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Avulsion fracture of the medial collateral ligament association with Segond fracture

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ABSTRACT

The Segond fracture is a tibial avulsion injury of the insertion of the middle third of the lateral capsular ligament that is typically associated with anterior cruciate ligament and meniscal tears. The classically assigned mechanism of injury is a combination of internal rotation and varus stress. We report two cases of Segond fractures that presented with a variant pattern including osseous avulsion injuries of the medial collateral ligament at the femoral origin, anterior cruciate ligament tear, and pivot shift-type osseous contusion pattern, suggesting an alternative mechanism of injury that includes dominant valgus stress and external rotation components. Awareness of this pattern may aid radiologists, surgeons, and sport medicine physicians in the accurate diagnosis of this injury complex and initiation of appropriate treatment in a timely fashion.

1. Introduction

The Segond fracture was first described by Paul Segond in 1879 as a cortical avulsion of the tibial insertion of the middle third of the lateral capsular ligament at lateral aspect of the tibial plateau [1]; however, participation of the iliotibial tract and anterior oblique band have been suggested since [2]. The classically assigned mechanism of injury is a combination of internal rotation and varus stress, which may result in anterior rotational instability of the knee joint [3].

Segond fractures are often associated with a characteristic pattern of additional injuries, which most commonly includes anterior cruciate ligament tears in 75–100% and meniscal tears in 66–100% [4], but also posterolateral corner injuries, including the popliteus tendon, fibular insertions of the biceps femoris tendon, and arcuate ligament. Posterior cruciate ligament and fibular collateral ligament tears may occur in association as well, whereas an association with avulsion fractures of the femoral origin of the medial collateral ligament has not been described previously.

We report two cases of Segond fractures who presented with a different pattern, comprised of avulsion fractures of the femoral attachment of the medial collateral ligament, anterior cruciate ligament tears, and pivot shift-type osseous contusion injuries, suggesting an alternative mechanism that involves dominant valgus stress and external rotation components.

2. Case presentation

2.1. Case 1

A 16-year-old male teenager presented with mild knee pain after a motorcycle accident four days earlier, which was initially treated with a knee splint. Findings on physical examination included intact skin, a subcutaneous hematoma, moderate soft tissue swelling about the knee, and a palpable joint effusion. There was tenderness to palpation along the medial and lateral joint lines, whereas passive patellar motion did not elicit pain. Peripheral sensory and motor functions were preserved. There was anteroposterior instability of the knee, suggesting an anterior cruciate ligament tear. There were no clinical signs of meniscus injury.

Radiographs of the knee showed a Segond fracture, cortical irregularity along the medial aspect of medial femoral condyle, deepening of the condylopatellar sulcus at the lateral femoral condyle, and lipohemarthosis. CT images showed a Segond fracture with longitudinally-oriented cortical bone fragment located in parallel to the lateral cortex of the proximal tibial plateau, an osseous avulsion fracture of the femoral origin of the superficial layer of the medial collateral ligament, non-displaced impaction facture of the condylopatellar sulcus of the

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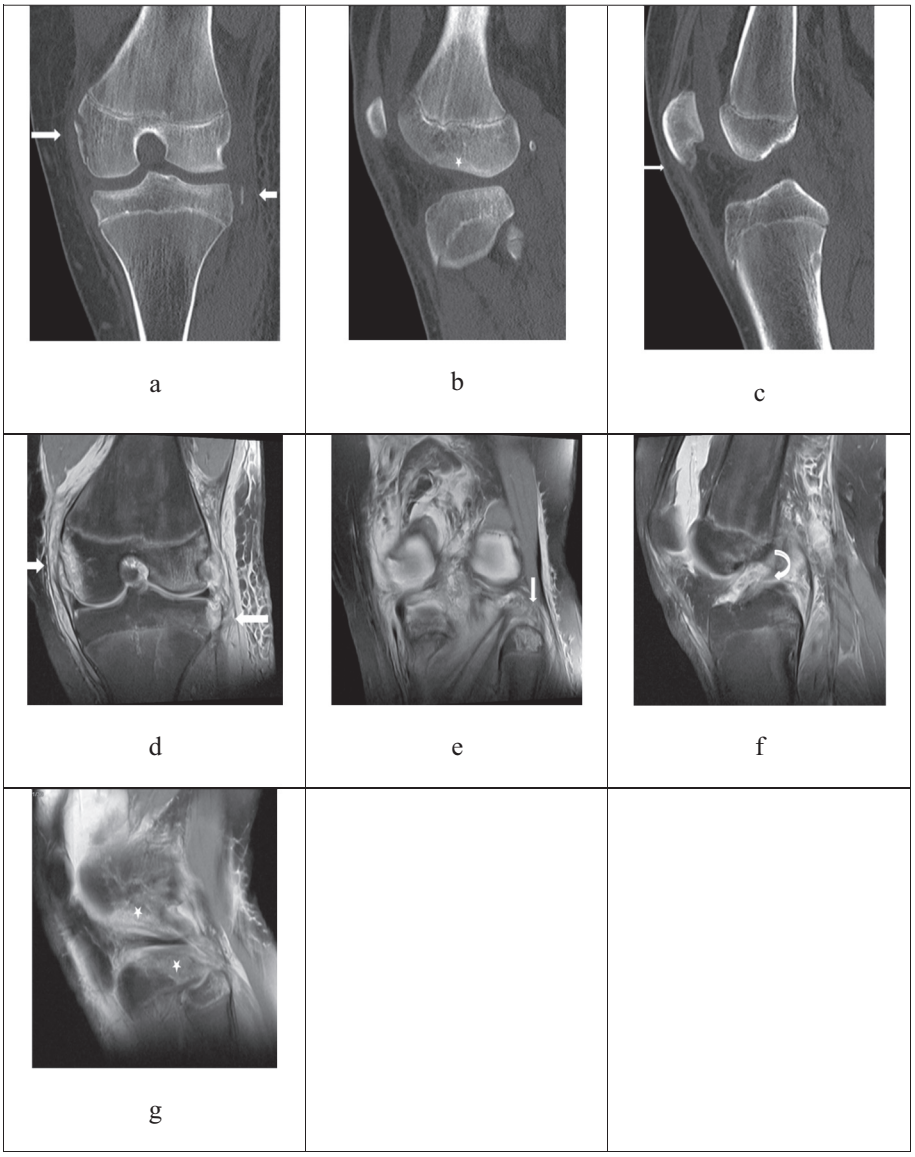

Fig. 1. 16-year-old male teenager with acute knee injury. Coronal (a) and sagittal (b and c) CT image show a Segond fracture (a, short arrow), an osseous avulsion of the femoral origin of the medial collateral ligament (a, long arrow), an impaction facture of the condylopatellar sulcus of the lateral femoral condyle (b, asterisk), and a periosteal sleeve avulsion of the patella (c, arrow). Coronal (d and e) and sagittal (f and g) T2-weighted MR image with spectral fat suppression show a Segond fracture (d, long arrow), an avulsion fracture of the femoral origin of the medial collateral ligament (d, short arrow), posterolateral corner injury with avulsion of the arcuate ligament (e, arrow), full-thickness tear of the anterior cruciate ligament (f, arrow), and pivot shift-type bone contusions of the lateral femoral condyle and the posterior aspect of the lateral tibial plateau (g, asterisks).

lateral femoral condyle with deepening and increased bone density, and a patellar sleeve avulsion with mildly displaced cortical fracture of the inferior pole of the patella (Fig. 1a–c). MR images showed several areas of focal bone marrow edema pattern along the fracture margins of the Segond fracture at the lateral cortex of the proximal tibial plateau, the fracture margins of the avulsion fracture of the femoral origin of the medial collateral ligament, the condylopatellar sulcus and posterior tibia plateau of the lateral compartment due to a pivot-shift-type osseous contusion injury, and styloid process of the proximal fibula due to an avulsion injury of the arcuate ligament (Fig. 1d–g). Additional injuries included a full-thickness tear of the anterior cruciate ligament, a non-displaced patellar sleeve avulsion, a partial tear of the proximal popliteus tendon, and a hemorrhagic joint effusion.

2.2. Case 2

A 19-year-old male teenager presented to our institution after a motorcycle accident, during which his left knee collided with a street sign. On physical examination, there was moderate swelling of the knee joint and a skin laceration of the posterolateral popliteal region. Blood supply and sensory intervention were normal.

Radiographs of the knee showed fractures of the femur and fibula, and a Segond fracture of the knee. CT images showed a Segond fracture, avulsion of the femoral origin of the medial collateral ligament and an impaction facture of the condylopatellar sulcus of the lateral femoral condyle (Fig. 2a, b). MR images that were obtained after osteosynthesis of the femur fracture showed a Segond fracture and the avulsion fracture of the femoral attachment of the superficial medial collateral ligament, but also a full-thickness tear of the anterior cruciate ligament, pivot shift-type bone contusions of the lateral femoral condyle and the posterior aspect of the lateral tibial plateau, and a full-thickness tear of the anterior cruciate ligament (Fig. 2c, d). In addition, a hemorrhagic joint effusion was present as well.

3. Discussion

We describe two cases of Segond fracture with a variant pattern of associated injuries, including osseous avulsion fractures of the femoral origin of the medial collateral ligament, anterior cruciate ligament tears, and pivot shift type bone contusions with impaction fractures of the condylopatellar sulcus, suggesting an alternative mechanism that involves dominant external rotation and valgus stress components, which is in contradistinction to the classically-described mechanism of internal rotation and varus stress.

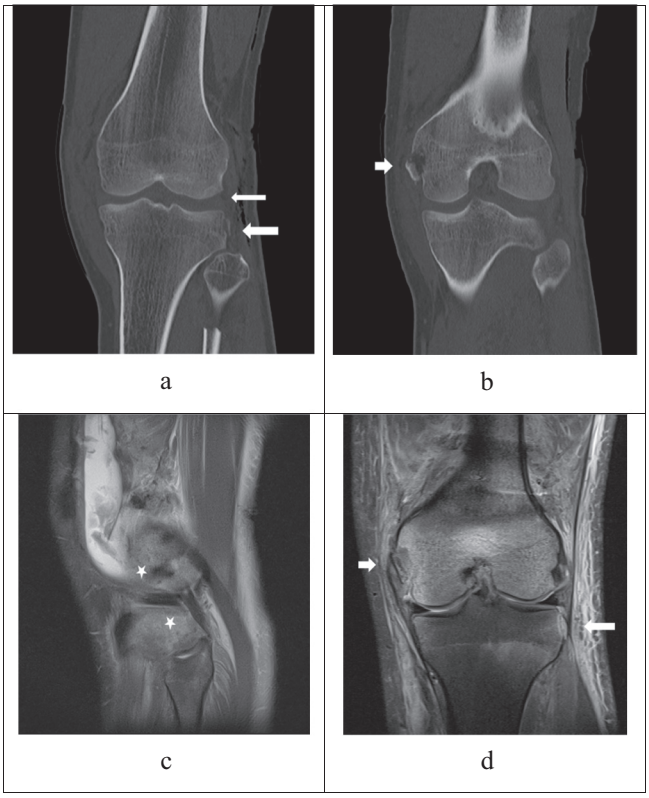

Fig. 2. 19-year-old male teenager with acute knee injury. Coronal CT images (a and b) show a Segond fracture (a, thick arrow), an impaction facture of the condylopatellar sulcus of the lateral femoral condyle (a, thin arrow), proximal fibular fracture, and an osseous avulsion of the femoral origin of the medial collateral ligament (b, arrow). Sagittal T2-weighted MR image with spectral fat suppression (c) shows pivot shift-type bone contusions of the lateral femoral condyle and the posterior aspect of the lateral tibial plateau (c, asterisks). Coronal fat-suppressed intermediate-weighted MR image (d) shows a Segond fracture (d, long arrow) and an avulsion fracture of the femoral origin of the medial collateral ligament (d, short arrow).

Various studies have investigated the types and frequencies of associated knee injuries in the presence of a Segond fracture, which include anterior cruciate ligament tears in 71–100%, meniscal injuries in 41–66%, lateral collateral ligament tears in 18%, posterior cruciate ligament years in 11%, and avulsion fracture of the fibular head in 10% of cases, as well as rare injuries of the popliteus and biceps femoris tendon and iliotibial band, and biceps [1,2,5–7]. An association with medial collateral ligament soft tissue injuries has been reported in 48–62% of small cohorts [8,9]. However, an association with an osseous avulsion fracture of the femoral origin of the superficial layer of the medical collateral ligament has not been described.

The medial collateral ligament complex is formed by a superficial and deep layer, and functions as the prime static stabilizer to valgus stress that promotes sagittal and rotational stability. The superficial fibers form a 10–12 cm long band, which originates from the posterior aspect of medial femoral condyle and has osseous and soft tissue attachments at the tibia, whereas the weaker deep layer has meniscofemoral and meniscotibial components [10]. The most common mechanisms of injury includes a high-velocity impact to the lateral aspect of the knee with resultant valgus deformity, whereas various degrees of knee flexion result in additional tibial rotation and translation [11]. Injuries of the medial collateral ligament complex are typically ligamentous and most commonly occur in the proximal aspect of the superficial layer, whereas avulsion fractures of the femoral attachment are uncommon.

Our findings suggest dominant external rotation and valgus stress components as a mechanism for Segond fractures. This combination of forces may also cause osseous avulsion fractures of the femoral origin of the superficial layer of the medial collateral ligament, which should prompt an evaluation for a Segond fracture and associated injuries [11].

4. Conclusion

Dominant valgus stress and external rotation may represent an alternative mechanism of Segond fractures that are distinctively characterized by a concomitant avulsion fracture of the femoral origin of the superficial portion of the medial collateral ligament. Awareness of this pattern may aid in the further understanding of the mechanisms of Segond fractures and help radiologists, surgeons and sport medicine physicians in the accurate diagnosis of this injury complex and initiation of appropriate treatment in a timely fashion.

Conflict of interest

All named authors hereby declare that they have no conflicts of interest to disclose.

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