
THE ROLE OF SONOGRAPHY IN THE DIAGNOSIS OF TRAUMATIC RUPTURE OF THE ANTERIOR CRUCIATE LIGAMENT OF THE KNEE

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ABSTRACT

OBJECTIVE: To evaluate the usefulness and value of sonography in the diagnosis of a rupture of the anterior cruciate ligament resulting from a recent knee injury, which was indicated by a physical examination suggesting of a traumatic anterior cruciate ligament injury.

MATERIALS & METHODS: Sonography was prospectively performed in 16 patients with a recent traumatic knee injury, in which a physical examination by an orthopaedist suggested a traumatic rupture of the anterior cruciate ligament of the knee. The presence of a hypoechoic collection along the lateral wall of the femoral intercondylar notch was interpreted as a hematoma together with a ligament stump at the femoral attachment of the anterior cruciate ligament. The operative findings were compared in 12 cases. Arthroscopy was subsequently performed in 2 cases.

RESULTS: The positive sonographic findings were confirmed by operative findings in 12 of 16 patients and the negative sonographic findings were confirmed by arthroscopy in 2 of 16 patients. In the remaining 2 of the 16 cases, there was a loss of follow up.

CONCLUSION: Sonography is a useful, available and inexpensive method of detecting the presence of a rupture of the anterior cruciate ligament, particularly in the hospitals which do not have MRI.

INTRODUCTION

In the hospitals which do not have advanced imaging machines such as magnetic resonance imaging, the patients with painful swollen knee after injury may present the primary care physician with diagnostic difficulties. Early clinical examination can be unreliable because of pain and poor muscle relaxation.¹ Sonography has a potential role as an inexpensive, available, sensitive and specific screening test to confirm the diagnosis of a rupture of the anterior cruciate ligament in those patients who

would benefit from specialist consultation and further investigation with magnetic resonance imaging.

The purpose of this study was to evaluate the accuracy, usefulness and value of sonography in the diagnosis of a rupture of the anterior cruciate ligament in the setting of a recent knee injury in which a physical examination by an orthopaedist suggested a rupture of the ligament.

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MATERIALS AND METHODS

Sixteen patients with a history of traumatic knee pain within the preceding 10 weeks, who were presented to one of the three orthopaedic surgeons and in whom the physical examinations suggested a traumatic anterior cruciate ligament rupture, underwent sonographic examinations of their injured knees.

The study group included 15 males and 1 female from 20 to 42 years of age. The sonographic examinations were done within one week of referral, usually on the same day. The physical examinations were done between 1 and 60 days after the knee injury, and then referred to the radiologist.

The sonographic examinations were done by the same radiologist.

The sonography was done with a real time 3535 B&K Medial Ultrasound machine using both a linear 7.5, 5.5 –MHz and a curved 3.5, 5.0-MHz transducer.

All patients were examined in the prone position with the posterior knee (popliteal) approach.

A transverse scan of the intercondylar notch was taken as the standard plane for the assessment of the anterior cruciate ligament.² The scan clearly showed both walls of the notch, the smooth hypoechoic concave synovium, and the popliteal artery lying just posterior to the lateral femoral condyle. The hypoechoic synovium, which is 2–3 mm. thick, lies parallel to the bony outline. Echogenic intercondylar fat lies centrally. (Fig 1, Fig 2)

The criteria for acute disruption of the anterior cruciate ligament in this study is the presence of a hypoechoic collection along the lateral wall of the femoral intercondylar notch with a convex medial border obscuring the covering synovium and displacing the intercondylar fat medially. The hypoechoic collection at the origin of the anterior

cruciate ligament is thought to represent a hematoma near the origin of the anterior cruciate ligament³ together with the anterior cruciate ligament stump in the cases of a complete tearing. (Fig. 3)

The hematoma size was measured at its maximum width in 2 planes at the femoral attachment of the anterior cruciate ligament.

The contralateral asymptomatic knee was examined in all cases.

The sonographic findings were confirmed by knee operation with anterior cruciate ligament reconstructions in 12 cases.

Arthroscopy was done in 2 cases

In two cases where patients had positive sonographic findings of a rupture of the anterior cruciate ligament, neither arthroscopy nor knee operation was done because of the patients did not come back to the hospital for further management.

RESULTS

The sonographic study showed a hypoechoic lesion at the origin of the anterior cruciate ligament in 14 patients. In 12 of these patients, the diagnosis was confirmed by knee operation and the surgical procedure was anterior cruciate ligament reconstruction. In the remaining 2 cases, the patients did not show up for further treatment.

2 of all 16 patients had negative sonographic findings. Arthroscopy was done and showed that the anterior cruciate ligaments were intact in both cases.

The average width of the hematoma in cases of anterior cruciate ligament rupture was 8 x 11.7 mm., and ranged from 4.7-15 mm. for the transverse plane and 7.5-20 mm. for the longitudinal plane.

The results of this study are shown in the table.

Case	Age in years / sex	duration A / B	US Findings	Size of the lesion. (mm.)	Treatment
1	37 M	1/1	Hypoechoic lesion at ACL origin, joint effusion.	4.7x11	Knee operation with ACL reconstruction
2	42 M	30/30	Hypoechoic lesion at ACL origin	8x12	Knee operation with ACL reconstruction
3	26 F	14/14	Fusiform hypoechoic lesion at ACL origin	5x16	Knee operation with ACL reconstruction
4	20 M	20/20	Hypoechoic lesion at ACL origin	10x12	Knee operation with ACL reconstruction
5	28M	5/5	Hypoechoic lesion at ACL origin	8x12	Knee operation with ACL reconstruction
6	26 M	1/10	Hypoechoic lesion at ACL origin	7.3x7.5	Knee operation with ACL reconstruction
7	30M	60/60	Hypoechoic lesion at ACL origin	15x20	Knee operation with ACL reconstruction
8	35M	2/2	Hypoechoic lesion at ACL origin	7x11	Knee operation with ACL reconstruction
9	20M	1/11	Fusiform hypoechoic lesion at ACL origin	5x8	Knee operation with ACL reconstruction
10	25 M	1/20	Hypoechoic lesion at ACL origin	6x8	Knee operation with ACL reconstruction
11	25 M	3/3	Hypoechoic lesion at ACL origin	10x12	Knee operation with ACL reconstruction
12	22 M	3/3	Soft tissue swelling; Joint effusion; No hypoechoic lesion at ACL origin	- -	Arthroscopy - Intact ACL, Normal meniscus
13	22 M	1/5	Marked soft tissue swelling; Joint effusion; No hypoechoic lesion at ACL origin	-	Arthroscopy - Intact ACL
14	38 M	1/7	Hypoechoic lesion at ACL origin	9x10	Knee operation with ACL reconstruction
15	23 M	3/3	Hypoechoic lesion at ACL origin	11x15	Loss of follow up
16	27 M	2/2	Hypoechoic lesion at ACL origin	8x9	Loss of follow up

ACL = Anterior cruciate ligament.

M= Male F = Female

Duration A/B = Duration of pain in days / Time from injury to sonographic examination in days.

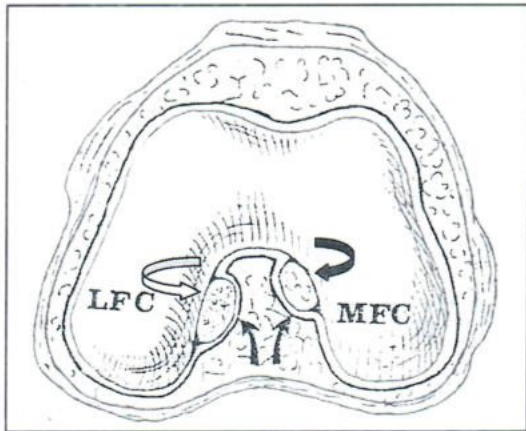


Fig.1A

Fig.1A Anatomic drawing shows femoral intercondylar notch in cross section. Anterior cruciate ligament(white arrow) originates from medial aspect of lateral femoral condyle (LFC). Posterior cruciate ligament(black arrow) lies against medial femoral condyle (MFC). A synovial membrane (curve black arrows) envelopes both ligaments.

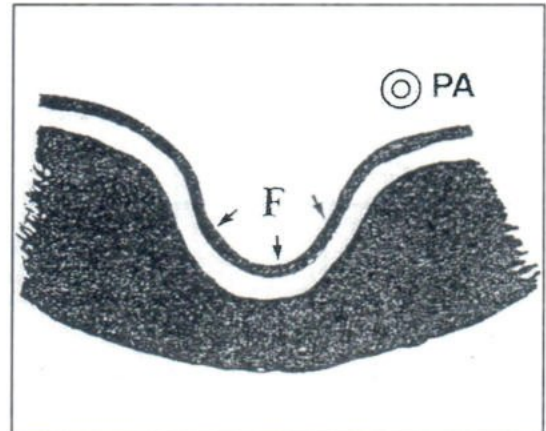


Fig.1B

Fig 1B Anatomic drawing of findings on transverse sonogram taken of region in A shows curves of femoral intercondylar notch, covering synovium(arrows),intercondylar fat (F) and popliteal artery (PA)

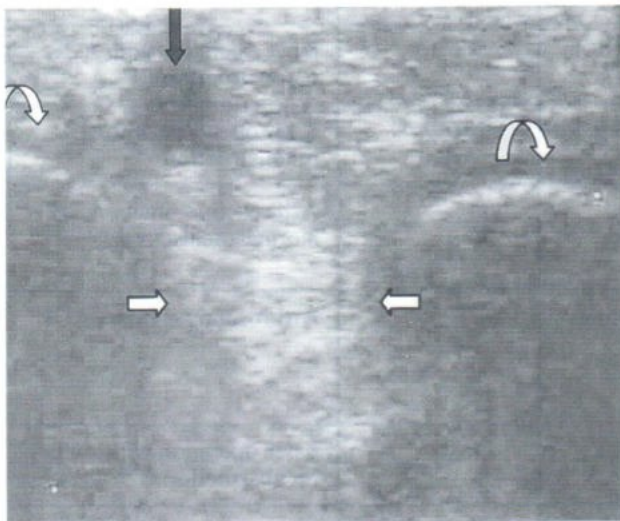


Fig.2 A

Fig.2 A A transverse scan of the intercondylar notch of **left** knee showed both walls of the notch (white arrows), the hypoechoic concave synovium (curve arrow), and the popliteal artery (black arrow).

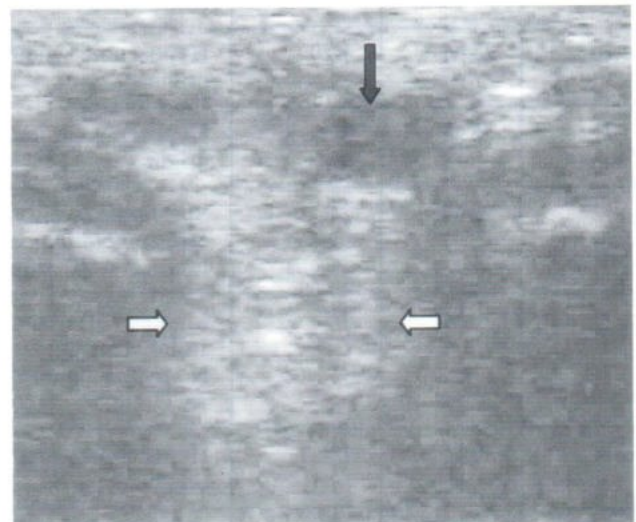


Fig.2 A

Fig.2 B A transverse scan of the intercondylar notch of **right** knee.

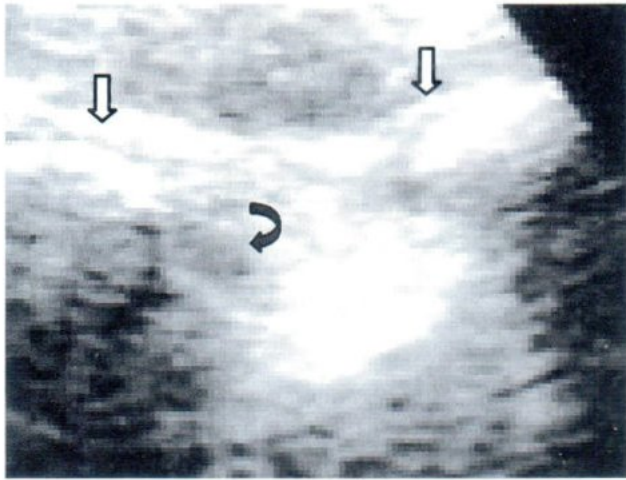


Fig. 3 A

Fig. 3 A Sonogram of case 5 shows a 8x12 mm. hypoechoic collection representing hematoma, at lateral wall of left femoral intercondylar notch (curved black arrow Hypoechoic synovium lies papallel the femoral condyles (white arrows). Knee operation revealed ACL disruption at femoral attachment and a hematoma at ACL origin.

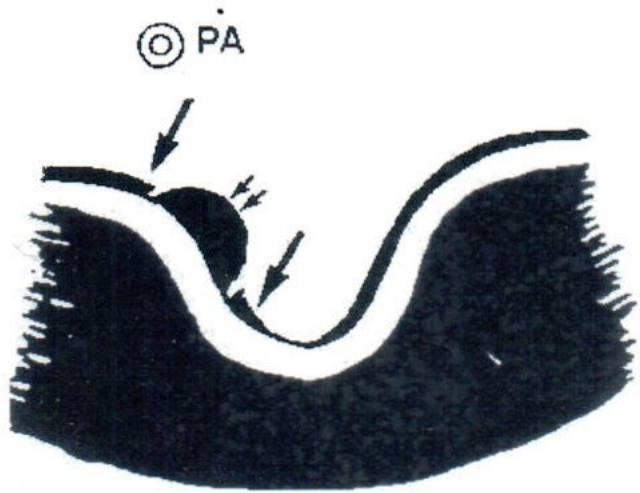


Fig. 3 B

Fig. 3 B Anatomic drawing of sonographic findings in A : Convex collection (small arrows) is hematoma at ACL origin. It obscures covering synovium (Large arrows)

PA = Popliteal artery.

ACL = Anterior cruciate ligament.



Fig. 4 A

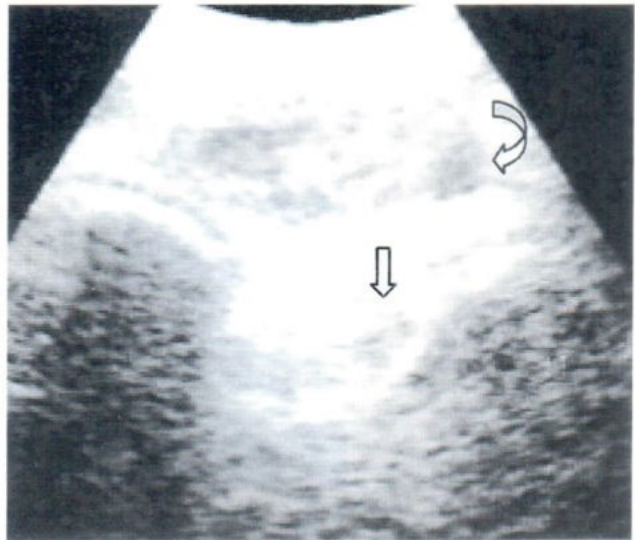


Fig. 4 B

Fig. 4 Transverse scan of the intercondylar notch of patient number 14 showed no abnormal echogenicity of left knee (A). A hypoechoic collection (white arrow) at lateral wall of the femoral intercondylar notch of right knee represents hematoma at ACL origin.

Popliteal artery = curved arrow

ACL=Anterior cruciate ligament

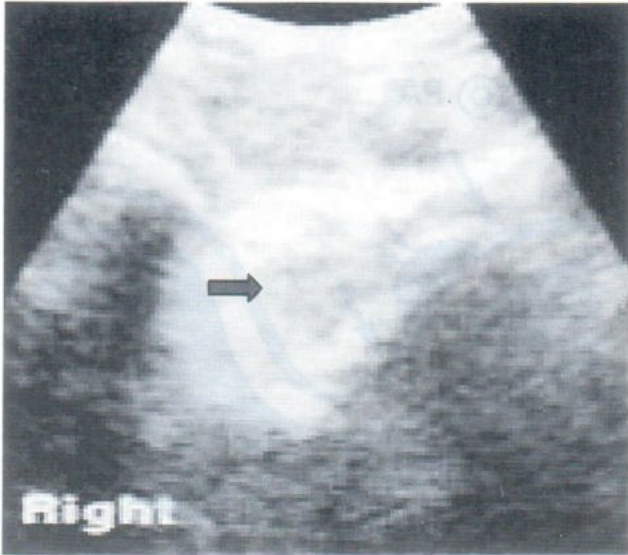


Fig.5A

Fig.5A Sonogram of case 7. showed a 15x20 mm. convex hypoechoic collection (black arrow) at the ACL origin of right knee, which was a hematoma together with a ligament stump. The sonographic finding was confirmed by knee operation.



Fig.5B

Fig.5B Case 3. Sonogram of right knee showed fusiform hypoechoic collection (curved arrow) at lateral wall of the intercondylar notch and knee operation revealed midsubstance tear of the right ACL.

ACL = anterior cruciate ligament

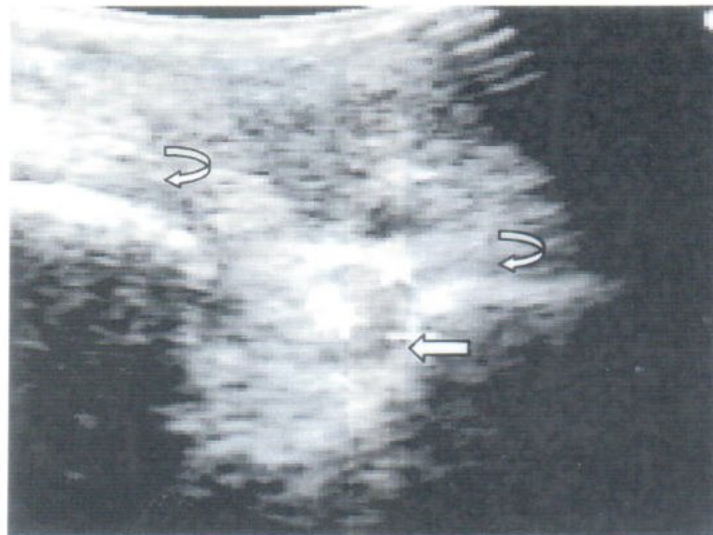


Fig.6 Case 1. Sonogram of right knee showed a 4.7x11 mm. hypoechoic collection at origin of right ACL (white arrow) and thickening of the hypoechoic synovium (curved arrow). The findings represented hematoma at ACL origin and joint effusion, respectively. Knee operation revealed midsubstance tear of right ACL and a hematoma at ACL origin.

DISCUSSION

The anterior cruciate ligament is approximately 38 mm. in length (range from 25 to 41 mm) with a width of approximately 1 cm. (range 7 to 12 mm) The anterior cruciate ligament has a synovial membrane envelope and is described as being intraarticular but extrasynovial. The anterior cruciate ligament arises from the posterolateral corner of the medial aspect of the lateral femoral condyle in the intercondylar notch. The tibial attachment/insertion is in a fossa in front of and lateral to the anterior tibial spine.⁴

Normally the anterior cruciate ligament is difficult to visualize sonographically.

The presence of a hypoechoic collection with a convex medial border obscuring the covering synovium and displacing the intercondylar fat medially was interpreted as indicating disruption of the anterior cruciate ligament. The hypoechoic collection, which is near the origin of the anterior cruciate ligament, is thought to represent a hematoma and the anterior cruciate ligament stump, the latter of which occurs in the cases of complete ligament tearing.

The presence of hematoma was found to be 100 % specific for the anterior cruciate ligament rupture.²

Most disruptions of the anterior cruciate ligament are either at the femoral attachment or midsubstance⁵; therefore the majority of the anterior cruciate ligament disruptions should be detectable with this sonographic technique. The disruptions occurring at the tibial attachment might not be detected with this sonographic technique because the hematoma might not be visible at the femoral origin.

The diagnosis of anterior cruciate ligament rupture by this sonographic technique is therefore an indirect method, relying on visualizing the hematoma

that occurs as a result of anterior cruciate ligament disruption rather than the disrupted ligament itself.

The sensitivity, specificity, positive predictive value and negative predictive value were not calculated in this study because of the small number of patients (16 patients). Further study with more collected patients is required to determine the accuracy of sonography in the diagnosis of anterior cruciate ligament rupture.

In conclusion, sonography is a very useful method of examination to confirm the diagnosis of disruptions of the anterior cruciate ligament in patients with a recent knee injury which was indicated by a physical examination suggesting a traumatic anterior cruciate ligament rupture. Sonography is an available and inexpensive adjunct in the assessment of patients with an acute knee injury, particularly in hospitals which do not have magnetic resonance imaging. This sonographic technique could significantly help orthopaedic surgeons to confirm their diagnoses and enable them to do further management such as anterior cruciate ligament reconstruction without further investigation by MRI.

REFERENCES

1. Noyes FR, Bassett RW, Grood ES, Butler DL. Arthroscopy in acute traumatic hemarthrosis of the knee : incidence of anterior cruciate tears and other injuries. *J Bone Joint Surg Am* 1980 ; 62-A : 687-695
2. R. Ptasznik, J Feller, J Bartlett , G. Fitt, A. Mitchell, O. Hennessy. The value of sonography in the diagnosis of traumatic rupture of the anterior cruciate ligament of the knee. *AJR* 1995 ; 164: 1461-1463
3. Berquist TH, Ehman LE. The knee. In: Berquist TH, ed. *MRI of the musculoskeletal system*. New York: Raven, 1990:195-251

4. Charles A. Rockwood, Jr, Devid P. Green, Robert W. Bucholz. Injuries of The Cruciate Ligaments. Fractures in Adults, 3rd ed. New York : London, 1991 ; 1865 – 1885
5. Peagin JA, Abbott Hg, Rokus JR. The isolated tear of the anterior cruciate ligament. J Bone Joint Surg Am 1972 ;47-A : 1340-1341
6. Van Holsbeek M, Introcaso JH. Musculoskeletal ultrasound, 1st ed. St. Louis: Mosby, 1991 : 300-308