


# Preoperative Comorbidities and Postoperative Complications Do Not Influence Patient-Reported Satisfaction Following Humeral Head Resurfacing: Mid- to Long-term Follow-up of 106 Patients

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## Abstract

**Background:** Humeral head resurfacing (HHR) has emerged as an alternative treatment for glenohumeral osteoarthritis. We investigated the outcomes of HHR using validated patient-reported outcome (PRO) measures.

**Methods:** A retrospective review was performed on 213 patients who underwent HHR. A PRO follow-up was performed by administering a questionnaire including the American Shoulder and Elbow Society (ASES) score, Brophy activity survey, short form of the Disabilities of the Arm, Shoulder and Hand (quickDASH) survey, and general shoulder function. PRO scores were stratified by comorbidities and complications.

**Results:** Survey responses were received from 106 patients (51%), with a mean follow-up of  $5.6 \pm 1.8$  years (range: 9 months to 6.1 years). Preoperative comorbidities were associated with significantly higher quickDASH scores. Postoperative complications were associated with significantly higher rates of current pain, higher visual analog scale scores, night pain, lower subjective shoulder values, and lower ASES pain and total scores. No differences in patient satisfaction were identified between the cohorts with and without preoperative comorbidities and between the cohorts with and without postoperative complications.

**Conclusion:** In our cross-sectional analysis of mid- to long-term outcomes following HHR, preoperative comorbidities, or postoperative complications had no impact on patient-perceived postoperative satisfaction or most PROs. HHR is clinically viable in a wide variety of patients. Future work is necessary to compare the efficacy of HHR compared with more traditional total shoulder arthroplasty and stemmed hemiarthroplasty regarding long-term outcomes and appropriate indications.

## Keywords

Humeral head resurfacing, hemiarthroplasty, arthroplasty, shoulder, osteoarthritis, resurfacing, patient-reported outcomes

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## Introduction

Osteoarthritis of the glenohumeral joint has been traditionally treated with either total shoulder arthroplasty (TSA) or stemmed hemiarthroplasty. As these methods utilize stemmed prostheses to replace the humeral head, they are associated with a more significant risk of transfection<sup>1</sup> and iatrogenic fracture,<sup>2</sup> as well as more complicated revision.<sup>3</sup> TSA is commonly complicated by

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glenoid component loosening,<sup>4</sup> while hemiarthroplasties display evidence of progressive glenoid wear.<sup>5,6</sup> Humeral head resurfacing (HHR) is an arthroplasty technique that avoids an anatomic neck cut and preserves bone stock.<sup>7-9</sup>

Although benefits of HHR may include patient-specific reconstruction and preserved bone stock, clinical outcomes following HHR have been poorly described.<sup>10</sup> Available literature is limited by sample size,<sup>11,12</sup> and mid- to long-term patient-reported outcomes (PROs) have not been extensively reported.<sup>13</sup> Prior studies suggest that HHR may reduce the risk of humeral fracture while maintaining normal joint anatomy<sup>14,15</sup> and reducing eccentric glenoid wear.<sup>16</sup> HHR may represent an attractive option for younger patients and those with isolated humeral head arthritis because of its theoretical lower risk profile. The goal of our study was to evaluate the mid- to long-term PROs following HHR. We hypothesized that patients with preoperative comorbidities and postoperative complications would have significantly lower PRO scores and lower rates of satisfaction following surgery.

## Materials and Methods

### Study Design

In an institutional review board-approved study, a cross-sectional survey analysis of the mid- to long-term outcomes of HHR at a single large academic institution was performed. All HHR procedures performed at our institution by 4 different sports medicine and shoulder fellowship trained orthopedic surgeons with 5 to 15 years of experience were identified from January 1, 2000 to December 31, 2014. Implants used were Biomet Copeland resurfacing humeral head and Tornier Aequalis HemiCAP resurfacing humeral head. PROs were paired with a retrospective chart analysis performed in 2015 to record demographic, surgical, and complication data.

### Participants/Study Subjects

All patients older than 18 years who had an HHR procedure performed from January 1, 2000 to December 31, 2014 for primary (degenerative) osteoarthritis, posttraumatic osteoarthritis, rheumatoid arthritis, or avascular necrosis of the humeral head were included. Exclusion criteria were as follows: age under 18 years, lost to follow-up earlier than 6 months postoperatively, a history of septic arthritis in the operative shoulder, a history of drug-seeking behavior or chronic pain syndrome prior to surgery, or a history of brachial plexus dysfunction or spinal disease requiring conservative or surgical intervention.

### Variables and Outcome Measures

All nondeceased patients were mailed an invitation letter informing them about the PRO study, along with a consent form. Recruitment involved a maximum of 3 mailings and 3 follow-up telephone calls per subject. Those willing to participate had the option of completing a PRO questionnaire online via Research Electronic Data Capture (REDCap) or in paper form. Paper responses were copied into the REDCap system upon receipt. The questionnaire was comprised of metrics previously validated in the shoulder arthroplasty population, including the American Shoulder and Elbow Society (ASES) score,<sup>17</sup> the Brophy activity survey,<sup>18</sup> and the short form of the Disabilities of the Arm, Shoulder and Hand (quickDASH) survey.<sup>19</sup> The questionnaire asked respondents for demographic information (occupation, education, disability status) and included questions about their postoperative satisfaction with a symptom-specific and a composite (0%–100%) subjective shoulder value (SSV; Figure 1). For the purpose of this study, the primary determinant of overall procedure “success” was defined as an SSV  $\geq 80\%$ , with a concurrent response of satisfied with current symptoms, which was either “somewhat satisfied” or “very satisfied” to the question “If you had to spend the rest of your life with the symptoms you have now, how would you feel about it?” PRO scores were compared between subjects with or without preoperative comorbidities (body mass index  $\geq 40$ , diabetes mellitus, smoker, prior rotator cuff dysfunction, such as prior rotator cuff tear, partial rotator cuff tear, and impingement symptoms, prior nonarthroplasty surgery, or autoimmune/rheumatologic disease) as well as between subjects with or without postoperative complications. Complications were defined as postoperative pain for any reason, extended narcotic needs, infections, wound complications, a return to the operating room, and the need for revision arthroplasty.

### Accounting for All Study Subjects

A total of 213 patients met our inclusion/exclusion criteria. Of these, 6 were deceased. Survey responses were received from 106 patients (112 shoulders) for a response rate of 51.2% (Figure 2). Mean follow-up was  $5.6 \pm 1.8$  years, with a range of 9 months to 6.1 years. When compared with the non-PRO responders, the 106 subjects of the PRO study cohort were not significantly different in terms of demographics, preoperative comorbidities, complications, and surgical characteristics (Table 1).

### Statistical Analysis—Study Size

Statistical analysis was performed by the investigators using GraphPad Prism 7.0 (LaJolla, CA). Normality in

Since your surgery, how would you rate the change in the status of your shoulder?

Better  
 About the same  
 Worse

If you answered "Better," please indicate how much better the status of your shoulder has been since your surgery:

Very much better  
 Much better  
 A good deal better  
 Moderately better  
 Somewhat better  
 A little better  
 Almost the same, hardly any better at all

If you answered "Worse," please indicate how much worse the status of your shoulder has been since your surgery:

Very much worse  
 Much worse  
 A good deal worse  
 Moderately worse  
 Somewhat worse  
 A little worse  
 Almost the same, hardly any worse at all

If you had to spend the rest of your life with the symptoms you have now, how would you feel about it?

Very satisfied  
 Somewhat satisfied  
 Neither satisfied or dissatisfied  
 Somewhat dissatisfied  
 Very dissatisfied

Taking into account all the activity you have during your daily life, your level of pain and also your activity limitations and participation restrictions, do you consider the current state of your shoulder satisfactory?

Yes  
 No

How would you rate your shoulder today as a percentage of normal (0% to 100% scale with 100% being normal)?

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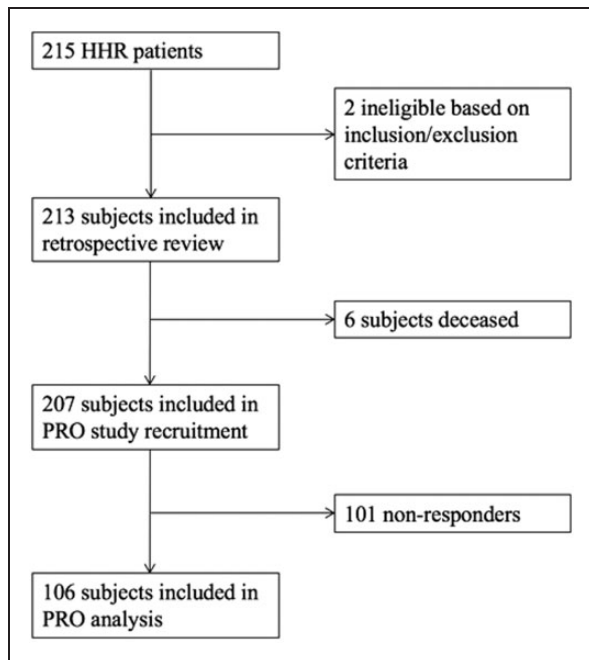
**Figure 1.** Questionnaires included survey questions about postoperative satisfaction and current symptom complaints.

all cases was confirmed using the Kolmogorov–Smirnov test. Categorical variables were compared with Fisher's exact test, while Student's *t* test was used for continuous variables. Significance was defined in all cases as  $P < .05$ .

## Results

Preoperative comorbidities were present in 56 of 106 subjects and were associated with significantly higher quickDASH scores ( $48.0 \pm 8.1$  vs  $42.9 \pm 11.9$ ,  $P = .040$ ; Table 2). However, preoperative comorbidities were not associated with significant differences in rates of current pain, narcotic use, ASES scores, or Brophy scores. Postoperative complications occurred in 30 of 106 subjects. Heavy laborers were more likely to have a postoperative complication. Impingement-related pain was the

most prevalent source of complication, occurring in 26 (24.5%) patients. Four patients returned to the operating room: 2 for adhesive capsulitis, 1 for hematoma evacuation, and 1 for an acute supraspinatus tear 9 months postoperatively. No patient required a revision arthroplasty at the time of final follow-up. Postoperative complications were associated with significantly higher rates of current pain (86.2% vs 50.0%,  $P < .001$ ), higher visual analog scale (VAS) pain ratings ( $3.6 \pm 2.6$  vs  $1.9 \pm 2.4$ ,  $P = .002$ ), higher rates of night pain (63.6% vs 38.6%,  $P = .02$ ), ASES total scores ( $44.7 \pm 25.9$  vs  $55.0 \pm 22.3$ ,  $P = .04$ ), and SSV ( $65.8 \pm 26.7\%$  vs  $75.9 \pm 21.7\%$ ,  $P = .04$ ; Table 2). Postoperative complications were not associated with significant differences in the rate of narcotic use, ASES function scores, quickDASH scores, or Brophy scores.



**Figure 2.** Two hundred fifteen patients underwent HHR between 2000 and 2014, with 213 eligible for the study based on inclusion and exclusion criteria. After recruitment, 106 patients were included in the PRO analysis. HHR, humeral head resurfacing; PRO, patient-reported outcome.

Preoperative comorbidities were not associated with significant differences in overall patient-reported satisfaction with current symptoms (73.8% vs 69.5%,  $P = .687$ ) or rates of procedure “success,” defined as a self-reported SSV above 80% and a satisfaction with current symptoms as “somewhat satisfied” or “very satisfied” (67.9% vs 64.0%,  $P = .678$ ; Table 2). The majority of patients felt that their symptoms improved after surgery, whether they had preoperative comorbidities (78.7% vs 74.6%,  $P = .668$ ) or postoperative complications (72.7% vs 78.2%,  $P = .630$ ). Postoperative complications were also not associated with differences in satisfaction with current symptoms (66.7% vs 73.6%,  $P = .500$ ) or procedure success (56.7% vs 69.7%,  $P = .256$ ). Of note, although the mean SSV for each group were lower than 80, the majority of the patients (70 of the 106) reported an SSV of 80 or higher. The average value was skewed by the few patients with very low SSVs—13 of the 106 patients had an SSV less than the standard deviation below the average SSV of the entire cohort.

## Discussion

Our study with a mean follow-up of 5.6 years found that neither preoperative comorbidities nor postoperative complications impact overall patient-perceived

**Table 1.** Demographics, Preoperative Comorbidities, and Shoulder Characteristics of Subjects Who Did Not Respond and Responded to the PRO Survey Are Shown.

	Non-PRO (n = 107)	PRO (n = 106)	P
<b>Demographics</b>			
Age (years)	64.0 ± 13.2	63.8 ± 9.5	.789
Male	74/107 (69.2%)	66/106 (62.3%)	.314
BMI (kg/m <sup>2</sup> )	29.8 ± 6.8	29.4 ± 5.0	.656
Heavy labor occupation	44/86 (51.1%)	38/82 (46.3%)	.541
<b>Preoperative comorbidities</b>			
Diabetes mellitus	13/107 (12.1%)	11/106 (10.4%)	.829
Hypertension	60/107 (56.1%)	60/106 (56.6%)	>.999
Heart disease (CAD/CHF)	21/107 (19.6%)	20/106 (18.9%)	>.999
Hyperlipidemia	30/107 (28.0%)	37/106 (34.9%)	.304
COPD/lung disease	7/107 (6.5%)	3/106 (2.8%)	.332
Autoimmune disease	2/107 (1.9%)	2/106 (1.9%)	>.999
Smoker	19/107 (17.8%)	10/106 (9.4%)	.109
Inflammatory arthritis	4/107 (3.7%)	2/106 (1.9%)	.683
Immunosuppression	2/107 (1.9%)	4/106 (3.8%)	.445
<b>Surgical characteristics</b>			
Dominant shoulder injured	41/78 (52.6%)	47/79 (59.5%)	.423
Prior rotator cuff dysfunction	30/107 (28.0%)	30/106 (28.3%)	>.999
Prior nonarthroplasty surgery	27/107 (25.2%)	26/106 (24.5%)	>.999
Surgeon			.711
Surgeon 1	95/107 (88.8%)	93/106 (87.7%)	
Surgeon 2	8/107 (7.5%)	6/106 (5.7%)	
Surgeon 3	3/107 (2.8%)	5/106 (4.7%)	
Surgeon 4	1/107 (0.9%)	2/106 (1.9%)	
<b>Postoperative complications</b>			
Infection	0/107 (0%)	0/106 (0%)	–
Pain	1/107 (0.9%)	0/106 (0%)	>.999
Wound complication	1/107 (0.9%)	1/106 (0.9%)	>.999
Capsulitis	3/107 (2.8%)	3/106 (2.8%)	>.999
Rotator cuff dysfunction	10/107 (9.3%)	5/106 (4.7%)	.284
Impingement	27/107 (25.2%)	26/106 (24.5%)	>.999
Subscapularis failure	0/107 (0%)	0/106 (0%)	–

Abbreviations: BMI, body mass index; CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; PRO, patient-reported outcome.

satisfaction or most other PRO measures following HHR. These findings suggest that HHR may be a viable alternative to more extensive arthroplasty procedures for a broad range of patients. HHR is an alternative to stemmed hemiarthroplasty for the treatment of glenohumeral and isolated humeral head arthritis.<sup>3</sup> There is a paucity of prior research evaluating long-term outcomes following HHR, and the existing evidence appears to be inconsistent. HHR has been associated with high revision rates<sup>20</sup> and less accurate humeral head positioning when compared with hemiarthroplasty.<sup>11</sup> Additional prior work recommends HHR only for concentric osteoarthritis without glenoid erosion due to high failure rates from glenoid wear.<sup>21</sup> Although HHR has been thought to preserve bone stock, permitting a later revision if needed, a loss of bone volume was noted below the HHR implant,<sup>22</sup> and revisions after HHR had lower Western Ontario Osteoarthritis of the Shoulder Index scores.<sup>23</sup> It has



**Table 2.** Patient-Reported Outcome Scores for Subjects With and Without Preoperative Comorbidities and Postoperative Complications Are Shown.

	Preoperative Comorbidities (n = 56)	No Preoperative Comorbidities (n = 50)	P	Postoperative Complications (n = 30)	No Postoperative Complications (n = 76)	P
Current pain	38/55 (69.0%)	25/50 (50.0%)	.072	25/29 (86.2%)	38/76 (50.0%)	<b>&lt;.001</b>
VAS	2.6 ± 2.6	2.1 ± 2.5	.312	3.6 ± 2.6	1.9 ± 2.4	<b>.002</b>
Night pain	32/62 (51.6%)	23/59 (39.0%)	.202	21/33 (63.6%)	34/88 (38.6%)	<b>.023</b>
Narcotic use	7/46 (15.2%)	5/50 (10.0%)	.543	7/29 (24.1%)	7/74 (9.5%)	.062
ASES						
Pain score	37.1 ± 13.2	39.7 ± 12.3	.298	32.2 ± 12.6	40.8 ± 12.0	<b>.001</b>
Function score	32.5 ± 12.4	32.7 ± 12.6	.933	29.5 ± 12.1	34.0 ± 12.4	.076
Total score	54.5 ± 25.1	48.6 ± 20.9	.184	44.7 ± 25.9	55.0 ± 22.3	<b>.037</b>
quickDASH score	48.0 ± 8.1	42.9 ± 11.9	<b>.040</b>	46.3 ± 10.2	54.1 ± 10.7	.601
Brophy score	12.9 ± 5.5	13.6 ± 5.8	.541	13.0 ± 5.4	13.3 ± 5.8	.802
Surgery helped	48/61 (78.7%)	44/59 (74.6%)	.668	24/33 (72.7%)	68/87 (78.2%)	.630
Satisfied w/current symptoms	45/61 (73.8%)	41/59 (69.5%)	.687	22/33 (66.7%)	64/87 (73.6%)	.500
Subjective shoulder value (%)	72.3 ± 22.3	74.1 ± 24.9	.677	65.8 ± 26.7	75.9 ± 21.7	<b>.038</b>
Success <sup>a</sup>	38/56 (67.9%)	32/50 (64.0%)	.687	17/30 (56.7%)	53/76 (69.7%)	.256

Abbreviations: ASES, American Shoulder and Elbow Society; DASH, Disabilities of the Arm, Shoulder and Hand; VAS, visual analog scale. P < .05 are bolded.

been proposed that HHR results in poor postoperative range of motion in those with preexisting rotator cuff injury,<sup>24</sup> although various studies have shown that pain relief,<sup>20</sup> functional improvement, patient satisfaction,<sup>25</sup> and improved range of motion were noted postoperatively.<sup>20,26</sup> A major limitation of current HHR literature is small sample sizes. The largest recent study evaluated intraoperative and postoperative complications in patients undergoing all forms of shoulder arthroplasty (n = 12 559) and found that patients undergoing HHR (n = 2329) had fewer complications than those undergoing TSA, and that the superior approach resulted in fewer complications than the deltopectoral approach.<sup>27</sup> Two other large registries have been used to look at outcomes of HHR and focus primarily on outcomes from revision surgery (n = 1210),<sup>23</sup> as well as patient outcome comparison among resurfacing prosthesis (n = 195), hemiprosthesis (n = 408), total prosthesis (n = 86), and reverse total prosthesis (n = 170).<sup>28</sup> Although there are several recent studies with longer follow-up, ours is the largest, aside from the 3 previously mentioned, to examine PROs following HHR (Table 3).

In our cohort, patients who experienced a postoperative complication did not report a significant difference in PROs with the exception of pain and had significantly higher rates of current pain, night pain, and higher VAS pain severity. This is also reflected in worse ASES pain and ASES total scores. However, despite a high 50% prevalence of some level of pain following HHR in our entire cohort, ASES scores are lower than most recent studies (Table 4).<sup>14,25,29</sup> Heavy laborers were also more likely to have a postoperative complication. This may be

useful information to consider when evaluating the clinical utility of HHR in this population, especially since HHR is often considered in younger, more active patients.

Although prior work has mainly focused on objective clinical outcomes following HHR, such as range of motion, radiographic measurements (fracture, component loosening, osteolysis), complications,<sup>11,13</sup> and osseous integration,<sup>30</sup> our primary definition of procedure success was long-term patient-reported satisfaction. Patient satisfaction and whether they would have the procedure again was not significantly different for patients with preoperative comorbidities or postoperative complications, or even those who required reoperation. In addition, no difference was observed between “successful” and “unsuccessful” procedures. On the whole, 71.7% of patients were satisfied with their current symptoms, while the “success” criteria were met in 66.0% of cases. Our findings suggest that while complications result in higher rates of pain postoperatively, this pain is mild and does not significantly impact shoulder function or patient satisfaction. Patient satisfaction following TSA has been reported in several recent studies,<sup>4</sup> but few HHR studies include satisfaction as an outcome measure. Levy et al.<sup>7</sup> reported that 81.6% of patients felt better or much better from preoperatively, and Alizadehkhayat et al.<sup>8</sup> reported that 85% were satisfied with their results, which are consistent with our result of 76.7% (Table 4). Sweet et al.<sup>25</sup> and Pritchett<sup>31</sup> reported 90% and 95% patient satisfaction with the procedure, respectively, compared to our 71.7% satisfaction with current symptoms, although definitions of satisfaction

are inconsistent across studies. Although objective data are certainly important, patient-reported satisfaction may be a more clinically relevant outcome measure. This is further supported by our study, as satisfaction and most subjective outcome measures were not influenced by rates of complication. A recent study by Verstraelen et al. demonstrated a similar concept,

showing that despite poor radiographic outcomes at a mean of 7.2 years after HHR, clinical outcomes were good.<sup>32</sup>

Our study has several limitations. First, patients were given the option of completing the PRO survey electronically or in paper form. Although this allowed for a better response rate and potentially a more representative sample, ambiguous responses on the paper survey had to be interpreted and converted into the electronic form. To provide consistency in interpretation, a single author performed this task for all paper surveys. Second, the design of our study is inherently subject to response bias, especially with 51.2% survey response rate, which can be considered low. However, this response rate is quite comparable to other survey-based studies. A systematic review of 219 studies on mail surveys published in medical journals reports an average response rate of around 60%.<sup>33</sup> In addition, comparison of the respondent subset with the nonresponders showed no significant differences in demographics or patient health or shoulder characteristics, indicating that the sample of patients in this study is representative of the entire population of patients undergoing HHR at our institution over the past 15 years (Table 1). However, the low follow-up still remains a weakness, as patients who needed revision or conversion of their arthroplasty may have been more likely to seek care elsewhere and thus higher in the lost to follow-up group. Third, our study did not include an analysis of objective data, such as pre- and postoperative range of motion and pre- and postoperative radiographic measures, as we were limited by inconsistent reporting in the chart and the lack of consistent advanced imaging postoperatively. Finally, a thorough review of the electronic medical record was used to identify preoperative comorbidities and postoperative complications. However, electronic medical

**Table 3.** Sample Size and Follow-up Time Are Shown for Recently Published HHR Studies.

	HHR Sample Size	Mean Follow-up (Years)
Al-Hadithy et al.	41	5.1
Alizadehkhayat et al.	102	4
This study	112	5.6
Cowling et al.	2329	NA
Delaney et al.	39	4.3
Fevang et al.	195	4.3
Fuerst et al.	35	6.1
Geervliet et al.	48	6.4
Giannotti et al.	42	2.8
Hammond et al.	7	n/a
Hawi et al.	49	9
Lebon et al.	41	3.7
Levy et al.	54	14.5
Glanzmann et al.	44	2.0
Mansat et al.	64	3.0
Mullet et al.	21	4.5
Rasmussen et al.	1210	1.0
Schmidutz et al.	14	2.0
Soudy et al.	105	4.7
Sweet et al.	20	2.7
Verstraelen et al.	33	7.2
von Engelhardt et al.	12	1.7

Abbreviations: HHR, humeral head resurfacing; NA, not applicable.

**Table 4.** Overall Patient-Reported Outcome Scores for All Subjects Are Shown, Along With Available Values From Prior Studies.

	Study Population	Alizadehkhayat et al.	Delaney et al.	Geervliet et al.	Giannotti et al.	Lebon et al.	Levy et al.	Sweet et al.
Current pain	63/105 (60.0%)							
VAS	2.35 ± 2.54	4.5 ± 2.7	3.1	2.9 ± 2.8		1.3 ± 2.0		2.1 ± 2.3
Night pain	55/121 (45.5%)							
Narcotic use	14/103 (13.6%)							
ASES								
Pain score	38.5 ± 12.7				35 ± 6.6			
Function score	32.8 ± 12.4				42 ± 8.2			
Total score	52.2 ± 23.7		76		76.6 ± 14.8			78.8 ± 20.7
quickDASH score	45.5 ± 10.5					17 ± 15		
Brophy score	13.2 ± 5.7							
Surgery helped	92/120 (76.7%)						81.6%	
Satisfied w/current symptoms	86/120 (71.7%)	85%						
Subjective shoulder value (%)	73.2 ± 23.5		71				87	
Success <sup>a</sup>	70/106 (66.0%)							

Abbreviations: ASES, American Shoulder and Elbow Society; DASH, Disabilities of the Arm, Shoulder and Hand; VAS, visual analog scale.

records are not always accurate and/or thorough and preoperative comorbidities may have been missed. In addition, complications may have been missed if a patient was lost to follow-up. With more complete collection of complications, it would have been valuable to further stratify patients to different magnitudes of complications and compare the outcome measures.

## Conclusion

In conclusion, in our cross-sectional analysis of mid- to long-term outcomes following HHR, preoperative comorbidities or postoperative complications had no impact on patient-perceived postoperative satisfaction or most PROs. HHR is clinically viable in a wide variety of patients and can be considered in patients particularly with unipolar humeral disease or minimal glenoid disease, and younger patients with a desire to preserve bone stock. Future work is necessary to compare the efficacy of HHR compared with more traditional TSA and stemmed hemiarthroplasty regarding long-term outcomes and appropriate indications.

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## Ethical Statement

All studies were performed in accordance with the ethical standards in the 1964 Declaration of Helsinki.

## Ethical Review

This study was the product of the University of Pittsburgh IRB PRO14090251—"Evaluation of Clinical Outcomes and Complications of HemiCAP Humeral Head Resurfacing."

## Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: The senior author (Albert Lin) is a consultant for Arthrex and Wright/Tornier. Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements) that might post a conflict of interest in connection with the submitted article.

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