The Role of Magnetic Resonance Imaging for Diagnosing Soft Tissue Lesions Associated with Anterior Cruciate Ligament Injuries

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Magnetic resonance imaging has become the gold standard for soft tissue lesions evaluation especially after a traumatic event where there is need for diagnostic confirmation. The objective of the current paper was to evaluate the ability of magnetic resonance imaging in diagnosing soft tissue lesions in patients who underwent anterior cruciate ligament reconstruction compared with arthroscopic findings. Through the ability to diagnose soft tissue injuries, particularly meniscal lesions, magnetic resonance imaging should be considered as fundamental in guiding therapeutic management in patients with anterior cruciate ligament lesions.

Keywords: anterior cruciate ligament, soft tissue lesion, MRI, arthroscopy

The anterior cruciate ligament lesion is one of the most frequent ligamentous injuries, mostly associated with pivot and contact sports [1]. The tearing usually results from a twisting mechanism during valgus stress and external rotation of the tibia [2]. If the traumatic event results from a high level of energy, associated lesions occur [3], as meniscal tears (the traumatic event is most frequently associated with tearing of the posterior horn of the lateral meniscus), collateral ligament lesions (with the medial collateral ligament being more frequently affected), subchondral bone impaction and osseous edema (lateral compartment bone edema has a high diagnostic specificity for anterior cruciate ligament tears).

The diagnosis of anterior cruciate ligament rupture is usually based upon patient history and positive clinical testing [4]. Magnetic resonance imaging (MRI) through it's characteristics (repeatable, noninvasive technique which utilizes nonionizing radiation to generate high contrast images of hard and soft tissues) [5,6] has become the gold standard for evaluating soft tissue lesions around the knee[7,8]. In clinical practice, it is routinely used to diagnose or confirm clinical suspicions for meniscal, ligamentous and chondral lesions[9], specifically in a pre-operative setting in order to plan the arthroscopic treatment[10].

When investigating anterior cruciate ligament ruptures on magnetic resonance examination, there are direct and indirect signs[11,12]. The direct signs are represented by the partial or total discontinuity in at least one plane, horizontalisation of the distal ligamentous fragment, intraligamentous or diffuse hyper signal, abnormal magnetic signal in the intercondylar fossa, ill-defined ligamentous contour or complete lack of ligamentous visualization. The indirect signs include anterior subluxation of the lateral tibial plateau, verticalisation of the posterior cruciate ligament, distention or buckling of the patellar tendon and intra-articular effusion [1].

However, the sensitivity of magnetic resonance for detection of meniscal injury is far from 100%[13]. This is specifically the situation when dealing with lateral meniscus tears, especially when dealing with lesions located in the posterior horn [14]. Regarding chondral evaluation, MRI's diagnostic capacity falls behind due to the lack of special software availability and current machine power standards [5,15-17].

The objective of the current paper was to evaluate the ability of MRI in diagnosing soft tissue lesions in patients who underwent anterior cruciate ligament reconstruction compared with arthroscopic findings. The hypothesis was that MRI is a reliable tool for the preoperative diagnosis of soft tissue lesions.

Experimental part

The study has been approved by the Institutional Review Board. A total of 74 patients who underwent anterior cruciate ligament reconstruction at the Foisor Clinical Hospital between January - December 2016 were included in the study. The inclusion criteria were represented by the presence of an anterior cruciate ligament tear with clinical suspicion of associated intra-articular soft tissue lesions.

Mean age (years)	30.5(16-43)
Gender	
Male	55(74)
Female	19(26)
Mean number of weeks from trauma to MRI (weeks)	17.5(6-85)
Mean number of associated lesions	1.3 (1 - 3)

Table 1
DEMOGRAPHIC DATA AND CLINICAL DETAILS

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Exclusion criteria were comprised of the presence of associated extra-articular lesions, revision anterior cruciate ligament surgery and previous surgical procedures.

Demographic data were collected as shown in table 1. The male to female ratio is 3:1. The mean patient age is 30.5 years with an age span between 16 and 43 years.

All patients were evaluated using a standard protocol which included preoperative clinical testing (Lachman test, Pivot shift test, McMurray test and Apley tests) and MRI examination using a 1.5 Tesla machine. The MRI report was reviewed in the operating room prior to surgery and the identified lesions were noted. Arthroscopic evaluation was performed by a single surgeon thus minimizing inter-observer bias [18,19].

During surgery, the menisci and cartilage were inspected through standard parapatellar arthroscopic portals and were further tested using arthroscopy probes. Arthroscopic findings were used as reference for data comparison. Statistical analysis was performed for positive and negative predictive values, sensitivity, specificity and accuracy of the MRI for diagnosing associated soft tissue lesions in patients with anterior cruciate ligament injuries.

Results and discussions

The associated soft tissue lesions as determined during the arthroscopic procedure are noted in table 2. The main finding of the study is that 97% of the patients, with an anterior cruciate ligament lesion older than 6 weeks, have associated soft tissue injuries, with 85% of patients presenting a meniscal lesion. The range of associated soft tissue lesions spans between 1 and 3 and should be sought after during surgery.

The role of MRI for diagnosing preoperatively soft tissue lesions is demonstrated in table 3. The sensitivity and specificity of MRI for diagnosing meniscal lesions was nearly similar for the medial and lateral meniscus. MRI examination showed a sensitivity of 55% and a specificity of 79% for diagnosing chondral lesions. The results of the current study are consistent with already published literature data [4,14,20,21].

Table 2
OCCURRENCE OF CONCOMITANT INJURIES IN CHRONIC ANTERIOR CRUCIATE LIGAMENT RUPTURE PATIENTS

Lesion type	Number of patients	Percentage
Chondral	9	12%
Lateral Meniscus	19	25%
Medial Meniscus	45	60%

MRI is a reliable tool for the diagnosis of soft tissue lesions of the knee and the study data are consistent with the literature [1,2,4,20,21]. It is very useful during preoperative planning and is preferable to diagnostic arthroscopy which carries surgical and anesthetic risks [20]. In contrast, there is good evidence in the current literature that MRI correlates excellently with arthroscopic findings and it is highly recommended for a complete preoperative diagnosis.

Khanda et al concluded that MRI is a good, accurate and non-invasive method for meniscal and ligamentous lesion assessment and that it can be used as a first line investigation in patients presenting with knee trauma with soft tissue involvement [22,23]. Lateral meniscal tears are more likely to be missed if the tear is situated in the posterior horn or if it spans less than one third of the meniscal length [1,2,4,24]. The reason for this difficulty is the proximity of the lateral meniscus to the popliteal artery, adjacency to the meniscofemoral ligaments and magic angle effect secondary to the meniscal slope, predisposing the posterior horn to artefact formation and signal to noise ratio inferior values [2,25,26].

Cartilage imaging necessitates acquisition parameters suitable for articular surface delamination. Fast spin-echo sequences have shown high sensitivity (87%), specificity (94%) and accuracy (92%) for chondral lesion detection in the knee as compared with arthroscopic findings. Unfortunately, traditional T1 and T2 images have lower signal-to-noise ratio and do not provide the necessary contrast resolution for chondral visualization [5,24].

The choice for undertaking therapeutic arthroscopy in patients with no residual instability who do not want anterior cruciate ligament reconstruction should only be taken after soft tissue lesion confirmation on magnetic resonance examination [20,23].

The main strengths of the current study are that the arthroscopic procedure was performed by a single surgeon which eliminate inter-observer bias [18] and that MRI examinations were done on 1.5 Tesla machines which provide excellent imaging quality. The main study limitations of the study are represented by the small patient population [26] and the fact that the examinations were performed on different MRI machines [10,27].

Conclusions

Through the ability to diagnose soft tissue injuries, particularly meniscal lesions, magnetic resonance imaging should be considered as a fundamental tool in guiding therapeutic management in patients with anterior cruciate ligament lesions.

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	Anterior cruciate ligament	Chondral lesions	Medial meniscus	Lateral meniscus
Positive predictive value (%)	100	100	80	80
Negative predictive value (%)	100	55	77	80
Sensitivity(%)	97	55	78	84
Specificity(%)	100	100	79	75
Accuracy(%)	97	35	50	57

Table 3
DIAGNOSIS PARAMETERS OF MAGNETIC RESONANCE EXAMINATION AS COMPARED WITH ARTHROSCOPIC REFERENCE

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