Clinical, MRI and Arthroscopic Correlation of Anterior Cruciate Ligament Rupture and Meniscal Pathology in a District Hospital

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Purpose

Over recent years, the use of MRI to investigate internal derangement of the knee prior to surgery has become routine clinical practice in many hospitals. MRI is used to confirm clinical suspicions and investigate for associated pathologies. (1) Although diagnostic arthroscopy remains the gold standard for the detection of internal knee derangement, MRI is a proven safe and accurate diagnostic tool.(2, 3) Diagnostic arthroscopy remains an invasive procedure and is not without risks and potential complications like any other surgical procedure. (2-4) As such, MRI has significantly replaced diagnostic arthroscopy as the most common initial investigation of internal derangement of the knee.(5)

Many studies have been conducted confirming the accuracy of MRI in detecting internal derangements of the knee. One question though still arises as to whether MRI is necessary if history and clinical examination have already been used to diagnose pathology.(6) MRI can be an expensive investigation and is not freely available in many hospitals, contributing to delay in surgical intervention and rehabilitation.

Much of the research on the accuracy of MRI has been conducted in centers with subspecialist musculoskeletal radiologists. Furthermore, much of the research into the accuracy of clinical examination has been conducted based on evaluation by orthopaedic consultants or knee specialists. Availability and access to MRI and arthroscopic surgery is becoming more prevalent in smaller, peripheral, less sub-specialised medical facilities. Few studies have been conducted in regional or district hospitals with generalist radiologists interpreting MRI or with clinical examination performed by registrars and residents.

This study will investigate the diagnostic performance of clinical examination and MRI in detecting internal knee pathology, specifically anterior cruciate ligament ruptures and meniscal pathology, in a district hospital. Furthermore, the usefulness of MRI in the presence of positive clinical findings will be considered.
Methods and materials

Ethics approval granted from the Townsville Hospital and Health Service Human Research Ethics Committee.

A retrospective review of all knee arthroscopies performed at The Townsville Hospital during the 22 months from September 2009 to June 2011 was undertaken. In total 274 knee arthroscopies were performed in this time.

No indication for arthroscopy was excluded unless no corresponding MRI or clinical information from chart review was found.

Information regarding the operative details, including operative findings and the intervention performed was gained through the Operation Room Management Information System (ORMIS) of the hospital.

Surgery was performed by experienced specialist lower limb and general orthopaedic surgeons, as well as accredited and unaccredited orthopaedic registrars under the supervision of an orthopaedic consultant.

A chart review was undertaken in order to determine the preoperative findings from clinical history and examination. Where the information was available, the presence or absence of ACL injury, medial meniscal and/or lateral meniscal pathology was recorded.

MRI data was accessed through the hospital's Picture Archiving and Communication System (PACS). MRI reports were searched for and reviewed by an experienced radiologist. MRI findings relating to ACL and/or meniscal pathology were recorded. All MRI was performed on a 1.5T MRI using PD fat saturated axial, coronal, sagittal and PD non fat saturated sagittal sequences.

Using 2x2 contingency tables the sensitivity (SN), specificity (SP), positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy were calculated with regard to clinical diagnosis and MRI findings of ACL ruptures, medical meniscal and lateral meniscal pathology (Table 1). Calculations of diagnostic accuracy of MRI and clinical diagnosis were calculated independent of each other and compared to arthroscopy as the gold standard.
### Table 1: 2x2 contingency table analysis

<table>
<thead>
<tr>
<th>Gold Standard</th>
<th>+ve</th>
<th>-ve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test +ve</td>
<td>True positive (TP)</td>
<td>False positive (FP)</td>
</tr>
<tr>
<td>Test -ve</td>
<td>False negative (FN)</td>
<td>True negative (TN)</td>
</tr>
</tbody>
</table>

Sensitivity = \( \frac{TP}{TP + FN} \)  
Specificity = \( \frac{TN}{TN + FP} \)  
PPV = \( \frac{TP}{TP + FP} \)  
NPV = \( \frac{TN}{TN + FN} \)  
Accuracy = \( \frac{(TP+TN)}{(TP+FP+FN+TN)} \)
Results

274 Arthroscopies were performed from September 2009 to June 2011. Patients’ ages ranged from 12 to 75 years with an average age of 43 years. There were 148 men and 126 females. There were 139 arthroscopies performed on the right knee and 135 on the left. Once missing data was excluded, a summary of the total number results available for analysis of Clinical Diagnosis and MRI in diagnosing ACL and meniscal pathology is displayed in Tables 2 and 3, respectively.

ANTERIOR CRUCIATE LIGAMENT

Of the total number of arthroscopies performed, clinical diagnosis information regarding the ACL was available for 118 arthroscopies and MRI data available for 79. The results of statistical analysis are displayed in Table 2. A comparison of the performance of clinical diagnosis versus MRI for detecting ACL rupture is displayed in Figure 1.

Of the three false negative results following clinical history and examination, two subsequently underwent magnetic imaging which confirmed an ACL rupture and no MRI data was available for the third. Of the 5 false positive clinical diagnoses of ACL rupture, one had a previous ACL reconstruction and MRI was also indeterminate as to the state of the graft. Of the remaining four, two had no MRI data for comparison. For the two that had MRI, one MRI diagnosed a rupture and the other did not. All patients with arthroscopically confirmed ACL rupture went on to have ligament reconstruction. Of the 52 patients who underwent ACL reconstruction, MRI looks to have only changed management in two patients.

MEDIAL MENISCUS

Of the total number of arthroscopies performed, clinical diagnosis information regarding the medial meniscus was available for 99 arthroscopies and MRI data available for 85. The results of statistical analysis are displayed in Table 5. A comparison of the performance of clinical diagnosis versus MRI for detecting medial meniscal pathology is displayed in Figure 2.

Of the 11 false positive medial meniscal tears on clinical diagnosis, 4 had no MRI data. Of the remaining seven, MRI also diagnosed a medial meniscal tear in three and concluded there was no tear in four. Of the twelve false negative clinical diagnoses, MRI data was
only available for four patients. Two of them had tears on MRI, and the other two were negative.

LATERAL MENISCUS

Data was available for analysis on clinical diagnosis for lateral meniscal pathology in 59 arthroscopies and on comparison with MRI in 83 arthroscopies. The results of the statistical analysis are displayed in Table 5. Figure 3 displays the comparison of the performance of clinical diagnosis versus MRI for detecting lateral meniscal pathology.

MRI data was available for four of the false negative results of clinical diagnosis. Of these four, MRI was only 50% accurate with two MRI reporting a tear and the other two reporting no tear. Of the six false positive results of clinical diagnosis, MRI data was available for four, with MRI once again providing 50% accuracy with two MRI reporting a tear and the other two not.
**Table 2:** Clinical diagnosis data available for analysis

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<table>
<thead>
<tr>
<th></th>
<th>ACL</th>
<th>MM</th>
<th>LM</th>
</tr>
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<tbody>
<tr>
<td>True positives</td>
<td>49</td>
<td>60</td>
<td>17</td>
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<tr>
<td>False positives</td>
<td>5</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>True negatives</td>
<td>61</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>False negatives</td>
<td>3</td>
<td>12</td>
<td>11</td>
</tr>
</tbody>
</table>

ACL, anterior cruciate ligament; LM, lateral meniscus; MM, medial meniscus

**Table 3:** MRI data available for analysis

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<table>
<thead>
<tr>
<th></th>
<th>ACL</th>
<th>MM</th>
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</tr>
</thead>
<tbody>
<tr>
<td>True positives</td>
<td>32</td>
<td>39</td>
<td>20</td>
</tr>
<tr>
<td>False positives</td>
<td>4</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>True negatives</td>
<td>38</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>False negatives</td>
<td>5</td>
<td>9</td>
<td>12</td>
</tr>
</tbody>
</table>

ACL, anterior cruciate ligament; LM, lateral meniscus; MM, medial meniscus

**Table 4:** ACL injuries

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<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Diagnosis</td>
<td>94%</td>
<td>92%</td>
<td>91%</td>
<td>95%</td>
<td>93%</td>
</tr>
<tr>
<td>MRI</td>
<td>86%</td>
<td>90%</td>
<td>89%</td>
<td>88%</td>
<td>89%</td>
</tr>
</tbody>
</table>

NPV, negative predictive value; PPV, positive predictive value;

**Table 4:** ACL injuries
Figure 1: ACL clinical diagnosis vs MRI performance (%)

ACC, accuracy; NPV, negative predictive value; PPV, positive predictive value; SN, sensitivity; SP, specificity.

**Fig. 1:** ACL clinical diagnosis vs MRI performance (%)

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<table>
<thead>
<tr>
<th>Table 5: Medical meniscal pathology</th>
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<tr>
<td></td>
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<tr>
<td><strong>Clinical Diagnosis</strong></td>
</tr>
<tr>
<td>Sensitivity</td>
</tr>
<tr>
<td>83</td>
</tr>
<tr>
<td><strong>MRI</strong></td>
</tr>
<tr>
<td>Sensitivity</td>
</tr>
<tr>
<td>81</td>
</tr>
</tbody>
</table>

NPV, negative predictive value; PPV, positive predictive value;

Table 5: Medial meniscal pathology

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**Figure 2:** Medial meniscus clinical diagnosis vs MRI performance

ACC, accuracy; NPV, negative predictive value; PPV, positive predictive value; SN, sensitivity; SP, specificity.

**Table 6:** Lateral meniscus pathology

<table>
<thead>
<tr>
<th>Clinical Diagnosis</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI</td>
<td>62</td>
<td>88</td>
<td>77</td>
<td>79</td>
<td>78</td>
</tr>
</tbody>
</table>

NPV, negative predictive value; PPV, positive predictive value;
ACC, accuracy; NPV, negative predictive value; PPV, positive predictive value; SN, sensitivity; SP, specificity.

**Fig. 3:** Lateral meniscus clinical diagnosis vs MRI performance (%)

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Conclusion

The results of this study suggest the diagnostic performance of MRI for detecting ACL ruptures and meniscal pathology when performed in a non-specialised district hospital is comparable to that of specialised centres and the literature at large.

In this study, history and clinical examination proved to have similar diagnostic performance to MRI in detecting ACL rupture and meniscal pathology of the knee, with the exception of poorer specificity in detecting medial meniscal pathology.

The data would suggest that if ACL rupture is diagnosed from clinical history and examination, preoperative MRI may be unnecessary and perhaps even detrimental due to delaying patient care. In a public district hospital with already lengthy wait times for surgery and limited resources the use of preoperative MRI should be carefully considered for each patient and the routine use for all patients may be unnecessary.
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References


