Original Article

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Radiology Section

Evaluation of Anterolateral Ligament of Knee Using USG and MRI in Cases of Anterior Cruciate Ligament Tear

SANGRAM PANDA[1], JATAVATH SRAVANTHI[2], GOWRI SHANKAR KEJRIWAL[3], CHAMARTHI MADHAVI[4]

ABSTRACT

Introduction: Injury patterns of recently debated and described Anterolateral Ligament (ALL) of the knee show internal rotation laxity with concomitant Anterior Cruciate Ligament (ACL) and Iliotibial Band (ITB) injuries. Evaluation of ALL by means of Ultrasonography (USG) and Magnetic Resonance Imaging (MRI) have become necessary for recognition and repair of the ALL lesions in cases of ACL tears to avoid high graft failure rates and residual postoperative rotational instability.

Aim: To compare the diagnostic ability of USG and MRI to detect ALL injuries in ACL tear patients.

Materials and Methods: A cross-sectional observational study was performed in a study population of 92 patients who were evaluated from August 2017 to June 2019. A 1.5-Tesla MRI and USG scan with the 12-MHz linear probe was used. Two radiologists evaluated the ALL individually on MRI and USG scans. The agreement between these examiner's findings was evaluated with Cohen's kappa.

Results: On MRI, ALL was identified in 97.8% of patients and appeared injured in 69.56% of cases (64/92, κ=0.83). Out of these 64 ALL injured patients, 4.34% of patients (4/92, κ=0.85) has segond fracture and the remaining 65.21% of patients (60/92, κ=0.89) ALL was found to be injured with intact enthesis. ALL was identified and visible over its entire length in 100% of patients in USG. The ALL was injured in 82.6% of cases (76/92, κ=0.91). An USG segond fracture was present in 34.78% of cases (32/92, κ=0.89) and enthesis was intact in 47.8% of cases (44/92, κ=0.93). There was a significant correlation between the USG and MRI findings for the ALL injury and segond's fracture.

Conclusion: Although MRI can be used to identify and grade the extent of ALL injury, USG is seen to be more sensitive in the identification of normal anatomy and pathology. As most ALL injuries occur at the femoral or tibial portions, the USG may be useful as a diagnostic tool for ALL injury.

Keywords: Anterolateral ligament injuries, Avulsion, Enthesis, Ultrasonographic segond fracture

INTRODUCTION

Anatomy of the lateral aspect of the knee is complex, with numerous structures providing stability. Structures such as the ITB, fibular collateral ligament, and biceps femoris tendon are readily apparent on MRI and are easy to identify [1]. Recently, there has been much debate about the existence of a structure called 'ALL' which was first described by Dr. Paul Segond in 1879 as a pearly, fibrous band which showed extreme amounts of tension during forced internal rotation of the knee [2]. It is an ill-defined sheet-like structure coursing along with the lateral knee from the lateral femoral epicondyle to the lateral condyle of the tibia and inserting between Gerdy's tubercle and the proximal fibular head [3]. ALL injuries increased internal rotation laxity with concomitant ACL and ITB injuries as evidenced in some cadaveric studies [4].

Recently, there have been suggestions that this structure may have an association with ACL injuries and with the genesis of anterolateral knee instability [5-8]. High graft failure rates and residual postoperative rotational instability has been reported in up to 25% of patients after ACL reconstruction [9]. On the other hand, ALL reconstruction in patients with ACL reconstruction showed promising clinical results with improved rotational stability [10,11]. Hence, evaluation of ALL by means of imaging examinations have become necessary for recognition and repair of the ALL lesions in cases of ACL tears. In present study, assessment of ALL was done using both USG and MRI in ACL tear cases and to compare the diagnostic ability of USG and MRI in these patients.

MATERIALS AND METHODS

A hospital based cross-sectional observational study was conducted from August 2017 to June 2019, and the patients who were 18 years or older with recent history of knee trauma (less than three weeks before examination) and diagnosed with an acute ACL tear on MRI knee were included in the study. IEC waiver was obtained for this study. Patients with chronic ACL tears, previous Knee surgery, Osteoarthritis (>Kellegren Lawrence Grade II), Inflammatory arthritis, history of knee infections, patients who have claustrophobia and patients who are not willing to give consent were excluded.

A study population of 125 patients with acute ACL injury based on clinical and MRI findings was enrolled in the study, out of whom 92 patients who met the inclusion criteria were evaluated [Table/Fig-1]. The radiological examinations that the patient underwent were: Standard radiographs of the injured knee (Both AP and Lateral views); MRI of the injured knee; USG of both knees. Informed consent was obtained from each patient, prior to the survey. In present study, MRI was used to diagnose ACL injuries, and subsequently, USG was performed in every patient with an ACL tear.

Every patient was evaluated by two radiologists who were blinded to each other's findings, and each radiologist had to answer the following questions on both the MRI and USG examinations:

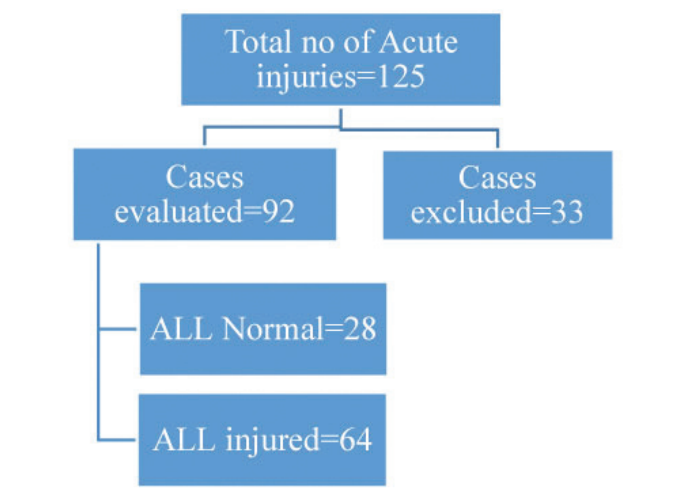
Is the ALL visible? (i.e., if it could be identified along its entire length from the femoral origin to the tibial insertion).

If the ALL is visible, is it injured?

a) At its femoral insertion, tibial insertion, or meniscal part.

b) If it was avulsed from its tibial insertion (Segond fracture).

The data generated by both radiologists were collected.



[Table/Fig-1]: Schematic distribution of cases in the study.

Study Protocol

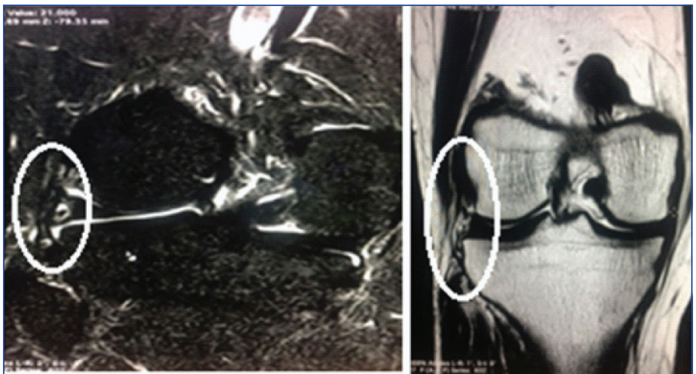
MRI: A 1.5-Tesla unit (Philips Ingenia) was used with dedicated high resolution sequences. The patient was supine with knee placed in 10° flexion for the examination. The following protocol was used: Axial, Coronal and Sagittal-Proton density fat saturated sequences; Axial and Coronal- STIR and Sagittal -T1WI and T2WI with 3 mm slice thickness and 140 mm field of view.

USG: A USG scan was performed using a 12-MHz superficial probe (PHILIPS AFFINITI 70). Subjects were lying in supine position with the knee partially flexed (70°), and the foot internally rotated, resulting in the ligament being taut. The major axis for visualisation of ALL was in coronal plane. The Lateral Inferior Genicular Artery (LIGA) acts as an important landmark for identification of ALL's tibial insertion. Identifying the insertion of ITB on the Gerdy tubercle and then slightly rotating the probe posteriorly helps to locate the tibial insertion of the ALL. From this point follow the ALL proximally and rotate 20° counter clockwise in axial plane for better visualisation of its femoral insertion.

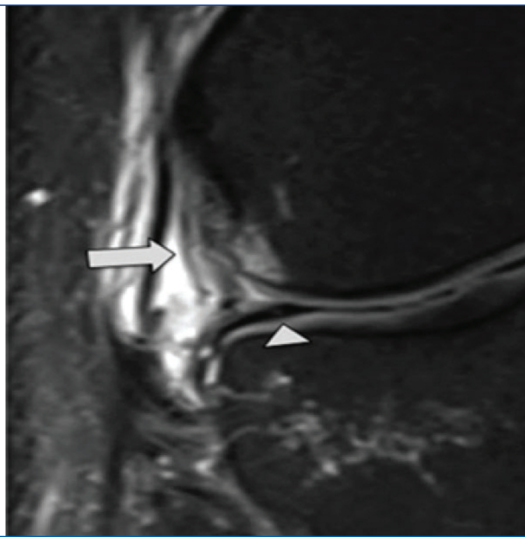
MRI analysis: The ALL was divided into femoral, tibial, and meniscal portions [Table/Fig 2,3], and the lesions and/or abnormalities of each portion were characterised. ALL was considered abnormal when it showed proximal or distal bone detachment at the site of ALL attachment, discontinuity of fibers, or irregular contour associated with periligamentous edema [Table/Fig-4].

Segment of ALL injured	No.of cases
Femoral	19
Meniscal	18
Tibial	23 (4 with Segond)
Femoral+Tibial	4
Total	64

[Table/Fig-2]: No. of cases with segment wise ALL injury on MRI.

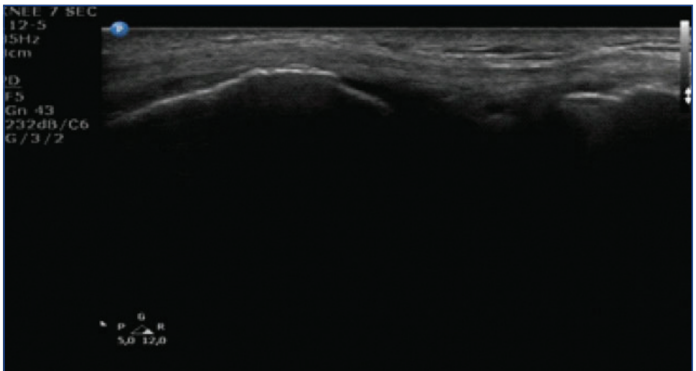


[Table/Fig-3]: Magnetic resonance coronal STIR and coronal T2 images depicts a normal anterolateral ligament depicting femoral portion, meniscal portion and tibial portion.



[Table/Fig-4]: Magnetic resonance coronal proton density fat saturation depicts a lesion in both meniscal and tibial portions of the anterolateral ligament (ALL). A meniscal tear is associated. ALL femoral portion (arrow) and meniscal tear (arrow head).

USG analysis: The ligament mid-substance and the femoral, meniscal, and tibial insertions of the ALL were analysed. Normal ALL can be delineated in USG by identifying its fibrillary framework showing anisotropy [Table/Fig-5] whereas injured ALL due to stretching or tearing results in reduction of its normal echogenicity showing irregular contours. Fluid can be seen around the injured ligament. Any bone damage at the ALL's tibial insertion (USG Segond's lesion) [Table/Fig-6] was noted.



[Table/Fig-5]: Longitudinal USG view of a normal anterolateral ligament.

[Table/Fig-6]: A case of ALL avulsion in a right knee from its tibial attachment (arrow) (Segond).

STATISTICAL ANALYSIS

Descriptive statistical analysis was carried out in the present study. Results of continuous parameters were presented as mean and standard, and results of categorical parameters were presented in Number (%). Significance was assessed at 5% level of significance. For the status of the ALL on MRI and USG, to evaluate the reproducibility of the results, the agreement between two observers was determined with the Cohen κ coefficient. Chi-square test was used to find the significance of study parameters on a categorical scale between two or more groups. The statistical analysis was performed by the Excel 2011 and SPSS software version 23.

RESULTS

A study population of 92 patients who met the inclusion criteria was evaluated. The age range of the patients who were included in the study was between 12 years to 55 years (30.4±10.09 years). The right knee was injured in 70 patients, and the left knee was injured in 22 patients [Table/Fig-7]. Among the study population, 78 (85%) were male patients, and 14 (15%) were female patients.

Injured knee	Number of patients	%
Left	22	23.9
Right	70	76
Total	92	100.0

[Table/Fig-7]: Injured knee.

On MRI, the ALL was identified in 97.8% of patients. The ALL appeared injured in 69.56% of cases. On MRI, Segond fracture was present in 4.34% of patients. On the USG, the ALL was identified and visible over its entire length in 100% of patients. The ALL was injured in 82.6% of cases. An ultrasonographic Segond fracture was present in 34.78% of cases [Table/Fig-8]. All the injuries visible on MRI were also visible on USG. Enthesis was found to be intact in all the femoral segment injured cases. The study showed almost perfect interobserver agreement for identification of entire length of ALL, ALL injuries, and for segond's fracture.

	MRI no.	Frequency (%)	Interobserver agreement (κ)	USG no.	Frequency (%)	Interobserver agreement (κ)
Entire all identified	90	97.8	0.93	92	100	1
ALL injured	64	69.56	0.83	76	82.6	0.91
Segond fracture	4	4.34	0.85	32	34.78	0.89
ALL abnormal with no detectable detachment at enthesis	60	65.21	0.89	44	47.8	0.93

[Table/Fig-8]: Detection of anterolateral ligament on MRI and USG.

There was a significant correlation between the USG and MRI findings for the ALL injury (Chi-square test=4; p<0.03). ALL status was classified as injured on the USG in 12 patients, in whom it was classified as uninjured on MRI. There was a significant correlation between US and MRI for the description of segond's fracture (Chi-square test=23; p<0.001). In 28 patients, there was a difference in the detection of segond's fracture, where the USG showed bone avulsion while the MRI did not.

DISCUSSION

USG is a dynamic examination. The spatial resolution of USG is superior to other imaging modalities, which makes easier to diagnose bone damage, even if the avulsion is small [12]. Currently there are only few studies [13,14] outlining the importance of USG over MRI in ALL injuries, even though detection rate for the USG is quite high using dynamic manoeuvres. Present study convincingly proves that USG has a significant role to play in the diagnosis and management especially in resource poor settings. More studies need to be done for standardisation of the detection procedure and framing of protocols.

This study described the appearance of the ALL when associated with an ACL tear on USG and MRI, with a strong correlation between the two imaging modalities (Pearson's Chi-squared=4, p<0.03). The interobserver agreement was high for both USG (κ=0.89- 1) and MRI (κ=0.85-0.93). This means that the USG is as reproducible as MRI for detecting ALL and ALL injuries. USG is a reliable tool for detecting ALL damage in injured knees. Cavaignac E et al., in their study showed that USG was able to diagnose 63% (19/30) of cases with ALL injury whereas present study was able to diagnose 82% (76/92) cases of ALL injuries [13]. In this study, the USG was able to detect 12 more cases of ALL injury than did MRI. The difference in the ability to detect the ALL between MRI and US can be explained by the better spatial resolution for USG and the position in which the examination was performed [12]. Three-dimensional isotropic sequences have been used in uninjured knees, with the ALL being detected in 100% of cases, so these sequences could improve the detection of ALL injuries using MRI [15]. MRI identified the ALL in 97.8% of patients in present study, whereas Claes S et al., and Helito CP et al., reported 76% and 71.7% of cases in a study done by them [16,17]. The challenges with identifying the ALL on MRI can be because of thinness, ligament's orientation, and also to its proximity to adjacent ligament structures [18]. According to Hartigan DE et al., ALL was visible in 100% of cases on MRI; however interobserver agreement for the analysis of ALL injuries was found poor [19].

In the present study, ALL injury rate of 69.56% on MRI and 82.6% in the US. These results are in agreement with studies done by Faruch Bilfeld M et al., were ALL injury rate was found to be in 53% of cases on MRI and 63% of cases on USG, respectively [20]. Most of the ALL tears we came across were at the tibial attachment, which is similar to studies done by Claes S et al., and Helito CP et al., [16,17]. It was easier to see the ALL on US than on MRI, as the present study shows US detection of ALL was 100%, similar to study done by Cavaignac E et al., [13]. The superior ability of USG in detecting the ALL (100%) relative to MRI (97.8%) can also be explained by the position in which the examination was performed: USG was carried out while keeping the knee flexed and internally rotated (which makes the ALL tense), whereas MRI was performed in 10° flexion and neutral rotation.

Currently, no validated arthroscopy method exists for viewing the ALL during ACL reconstruction procedures. The role of these two imaging modalities must still be defined. Nevertheless, the cost effectiveness and accessibility of the USG especially performing dynamic manoeuvres and placing the ligament under tension during the examination make USG very effective for analysing the ALL. Since MRI is routinely performed in cases of internal derangement of knee to diagnose ACL tears, use of three-dimensional sequences and acquisition performed in the internal rotation could make it more effective for analysing the ALL.

LIMITATION

Present study has certain limitations. A comparison of the diagnostic relevance of the two imaging methods could not be performed as there is currently no gold standard for analysing ALL. The ALL's meniscal insertion was not visible on the USG because of the perpendicular orientation of the USG probe to the ALL's fibers that insert on the meniscus.

CONCLUSION

ALL injury is a commonly associated pathology in patients with an ACL injury. As USG is low-cost, real-time imaging modality that has a very good spatial resolution. It can reliably identify the ALL and ALL injuries. Special emphasis should be made in the evaluation of knee trauma to rule out ALL injury to avoid graft failures and residual postoperative rotational instability. Although MRI can be used to identify and grade the extent of ALL injury, USG is proved to be more sensitive in the identification of normal anatomy and pathology. USG can be used as an adjunct modality in the evaluation of ALL injuries.

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PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Radiodiagnosis, Maharajah's Institue of Medical Sciences, Vizianagaram, Andhra Pradesh, India.
2. Junior Resident, Department of Radiodiagnosis, Maharajah's Institue of Medical Sciences, Vizianagaram, Andhra Pradesh, India.
3. Professor, Department of Radiodiagnosis, Maharajah's Institue of Medical Sciences, Vizianagaram, Andhra Pradesh, India.
4. Professor, Department of Radiodiagnosis, Maharajah's Institue of Medical Sciences, Vizianagaram, Andhra Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Jatavath Sravanthi,
B/730, Hill Colony, Nagarjunasagar, Nalgonda-508202, Telangana, India.
E-mail: dr.sravanthirad@gmail.com

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