweightbearing knee immobilizer with the leg in full extension was used for 6 weeks. Recovery was uncomplicated, and range of motion and weightbearing began at 6 weeks.

Keywords: segond fracture; anterior cruciate ligament injury; tibial spine avulsion; knee hemarthrosis; tibial physeal injury

Initially described following cadaveric studies in the late 19th century by Dr. Paul Segond, the Segond fracture is now widely accepted as a pathognemonic radiographic marker of anterior cruciate ligament injury (ACL).^{1,8} Classically resulting from internal rotation and varus stress of the knee in flexion, the Segond fracture is an avulsion injury of the lateral tibial plateau and midlateral capsule that frequently accompanies ACL rupture.¹ This injury commonly includes meniscal injury.⁵

A Segond fracture has an associated ACL injury 75% to 100% of the time,^{3,5} and it occurs in approximately 9% to 12% of all ACL tears.^{6,10} In terms of positive predictive value, a Segond fracture is found in less than 1% of other types of knee injuries and is thus most frequently linked to an ACL injury.⁶ In skeletally immature patients, the link between Segond fractures and ACL injury may not be as definitive, perhaps owing to underlying differences in relative strength of ligament and bone.⁷

CASE PRESENTATION

A 16-year-old male cyclist was injured in an incident in which he slipped off his seat. Based on the patient's recollection of the mechanism of injury, an axial load was applied to his hyperextended left leg. He felt a pop in his knee, which was followed by instant knee pain. An effusion developed within 1 hour. There was no history of knee injury or instability symptoms.

Physical examination revealed a large effusion, with tenderness to palpation along the medial joint line, the lateral joint line, and the proximal-lateral tibial plateau. Range of motion was limited because of pain. Stability testing revealed no varus, valgus, or posterior instability. There was a grade 2 Lachman (compared with the contralateral limb). Pivot-shift testing and anterior drawer testing were not performed, owing to the acuity of the injury.

Initial radiograph of the injured left knee demonstrated a lipohemarthrosis related to a 10-mm separated bony body on the lateral margin of the proximal tibial epiphysis (Segond fracture) (Figure 1). Further imaging was recommended to investigate ligamentous or meniscal damage.

An magnetic resonance image of the knee showed no evidence of an anterior or posterior cruciate ligament or meniscal tear (Figure 2A). An undisplaced Salter-Harris type IV fracture of the left proximal tibia was identified (Figure 2B). The fracture extended obliquely through the medial tibial plateau anterosuperior to posteroinferior. A 10-mm avulsed fragment with signal change consistent with an acute injury was present in the tibial plateau corresponding to the Segond fracture (Figure 3). Also present was an acute undisplaced subchondral fracture of the weightbearing lateral femoral condyle, with corresponding bone marrow edema (bone bruise) in the proximal lateral tibial plateau (Figure 3).

The patient was treated in a nonweightbearing knee immobilizer, with the leg in full extension, for 6 weeks. His

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No potential conflicts of interest declared.

DOI: 10.1177/1941738110379215

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Figure 1. A, anteroposterior radiograph demonstrates the Segond fracture (white arrow); B, lateral radiograph demonstrates the lipohemarthrosis (black arrow).



Figure 2. A, sagittal T1 magnetic resonance image demonstrates Salter-Harris type IV fracture of the proximal tibia (white arrows); B, sagittal oblique T2 turbo spin echo magnetic resonance image demonstrates intact anterior cruciate ligament (black arrow).

recovery course was uncomplicated, and he began range of motion and weightbearing at 6 weeks. At the 6-week, 3-month, 6-month, and 12-month assessments, there was no evidence of ACL instability (grade 0 Lachman).

DISCUSSION

Since Dr Segond described the lateral tibial avulsion fracture, its association with ACL injury has been well documented.^{3,5,6,10} ACL injuries occurring in skeletally immature individuals appear to follow a trend similar to that of their adult counterparts with regard to Segond injury.^{7,11} ACL injury has been found to be responsible for 29% to 47% of pediatric acute knee effusions, with a Segond fracture occurring in 6% of these ACL injuries.^{7,11} These percentages are similar

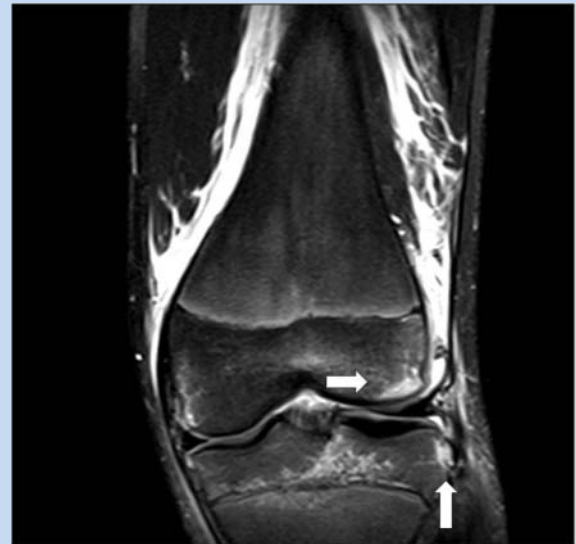


Figure 3. Coronal T2 turbo spin echo magnetic resonance image demonstrates lateral femoral condyle impaction fracture (horizontal arrow) and Segond fracture (vertical arrow).

though slightly lower than those outlined above in the adult population.^{6,10} However, in skeletally immature patients, a Segond fracture may not be as pathognomonic for ACL injury as in adults. Sferopoulos et al described a relationship between Segond fractures and tibial eminence fractures,⁹ and a slightly displaced Salter-Harris type IV injury linked to a Gerdy tubercle avulsion. This was likely due to an eccentric contraction of the iliotibial band, resulting in a fracture across the physis. The risk of growth disturbance after a fracture involving the proximal tibial physis is greater than 25%, with the most common residual deformity being recurvatum.⁴

A likely explanation for the differing injury profile associated with a Segond fracture in children compared with adults involves the biomechanical differences in ligament and bone at this stage of development. In children, the knee ligaments are known to be stronger than the adjacent physeal plate,² particularly around pubertal growth spurts.^{2,9} This is an important consideration in Segond fractures in the pediatric population. The impaction fracture and associated bone bruising in the lateral compartment are likely related to loading through this compartment. Magnetic resonance imaging remains important in the evaluation of these fracture patterns so that the full extent of the injury can be identified.

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