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CLINICAL RESEARCH

High Incidence of Hemiarthroplasty for Shoulder Osteoarthritis Among Recently Graduated Orthopaedic Surgeons

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Abstract

Background Primary glenohumeral osteoarthritis is a common indication for shoulder arthroplasty. Historically, both total shoulder arthroplasty (TSA) and hemi-shoulder arthroplasty (HSA) have been used to treat primary glenohumeral osteoarthritis. The choice between procedures is a topic of debate, with HSA proponents arguing that it is less invasive, faster, less expensive, and technically less demanding, with quality of life outcomes equivalent to those of TSA. More recent evidence suggests TSA is superior in terms of pain relief, function, ROM, strength, and patient satisfaction. We therefore investigated the practice of recently graduated orthopaedic surgeons pertaining to the surgical treatment of this disease.

Questions/purposes We hypothesized that (1) recently graduated, board eligible, orthopaedic surgeons with fellowship training in shoulder surgery are more likely to perform TSA than surgeons without this training; (2) younger patients are more likely to receive HSA than TSA; (3) patient sex affects the choice of surgery; (4) US geographic region affects practice patterns; and (5) complication rates for HSA and TSA are not different.

Methods We queried the American Board of Orthopaedic Surgery's database to identify practice patterns of orthopaedic surgeons taking their board examination. We identified 771 patients with primary glenohumeral osteoarthritis treated with TSA or HSA from 2006 to 2011. The rates of TSA and HSA were compared based on the treating surgeon's fellowship training, patient age and sex, US geographic region, and reported surgical complications.

Results Surgeons with fellowship training in shoulder surgery were more likely (86% versus 72%; OR 2.32; 95% CI, 1.56–3.45, $p < 0.001$) than surgeons without this training to perform TSA rather than HSA. The mean age for patients receiving HSA was not different from that for patients receiving TSA (66 versus 68, years, $p = 0.057$). Men were more likely to receive HSA than TSA when compared to women (RR 1.54; 95% CI, 1.19–2.00, $p = 0.0012$). The proportions of TSA and HSA were similar regardless of US geographic region (Midwest HSA 21%, TSA 79%; Northeast HSA 25%, TSA 75%; Northwest HSA 16%, TSA 84%; South HSA 27%, TSA 73%; Southeast HSA 24%, TSA 76%; Southwest HSA 23%, TSA 77%; overall $p = 0.708$). The overall complication

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Each author certifies that his or her institution approved the human protocol for this investigation that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.
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rates were not different with the numbers available: 8.4% (15/179) for HSA and 8.1% (48/592) for TSA ($p = 0.7555$).

Conclusions The findings of this study are at odds with the recommendations in the current clinical practice guidelines for the treatment of glenohumeral osteoarthritis published by the American Academy of Orthopaedic Surgeons. These guidelines favor using TSA over HSA in the treatment of shoulder arthritis. Further investigation is needed to clarify if these practice patterns are isolated to recently graduated board eligible orthopaedic surgeons or if the use of HSA continues with orthopaedic surgeons applying for recertification.

Level of Evidence Level III, therapeutic study. See Instructions for Authors for a complete description of levels of evidence.

Introduction

Glenohumeral osteoarthritis is a common etiology of shoulder pain and a common indication for shoulder arthroplasty [2, 12, 25]. Patients suffering from glenohumeral osteoarthritis experience significant discomfort, loss of function, and a decreased quality of life. In terms of its effect on patient health status, as measured by the SF-36, glenohumeral osteoarthritis is comparable to diseases such as congestive heart failure, acute myocardial infarction, and diabetes mellitus [7]. Treatment options are influenced by patient age, severity of symptoms, medical comorbidities, radiographic findings, and patient characteristics. For those patients with advanced glenohumeral osteoarthritis who have failed to gain adequate pain relief and function with nonoperative measures, shoulder arthroplasty provides excellent pain relief, improved function, and a high rate of patient satisfaction [18].

Historically, both total shoulder arthroplasty (TSA) and hemi-shoulder arthroplasty (HSA) have been used to treat primary glenohumeral osteoarthritis [17]. The choice between HSA and TSA has been a topic of debate, with proponents of HSA arguing that it is a less invasive, faster, cheaper, and technically less demanding procedure, with quality of life outcomes equivalent to those of TSA. Though there is evidence to support these claims [4, 8, 16], more recent randomized controlled trials, multicenter studies, and meta-analyses have concluded that TSA is superior to HSA for treatment of primary glenohumeral osteoarthritis in terms of pain relief, function, ROM, strength, and patient satisfaction [4, 5, 8, 20, 21, 27]. Furthermore, based on studies from 2003 and 2005, the American Academy of Orthopaedic Surgeons (AAOS), in its clinical practice guidelines from 2009 [13], recommend using TSA over HSA because it achieves superior pain relief, better global health assessment scores, and lower revision rates. There may be variation in the results of these studies based on factors such as the available glenoid bonestock and the integrity of the rotator cuff which are known to affect the outcomes following shoulder arthroplasty.

The purpose of this study was to investigate the practice patterns of recently trained orthopaedic surgeons using the database maintained by the American Board of Orthopaedic Surgery (ABOS). We hypothesized that (1) recently graduated, board eligible, orthopaedic surgeons with fellowship training in shoulder surgery (shoulder surgeons), hand surgery (hand surgeons), or sport medicine (sport surgeons) are more likely to perform TSA for primary glenohumeral osteoarthritis than those orthopaedic board eligible surgeons who have not had this fellowship training (other surgeons); (2) younger patients are more likely to receive HSA than TSA for glenohumeral osteoarthritis; (3) patient sex affects the choice of whether HSA or TSA is performed; (4) US geographic region has an effect on practice patterns; and (5) complication rates for HSA and TSA are similar.

Patients and Methods

In the United States, board certification in orthopaedic surgery is regulated by the ABOS. To be eligible to sit for the board examination, a surgeon must have graduated from an accredited orthopaedic surgery residency program [6]. The examination consists of two parts. Successful completion of the computerized multiple-choice examination, which is Part I, is a prerequisite to sit for Part II. Part II is a practice-based oral examination, which most surgeons take during their first 2 years of practice. Surgical cases performed during a predetermined 6-month period are submitted for review. The data submitted for each case are self-reported and include ICD-9-CM codes, Current Procedural Terminology (CPT®) codes, patient age and sex, geographic region of the surgeon's practice, surgical complications, fellowship training of the surgeon, and a brief verbal description of the procedure and its indications. These cases are entered into a secure database maintained on behalf of the ABOS by Data Harbor Solutions (Hinsdale, IL, USA) [6]. Before submitting their cases to the ABOS, surgeons are informed that the data they submit may be used for research purposes.

Study Cohort

We queried this database for patients with primary glenohumeral osteoarthritis, using ICD-9-CM Codes 715.11, 715.21, 715.31, and 715.91, treated with either TSA (CPT® Code 23472) or HSA (CPT® Code 23470), between the years 2006 and 2011. During this period, we identified 1837 patients treated with TSA or HSA for glenohumeral osteoarthritis. After excluding ICD-9-CM Codes 715.21 (secondary osteoarthritis of the shoulder), 715.31 (primary or secondary osteoarthritis of the shoulder), and 715.91 (generalized or localized osteoarthritis of the shoulder), leaving only patients identified with ICD-9-CM Code 715.11 (primary osteoarthritis of the shoulder), 1233 patients remained. The records of these patients were then manually examined. Using the verbal case descriptions, reverse TSAs and HSAs performed for cuff tear arthropathy were excluded. This step was necessary because reverse TSA uses the same CPT® code as conventional TSA, and cuff tear arthropathy uses the same ICD-9-CM code as glenohumeral osteoarthritis. We excluded 462 patients receiving reverse TSA, HSA performed for cuff tear arthropathy, or shoulder arthroplasty performed for reasons other than primary glenohumeral osteoarthritis, leaving 771 patients for inclusion in the study. There were 397 (51%) women and the mean age was 67 years in this study population. Of the 771 surgeries, 592 (77%) were TSAs and 179 (23%) were HSAs. The surgeries were grouped by CPT® code and each group was analyzed based on the variables of patient age and sex, geographic region of the surgeon's practice, fellowship training of the surgeon, and self-reported surgical complications.

Information on the general medical condition of the specific patient and imaging studies are not included in the database and we were therefore unable to account for these factors in our analysis.

Data Analysis

All computations and statistical analyses were performed by Data Harbor Solutions. The proportion of TSA and HSA performed for glenohumeral osteoarthritis was determined. For the purposes of this analysis, the data were divided into groups based on the treating, board eligible, orthopaedic surgeon's fellowship subspecialty training: Shoulder surgeons, hand surgeons, sport surgeons, or other surgeons. Comparisons between surgeon groups were performed using the two-tailed Fisher exact test. The two-tailed Student's t-test was used to compare the proportions of HSA and TSA based on patient age. The two-tailed Fisher exact test was again used to compare the proportions of HSA and TSA based on patient sex. To enable comparison based on geographic region, the United States was separated into six regions as described by Anglen and Weinstein [1]: Midwest, Northeast, Northwest, South, Southeast, and Southwest. Comparisons based on US geographic region were performed using the two-tailed chi-square test. We compared complication rates between TSA and HSA using the two-tailed Fisher's exact test. Alpha was set to 0.05 for all statistical tests.

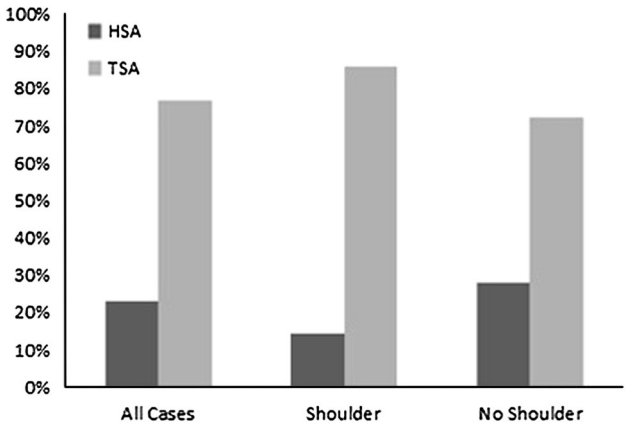

Fig. 1 This graph compares the relative rates of HSA and TSA among all surgeons, shoulder fellowship-trained surgeons, and all other fellowship-trained surgeons.

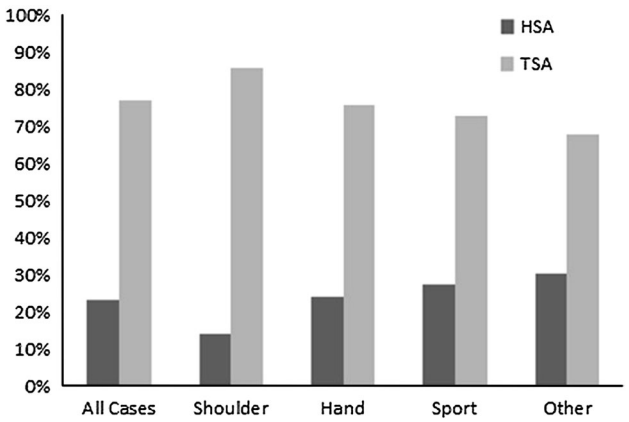

Fig. 2 This graph compares the relative rates of HSA and TSA among surgeons according to varying subspecialty training.

Results

Surgeons with fellowship training in shoulder surgery were more likely than surgeons without this training to perform TSA rather than HSA (86% versus 72%; OR 2.32; 95% CI, 1.56–3.45, $p < 0.001$) (Fig. 1). However, hand surgeons or sport surgeons were not more likely to perform TSA when compared with surgeons with other, or no, fellowship

Table 1. Surgery according to patient sex

Sex	Number of surgeries	
	HSA (n = 179)	TSA (n = 592)
Male	106 (59%)	268 (45%)
Female	73 (41%)	324 (55%)

HSA = hemi-shoulder arthroplasty; TSA = total shoulder arthroplasty.

Table 2. Surgery based on US geographic region

US geographic region	Number of surgeries	
	HSA (n = 179)	TSA (n = 592)
Midwest	44 (25%)	162 (27%)
Northeast	30 (17%)	89 (15%)
Northwest	8 (4%)	42 (7%)
South	31 (17%)	85 (14%)
Southeast	33 (18%)	106 (18%)
Southwest	33 (18%)	108 (18%)

HSA = hemi-shoulder arthroplasty; TSA = total shoulder arthroplasty.

Table 3. Self-reported surgical complications

Surgical complications	HAS		TSA	
	Number	Percent	Number	Percent
Fracture	5	2.8%	10	1.7%
Dislocation	0	0.0%	2	0.3%
Hemorrhage	0	0.0%	2	0.3%
Implant failure	0	0.0%	1	0.2%
Implant fracture	0	0.0%	1	0.2%
Infection	1	0.6%	5	0.8%
Nerve palsy/injury	0	0.0%	12	2.0%
Nonunion/delayed union	0	0.0%	0	0.0%
Skin ulcer/blister	1	0.6%	3	0.5%
Surgical unspecified	5	2.8%	10	1.7%
Tendon ligament injury	2	1.1%	2	0.3%
Wound dehiscence	1	0.6%	1	0.2%
Total complications	15	8.4%	49	8.3%
Total cases with complications	15	8.4%	48	8.1%

HSA = hemi-shoulder arthroplasty; TSA = total shoulder arthroplasty.

training (hand surgeons versus other surgeons: 76% versus 68%, OR 1.47; 95% CI, 0.81–2.66, p = 0.126; sports surgeons versus other surgeons: 73% versus 68%, OR 1.26; 95% CI, 0.80–1.99, p = 0.153) (Fig. 2).

Younger patients were not more likely to receive HSA than TSA. The mean age for patients receiving a HSA was not different from the mean age for those receiving a TSA (66 years versus 68 years; p = 0.057). Men were more likely to receive HSA rather than TSA when compared to women (RR 1.54; 95% CI, 1.19–2.00, p = 0.0012) (Table 1).

The proportions of TSA and HSA performed were not different regardless of US geographic region (Midwest HSA 21%, TSA 79%; Northeast HSA 25%, TSA 75%; Northwest HSA 16%, TSA 84%; South HSA 27%, TSA 73%; Southeast HSA 24%, TSA 76%; Southwest HSA 23%, TSA 77%; overall (p = 0.708) (Table 2).

The overall complication rate was not different: 8.4% (15/179) for HSA and 8.1% (48/592) for TSA (p = 0.76) (Table 3).

Discussion

Shoulder arthroplasty is a good option for patients suffering from advanced primary glenohumeral osteoarthritis [18]. In this patient population, the choice between HSA and TSA has been a topic of debate. HSA is less invasive, faster, and cheaper. It is also less technically demanding and some studies have shown quality of life outcomes equivalent to that of TSA [8, 23]. However, more recent randomized controlled trials, multicenter studies, and meta-analyses have concluded that TSA achieves superior pain relief, function, ROM, strength, and patient satisfaction [4, 5, 20, 21, 27]. There may be variation in the results of these studies based on factors such as the available glenoid bonestock and the integrity of the rotator cuff, which are known to affect the outcomes following shoulder arthroplasty, as well as based on the training of the treating surgeon. We therefore investigated the practice patterns of recently trained, board eligible, orthopaedic surgeons in their treatment of primary glenohumeral osteoarthritis. We hypothesized that (1) surgeons with fellowship training in shoulder surgery are more likely to perform TSA than surgeons without this fellowship training; (2) younger patients are more likely to receive HSA than TSA; (3) patient sex affects the choice of HSA or TSA; (4) US geographic region affects practice patterns; and (5) complication rates for HSA and TSA are not different (Table 3).

This study has limitations. The complications compared in this study are self-reported surgical complications, medical complications were not included in this analysis. There is inherent bias in any self-reported data, however, systematic under reporting of complications favoring either procedure is unlikely. This study is also susceptible to selection bias. Patients with more severe shoulder arthritis may have self-selected surgeons with subspecialty training in shoulder surgery. This study design does not enable us to

ensure that glenohumeral arthritis seen by the shoulder specialists and the non-specialists were of equivalent severity. It is possible that some of the HSAs may have been performed in patients who did not have sufficient glenoid bone stock to enable TSA. Also, in some cases, the choice of HSA over TSA may have been driven by the shorter operating time and decreased blood loss associated with HSA [8]. We were not able to account for these factors in our analysis. As with all database-driven studies, the strengths and weaknesses of this study reflect the quality of the database and its verifiers. It contains detailed and specific information about a large number of surgeries performed by a cohort of orthopaedic surgeons. The case lists contain all the surgical procedures performed by those surgeons during a defined 6-month period each year and they are certified by medical record custodians at each hospital as being complete. Although the data are self-reported, we believe that the candidates for board certification take great care to be complete and accurate in the data they enter. They know that some cases will be selected and examined in detail as part of a high-stakes examination process and because there are adverse consequences (potential failure) associated with discovery of incorrect or incomplete information. The surgeons in this study are in the early stages of their career, as most have been in practice for less than 2 years. These results may not be entirely reflective of all practicing orthopaedic surgeons. Future studies will need to compare data from surgeons recertifying at 10-year intervals to investigate the practice patterns of surgeons further on in their surgical career.

Despite evidence and clinical practice guidelines in favor of TSA, a large proportion of HSAs are performed for primary glenohumeral osteoarthritis by candidates sitting for Part II of the ABOS certification process. We suppose that the choice of recently trained orthopaedic surgeons is influenced by their residency training and by the extent of their subspecialty training. In our study, shoulder surgeons were significantly more likely to perform a TSA for primary glenohumeral osteoarthritis, than were surgeons who have not completed fellowship training in shoulder surgery. Other subspecialists such as hand surgeons or sport surgeons who may have significant elective shoulder practice were also examined. However, these surgeons were not more likely to perform a TSA for primary glenohumeral osteoarthritis than were other surgeons. Until recently, there were no guidelines addressing the surgical treatment of glenohumeral osteoarthritis and the choice of HSA or TSA was largely a matter of surgeon preference [18]. However, now the AAOS has published clinical practice guidelines favoring the use of TSA over HSA [13]. Compared to hip and knee arthroplasty, shoulder arthroplasties are more often performed by low-volume surgeons [11]. It is well known that certain outcomes following shoulder arthroplasty, such as hospital stay, deep infections and other complications, are correlated with surgeon experience and the volume of these surgeries performed at the hospital where the patient is treated [10, 15]. In addition, provider volume has been shown to influence the type of surgery selected for treatment of glenohumeral osteoarthritis with higher-volume providers performing TSA more often than low-volume providers [14]. The increased technical difficulty of TSA over HSA may influence the surgeon's decision in favor of HSA, an observation that is consistent with the aforementioned evidence that low-volume providers are more likely to choose HSA over TSA [14, 22].

We hypothesized that younger patients would be more likely to receive a HSA, however, this hypothesis is not supported by our data. This finding was surprising because the degenerative nature of primary glenohumeral arthritis suggests that older patients would be more likely to have significant glenoid wear, necessitating glenoid resurfacing. Walch et al. [24] showed that increasing age was associated with increased glenoid retroversion in patients with primary glenohumeral arthritis. Similar results have also been found in studies of non-human primates [19]. However, it is possible that in patients where the arthritis has progressed to the point of needing a shoulder arthroplasty, age no longer predicts the amount of glenoid wear, and by extension the need for glenoid resurfacing. We also thought that the fear of glenoid component loosening would make surgeons more hesitant to use TSA in younger, more active patients. It is possible that the superior clinical outcomes of TSA and belief in improved cementing techniques served to mitigate concerns of early failure of the glenoid component.

The study confirmed our hypothesis that sex would have an effect on practice patterns. Almost 60% of the patients receiving HSA were men in this study, where men accounted for less than ½ of the overall patient population. Several possible explanations may exist explaining this finding. Surgical exposure for TSA is probably more difficult in males than in females because of increased muscle bulk, potentially influencing surgeons to choose HSA. Another possible explanation is available bone stock. It is possible that males present with greater degree of glenoid wear compared to females. Increased glenoid wear and limited glenoid bone stock may influence surgeon's choice for HSA versus TSA.

The study refuted our hypothesis that we would detect a geographic regional difference in the practice pattern of surgeons throughout the United States. No difference was found, although there was a trend toward performing more HSAs in the three southern regions. This was unexpected given the numerous reports out of the Dartmouth Atlas project which highlights significant regional differences in health care delivery and associated costs [3, 9, 26]. Such

regional differences in care leave room for improvement both in quality and cost of care. Therefore, we felt that it was important to investigate this in our study, especially in the current health care environment where an increasing emphasis is being placed on cost containment.

Similar to previous studies, we did not see a difference in the rates of surgical complications between TSA and HSA [8, 16]. Despite being a more invasive procedure with longer operating time, TSA does not appear to be associated with more complications. Long-term complication rates are not accounted for in this study as they are not captured as part of the data collection for part II of the board exam. Other authors have shown higher revision rates for HSA compared with TSA [8, 16]. This further stresses the point highlighted in the AAOS clinical practice guidelines, that TSA should be favored over HSA in the treatment of primary glenohumeral osteoarthritis.

In summary, we found that despite current AAOS clinical practice guidelines favoring TSA, HSA is a procedure commonly performed for primary glenohumeral osteoarthritis among recent orthopaedic graduates. The proportion was lower in shoulder fellowship-trained surgeons, who were more likely to perform TSA for this indication. The procedure of choice for recently graduated, board eligible, orthopaedic surgeons is likely influenced by their experience in residency and fellowship training. Future studies should investigate whether this discrepancy between guidelines and clinical practice remains when board certified orthopaedic surgeons recertify. It may also be beneficial to clarify if the presence of fellowship trained shoulder surgeons at a residency program affects the practice patterns of its graduates. Continuing medical education and an increased focus on clinical practice guidelines may affect a change in practice patterns towards those treatments with stronger support in the available literature.

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