

Radiology Corner, Case #14

The Deep Lateral Femoral Notch: A Sign of Anterior Cruciate Ligament Disruption

Guarantor: Col Timothy G. Sanders, MC, USAF (Ret.)¹

Contributors: Col Timothy G. Sanders, MC, USAF (Ret.)¹; COL Les Folio, USAF, MC, SFS;¹

Note: This is the full text version of the radiology corner question published in the July 2007 issue, with the abbreviated answer in the August 2007 issue.

The “deep lateral femoral notch” sign refers to an osteochondral impaction injury of the lateral femoral condyle that is associated with disruption of the anterior cruciate ligament (ACL). At the time of injury, the tibia translates anteriorly relative to the femur resulting in an impaction injury of the lateral femoral condyle against the posterior tibial plateau. Identification of the “deep” sulcus on the lateral radiograph of the knee is a clear indicator of significant trauma and has a high association with ACL disruption.

Introduction

Internal derangement of the knee is a common sports related injury and the conventional radiograph is often the first imaging study performed following injury. Subtle osseous abnormalities can suggest the presence of a more serious underlying soft tissue injury and the “deep lateral femoral notch” sign is just such a finding and is usually associated with disruption of the anterior cruciate ligament (ACL). Identification of a deep lateral femoral sulcus on initial radiographs of the knee indicates the presence of anterolateral rotatory instability of the knee until proven otherwise. MR imaging of the knee will often demonstrate disruption of the ACL along with additional soft tissue injuries (1).

History

The patient was a 21-year man, who twisted his knee while playing in a softball game. Following the injury, he complained of difficulty running, pain in the posterolateral aspect of the knee and joint swelling. Initial physical examination of the knee revealed a small joint effusion, but no deformity. The knee demonstrated full range of motion and there was no documentation of instability.

Summary of Imaging Findings

Lateral radiograph of the knee demonstrates a deep, irregular appearing lateral femoral sulcus, and a small joint effusion, but is otherwise normal (Fig 1). Follow up MR imaging demonstrates marrow edema in the lateral femoral condyle and in the posterior tibial plateau. The lateral femoral sulcus appears deepened and irregular in contour. T2-weighted sagittal image through the region of the intercondylar notch demonstrates complete disruption of the anterior cruciate ligament (Fig 2).



Fig 1. Lateral view of the knee demonstrates a deep lateral femoral sulcus (arrow) with irregularity and asymmetry of the notch.

Discussion

Several apparently minor osseous abnormalities of the knee have been described on conventional radiographs that are associated with more serious but radiographically occult soft tissue injuries. These include avulsion fracture of the anterior tibial spine and avulsion fracture of the lateral tibial plateau (Segond fracture), both associated with ACL disruption and avulsion fracture of the posterior intercondylar insertion of the posterior cruciate ligament (2-4). The deep femoral sulcus sign, however, is the most common radiographic sign associated with ligamentous injury of the knee. Because it is an impaction injury rather than an avulsion injury, it can be a subtle finding on radiographs, and one that is often overlooked.

¹ Department of Radiology and Radiological Sciences; Uniformed Services University of the Health Sciences, Bethesda, Maryland 20814-4799

Reprint & Copyright © by Association of Military Surgeons of U.S., 2006.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 2007		2. REPORT TYPE		3. DATES COVERED 00-00-2007 to 00-00-2007	
4. TITLE AND SUBTITLE The Deep Lateral Femoral Notch: A Sign of Anterior Cruciate Ligament Disruption				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Uniformed Services University of the Health Sciences, Department of Radiology and Radiological Sciences, 4301 Jones Bridge Road, Bethesda, MD, 20814				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 3	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

A normal lateral radiograph of the knee demonstrates a normal shallow groove along the lateral femoral condyle that is formed by the junction of the tibiofemoral and patellofemoral curvatures. This notch is referred to as the lateral condylopatellar sulcus and it is normally smooth and symmetric in appearance measuring less than 1.5 mm in depth (5). During the pivot shift mechanism of injury, the knee while in slight flexion undergoes a twisting injury and valgus stress that leads to disruption of the ACL thus allowing anterior translation of the tibia relative to the femur. As the tibia and femur return to their normal position, the lateral femoral condyle impacts the posterolateral tibial plateau resulting in an osteochondral impaction fracture of the lateral femoral condyle.



Fig 2. Sagittal STIR image through the lateral femoral condyle demonstrate a deep irregular appearing lateral femoral sulcus (long arrow). Marrow edema is also noted in the lateral femoral condyle and lateral tibial plateau (short arrows).

The radiograph will demonstrate an irregular asymmetric appearing notch that is greater than 2 mm in depth. This is referred to as the “deep lateral femoral sulcus” sign. The depth of the notch is measured by drawing a line tangential to the sulcus along the articular surface of the lateral femoral condyle and then by measuring the distance from the line to the depth of the sulcus (Fig 5). The presence of a deep lateral femoral sulcus is nearly always associated with ACL disruption but lacks sensitivity; the absence of the sign therefore does not exclude the presence of an ACL tear (5).



Fig 3. T2-weighted image through the lateral femoral condyle demonstrate a deep irregular appearing lateral femoral sulcus (long arrow). Marrow edema is also noted in the lateral femoral condyle and lateral tibial plateau (short arrows).

MR imaging also demonstrates an irregular appearing deep lateral femoral sulcus and in addition it will demonstrate marrow edema within the lateral femoral condyle and the posterior tibial plateau secondary to the impaction injury (6). This pattern of marrow edema has been referred to as the “pivot shift” marrow edema pattern and is also highly specific for ACL injury. See figures 2, 3 and 4 for examples in our case. MR imaging will demonstrate the ACL disruption along with associated injuries of internal derangement to include meniscal tear, chondral injury and collateral ligament tear.

The “deep lateral femoral sulcus” sign is a subtle radiographic finding that when present on a plain film can provide an important clue that an ACL injury has occurred. It results from an impaction of the lateral femoral condyle against the posterior tibial plateau at the time of ACL disruption. Identification of this finding on radiographs of the knee should prompt further evaluation of the knee with MR imaging.



Fig 4. Sagittal T2-weighted image through the level of the intercondylar notch demonstrates disruption (arrow) of the proximal fibers of the ACL.

Note: Follow this link for Category 1 CME or CNE in the case of the week in the MedPix™ digital teaching file.

<http://rad.usuhs.mil/amsus.html>



Fig 5. This figure demonstrates how to measure the lateral condylopatellar sulcus to see if it is less than 2 mm. The depth of the notch is measured by drawing a line tangential to the sulcus along the articular surface of the lateral femoral condyle and then by measuring the distance from the line to the depth of the sulcus. When this measurement is greater than 2 mm it is referred to as the "deep lateral femoral sulcus" sign.

References

1. Cobby MJ, Schweitzer ME, Resnick D: The deep lateral femoral sulcus notch: an indirect sign of a torn anterior cruciate ligament. *Radiology* 1992; 184(3): 855-8.
2. Eady JL, Cardenas CD, Sopa D. Avulsion of the femoral attachment of the anterior cruciate ligament in a seven-year-old child. *J Bone Joint Surg [Am]* 1982; 64-1376.
3. Woods GW, Stanely RF, Tullos HS. Lateral capsular sign: X-ray clue to a significant knee instability. *Am J Sports Med* 1979; 7:27.
4. Pauly T, VanEnde R. Avulsion fracture. *Arch Orthop Trauma Surg* 1989; 108:325.
5. Delzell PB, Schils JP, Recht MP. Subtle fractures about the knee: Innocuous-appearing yet indicative of significant internal derangement. *AJR Am J Roentgenol* 1996; 167(3): 699-703.
6. Gentili A, Seeger LL, Yao L, Do HM. Anterior cruciate ligament tear: indirect signs at MR imaging. *Radiology* 1994; 193(3): 835-40.