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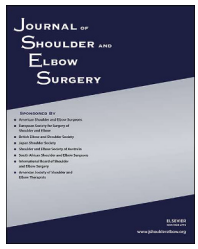

Return to sport after shoulder arthroplasty: an ASES multicenter analysis of sport-specific predictors of performance in reverse shoulder arthroplasty and total shoulder arthroplasty

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ABSTRACT

Background: Many patients undergoing shoulder arthroplasty—either reverse shoulder arthroplasty (rTSA) or anatomic shoulder arthroplasty (aTSA)—strongly desire to return to sport, yet return-to-sport (RTS) outcomes remain incompletely defined. This study aimed to determine RTS rates following rTSA and aTSA and to identify patient-specific and sport-specific factors associated with postoperative athletic performance.

Methods: A multicenter retrospective analysis with prospective administration of RTS questionnaires was conducted among patients who underwent rTSA or aTSA between 1 and 3 years postoperatively. Twenty-four ASES surgeons from 17 U.S. institutions participated. Study design and parameters were defined using a Delphi consensus method. The RTS questionnaire assessed participation in seven sports: golf, pickleball, tennis, running, weightlifting, yoga, and swimming. Outcomes included RTS status, changes in performance, enjoyment, participation frequency, time to RTS, and shoulder satisfaction (0-10). Univariate ANOVA compared outcomes across sports.

This study was approved by the Institutional Review Board of the New England Baptist Hospital (project number #2142768)

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Two age- and gender-matched propensity score analyses compared (1) rTSA versus aTSA for glenohumeral osteoarthritis (GHOA) and (2) rTSA for GHOA versus rotator cuff arthropathy (RCA). Multivariate logistic regression identified predictors of worse postoperative performance.

Results: A total of 961 patients completed the questionnaire; 55.9% ($n = 537$) participated in at least one sport preoperatively and attempted RTS postoperatively, yielding 656 sport participations. Mean follow-up was 24.0 ± 8.1 months, mean age was 68.3 ± 8.2 years, mean BMI was 28.5 ± 5.8, and 65.6% were male. Across all sports, 89.2% of participants were still playing, and 80.2% reported improved or unchanged performance, with no differences between sports. Overall RTS rates were highest for running (92.9%), tennis (92.3%), and weightlifting (93.1%). Most patients returned within 3-6 months (44.7%). In matched GHOA cohorts ($n = 165$ each), rTSA demonstrated higher rates of improved or stable performance (87.9% vs 78.9%, $P = 0.039$) and greater satisfaction ($P = 0.007$) compared to aTSA, with similar RTS rates (93.3% vs 89.1%). Diagnosis of GHOA (OR, 0.20; $P = 0.001$) and post-capsulorrhaphy arthropathy (OR, 0.07; P=0.021) were independently associated with lower odds of worsened postoperative sport performance.

Conclusion: Return to sport following shoulder arthroplasty is high, with most patients reporting maintained or improved performance. In patients with GHOA, rTSA was associated with higher rates of improved or stable sport performance and greater satisfaction compared to aTSA.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Shoulder arthroplasty; Return to sport; Reverse total shoulder arthroplasty (rTSA); Anatomic total shoulder arthroplasty (aTSA); Glenohumeral osteoarthritis (GHOA); Rotator cuff arthropathy (RCA); Sports performance outcomes; Propensity score matching

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Shoulder arthroplasty has become an increasingly popular treatment for a wide range of pathologies affecting the glenohumeral joint.[1,3,5,6,11] With increasing awareness of both anatomic total shoulder arthroplasty (aTSA) and reverse shoulder arthroplasty (rTSA), coupled with broadening surgical indications, there has been an exponential increase in the number of arthroplasties performed globally.[3,9,11] As both aTSA and rTSA become more commonplace, there is an increasing demand from patients to resume an active lifestyle postoperatively.[1]

Return to sport (RTS) has been shown to be an important factor for patient satisfaction following lower extremity joint replacement[1,28] and is a topic of growing interest following shoulder arthroplasty.[1,16,21,23,24,25] Several smaller studies have demonstrated promising results regarding RTS following both aTSA and rTSA.[16,21,23] Previously reported RTS following rTSA is generally less promising compared with aTSA; however, these data are derived from small samples with considerable heterogeneity for preoperative diagnosis.[16,21,23] Although there is a scarcity of data on the role of preoperative diagnosis on RTS following rTSA, glenohumeral osteoarthritis (GHOA) has been shown to be associated with improved functional outcomes compared with rotator cuff arthropathy (RCA).[22] Percentage participation following shoulder arthroplasty also seems to depend on the type of sport, with higher-demand activities demonstrating lower rates of return; however, there is considerable variability between studies.[2,8,24]

The purpose of this investigation was to identify the rate of RTS and self-rated performance for 7 common sports using a large multicenter cohort of patients undergoing both aTSA and rTSA. The role of preoperative diagnosis on rate of RTS and postoperative performance following rTSA was also assessed. We hypothesized that overall rates of RTS following shoulder arthroplasty would be high, with the highest rates being observed for sports requiring less shoulder activity. For patients with a diagnosis of GHOA, the rate of return and postoperative performance was expected to be higher for those undergoing aTSA vs. rTSA. Furthermore, we expected rates of return, along with postoperative performance and satisfaction, to be higher for those undergoing rTSA for GHOA compared to those with RCA.

Materials and methods

Study design

A multicenter analysis using sport-specific RTS questionnaires was completed by the patients of 24 American Shoulder and Elbow Society (ASES) surgeons across 17 institutions undergoing rTSA or aTSA. Study parameters were defined by the Delphi method, requiring 75% agreement for consensus. Inclusion and exclusion criteria, study definitions, as well as the questionnaires were determined using the Delphi method. Patients who underwent rTSA or aTSA between April 2021 and April 2024 were eligible for inclusion, provided they had a minimum of 1-year and a maximum of 3-year follow-up. The following diagnoses were included: glenohumeral osteoarthritis, RCA, post-capsulorrhaphy arthropathy (PCA), fracture sequelae, acute fracture, avascular necrosis, inflammatory arthritis, massive cuff tear without arthritis, and revision arthroplasty. The timing of inclusion varied based on when each institution contacted their respective patients. All eligible patients were contacted, and those who completed the RTS questionnaires were included in the study.

Sport questionnaires

The RTS questionnaires assessed participation in the following sports: golf, pickleball, tennis, running, weightlifting, yoga, and swimming. Patients could report participation in up to 2 sports. The total number of patient responses was defined as the number of athletes, whereas the total number of sport participants accounted for patients selecting multiple

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sports and providing sport-specific responses. The primary outcome of interest was postoperative sport performance relative to preoperative level categorized as improved/stayed the same or worsened. Secondary outcomes of interest included ability to return to sporting activities postoperatively (yes/no), frequency of sport participation relative to preoperative level (more frequently/same frequency vs. less frequently), and enjoyment level relative to preoperatively (more enjoyable/same amount vs. less enjoyable). The timing of RTS was determined at predefined intervals of <3 months, 3-6 months, 7-12 months, and ≥12 months. Overall subjective satisfaction with their operative shoulder during sporting activities was assessed numerically (0-10, with 10 being most satisfied).

Delphi method

The Delphi method is an iterative survey process that is used to reach a consensus across a group of experts. Eight contributing ASES surgeons used the Delphi method to define study parameters as well as design the sport-specific questionnaires. Consensus was defined as a minimum of 75% agreement on each questionnaire. Anonymity was maintained throughout the iterative process to minimize bias. A total of 16 rounds were produced to define the study protocol as well as design the RTS questionnaires. During each round, closed- and open-ended questions were sent to all surgeons and their responses recorded. Written responses not included in the original question stem for those questions not achieving consensus were subsequently added for further rounds. After each round, results were presented to the entire group. There was no attrition between rounds.

Statistical analysis

Data were assessed for normality, and appropriate parametric or nonparametric tests were applied. Continuous variables were reported as means and standard deviations, whereas categorical variables were summarized as counts and percentages. Univariate analysis of variance was used to compare patient outcomes across different sports as well as overall participant outcomes for all diagnoses.

Two separate age- and sex-matched propensity score analyses were conducted: the first compared primary rTSA and aTSA performed for glenohumeral osteoarthritis (GHOA) with an intact rotator cuff, and the second compared primary rTSA performed for GHOA vs. RCA. Categorical variables were compared using Pearson χ^2 test, and continuous variables were analyzed using the Wilcoxon test. A multivariable logistic regression model was constructed to identify patient factors associated with worse postoperative performance across all sports. Results are presented as odds ratios with 95% confidence intervals. Wald statistics and analysis of variance plots were generated to assess the relative strength of predictor variables. Statistical analyses were performed using open-source R statistical software (R Foundation for Statistical Computing, Vienna, Austria), with multivariable models fit using the rms package (https://cran.r-project.org/web/packages/rms/).

Table I – Overall athlete cohort demographics (N = 471)

Parameter	Mean ± SD or % (n)
Age, yr	68.3 ± 8.2
Sex	
Male	65.6 (309)
Female	34.4 (162)
Type of arthroplasty	
rTSA	70.4 (331)
aTSA	29.6 (139)
BMI	28.5 ± 5.8
Follow-up, mo*	24.0 ± 8.1
Dual sport†	36.9 (172)
ASA score >2	22.1 (104)
Comorbidities	
Hypertension	39.7 (187)
Hypercholesterolemia	41.0 (193)
Diabetes mellitus	10.0 (47)
Osteoporosis	4.0 (19)
Obesity	30.4 (143)
History of smoking	27.6 (130)
Prior ipsilateral shoulder surgery	27.8 (131)
Complications	3.4 (16)
Primary diagnosis	
GHOA	68.2 (321)
RCA	18.3 (86)
PCA	2.5 (12)
Fracture sequelae	1.1 (5)
Acute fracture	1.9 (9)
Avascular necrosis	0.7 (2)
Inflammatory arthritis	0.6 (3)
Massive cuff tear without arthritis	2.5 (12)
Failed arthroplasty	2.8 (13)

rTSA, reverse total shoulder arthroplasty; *aTSA*, anatomic total shoulder arthroplasty; *BMI*, body mass index; *ASA*, American Society of Anesthesiologists score; *GHOA*, glenohumeral osteoarthritis; *RCA*, rotator cuff arthropathy; *PCA*, post-capsulorrhaphy arthropathy; *SD*, standard deviation.

* Follow-up was defined as the amount of time between surgery and questionnaire response.

† Dual sport was defined as patients who indicated participation in multiple sports.

Results

Overall athlete demographics

Nine hundred sixty-one patients responded to the RTS questionnaire, with 55.9% (n = 537) indicating participation in 1 or more sports (Table I). Among those indicating participation, 471 patients completed each of their selected sport-specific questionnaires. Mean follow-up was 24.0 ± 8.1 months. The mean age was 68.3 ± 8.2 years, with 65.6% (n = 309) males. rTSA was performed in 70.4% of patients (n = 331), whereas 29.6% underwent aTSA (n = 139). The primary diagnosis was GHOA in 68.2% of patients (n = 321) and RCA in 18.2% (n = 86).

Sport participant breakdown by sport

We included 656 sport participants (given the multi-sport participation) involved in golf (n = 208), weightlifting (n = 175), swimming (n = 105), yoga (n = 56), pickleball (n = 58),

Table II – Overall sport participant breakdown by sport (all diagnoses, rTSA and aTSA)

Parameter	Overall (n = 656)	Golf (n = 208)	Pickleball (n = 58)	Tennis (n = 26)	Running (n = 28)	Weightlifting (n = 175)	Yoga (n = 56)	Swimming (n = 105)	*P* value
Age		69.0 ± 7.9	67.8 ± 9.3	69.0 ± 13.2	67.2 ± 7.0	66.6 ± 9.1	67.6 ± 7.6	69.0 ± 7.0	.152
Male sex	-	77.9 (162)	58.6 (34)	69.2 (18)	78.6 (22)	73.1 (128)	23.2 (13)	45.7 (48)	<.001*
BMI	-	29.0 ± 5.5	27.7 ± 7.0	25.0 ± 3.1	26.5 ± 3.5	28.3 ± 4.8	26.7 ± 5.6	29.6 ± 6.7	<.001*
Still playing postoperatively?: Yes	89.2 (585)	88.9 (185)	79.3 (46)	92.3 (24)	92.9 (26)	93.1 (163)	89.3 (50)	86.7 (91)	.122
Performance level compared to preoperative: Improved/stayed the same	80.2 (526)	79.3 (165)	86.2 (50)	65.4 (17)	92.9 (26)	79.4 (139)	83.9 (47)	78.1 (82)	.192
Enjoyment level compared to preoperative: More enjoyable/ same amount	83.5 (548)	82.7 (172)	84.5 (49)	73.1 (19)	92.9 (26)	87.4 (153)	82.1 (46)	79.0 (83)	.275
Frequency of participation compared to preoperative: More frequently/same amount		73.1 (152)	74.1 (43)	69.2 (18)	71.4 (20)	77.1 (135)	75.0 (42)	68.6 (72)	.821
How long after surgery did you resume sport participation?	n = 637	n = 205	n = 54	n = 24	n = 28	n = 173	n = 53	n = 100	
<3 mo	17.6 (112)	10.2 (21)	13.0 (7)	7.1 (3)	**46.4 (13)**	19.7 (34)	20.8 (11)	23.0 (23)	.004*
3-6 mo	44.7 (285)	46.8 (96)	48.1 (26)	**54.2 (13)**	46.4 (13)	39.3 (68)	43.4 (23)	46.0 (46)	
7-12 mo	26.7 (170)	**31.7 (65)**	20.4 (11)	20.8 (5)	7.1 (2)	29.5 (51)	26.4 (14)	22.0 (22)	
≥12 mo	11.0 (70)	11.2 (23)	**18.5 (10)**	12.5 (3)	0.0 (0)	11.6 (20)	9.4 (5)	9.0 (9)	
Satisfaction score: 0-10	9.1 ± 1.8	9.2 ± 1.5	9.3 ± 1.6	8.7 ± 1.9	9.1 ± 2.2	9.2 ± 1.9	9.0 ± 1.7	8.8 ± 2.2	.559

rTSA, reverse total shoulder arthroplasty; *aTSA*, anatomic total shoulder arthroplasty; *BMI*, body mass index.
Data are presented as mean ± standard deviation or percentage (count).
* Denotes statistical significance at alpha risk set to .05 (indicated in bold).

running (n = 28), and tennis (n = 26). There were significant differences in sex distribution between sport participants, as well as body mass index (BMI). Male participation by sport was as follows: running (78.6%), golf (77.9%), weightlifting (73.1%), pickleball (58.6%), tennis (69.2%), yoga (23.2%), and swimming (45.7%) ($P < .001$). Mean BMI by sport was golf (29.0 ± 5.5), pickleball (27.7 ± 7.0), tennis (25.0 ± 3.1), running (26.5 ± 3.5), weightlifting (28.3 ± 4.8), yoga (26.7 ± 5.6), and swimming (29.6 ± 6.7) ($P < .001$). There was no significant difference in mean age across all sport participants (Table II).

Overall, 89.2% of participants (n = 585) returned to sports postoperatively, with no significant differences in the rates across the 7 sports ($P = .122$). Sport-specific rates of return consisted of 88.9% for golf, 79.3% for pickleball, 92.3% for tennis, 92.9% for running, 93.1% for weightlifting, 89.3% for yoga, and 86.7% for swimming. Among the 71 participants who did not RTS, 33 (46.5%) reported it was due to reasons unrelated to their shoulder. Additionally, 80.2% of participants (n = 526) reported their performance either improved or stayed the same, which also did not differ between sports ($P = .192$). Sport-specific rates of improved or same performance consisted of 79.3% for golf, 86.2% for pickleball, 65.4% for tennis, 92.9% for running, 79.4% for weightlifting, 83.9% for yoga, and 78.1% for swimming. Moreover, 83.5% of participants (n = 548) reported more or the same enjoyment since surgery, with no significant differences observed between sports ($P = .275$). Sport-specific rates of more or the same enjoyment were 82.7% for golf, 84.5% for pickleball, 73.1% for tennis, 92.9% for running, 87.4% for weightlifting, 82.1% for yoga, and 79.0% for swimming. Also, 73.5% of participants (n = 482) reported more or the same frequency of participation since surgery, with no significant differences observed between sports ($P = .821$). Sport-specific rates of more or the same frequency of participation were 73.1% for golf, 74.1% for pickleball, 69.2% for tennis, 71.4% for running, 77.1% for weightlifting, 75.0% for yoga, and 68.6% for swimming. Most participants (44.7%) returned to sports within 3-6 months postoperatively, whereas an additional 26.7% returned within 7-12 months. Overall, patients reported a mean satisfaction score of 9.1 ± 1.8 with no significant difference across all sports (Table II).

Age and sex propensity score–matched rTSA vs. aTSA for GHOA

After propensity score matching by age and sex for patients undergoing rTSA for GHOA and aTSA for GHOA, the cohort consisted of 330 patients. There were no significant differences in age (rTSA 67.4 ± 7.0 years vs. aTSA 67.3 ± 7.0 years; $P = .856$), sex (rTSA 71.5% male vs. aTSA 70.9% male, $P > .999$), or BMI (rTSA 28.8 ± 5.4 vs. aTSA 28.3 ± 5.8, $P = .317$). There were no differences in the overall ability to return to sports (rTSA: 93.3%, n = 154, vs. aTSA: 89.1%, n = 147, $P = .243$), frequency (more frequent or same amount) of sport participation (rTSA: 78.2%, n = 129, vs. aTSA: 71.5%, n = 118, $P = .205$) or the enjoyment level (more enjoyable or same amount) during sport participation (rTSA: 90.9%, n = 150, vs. aTSA: 83.0%, n = 137, $P = .050$) comparing patients undergoing rTSA and aTSA. Significantly more patients reported that their performance either improved or stayed the same after rTSA compared with aTSA (87.9%, n = 145, vs. 78.9%, n = 130, $P = .039$). Additionally, overall subjective postoperative satisfaction with their shoulder during sporting activities was

Table III – Sport participant breakdown of age- and sex-matched primary rTSA and aTSA cohorts

Parameter	All sports		P value
	Primary rTSA for GHOA (n = 165)	Primary aTSA for GHOA (n = 165)	
Age*	67.4 ± 7.0	67.3 ± 7.0	.856
Sex*			
Male	71.5 (118)	70.9 (117)	>.999
Female	28.9 (47)	29.1 (48)	
BMI	28.8 ± 5.4	28.3 ± 5.8	.317
Still playing postoperatively?: Yes	93.3 (154)	89.1 (147)	.243
Performance level compared to preoperative: Improved/ Stayed the same	87.9 (145)	78.9 (130)	**.039**†
Enjoyment level compared to preoperative: More enjoyable/ same amount	90.9 (150)	83.0 (137)	.050
Frequency of participation compared to preoperative: More frequently/same amount	78.2 (129)	71.5 (118)	.205
How long after surgery did you resume sport participation?			
<3 mo	15.8 (26)	18.2 (30)	.507
3-6 mo	43.0 (71)	44.2 (73)	
7-12 mo	27.3 (45)	25.5 (42)	
≥12 mo	12.1 (20)	7.3 (7)	
Satisfaction score: 0-10	9.5 ± 1.2	9.0 ± 1.9	**.007**†

rTSA, reverse total shoulder arthroplasty; *aTSA*, anatomic total shoulder arthroplasty; *BMI*, body mass index; *GHOA*, glenohumeral osteoarthritis.
Data are presented as mean ± standard deviation or percentage (count).
* Variables used to propensity score match rTSA and aTSA patients.
† Denotes statistical significance at alpha risk set to .05.

Table IV – Sport participant breakdown of comparing matched cohort diagnoses of GHOA and RCA for primary rTSA

Parameter	Primary rTSA for GHOA (n = 223)	Primary aTSA for RCA (n = 103)	P value
Age*	69.8 ± 5.6	70.2 ± 5.5	.907
Sex*			
Male	68.6 (143)	56.3 (58)	.220
Female	35.9 (80)	43.7 (45)	
BMI	28.3 ± 5.6	28.3 ± 5.7	.907
Still playing postoperatively?: Yes	93.7 (209)	86.4 (89)	.050
Performance level compared to preoperative: Improved/ stayed the same	90.6 (202)	73.8 (76)	<.001†
Enjoyment level compared to preoperative: More enjoyable/ same amount	93.7 (209)	80.6 (83)	<.001†
Frequency of participation compared to preoperative: More frequently/same amount	79.4 (177)	65.0 (67)	.008†
How long after surgery did you resume sport participation?			
<3 mo	18.8 (42)	20.4 (21)	.830
3-6 mo	43.5 (97)	44.7 (46)	
7-12 mo	25.1 (56)	20.4 (21)	
≥12 mo	10.8 (24)	11.7 (12)	
Satisfaction score: 0-10	9.6 ± 1.1	8.8 ± 2.0	<.001†

GHOA, glenohumeral osteoarthritis; *RCA*, rotator cuff arthropathy; *rTSA*, reverse total shoulder arthroplasty; *BMI*, body mass index; *aTSA*, anatomic total shoulder arthroplasty.
Data are presented as mean ± standard deviation or percentage (count).
* Variables used to propensity score match GHOA and RCA patients.
† Denotes statistical significance at alpha risk set to .05.

slightly higher after rTSA compared with aTSA (9.5 ± 1.2 vs. 9.0 ± 1.9, $P = .007$) (Table III).

Age and sex propensity score–matched rTSA for GHOA vs. RCA

After propensity score matching by age and sex for patients undergoing rTSA for GHOA and rTSA for RCA, the cohorts consisted of 223 and 103 patients, respectively. There were no significant differences in age (GHOA 69.8 ± 5.6 years vs. RCA 70.2 ± 5.5 years; $P = .907$), sex (GHOA 68.6% male vs. RCA 56.3% male, $P = .220$), or BMI (rTSA 28.3 ± 5.6 vs. RCA 28.3 ± 5.7, $P = .907$). There was a significant difference in the overall ability to return to sports (GHOA: 93.7%, n = 209, vs. RCA: 86.4%, n = 89, $P = .050$) comparing patients undergoing rTSA for GHOA compared with RCA. Significantly more patients with GHOA also reported participating at an improved or similar level (90.6%, n = 202, vs. 73.8%, n = 76, $P < .001$), participating at an increased or similar frequency (79.4%, n = 177, vs. 65%, n = 67%, $P = .008$), participating with an increased or similar enjoyment level (93.7%, n = 209, vs. 80.6%, n = 84, $P < .001$), and had higher subjective satisfaction with their shoulder during sporting activities (9.6 ± 1.1 vs. 8.8 ± 2.0, $P < .001$) compared with those patients with RCA (Table IV).

Predictors of worse postoperative performance

Multivariate logistic regression demonstrated that a diagnosis of GHOA (odds ratio 0.20, 95% confidence interval 0.08-0.54; $P = .001$) and PCA (odds ratio 0.07, 95% confidence interval 0.01-0.68; $P = .021$) were independently protective against worse postoperative performance across all sports (Table V).

Discussion

The results of this large multicenter study demonstrated a very high rate of RTS and self-reported satisfaction following shoulder arthroplasty. Notably, this high rate did not significantly differ between aTSA and rTSA or the 7 different sports

Table V – Factors predictive of worse postoperative performance in all sports

Parameter	β coefficient	Confidence interval		P value
		2.5	97.5	
BMI*	1.03	0.99	1.07	.110
Age*	1.01	0.99	1.04	.350
Revision arthroplasty	0.53	0.13	2.1	.367
Prior ipsilateral surgery	1.30	0.80	2.12	.297
Complication	2.50	0.96	6.51	.061
Diagnosis of RCA	0.37	0.13	1.04	.060
Diabetes mellitus	0.57	0.26	1.26	.109
History of smoking	1.16	0.73	1.84	.524
Female sex	0.94	0.60	1.46	.771
Diagnosis of GHOA	0.20	0.08	0.54	.001†
Diagnosis of MCT without arthritis	2.54	0.56	11.6	.227
Diagnosis of PCA	0.07	0.01	0.68	.021†
Diagnosis of fracture sequela	0.20	0.02	1.99	.169

BMI, body mass index; *RCA*, rotator cuff arthropathy; *GHOA*, glenohumeral osteoarthritis; *MCT*, massive cuff tear; *PCA*, post-capsulorrhaphy arthropathy.

* Continuous variable with odds ratio, representing the risk associated with each 1-unit increase.

† Denotes statistical significance at alpha risk set to .05.

included in this investigation. Patients who underwent rTSA for GHOA reported a higher overall rate of return, improved performance, and satisfaction postoperatively compared with other preoperative diagnoses. The diagnoses of GHOA and PCA were also found to correlate with better postoperative sports performance.

Previous studies have demonstrated relatively high rates of RTS following shoulder arthroplasty, with several studies reporting rates ranging from 70% to 85%.[1,8,14,16,21,23,24,25] However, an overall rate of return of 89.2% is, to our knowledge, the highest reported rate of RTS for a combined cohort of patients undergoing both primary and revision rTSA and aTSA. The time to return was also slightly earlier, with nearly half of the patients returning within 3-6 months postoperatively.[1,16] Although the reason for this is likely multifactorial, an important consideration is the relative homogeneity of the patient population. Specifically, most of the patients were treated for GHOA, a diagnosis associated with improved postoperative range of motion and patient-reported outcomes, particularly following rTSA.[7,13,18,22] This could ultimately translate into improved ability to return to sports, contributing to the higher and faster rate of return seen in this investigation.

Although it was hypothesized that a higher rate of return would be seen in sports that place less demand on the shoulder, no sport-specific differences were identified in RTS in the present study. This hypothesis was based on results from earlier meta-analyses that revealed lower rates of RTS for sports that place a "higher demand" on the shoulder, including tennis and weightlifting.[2,8,24] However, more recent data on return to racket sports have demonstrated higher RTS following aTSA and rTSA, similar to the results of this investigation.[27] Interestingly, we found no difference between RTS for tennis and pickleball. The similar rate of return for pickleball, a lower-demand racket sport that has recently experienced exponential growth in popularity, suggests that sport intensity may not be as important an RTS determinant as originally believed.[20] Our RTS results for weightlifting are also in line with this theory. Despite the strength requirements and frequent recommendations to avoid heavy lifting, the rate of return to this sport following aTSA and rTSA were higher than what has been reported previously.[2]

For medium- and lower-demand activities, such as golf, yoga, swimming, and running, the rates observed seem to be relatively consistent with those reported in the literature.[4,12,19,25] It should be noted that some differences have been reported when comparing aTSA and rTSA for certain activities. Boltuch et al[4] found that golfers who underwent aTSA reported greater improvements in pain and driving distance than those undergoing rTSA, despite similar overall RTS.[4] Mousad et al[19] found that significantly more swimmers returned to their sport following aTSA; however, overall ability and satisfaction were similar for both procedures among those who returned. Although both studies included both RCA and OA patients, the findings suggest there is some nuance regarding how patients return to different sports, which warrants further study. Our robust sport-specific data demonstrate a high degree of homogeneity not only in terms of rate of return but also in terms of enjoyment, performance, and frequency of participation following both aTSA and rTSA. These RTS data, derived from one of the largest cohorts to date, suggest that a significant percentage of patients can expect to return to sport, even when participating in higher-demand activities.

The similar RTS results for patients undergoing aTSA and rTSA for GHOA in this study further highlight the role of preoperative diagnosis on postoperative sport participation. Historically, reported rates of RTS for those undergoing aTSA have been consistently higher than that for patients treated with rTSA.[1,16] A meta-analysis of 13 studies conducted by Liu et al[16] demonstrated a significantly higher rate of return following aTSA, 92.6%, compared with rTSA, 74.9%. One important consideration is that rTSA is used to treat a much broader spectrum of pathology, which can influence

postoperative outcomes.[1,3,5-7,11,13,18,22] Although multiple studies have demonstrated good outcomes following rTSA for many indications, diagnoses such as RCA, fractures, inflammatory arthritis and revisions are associated with less consistent results.[7,13,18] Thus, in order to mitigate the influence of different preoperative diagnoses, our comparison for RTS following aTSA and rTSA looked specifically at an age- and sex-matched cohort of patients with a diagnosis of GHOA. When controlling for these factors, no significant differences were found in the rate of return or frequency of participation in sport postoperatively.

These findings not only highlight the importance of preoperative diagnosis in determining postoperative outcomes following shoulder arthroplasty but also suggest that RTS may be more influenced by disease factors instead of the type of arthroplasty being performed.

Interestingly, significantly more patients reported that their performance either improved or stayed the same following rTSA compared with aTSA for GHOA. Patients who underwent rTSA also reported significantly higher subjective satisfaction with their shoulder during sporting activities. These findings differ from traditional perceptions regarding outcomes following rTSA and aTSA. Although the reason for these findings is not entirely clear, it could potentially be related to differences in the degree of arthritis between these 2 cohorts. Patients undergoing rTSA for more severe GHOA may have had a lower baseline level of function prior to surgery, which could result in the subjective experience of greater improvement. Changes in rTSA design, such as increased lateralization and smaller neck-shaft angle, have been shown to increase external and internal rotation and decrease scapular impingement.[17,26,30] These changes could in theory facilitate RTS, particularly those requiring dynamic shoulder motion; however, this has yet to be proven clinically.[15,24] As surgeons have become more experienced with rTSA, optimized implant positioning and better surgical technique may also be a contributing factor to improved outcomes.[10,29] Godin et al[10] looked at the effect of subscapularis repair following rTSA and found that the rate of RTS in those who had their subscapularis muscle repaired was significantly higher. Although all of these factors are beyond the scope of the current investigation, they could be areas for further study. Despite some remaining questions, the higher number of patients with improved function and satisfaction following rTSA provides new insight regarding the degree to which patients resume an active lifestyle after this procedure, which may be similar to those undergoing aTSA.

As hypothesized, the rate of RTS for rTSA in patients with GHOA was higher than those with RCA. The manner in which these patients return is also more robust, which is consistent with the literature that suggests GHOA is linked to improved postoperative outcomes.[18,22] This is further supported by the fact that, following multivariate regression, GHOA was found to correlate with improved performance across all sports. Interestingly, PCA was also found to be protective. Ultimately, these data should help shoulder arthroplasty surgeons provide better, disease-specific, RTS counseling.

The strengths of this study include the multicenter cohort and Delphi design. Our results are derived from data from 24 surgeons working at 17 different institutions and is the largest known cohort of patients evaluated for RTS following both aTSA and rTSA. The study also includes data on 7 different sports that were deemed, via the Delphi process, to be the most popular among this patient population. This study does, however, have several limitations that should be noted. Most importantly, this is a retrospective analysis relying on patient recall of their preoperative function. Patients completed questionnaires during their postoperative visit, which comes with a significant risk of recall bias. Reliance on patient questionnaires for data collection also increases the risk of selection bias as patients had to "opt in" to participate. To help mitigate this, propensity score matching for age and sex was used for our comparative analyses regarding arthroplasty type and preoperative diagnosis. Another important consideration is the high percentage of patients with GHOA compared with other diagnoses. Additionally, the inclusion of multiple preoperative diagnoses introduces heterogeneity that may influence RTS outcomes. Furthermore, variation regarding implant systems and surgical technique across the multiple centers may serve as additional confounders. Although this reflects real-world shoulder arthroplasty practice, future studies with larger, diagnosis-specific cohorts may allow for more narrowly defined subgroup analyses to better elucidate the role of these parameters. rTSA for GHOA was associated with greater RTS and better performance and satisfaction while also correlating with better outcomes. Future studies should aim to include not only higher numbers of patients with RCA but also other diagnoses to better characterize how they affect rates of RTS. Additionally, this study did not capture granular sport-specific details such as level of play, intensity of participation, or specific activity components (eg, overhead serving in tennis or stroke type in swimming). As a result, RTS was defined as overall participation rather than performance of specific high-demand movements. Future investigations should focus on aTSA- and rTSA-specific rates and collect more granular sport-specific metrics. Finally, longer-term data are needed to determine the durability of the high rates of return reported in this study.

Conclusion

Patients demonstrate a high rate of RTS and satisfaction across a variety of sporting activities following rTSA and aTSA, with most patients returning to sports between 3 and 6 months postoperatively. The overall ability to return to sports was similar irrespective of the type of sport or arthroplasty (rTSA vs. aTSA). However, rTSA performed for GHOA was associated with higher RTS rates and performance compared with rTSA performed for RCA. The indication of GHOA and post-capsulorrhaphy also predicted improved sport performance in this study.

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REFERENCES

1. Aim F, Werthel J-D, Deranlot J, Vigan M, Nourissat G. Return to sport after shoulder arthroplasty in recreational athletes: a systematic review and meta-analysis. Am J Sports Med 2018;46:1251–7. https://doi.org/10.1177/0363546517714449.
2. Ames A, Shah SS, Pettit R, Li L, Chilton M, Gaylord B, et al. Against surgeons' advice: the return to sport in high-demand weightlifters following anatomic total shoulder arthroplasty at average 3.6 years' follow-up. J Shoulder Elbow Surg 2023;32:e153–9. https://doi.org/10.1016/j.jse.2022.09.027.
3. Best MJ, Aziz KT, Wilckens JH, McFarland EG, Srikumaran U. Increasing incidence of primary reverse and anatomic total shoulder arthroplasty in the United States. J Shoulder Elbow Surg 2021;30:1159–66. https://doi.org/10.1016/j.jse.2020.08.010.
4. Boltuch A, Grewal G, Cannon D, Toma J, Levy JC. Return to golf after shoulder arthroplasty: golf performance and outcome scores. Semin Arthroplasty 2022;32:343–50. https://doi.org/10.1053/j.sart.2021.11.007.
5. Cappellari A, Trovarelli G, Andriolo M, Berizzi A, Ruggieri P. Reverse shoulder arthroplasty for treatment of proximal humerus complex fractures in elderly: a single institution experience. Injury 2022;53(Suppl 1):S2–7. https://doi.org/10.1016/j.injury.2020.07.056.
6. Cazeneuve JF, Cristofari DJ. The reverse shoulder prosthesis in the treatment of fractures of the proximal humerus in the elderly. J Bone Joint Surg Br 2010;92:535–9. https://doi.org/10.1302/0301-620x.92b4.22450.
7. Coscia AC, Matar RN, Espinal EE, Shah NS, Grawe BM. Does preoperative diagnosis impact patient outcomes following reverse total shoulder arthroplasty? A systematic review. J Shoulder Elbow Surg 2021;30:1458–70. https://doi.org/10.1016/j.jse.2020.10.003.
8. Davey MG, Davey MS, Hurley ET, Gaafar M, Pauzenberger L, Mullett H. Return to sport following reverse shoulder arthroplasty: a systematic review. J Shoulder Elbow Surg 2021;30:216–21. https://doi.org/10.1016/j.jse.2020.08.006.
9. Farley KX, Wilson JM, Kumar A, Gottschalk MB, Daly C, Sanchez-Sotelo J, et al. Prevalence of shoulder arthroplasty in the United States and the increasing burden of revision shoulder arthroplasty. JBJS Open Access 2021;6:e20.00156. https://doi.org/10.2106/jbjs.Oa.20.00156.
10. Godin JA, Pogorzelski J, Horan MP, Lacheta L, Hussain ZB, Altintas B, et al. Impact of Age and Subscapularis Tendon reparability on return to recreational sports activities and 2-Year outcomes after reverse total shoulder arthroplasty. Orthop J Sports Med 2019;7:2325967119875461. https://doi.org/10.1177/2325967119875461.
11. Harjula JNE, Paloneva J, Haapakoski J, Kukkonen J, Äärimaa V. Increasing incidence of primary shoulder arthroplasty in Finland - a nationwide registry study. BMC Musculoskelet Disord 2018;19:245. https://doi.org/10.1186/s12891-018-2150-3.
12. Hoffman TR, Galasso LA, Noble MB, Ardebol J, Denard PJ. Return to yoga following anatomic or reverse total shoulder arthroplasty. JSES Int 2025;9:1210–4. https://doi.org/10.1016/j.jseint.2025.01.013.
13. Kennedy J, Klifto CS, Ledbetter L, Bullock GS. Reverse total shoulder arthroplasty clinical and patient-reported outcomes and complications stratified by preoperative diagnosis: a systematic review. J Shoulder Elbow Surg 2021;30:929–41. https://doi.org/10.1016/j.jse.2020.09.028.
14. Kolling C, Borovac M, Audigé L, Mueller AM, Schwyzer H-K. Return to sports after reverse shoulder arthroplasty—the Swiss perspective. Int Orthop 2018;42:1129–35. https://doi.org/10.1007/s00264-017-3715-8.
15. Larose G, Fisher ND, Gambhir N, Alben MG, Zuckerman JD, Virk MS, et al. Inlay versus onlay humeral design for reverse shoulder arthroplasty: a systematic review and meta-analysis. J Shoulder Elbow Surg 2022;31:2410–20. https://doi.org/10.1016/j.jse.2022.05.002.
16. Liu JN, Steinhaus ME, Garcia GH, Chang B, Fields K, Dines DM, et al. Return to sport after shoulder arthroplasty: a systematic review and meta-analysis. Knee Surg Sports Traumatol Arthrosc 2018;26:100–12. https://doi.org/10.1007/s00167-017-4547-1.
17. Luthringer TA, Larose G, Young Kwon M, Zuckerman JD, Virk MS. Reverse total shoulder arthroplasty: biomechanical considerations and the concept of lateralization. Bull NYU Hosp Joint Dis 2022;80:65–74.
18. Michaelson EM, Ranson WA, Schroen CA, Cagle PJ. Does preoperative diagnosis impact patient outcomes following reverse total shoulder arthroplasty? JSES Int 2024;9:1863–70. https://doi.org/10.1016/j.jseint.2024.06.018.
19. Mousad AD, Xie J, Schodlbauer DF, Beleckas CM, Levy JC. Return to swimming after shoulder arthroplasty. J Shoulder Elbow Surg 2025;34:e505–12. https://doi.org/10.1016/j.jse.2024.10.013.
20. Olsen AA, Li A, Johnson DD, Manson HC. Pickleball primer: an overview of common injuries, treatment, and optimization strategies in pickleball athlete. J Am Acad Orthop Surg 2024;32:763–70. https://doi.org/10.5435/jaaos-d-23-00705.
21. Papalia R, Ciuffreda M, Albo E, De Andreis C, Diaz Balzani LA, Alifano AM, et al. Return to sport after anatomic and reverse total shoulder arthroplasty in elderly patients: a systematic review and meta-analysis. J Clin Med 2020;9:1576. https://doi.org/10.3390/jcm9051576.
22. Saini SS, Pettit R, Puzzitiello RN, Hart PA, Shah SS, Jawa A, et al. Clinical outcomes after reverse total shoulder arthroplasty in patients with primary glenohumeral osteoarthritis compared with Rotator Cuff Tear arthropathy: does preoperative diagnosis make a difference? J Am Acad Orthop Surg 2022;30:e415–22. https://doi.org/10.5435/jaaos-d-21-00797.
23. Salem HS, Park DH, Thon SG, Bravman JT, Seidl AJ, McCarty EC, et al. Return to golf after shoulder arthroplasty: a systematic review. The Am J Sports Med 2021;49:1109–15. https://doi.org/10.1177/0363546520923070.

24. Tangtiphaiboontana J, Mara KC, Jensen AR, Camp CL, Morrey ME, Sanchez-Sotelo J. Return to sports after primary reverse shoulder arthroplasty: outcomes at mean 4-Year Follow-up. Orthop J Sports Med 2021;9:23259671211012393. https://doi.org/10.1177/23259671211012393.
25. Tramer JS, Klag EA, Kuhlmann NA, Sheena GJ, Muh SJ. Return to golf following reverse total shoulder arthroplasty. Arch Bone Jt Surg 2021;9:306–11. https://doi.org/10.22038/abjs.2020.40802.2109.
26. Valenti P, Sauzières P, Katz D, Kalouche I, Kilinc AS. Do less medialized reverse shoulder prostheses increase motion and reduce notching? Clin Orthop Relat Res 2011;469:2550–7. https://doi.org/10.1007/s11999-011-1844-8.
27. Vegas A, Cannon D, Garcia JR, Rodriguez HC, Levy J, Lapica H, et al. Return to racket sports after shoulder arthroplasty: performance and outcome scores. Semin Arthroplasty 2023;33:447–54. https://doi.org/10.1053/j.sart.2023.02.006.
28. Weiss JM, Noble PC, Conditt MA, Kohl HW, Roberts S, Cook KF, et al. What functional activities are important to patients with knee replacements? Clin Orthop Relat Res 2002;404:172–88.
29. Yamada E, Kozono N, Nabeshima A, Tashiro E, Nakashima Y. Baseplate inferior offset affects shoulder range of motion in reverse shoulder arthroplasty in Asian population. J Orthop Surg Res 2024;19:25. https://doi.org/10.1186/s13018-023-04506-w.
30. Zitkovsky HS, Carducci MP, Mahendraraj KA, Grubhofer F, Jawa A. Lateralization and decreased neck-shaft angle reduces scapular notching and heterotopic ossification. J Am Acad Orthop Surg 2020;28:e1073–80. https://doi.org/10.5435/jaaos-d-19-00808.