Knee Surg Sports Traumatol Arthrosc (2015) 23:1925–1928
DOI 10.1007/s00167-014-2965-x

KNEE

Segond fracture in an adult is not pathognomonic for ACL injury

R. Wharton · J. Henckel · G. Bhattee · S. Ball · S. Church

Received: 20 September 2013 / Accepted: 19 March 2014 / Published online: 1 April 2014
© Springer-Verlag Berlin Heidelberg 2014

Abstract The Segond fracture is an avulsion fracture of the lateral tibial plateau and is considered pathognomonic for anterior cruciate ligament (ACL) injury. A case of a Segond fracture occurring with a clinically, radiologically and arthroscopically intact ACL is presented. This was associated with a serious injury to the posterolateral corner requiring surgical reconstruction. Relevant literature is discussed, and the suggestion is made that, whilst an ACL rupture may be the most commonly noted soft tissue component associated with a Segond fracture, the clinician should have a high level of suspicion for other serious soft tissue injuries.
Level of evidence V.

Keywords Segond fracture · Anterior cruciate ligament · Posterolateral corner · Lateral capsular ligament

Introduction

The Segond fracture is an avulsion injury of the lateral capsule of the knee joint from the lateral tibial plateau. It is most commonly seen on antero-posterior radiographs taken after an acute knee injury. This injury was first described by the French surgeon Paul Segond in 1879 as a result of forced internal rotation and varus strain on cadaveric knees [24]. On account of its high association with anterior cruciate ligament (ACL) injury, the Segond fracture is considered pathognomonic for ACL rupture [2, 8–10, 13, 15–17, 19, 24, 27, 28] and is a clinically important radiological finding which should prompt specialist referral.

There have been two previous reports of Segond fracture without ACL injury, but both were described in paediatric patients [1, 23] where the relatively weak physis generates a different injury profile to that of an adult.

Case report

A 32-year-old male amateur triathlete presented following a motorcycle accident during which he was knocked unconscious and was therefore unable to recall the mechanism of injury. Clinical examination revealed a large left knee effusion with lateral tenderness. Plain radiographs (Fig. 1) demonstrated a Segond fracture, and an injury to the ACL was therefore suspected. This was difficult to assess clinically in view of the patient's obvious discomfort. An outpatient MRI scan (Figs. 2, 3) revealed an intact ACL, but there was a distal rupture of the lateral collateral ligament so precipitous surgery was performed.

On examination under anaesthetic, Lachman's test, anterior drawer and pivot shift tests were all negative. Dial test was positive at 30°, and significant varus laxity was noted. At arthroscopy, there was no meniscal or chondral damage and the ACL and PCL were both intact and of normal appearance; lateral 'drive-through' sign was positive suggestive of an injury to the lateral collateral ligament. The popliteus muscle–tendon unit was attenuated but intact.

The posterolateral corner was then approached via a lateral incision. The popliteofibular ligament was intact. A linear contusion was identified running along the course of the lateral capsular ligament at the distal end of which the Segond fracture was identified (Fig. 4). The lateral collateral ligament had avulsed from the fibular head and was

R. Wharton (✉) · J. Henckel · G. Bhattee · S. Ball · S. Church
Department of Trauma and Orthopaedics,
Chelsea and Westminster Hospital, 369 Fulham Road,
London SW10 9NH, UK
e-mail: rupertwharton@hotmail.co.uk

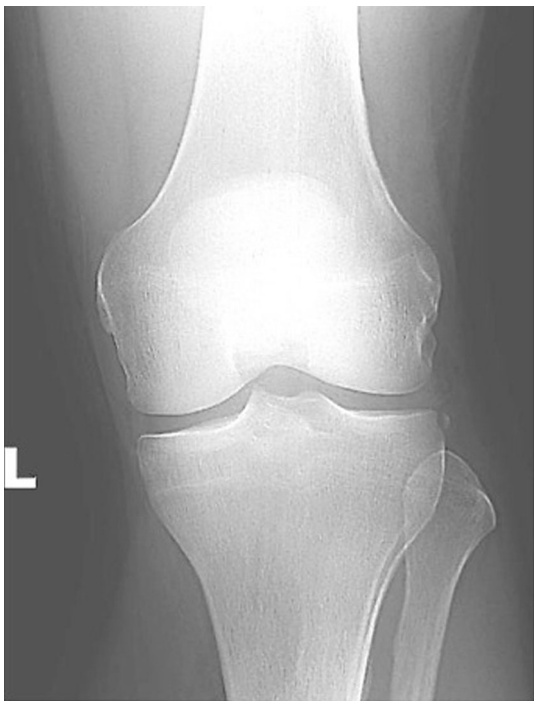

Fig. 1 AP radiograph demonstrating the Segond fracture

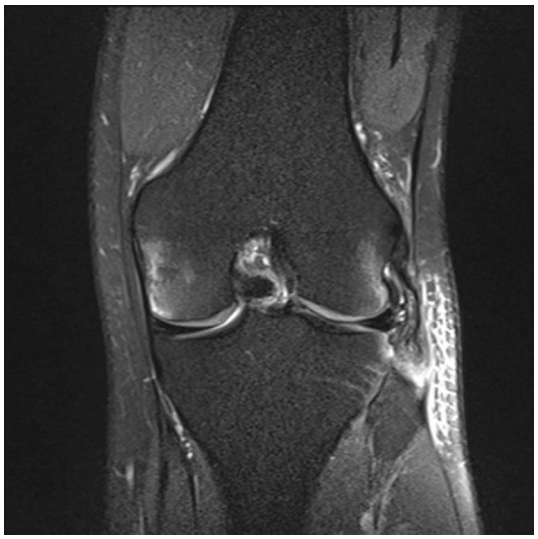

Fig. 2 Coronal MRI demonstrating distal avulsion of the LCL

reattached with intraosseous sutures. The repair was augmented with a modified Larson posterolateral corner reconstruction using a LARS™ (Ligament Augmentation and Reconstruction System) PPLY-100 ligament. One year postoperatively, the patient had rehabilitated well. Clinical examination demonstrated a good range of movement with no signs of ACL or posterolateral corner laxity. The patient returned to triathlon training with no pain, locking or instability, and has plans to compete in the near future.

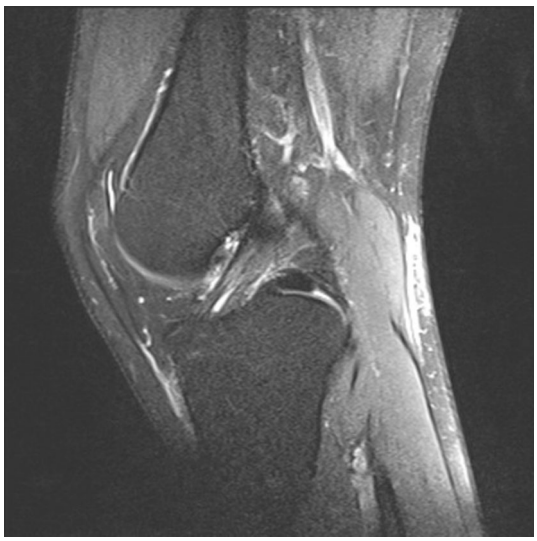

Fig. 3 Sagittal MRI; the ACL returns a normal signal

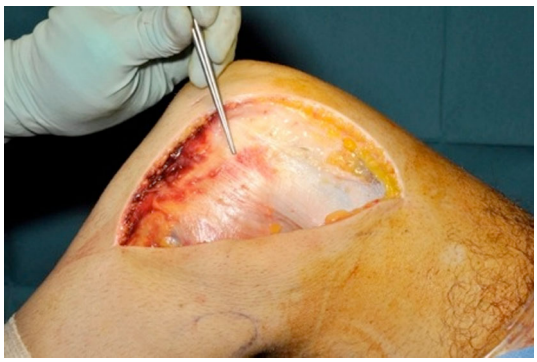

Fig. 4 Clinical photograph demonstrating a linear contusion over the lateral capsular ligament. The Segond fracture was identified at its distal end

Discussion

The Segond fracture was first described by Paul Segond in 1879 following a series of cadaveric experiments. He noted that internal tibial rotation in association with varus stress caused avulsion of the meniscosynovial portion of the middle third of the lateral joint capsule. The avulsion was first described radiographically in 1936 by Milch [21]. Subsequent cadaveric and radiological experiments have confirmed that the fracture fragment seen on imaging is continuous with the iliotibial band or anterior oblique band of the lateral capsular ligament [6, 9, 17, 18, 21, 24].

Injuries of the anterior cruciate ligament most commonly occur on valgus strain with internal or external rotation [4, 5, 20, 25], in contrast to the varus described by Segond. However, other accepted mechanisms include hyperextension, varus strain with internal tibial rotation and sudden deceleration [11, 12, 14, 22]. Internal rotation

and varus strain put both the lateral capsular ligament and the anterior cruciate ligament under tension, hence the frequent finding of ACL rupture with this injury. Internal rotation also causes a relative anterior translation of the tibia on the femur in the lateral compartment, with a resultant pattern of lateral-sided bone bruising seen on the posterolateral tibial plateau and antero-lateral femoral condyle on MRI [7, 29].

There are few articles describing the presence of a Segond fracture in the absence of ACL injury. Those that have been published describe injuries in skeletally immature populations [1, 23]. Physeal bone is relatively weak in comparison with the strong fibrous tissue of the joint capsule or the lateral collateral ligament. This is demonstrated by the relatively high incidence of ACL avulsion injuries in paediatric populations, although an ACL rupture has recently been reported in the presence of a Segond fracture in a skeletally immature 14 year old [26].

Despite a Segond fracture being considered a very specific indicator of ACL injury, it has low sensitivity as it only occurs in 3–9 % of ACL injuries, and 6–13 % of clinically unstable acute knee presentations [3, 15, 16]. This is likely to be a reflection of the fact that ACL ruptures associated with a varus mechanism of injury are rarer than those associated with a valgus mechanism [4, 5, 20, 25]. Valgus strain does not produce the required vectors for lateral capsular tension and avulsion. Furthermore, the presence of a Segond fracture does not imply a higher energy injury leading to abnormal laxity; one case series reported a high percentage of stable knees despite the presence of a Segond fracture [17].

In the reported case, the mechanism of injury is unknown on account of involvement in a high-speed motor vehicle accident and subsequent loss of consciousness. The presence of a Segond fracture is suggestive of varus strain with internal rotation, and this is supported by the presence of a lateral collateral ligament injury. Clinical, radiological and arthroscopic examination all confirmed the ACL to be intact and normal. It is therefore felt that clinicians should consider all structures put at risk by this mechanism when assessing acutely injured patients. Furthermore, whether or not the ACL examines normally, in the presence of a Segond fracture clinicians should rule out injury to the posterolateral corner.

Conclusion

The Segond fracture is currently considered pathognomonic for an injury to the anterior cruciate ligament. This case has demonstrated that the significance of this fracture is the mechanism it suggests. It occurs following internal rotation and varus strain; so although there may be a rupture of the ACL, this is not inevitable and a significant extra-articular injury should also be excluded.

References

1. Arneja SS, Furey MJ, Alvarez CM, Reilly CW (2010) Segond fractures: not necessarily pathognomonic of anterior cruciate ligament injury in the pediatric population. Sports health 2(5): 437–439
2. Bathala EA, Bancroft LW, Ortiguera CJ, Peterson JJ (2007) Radiologic case study. Segond fracture. Orthopedics 30(9): 688–797
3. Bock GW, Bosch E, Mishra DK, Daniel DM, Resnick D (1994) The healed Segond fracture: a characteristic residual bone excrescence. Skeletal Radiol 23(7):555–556
4. Boden BP, Dean GS, Feagin JA Jr, Garrett WE Jr (2000) Mechanisms of anterior cruciate ligament injury. Orthopedics 23(6):573–578
5. Boden BP, Sheehan FT, Torg JS, Hewett TE (2010) Noncontact anterior cruciate ligament injuries: mechanisms and risk factors. J Am Acad Orthop Surg 18(9):520–527
6. Campos JC, Chung CB, Lektrakul N, Pedowitz R, Trudell D, Yu J, Resnick D (2001) Pathogenesis of the Segond fracture: anatomic and MR imaging evidence of an iliotibial tract or anterior oblique band avulsion. Radiology 219(2):381–386
7. Chin YC, Wijaya R, Chong LR, Chang HC, Lee YH (2013) Bone bruise patterns in knee injuries: where are they found? Eur J Orthop Surg Traumatol. doi:10.1007/s00590-013-1319-6
8. Cosgrave CH, Burke NG, Hollingsworth J (2012) The Segond fracture: a clue to intra-articular knee pathology. Emerg Med J 29(10):846–847
9. Davis DS, Post WR (1997) Segond fracture: lateral capsular ligament avulsion. J Orthop Sports Phys Ther 25(2):103–106
10. Dietz GW, Wilcox DM, Montgomery JB (1986) Segond tibial condyle fracture: lateral capsular ligament avulsion. Radiology 159(2):467–469
11. Fauno P, Wulff Jakobsen B (2006) Mechanism of anterior cruciate ligament injuries in soccer. Int J Sports Med 27(1):75–79
12. Feagin JA Jr, Lambert KL (1985) Mechanism of injury and pathology of anterior cruciate ligament injuries. Orthop Clin North Am 16(1):41–45
13. Felenda M, Dittel KK (1992) Importance of the Segond avulsion fracture as a sign of complex ligamentous knee injury. Aktuelle Traumatol 22(3):120–122
14. Geyer M, Wirth CJ (1991) A new mechanism of injury of the anterior cruciate ligament. Unfallchirurg 94(2):69–72
15. Goldman AB, Pavlov H, Rubenstein D (1988) The Segond fracture of the proximal tibia: a small avulsion that reflects major ligamentous damage. Am J Roentgenol 151(6):1163–1167
16. Hess T, Rupp S, Hopf T, Gleitz M, Liebler J (1994) Lateral tibial avulsion fractures and disruptions to the anterior cruciate ligament. A clinical study of their incidence and correlation. Clin Orthop Relat Res 303:193–197
17. Irvine GB, Dias JJ, Finlay DB (1987) Segond fractures of the lateral tibial condyle: brief report. J Bone Joint Surg Br 69(4):613–614
18. Johnson LL (1979) Lateral capsular ligament complex: anatomical and surgical considerations. Am J Sports Med 7(3):156–160
19. Kerr HD (1990) Segond fracture, hemarthrosis, and anterior cruciate ligament disruption. J Emerg Med 8(1):29–33
20. Krosshaug T, Nakamae A, Boden BP, Engebretsen L, Smith G, Slauterbeck JR, Hewett TE, Bahr R (2007) Mechanisms of

anterior cruciate ligament injury in basketball: video analysis of 39 cases. Am J Sports Med 35(3):359–367
21. Milch H (1936) Cortical avulsion fracture of the lateral tibial condyle. J Bone Joint Surg Am 18(1):159–164
22. Quatman CE, Hewett TE (2009) The anterior cruciate ligament injury controversy: is "valgus collapse" a sex-specific mechanism? Br J Sports Med 43(5):328–335
23. Reddy D, Alexander R, Hussain WM, Leland JM (2012) Adolescent Segond fracture with an intact anterior cruciate ligament. Orthopedics 35(7):1112–1115
24. Segond P (1879) Recherches cliniques et expérimentales sur les épanchements sanguins du genou par entorse. Bureaux du Progrès Médical, Paris
25. Shimokochi Y, Shultz SJ (2008) Mechanisms of noncontact anterior cruciate ligament injury. J Athl Train 43(4):396–408
26. Tei K, Kubo S, Matsumoto T, Matsushita T, Matsumoto A, Kurosaka M, Kuroda R (2012) Combined osteochondral fracture of the posterolateral tibial plateau and Segond fracture with anterior cruciate ligament injury in a skeletally immature patient. Knee Surg Sports Traumatol Arthrosc 20(2):252–255
27. Valkering KP, Breederveld RS (2009) Segond fracture. J Am Coll of Surg 208(4):646
28. Weber WN, Neumann CH, Barakos JA, Petersen SA, Steinbach LS, Genant HK (1991) Lateral tibial rim (Segond) fractures: MR imaging characteristics. Radiology 180(3):731–734
29. Westermann RW, Wolf BR, Wahl CJ (2013) Does lateral knee geometry influence bone bruise patterns after anterior cruciate ligament injury? A report of two cases. Iowa Orthop J 33:217–220