Paper #18 QUANTIFICATION OF COST SAVINGS FROM OUTPATIENT TOTAL SHOULDER ARTHROPLASTY

James M. Gregory, MD, *Alexander M. Wetzig, BS, Colton D. Wayne, BS, Ryan J. Warth, MD, Lane Bailey, PhD, PT, University of Texas Health Science Center at Houston, Houston, Texas, USA*

Introduction: Finding ways to contain costs in joint replacement surgery has become a central issue as the cost of healthcare continues to rise. High-volume arthroplasty centers have been shown to have lower costs and better outcomes. Outpatient arthroplasty has also been shown to help control healthcare costs, and recent studies suggest that outpatient total shoulder arthroplasty (TSA) is safe and effective for appropriately selected patients. However, specific costs associated with outpatient TSAs remain poorly studied. The purpose of this study was to evaluate and compare the patient-level costs of elective inpatient and outpatient total shoulder arthroplasty (TSA) in the State of Texas between 2010 and 2015. We hypothesized that the cost of inpatient and outpatient TSA from 2010 to 2015 increased at the similar rates and that outpatient TSA would be significantly less costly than both high- and low-volume inpatient centers.

Methods: De-identified inpatient and outpatient records for the State of Texas are publicly available and were obtained from the Texas Department of State Health Services in November 2016 covering the interval from 2010-2015. These records included billing information related to all patient visits regardless of age and health insurance coverage. Inpatient and outpatient records that included ICD-9-CM codes (inpatient before October 2015), ICD-10-PCS codes (inpatient after October 2015) and CPT codes (outpatient) for elective primary TSA were extracted for analysis (ICD-9-CM codes: 81.80, 81.88; ICD-10-PCS codes: 0RRJ0JZ, 0RRK0JZ, 0RRJ0J6, 0RRJ0J7, 0RRK0J6, 0RRK0J7, 044J00Z, 0RRK00Z; CPT codes: 23472). Outpatient records which included CPT codes 99231 and 99235 (postoperative inpatient observation codes) were considered to represent inpatient TSA. Cost analyses were performed comparing inpatient and outpatient TSA using a one-way ANOVA was used to compare baseline patient demographics and average costs. Inpatient TSA centers performing more than 15 TSAs per year were considered to represent high-volume centers. A mixed model ANOVA (group x time) was used to determine the change in average total costs between inpatient and outpatient TSA procedures from 2010 thru 2015. Statistical significance occurred when $P < .05$.

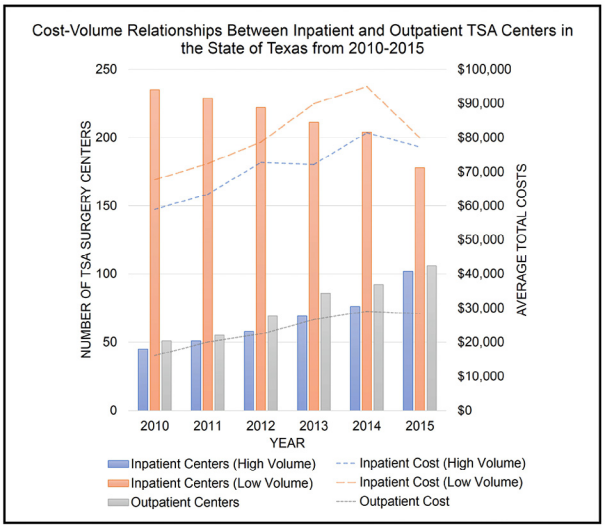

Figure 1 Bar graph showing average cost for inpatient and outpatient TSA according to high- and low-volume thresholds (>15 TSAs/year indicates high-volume).

Table 1 Direct comparisons between itemized costs of inpatient and outpatient TSA centers

Cost Categories	Inpatient	Outpatient	Cost Difference	P-value
Total, ± SD	$73,624 ± $11,472	$49,013 ± $2,214	-$24,611 ± $8,262	< 0.001*
Covered Charges, ± SD	$68,624 ± $19,643	$47,034 ± $3,152	-$21,230 ± $14,067	< 0.001*
Non-Covered Charges, ± SD	$5,360 ± $16,085	$1,979 ± $2,724	-$3,381 ± $11,536	< 0.001*
Accommodation Charges, ± SD	$8,475 ± $12,441	$0 ± $0	-$8,475 ± $12,441	< 0.001*
Physical Therapy Charges, ± SD	$489 ± $695	$207 ± $305	-$282 ± $537	< 0.001*
Occupational Therapy Charges, ± SD	$243 ± $527	$56 ± $185	-$187 ± $395	< 0.001*
Operating Room Charges, ± SD	$18,593 ± $12,687	$17,376 ± $11,327	-$1,157 ± $12,026	0.001*
Anesthesia Charges, ± SD	$3,286 ± $2,786	$2,387 ± $2,291	-$899 ± $2,551	0.315
Laboratory Charges ± SD	$1,976 ± $3,696	$692 ± $936	-$1,284 ± $2,696	< 0.001*
Radiology Charges, ± SD	$952 ± $2,482	$396 ± $575	-$556 ± $1,802	< 0.001*

*Statistical significance (p<0.05)

Results: The average total costs for TSA between 2010 and 2015 were significantly less for procedures performed outpatient versus inpatient ($49,013 ± $2,214 versus $73,624 ± $11,372; $P < .001$). Cost savings related to outpatient TSA persisted even when accommodation costs were excluded, and when compared directly to high-volume inpatient centers ($22,909 ± $13,595 versus $66,222 ± $37,271; $P < .001$). **Figure 1** shows the average cost for inpatient and outpatient procedures according to their yearly volume (high- and low-volume). Outpatient TSA was found to have significantly lower costs with respect to operating room, laboratory, physical therapy, occupational therapy, radiology services, and laboratory services (**Table 1**). Costs increased significantly for both inpatient and outpatient TSA from 2010 to 2015 (Inpatient TSA: $59,413 ± $692 in 2010 to $85,931 ± $525 in 2015; Outpatient TSA: $36,445 ± $2,676 in 2010 to $56,476 ± $1,919 in 2015; $P < .001$). There was no "group x time" interaction ($F = 0.758$, $P = .781$), indicating that the rate of cost increase between 2010 and 2015 were not statistically significant.

Conclusion: Overall costs for TSA continue to rise substantially, and these trends appear to be consistent for both inpatient and outpatient procedures. Outpatient TSA demonstrates significantly lower costs that inpatient TSA, even when costs related directly to hospital accommodation were excluded, and when compared directly to high volume inpatient centers. Protocols for safe and effective treatment of appropriately selected patients in an outpatient setting should be developed to minimize health care costs.

Paper #19 OSSEOUS INTEGRATION OF THE CENTRAL PEG OF AN ALL-POLYETHYLENE GLENOID WITH THREE DIFFERENT SURGICAL TECHNIQUES

Patrick J. Denard, MD[a], Reuben Gobezie, MD[b], Anthony A. Romeo, MD[c], ***Evan S. Lederman, MD[d,e],*** *[a]Southern Oregon Orthopedics, Medford, Oregon, USA; [b]The Cleveland Shoulder Institute, Beachwood, Ohio, USA; [c]Rush University Medical Center, Chicago, Illinois, USA; [d]The Orthopedic Clinic Association, Phoenix, Arizona, USA; [e]Department of Orthopedic Surgery, University of Arizona College of Medicine Phoenix, Phoenix, Arizona, USA*

Background: Several all-polyethylene glenoid components are designed for osseous integration in the central peg. Surgical techniques for treatment of the central peg include no graft (NG), autogenous bone graft (ABG), and demineralized bone matrix (DBM). The purpose of this study was to compare osseous integration with these three techniques. The hypothesis was there would be no difference in ossesous integration or radiographic loosening with these three techniques.

Methods: A multicenter randomized control trial was performed on primary total shoulder arthroplasties performed with a

press-fit humeral stem and a peripherally cemented pegged glenoid designed for central bone ingrowth. One hundred and fifty-two patients were randomized based on treatment of the central peg (NG, ABG, DBM). Functional outcome, osseous integration of the central peg, and glenoid loosening were assessed at a minimum of 1 year postoperative.

Results: There were statistically significant improvements in functional outcome in all groups from baseline to postoperative, with no difference between groups. Central bone in-growth was observed in 90% of cases treated with ABG, 70% of cases treated with DBM, and 62% of cases treated with no bone graft.

Conclusion: At short-term follow-up there is no difference in functional outcome or revision between different surgical techniques for treatment of the central post during placement of an all-polyethylene glenoid designed for bone in-growth. Osseous integration appears to be higher with ABG compared to leaving the central post untreated.

Paper #20 FACTORS ASSOCIATED WITH HIGH PAIN INTENSITY AFTER TOTAL SHOULDER ARTHROPLASTY

Mariano E. Menendez, MD[a], Sarah M. Lawler, BA[b], David C. Ring, MD, PhD[c], ***Andrew Jawa, MD[a,b],*** *[a]Department of Orthopaedic Surgery, New England Baptist Hospital, Tufts University School of Medicine, Boston, Massachusetts, USA; [b]Boston Sports and Shoulder Center, Waltham, Massachusetts, USA; [c]Department of Surgery and Perioperative Care, Dell Medical School at the University of Texas at Austin, Texas, USA*

Introduction: As reimbursement becomes increasingly tied to quality and patient experience, there is growing interest in alleviation of postoperative pain combined with optimal opioid stewardship. We characterized predictors of severe inpatient pain after elective total shoulder arthroplasty, and evaluated its association with opioid use, operative time, hospital length of stay, discharge disposition, and cost.

Objective: We sought to characterize preoperative characteristics associated with severe pain among patients admitted to a hospital after TSA. Additionally, we evaluated the association of severe postoperative pain with inpatient opioid use, operative time, hospital length of stay, discharge disposition, and cost. An improved understanding of factors contributing to severe postoperative pain—and costlier care—can inform the development of enhanced recovery pathways based on comprehensive care of a patient's physical, mental, and social determinants of health.

Methods: A total of 415 patients undergoing elective primary total shoulder arthroplasty between 2016-2017 were identified from our prospectively collected registry. Severe postoperative pain was defined as peak pain intensity $\geq 75^{th}$ percentile. Multivariable logistic regression modeling was used to determine preoperative characteristics (e.g. demographics, emotional health, comorbidities, American Shoulder and Elbow Surgeons [ASES] score) associated with severe pain. Opioid consumption was expressed as oral morphine equivalents (OMEs). Costs were calculated using time-driven activity-based costing.

Results: In decreasing order of magnitude, the predictors of severe postoperative pain were greater number of self-reported allergies, preoperative chronic opioid use, lower ASES score, and depression. Patients reporting severe pain took more opioids (202 vs 84 mg OMEs), stayed longer in the hospital (2.9 vs 2.0 days), used postacute inpatient rehabilitation services more frequently (28 vs 10%), and were more likely to be high-cost patients (23 vs 5%; all $P < .001$), but they did not have longer surgeries (166 vs 165 minutes, $P = .86$).

Conclusion: Efforts to address psychological and social determinants of health might do as much or more than technical improvements to alleviate pain, limit opioid use, and contain costs after shoulder

Level of Evidence: III, prognostic.

Paper #21 POSTERIOR AUGMENTED GLENOIDS COMPARED TO NON-AUGMENTED GLENOIDS IN ANATOMIC TOTAL SHOULDER ARTHROPLASTY

Richard J. Friedman, MD, FRCSC[a]*, Sean Grey, MD[b], Thomas W. Wright, MD[c], Pierre-Henri Flurin, MD[d], Joseph D. Zuckerman, MD[e], Christopher Roche, MBA, MS[f], [a]Medical University of South Carolina, Charleston, South Carolina, USA; [b]Ortho Center of the Rockies, Fort Collins, Colorado, USA; [c]University of Florida, Department of Orthopaedics, Gainesville, Florida, USA; [d]Bordeaux-Merignac Clinic, France; [e]Hospital for Joint Diseases, New York, New York, USA; [f]Exactech, Gainesville, Florida, USA*

Purpose: The use of a posterior augmented glenoid to correct posterior wear, subluxation and retroversion remains controversial. The purpose of this study is to compare the clinical and radiographic outcomes of patients with significant posterior glenoid wear treated with a posterior augmented glenoid and compare them to age/gender/follow-up matched patients without glenoid wear treated with a non-augmented pegged glenoid in anatomic total shoulder arthroplasty (aTSA).

Methods: 182 patients undergoing primary aTSA with 2 year minimum follow-up (mean 42 months) were reviewed. 91 patients (mean age = 66 yrs; 37F/54M) received a posterior augmented pegged glenoid and 91 age/gender/follow-up matched patients received a non-augmented pegged glenoid. Patient data was retrospectively reviewed from a multi-institutional WIRB approved registry. Each patient was evaluated preoperatively and at latest follow-up using SST, UCLA, ASES, Constant, and SPADI scoring metrics; active abduction, forward flexion, and internal/external rotation were measured. Radiolucent glenoid line assessment was performed from radiographs at latest follow up. A Student's two tailed unpaired t-test ($P < .05$) quantified differences.

Results: Each cohort demonstrated significant improvements in pain and function following primary aTSA. At latest follow-up, augmented glenoids were generally better than non-augmented glenoids; however, few differences were noted in pre-to-postoperative improvement between augmented and non-augmented glenoids. Augmented glenoids were associated with significantly more improvement in active abduction, forward flexion, and external rotation as compared to non-augmented glenoids. The overall complication rate was 6.6%, where augmented patients had 1 aseptic glenoid loosening compared to 3 cases in the non-augmented group. Radiographic data was available for 70% of the patients. There were no significant differences in the rate of glenoid radiolucent lines (35% augmented, 40% non-augmented) or the average line grade (0.68 augmented, 0.86 non-augmented) between the two cohorts. There were no differences in humeral radiolucent line rates between the two groups.

Discussion: At a mean follow-up of 3.5 years, few clinically relevant differences were observed between the augmented and non-augmented cohorts, despite the augment cohort being disadvantaged by posterior glenoid wear. This is likely due to the correction of the retroversion and posterior subluxation, with improved tensioning of the rotator cuff. There were no patients in which the humeral head re-subluxated posteriorly. Complication rates and radiographic outcomes were similar between the two groups. Posterior augmented glenoids are a viable option for the posteriorly worn osteoarthritic glenoid; however, longer follow-up is necessary to determine how these early results hold up over time.

Paper #22 MUSCLE-DERIVED ACTIVATED ENDOTHELIAL CELLS AS A NEW CELL SOURCE TO ENHANCE TENDON-TO-BONE HEALING: IN VIVO STUDY IN A MURINE ROTATOR CUFF REPAIR MODEL

Susumu Wada, Amir Lebaschi, Yusuke Nakagawa, MD, PhD, Camila Carballo, PhD, PT, Dean Wang, MD, Daniel Nemirov, BA, Zoe Album, BS, Liang Ying, Xiang-Hua Deng, MD, ***Scott A. Rodeo, MD,*** *Orthopaedic Soft Tissue Research Program, Hospital for Special Surgery, New York, New York, USA*