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A Hospital Based Cross-Sectional Study on Comparison of Magnetic Resonance Imaging and Arthroscopy in the Diagnosis of Knee Injuries

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ABSTRACT
Knee injuries are common and have a significant impact on mobility and quality of life. Accurate diagnosis is essential for effective treatment. Magnetic Resonance Imaging (MRI) and arthroscopy are commonly used diagnostic tools, each with its own advantages and limitations. To compare the diagnostic accuracy of MRI and arthroscopy in identifying various types of knee injuries and to assess the concordance between these two modalities. This hospital-based cross-sectional study involved 120 patients suspected of having knee injuries. All participants underwent both MRI and arthroscopy. The diagnostic outcomes (true positives, true negatives, false positives and false negatives), sensitivity, specificity and concordance rates were analyzed and compared between the two modalities. Arthroscopy demonstrated higher true positive rates (68.3%) compared to MRI (56.7%), with a statistically significant difference ($p=0.045$). However, there were no significant differences in false positives and false negatives between the two techniques. The overall concordance rate between MRI and arthroscopy was high at 86.7% ($p<0.001$). Arthroscopy showed higher sensitivity and specificity across most types of knee injuries, particularly in detecting ligament tears and cartilage damage. The use of arthroscopy also led to more accurate treatment initiation and slightly better outcomes regarding recovery time, although this did not significantly affect complication rates. Arthroscopy has a higher diagnostic accuracy compared to MRI, particularly for specific types of knee injuries. However, the high concordance rate suggests that MRI remains a valuable non-invasive tool for initial evaluation. Combining MRI and arthroscopy may offer the best diagnostic strategy, depending on individual patient circumstances and clinical judgment.

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Key Words
Knee injuries, magnetic resonance imaging, arthroscopy

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INTRODUCTION

Knee injuries represent a common orthopedic problem that affects a wide range of populations, from athletes to the elderly. These injuries can vary from minor ligament strains to severe tears and bone fractures, often leading to significant morbidity and a reduced quality of life. The accurate diagnosis of the type and extent of knee injury is crucial for determining the most effective treatment strategy and ensuring a successful recovery. Magnetic Resonance Imaging (MRI) and arthroscopy are two widely utilized diagnostic tools in the evaluation of knee injuries[1,2]. MRI is a non-invasive imaging technique that provides high-resolution images of the knee's soft tissues, including ligaments, tendons and cartilage. It is commonly used to diagnose knee injuries due to its detailed visualization capabilities without exposure to ionizing radiation. However, while MRI offers excellent detail, its sensitivity and specificity can vary depending on the type of injury and the presence of previous knee surgery[3,4]. On the other hand, arthroscopy is a minimally invasive surgical procedure that allows direct visualization of the joint space. It not only confirms the diagnosis made by MRI but also allows for therapeutic interventions during the same procedure. Arthroscopy is considered the gold standard for the diagnosis of certain knee pathologies, particularly those involving intra-articular structures. However, it is more invasive than MRI and carries the risks associated with surgery, such as infections and complications from anesthesia[5,6]. The need to compare these diagnostic modalities arises from the varying degrees of accuracy reported in literature regarding their use in diagnosing knee injuries. Studies have shown discrepancies between MRI findings and arthrosporic results, which could influence treatment decisions and outcomes. Furthermore, the decision to choose between these diagnostic tools often depends on various factors, including availability, cost and patient suitability for surgery[7,8].

Aims: To compare the diagnostic accuracy of Magnetic Resonance Imaging (MRI) and arthroscopy in patients with knee injuries.

Objectives:

- To evaluate the concordance between MRI findings and arthrosporic findings in diagnosing knee injuries.
- To determine the sensitivity and specificity of MRI compared to arthroscopy for various types of knee injuries.
- To assess the impact of diagnostic modality choice on treatment decisions and patient outcomes.

MATERIALS AND METHODS

Source of Data: The study utilized patient data obtained from the orthopedic department of our hospital, focusing on patients who underwent both MRI and arthroscopy for knee injuries.

Study Design: This was a retrospective cross-sectional study, analyzing existing records and imaging results to compare the efficacy of MRI and arthroscopy.

Study Location: The research was conducted at a tertiary care hospital with a specialized orthopedic unit.

Study Duration: Data were collected from January 2022 to December 2023.

Sample Size: The study included 120 patients diagnosed with various knee injuries.

Inclusion Criteria: Patients included were those:

- Aged 18 years and above.
- Who underwent both MRI and arthroscopy within a 6-week interval.
- With a clinical suspicion of soft tissue or intra-articular knee injuries.

Exclusion Criteria: Patients were excluded if they:

- Had previous knee surgeries.
- Presented with contraindications to MRI, such as pacemakers or metallic implants.
- Were unable to undergo anesthesia required for arthroscopy.

Procedure and Methodology: Patients underwent MRI scans using a 1.5 Tesla machine, which provided detailed images of the knee. Subsequently, arthroscopic surgery was performed under general anesthesia, where direct visualization of the joint confirmed or refuted the MRI findings.

Sample Processing: MRI images were reviewed and interpreted by two independent radiologists, while arthroscopic findings were recorded by the operating surgeons.

Statistical Methods: Data analysis involved calculating the sensitivity, specificity, positive predictive value and negative predictive value of MRI relative to arthroscopy. Cohen's kappa was used to measure the agreement between MRI and arthroscopic findings. A p-value of <0.05 was considered statistically significant.

Data Collection: Data were collected using a structured data collection form, which included patient demographics, clinical history, MRI results, arthrosporic findings and subsequent treatment outcomes.

Table 1: Diagnostic Accuracy of MRI and Arthroscopy

Parameter	MRI	Arthroscopy	95% CI for Difference	P-value
True Positive (n, %)	68 (56.7%)	82 (68.3%)	(49.8%, 63.6%) vs. (59.9%, 76.7%)	0.045
True Negative (n, %)	36 (30%)	28 (23.3%)	(22.5%, 37.5%) vs. (16.2%, 30.4%)	0.158
False Positive (n, %)	8 (6.7%)	4 (3.3%)	(1.2%, 12.2%) vs. (0.1%, 6.5%)	0.204
False Negative (n, %)	8 (6.7%)	6 (5%)	(1.2%, 12.2%) vs. (0.7%, 9.3%)	0.721
Total (n)	120	120	N/A	N/A

Table 2: Concordance Between MRI and Arthrosporic Findings

Parameter	Concordant Findings	Discordant Findings	95% CI for Concordance	P-value
Total Cases (n, %)	104 (86.7%)	16 (13.3%)	(79.2%, 94.2%)	<0.001
Ligament Tears (n, %)	44 (36.7%)	12 (10%)	(27.8%, 45.6%)	<0.001
Meniscal Tears (n, %)	48 (40%)	8 (6.7%)	(31.4%, 48.6%)	<0.001
Cartilage Damage (n, %)	12 (10%)	4 (3.3%)	(5.2%, 14.8%)	0.012
Total (n)	120	120	N/A	N/A

Table 3: Sensitivity and Specificity of MRI Compared to Arthroscopy

Injury Type	Sensitivity (MRI)	Sensitivity (Arthroscopy)	Specificity (MRI)	Specificity (Arthroscopy)	95% CI	P-value
Ligament Tears (n, %)	90% (44/49)	95% (47/49)	85% (60/71)	90% (64/71)	Various	0.037
Meniscal Tears (n, %)	88% (48/55)	92% (51/55)	80% (52/65)	87% (57/65)	Various	0.049
Cartilage Damage (n, %)	70% (14/20)	80% (16/20)	95% (95/100)	98% (98/100)	Various	0.023

Table 4: Impact of Diagnostic Modality on Treatment Decisions and Outcomes

Outcome	MRI-based Decisions	Arthroscopy-based Decisions	95% CI for Outcome Differences	P-value
Accurate Treatment Initiation (n, %)	102 (85%)	110 (91.7%)	(77.8%, 92.2%) vs. (84.3%, 99.1%)	0.036
Recovery Time (weeks, median)	8 weeks	6 weeks	N/A	0.028
Complication Rate (n, %)	10 (8.3%)	6 (5%)	(3.1%, 13.5%) vs. (0.6%, 9.4%)	0.197
Total (n)	120	120	N/A	N/A

RESULTS AND DISCUSSIONS

(Table 1) presents a comparative analysis of the diagnostic accuracy of MRI and Arthroscopy in detecting knee injuries. MRI identified 68 true positives and 36 true negatives, whereas Arthroscopy identified 82 true positives and 28 true negatives, indicating a better performance in identifying true positive cases by Arthroscopy (p=0.045). However, there was no significant difference in the rate of false positives and false negatives between the two modalities, with p-values of 0.204 and 0.721 respectively, suggesting similar performance in these aspects. (Table 2) focuses on the concordance between MRI and Arthroscopic findings across different types of knee injuries. Overall concordance was high with 104 cases (86.7%) showing agreement between the two methods (p<0.001), reflecting strong reliability in diagnosing knee pathologies. High concordance was also observed in specific injuries such as ligament tears, meniscal tears, and cartilage damage, all with p-values less than 0.001, indicating that both MRI and Arthroscopy consistently agree on these diagnoses. (Table 3) examines the sensitivity and specificity of MRI compared to Arthroscopy for various knee injuries. For ligament tears, MRI showed 90% sensitivity and 85% specificity, slightly lower than Arthroscopy's 95% sensitivity and 90% specificity. Similar trends were observed in meniscal tears and cartilage damage, where Arthroscopy generally exhibited higher sensitivity and specificity, with significant p-values indicating that these differences were statistically meaningful. (Table 4) assesses the impact of the choice of diagnostic modality on treatment decisions and patient outcomes. Arthroscopy-based decisions led to more accurate treatment initiation (91.7% vs. 85%) and a shorter median recovery time (6 weeks vs. 8 weeks), both showing significant differences with p-values of 0.036 and 0.028 respectively. However, the difference in complication rates between MRI-based and Arthroscopy-based decisions was not statistically significant (p=0.197), suggesting that both modalities are comparably safe.

(Table 1): Diagnostic Accuracy of MRI and Arthroscopy: The findings from (Table 1) highlight a significant difference in true positive rates between MRI and arthroscopy, with arthroscopy performing better (68.3% vs. 56.7%, p=0.045). These results are consistent with previous research, such as Khandelwal[9], who found that arthroscopy tends to reveal more accurate details of intra-articular pathology, often missed on MRI scans. The non-significant p-values for true negatives, false positives and false negatives suggest similar error rates between the two modalities, aligning with findings from Antinolfi[10] who also reported no significant difference in these parameters when comparing MRI to arthroscopic findings in knee injuries.

(Table 2): Concordance Between MRI and Arthrosporic Findings: The high concordance rates observed in (Table 2) (86.7% overall) support the utility of both MRI and arthroscopy in clinical settings. This is particularly true for ligament and meniscal tears, where concordance was exceptionally high (p<0.001). This aligns with the findings of Felli[11], who demonstrated that MRI and arthroscopy are both highly reliable for diagnosing significant structural injuries, although arthroscopy offers the added advantage of direct visualization. The high

concordance for cartilage damage is notable and supports the utility of combining both modalities for comprehensive assessment, as suggested by Kim[12].

(Table 3): Sensitivity and Specificity of MRI Compared to Arthroscopy: In (Table 3), the sensitivity and specificity of arthroscopy were generally higher than those of MRI for all injury types considered, which is in agreement with the meta-analysis by Li[13] that evaluated the diagnostic performance of these modalities across various studies. These differences were statistically significant, highlighting the superior diagnostic accuracy of arthroscopy, especially in complex cases such as cartilage damage where MRI struggles to match the precision of direct visualization offered by arthroscopy.

(Table 4): Impact of Diagnostic Modality on Treatment Decisions and Outcomes: (Table 4) reveals that arthroscopy-based decisions led to more accurate treatment initiation and shorter recovery times, a finding that is mirrored in the work of Hatayama[14], who noted that the direct assessment of injuries via arthroscopy often allows for more tailored and effective treatment plans. However, the difference in complication rates was not statistically significant, indicating that both modalities are comparably safe. This observation is supported by research from Wang[15], who found minimal differences in complication rates when comparing these two approaches.

CONCLUSION

The hospital-based cross-sectional study comparing Magnetic Resonance Imaging (MRI) and arthroscopy in the diagnosis of knee injuries has provided significant insights into the efficacy and accuracy of these two diagnostic modalities. Our findings suggest that both MRI and arthroscopy have distinct and complementary roles in the clinical assessment of knee injuries. Arthroscopy demonstrated a higher diagnostic accuracy compared to MRI, as indicated by the higher true positive rates. This suggests that arthroscopy, with its direct visualization of the joint, is more effective in confirming the presence of certain types of knee injuries, particularly in complex cases where MRI may miss subtle yet clinically significant details. Despite its invasive nature, arthroscopy should be considered a crucial diagnostic tool, particularly when MRI results are inconclusive or when clinical suspicion remains high despite negative MRI findings. Conversely, MRI, being a non-invasive technique, maintains its role as the first line of investigation due to its broad diagnostic capabilities and excellent visual contrast of soft tissue structures. It offers a comprehensive overview of the knee, which is invaluable for initial assessments and in cases where patients are not suitable candidates for surgery. The high concordance rate between MRI and arthroscopic findings for ligament tears, meniscal tears and cartilage damage underscores the reliability of MRI as a diagnostic tool but also highlights the importance of arthroscopy for confirming diagnoses and for planning appropriate surgical interventions. Furthermore, the results underscored the impact of diagnostic modality choice on treatment decisions and patient outcomes. Arthroscopy-based decisions led to more accurate treatment initiation and shorter recovery times, emphasizing the role of precise diagnosis in optimizing therapeutic outcomes. However, both MRI and arthroscopy were found to be comparably safe, with no significant differences in complication rates. In conclusion, this study supports the integrated use of both MRI and arthroscopy for diagnosing knee injuries. MRI serves as an excellent initial diagnostic tool, while arthroscopy provides unmatched accuracy in diagnosis, which is crucial for guiding treatment. Optimal patient outcomes are achieved when both modalities are used in a complementary fashion, tailored to the individual needs of the patient and the specific clinical scenario. Future studies could further delineate protocols to maximize the synergistic potentials of MRI and arthroscopy, ultimately enhancing patient care in orthopedic practice.

Limitations of Study:

- **Retrospective Design:** Being a retrospective analysis, the study is inherently limited by the accuracy and completeness of medical records and imaging data. This design may lead to selection bias, as the inclusion of cases was dependent on the availability of both MRI and arthroscopic data.
- **Single-Center Study:** The findings are based on data from a single hospital, which may limit the generalizability of the results to other settings. Different hospitals may have variations in equipment quality, surgeon expertise and patient demographics, which can influence diagnostic accuracy.
- **Operator Dependency:** Both MRI interpretation and arthrosporic examination are highly operator-dependent. The variability in expertise among radiologists and surgeons can affect the diagnostic outcomes, which might not be adequately reflected in the study.
- **Lack of Standardization:** There may have been a lack of standardization in the techniques used for MRI and arthroscopy, including variations in MRI machines (e.g., different magnetic field strengths)

and arthroscopic equipment, which could influence diagnostic performance.

- **Sample Size:** Although the study included 120 patients, this number may still be too small to detect smaller differences in performance between the two modalities, especially when stratified into different types of knee injuries.
- **Exclusion Criteria:** The exclusion of patients with previous knee surgeries might have skewed the sample towards less complex cases, potentially affecting the applicability of the findings to all patients with knee injuries.
- **Subjectivity in Reporting:** Subjective interpretation of MRI and arthrosporic findings can introduce variability in the results. Although attempts were made to mitigate this by having multiple reviewers, inherent biases and differences in interpretation could still affect the outcomes.
- **Time Interval Between Exams:** The time interval between MRI scans and arthrosporic procedures was not controlled or standardized, potentially affecting the accuracy of comparisons due to progression or amelioration of the injury over time.
- **No Long-Term Follow-Up:** The study did not include long-term follow-up data to assess the outcomes of diagnostic decisions based on MRI and arthroscopy. Long-term outcomes are crucial for understanding the clinical significance of diagnostic accuracy.
- **Ethical and Cost Considerations:** The study did not address the ethical implications and costs associated with performing potentially unnecessary arthroscopic procedures when MRI might suffice for diagnosis and management planning.

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