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A RELIABLE METHOD FOR DIAGNOSING MENISCAL TEARS IN THE KNEE USING 0.3 TESLA MRI

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ABSTRACT

Objective: The purpose of this research is to evaluate the diagnostic accuracy of arthroscopic findings versus a 0.3-tesla MRI for meniscal damage in the knee.
Methodology: Eighty individuals were sent from the orthopaedic clinic who met the inclusion criteria for the study. This 0.3 Tesla scan was done by just one MRI technician. A professor of orthopedics performed an arthroscopy to corroborate the MRI's findings. Using a proforma spreadsheet, we recorded and examined all of the information.00
Results Out of the total, 72 were males (or 90%) and 8 were females (or 10%). Mean age of the cases was 27.16 years. Contrary to arthroscopy, MRI was more sensitive (98%), specific (94%), and accurate (96%), when it came to identifying meniscal lesions of the knee joint.
Conclusion: We found that magnetic resonance imaging (MRI) is a safe, accurate, and noninvasive way to assess meniscal injuries.

INTRODUCTION

A fibrocartilaginous tissue called a meniscus helps to stabilise the knee joint by absorbing impact and supporting the tibia-femur joint [1,2]. It consists of two separate pieces: the medial meniscus and the lateral meniscus. Damage to the meniscus occurs in 6-7% of the population per 10,000 people [3]. The inability to move freely and the patient's quality of life are severely diminished when meniscal damage occurs as a consequence of dysplasia, chronic strain, or acute sprains. The patient may experience a constellation of clinical symptoms, including pain and dysfunction. When a meniscal injury is detected, surgery is usually the next step. It is critical to have a rapid and precise preoperative diagnosis.

When it comes to imaging soft-tissues, magnetic resonance imaging (MRI) can really be pretty good. This imaging approach provides the most accurate picture of the meniscus's shape and internal structure, making it ideal for diagnosing meniscus injuries [4,5]. To identify a meniscal injury, the best imaging technique is fat-suppressed fast spin-echo proton density-weighted imaging, also known as FS FSE PDWI. This technique produces homogeneous hypointense signals on MRI scans. A multi-center study [6] brought attention to the clinical implications of evaluating the risk and prognosis of meniscal injury. However, there are a few caveats to MRI diagnosis that make it fall short of perfection. First, there are a lot of tissues that aren't perfectly spherical that surround the meniscus. Second, photographs often do not adequately convey the abnormal signal of a meniscal tear. Finally, a patient usually generates 100 images, which means that MRI data can be huge. An important factor in the accuracy of the diagnosis is the clinician's degree of diagnostic competence. Other subjective considerations may also influence the diagnostic findings.

There has been a meteoric rise in the amount of time and money spent studying how artificial intelligence (AI) may improve medical imaging in the hopes that this would eventually lead to better diagnosis and more efficient treatments. Improving data processing efficiency and reducing the risk of human error in illness pattern identification is possible with the use of deep learning and other AI technologies [7,8]. Famous examples of classical machine learning methods include neural networks, k-nearest neighbours, support vector machines, naive Bayes classifiers, and random decision forests. The primary building blocks of these systems are the basic AI components. Thanks to deep learning, computers can now learn from datasets automatically, doing away with the requirement to manually choose features. This has completely changed the game for image processing.

While deep AI has made great strides in analysing knee MRIs, it has made far less use of AI when dealing with other critical medical conditions, such as tumours, nerve damage, and lung nodules. There is a dearth of studies on meniscus compared to bone and cartilage because picture segmentation and post-processing are impractical. While most AI studies have concentrated on the sagittal plane alone, a handful have looked at meniscal tears in all three simultaneously [9]. This method requires refinement to increase the diagnostic accuracy of MRI, according to these experiments, which found AUCs ranging from 0.847 to 0.910 [10].

METHODS AND MATERIALS

Patients evaluated for knee instability and locking by the orthopedic outpatient department (OPD) for magnetic resonance imaging (MRI) ranged in age from fourteen years old to fifty-six years old. Tumors, surgeries, and intra-articular cracks in the knee were all eliminated as potential causes. Before a technician conducted 0.3-Tesla MRIs, orthopedic surgeons evaluated their patients and collected medical histories. Damage to the meniscal tissue was detected on the medial and lateral sides using magnetic resonance imaging. One orthopaedic physician compared magnetic resonance imaging (MRI) to knee arthroscopy, the gold standard in patient follow-up. Anyone with a knee malignancy, knee surgery, or intra-articular fracture was ineligible to participate. Patients who were pregnant or had metallic implants should not undergo magnetic

resonance imaging (MRI) due to safety concerns. One researcher looked at the Toshiba 0.3 Tesla Visart TM series in this investigation. As part of the imaging method, T2-weighted images were captured in three different planes: sagittal (T1), coronal (T2), and (T2*). The imaging coils were utilized for the knee and the remaining limbs. Two board-certified radiologists independently evaluated the images and documented their results. We used a modified Lotysch et al. classification method to evaluate meniscal damage on MR images.

When MRI was used to detect meniscal tears, a grade three signal intensity was noted, which means that the signal intensity within the meniscus was clearly visible on the articular surface. Only board-certified orthopedic physicians performed the arthroscopic examinations. Two different portals, one on each side of the knee, were used to insert the 30-degree arthroscope. The arthroscopist documented their findings and subsequent treatment after meticulously examining and studying each structure. The arthroscopist might have kept going with the procedure or stopped it to fix it.

The dataset consisted of findings from arthroscopy and MRI scans.
All data were analyzed using SPSS version 24. We provided gender as a qualitative variable using percentages and frequencies. They provided the average age and the standard deviation. We compared MRI with arthroscopy and looked at its sensitivity, specificity, PCV, and accuracy. The amount of correct diagnoses, which include both true positives and false negatives, is called accuracy. The following are the definitions of TP/(TP+FN), TN/(FP+TN), PPV, and NPV.

RESULTS

The included cases had mean age 35.14 years. 72 (90% were males and 8 (10%) were females. Left side was the most common affected side 68 (85%).(table 1)

Table-1: Baseline details on the cases

Variables	Frequency (80)	Percentage
Mean age (years)	35.14	
Gender		
Male	72	90
Female	8	10
Affected Side		
Left	68	85
Right	12	15

Frequency of medial meniscus was 67 (83.8%) and lateral meniscus was 22 (27.5%) by arthroscopy and by MRI medial was 65 (81.3%) lateral meniscus was 20 (25%)(table 2)

Table-2: Comparison of results

Variables	Frequency	Percentage
Arthroscopy		
medial meniscus	67	83.3
lateral meniscus	22	27.5
MRI		
medial meniscus	65	81.3
lateral meniscus	20	25

According to reliability, 36 true positive, 36 false negative, 4 false positive and 4 false were found among lateral meniscus while in medial meniscus, 66 true positive and 12 true negative was observed.(table 3)

Table 3: accuracy of magnetic resonance imaging (MRI) using arthroscopy

Variables	Medial meniscus	Lateral meniscus
True +ve	66	36
True -ve	12	36
False +ve	1	4
False -ve	1	4

Contrary to arthroscopy, MRI was more sensitive (98%), specific (94%), and accurate (96%), when it came to identifying meniscal lesions of the knee joint

Table 4: Accuracy of MRI

Variables	Medial Meniscus	Lateral Meniscus
Accuracy	96	**94**
Sensitivity	98	**94**
Specificity	94	**96**
Negative predictive value	85	**96**
Positive predictive value	**94**	**92**

DISCUSSION

It is best to save this procedure for therapeutic reasons only, despite the fact that diagnostic tools like magnetic resonance imaging (MRI) have advanced. You might be able to rule out any internal knee abnormalities with a regular magnetic resonance imaging. This reveals issues with the cartilage, ligaments, and meniscus. This form of evaluation is currently preferred by most orthopaedic doctors. The reliability of 0.3 Tesla MRI in identifying meniscal tears in the knee was the focus of this study. The most reliable source was the results of arthroscopic exams.
Although only six out of one hundred individuals were examined for medial meniscus anomalies, eighty-two percent of those patients were found to be affected. A lateral meniscus tear was detected in 35 cases, or 35% of the total [11]. The majority of meniscal tears were classified as medial in a research conducted by Winters K et al., which comprised 66 patients. Specifically, 62 out of 66 were classified as such. Of the 66 meniscal rips that were found, 26 of them were on the side. In our study, the average age of the patients was 31.456.90 years old, on average 31 years old. Winters K et al.[12] found that, on average, their patients were 35 years old when they

were treated. Compared to the general population, patients who received both arthroscopy and MRI tended to be younger in our study[13]. This group of patients had an average age of 31.456.7 years. Due to the fact that our younger generation is more likely to be involved in accidents since they are the leading figures in the expansion of a rising country, the current research discovered that 72 patients (90%) were male and 8 patients (10%) were female. Our younger generation is more prone to be involved in accidents compared to previous studies, which is why there is an age discrepancy. Based on their examination of 100 patients, Gul-e-khanda and colleagues determined that there were 63 males and 37 females, or 63% and 37% of the total, respectively. There were 55 male patients (or 55% of the total) and 45 female patients (or 45% of the total) in the study carried out by Winters K et al. [14]. Injuries sustained by men are more common than those sustained by women in contemporary culture, even though women constitute about 55% of the population. Several factors contribute to this, including the fact that they are the main earners for their families and fall within the age bracket most prone to such accidents (those between the ages of 19 and 34). [15] Gul-e-khanda et al. four's study spanned two years, but Winters K. et al. 14's study spanned five years. Our inquiry, on the other hand, was very short, lasting only six months. Based on his findings, Noble[16] concluded that doctors shouldn't undergo arthroscopies unless it's really required. Not only that, but he did say that MR imaging results might sometimes back up doctors' clinical judgement. In a study by Mackenzie R et al., the sensitivity of magnetic resonance imaging (MRI) for menisci was reported as 85%, whereas a survey by Gul-e-khanda et al. revealed its specificity to be 96%. [17] There was a 91% success rate for the medial menisci and an 85% success rate for the lateral menisci in general, as well as a 99% sensitivity, 67% specificity, 91% positive predictive value, and 99% negative predictive value for the medial menisci.

Another study by Winters K et al. [18] found that magnetic resonance imaging (MRI) of the medial meniscus had a sensitivity of 87%, specificity of 92%, positive predictive value of 90%, negative predictive value of 89%, in addition to an accuracy of 92%. In our investigation of 100 cases involving MRI and arthroscopy, lateral meniscus MRI had a sensitivity of 46%, specificity of 91%, positive predictive value of 55%, negative predictive value of 88%, and accuracy of 82%. Based on our research, MRI of the meniscus has the following features: 97% sensitivity, 85% specificity, and 96% accuracy for the medial meniscus and the lateral meniscus, and 96% accuracy for the other.[19]

The results for the lateral meniscus were 97% sensitivity, 97% specificity, and 97% accuracy, while the positive predictive value was 90% and the negative predictive value was 85%. The overall accuracy rate was 96%.

Oei and colleagues [20] performed a meta-analysis and found that when medial and lateral menisci were combined, the sensitivity was 92% and 80%, respectively, and the specificity was 87% and 97%. The 29 studies that assessed the reliability of MRI for meniscal and ligamentous knee problems ran the gamut from 1992 to 2015, and their results were used to draw this conclusion. The most common areas for meniscal tears to occur are the posterior horn of the medial meniscus and the anterior horn of the lateral meniscus. There have been reports of sensitivity, specificity, and accuracy rates ranging from 81% to 97% with magnetic resonance imaging (MRI) in the diagnosis of meniscal injuries.[21] We found results that were similar in our investigation. In order to determine whether patients had false-positive MR imaging results, Quinn and Brown reviewed their arthroscopy videotapes. The suspicious area of the meniscus was never apparent in any of the patients, according to this research's findings. A large proportion of MR imaging false-positive results may be due to arthroscopic investigations that turned out to be false negatives. Alternatively, our study's results show that MRI can reliably diagnose knee internal derangement. Because of its non-invasiveness, high value, and cheap cost, magnetic resonance imaging (MRI) has become an essential diagnostic technique in recent years.

CONCLUSION

One noninvasive and very dependable imaging technique that can be used to evaluate meniscal tears is magnetic resonance imaging (MRI). It can be used as a preliminary diagnostic tool for those who have experienced knee soft tissue injuries.

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