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Sports after shoulder arthroplasty: a comparative analysis of hemiarthroplasty and reverse total shoulder replacement

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Background: Traditionally, fewer postoperative sport restrictions are imposed on hemiarthroplasty (HHA) patients on than reverse total shoulder arthroplasty (RTSA) patients. However, functional outcomes have been shown to be superior in RTSA. No direct comparison of RTSA vs HHA has been done on rates of return to sports in patients with glenohumeral arthritis and rotator cuff dysfunction, proximal humeral fractures, or rheumatoid arthritis.

Methods: This is a retrospective review of consecutive RTSA and HHA patients collected from our institution's shoulder arthroplasty registry. All patients playing sports preoperatively with minimum 1-year follow-up were included. Final follow-up included an additional patient-reported questionnaire with questions regarding physical fitness and sport activities.

Results: The study included 102 RTSA and 71 HHA patients. Average age at surgery was 72.3 years for RTSA compared with 65.6 years for HHA ($P < .001$). Patients undergoing RTSA had improved visual analog scale scores compared with HHA (−5.6 vs −4.2, $P = .007$), returned to sports after RTSA at a significantly higher rate (85.9% vs 66.7%, $P = .02$), and were more likely to be satisfied with their ability to play sports ($P = .013$). HHA patients were also more likely to have postoperative complaints than RTSA patients (63% vs 29%, $P < .0001$). No sports-related complications occurred. Female sex, age <70 years, surgery on the dominant extremity, and a preoperative diagnosis of arthritis with rotator cuff dysfunction predicted a higher likelihood of return to sports for patients undergoing RTSA compared with HHA.

Conclusions: Despite traditional sport restrictions placed on RTSA, patients undergoing RTSA can return to sports at rates higher than those undergoing HHA, with fewer postoperative complaints.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: Reverse total shoulder arthroplasty; hemiarthroplasty; sports; shoulder replacement; physical fitness; return to activity

Physical fitness is an important consideration for patients undergoing joint replacement. Studies have demonstrated improved surgical satisfaction is associated with return to preoperative activity levels.[24] Evaluations of patient return to

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activities have been extensively studied in hip and knee arthroplasty, demonstrating that up to 90% of patients resume preoperative physical activities.[9,22,25] Despite the plethora of lower extremity data, more recent interest has developed evaluating athletics after shoulder replacement.[11,14,18,22,27]

It is generally accepted that patients with glenohumeral osteoarthritis and an intact rotator cuff achieve the best results with anatomic total shoulder arthroplasty (TSA). However, in patients with rotator cuff dysfunction due to tears, denervation, inflammatory arthropathies, or fracture, surgeons and patients must decide whether to undergo humeral hemiarthroplasty (HHA) or reverse total shoulder arthroplasty (RTSA).[2,15,23] HHA has been traditionally thought to be the safer option compared with RTSA for patients who wish to remain active because there is less risk of failure.

The ability of patients to return to their sporting activities after these 2 procedures has not been directly compared, however. Recent studies surveying shoulder surgeons show that they often place fewer postoperative sports restrictions on HHA patients than on those undergoing RTSA.[7,13] As such, despite recent literature demonstrating improved functional and range of motion (ROM) outcomes for RTSA compared with HHA,[1,3,5,12,26] surgeons may be inclined to perform the "safer" HHA operation on patients given their preference to return to more physical activities.

Limited literature exists evaluating RTSA or HHA and return to physical activities. The most recent evaluation of RTSA found up to 85% return to sport,[6] whereas other studies have found similar postoperative participation without reporting specific rates of return.[11] Rates of return to physical activities range from 75% to 81% in the HHA literature, although most involved small cohorts.[14,21,27] Although these rates aid in managing the expectations of patients undergoing these individual procedures, no study has directly compared rates of return to sports after RTSA and HHA or sports-related complications.

The purpose of this study was to determine if patients who are not candidates for anatomic TSA due to rotator cuff dysfunction, rheumatoid arthritis, or proximal humeral fracture had better return to sports when they underwent HHA compared with RTSA. We hypothesized that patients undergoing RTSA would return to preoperative physical activities at an equal level as patients undergoing HHA, with no additional increase in rate of complications from participation in sports. Secondarily, we hypothesized that the RTSA cohort would have better functional and satisfaction outcomes than HHA patients with similar diagnoses.

Materials and methods

A prospectively collected shoulder arthroplasty registry was queried retrospectively for consecutive patients who underwent HHA or RTSA from 2007 to 2013. All patients must have had a contraindication for an anatomic TSA, including rotator cuff dysfunction, inflammatory arthritis, or proximal humeral fracture. Therefore, all patients met indications criteria to receive HHA or RTSA. The decision between these 2 procedures was determined by shared decision making between the surgeons and the patients.

All patients in the cohort received a Biomet Comprehensive Reverse Total Shoulder Arthroplasty or a Biomet Comprehensive Hemiarthroplasty (Warsaw, IN, USA). Patients who underwent revision procedures and bilateral procedures were also included. Patients were excluded if they had follow-up of less than 1 year. Deceased status was confirmed using Social Security records. Patients unreachable after 5 telephone attempts and 1 mailing were considered lost to follow-up. Finally, during telephone interviews, patients who had not participated in a sport within 3 years preoperatively were excluded.

After applying our initial inclusion and exclusion criteria, 132 consecutive patients had undergone RTSA at a single institution with a least 1 year of follow-up, and 97 patients underwent HHA with at least 1 year of follow-up for the aforementioned indications. In the RTSA group, 21 patients were lost to follow-up, 5 patients declined to respond to the survey, and 4 had died. Thus, 102 RTSA patients were interviewed by phone. In the HHA group, 17 patients were lost to follow-up, 2 declined to participate, and 7 patients had died, leaving 71 patients remaining available for interview. All analyses were performed per-patient because only 4 patients underwent bilateral HHA.

Clinic and operative records for eligible patients were reviewed for preoperative diagnosis, body mass index (BMI), age, other medical comorbidities, and operative complications. The information obtained from the records was cross-referenced with patients during the telephone interview. Prospectively collected preoperative American Shoulder and Elbow Society (ASES) and visual analog scale (VAS) pain scores were also obtained from the shoulder arthroplasty registry.

The telephone interview used an outcome questionnaire (Appendix S1) based on the work by McCarty et al[14] and other studies on return to sport after arthroplasty.[7,25] This questionnaire included demographic data, preoperative activity assessment (including sports participation),[7,8] postoperative activity assessment, and subjective fitness level. The fitness sports category was based on a similar categorization by prior studies[16,25] and was defined as lightweight training or resistance bands (not used for physical therapy) with gym attendance greater than 2 hours weekly. No patient in either cohort participated in heavy weight lifting. If a sport was stopped postoperatively, we recorded the reason for discontinuation. Direct rates of return were calculated for each sport, but only if the patients participated in that specific sport preoperatively. New sports started postoperatively were recorded separately. Finally, ASES and VAS questionnaires were administered.[18]

Postoperative sports protocol

A similar postoperative rehabilitation protocol was followed for HHA and RTSA, which included 4 weeks in a sling, with the initiation of passive ROM at 2 weeks, active ROM at 6 weeks, and strengthening at 3 months. Prior recreational activities and work were encouraged after 3 months. The only restriction verbalized to the patient was to avoid contact sports.

Statistics

After skewness and kurtosis analysis a normally distributed data set, comparative differences between the study groups were done using independent-sample *t* tests for continuous variables and χ^2 and Fisher exact tests for categorical variables. Changes in patient-reported outcome measures were assessed using paired-sample *t* tests. Subanalyses were then performed by controlling for sex, age, and preoperative diagnoses. Patients with arthritis with rotator cuff dysfunction or rotator cuff tear arthropathy were grouped for analysis because they represent a similar group of patients in whom surgeons would consider performing HHA or RTSA: the competency of the rotator cuff in these patients was seen as a contraindication to anatomic TSA. All tests used 2-sided hypothesis testing with statistical significance set at $P < .05$ and were conducted with SPSS 19.0 software (IBM Corp, Armonk, NY, USA).

Results

Demographics

Compared with the HHA group, patients undergoing RTSA were generally older at the time of surgery (72.3 vs 65.6 years, $P < .001$) and at the time of follow-up (74.3 vs 70.9 years, $P = .014$). Average follow up was 31.7 months (range, 11.5-65 months) for RTSA and 62.9 months (range, 13-90.2 months) for HHA ($P < .001$). The gender proportions were equivalent, with a predominance of women in both groups (67.6% vs 67.6%, $P = 1$), and the average BMI (28.3 vs 28.5 kg/m^2, $P = .87$) was essentially equal. Both groups had similar distributions of surgery on their dominant extremity (RTSA: 56.9% vs HHA: 60.6%, $P = .64$; Table I).

Validated outcome measures

In terms of overall outcome measures, both groups had statistically significant improvements in the VAS score and ASES score after RTSA (Tables II and III). There was, however, better improvement in the VAS pain score for RTSA than for HHA (−5.64 vs −4.15, $P = .007$), which was more pronounced for patients older than age 70. There was no difference in the change in the ASES score (+38.8 vs +36.5, $P = .63$) regardless of diagnosis, gender, or age (Table III). Women also had greater pain improvement after RTSA than after HHA (Table II). When subdivided by diagnosis, patients with arthritis and rotator cuff dysfunction had more improvement in their VAS pain scores postoperatively with RTSA than with HHA (Table II).

HHA patients were also more likely to have postoperative complaints than RTSA patients (63% vs 29%, $P < .0001$). Most commonly, 45% (32 of 71) of patients undergoing HHA complained of chronic pain and 32.4% (23 of 71) complained of stiffness compared with 10.5% (11 of 102) complaining of pain and 11.8% (12 of 102) complaining of stiffness in patients undergoing RTSA.

Table I Demographics of hemiarthroplasty and reverse total shoulder arthroplasty cohorts

Variable	HHA (n = 71) No. (%)	RTSA (n = 102) No. (%)	*P* value*
Diagnosis			
Arthritis + RCD	51 (71.8)	80 (78.4)	.3688
Proximal humeral fractures	17 (23.9)	17 (17.1)	.2493
Rheumatoid arthritis	3 (4.2)	5 (5.2)	1
Age, y			
<70	47 (66.2)	44 (43.1)	**.0033**
>70	24 (33.8)	58 (56.9)	**.0033**
Gender			
Male	23 (32.4)	33 (32.4)	1
Female	48 (67.6)	69 (67.6)	1
Extremity			
Dominant	43 (60.6)	58 (56.9)	.6418
Nondominant	28 (39.4)	44 (43.1)	.6418

HHA, hemiarthroplasty; *RTSA*, reverse total shoulder arthroplasty; *RCD*, rotator cuff dysfunction.
* Values in bold are statistically significant ($P < .05$).

Table II Change in visual analog scale score after shoulder arthroplasty

Variable	HHA	RTSA	*P* value*
Overall	−4.15	−5.64	**.007**
Diagnosis			
Arthritis + RCD	−3.90	−5.61	**.008**
Proximal humeral fractures	−4.24	−6.35	.53
Rheumatoid arthritis	−6.53	−6.58	.97
Age, y			
<70	−4.56	−5.66	.133
>70	−3.36	−5.61	**.018**
Gender			
Males	−4.78	−5.50	**.44**
Females	−3.84	−5.71	**.007**
Extremity			
Dominant	−3.94	−5.30	**.057**
Nondominant	−4.46	−6.12	**.047**

HHA, hemiarthroplasty; *RCD*, rotator cuff dysfunction; *RTSA*, reverse total shoulder arthroplasty.
* Values in bold are statistically significant ($P < .05$).

Table III Change in American Shoulder and Elbow Surgeons score after shoulder arthroplasty

Variable	HHA	RTSA	*P* value
Overall	+37	+39	**.**63
Diagnosis			
Arthritis + RCD	+34	+43	**.**083
Proximal humeral fractures	+34	+45	**.**48
Rheumatoid arthritis	+52	+61	.51
Age, y			
<70	+42	+42	.96
>70	+30	+38	.33
Gender			
Males	+42	+39	.96
Females	+35	+40	.44
Extremity			
Dominant	+33	+41	.21
Nondominant	+45	+39	.44

HHA, hemiarthroplasty; *RCD*, rotator cuff dysfunction; *RTSA*, reverse total shoulder arthroplasty.

Return to sports

A similar proportion of patients in both groups participated in sports preoperatively (HHA: 71.8% vs RTSA: 74.5%, $P = .73$). The average age of patients who participated in sports preoperatively was younger in the HHA group than in the RTSA group (63.51 vs 72.26 years, $P < .05$). RTSA patients returned to sports at a significantly higher rate (85.9% vs 66.7%, $P = .0154$). For those who returned, average time to full return to sports did not differ between the 2 groups (HHA: 6.2 months vs RTSA: 5.3 months, $P = .40$). Comorbidities and BMI had no effect on return to sport in either cohort.

For men, there was no difference in the rate of return between HHA and RTSA (68.1% vs 88.5%, $P = .15$). For women, the rate of return was higher for RTSA compared with HHA (88% vs 65.5%, $P = .022$; Table IV). When controlling for age, there was a significant difference in the rate of return to sports for patients younger than 70 years for RTSA compared with HHA (96.8% vs 65.0%, $P < .001$) but not for patients older than age 70 (81.2% vs 72.7%, $P = .67$). When controlling for surgery on the dominant vs nondominant extremity, patients undergoing RTSA had higher rates of return than those undergoing HHA for their dominant extremity only ($P = .004$).

When subanalyzed by diagnosis, overall rates of return to at least 1 sport only differed for the group with arthritis and rotator cuff dysfunction (RTSA: 89.8% vs HHA: 65.7%, $P < .01$). There was no difference in rates of return for proximal humeral fractures (76.9% vs 76.9%, $P = 1$), or rheumatoid arthritis (100% vs 33%, $P = .14$; Table IV).

Fitness sports, swimming, and cycling were among the top sports that patients returned to postoperatively in both groups. Patients returned to fitness sports at a greater rate after undergoing RTSA than after HHA, but there was no difference between RTSA or HHA for sport-specific rates of return when categorized by level of impact (Table V).

Preoperative fitness levels and postoperative satisfaction

Preoperatively, there was no difference in the proportion of patients participating in 2 or more hours of physical fitness between the HHA and RTSA groups (60.5% vs 66.7%, $P = .42$). A similar percentage of patients in both groups felt their physical fitness improved (HHA: 40.8% vs RTSA: 41.1%, $P = 1$). More patients undergoing RTSA felt their sports outcome was good to excellent compared with patients undergoing HHA (86.3% vs 62.0%, $P = .013$). The proportion of patients who felt they had good to excellent surgical outcomes was also higher in the RTSA group (92.2% vs 81.6%, $P = .0566$). There were no sport-related complications in either group.

Discussion

Return to sports and physical activities has become an increasingly important part of patient satisfaction after orthopedic surgical procedures. There is a relative paucity of studies regarding return to sports in the shoulder arthroplasty literature compared with the literature in hip and knee arthroplasty. The lack of data on shoulder arthroplasty return to sports may be partly due to a lack of consensus among shoulder surgeons and the perceived need for surgeons to restrict patients' activity after shoulder arthroplasty, with HHA perceived to be "safer" than RTSA for patients who wish to return to sports.[7,13]

This study is one of the largest to compare return to activity after RTSA vs HHA and the first to directly compare sport-specific rates between the 2 shoulder arthroplasty groups. The study was designed to help surgeons and patients decide between HHA and RTSA when TSA is contraindicated. In this investigation, we found that patients undergoing RTSA returned to ≥1 sporting activity at a higher rate than patients undergoing HHA, without an increase in sports-related complications. Also, more RTSA patients had subjectively higher satisfaction with their surgery and their ability to return to sports. Age, gender, surgery on the dominant vs nondominant extremity, and preoperative diagnosis were among the most important variables affecting return to sport. Specifically, women, patients younger than age 70, surgery on the dominant extremity, and patients with a preoperative diagnosis of arthritis/rotator cuff dysfunction returned to sports at a much higher rate after RTSA than after HHA.

In terms of sports-specific return rates, aside from fitness sports, the rates of return for the most commonly reported sports, such as swimming, cycling, doubles tennis, golf,

Table IV Return to ≥1 sport after shoulder arthroplasty surgery

Variable	HHA	RTSA	*P* value*
	No (%)	No (%)	
Overall	34/51 (66.7)	67/76 (88.2)	**.0063**
Diagnosis			
Arthritis + RCD	23/35 (65.7)	53/59 (89.8)	**.0063**
Proximal humeral fractures	10/13 (76.9)	10/13 (76.9)	1
Rheumatoid arthritis	1/3 (33)	4/4 (100)	.14
Age, y			
<70	26/40 (65.0)	31/32 (96.8)	**.0009**
>70	8/11 (72.7)	36/44 (81.2)	.6741
Gender			
Males	15/22 (68.1)	23/26 (88.5)	.15
Females	19/29 (65.5)	44/50 (88)	**.022**
Extremity			
Dominant	16/30 (53.3)	40/47 (85.1)	**.0036**
Nondominant	18/21 (85.7)	27/29 (93.1)	.64

HHA, hemiarthroplasty; *RCD*, rotator cuff dysfunction; *RTSA*, reverse total shoulder arthroplasty.
* Values in bold are statistically significant ($P < .05$).

Table V Top activities for patients before and after shoulder arthroplasty

Sport	Within 3 y before RTSA	After RTSA	Rate of return	Within 3 y before HHA	After HHA	Rate of return	*P* value*
	(No.)	(No.)	(%)	(No.)	(No.)	(%)	
Noncontact high-load sports							
Singles tennis	12	4	33.3	5	3	60	.59
Doubles tennis	8	3	37.5	6	4	66.7	.59
Softball/baseball	1	1	100	4	2	50	1
Noncontact low-load sports							
Swimming	33	23	69.7	15	9	60	.53
Fitness sports	27	27	100	13	9	69.2	**.008**
Golf	20	11	55	13	7	53.8	1
Cycling	12	8	66.7	7	4	57.1	1
Fishing	4	1	25	1	1	100	.4
Rowing	1	1	100	1	1	100	1
Non-upper extremity sports†							
Running	7	5	71.4	10	7	70	1
Downhill skiing	7	2	28.6	5	2	40	1
Dancing	2	1	50	2	1	50	1
Horseback riding	2	1	50	1	0	0	1
Contact sports							
Basketball	1	1	100	2	1	50	1

HHA, hemiarthroplasty; *RTSA*, reverse total shoulder arthroplasty.
* Values in bold are statistically significant ($P < .05$).
† With risk of falling.

downhill skiing, and singles tennis, were equivalent between RTSA and HHA; these values were lower on average, however, than those rates reported after TSA.[14,18] We also found an essentially equivalent average time to return to full sports between HHA (6.2 months) and RTSA (5.3 months), which is comparable to the time reported in the TSA literature, which ranges from 4.5 to 11.2 months.[10,14,18]

An important weakness of this study is the heterogeneity of the RTSA and HHA groups. Although there was no difference in gender proportion, proportion of surgery on the dominant extremity, BMI, or associated comorbidities, the RTSA cohort was on average older and had less follow-up than the HHA group. These differences create the potential for significant bias, but they occurred due to increasing

familiarity of the surgeons with RTSA during the study period. The more comfortable the surgeons became with the technique, outcomes, and expected complications, the more the indications for the procedure expanded.

Our experience is representative of national trends in RTSA use.[17] However, it is possible that younger patients and those with higher functional expectations may have been counseled preoperatively toward HHA rather than to RTSA. In addition, lower expectations set at the time of surgery for RTSA may have led to a false sense of subjective success in postoperative ratings or patient satisfaction, or both.

Subanalyses controlling for those variables were performed to account for these differences (Tables II-IV). Of particular note, the rate of return to sports for RTSA compared with HHA was actually slightly more pronounced for patients younger than 70 years. However, by subdividing the cohort, some of our other statistical power decreased. This may explain why prior literature[1,3,5,12,26] comparing RTSA vs HHA demonstrated improved functional outcomes for patients undergoing RTSA for rotator cuff arthropathy and proximal humeral fractures; however, these studies did not include any analysis on the rate of postoperative return to sports.

Our results did not reach statistical significance with regards to improvements in the ASES score when selecting for those specific diagnoses. Nevertheless, the difference in VAS pain score improvement was significant. In addition, our rates of return for specific diagnoses after HHA or RTSA are consistent with past rates reported in the literature in the elderly population.[20,21]

Other limitations inherent to this study are its retrospective nature and potential for patient recall bias as well as investigator bias given the use of a telephone survey. However, telephone surveys have demonstrated a greater patient response rate compared with mailed surveys,[19] and thus, our cohorts may be more diverse and representative. We also attempted to reduce patient recall bias by cross-referencing patient records when available.

Although both cohorts demonstrated success in return to noncontact high-load sports without sports-related complications and on average experienced improved VAS and ASES scores, caution should be used when applying these conclusions long-term. The average follow-up for the RTSA group and HHA group was 31 and 62 months respectively, without a final physical examination or radiographic assessment, which is left out in many studies regarding return to sports after shoulder arthroplasty.[4,11,14,27] The lack of radiographic data to record possible wear, loosening, or other signs of hardware damage may discourage some orthopedic surgeons from recommending return to sports. Nevertheless, the lack of patient-reported complications as a result of participating in a wide-variety of sports as well as focus on ASES and VAS pain scores gives orthopedic surgeons a platform to discuss and manage patient expectations regarding outcomes with respect to these 2 shoulder arthroplasty options.

Conclusions

Although postoperative activity restrictions have traditionally been the most stringent after RTSA, this study's findings suggest that patients undergoing RTSA can safely return to ≥1 sport at rates higher than those for HHA without an increase in sports-related complications. Women, patients aged younger than 70, surgery on the dominant extremity, and patients with a preoperative diagnosis of osteoarthritis with rotator cuff dysfunction predicted a higher rate of return to sport after RTSA compared with HHA. In addition, RTSA patients have significantly fewer postoperative complaints and are more likely to be satisfied with their sports outcomes than HHA patients. The reported outcomes in this study should help dispel the myth that HHA more reliably returns patients to sports compared with RTSA and help orthopedic surgeons manage patient expectations when discussing these 2 shoulder arthroplasties.

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Supplementary data

Supplementary data related to this article can be found online at doi:10.1016/j.jse.2015.11.003.

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