

Head-to-head comparison between magnetic resonance imaging and arthroscopy findings for ligamentous and meniscal knee injuries: a cross-sectional observational study in Palestine

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ABSTRACT

Background: Traumatic knee injuries are widespread, especially among young adults; when a clinical exam suspects the diagnosis, it is evaluated by magnetic resonance imaging (MRI) and confirmed by arthroscopy. MRI is non-invasive and saves patients from potential general anesthesia and surgical site infection complications. We aim to assess the precision of ligamentous and meniscal injuries by MRI compared to the gold standard knee arthroscopy. **Methods:** We performed a cross-sectional observational study at An-Najah University Hospital (NNUH). Patients who underwent knee arthroscopic surgery and had preoperative MRIs were included in this study. The magnetic resonance and intraoperative findings during arthroscopy were recovered from patients' records and compared for sensitivity and specificity. **Results:** 107 patients were included in our research. Their MRI and arthroscopy findings were compared using a cross-tabulation test. MRI sensitivity to detect anterior cruciate ligament and medial meniscal tears was 57.1% and 86%, respectively. However, the specificity of the lateral meniscal tear was 89.6%. Furthermore, concerning the type of tear, the sensitivity of MRI to diagnose a full-thickness tear was 66.7%. For the specificity of partial tears, it was measured as 94.2%. **Conclusion:** For assessing ligamentous knee tears, MRI may be a reliable, accurate, and less invasive option. It can be reliably employed as the first-line investigation; however, the gold standard investigation is arthroscopy. MRI is less invasive, has a major adjuvant rule that helps the surgeon avoid lengthy knee exploration of the knee during arthroscopy by focusing on preoperative MRI findings, and could be considered standard routine imaging for a patient scheduled for arthroscopy.

Keywords: Mri; Arthroscopy; Knee; Medial Meniscus; Injury; Lateral Meniscus; Anterior Cruciate Ligament.

INTRODUCTION

The knee joint is a hinge joint located in the lower limb, shares the forces of the patella, tibia, and femur [1], and is considered one of the most vulnerable joints to injury in all age groups. Magnetic resonance imaging (MRI) is one of the most widely used modalities in diagnosing joint complaints [2], and it is considered one of the crucial factors in the diagnosis of certain types of knee injuries [3]. It is considered a non-invasive and radiation-free modality[2]. MRI is important in detecting soft tissue injuries to explain patients' symp-

toms[3]. In addition, MRI supports the diagnosis of knee abnormalities before arthroscopic evaluation and surgery [3].

Arthroscopy is an important procedure in orthopedic surgery. It is done by direct visualization of the internal structures of the joint, which also has diagnostic and therapeutic applications [4]. In addition, it is considered a non or minimally invasive technique with a lower risk of complications [5], which is regarded as the best method for knee injury diagnosis [4].

In this study, MRI accuracy assessment in detecting ligamentous and meniscal injuries was our goal, according to their location and type

and the shape of the menisci compared to the standard gold arthroscopy.

In reviewing the literature, many studies on MRI and its accuracy in determining the diagnosis of knee pathology were published. However, no single study in Palestine has emphasized the relationship between the magnetic resonance and arthroscopy results and compared them. MRI supports the diagnosis of knee injuries before arthroscopic evaluation and surgical options. In addition, we cannot rely only on the patient's history for diagnosis [6] or clinical examination. Recently, several studies have been published that compare MRI to diagnostic arthroscopy.

Using MRI, doctors can rule out knee pathologies rather than their diagnosis of them [7]. On the other hand, arthroscopy is considered the best therapeutic and diagnostic method [8]. Unfortunately, in our country, arthroscopy experts and the necessary tools are not always available, and arthroscopy remains an invasive procedure requiring prepared hospitals and professional orthopedic specialists. So our objectives in this research are to assess the accuracy of MRI imaging and determine if it can replace diagnostic arthroscopy in a specific type of tear that can be managed conservatively. Furthermore, to evaluate M.R. imaging results and compare them to the results received from arthroscopy in diagnosing knee ligamentous/meniscal tears. Then calculate the sensitivity and specificity of M.R. imaging compared to arthroscopic results and evaluate the outcome of each case. In Palestine, to our knowledge, there are not enough studies and information that prefer MRI or arthroscopy to diagnose knee tears.

METHODS

Study design

This is a descriptive type of cross-sectional study.

Study setting and population of the study

This study was carried out in the Medical Imaging and Operations Departments at An-Najah National University Hospital (NNUH), a referral center for this type of injury for proper treatment. All patients' profiles that

were involved in this research met our inclusion criteria during the period of this study from November 2019 to June 2021.

Sample size and sampling technique

The present study sample comprised patient profiles from the Medical Imaging and Operations Departments for knee arthroscopy. The sample size was calculated using an online Raosoft sample size calculator, which showed a convenient sample of 158. We collected all available profiles in the NNUH between 2014 and June 2021.

Inclusion criteria

All patients with knee complaints had a preoperative MRI followed by knee arthroscopy.

Exclusion criteria

Patients who underwent an arthroscopic procedure but did not perform a preoperative MRI. Patients who did not have MRI images, reports, or arthroscopic reports. Patients who witnessed traumatic events during the period between preoperative MRI and arthroscopy.

Data collection instrument

All data were obtained from the computerized health information system (HIS) from 2016 until 2021, data before 2016 until 2014 were obtained from non-computerized hospital archives, and data that lacked reports tried to be obtained from the patients by phone call or meeting. Finally, we recorded all MRI and arthroscopic reports using the SPSS program.

Ethical issues

This research has been authorized by the Institutional Review Board (IRB) of An-Najah National University. Furthermore, we got permission from NNUH to access all data we need. The Helsinki Declaration carried out the study.

Statistical analysis

The results of our study were illustrated using numbers in addition to percentages in tables and figures. Statistical analysis was used to calculate the sensitivity and specificity to evaluate the reliability of the arthroscopic and magnetic resonance results. The definitive diagnosis was extracted from arthroscopy results to evaluate the sensitivity, specificity,

and precision of M.R. imaging. Sensitivity was calculated from the number of true positive results divided by the sum of true positive and false-negative results. Specificity was calculated from the number of true negative results divided by the sum of true negative and false-positive results of arthroscopy patients. The level of significance was set at $P < 0.05$. The result shows the demographic data of the patients and descriptive and analytical results of the diagnostic findings of both arthroscopy and MRI for the targeted area. Data analysis was done to calculate true positives, negatives, and false negatives. Using these, specificity and sensitivity were calculated with arthroscopic examination as the gold standard for comparison.

RESULTS

Of 158 patients, 107 met our inclusion criteria and participated in the study. Twenty-

one patients were excluded because their MRI images or reports were not found in hospital records. We excluded nine patients because their arthroscopic reports were not found in hospital records; we also excluded twenty patients because we could not obtain their arthroscopic and MRI reports. A patient had an arthroscopic procedure, but we could not find his registration in the system.

Demographic data of patients

MRI and arthroscopy examined 107 patients for possible internal knee disruptions. Eighty of them were males, and 27 were females. The age of patients ranged from 11 years to 63 years. The highest number of cases of patients was in the 18-40 age category. The mean value of the age of the patients was 35.64 years (Table 1).

Table (1): Frequencies and percentages of demographic data of patients.

Variable	Values	Frequency	Percentage
Age	<18	5	4.6%
	18 – 40	64	59.8%
	> 40	38	35.5%
Gender	Male	80	74.7%
	Female	27	25.2%
Residency	Nablus	79	73.8%
	Tulkarem	6	5.6%
	Jenin	10	9.3%
	Gaza strip	5	4.6%
	Qalqilya	1	0.93%
	Hebron	1	0.93%
	Jaba'	1	0.93%
	Bethlehem	2	1.86%
Ramallah	2	1.86%	

Difference between tear locations

Different ligament tears were evaluated. Of 107 patients evaluated, there were 7 ACL injuries, 0 PCL tears, 50 medial meniscus, and 30 tears of lateral meniscus, according to arthroscopy. The sensitivity and specificity of MRI to assess anterior cruciate ligament tears have been reported to be 57.1% and 96%, respectively.

The precision of M.R. imaging in PCL tears diagnosis is unclear in this research because the PCL tear is extracapsular and cannot be seen by arthroscopy. Of the 107 sample cases, there were no cases of PCL tears. All patients with meniscal tears were included in this study. A total of 50 cases had a medial meniscus tear in which MRI detected 43, one of them with a sensitivity of 86%. Regarding lateral meniscal tears, 15 cases were diagnosed with MRI out of 30 cases reported by

arthroscopy, so the sensitivity was 50%, and the specificity was 89.6% (Table 2).

Table (2): Difference between locations.

Location	Arthroscopy	MRI		Sens.	Spec.
		Yes	No		
ACL	Yes	4	3	57.1%	96%
	No	4	96		
MM	Yes	43	7	86%	57.8%
	No	24	33		
LM	Yes	15	15	50%	89.6%
	No	8	69		

ACL: Anterior cruciate ligament

MM: Medial meniscus

L.M.: Lateral meniscus

MRI: Magnetic resonance imaging

Spes: Specificity

Sens: sensitivity

The difference in a meniscus shape

The discoid meniscus is a congenital abnormality that makes the knee joint more prone to injury. The sensitivity and specificity

were calculated for the discoid and medial meniscus. They showed 100% and 99%, respectively, and for the lateral meniscus, the calculations showed a sensitivity of 66.7% and a specificity of 99% (Table 3).

Table (3): Different meniscus shapes.

Shape	Arthroscopy	MRI		Sens.	Spec.
		Yes	No		
Discoid MM	Yes	1	0	100%	99%
	No	1	105		
Discoid LM	Yes	3	1	66.7%	99%
	No	1	102		

MM: Medial meniscus

L.M.: Lateral meniscus

MRI: Magnetic resonance imaging

Spes: Specificity

Sens: sensitivity

The difference in tear type

Considering the type of tear, the calculations found that the sensitivity of MRI in diagnosing a full-thickness tear and a horizontal

tear was 66.6%. On the other hand, the specificity of MRI in diagnosing bucket-handle tears was 96.7% (Table 4).

Table (4): Difference in tear type.

Type	Arthroscopy	MRI		Sens.	Spec.
		Yes	No		
Bucket handle tear	Yes	8	8	50%	96.7%
	No	3	88		
Radial tear	Yes	1	1	50%	97.1%
	No	3	102		
Horizontal tear	Yes	2	1	66.6%	91.3%
	No	9	95		

Type	Arthroscopy	MRI		Sens.	Spec.
		Yes	No		
Flap tear	Yes	0	2	0%	100%
	No	0	98		
Complex tear	Yes	5	4	55.5%	93.8%
	No	6	92		
Partial tear	Yes	1	1	50%	94.2%
	No	6	99		
Full tear	Yes	2	1	66.6%	99%
	No	1	103		

MRI: Magnetic resonance imaging

Spes: Specificity

Sens: sensitivity

DISCUSSION

The study demonstrates the sensitivity, specificity, and accuracy of MRI compared to arthroscopic findings for specific knee injuries, considering that the Gold Standard modality is arthroscopy.

In 2016, a study correlated the findings of MRI with Arthroscopy in internal knee derangements of the knee and assessed the sensitivity, specificity, and precision of MRI compared to arthroscopy [9]. They concluded that diagnostic arthroscopy was more accurate than MRI. Our study found that we can rely on MRI to identify tears, especially ACL tears, with a specificity of 96%, but MRI may not be accurate in distinguishing tear types.

In 2017, compared preoperative MRI and knee joint arthroscopy [10]. They aimed to determine whether the positive or negative M.R. imaging results were compared to the arthroscopic results. MRI was performed on 470 patients who had arthroscopic surgery. The sensitivity, specificity, and precision of MRI were calculated. They concluded that preoperative M.R. imaging could prevent unnecessary diagnostic arthroscopy.

In 2013, Dzoleva-Tolevska R, Poposka A, Temelkovski Z, Samardziski M, and Georgieva D assessed the accuracy of MRI compared to arthroscopy for the detection of meniscal lesion detection [11]. To answer whether the diagnosis of MRI affects the treatment chosen by the orthopedic surgeon. MRI's sensitivity and specificity for the medial meniscus were 79.5% and 38.1%, respectively. The sensitivity and specificity for lateral meniscus were 40% and 92.7%, respectively.

Therefore, they concluded that the accuracy of careful clinical examination in conjunction with MRI is very high.

In our study, the sensitivity and specificity of the medial meniscus were 86% and 57.8%. At the same time, the sensitivity and specificity for the lateral meniscus were 50% and 98.6%, respectively. To compare our results with the previously mentioned study, the medial meniscus sensitivity was 84.7%, and the specificity was 55.5%. The sensitivity was 50% for the lateral meniscus, and the specificity was 90%. Our results also showed very good MRI in diagnosing meniscal tears based on sensitivity and specificity results.

A study by Khanda GE, Akhtar W, Ahsan H, and Ahmad N evaluated the validity of MRI in assessing meniscal and cruciate ligamentous injuries to the knee joint and compared it with arthroscopic results [12]. This study was a one-year prospective cross-sectional study from 2006 to 2007. It concluded that the sensitivity, specificity, and precision for MRI of the menisci and ligaments were 100% sensitivity for the medial meniscus, 69.27% specificity, and 92% precision. Moreover, the lateral meniscus had 87.5% sensitivity, 88.23% specificity, and 88% accuracy. The anterior cruciate ligament yielded 86.67% sensitivity, 91.43% specificity, and 88% accuracy. Their study revealed high sensitivity, specificity, and precision for the meniscus and ligament injuries compared to arthroscopy. They concluded that MRI is highly accurate in diagnosing tears of the menisci and cruciate ligaments.

In our study, however, out of 107 patients, 7 ACL tears and no PCL tears were

seen. In addition, 96 out of 107 patients were reported negative by MRI compared to arthroscopy (100 patients), giving a specificity of 96%. Four positive MRI cases of 7 positives on arthroscopy were reported, giving a sensitivity of 57.1%.

The results of our study and the study by Khanda GE, Akhtar W, Ahsan H, and Ahmad N concluded that the precision of MRI in diagnosing ACL tears is high and can be excellent as an initial diagnosis method for ACL tears [12].

Arthroscopy reported five positive lateral and medial menisci cases regarding the meniscus shape. MRI showed four positive discoid menisci and only 2 cases of false-negative results, which reported positive on MRI but negative on arthroscopy. The sensitivity was 100% for the medial meniscus; this result is not convenient since it represents one case of all cases, and however, the sensitivity for the lateral meniscus was 66.7%.

Considering the type of tear, the calculations found that the best type detected by MRI is the full-thickness tear (66.6% sensitivity) because it encounters the whole thickness of the ligaments. However, the partial-thickness tear had low sensitivity (50%).

Strengths and Limitations

So far, this study is the first in Palestine that measures the sensitivity, specificity, and accuracy of M.R. imaging compared to the gold standard procedure arthroscopy using the NNUH database.

However, limitations of our study include its cross-sectional nature, for example, the inability to follow patient investigations and treatment. We also lacked many data due to subjective bias and the lengthy period of data collection (2014-2021). (seven years). Also, the results cannot be generalized because of the small sample size. Finally, there were some clinical considerations that we could not achieve; one of them is that MRI reports were not limited to the NNUH medical imaging center alone, but we accepted outside reports from other medical imaging centers, which raised investigator bias. Another limitation could be that MRI is an expensive diagnostic tool, so it is not affordable for all patients and more confined to private-sector patients. This

leads us to another limitation: MRI in government institutes does not cover entire cities. Some cities lack designated MRIs in medical imaging departments, forcing patients to travel to other cities and medical centers for appointments that may be far away due to overcrowding in these facilities.

CONCLUSION

Our main goal of this research was to compare preoperative M.R. imaging results and knee arthroscopy for patients at NNUH. It should be noted that arthroscopy is the best method. Finally, we conclude that certain tears are strongly detectable by MRI, such as ACL, MM, and L.M., protecting patients from diagnostic arthroscopic surgery. However, MRI had low accuracy and was less reliable in distinguishing the type of tear. As a result, we conclude that MRI plays an important role in assisting orthopedic surgeons in avoiding lengthy knee exploration during arthroscopy and preventing patients from having unnecessary arthroscopy, which can be managed conservatively by relying on MRI diagnosis alone.

We recommend enlarging the sample size and including more hospitals in future research. In addition, it might be better to have two radiologists read the MRI blindly and then compare their results to strengthen the research. Moreover, it would be better for the study to be prospective rather than retrospective. A standardized MRI protocol for reading MRI reports is highly recommended.

List of abbreviations

ACL	Anterior cruciate ligament
L.M.	Lateral meniscus
MM	Medial meniscus
MRI	Magnetic resonance imaging
NNUH	Najah national university hospital
PCL	Posterior cruciate ligament
y/o	Year Old
Sn	Sensitivity
Sp	Specificity

Declarations

Ethics approval and consent to participate

The Institutional Review Board (IRB) of An-Najah National University has approved all components of the study protocol. We affirm that the information gathered was only for clinical research purposes. The *IRB of An-Najah National University* approved only verbal consent. Because we did not collect any identifying information during the data collection and our study did not pose a major risk to participants, our ethics committee waived the requirement for written consent. All research activities were carried out by relevant guidelines and regulations

Consent for publication

Not applicable.

Availability of data and materials

The data from our surveillance are not available in the public domain due to privacy and ethical restrictions, but anyone interested in using the data for scientific purposes is free to request permission from the corresponding author: Dr. Mosab Maree (Email: m.maree@najah.edu).

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Z.H., A.H., and A.B. collected data, performed analysis, and wrote the first draft. M.M., A.A., M.A., and M.J. provided logistical assistance, conceptualized and designed the study, organized, supervised, participated in the field study, and assisted in writing and producing the final version of the manuscript. All authors read and approved the final manuscript.

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