Changes Within Clinical Practice After a Randomized Controlled Trial of Knee Arthroscopy for Osteoarthritis

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Background: In 2002, Moseley et al published a randomized controlled trial (RCT) that showed no difference between knee arthroscopy and placebo for patients with osteoarthritis (OA). We wanted to assess the impact of the trial on clinical practice in the United States.

Purpose/Hypothesis: To evaluate changes in knee arthroscopy practice before and after publication of the article by Moseley et al and to assess the effect of this landmark RCT on the behavior of practicing orthopaedic surgeons. We hypothesized that after publication of the Moseley trial, the overall frequency of knee arthroscopy would decrease, that the mean age of patients undergoing knee arthroscopy would decrease, and that the proportion of arthroscopies for a diagnosis of OA would decrease.

Study Design: Descriptive epidemiology study.

Methods: The State Ambulatory Surgery Database was used to analyze cases from 1998 to 2006, which were classified as meniscus tear, OA, or OA with meniscus tear. Changes in age, surgery rates, and case classification were evaluated before and after Moseley's trial using Student t tests and analysis of variance.

Results: After publication of the trial, the number of knee arthroscopies per year increased from 155,057 in 1998 to 172,317 in 2006 ($P \leq .001$). Mean patient age increased from 47.6 to 49.2 years ($P < .001$). Meniscus tears increased from 69.1% to 70.8%, representing approximately 15,500 additional cases per year. OA decreased from 10.6% to 7.2%, representing approximately 4000 fewer cases per year. OA with meniscus tear increased from 20.3% to 22.0%, representing approximately 6400 additional cases per year.

Conclusion: While overall age and rates of knee arthroscopy increased contrary to our hypothesis, we identified a decrease in rates of knee arthroscopy for OA after publication of the Moseley trial, demonstrating that well-publicized RCTs can influence patterns of clinical practice.

Keywords: knee arthoscopy; osteoarthritis; meniscus tears

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Knee arthroscopy is one of the most common orthopaedic surgical procedures performed in the United States, with over 500,000 cases annually. In the past, a primary indication for knee arthroscopy was debridement for osteoarthritis (OA) based on favorable results from case series and anecdotal experience.[4,6-8,11-15] However, this conventional wisdom was called into question in 2002 by the publication of the landmark study by Moseley et al[19] in which they reported the results of randomizing 180 patients to either arthroscopic debridement (n = 59), arthroscopic lavage (n = 61), or a sham procedure (n = 60). They could not detect any significant differences between groups in terms of pain relief or functional outcome.[1] Because an important goal of conducting clinical research is to convey results to practicing physicians and potentially change clinical practice, it is important to assess the differences in practice patterns before and after the dissemination of important clinical research findings. Potts et al[22] studied the practice

patterns of orthopaedic surgeons collecting cases for their American Board of Orthoaedic Surgery (ABOS) Part II examination and demonstrated a decrease in the rate of knee arthroscopy of over 40% after the publication of the Moseley trial. However, this population of surgeons may demonstrate different behavior than the general population because they know that their decisions will be scrutinized during review of case lists and oral examination. Additional studies have evaluated changes in practice patterns in the Veterans Administration (VA) Health System as well as in the Florida State Ambulatory Surgery Database with conflicting results.[1]

The specific aim of this study was to evaluate changes in knee arthroscopy practice patterns before and after the publication of Moseley's results to assess the effect of this landmark randomized clinical trial on the behavior of practicing orthopaedic surgeons utilizing data from a more respresentative sample than previous studies by utilizing as many states as possible in the State Ambulatory Surgery Database (SASD). In addition, we wanted to categorize patients into meaningful groups based on the presence of meniscus tear, OA, or both. We hypothesized that after the publication of the Moseley trial, the overall frequency of knee arthroscopy would decrease, that the mean age of patients undergoing knee arthroscopy would decrease, and that the proportion of patients with a diagnosis of OA would decrease.

METHODS

Data Source

The SASD is a program of the Agency for Healthcare Research and Quality that captures patient discharge records in 26 states. This program is part of a federal-state-industry partnership to collect data that inform policy decisions related to health care. The majority of the participating states report cases from hospital-affiliated and freestanding surgery centers, with a dataset of over 100 clinical and nonclinical variables contained in a hospital discharge abstract, including all listed diagnoses, all listed procedures, patient demographics (eg, sex, age, and, for some states, race), and expected payment source (eg, Medicare, Medicaid, private insurance, self-pay). This database can be accessed to retrieve information from states throughout a variety of regions in the United States representative of nationwide practice trends. The SASD from the Health Care Utilization Project[9] served as the data source in our study, and information was obtained from the years 1998, 2000, 2002, 2004, and 2006. The SASD excludes data elements that could directly or indirectly identify individuals or physicians.[9]

Each state's participation in the SASD is voluntary, so the geographical distribution of the states is based on the states that participated in the SASD during the years of interest and not based on any sort of selection process. All states include data from hospital-owned ambulatory surgery centers, and all of the states in our sample except for Maryland and New Jersey include data from surgery centers not affiliated with a hospital. Therefore, there is a mix of academic, urban, and rural surgery centers represented in this dataset. We chose to select all states with data available during the years of interest.

The following states have data available for the years 1998 through 2006: Colorado, Florida, Maryland, New Jersey, New York, Utah, and Wisconsin. North Carolina and South Carolina only have data from 2000 through 2006. All of these states except for Maryland and New Jersey report cases from hospital-affiliated and freestanding surgery centers, while Maryland and New Jersey report discharge summaries from hospital-affiliated surgery centers only. Nearly 40 million discharge records were included in this sample.

Inclusion and Exclusion Criteria

We selected cases from the database with a goal of identifying 3 groups of procedures: arthroscopy for treatment of osteoarthritis (OA), arthroscopy for treatment of meniscus tear (M), and arthroscopy for treatment of osteoarthritis and meniscus tear (OAM).

First, we extracted all cases from the database in which knee arthroscopy had been performed for meniscectomy, chondroplasty, or both. Next, we excluded cases where additional procedures were performed, including meniscus repair, meniscal transplantation, removal of loose body, synovectomy, lavage and drainage for infection, ligament reconstruction, microfracture, osteochondral grafting, mosaicplasty, or diagnostic arthroscopy. We also excluded cases performed in conjunction with open procedures such as distal femoral or proximal tibial osteotomy.

To identify and classify cases, we used International Classification of Diseases, 9th Revision (ICD-9) diagnosis codes and either Current Procedural Terminology (CPT) or ICD-9 procedure codes. We used CPT codes for states that provided both types of procedure codes. We then used a combination of procedure code and diagnosis code to assign each case to a group.

Data Analysis

Cases were divided as pre- and postpublication. Because the trial results of Moseley et al[19] were published in late 2002, and because some insurance payers began refusing payment for a primary diagnosis of OA in 2003, we used 2003 as the year dividing the pre- and postpublication periods. Demographic characteristics were summarized using frequencies and percentages for categorical variables and means and standard deviations for continuous variables. Cases per year and patient age were compared before and after publication of the article using Student t tests and a significance level of $P < .05$. Case classification as OA, M, or OAM was compared using analysis of variance and a significance level of $P \leq .05$. The Holm correction was used to account for multiple comparisons.

RESULTS

We analyzed cases from 1998, 2000, 2002, 2004, and 2006. Selection of cases from the database according to the inclusion and exclusion criteria identified 809,804 cases of knee

TABLE 1
Basic Summary Statistics for the Study Cohort[a]

Factor	Overall (N = 809,804)
Patient age, y	48.2 ± 15.6
Patient sex	
Male	438,157 (54.1)
Female	371,494 (45.9)
Patient race	
White	463,763 (81.4)
Black	48,953 (8.6)
Hispanic	33,899 (5.9)
Asian or Pacific Islander	4228 (0.74)
Native American	2894 (0.51)
Other	16,015 (2.8)
Expected primary payer	
Medicare	119,107 (14.7)
Medicaid	19,021 (2.4)
Private insurance	542,306 (67.1)
Self-pay	15,622 (1.9)
No charge	734 (0.09)
Other	110,935 (13.7)
State	
Colorado	29,940 (3.7)
Florida	221,329 (27.3)
Maryland	54,346 (6.7)
New Jersey	81,903 (10.1)
New York	233,818 (28.9)
North Carolina	14,829 (1.8)
South Carolina	42,436 (5.2)
Utah	35,999 (4.4)
Wisconsin	95,204 (11.8)

[a]Continuous variables are presented as mean ± SD, and categorical variables are presented as n (%).

TABLE 2
Number of Cases per Year and Year Grouping
Before and After 2003[a]

Year	No. of Arthroscopies
1998	136,031 (16.8)
2000	164,156 (20.3)
2002	164,983 (20.4)
2004	165,844 (20.5)
2006	178,790 (22.1)
Year group	
Before 2003	465,170 (57.4)
After 2003	344,634 (42.6)

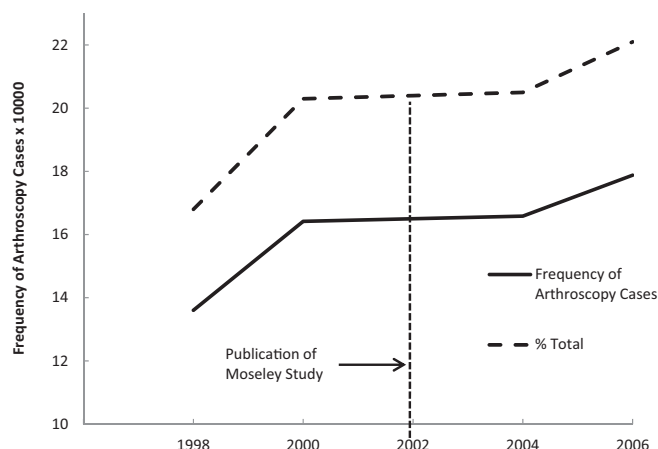[a]Values are presented as n (%).

Figure 1. Graphic display of yearly frequency of knee arthroscopy from 1998 to 2006. The vertical dotted line indicates 2003, which is defined as a reference point for the publication of Moseley's research.

arthroscopy with meniscectomy or chondroplasty. The mean age of patients undergoing surgery was 48.2 ± 15.6 years (54.1% male; 81.4% white, 8.9% black, 5.9% Hispanic). The most common primary payers were private insurance (67.1%), Medicare (14.7%), and Medicaid (2.4%). The majority of cases were from New York (28.9%), Florida (27.3%), Wisconsin (11.8%), and New Jersey (10.1%). Additional details on summary statistics are provided in Table 1.

The number and percentage of cases per year both before and after 2003, which we defined as the transition date associated with publication of Moseley's article, are noted in Table 2 and Figure 1. The overall frequency of knee arthroscopies rose from 2000 through 2006 and is outlined in Figure 2.

The mean age of patients undergoing knee arthroscopy was 48.2 ± 15.6 years. For patients in the OA group, mean age decreased from 41.5± 14.9 years prepublication to 40.8 ± 14.2 years postpublication ($P < .001$). For patients in the M group, mean age increased from 46.7 ± 15.7 years prepublication to 48.3 ± 15.7 years postpublication ($P < .001$). For patients in the OAM group, mean age increased from 53.4 ± 14.4 years prepublication to 54.4 ± 13.4 years postpublication ($P < .001$). Results broken down by age are presented in Table 3.

The rate of knee arthroscopy was 155,057 cases per year before 2003 and 172,317 cases per year after 2003 ($P < .001$). The mean patient age was 47.6 years before 2003 and 49.2 years after 2003 ($P < .001$). Arthroscopies for meniscus tear increased from 69.1% before 2003 to 70.8% after 2003, representing an increase of approximately 15,500 cases per year after publication of the Moseley trial in the states studied. Arthroscopies for OA decreased from 10.6% before 2003 to 7.2% after 2003, representing a decrease of approximately 4000 cases per year. Arthroscopies for meniscus tear and OA increased from 20.3% before 2003 to 22.0% after 2003, representing an increase of approximately 6400 cases per year after the publication of the Moseley trial, as presented in Table 4.

DISCUSSION

Our analysis is the first to assess changes in practice patterns related to the publication of Moseley's randomized controlled trial[19] using hospital discharge data from multiple states, including over 800,000 procedures. We expected that practicing orthopaedic surgeons would perform fewer
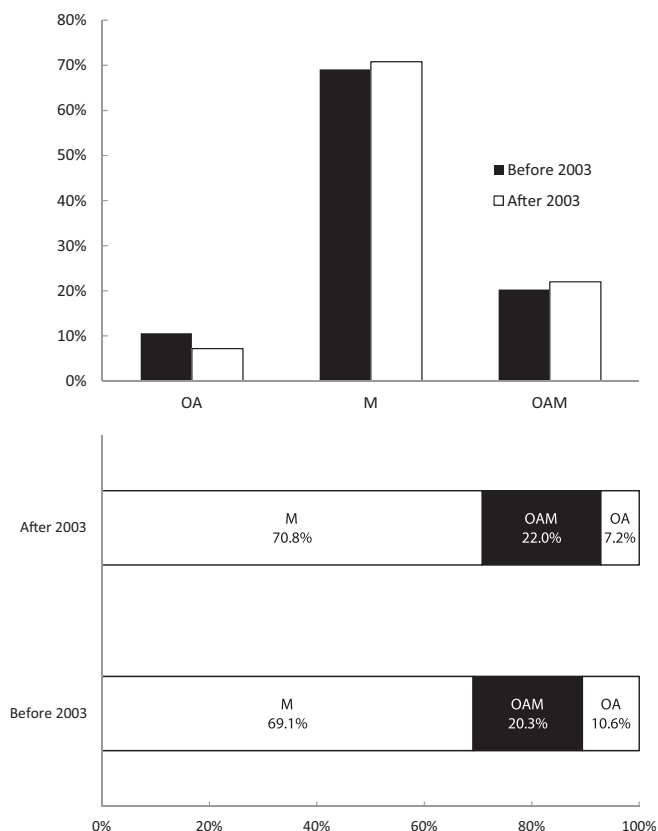
Figure 2. Percent of arthroscopies performed for each diagnosis. M, meniscal tear; OA, osteoarthritis; OAM, osteoarthritis and meniscus tear.

TABLE 3
Relationship Between Ages Separated by Differential
Diagnosis Before and After 2003 for All States[a]

| | Before 2003 | | After 2003 | | |
Factor	n	Mean ± SD	n	Mean ± SD	P^b
Patient age (M)	304,128	46.7 ± 15.7	233,200	48.3 ± 15.7	<.001
Patient age (OA)	46,982	41.5 ± 14.9	23,085	40.8 ± 14.2	<.001
Patient age (OAM)	94,199	53.4 ± 14.4	75,756	54.4 ± 13.4	<.001

[a]M, meniscal tear; OA, osteoarthritis; OAM, osteoarthritis and meniscus tear.
[b]P values are from Student t tests.

TABLE 4
Distribution of Category[a]

Factor	Before 2003 (n = 465,170)	After 2003 (n = 344,634)	P^b
M			**<.001**
No	143,577 (30.9)	100,633 (29.2)	
Yes	321,593 (69.1)	244,001 (70.8)	
OA			**<.001**
No	415,886 (89.4)	319,863 (92.8)	
Yes	49,284 (10.6)	24,771 (7.2)	
OAM			**<.001**
No	370,877 (79.7)	268,772 (78.0)	
Yes	94,293 (20.3)	75,862 (22.0)	

[a]Results are presented as n (%). M, meniscal tear; OA, osteoarthritis; OAM, osteoarthritis and meniscus tear.
[b]P value is from a chi-square test. Boldface indicates statistical significance.

arthroscopies for treatment of OA of the knee, which would result in a decrease in the overall number of arthroscopic procedures, a decrease in the mean age of patients undergoing arthroscopy, and a decrease in the percentage of patients with a diagnosis of OA. We identified a significant increase in arthroscopic procedures after the publication of the article, but there was a significant decrease in the frequency of knee arthroscopies performed for OA (equivalent to over 4000 cases per year in the states studied). While there were statistically significant changes in the ages of patients undergoing arthroscopy, these changes were very small and did not support our hypothesis that mean age would decline as fewer patients with OA underwent arthroscopic surgery.

Many observational studies suggest that partial meniscectomy consistently relieves symptoms and improves function in patients without concomitant knee disorders.[13,18,24,27] In the setting of OA, the outcomes of partial meniscectomy have not been as predictable.[2,8,13,16-18,23,25,27] This is an important subset of patients, as 80% of patients with OA have concomitant meniscal tears.[3] Buldu et al[4] found that patients with mechanical symptoms in the setting of OA to have statistically significant improvements in Oxford and Lysholm scores. Since the recommendations in Moseley's randomized controlled trial, we expected that overall frequency of knee

arthroscopy would decline because of a decrease in the number of OA arthroscopy cases; however, we actually noted an increase in the overall frequency of knee arthroscopy.

We examined percentage changes in the diagnostic categories (M, OA, and OAM) to which each arthroscopic surgical debridement was classified before and after 2003. In our study, we noted a decrease in cases classified as OA from 10.6% before 2003 to 7.2% after 2003. This 3.4% decline signaled a relative 30% decrease in the number of cases classified as OA after 2003 compared with before this date. Interestingly, we did appreciate a reciprocal rise of 1.7% in each of the M and OAM groups, indicating that perhaps many cases previously coded as OA were now being categorized as M and OAM after 2003.

A recently published study investigating the practice patterns of examinees sitting for the ABOS Part II examination from 1999 to 2009 noted knee arthroscopy for patients with OA decreased after the publication of Moseley's article.[22] However, due to the unique nature of this study population, they also cautiously recommended further study to evaluate whether this change occurred in the orthopaedic community as a whole versus only in surgeons operating during their board collection period. Potts et al[22] studied the ABOS case log database and noted a decrease in knee arthroscopy cases for patients with OA. However, this

study population includes bias based on newly trained surgeons who may be apprehensive and selective of their cases due to their upcoming oral board certification examination. The number and sample of cases that they submitted for consideration may not be reflective of those performed in the overall orthopaedic community, and thus, may not be generalizable to the specialty at large. In contrast with our study, they did not note a difference in patient age due to smaller sample size and appreciated a steady decline in the percentage of arthroscopic meniscectomies performed for OA.

Howard et al[12] studied the rates of arthroscopy with debridement and lavage as well as overall arthroscopy rates in the Florida portion of the SASD to determine the impact of the Moseley trial publication as well as Kirkley trial publication that randomized patients in Ontario, Canada, to arthroscopy versus nonsurgical treatment for OA. They found a 47% decrease in the number of debridement and lavage procedures per 100,000 adults, which is in agreement with our finding of fewer arthroscopies in the OA group. In addition, they showed an overall increase in the rate of knee arthroscopy over the study period, which is in agreement with our finding of overall increased arthroscopy rates. However, it is difficult to compare the 2 studies directly because their analysis did not attempt to identify whether patients had OA, meniscus tear, or both OA and meniscus tear.

Kim et al[14] studied the National Survery of Ambulatory Surgery with procedures coding for knee arthroscopy or anterior cruciate ligament reconstruction. The results noted a 49% increase in the number of arthroscopic knee surgeries performed between 1996 and 2006 in patients aged 45 to 64 years and >65 years undergoing arthroscopy and revealed that the knee arthroscopy rates in the United States are more than double that of England or Ontario, Canada. Although their patient population included all knee arthroscopies performed in the ambulatory surgical setting, more than 50% of their patients were classified as having surgery for either a meniscus tear or OA.[14] This finding is also in agreement with our finding that suggests patients who were classified as OA prior to publication of the Moseley trial were being classified as OAM or M after publication of the trial.

We noted a statistically significant increase in patient age in the M and OAM groups. Accordingly, we also observed a reciprocal decrease in the age of patients classified as OA after 2003. With the integration of Moseley's data and less knee arthroscopy performed for OA, one would expect the mean patient age to decline as the older population of OA patients would increasingly be treated nonoperatively. However, it appears the M and OAM groups became older while the OA group became younger. One possible explanation for this finding is that after 2003, the M and OAM groups collected older patients who had previously been classified as OA. Instead of being grouped as OA, these same individuals were categorized to either M or OAM, thus increasing the mean patient age in these groups. Together, these findings support the idea that with the publication of a randomized controlled trial along with reimbursement changes, orthopaedic surgeons have continued to perform arthroscopic knee procedures with narrowed surgical indications. Since the publication of the Moseley research, Medicare, Medicaid, and most insurance companies do not reimburse for fees associated with knee arthroscopy with a primary diagnosis of OA.

Adelani et al[1] evaluated the rates of arthroscopy for knee OA and found there was no decrease in the rates of arthroscopy after the Moseley publication within the Veterans Health Administration (VHA) system population. The results from Adelani et al[1] differ from prior published literature on the rates of arthroscopy in the setting of OA; however, the overall number of arthroscopies in the VHA setting are significantly below the national average.[1] Based on the data, the mean age of patients undergoing knee arthroscopy in the setting for OA was significantly lower in the 2 time periods studied (1998-2002 [67.1 years] and 2006-2010 [67.0 years]) from other published studies by Holmes et al,[10] Howard et al,[12] and Potts et al.[22] In assessing patient demographics, the largest increase of patients undergoing knee arthroscopy from 2006 to 2010 occurred in the patients 55 to 65 years of age. The other 2 age groups (50-55 and ≥65 years) noted a 14% and 7% decrease, respectively, in knee arthroscopies for OA. Considering VHA surgeons may not be routinely submitting claims to insurance companies, the coding data may be different in comparison with coding data from surgeons who are submitting codes to private insurers.[11] In addition, Nugent and Hendricks[21] described the challenges of comparing the private sector of health care to VHA care, citing the benefits and scopes of services differ; therefore, a cautious approach must be used when applied to a broader patient population.

Previous authors have discussed the importance of disseminating research findings in an effort to influence treatment decisions, particularly in cases where changes can be beneficial to the patient population.[20] However, there can be many challenges to causing a shift in practice patterns, often due to clinicians' reluctance to accept new ideas.[15] Another possible explanation is that clinicians have concerns about external validity and are concerned that trial participants arenot representatative of the general population, as described by Rothwell[26] and Vijan et al.[28] Other authors have described the challenges associated with the application of valid recommendations from systematic reviews being related to factors such as patient selection, clinical setting, feasibility, and cost.[6,7] One example of the failure to appropriately translate clinical research findings into a change in practice patterns is demonstrated in a study by Califf et al,[5] which showed no clinical benefit, higher rates of early complications, and higher costs in patients with coronary artery disease treated with directional coronary atherectomy. In spite of this overwhelming evidence against the use of directional coronary atherectomy, there was actually an increase in its use after publication of the trial results.[5] Our findings support the reported literature of others who have studied practice patterns related to publication of the Moseley trial and show that the orthopaedic community has done an effective job of disseminating results and influencing the decisions of practicing surgeons.

The limited number of states is a limitation of the datasets, and not all states reported data during the years studied. However, data are reported for patients regardless of insurance status, so cases represented in our sample include both private and government insurance. Therefore, the study limitations involve accessibility to only 9 states. We believe that these states represent a diverse geographical set that allow for generalizability of practice throughout the United States. Likewise, the database also does not contain surgeon-specific factors or trends among individual surgeons contributing to the data set. Because of the anonymous and confidential nature of the national database, this information was not available for further study or analysis. Future directions for study could include analysis of databases that include surgeon-level data and study of the impact of other important clinical studies on practice patterns.

CONCLUSION

Our findings demonstrate that while overall knee arthroscopy rates increased in the years after the publication of the Moseley trial and the mean age of patients slightly increased, the number of cases performed for an indication of isolated OA decreased, as did the overall number of cases per year performed for OA. The number of cases performed for meniscus tear or meniscus tear and OA increased, while the number of arthroscopies performed for an indication of isolated OA decreased. Although the percentage of Medicare patients varied within the subset of patients in the data set, the changes within the frequencies were similar in each state. The inference of the private insurance carriers not reimbursing for surgical procedures can be made; however, it is important to assess the growth in population during the 8-year span within the states in the ages studied.

These findings support the notion that practicing orthopaedic surgeons do modify their approach to treatment in response to well-publicized, high-quality clinical outcomes research. It is of critical importance that orthopaedic surgeons continue to perform clinical research to convey important treatment decisions and disseminate their results to ensure evidence-based medicine.

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