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ORIGINAL ARTICLE

Return to Work After Shoulder Replacement for Glenohumeral Osteoarthritis Is Similar When Hemiarthroplasty Is Compared to Total Shoulder Arthroplasty

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Abstract *Background:* Return to work after shoulder arthroplasty for glenohumeral osteoarthritis (OA) is an important consideration for an aging workforce. *Questions/Purposes:* The aim of this study was to compare the shoulder function, pain levels, and rate of return to work in patients treated with anatomic total shoulder arthroplasty (aTSA) versus humeral hemiarthroplasty (HHA). *Methods:* A retrospective review of consecutive HHA patients was performed of our institution's shoulder arthroplasty registry. Inclusion criteria were pre-operative diagnosis of end-stage OA and more than 2 years' follow-up. HHA patients were statistically matched to aTSA patients and then screened for pre-operative work status; 26 HHA and 23 aTSA patients worked before surgery. There was no difference in average age (HHA, 62.4 years; aTSA, 61.7 years) or follow-up (HHA, 67.5 months; aTSA, 66.9 months). *Results:* Average American Shoulder and Elbow Surgeons (ASES) scores (HHA, 37.6 to 70.3; aTSA, 35.6 to 80.1) and visual analogue scale (VAS) for pain scores (HHA, 6.1 to 2.3; aTSA, 6.5 to 0.6) improved in both groups. However, HHA patients had worse final VAS scores, and aTSA patients were more satisfied (100% vs 77%); 61.5% of HHA patients returned to work post-operatively versus 87.0% of aTSA patients. There was no difference in time to return to work (HHA, 1.9 ± 2.3 months; aTSA, 1.3 ± 1.0 months). *Conclusion:* Patients with shoulder OA undergoing aTSA have higher rates of return to work, function, and satisfaction than those undergoing HHA.

Level of Evidence: III, retrospective cohort design, treatment study

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s11420-019-09692-0) contains supplementary material, which is available to authorized users.

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Keyword anatomic total shoulder arthroplasty · hemiarthroplasty · work · shoulder replacement · job · occupation · osteoarthritis

Introduction

Shoulder arthroplasty utilization continues to grow at an unprecedented rate, with an almost fivefold increase in the number of annual procedures performed from 2000 to 2011 [12, 22]. This exponential rise has been paralleled by a rise in the number of shoulder arthroplasties performed on younger patients, with an almost fourfold increase in patients between 50 and 64 years of age from 1998 to 2010 [24]. In the context of the current economic climate that has resulted in a rising average retirement age in the USA [18], returning to work after shoulder arthroplasty remains an important consideration.

For surgeons treating patients with end-stage glenohumeral osteoarthritis (OA) without rotator cuff disease, this younger patient population poses challenges; surgeons must counsel patients on whether to undergo humeral hemiarthroplasty (HHA) or anatomic total shoulder arthroplasty (aTSA). Multiple studies have demonstrated that patients with glenohumeral arthritis who undergo aTSA have improved pain relief, higher functional scores, better satisfaction, and more range of motion compared to those who undergo HHA [2, 6, 17, 20, 25]. Still, concerns over implant longevity and lower survival rate due to glenoid loosening, particularly in patients under age 55 years [5, 19], may push surgeons to recommend HHA to younger patients who wish to remain active and employed. Additionally, many patients have lifting restrictions after aTSA, which may limit their work capacity and ability to return to work [10].

Few studies exist on return to work after shoulder arthroplasty for glenohumeral arthritis. This is likely due to glenohumeral arthritis being seen previously more often in the retired population. Garcia et al. found a return-to-work rate after HHA of 69.4% [8], which is higher than that reported in other studies after aTSA (30.7 to 38.6%) [3, 11]. While these small case series can be used to aid clinicians in managing the expectations of patients undergoing these procedures, no study has directly compared either rates of return to work after aTSA and HHA or work-related complications. The available literature also does not explain the large discrepancy between reported return-to-work rates favoring HHA and the functional, pain, and range of motion scores favoring aTSA.

The purposes of this study were to (1) compare return-to-work rates after HHA and aTSA and (2) compare functional and pain scores after HHA and aTSA for glenohumeral OA without rotator cuff dysfunction. We hypothesized that return-to-work rates after aTSA would be comparable to those following HHA, and that aTSA would produce better functional and pain scores.

Methods

After receiving institutional review board approval, we performed a retrospective review of our institution's prospectively collected shoulder arthroplasty registry for all patients from 2000 to 2013 who underwent HHA; aTSA was not initially included in this query as HHA is considerably rarer. Inclusion criteria were a pre-operative diagnosis of end-stage glenohumeral osteoarthritis with minimum follow-up of 2 years. Exclusion criteria were pre-operative diagnoses of inflammatory arthritis, fracture, avascular necrosis, or rotator cuff dysfunction and less than 2 years' follow-up. The decision to undergo either aTSA or HHA was made by surgeon and patient after weighing all concerns including the activities and work patients were hoping to return to, age of patient, longevity of implant, and the possibility of glenoid wear or loosening based on the implant selected. After the selection process, all available HHA patients were matched to an aTSA patient by pre-operative diagnosis, age (± 5 years), sex, body mass index (BMI), dominant extremity, and follow-up period (± 6 months). Patients were then further excluded from the study if they had not worked in the 3 years prior to shoulder arthroplasty. An overlapping cohort of arthroplasty patients was previously investigated for return to work [8].

Forty-five HHA patients met final inclusion criteria. Using the Bergstralh and Kosanke macro [1], 45 aTSA patients from the same shoulder registry were matched to the 45 HHA patients. Three were lost to follow-up, and two declined to participate from each group (12%). Forty HHA patients and 40 aTSA patients remained available with minimum 2-year follow-up. From this cohort, 17 aTSA (42.5%) and 14 HHA (35%) patients who had not worked in the 3 years before undergoing shoulder arthroplasty were excluded before further analysis. The final cohort included 26 HHA and 23 aTSA patients. Average age at surgery was 62.4 years (range, 42.7–87.7 years) for HHA and 61.7 years (range, 47.7–75.6 years) for aTSA ($p = 0.800$). Average follow-up was 62.4 months (range, 24.6–90.2) for HHA and 62.1 months (range, 24.1–89.9) for aTSA ($p = 0.950$). There was no statistical difference between the two groups in baseline demographics or comorbidities (Table 1).

All patients in the cohort received a fixed angle press fit stem (Biomet Comprehensive Shoulder, Warsaw, IN, USA). All procedures were performed in a similar fashion through a deltopectoral approach. The subscapularis was managed per surgeon preference, most commonly subscapularis tenotomy (90%), with a minority (10%) of cases involving a lesser tuberosity osteotomy. A similar rehabilitation protocol was followed by all surgeons: 4 weeks in a sling with the initiation of passive range of motion at 2 weeks, active range of motion at 6 weeks, and strengthening at 3 months post-operatively. Prior recreational activities and work were encouraged after 3 months. The only restriction told to patients was to avoid contact sports. The senior surgeon did not place work restrictions on either cohort, allowing all patients to return to work when they felt ready.

Social security records were used to determine deceased status. Study personnel then contacted non-deceased patients and administered a questionnaire by phone. The questionnaire included work-related questions previously used in the literature (Online Resource 1) [7, 9, 13–15]. Five attempts were made to reach the patients, in addition to one mailed survey. Patients were considered lost to follow-up if they failed to respond. Data from the prospective registry included pre-operative scores on the American Shoulder and Elbow Surgeons (ASES) scale for overall function and the visual analogue scale (VAS) for pain.

Initial pre-operative diagnoses, BMI, age, comorbidities, and operative complications were obtained from patient records and confirmed during the phone interview. Objective outcomes including post-operative stiffness and instability were determined by patient responses.

Table 1 Patient demographics

	HHA ($n = 26$)	aTSA ($n = 23$)	p value
Age (years)	62.4 ± 10.5	61.7 ± 7.7	0.800
Follow-up (months)	62.4 ± 15.3	62.1 ± 15.9	0.959
Gender (ratio M/F)	12/14	10/13	1.000
Body mass index (kg/m^2)	29.8 ± 7.1	29.2 ± 6.5	0.770
Dominant/Nondominant Extremity	16/10	14/9	1.000

aTSA anatomic total shoulder arthroplasty, *HHA* humeral hemiarthroplasty

Employed patients were stratified by intensity of work (sedentary, light, or heavy), as defined by the US Department of Labor (Online Resource 2) [26]. Retirees were stratified by rationale for retirement (shoulder, medical causes, or other). These categories were designed based on prior literature [4].

Statistics

Patients were matched using a SAS Software macro developed by Bergstralh and Kosanke [1], which implements a greedy matching algorithm. The algorithm calculates a distance, Dij, between every case and every control as a weighted sum of the absolute differences between cases and controls for selected matching variables. After the cases and controls are randomly sorted, the first case is matched with the closest control based on Dij. This process continues for each case and is repeated until the desired number of controls have been matched to every case. For this study, one control was matched to each case on the variables age (± 5 years), sex (exact), and follow-up period (± 6 months) and they all had the same weight.

Student t tests were used to compare the two study populations for continuous variables, and χ^2/Fisher's exact tests were used to compare categorical variables. Changes in patient-reported outcome measures also were assessed using paired sampled t tests. Tests were conducted using two-sided hypothesis testing with statistical significance set at $p \leq 0.05$ and conducted with SPSS 22.0 (IBM, Armonk, NY, USA).

Results

Of the final cohort, 76.9% of HHA patients (20/26) compared to 17.4% of aTSA patients (4/23) had post-operative complaints with the shoulder ($p < 0.001$). The most common complaints were chronic pain and stiffness: 57.7% of HHA patients (15) compared to 0% of aTSA patients complained of chronic pain ($p < 0.001$); 30.8% of HHA patients (8) and 13% of aTSA patients (3) described stiffness in the shoulder ($p = 0.180$).

Four patients in the HHA group (15.4%) underwent revision surgery at an average of 4.8 years (range, 3.4–7.7): three patients had progressive glenoid arthritis (two converted to aTSA, one to reverse total shoulder arthroplasty [RTSA]); one patient was converted to RTSA for recurrent dislocation. The revision rate for progressive glenoid osteoarthritis in the HHA group was 8.7% (2/23) at an average of 5.2 years (3.8 to 7.2): one underwent revision aTSA for recurrent dislocation, while the other underwent RTSA for pain and stiffness due to rotator cuff dysfunction. No patient in the aTSA group underwent revision for glenoid loosening, and there were no infections in either group. There was no difference in the proportion of revisions between the HHA and aTSA groups ($p = 0.671$).

Both groups had statistically significant decreases in their VAS pain scores and increases in their ASES scores following surgery. While there were no differences in preoperative pain or ASES scores, patients in the aTSA group had statistically significantly lower average delta pain and post-operative instability VAS scores (Table 2). There was no statistical difference in the delta ASES scores. Patient satisfaction was higher following aTSA: 20/26 (76.9%) of HHA patients were satisfied or very satisfied with the

Table 2 Outcomes scores

	HHA ($n = 26$)	TSA ($n = 23$)	p value
Pre-op pain VAS	6.1 ± 2.5 (0.2–10)[a]	6.5 ± 2.3 (0.2–10)[b]	0.483
Post-op pain VAS	2.3 ± 3.0 (0–8)[a]	0.6 ± 1.0 (0–3)[b]	*0.014*
Delta VAS	− 3.8 ± 4.3	− 6.0 ± 2.2	*0.031*
Instability VAS	1.9 ± 1.9 (1–8)	0.2 ± 1.0 (0–5)	*< 0.001*
Pre-op ASES	37.6 ± 18.7 (3.3–80.7)[c]	35.6 ± 22.9 (0–77.5)[d]	0.74
Post-op ASES	70.3 ± 25.6 (18.3–100)[c]	80.1 ± 21.1 (25–100)[d]	0.16
Delta ASES	32.7 ± 30.7	44.5 ± 29.7	0.180
Satisfaction, n (%)	20/26 (76.9%)	23/23 (100%)	*0.024*

[a,b,c,d] $p < 0.0001$

aTSA anatomic total shoulder arthroplasty, *HHA* humeral hemiarthroplasty, *VAS* visual analog scale score, *ASES* American Shoulder and Elbow Surgeons score

Table 3 Return to work after aTSA vs HHA

	RTW after aTSA (%)	Mean time to RTW (months)	RTW after HHA	Mean time to RTW (months)	*p* value (RTW)	*p* value (time to RTW)
Total	20/23 (87.0%)	1.29	16/26 (61.5%)	1.88	0.057	0.340
Occupation intensity						
Sedentary	7/7 (100%)	1.04	8/13 (61.5%)	1.06	0.114	0.964
Light	9/11 (81.8%)	1.06	7/10 (70%)	2.76	0.635	0.108
Heavy	3/3 (100%)	1.83	1/3 (33%)	2.25	0.084	0.844

RTW return to work, *aTSA* anatomic total shoulder arthroplasty, *HHA* humeral hemiarthroplasty

surgery compared to 23/23 (100%) of aTSA patients ($p = 0.024$).

Sixteen of 26 (61.5%) HHA patients returned to work compared to 20/23 (87.0%) aTSA patients (having worked within 3 years prior to surgery) ($p = 0.057$). In the HHA group, only one patient retired due to the shoulder after surgery. Two patients retired due to the shoulder within 3 years prior to surgery, two patients retired within 3 years prior to surgery due to medical reasons, and five patients retired due to nonspecified reasons. Of the three patients who did not return to work in the aTSA group, two had retired within the 3 years prior to surgery, one due to the shoulder and the other due to other medical reasons. The remaining patient retired due to nonspecified reasons. No patients changed job demands after surgery. When subdivided by intensity, there was no statistical difference in the proportion of patients who returned to sedentary, light, or heavy duty in either group. There was no statistical difference in the time to return to work following HHA or aTSA (1.88 months vs 1.29 months, respectively; $p = 0.350$) (Table 3). Job descriptions of patients who returned to work by demand are shown in Table 4.

There was no correlation between the patient's ability to return to work and age, gender, BMI, comorbidities, surgery on dominant extremity, revision status, or satisfaction after surgery.

Discussion

In today's economic climate, patients often ask whether and when they will be able to return to work following surgery. The purpose of this study was to compare work and functional outcomes between patients undergoing HHA and aTSA. These results are relevant in discussing expectations with patients following shoulder arthroplasty. The results of this study demonstrate that the majority of patients undergoing aTSA (87%) and HHA (61.5%) for glenohumeral osteoarthritis are able to return to work between 1 and 2 months after surgery without changing occupations. While aTSA trended toward a higher rate of return to work, the differences did not reach statistical significance. Additionally, only one (3.8%) patient in our HHA cohort (none in the aTSA cohort) retired after surgery due to limitations from the shoulder. Of significance, the majority of patients performed light or sedentary work, which did not require extensive shoulder use.

Table 4 Occupations of patients working post-operatively

Occupation intensity	HHA	aTSA
Sedentary	Private investor	Speech writer
	Office manager	Loan officer
	Teacher	Secretary
	Attorney	Social worker
	Computer work	Police officer
	IT expert	Healthcare consultant
	Banker	Editor
	Bus driver	Office clerk
Light	Painter	University professor
	Social worker	Event planner
	Speech Therapist	Director of pharmaceutical
	Project manager	Venture capitalist
	Dentist	Teacher (2)
	Neuromuscular therapist	Administrative assistant
	Facilities manager	Real estate agent
		Accounting
Heavy	Locksmith	Mechanic
		Registered nurse

aTSA anatomic total shoulder arthroplasty, *HHA* humeral hemiarthroplasty

The study's main limitation is its retrospective collection of data. Additionally, the results of this study may be more subjective than objective, with a potential for patient recall bias and investigator bias, given the use of a telephone survey. Nevertheless, phone surveys have shown better patient response rates compared to mailed surveys [23], which was responsible for the homogeneity of our matched cohorts. We also attempted to reduce the influence of patient recall bias by cross-referencing patient records when available. The study is also limited by geographic variations in its population's workforce. The majority of our subjects held jobs that required sedentary or light use of the upper extremity. It is unclear how these results can be extrapolated to populations participating in manual labor. The present study may be limited by the sample size of included patients. Post hoc power analysis revealed power of 52.5%, which signifies a type II error. Despite the potential for underpowering, the conclusions of the study are expected to be maintained. Additionally, selection of surgical procedure was based on expert assessment on a case-by-case basis using a shared clinical decision-making algorithm within the practice. Our study design may, therefore, have been influenced by selection bias.

The return-to-work rate in patients undergoing aTSA (87%) in this study is higher than that reported in aTSA literature. Previous studies reporting return to work have reported less than 40% of patients returned to work following aTSA. The discrepancy is likely due to age, level of duty, and composition of the cohorts in these other studies. Jawa et al. [11] reported 4/13 (30.8%) patients resumed work after shoulder arthroplasty; however, 12/13 of the patients in that cohort were heavy laborers. Additionally, there may have been other financial considerations within this cohort since that study primarily included patients who were cared for under their worker's compensation insurance. Bulhoff et al. [3] reported 22/57 (38.6%) returned to work, but the average age at surgery of their cohort was almost 10 years older than the average age in our cohort. In that cohort, it is possible that patients were at an age where they were more likely to retire than resume work postoperatively. On the other hand, the return-to-work rate following HHA in this study (61.5%) is comparable to that reported in the literature. Garcia et al. [8] reported a 69% rate of return to work following HHA, although they did not limit their cohort to patients with OA. However, this cohort did overlap with the present study, which may account for similarities in return to work rates. Nevertheless, we feel that the return to work results in both cohorts are more representative of the functional, pain, and range of motion outcomes of other studies that demonstrate more favorable outcomes following aTSA when compared to HHA [2, 6, 17, 20, 25].

In terms of return to work by intensity level, there was no difference in the rate of return between the two cohorts, likely due to the low number of patients involved in each sub-analyses. We also found an equivalent average time of return to work among the two arthroplasties options, averaging 1.3 (aTSA) and 1.8 (HHA) months, respectively, which is comparable to patients undergoing RTSA (2.3 months) [9] and hip and knee arthroplasty (range, 8–14 weeks) [4, 13, 15, 21]. An important feature of our results is that patients were able to resume high-load upper-extremity work after surgery without any work-related complications. The senior surgeons placed no work restrictions on patients post-operatively, with no maximum workload as long as patients could return to work without pain or dysfunction.

While both cohorts demonstrated relatively high rates of successful return to work without occupation change or other work-related complications, the lack of terminal radiographic follow-up to evaluate for glenoid wear or loosening may discourage some orthopedic surgeons from recommending return to work in patients, particularly those who are involved in heavy labor or high load upper extremity work. This theoretical concern for loosening may be more important for patients who choose to undergo aTSA, as there may be subclinical glenoid wear or loosening that may not be captured by this study. On the other hand, the need for glenoid resurfacing for arthritis progression after HHA may actually be higher than the revision rate for glenoid loosening after aTSA [16]. Nevertheless, the lack of patient-reported complications despite returning to a variety of occupations and improvement in both VAS and ASES scores can help orthopedic surgeons, and their patients decide between these two shoulder arthroplasty options for glenohumeral arthritis.

In conclusion, we found that 87% of patients who worked before aTSA and 61.5% of patients who worked before HHA were still working at final follow-up, although the majority were low-duty workers. Only one (3.8%) patient retired for reasons attributed to the shoulder operation. Patients with OA undergoing aTSA have high rates of return to work, function, and satisfaction compared to those undergoing HHA.

Compliance with Ethical Standards

Conflict of Interest: Anirudh K. Gowd, BS, Gregory Mahony, MS, Alec Sinatro, BA, and Hao-Hua Wu, MD, declare that they have no conflicts of interest. Joseph N. Liu, MD, reports personal fees from Smith & Nephew, outside the submitted work. Grant H. Garcia, MD, reports personal fees from Smith & Nephew, outside the submitted work. David M. Dines, MD, reports personal fees from Zimmer Biomet, outside the submitted work. Russell F. Warren, MD, reports personal fees from Zimmer Biomet and from Arthrex, Inc., outside the submitted work. Lawrence V. Gulotta, MD, reports personal fees from Zimmer Biomet and from Encore Medical, outside the submitted work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013.

Informed Consent: Informed consent was waived from all patients for being included in this study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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