Efficacy of Repeat Magnetic Resonance Imaging of the Knee

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abstract

A patient often initially presents to an orthopedic surgeon with the magnetic resonance image (MRI) ordered by his or her primary care physician in hand. Often, a significant period of time elapses after injury before the patient is assessed by the orthopedic surgeon; therefore, the initial MRI may be considered outdated because of a new injury or a change in symptoms or because the orthopedist may prefer a new study, a stronger magnet, or a special imaging protocol. However, the decision to repeat a knee MRI is presently an arbitrary one because no clinical guidelines exist to justify this practice.

All repeat knee MRIs performed at our academic institution in the past 9 years were retrospectively examined. Inclusion criterion was repeat MRI of the same knee with no surgical intervention. The formal radiology reports were grouped into 3 categories: change, no change, and unclear. Knee pathology was further grouped into 6 categories indicating what specific structures were pathological or injured. Logistic regression analysis was used to test the association of time vs category or condition change between MRIs. Of 3501 knee MRI studies, 88 patients had a total of 101 repeat MRIs. The average number of days between repeats for those with category or condition change was 612 vs 504 for those with no change. Age, sex, and time between MRIs were not significantly associated with a category or condition change. Repeat knee MRI prior to surgical intervention is becoming more prevalent and may have clinical merit. A further prospective study is warranted.

Figure: MRI demonstrating a small medial meniscus tear with minimal medial collateral ligament sprain (A). Repeat MRI revealed worsening medial meniscus tear with extrusion and blunting of free edge (B).
The evaluation of a patient with knee pain always requires a comprehensive clinical history and a thorough physical examination, but a meaningful knee evaluation often requires magnetic resonance imaging (MRI) as an adjunct diagnostic study. Although orthopedic surgeons will typically request a knee MRI study to confirm the diagnosis or determine the optimal treatment, knee MRIs have frequently been ordered by the referring primary care physician to expedite patients’ workup.

In the Direct Access to Magnetic Resonance Imaging: Assessment for Suspect Knees study, the British investigators concluded that general practitioners’ access to MRIs for patients presenting with a continuing knee problem is cost-effective. However, a significant period of time can elapse before patients are assessed by orthopedic surgeons, and the initial MRI may be considered outdated or irrelevant. This can occur because the patients sustained a new injury, the patients’ symptoms changed, or the consulted physicians simply prefer a new MRI study or a special imaging protocol. In this setting, physicians may request that patients undergo a repeat knee MRI.

Although the diagnostic merits of knee MRI are clear, and the overall risks to the patient from serial MRI are low, the efficacy of repeating this imaging modality in terms of enhancing its diagnostic merits or justifying its associated costs has not been clinically established. Therefore, the decision to repeat a knee MRI study is currently an arbitrary one because no clinical guidelines exist to support the practice.

The authors hypothesized that the practice of repeating MRI studies of the knee with pain symptoms with no clear and specific indications is extremely prevalent and ineffective. The objective of this retrospective study was to assess the efficacy of repeat knee MRIs prior to surgical intervention in patients with knee pain.

**MATERIALS AND METHODS**

All knee MRI studies performed at our academic institution between January 1, 2000, and December 8, 2008, were retrospectively reviewed. The initial time of data collection was established to coincide with the acquisition of a new MRI scanner (2 General Electric Signa LXI 1.5 Tesla magnets [GE Healthcare, Waukesha, Wisconsin]) at our institution. The study was reviewed and approved by the University of Texas Medical Branch Institutional Review Board and conducted in compliance with all institutional regulations. The study inclusion criteria mandated that all MRIs (initial and repeat) be performed on the same scanner using a standard protocol (Table 1). All included knee MRI studies were performed on the same patient knees with no intervening surgical procedure. If <2 MRI studies were done on the same knee, they were analyzed pair-wise.

The data collected included general patient demographics (age, sex), knee side, the specialty of the providers ordering the imaging study (orthopedic surgery vs non-orthopedic provider), and the time elapsed between the initial and repeat knee MRI studies. All final and formal radiology reports for initial and repeat knee MRIs of the study group patients were collected for review and comparison. All final and formal knee MRI reports were generated by the institution’s radiology faculty, who routinely read musculoskeletal MRI scans. All radiologists who interpreted repeat MRI studies (regardless of whether they were the same or different) had an opportunity to reinterpret the initial study and compare and refer to it while interpreting the repeat study. Patients were excluded from the study if the knee side could not be accurately determined and if the patient had surgery prior to a repeat MRI (as evident by postoperative changes on the formal radiology report).

The repeat knee MRI studies were separated into 3 distinct patient groups prior to more in-depth analysis: no change, change, and unclear. Furthermore, to delineate more precisely the nature of the knee pathology documented by MRI, the patients were further grouped into 6 categories (Table 2):
category A (menisci) included medial and lateral menisci; category B (ligaments) included the anterior cruciate ligament, posterior cruciate ligament, medial collateral ligament, and lateral collateral ligament; category C (extensor mechanism) included the patellar tendon, quadriceps tendon, and retinaculum; category D (osseous) included fracture, bone bruise, arthritis, chondromalacia, and osteochondritis dissecans; category E (miscellaneous) included loose bodies, effusion, and cyst, and category O included normal knees. In addition, the nature of disease change and progression within each knee pathologic condition was designated as worsening, improvement, or no change. If the initial knee MRI showed a medial meniscus tear (category A) but on the repeat MRI a medial meniscus tear and an ACL injury were found, the designation would be a change in category (from category A to B). However, if the initial MRI determined the presence of a medial meniscus tear and the repeat MRI showed worsening (progression) of the medial meniscus tear (eg, articular surface extension, or a bucket handle tear with prolapse), the designation would be the same category (category A) but with a change in condition (worsening).

Descriptive statistics were performed to determine the sample characteristics and distribution of the outcome variables. Logistic regression was used to test the association of time vs category or condition change between successive knee MRI studies. Statistical significance was determined when the \( P \) value was <.05.

**RESULTS**

The study identified 3501 knee MRI studies performed in our institution within the designated study period. Within this group, 88 patients had \( \geq 2 \) same-knee MRI studies with no surgical intervention between them. The majority of patients (\( n=77, 87.5\% \)) had \( 2 \) same-knee repeat MRI studies, 9 patients (10.2%) had 3, 1 (1.1%) patient had 4, and 1 patient (1.1%) had 2 MRI studies of the left knee and 3 MRI studies of the right knee, for a total of 190 MRI studies. One hundred thirty-four (70.5%) MRI studies were ordered by orthopedic surgeons, whereas 56 (29.5%) were ordered by physicians other than orthopedists. The multiple number of repeat MRI studies in some patients resulted in the formulation of 101 total imaging pairs in the final study patient group that could be analyzed. For example, if a patient had 3 MRI studies on the same knee without surgical intervention, only 2 pairs of imaging studies could be analyzed for category or condition change (1 pair between the first and second same-knee MRI, and a second pair between the second and third same-knee MRI).

The average age of the included patients was 51.1 years (range, 16-83 years; \( \text{SD}=12.9 \) years) and 49 (55.7%) patients were women. The average number of days between 2 consecutive MRI studies was 612.1 (SD=474.3) for those with category or condition changes between 2 knee MRI studies and 504 (SD=262.8) for those with no category or condition changes between the 2 studies. The shortest and longest time intervals between MRI studies were 27 and 2248 days (and demonstrated no category change but overall change, and category and overall change, respectively). Bivariate analysis revealed that time between same-knee MRI studies, age, and sex were not significantly associated with a category or condition change between MRI studies (\( P=.24, .34, \) and \( .91 \), respectively) (Table 3).

**Table 3**

Bivariate Analysis of MRI Category or Condition Change

<table>
<thead>
<tr>
<th>Variable</th>
<th>Change (n=78, 77.2%)</th>
<th>No Change (n=23, 22.8%)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days between 2 MRIs (mean, SD)</td>
<td>612.1, 474.3</td>
<td>504, 262.8</td>
<td>.24</td>
</tr>
<tr>
<td>Age, y (mean±SD)</td>
<td>50.7±13.3</td>
<td>49.6±12</td>
<td>.34</td>
</tr>
<tr>
<td>Men (n, %)</td>
<td>34, 75.6</td>
<td>11, 24.4</td>
<td>.91</td>
</tr>
<tr>
<td>Women (n, %)</td>
<td>44, 78.6</td>
<td>12, 21.4</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: MRI, magnetic resonance imaging.

**Table 4**

Relation of Time Between Same-knee MRI Studies and MRI Change with Adjustment for Age and Sex

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% CI) of Having Change Between 2 MRI Studies</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days between 2 MRIs</td>
<td>1.001 (0.999, 1.002)</td>
<td>.25</td>
</tr>
<tr>
<td>Age</td>
<td>1.01 (0.975, 1.047)</td>
<td>.58</td>
</tr>
<tr>
<td>Sex</td>
<td>1.128 (0.445, 2.875)</td>
<td>.8</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; MRI, magnetic resonance imaging

*Analysis performed by multiple logistic regression.*

**Table 5**

Change in Category and Overall Report Change

<table>
<thead>
<tr>
<th>Change in Category</th>
<th>Overall Report Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>38 no category change</td>
<td>23 no change</td>
</tr>
<tr>
<td>63 with category change</td>
<td>78 change</td>
</tr>
</tbody>
</table>
3). After adjustment for age and sex, the time between same-knee MRI studies was still not significantly associated with a change ($P = .25$) (Table 4).

Of the 101 repeat same-knee MRI pairs analyzed, 78 (77.2%) demonstrated a category or condition change (Figures 1, 2), whereas 23 (22.8%) did not (no change) (Figure 3). There were 63 (62.4%) repeat knee MRI studies that demonstrated a category change in the knee pathology category, whereas 38 (37.6%) did not (no category change) (Table 5). Of the 38 MRI pairs that did not change category designation, 15 (14.9%) demonstrated a change in condition; 2 (13.3%) of those MRI pairs improved, whereas 13 (86.7%) MRI pairs demonstrated worsening. Of all (n = 78) knee repeat MRI studies that demonstrated a change in knee condition, an improvement was noted in 14 (17.9%) MRI pairs, and worsening occurred in the remaining 64 (82.1%) MRI pairs.

**DISCUSSION**

MRI is a valuable method for clinicians to accurately detect pathology within the knee in a safe, noninvasive manner. However, the indications for obtaining a knee MRI have not been standardized. Some authors believe that a knee MRI is indicated for acute knee trauma, painful range of motion, or mechanical knee symptoms, whereas others suggest that this imaging modality should be restricted to situations in which an experienced clinician requires further information before arriving at a diagnosis or when conservative treatment seems possible.

Routine, indiscriminate knee MRIs are not advocated because of concerns related primarily to costs and access. MRI is a costly. At the authors' institution, the technical and professional fees for a single-knee MRI are $>2500. Moreover, MRI access has become more challenging as the indications for this modality expand; routine MRI imaging would further impede patient access and increase health care costs. Therefore, the authors became particularly alarmed to find that many patients eventually undergoing knee surgery presented with 1 MRI study, and to date the efficacy of this practice has not been reported in the literature.

Over a 9-year period, 190 of 3501 (5.4%) of all knee MRI studies performed at the authors' institution were repeat MRI studies. The actual incidence of repeat knee MRI is likely much higher because of an indeterminate group of patients having an initial or repeat knee MRI at an outside facility. Thus, the practice of repeat knee MRI is fairly...
commonplace despite the lack of supportive data. In some patients, this trend may be due to a dramatic change in symptoms; however, in many patients it may simply represent an arbitrary decision on the part of the clinician. Irrespective of the justification/indication, this retrospective study demonstrated that the majority (77%) of knee MRI pairs revealed a change in overall knee pathology, with 14 (17.9%) of 78 successive MRI studies showing improvement and 64 (82.1%) of 78 exhibiting progression of disease. A repeat knee MRI study may have merit in select patients and can provide new clinical information about the course of the knee pathology. No change in the repeat knee MRI may offer valuable information about the course of the knee disease, especially when a change is expected.

The major limitation of the study was that it was retrospective, and the specific reason for the repeat study could not be established. In addition, patients may have had an initial or repeat knee MRI study elsewhere that could not be detected by our methods. It was not determined whether the pathology found on repeat imaging would affect subsequent treatment. Finally, correlation of subsequent intraoperative pathology with the initial or repeat knee MRI findings was not performed.

However, a similar study by Mays et al.\textsuperscript{25} retrospectively examined the merits of repeat shoulder MRI prior to surgical intervention and demonstrated that 54% of patients had considerable change on repeat MRI; furthermore, one-third showed detectable changes when the repeat MRI was taken <90 days from the initial MRI. On the basis of these findings, we attempted to establish whether repeat knee MRI would have similar merit.

The current study shows that 77.2% of patients had significant change between MRI studies, and when the time interval to repeat was <90 days, 100% (n=4) of these patients showed significant change. The differences between the 2 studies could be due to the distinct biomechanics or disease processes affecting the shoulder and the knee, the ordering practices of physicians with regard to different joints, or the very different mean time interval between the 2 studies: 274 days in Mays et al.\textsuperscript{25} vs 612 days in the current study. Mays et al.\textsuperscript{25} had too few patients to perform a statistical analysis.

Repeat knee MRI prior to surgical intervention is becoming more prevalent and may have clinical merit. A well-controlled, prospective study that correlates patient symptoms, physician indications for ordering a repeat imaging study, the pathology detected by MRI, and the subsequent operative findings is warranted to determine the merits of a repeat knee MRI study.

REFERENCES