

RESEARCH ARTICLE

Comparing Relative Value Units among Shoulder Arthroplasty, Hemiarthroplasty, and ORIF for Proximal Humerus Fractures in the Elderly: Which is Most Worth Your Time?

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Abstract

Background: Relative value units (RVUs) are assigned to Current Procedural Technology (CPT) codes and give relative economic values to the services physicians provide. This study compared the RVU reimbursements for the surgical options of proximal humerus fractures in the elderly, which include arthroplasty (reverse [RSA] and total [TSA]), hemiarthroplasty (HA), and open reduction and internal fixation (ORIF).

Methods: Using the National Surgical Quality Improvement Program, a total of 1,437 patients of at least 65 years of age with proximal humerus fractures between 2008 and 2016 were identified. Of those, 259 underwent RSA/TSA (CPT code 23472), 418 underwent HA (CPT codes 23470 and 23616), and 760 underwent ORIF (CPT code 23615). Univariate analysis compared RVU per minute, reimbursement rate, and the average annual revenue across cohorts based on respective operative times.

Results: RSA/TSA generated a mean RVU per minute of 0.197 (SD 0.078; 95%CI [0.188, 0.207]), which was significantly greater than the mean RVU per minute for 23470 HA (0.156; SD 0.057; 95%CI [0.148, 0.163]), 23616 HA (0.166; SD 0.065; 95%CI [0.005, 0.156]), and ORIF (0.135; SD 0.048; 95%CI [0.132, 0.138]; $P < 0.001$). This converted to respective reimbursement rates of \$6.97/min (SD 2.78; 95%CI [6.63, 7.31]), \$5.48/min (SD 2.05; 95%CI [5.22, 5.74]), \$5.83/min (SD 2.28; 95%CI [5.49, 6.16]) and \$4.74/min (SD 1.69; 95%CI [4.62, 4.87]). After extrapolation, respective average annual revenues were \$580,386, \$456,633, \$475,077, and \$395,608.

Conclusion: RSA/TSA provides significantly greater reimbursement rates compared to HA and ORIF. Orthopaedic surgeons can use this information to optimize daily procedural cost-effectiveness in their practices.

Level of evidence: III

Keywords: Geriatric population, Humeral fracture, Relative value analysis, Surgical management

Introduction

Proximal humerus fractures are a common injury pattern sustained by the elderly as they are the third most common osteoporotic fracture, after

the distal radius and vertebrae (1). In addition, they make up about 6% of all fractures in the Western world (2). While different surgical management options for

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proximal humerus fractures exist, such as arthroplasty (reverse [RSA] and total [TSA]), hemiarthroplasty (HA), and open reduction and internal fixation (ORIF), there is no consensus on the best treatment option (3, 4). Additionally, the comparative economic value of these procedures, in terms of relative value units per time, has not been studied (5). Given the persistent surge in the population over 65 years of age, management of proximal humerus fractures are of continued importance (6).

The Centers for Medicare & Medicaid Services use the resource-based relative value scale (RBRVS). The RBRVS utilizes Relative value units (RVUs) to give relative economic value to different Current Procedural Terminology (CPT) codes (7). Each CPT code has a preset number of RVUs that are calculated based on physician work (wRVU), practice expense (peRVU), and malpractice (mRVU). The physician work component, which makes up the largest portion of the total RVUs, is based on relative level of time, skill, intensity, effort, and training to provide a specific service. The practice expense component is based on practice costs such as rent, equipment, supplies, and non-physician staff costs. The malpractice component, which normally makes up the smallest portion of the total RVUs, is based on professional liability expenses. Each of these components are also multiplied by a geographic practice cost index (GPCI), which serves to adjust component values based on differing costs across geographic areas. Ultimately, a conversion factor is used to convert RVUs to dollar amounts to determine compensation (8). While the RVU attempts to incorporate all relevant reimbursement factors, the literature has shown that there are still discrepancies in relative time and effort spent versus the amount of RVUs allocated in various other surgical procedures (9-13). Knowledge of potential discrepancies can lead to a better understanding of the economic worth of a physician's time. In turn, orthopaedists can optimize procedural cost-effectiveness in their practice when multiple treatment options exist for a specific condition.

These discrepancies have not been evaluated in the setting of proximal humerus fractures, thus an exploration into the assigned RVUs between different surgical options for proximal humerus fractures is warranted. The purpose of this study is to compare relative value parameters in RSA/TSA, HA, and ORIF for proximal humerus fractures in the elderly to determine which surgical choice has higher proportional reimbursements. Specifically, we focused on the mean operative time, average RVU per minute, reimbursement rate, revenue per day, and average annual revenue differences between the three different surgical options.

Materials and Methods

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database was employed to identify all patients older than 65 years who underwent RSA/TSA, HA, and ORIF for proximal humerus fractures between 2008 and 2016 (14). Institutional Review Board approval was obtained. RSA/TSA, HA, and ORIF procedures were identified based on their CPT codes, which were 23472, 23470

and 23616, and 23615 respectively (15). Arthroplasty using hemiarthroplasty (23470) and proximal humerus fracture hemiarthroplasty (23616) were both included in this analysis as both CPT codes were billed for proximal humerus fracture cases. Proximal humerus fractures were identified via International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) codes and the following codes were included: 812.00, 812.01, 812.09, 812.02, 812.03 (16). Operative times for each patient were extracted from NSQIP. Raw wRVU values and conversion factors were obtained from the CMS and American Medical Association website (15, 17). Since wRVU and conversion factors differ based on year, the respective wRVU and conversion factors were used based on the patient's operation year. To convert RVUs to dollars, wRVUs were multiplied by their respective conversion factors. wRVUs were used instead of total RVUs to maintain focus on the physician work portion of the total RVU formula in addition to preventing the effects of practice expense and malpractice on the analysis. An assumed 10-hour workday was used for daily revenue analysis. An assumed 160-day yearly operating schedule was used to account for weekends, holidays, vacation time, and clinic days as per past orthopaedic RVU analyses in the literature (12, 13, 18). Univariate analysis using SPSS Statistics version 25 (IBM Corporation, Armonk, NY) compared operative time as well as relative value parameters, such as RVU per minute, reimbursement rate, revenue per case, revenue per day, and the average annualized cost difference across cohorts.

Results

A total of 1,437 patients of at least 65 years of age were identified, 259 of whom underwent RSA/TSA, 418 of whom underwent HA, and 760 of whom underwent ORIF for proximal humerus fractures. The mean operative time for the RSA/TSA procedure was 130 minutes (SD 50.1; 95% CI [123.9, 136.2]). The mean operative times for the 23470 and 23616 HA procedure were 130 minutes (SD 47.8; 95%CI [124.1, 136.3]) and 127 minutes (SD 48.9%; 95%CI [120.2, 134.6]) respectively. The mean operative time for the ORIF procedure was 104 minutes (SD 41.8; 95%CI [101.2, 107.2]) [Table 1]. Mean operative times between RSA/TSA and 23470 and 23616 HA did not differ significantly, however, all were significantly longer than ORIF ($P < 0.001$). The number of each type of surgery per year is shown in [Figure 1], and the mean operative time per surgery per year is reported in [Figure 2].

RSA/TSA generated a mean RVU per minute of 0.197 (SD 0.078; 95%CI [0.188, 0.207]), which was significantly greater than the mean RVU per minute for 23470 HA (0.156; SD 0.057; 95%CI [0.148, 0.163]), 23616 HA (0.166; SD 0.065; 95%CI [0.005, 0.156]), and ORIF (0.135; SD 0.048; 95%CI [0.132, 0.138]; $P < 0.001$) [Table 1]. There was no significant difference between the RVU per minute for 23470 HA and 23616 HA ($P = 0.088$). Using respective conversion factors, reimbursement rates for RSA/TSA, 23470 HA, 23616 HA, and ORIF were found to be \$6.97/min (SD 2.78; 95%CI [6.63, 7.31]), \$5.48/min (SD 2.05; 95%CI [5.22, 5.74]), \$5.83/min (SD 2.28; 95%CI [5.49, 6.16]) and \$4.74/min (SD 1.69; 95%CI [4.62,

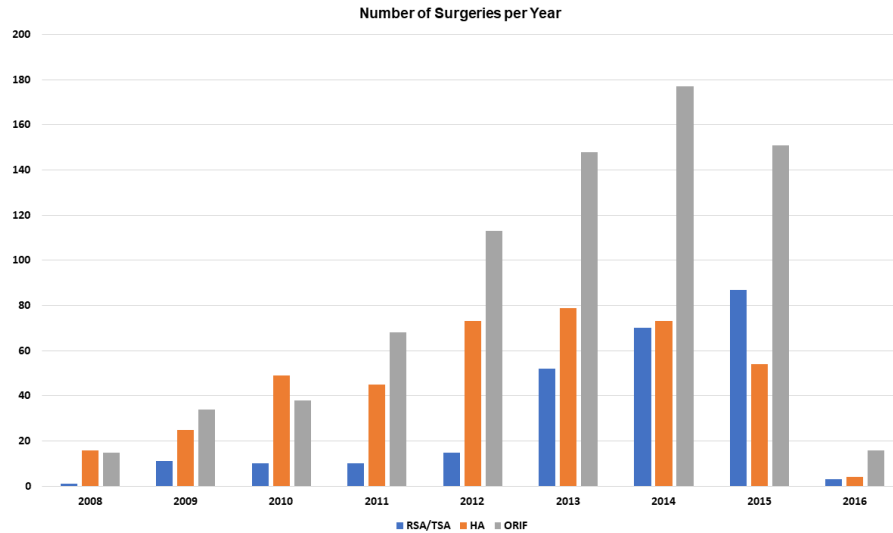


Figure 1. Number of each type of surgery per year.

4.87]) respectively. The mean RSA/TSA reimbursement rate was significantly greater than both HA and ORIF ($P<0.001$). There was no significant difference between 23470 HA and 23616 HA reimbursement rates ($P=0.101$). Using the respective operative times, mean revenue per case for RSA/TSA, 23470 HA, 23616 HA, and ORIF were \$907 (SD 361.194; 95%CI [862.657, 951.049]), \$713 (SD 267.008; 95%CI [679.392, 747.585]), \$742 (SD 290.068; 95%CI [699.644, 784.971]), \$495 (SD 176.574; 95%CI [481.937, 507.084]), respectively [Table 1]. The mean revenue per case for RSA/TSA was significantly greater than for both HA and ORIF ($P<0.001$). There was no significant difference between 23470 HA and 23616 HA mean revenues per case ($P=0.293$).

Using mean operative time and assuming a 10-hour workday, a physician can perform 4 RSA/TSA or HA procedures or 5 ORIF procedures per day. Based on this, revenue per day for RSA/TSA, 234470 HA, 23616 HA, and ORIF would be \$3,627, \$2,854, \$2,969, and \$2,473 respectively [Table 1]. RSA/TSA generates a greater revenue per day in comparison to both HA and ORIF ($P<0.001$). There was no significant difference between 23470 HA and 23616 HA revenues per day ($P=0.293$). Using revenue per day across 160 operating days, the average annual revenues generated for RSA/TSA, 234470 HA, 23616 HA, and ORIF were \$580,386, \$456,633, \$475,077, and \$395,608 respectively [Table 1]. When combining 23470 HA and 23616 HA, the average annual

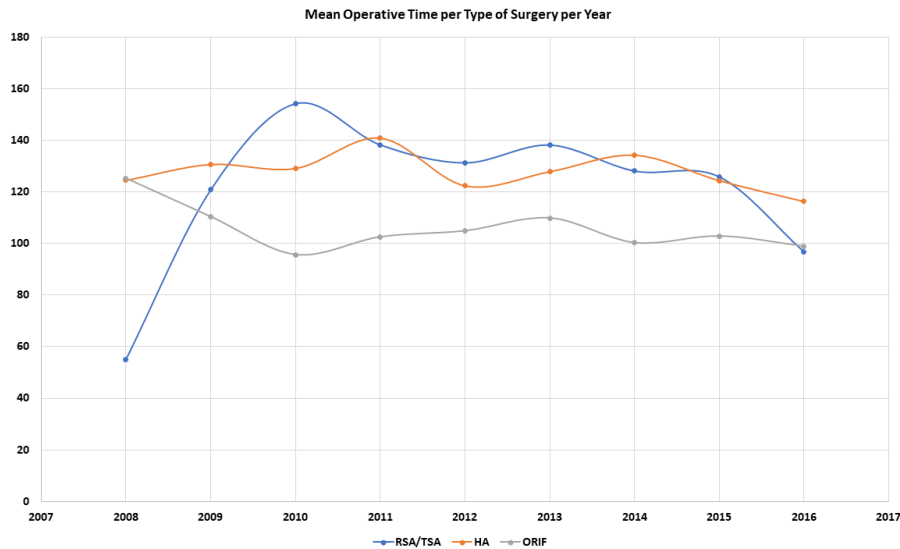


Figure 2. Mean operative time per type of surgery per year.

Table 1. Relative value analysis of reverse or total shoulder arthroplasty (RSA/TSA), hemiarthroplasty (HA 23470 and HA 23616), and open reduction and internal fixation (ORIF) for proximal humerus fractures in the elderly (> 65 years old).

	RSA/TSA	HA (23470, 23616)	ORIF	P-value
n	259	418 (238, 180)	760	
Operative Time	130	130, 127	104	<0.001
RVU 2008-2009	22.47	17.15, 18.19	12.12	
RVU 2010-2013	22.65	17.89, 18.37	12.30	
RVU 2014 and after	22.13	17.89, 18.37	12.30	
RVU/min	0.197	0.156, 0.166	0.135	<0.001
Reimbursement rate	6.97	5.48, 5.83	4.74	<0.001
Revenue per case (USD)	907	713, 742	495	<0.001
Cases per day	4	4	5	
Revenue per day (USD)	3627	2854, 2969	2473	<0.001
Average Annualized Difference (USD)	580,386	464,718	395,608	

revenue was \$464,718. This revealed an average annual difference (AAD) of \$115,667 between RSA/TSA and HA and an AAD of \$184,777 between RSA/TSA and ORIF, both in favor of RSA/TSA in elderly patients. Between 23470 HA and 23616 HA, the AAD was \$18,444 in favor of 23616 HA.

Discussion

RVUs are a basis of reimbursement for physicians. The physician work portion of RVUs includes factors such as time, skill, intensity, effort, and training (7). While reflective of the physician work portion, RVU compensation exhibited some discrepancies between procedures, even of similar lengths (10,11). In the case of proximal humerus fractures in the elderly, there are no current studies comparing the RVU reimbursement in a per time basis for the different surgical options. In this study, we found that RSA/TSA had the greatest RVU/min and reimbursement rate in comparison to 23470 HA, 23616 HA, and ORIF in elderly patients. This was the case even with mean operative times between RSA/TSA and HA not differing significantly. These results show that more value is put on RSA/TSA in comparison to HA and ORIF in terms of RVU compensation.

In the case of a physician's practice, operative time serves importance since it dictates the volume of operations that can be performed in a day. Operative time is also important in terms of infection rate as longer operative times are associated with increased infection rates. This trend has been shown across various orthopaedic procedures such as total knee arthroplasties, hip arthroplasties, arthroscopic rotator cuff repair, and spine surgeries (19-22). Cheng *et al.* conducted a systematic review that investigated operative time and infection rate across various surgical subspecialties. His pooled analysis for orthopaedic surgeries found an 84% increased likelihood of SSI with increased operative time ($P=0.0003$) (22). Physicians should be wary of such factors when analyzing cost-benefit analysis of different

surgical options.

Using the mean operative times in a hypothetical 10-hour workday, we found that physicians can perform either 4 RSA/TSA or HA procedures or 5 ORIF procedures in a single day. Even with higher daily volume of ORIF, RSA/TSA daily revenue was greater than 23470 HA, 23616 HA, and ORIF. When extrapolating to yearly revenues, RSA/TSA was found to have an AAD of \$115,667 over HA and an AAD of \$184,777 over ORIF.

While shoulder arthroplasty has the highest payment value per minute of all the surgical treatment options for proximal humerus fractures, it is associated with a range of postoperative complications. Glenoid component failure, rotator cuff tear, pain and stiffness, and instability are among the most common complications following shoulder arthroplasty (23). In a study of over 19,000 TSA and RSA cases, the complication rate was found to be 11% (24). One can therefore argue that although shoulder arthroplasty has better payment value, it may not be justified if complications are elevated. However, in our cohort, the complication rate was 6.1% for TSA, 8.4% for HA, and 5.7% for ORIF (not including transfusions), which were not significantly different. Therefore, based on our findings it does not seem like TSA/RSA is associated with a higher rate of complications. In the above study by Bohsali *et al.*, the complication rate reported is not for TSAs that are specifically for the treatment of proximal humerus fractures, which can explain the difference in results.

While hemiarthroplasties for proximal humerus fractures are meant to be billed under the 23616 CPT code, our data found that both hemiarthroplasty CPT codes, 23470 and 23616, were used for the same indication. When comparing each group, the only significant difference existed in the mean RVU (17.87 vs. 18.36; $P<0.001$). While not significant, 23616 HA had a greater revenue per day than 23470 HA (\$2969 vs. \$2854) and a greater yearly revenue (\$475,077 vs. \$456,633).

Sodhi *et al.* conducted a similar RVU analysis on primary

vs revision total knee arthroplasties (TKA) and found that despite increased time and complexity of revision TKAs, primary TKAs had greater RVUs per min compared to revision TKAs (0.26 vs. 0.22; $P < 0.001$) (12). Sodhi *et al.* also conducted the same RVU analysis on primary vs revision total hip arthroplasties (THA). Similarly, despite increased time and complexity of revision THAs, primary THAs had greater RVUs per min compared to revision THAs (0.260 vs. 0.249; $P < 0.001$) (13). Results such as these showcase that the physician work portion of total RVUs may not accurately depict the perceived time, skill, and effort that goes into wRVUs.

Some limitations to this study are that it is a retrospective database study, limiting the data to the NSQIP database. However, national patient data is more generalizable than patient data from a single hospital. In addition, since RSA and TSA procedures had the same CPT code, we could not distinguish RVU data between the two procedures. Furthermore, ORIF procedures may vary with complexity. Despite these limitations, our results are valid.

When using the RVU model for RSA/TSA, HA, and ORIF for proximal humerus fractures in the elderly, RSA/TSA had greater RVU/min compensation in comparison to 23470 HA, 23616 HA, and ORIF (0.197 vs. 0.156, 0.166, and 0.135; $P < 0.001$). This translates to an AAD of \$115,667 in favor of RSA/TSA over the combined HA and an AAD of \$184,777 of RSA/TSA over ORIF. Additionally, it was found that all types of surgery had similar rates of postoperative complications, reoperations, and readmissions. Therefore RSA/TSA provides the highest

payment value per minute with similar postoperative risks as the other surgical options. While this study shows discrepancies in compensation rates in favor of RSA/TSA, future studies showcasing why this disparity exists are needed. This study provides insight for orthopaedic surgeons to better understand the monetary value of their time. In addition, orthopaedic surgeons can utilize this information to increase the daily cost-effectiveness of their practice.

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