

# Workers' Societal Costs After Knee and Shoulder Injuries and Diagnosis with In-Office Arthroscopy or Delayed MRI

## A Cost-Minimization Analysis

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**Background:** The goal of this study was to evaluate the societal costs of using in-office diagnostic arthroscopy (IDA) compared with magnetic resonance imaging (MRI) for the diagnosis of intra-articular knee and shoulder pathology in employed patients receiving Workers' Compensation or disability coverage. The prevalence is estimated at 260,000 total cases per year.

**Methods:** A cost-minimization analysis of IDA compared with MRI was conducted. Direct costs (in 2018 U.S. dollars) were calculated from private reimbursement amounts and Medicare. Indirect costs were estimated from a societal perspective including effects of delayed surgical procedures on the ability to work, lost income, Workers' Compensation or disability coverage, and absenteeism. Four regions were selected: Boston, Massachusetts; Detroit, Michigan; Denver, Colorado; and San Bernadino, California. Sensitivity analyses were performed using TreeAge Pro 2019 software. The base assumption was that it would take approximately 4 weeks for a diagnosis with MRI and 0 weeks for a diagnosis with IDA.

**Results:** Direct costs to determine a knee diagnosis with IDA were \$556 less expensive (California) to \$470 more expensive (Massachusetts) than MRI. Assuming a 4-week wait, societal costs (indirect and direct) for knee diagnosis were anywhere from \$7,852 (Denver) to \$11,227 (Boston) less using IDA. Direct costs were similar for shoulder pathology. In order for MRI to be the less costly option, the MRI and the follow-up visit to the physician would need to occur directly after consultation. Under Medicare, direct costs were similar for both the knee and shoulder when comparing IDA and MRI. Including indirect costs resulted in IDA being the less costly option.

**Conclusions:** The use of IDA instead of MRI for the diagnosis of knee and shoulder pathology reduced costs. The potential savings to society were approximately \$7,852 to \$11,227 per operative patient and were dependent on scheduling and follow-up using MRI and on Workers' Compensation.

**Level of Evidence:** Economic and Decision Analysis Level IV. See Instructions for Authors for a complete description of levels of evidence.

Rotator cuff tears, meniscal tears, and anterior cruciate ligament (ACL) tears are 3 of the most common soft-tissue injuries treated, including surgically<sup>1-3</sup>. These conditions can be highly debilitating and can keep patients out of work or can decrease a patient's level of function if untreated<sup>4-7</sup>. Magnetic resonance imaging (MRI) and clinical evaluation are the most commonly used tools for diagnosis<sup>8,9</sup>. Long MRI waiting times can

be a challenge and have been associated with delays in diagnoses, canceled appointments, poorer outcomes, and financial losses<sup>10-12</sup>. Additionally, lag times in receiving care predict the length of disability<sup>13</sup>.

Recently, the use of in-office diagnostic arthroscopy (IDA) has been shown to be cost-saving and accurate for these conditions<sup>14-16</sup>. IDA can be performed on the initial patient visit,

**Disclosure:** Analysis was funded by an unrestricted grant from Trice Medical to J.V. The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJSOA/A283>).

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decreasing the time to surgical treatment and potentially allowing the patient to return to regular activities sooner.

The goal of this study was to evaluate the direct indirect cost savings of using IDA for the diagnosis of these conditions in 4 regions of the country: East (Boston, Massachusetts), Central (Detroit, Michigan), Midwest (Denver, Colorado), and West (San Bernardino, California). The hypothesis was that IDA is less expensive than MRI.

### Materials and Methods

A cost-minimization analysis comparing IDA with MRI was conducted for the diagnosis of employed patients with shoulder and knee injuries. Direct costs (in 2018 U.S. dollars) were calculated from the reimbursement amounts paid by private insurance for office visits, MRI, and IDA. These regions were chosen on the basis of access to high-volume data on private payer information per the RAND 2019 report<sup>17</sup> and on geographic representation. The Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist was used (see the CHEERS Checklist in the Appendix).

Indirect costs included the effects of a delayed surgical procedure on an individual's ability to work, disability, and the cost of lost productivity. It also included out-of-pocket costs<sup>18</sup>.

It was further assumed that incurring an injury was covered by Workers' Compensation or disability insurance. Patient income information was derived from the U.S. Bureau of Labor<sup>19</sup>; Workers' Compensation payments from California<sup>20</sup>, Michigan<sup>21</sup>, Massachusetts<sup>22</sup>, and Colorado<sup>23</sup>; and temporary disability insurance<sup>24-26</sup>.

To estimate the cost of lost productivity, the number of workdays lost was multiplied by a daily compensation wage multiplier of 1.61, where the multiplier was defined as the cost to an employer of an absence ( $\geq 2$  weeks)<sup>27</sup>. Thus, costs were investigated up to the point where a patient was informed of the diagnosis.

In order to determine the mean time for MRI, we contacted a scheduling department over a period of 3 months at a California facility.

Cost modeling software (TreeAge Pro 2019; TreeAge Software) was used to determine through sensitivity analysis which variables had the greatest effect in determining cost.

### Results

Appendix Table 1 shows the direct costs and indirect costs associated with obtaining a diagnosis for knee pathology; Appendix Table 2 details the variables and distributions used in the model, using California data.

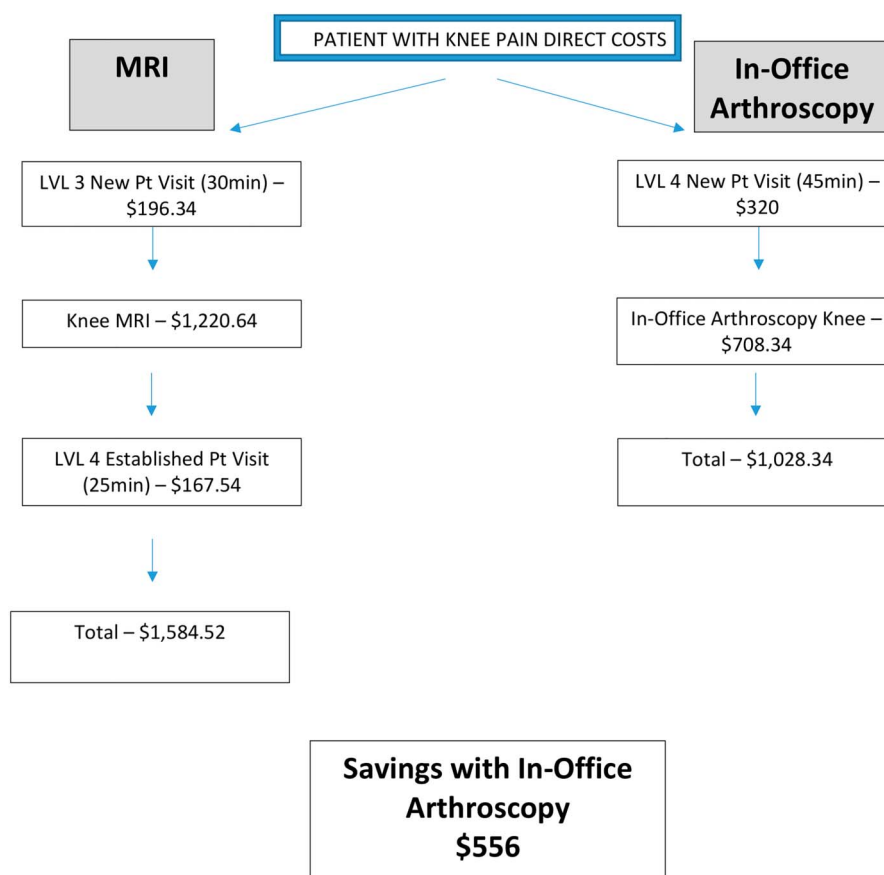


Fig. 1

Direct cost comparison between MRI and IDA: knee. LVL = level, Pt = patient.

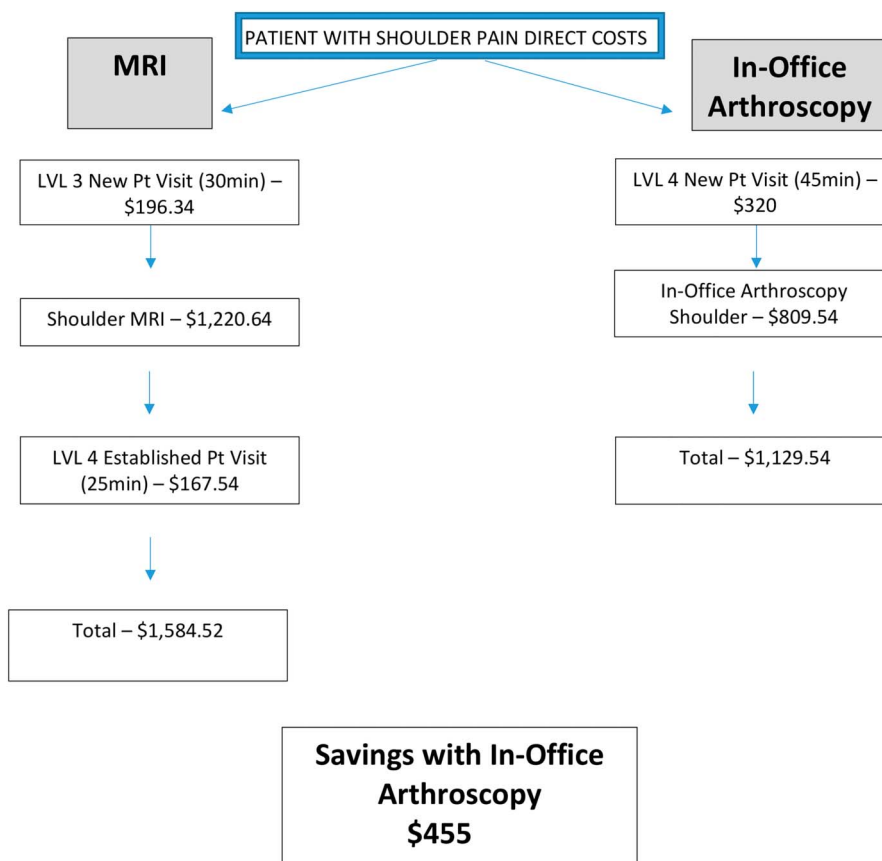


Fig. 2 Direct cost comparison between MRI and IDA: shoulder. LVL = level, Pt = patient.

The mean MRI scheduling wait time was 2.4 weeks. It was assumed there was an additional 12-day (1.71-week) wait for a follow-up visit to review the MRI<sup>28,29</sup>. Therefore, a total of 4 weeks (2.4 weeks + 1.7 weeks = 4.1 weeks, rounded to 4 weeks) was used for MRI. There was no wait time for IDA, as the procedure occurred directly after the patient workup in the office setting. Figures 1 and 2 identify direct cost comparisons for private payer patients in California and the resultant savings using IDA. Note that, for Massachusetts, the direct cost comparisons would result in IDA being the more expensive option by \$470. Direct cost comparisons for Medicare patients yielded no cost savings between IDA and MRI.

Using San Bernardino, California, as an example, the mean weekly wage was \$906<sup>19</sup>. Workers' Compensation pro-

vided two-thirds of this, or \$604 per week. For disability insurance, the mean payout was 60% of the weekly salary, or \$544<sup>30</sup>. The cost to the employer due to lost productivity caused by absenteeism was \$7,066. Thus, the additive societal savings provided by using IDA for returning to work 4 weeks earlier was \$10,968 (\$11,996 - \$1,028). Additive societal savings occurred in all regions evaluated. An assumption of no disability or Workers' Compensation costs and no loss in work time resulted in a direct cost savings of \$895 (\$1,905 - \$1,010).

In all regions evaluated, the wait for a diagnosis was >\$8,000 (Workers' Compensation + lost productivity + waiting time).

In a 3-way sensitivity analysis (see Appendix Table 3; Appendix Figures 1 and 2 are representative of the others), for MRI to be the less costly alternative, the MRI follow-up visit to the physician would need to occur within 3 to 6 days after the initial office visit. Additionally, for MRI to be the less costly alternative, Workers' Compensation would need to be below \$75 to \$240 per week with no loss in worker productivity.

As further confirmation of the mean California wait time data of 2.4 weeks, the literature shows that the mean time from the first patient visit to the physician review of MRI findings was 2 weeks<sup>31</sup>. Using a 2-week wait time resulted in societal costs as shown in Table I.

TABLE I Societal Costs Using Only a 2-Week Wait Time		
Region	MRI	IDA
Boston, Massachusetts	\$5,395	\$1,602
Denver, Colorado	\$6,562	\$1,203
San Bernardino, California	\$6,765	\$1,028
Detroit, Michigan	\$5,644	\$936

In a 1-way sensitivity analysis, the cost of the IDA would need to be >\$9,000 to \$12,000 for MRI to be less expensive (see Appendix Figures 3 and 4).

The shoulder assessment demonstrated similar findings (Fig. 2).

## Discussion

Prior analyses demonstrated cost savings when examining the direct cost for care in evaluating or diagnosing and treating knee and shoulder pathology<sup>14,16,32</sup>. The current analysis adds the impact of delays in diagnosis with MRI. The rapid rise of health-care costs in the United States is a concern for policymakers<sup>33-36</sup>. One method for containing costs is a value-centric approach, with care providing the highest clinical value supported<sup>34</sup>.

As it relates to value, patient satisfaction has been known to be adversely affected by increased waiting times<sup>37,38</sup>. Consequences of delays include negative effects on outcomes, care utilization, and the reputation of the organization<sup>39</sup>. Thus, timely follow-up may improve patients' perception and valuation of health care<sup>40,41</sup>.

One of the more common reasons for disability claims is musculoskeletal disorders<sup>42</sup>. Among work-related injuries in 2017, there were a mean (and standard deviation) of 115,900 ± 27,300 shoulder injuries and 151,000 ± 24,300 knee injuries<sup>43</sup>. Additionally, per the Bureau of Labor, the median time away from work was 22 days for knee and shoulder injuries<sup>44</sup>. Thus, the cost numbers provided herein are similar to other analyses. For 2016, 86.5% of the 138.2 million jobs in the U.S. were covered by Workers' Compensation<sup>45</sup>. Additionally, short-term disability covered 25% of government jobs to 45% of private sector jobs<sup>46</sup>. From a total indirect cost perspective, U.S. state analyses have identified non-medical costs per claim of \$2,004 to \$17,060 for knee injuries and \$2,863 to \$25,668 for shoulder injuries<sup>6,47</sup>. Even if only salary costs were calculated, over \$300 million (\$2,000 × 151,000 for knee injuries and \$2,863 × 116,000 for shoulder injuries) would be paid yearly. As mentioned above, a lag time of 1 to 2 weeks contributed an additional 10 days of disability. Lag times for MRI can also result from policies that require preauthorization<sup>48-52</sup>.

Sensitivity analysis appears to be rarely used<sup>53</sup>. It is important to perform in any type of cost analyses, considering uncertainty (e.g., wide variation of costs), and for the testing of robustness of assumptions (when used in modeling). Sensitivity analysis found that for MRI to be the less costly alternative, IDA pricing would need to be ≥\$1,750, along with no wait times for follow-up visits. Additionally, a patient would need to be poorly compensated via Workers' Compensation or disability insurance (e.g., below \$75 to \$240 per week) and absent from work. Private-payer pricing for IDA has been noted in prior studies to be considerably less than \$1,750<sup>32</sup>. Thus, it is unlikely that the use of MRI from a societal perspective would be less costly than IDA.


Studies at large institutions have identified a mean 8-day wait time, with wait times resulting in missed appointments<sup>10</sup>.

Thus, in surgical patients with the above indications, IDA would be preferred, as it saves time and money.

This study had several limitations. Even though scheduling an MRI can be problematic, the wait time may be shorter than 2 weeks. Another limitation was the learning curve with IDA and how this could affect the cost analysis. The study focuses mainly on operative determinations after diagnosis. Nonoperative treatment may be successful and initiated (albeit carefully, not fully understanding the diagnosis) after the initial office visit. Thus, the wait time may not be wasted time. IDA is not completely benign because complications could occur and may require a subsequent MRI. These costs were not included in the IDA arm. The existing literature to date for IDA has demonstrated no complications<sup>14,54,55</sup>. Another study showed no major complications (1,419 cases from 13 participating physicians), with minor complications being transient in nature<sup>56</sup>. Another limitation was the assumption that the patient is idle while waiting for the MRI and rehabilitation or bracing are not initiated. This may not be the case and could positively affect patient outcomes and lower costs. Another limitation was the assumption that diagnosis is an end point where all societal costs stop. Finally, this is a subset of Workers' Compensation patients (approximately 50,000) and may not be representative of the entire Workers' Compensation market.

The use of IDA instead of MRI for the diagnosis of knee and shoulder pathology reduced costs. The potential savings to society were approximately \$7,852 to \$11,227 per operative patient and were dependent on scheduling and follow-up using MRI and on Workers' Compensation.

## Appendix

 Supporting material provided by the authors is posted with the online version of this article as a data supplement at [jbjs.org \(http://links.lww.com/JBJSOA/A284\)](http://links.lww.com/JBJSOA/A284). ■

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