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# Return to golf after shoulder arthroplasty: an American Shoulder and Elbow Surgeons multicenter study predicting performance after reverse total shoulder arthroplasty and anatomic total shoulder arthroplasty

*ASES Multicenter Research Group*[*,1]


## ABSTRACT

***Background:*** Return to sport (RTS), particularly golf, and athletic performance following reverse shoulder arthroplasty (rTSA) and anatomic shoulder arthroplasty (aTSA) remain largely understudied. Moreover, limited data exist on characteristics that predict successful RTS. This study aimed to evaluate return to golf after shoulder arthroplasty, as well as identify patient factors associated with optimal return to play.

***Materials and methods:*** A multicenter analysis utilizing RTS questionnaires was distributed to patients undergoing rTSA or aTSA at 17 institutions. We assessed preoperative golf participation, return to golf postoperatively, golf performance relative to preoperative level, and frequency of golf participation. Overall subjective satisfaction with their operative shoulder during golf activities was assessed numerically (0-10). Two separate age- and sex-matched propensity score analyses were performed; first to compare rTSA and aTSA performed for osteoarthritis with an intact rotator cuff (glenohumeral osteoarthritis), and second to compare rTSA performed for glenohumeral osteoarthritis and rotator cuff arthropathy. Golf-specific outcomes included change of self-reported handicap and driving distance before and after surgery, as well as whether hand dominance influenced outcomes.

***Results:*** Two hundred eight patients reported golf participation, with a mean follow-up of 24.3 ± 5.7 months. The cohort was 77.9% male, with a mean age of 69.0 ± 7.9 years and body mass index of 29.0 ± 5.5. Postoperatively, 88.9% (n = 185) returned to golf, and 79.3% (n = 165) reported that their performance improved/remained unchanged. Most patients (46.8%) returned within 3–6 months, and


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See Appendix A for all disclosures.

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another 31.7% between 7 and 12 months. After propensity score matching, 91 rTSA and 48 aTSA patients were analyzed. Return-to-golf rates were similar (rTSA 95.6% vs. aTSA 90.0%, $P = .313$), as were rates of maintained/improved performance (84.6% vs. 81.3%, $P = .313$). No significant differences were found in preoperative or postoperative handicap, driving distance, or outcomes based on surgery on the dominant vs. nondominant side.

*Discussion:* Patients demonstrate a high rate of returning to golf following both rTSA and aTSA. Among golfers the ability to return to play and performance level was comparable between arthroplasty types. No significant differences were observed between rTSA and aTSA in terms of postoperative handicap, driving distance, or side of surgery relative to hand dominance. However, despite these similarities, revision arthroplasty was independently associated with worse postoperative patient perceived golf performance. As the number of active patients undergoing shoulder arthroplasty continues to rise, the ability to provide sport-specific counseling is essential for setting realistic expectations and supporting recovery.

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*Level of evidence:* Level III; Retrospective Cohort Comparison; Prognosis Study

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Golf is an increasingly popular sport, played in 206 countries worldwide.[36] In the United States alone, nearly 50 million people golf, in part because the game is accessible to individuals of all ages who have a wide range of physical health and ability.[27] While participation is growing among younger generations, golfers aged 50 and older still comprise 43% of total on-course participants, while those older than 65 account for about 20%.[27]

For these aging adults, golf represents a practical and safe form of physical activity. There are many health benefits of regular exercise such as reduced risk of diabetes,[31] osteoporosis,[13] chronic obstructive pulmonary disorder,[20] and heart disease.[11] Golf has been specifically associated with improved balance control,[34] joint proprioceptive activity,[33] flexibility,[30] and ability to confidently complete activities of daily living.[12] Beyond its physical benefits, golf is also linked to improved psychological and social well-being.[32] Given these advantages of golf for aging adults, many individuals undergoing orthopedic care are motivated to return to the sport. This is particularly relevant for those requiring surgical intervention for the shoulder given its intimate relationship to the golf swing.

Shoulder arthroplasty has become an increasingly popular treatment for a wide range of pathologies affecting the glenohumeral joint.[1,2,5,6,16] 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.[2,10,16] As both aTSA and rTSA become more commonplace, there is growing attention to patients' ability to return to sports (RTSs) and recreational activities after arthroplasty, as expectations increasingly extend beyond pain relief and basic function.[1] To best support these goals, surgeons must understand how postoperative outcomes—like return to golf—differ between aTSA and rTSA.

Lansdown et al[21] were among the first to compare rates of return to golf following rTSA and TSA. In their sample of 31 patients, they reported that patients were significantly more likely to resume golf after aTSA than after rTSA (93% vs. 56%, $P = .037$). The authors suggested this may be because the golf swing preferentially activates the rotator cuff muscles, whereas the deltoid plays only a minimal role.[7,9,19,26] Boltuch et al[3] conducted a similar analysis with an expanded cohort ($n = 69$) and found conflicting results. They reported that patients returned to golf at similar rates regardless of which arthroplasty they received (rTSA: 91% within 1 year, aTSA: 85%

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within 1 year, P = .640). There were, however, far more patients in their cohort who received aTSA (n = 47) than rTSA (n = 22), potentially influencing the results.

The comparison between aTSA and rTSA in the context of returning to golf remains incompletely understood. Our multicenter research group leveraged a large patient pool and propensity score-matched cohorts to better understand the differences between rTSA and aTSA for postoperative return to golf. In addition to evaluating rates of return to play, golf specific functional outcomes, patient factors, and diagnoses associated with optimal return to play, we also assessed whether the side of arthroplasty—leading or trailing shoulder—affects return to play, recognizing the distinct biomechanical roles of each shoulder during the golf swing. We hypothesized that aTSA and rTSA result in comparable return to golf outcomes, with no significant difference between the 2.

## Materials and methods

### Study design

A multicenter analysis utilizing golf-specific RTS questionnaires was completed by the patients of 24 American Shoulder and Elbow 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 (GHOA), rotator cuff arthropathy, post-capsulorrhaphy arthritis, 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 golf-specific RTS questionnaire were included in the study. This study was approved by the New England Baptist Hospital Institutional Review Board (Project# 2142768).

### Golf-specific RTS 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. In the current study, only golf participation was considered. The outcomes of interest were ability to return to golf postoperatively (yes/no), postoperative patient perceived golf performance relative to preoperative level (improved/stayed the same vs. worsened), frequency of golf 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). Patient reported golf performance metrics (change in driving distance and handicap) and effects of arthroplasty laterality (lead vs. trail shoulder) were also assessed. Dominant versus nondominant shoulder was defined based on patient self-reported hand dominance. In the golf swing, the lead shoulder (closer to target while swinging) is typically the player's nondominant shoulder while the trail shoulder (further from target while swinging) is typically the player's dominant shoulder. The timing of return to golf was determined at predefined intervals of <3 months, 3-6 months, 7-12 months, and 12+ months. Overall subjective satisfaction with their operative shoulder, while golfing 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 American Shoulder and Elbow Surgeons surgeons utilized the Delphi method to define study parameters as well as design the golf-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 golf questionnaire. 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, while 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 GHOA with an intact rotator cuff, and the second compared primary rTSA performed for GHOA versus rotator cuff arthropathy (RCA). Categorical variables were compared using Pearson's chi-squared 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 [Ref – FE HJ. rms: Regression Modeling Strategies. https://cran.r-project.org/web/packages/rms/].

**Table I – Golf participant cohort demographics**

| Parameter | n = 208 |
|---|---|
| Age | 69.0 ± 7.9 |
| Sex | |
| Male | 77.9% (162) |
| Female | 22.1% (46) |
| Type of arthroplasty | |
| rRSA | 74.0% (154) |
| aTSA | 26.0% (54) |
| BMI | 29.0 ± 5.5 |
| Follow-up A (months) | 24.3 ± 5.7 |
| ASA comorbidity score >2 | 26.9% (56) |
| Comorbidities | |
| Hypertension | 44.2% (92) |
| Hypercholesterolemia | 43.8% (91) |
| Diabetes mellitus | 11.1% (23) |
| Osteoporosis | 3.4% (7) |
| Obesity | 33.7% (70) |
| History of smoking | 33.7% (70) |
| Prior ipsilateral shoulder surgery | 31.3% (65) |
| Complications | 2.4% (5) |
| Primary diagnosis | |
| GHOA | 72.6% (151) |
| RCA | 14.4% (30) |
| PCA | 3.8% (8) |
| Fracture sequelae | 0.0% (0) |
| Acute fracture | 2.4% (5) |
| Avascular necrosis | 0.5% (1) |
| Inflammatory arthritis | 0.0% (0) |
| Massive cuff tear without arthritis | 2.4% (5) |
| Failed arthroplasty | 2.9% (6) |

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

## Results

### *Overall athlete demographics*

Two hundred eight patients responded to the golf-specific return-to-sport questionnaire with a mean postoperative follow-up of 24.3 ± 5.7 months (Table I). The mean age was 69.0 ± 7.9 years with 77.9% (n = 162) being male. rTSA was performed in 74.0% of patients (n = 154), while the remaining 26.0% underwent aTSA (n = 54). The primary diagnosis was GHOA in 72.6% of patients (n = 151), and RCA in 14.4% (n = 30).

### *Golf participant breakdown*

Overall, 88.9% of participants (n = 185) returned to golf postoperatively (Table II). Among the 23 participants who did not RTSs, 12 (52%) reported it was due to reasons unrelated to their shoulder. Additionally, 79.3% of participants (n = 165) reported their performance either improved or stayed the same, 73.1% of participants (n = 152) reported more or the same frequency of participation since surgery, and 82.7% of participants (n = 172) reported more or the same enjoyment since surgery. Most participants (46.8%) returned to golf within 3–6 months postoperatively, while an additional 31.7% returned within 7–12 months (Table II).

**Table II – Golf participant outcome breakdown**

| Parameter | Golf participants (n = 208) |
|---|---|
| Still playing postoperatively? | |
| Yes | 88.9% (185) |
| Performance level compared to preoperative | |
| Improved/stayed the same | 79.3% (165) |
| Enjoyment level compared to preoperative | |
| More enjoyable/same amount | 82.7% (172) |
| Frequency of participation compared to preoperative | |
| More frequently/same amount | 73.1% (152) |
| How long after surgery did you resume sport participation? | *n* = 205 |
| <3 mo | 10.2% (21) |
| 3-6 mo | 46.8% (96) |
| 7-12 mo | 31.7% (65) |
| 12+ months | 11.2% (23) |
| Satisfaction score | |
| 0-10 | 9.2 ± 1.5 |

### *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 cohorts consisted of 91 and 48 patients, respectively (Table III). There were no significant differences in age (rTSA 68.6 ± 6.4 years versus aTSA 67.4 ± 7.1 years; *P* = .338), sex (rTSA 78.0% male versus aTSA 91.3% male, *P* = .821), or body mass index (BMI) (rTSA 28.9 ± 5.1 versus aTSA 30.1 ± 6.6, *P* = .251). There were no differences in the overall ability to return to golf (rTSA: 95.6% vs. aTSA: 90.0%, *P* = .313), performance level (improved/stayed the same) of golfers (rTSA: 84.6% vs. aTSA: 81.3%, *P* = .789), frequency (more frequent/same amount) of golf participation (rTSA: 81.3% vs. aTSA: 75.0%, *P* = .514), enjoyment level (more enjoyable/same amount) during golf participation (rTSA: 91.2% vs. aTSA: 83.3%, *P* = .27), or overall postoperative satisfaction with shoulder while golfing (rTSA: 9.5/10 ± 1.1 vs. aTSA: 9.0/10 ± 1.8) comparing patients undergoing rTSA and aTSA.

Additionally, between these age- and sex-matched cohorts there was no significant difference between the changes in driving distance (rTSA: 1.2 ± 22.6 m vs. aTSA: −1.6 ± 40.5 m, *P* = .142) or handicap (rTSA: 0 ± 4.1 vs. aTSA: −0.9 ± 5.2, *P* = .17) comparing patients undergoing rTSA and total shoulder arthroplasty. Preoperative handicap (rTSA: 19.8 ± 8.2 vs. aTSA: 19.0 ± 9.6, *P* = .382) and driving distance (rTSA: 173.6 ± 43.9 m vs. aTSA: 185.1 ± 45.4 m) were not significantly different between the 2 cohorts (Table IV).

### *Breakdown of hand dominance in rTSA and aTSA for GHOA cohort*

For the rTSA cohort, outcomes were compared between patients who underwent surgery on their dominant versus nondominant side (Table V). Patients who underwent rTSA on their nondominant side were slightly older than those treated on their dominant side (*P* = .018*). There were no significant

**Table III – Golf participant breakdown of age- and sex-matched RSA and TSA cohorts**

| Parameter | Golf | | P value |
|---|---|---|---|
| | RSA for OA | TSA for OA | |
| | n = 91 | n = 48 | |
| Age* | 68.6 ± 6.4 | 67.4 ± 7.1 | .338 |
| Sex* | | | |
| Male | 78.0% (71) | 81.3% (39) | .821 |
| Female | 22.0% (20) | 18.7% (9) | |
| BMI | 28.9 ± 5.1 | 30.1 ± 6.6 | .251 |
| Still playing postoperatively? | | | |
| Yes | 95.6% (87) | 90.0% (43) | .313 |
| Performance level compared to preoperative | | | |
| Improved/stayed the same | 84.6% (77) | 81.3% (39) | .789 |
| Enjoyment level compared to preoperative | | | |
| More enjoyable/same amount | 91.2% (83) | 83.3% (40) | .27 |
| Frequency of participation compared to preoperative | | | |
| More frequently/same amount | 81.3% (74) | 75.0% (36) | .514 |
| How long after surgery did you resume golf participation? | | | |
| <3 mo | 7.7% (7) | 12.5% (6) | .211 |
| 3-6 mo | 42.9% (39) | 54.2% (26) | |
| 7-12 mo | 36.3% (33) | 20.8% (10) | |
| 12+ months | 13.2% (12) | 10.4% (5) | |
| Satisfaction score | | | |
| 0-10 | 9.5 ± 1.1 | 9.0 ± 1.8 | .124 |

*OA*, osteoarthritis; *BMI*, body mass index; *TSA*, total shoulder arthroplasty; *rTSA*, reverse total shoulder arthroplasty.
* Factors used for propensity matching.

**Table IV – Golf participant sport-specific breakdown of matched RSA and TSA cohorts**

| Parameter | Golf | | P value |
|---|---|---|---|
| | RSA for OA | TSA for OA | |
| | n = 91 | n = 48 | |
| What is your handicap? | | | |
| Preoperative | 19.8 ± 8.2 | 19.0 ± 9.6 | .382 |
| Postoperative | 19.7 ± 8.4 | 18.1 ± 9.8 | .174 |
| Change | 0 ± 4.1 | −0.9 ± 5.2 | .17 |
| Handicap improved/stayed the same | *n* = 68 | *n* = 34 | .127 |
| | 69.1% (47) | 85.3% (29) | |
| What is your average driving distance? (meters) | | | |
| Preoperative | 173.6 ± 43.9 | 185.1 ± 45.4 | .226 |
| Postoperative | 174.5 ± 43.3 | 182.4 ± 40.2 | .341 |
| Change | 1.2 ± 22.6 | −1.6 ± 40.5 | .142 |
| Driving distance improved/ stayed the same | *n* = 86 | *n* = 38 | |
| | 75.6% (65) | 76.3% (29) | >.999 |

*OA*, osteoarthritis; *TSA*, total shoulder arthroplasty; *rTSA*, reverse total shoulder arthroplasty.

differences between groups in sex, BMI, return-to-golf rates, postoperative performance, enjoyment, frequency of play, time to return to golf, or satisfaction with shoulder function while golfing (all *P*> .05).

Similarly, for aTSA patients (Table VI), no significant differences were found between dominant- versus nondominant-side procedures with respect to demographic variables or golfing-related outcomes, including return to play, performance level, enjoyment, frequency, time to resume play, and postoperative satisfaction (all *P*> .05).

### *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 67 and 24 patients, respectively. There were no significant differences in age (GHOA 70.2 ± 6.5 years vs. RCA 71.7 ± 6.3 years; *P* = .533), sex (GHOA 82.1% male vs. RCA 79.2% male, *P* = .992), or BMI (rTSA 28.6 ± 5.2 vs. RCA 29.0 ± 5.2, *P* = .858). Further, there was no significant difference in the overall ability to return to golf (GHOA: 94.0% vs. RCA: 87.5%, *P* = .375), performance level (improved/stayed the same, GHOA: 89.6% vs. RCA: 79.2%, *P* = .289), enjoyment while golfing (improved/stayed the same, GHOA: 92.5% vs. RCA: 87.5%, *P* = .430), frequency of play (more frequent/same amount, GHOA: 80.6% vs. RCA: 63.0%, *P* = .482), time to resume golfing (*P* = .128) or overall subjective postoperative satisfaction with shoulder while golfing (GHOA: 9.5/10 ± 1.1 vs. RCA: 9.7/10 ± 0.7, *P* = .690) comparing patients undergoing rTSA for GHOA compared to RCA (Table VII).

Additionally, between these age- and sex-matched cohorts there was no significant difference between the changes in driving distance (GHOA: 1.0 ± 20.5 m vs. RCA: −7.7 ± 16.2 m, *P* = .142) or handicap (GHOA: −0.5 ± 3.7 vs. RCA: 0.6 ± 3.5, *P* = .458) comparing patients undergoing rTSA for osteoarthritis and RCA (Table VIII). Preoperative handicap (GHOA: 19.6 ± 8.0 vs. RCA: 19.8 ± 12.8, *P* = .944) and driving distance (GHOA: 176.5 ± 42.6 m

**Table V – Golf participant breakdown of hand dominance in RSA for GHOA cohort**

| Parameter | Golf | | P value |
|---|---|---|---|
| | Dominant (R/R or L/L) | Nondominant (R/L or L/R) | |
| | n = 59 | n = 41 | |
| Age | 68.2 ± 6.9 | 71.6 ± 6.7 | .018* |
| Sex | | | |
| Male | 81.4% (48) | 75.6% (31) | .659 |
| Female | 18.6% (11) | 24.4% (10) | |
| BMI | 28.9 ± 5.2 | 28.6 ± 5.0 | .908 |
| Still playing postoperatively? | | | |
| Yes | 94.9% (856) | 92.7% (38) | .687 |
| Performance level compared to preoperative | | | |
| Improved/stayed the same | 83.1% (49) | 82.9% (34) | >.999 |
| Enjoyment level compared to preoperative | | | |
| More enjoyable/same amount | 88.1% (52) | 87.8% (36) | >.999 |
| Frequency of participation compared to preoperative | | | |
| More frequently/same amount | 79.7% (47) | 78.0% (32) | >.999 |
| How long after surgery did you resume golf participation? | | | |
| <3 mo | 8.5% (5) | 4.9% (2) | .928 |
| 3-6 mo | 45.8% (27) | 43.9% (18) | |
| 7-12 mo | 33.9% (20) | 36.6% (15) | |
| 12+ months | 11.9% (7) | 12.2% (5) | |
| Satisfaction score | | | |
| 0-10 | 9.4 ± 1.4 | 9.3 ± 1.3 | .583 |

*GHOA*, glenohumeral osteoarthritis; *BMI*, body mass index; *rTSA*, reverse total shoulder arthroplasty.

**Table VI – Golf participant breakdown of hand dominance in TSA for GHOA cohort**

| Parameter | Golf | | P value |
|---|---|---|---|
| | Dominant (R/R or L/L) | Nondominant (R/L or L/R) | |
| | n = 29 | n = 22 | |
| Age | 63.6 ± 9.7 | 68.7 ± 8.4 | .052 |
| Sex | | | |
| Male | 82.8% (24) | 81.8% (18) | >.999 |
| Female | 17.2% (5) | 18.2% (4) | |
| BMI | 31.2 ± 7.9 | 28.8 ± 4.0 | .470 |
| Still playing postoperatively? | | | |
| Yes | 86.2% (25) | 95.5% (21) | .375 |
| Performance level compared to preoperative | | | |
| Improved/stayed the same | 82.8% (24) | 81.8% (18) | >.999 |
| Enjoyment level compared to preoperative | | | |
| More enjoyable/same amount | 79.3% (23) | 90.9% (40) | .440 |
| Frequency of participation compared to preoperative | | | |
| More frequently/same amount | 72.4% (21) | 81.8% (18) | .518 |
| How long after surgery did you resume golf participation? | | | |
| <3 mo | 13.7% (4) | 9.1% (2) | .677 |
| 3-6 mo | 48.3% (14) | 63.6% (14) | |
| 7-12 mo | 17.2% (5) | 22.7% (5) | |
| 12+ months | 17.2% (5) | 4.5% (1) | |
| Satisfaction score | | | |
| 0-10 | 9.0 ± 1.7 | 9.0 ± 1.9 | .878 |

*GHOA*, glenohumeral osteoarthritis; *TSA*, total shoulder arthroplasty; *BMI*, body mass index.

vs. RCA: 182.7 ± 40.7 m) were not significantly different between the 2 cohorts.

### *Predictors of worse postoperative performance*

Multivariate logistic regression revealed that among revision arthroplasty, prior ipsilateral surgery, complications, and a diagnosis of RCA, only revision arthroplasty was significantly associated with worse postoperative patient perceived golf performance ($P$ = .032; Table IX).

## Discussion

As hypothesized, the results of this multicenter study demonstrate that the majority of patients (~89%) successfully

**Table VII – Golf participant breakdown of comparing diagnoses of OA and RCA for RSA**

| Parameter | RSA for OA | RSA for RCA | P value |
|---|---|---|---|
| | n = 67 | n = 24 | |
| Age | 70.2 ± 6.5 | 71.7 ± 6.3 | .533 |
| Sex | | | |
| Male | 82.1% (55) | 56.9% (19) | .992 |
| Female | 17.9% (12) | 79.2% (5) | |
| BMI | 28.6 ± 5.2 | 29.0 ± 5.2 | .858 |
| Still playing postoperatively? | | | |
| Yes | 94.0% (63) | 87.5% (21) | .375 |
| Performance level compared to preoperative | | | |
| Improved/stayed the same | 89.6% (60) | 79.2% (19) | .289 |
| Enjoyment level compared to preoperative | | | |
| More enjoyable/same amount | 92.5% (62) | 87.5% (21) | .430 |
| Frequency of participation compared to preoperative | | | |
| More frequently/same amount | 80.6% (54) | 63.0% (17) | .482 |
| How long after surgery did you resume golf participation? | | | |
| <3 mo | 7.4% (5) | 22.2% (6) | .128 |
| 3-6 mo | 44.8% (30) | 40.7% (11) | |
| 7-12 mo | 37.3% (25) | 18.5% (5) | |
| 12+ months | 9.0% (6) | 7.4% (2) | |
| Satisfaction score | | | |
| 0-10 | 9.5 ± 1.1 | 9.7 ± 0.7 | .690 |

*OA*, osteoarthritis; *RCA*, rotator cuff arthropathy; *BMI*, body mass index.

**Table VIII – Golf participant sport-specific breakdown of matched RSA and TSA cohorts**

| Parameter | Golf | | P value |
|---|---|---|---|
| | RSA for OA | RSA for RCA | |
| | n = 52 | n = 18 | |
| What is your handicap? | | | |
| Preoperative | 19.6 ± 8.0 | 19.8 ± 12.8 | .944 |
| Postoperative | 18.9 ± 7.5 | 20.5 ± 12.3 | .626 |
| Change | −0.5 ± 3.7 | 0.6 ± 3.5 | .458 |
| Handicap improved/stayed the same | 71.1% (37) | 66.7% (12) | .952 |
| | n = 60 | n = 22 | |
| What is your average driving distance? | | | |
| Preoperative | 176.5 ± 42.6 | 182.7 ± 40.7 | .546 |
| Postoperative | 177.2 ± 38.7 | 175.0 ± 36.8 | .620 |
| Change | 1.0 ± 20.5 | −7.7 ± 16.2 | .114 |
| Driving distance improved/ stayed the same | 76.7% (46) | 59.1% (13) | .196 |

*OA*, osteoarthritis; *RCA*, rotator cuff arthropathy.

**Table IX – Factors predictive of worse postoperative performance in golf**

| Sport | | | | |
|---|---|---|---|---|
| Parameter | ß-coef | Confidence interval | | P value |
| | | 2.5 | 97.5 | |
| Revision arthroplasty | 7.83 | 1.2 | 51.7 | .032* |
| Prior ipsilateral surgery | 0.85 | 0.38 | 1.93 | .703 |
| Complication | 5.71 | 0.80 | 40.8 | .082 |
| Diagnosis of RCA | 0.73 | 0.25 | 2.18 | .582 |

*RCA*, rotator cuff arthropathy.
* Factors used for propensity matching.

returned to golf after shoulder arthroplasty, with no significant difference between aTSA and rTSA. Specifically, the 2 cohorts showed comparable rates of return, changes in performance, enjoyment, and subjective satisfaction. Nearly half of patients resumed golf within 3 to 6 months postoperatively, with an additional third returning between 7 and 12 months. Return to golf outcomes were also unaffected by whether the arthroplasty was performed on the dominant or nondominant side, and within the rTSA cohort, diagnosis (RCA vs. GHOA) did not significantly influence postoperative golf outcomes. Only revision arthroplasty negatively impacted return to golf.

Our findings conflict with Lansdown et al,[21] who reported lower return to golf rates after rTSA when compared to aTSA. Their results were consistent with previous literature on RTS following shoulder arthroplasty that suggested outcomes after rTSA are generally less promising than after aTSA.[22,24,29] However, most of the current RTS literature is derived from small samples with considerable heterogeneity for preoperative diagnosis. The interpretability and generalizability of Lansdown at al.'s golf specific analysis was limited by similar factors, most notably a small sample size, as only 31 patients were included.

In contrast, Boltuch et al[3] performed a similar study with an expanded, though unbalanced, dataset and found results that align more closely with our own. They reported that nearly 90% of patients were able to return to golf within a year of surgery—nearly identical to the rate observed in the current study. Likewise, Boltuch et al found that patients perceived golf performance and enjoyment improved or remained the same for approximately 82% of patients, which is similar to the 79% and 83%, respectively, reported in our cohort.

Importantly, both Boltuch et al and the current study demonstrated that these measures did not differ between patients who received rTSA and aTSA.

When examining golf-specific performance metrics, our data parallels Boltuch et al in showing no significant difference in postoperative handicap change between rTSA and aTSA. However, our results diverge from Jensen and Rockwood[18] and Papaliodis et al[25] who reported that aTSA patients experienced greater handicap improvement. Boltuch et al also analyzed postoperative driving distance and found that aTSA patients experienced greater gains compared to rTSA patients. In our study, however, we observed no such significant difference for handicap or driving distance change between the 2 arthroplasty types. It is worth noting that rTSA patients tended to report lower preoperative driving distances and higher handicaps. Although these differences did not reach statistical significance, they may suggest that patients undergoing rTSA had more severe shoulder limitations. We believe our larger, balanced, propensity-matched cohorts provide an accurate estimate of handicap and driving distance outcomes after rTSA and aTSA, contributing meaningfully to the existing literature.

Comparing golf-specific outcomes of aTSA and rTSA invites a focused discussion on the biomechanics of the golf swing. Following each arthroplasty, muscles used for shoulder motion are different and may influence golf outcomes. In a golf swing performed with an intact (non-arthroplasty) shoulder, the deltoid is typically inactive except for a brief spurt of activity from the lead shoulder just before contact with the ball.[19] Meanwhile, the rotator cuff muscles are far more impactful, producing coordinated rotation and motor function. The subscapularis—the primary controller of humeral internal rotation—is the most active muscle throughout the swing[19] while infraspinatus and teres minor, involved in humeral external rotation, are also critical.[26] Management of the subscapularis in rTSA remains a subject of debate due to inconsistent surgical approaches as well as anatomic and implant considerations. While the subscapularis can often be repaired during rTSA, there is no consensus to dictate its universal repair algorithm. The decision is often left to the surgeon's preference and intraoperative judgment. Evidence on the benefits of repair is mixed: some studies suggest that repairing the subscapularis reduces complications and enhances internal rotation,[8,23,35] whereas others report no significant improvements, or even advise against repair,[4,14] citing potential limitations in external rotation and abduction, as well as increased demands on the posterior rotator cuff.[15,28]

It is also important to note that rTSAs are now frequently performed for cuff-intact GHOA, in which some rotator cuff function is preserved.[17] For these patients, postoperative shoulder mechanics may not be entirely deltoid-driven, as elements of the cuff can still contribute to motion and stability. Even so, our study found no significant difference in return-to-golf outcomes between rTSA patients with GHOA and those with RCA as their primary diagnosis.

From a biomechanical perspective, one might expect aTSA to provide an advantage to golfers over rTSA, given the ability to maintain a typical rotator cuff and the necessity for rTSA patients to adapt their swing to deltoid controlled motion. Importantly, the current study found no significant disparity in return to golf rates, patient perceived golf performance, enjoyment, or frequency of play. This suggests golfers are able to adapt their swing mechanics to anatomical shifts.

While the current study establishes that patients undergoing either aTSA or rTSA patients have a high likelihood of successfully returning to golf, evidence-based frameworks for supporting that return remain limited. We envision the data gathered from our work being able to contribute to golf and arthroplasty specific return to play protocols. This is a process that was started by Jensen and Rockwood[18] for only aTSA patients in which putting was allowed at 2 weeks, short chips at 4-6 weeks, medium irons at 6-8 weeks, long irons at 2 months, and then a gradual patient guided progression to full swings with a driver. These patients were also counseled to tee up all shots for 1 year, limiting ground impact and stress on the shoulder. Using expanded cohorts with patients who received both rTSA and aTSA to revisit this protocol development may be beneficial to outcomes. Future work should address whether return to play timelines or interventions should differ by arthroplasty type and whether cuff or deltoid targeted rehabilitation can further optimize outcomes.

The strengths of this project 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 return to golf following both aTSA and rTSA. The Delphi method required 75% consensus for all used study questionnaires and inclusion/exclusion criteria, enhancing rigor.

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. This inherently 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. Further, because the survey assessed RTS broadly rather than golf specifically, the denominator of patients who received the survey and would have selected golf cannot be determined. As a result, a true response rate for golf participation could not be calculated. To help mitigate these limitations, 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 to other diagnoses. There were also no objective swing or performance metrics collected with radar-based golf technologies (eg, driving distance, swing speed, dispersion, and other measures of swing mechanics such as path, attack angle, and smash factor), which could have eliminated the subjectivity of patients reporting their own golf statistics. Finally, this study involves multiple comparisons across several outcome domains, which increases the potential for type I error. No multiplicity correction was applied due to the exploratory nature of the study; thus, these findings should be interpreted with caution and considered hypothesis-generating rather than confirmatory.

Future research should include longer follow-up time to assess the durability of golf-specific outcomes, as well as objective performance metrics to strengthen findings—though these bring financial and logistic challenges. A focused analysis on whether the subscapularis should be repaired during rTSA for patients hoping to return to golf would be another apt next step. Due to the multicenter nature of the present study, operative reports from all participating institutions were not available for centralized review; therefore, specific details regarding subscapularis management (eg, peel, tenotomy, or lesser tuberosity osteotomy) could not be reliably collected or analyzed. Additionally, biomechanical studies using surface or intramuscular electromyography could provide valuable insight into how aTSA and rTSA alter shoulder function during the golf swing. Lastly, expanding research to other upper-extremity sports, such as tennis and pickleball, would also broaden clinical guidance for active patients following shoulder arthroplasty.

## Conclusion

Patients undergoing aTSA and rTSA can expect high rates of return to golf, stable or improved performance, and high satisfaction. Enjoyment and frequency typically remain the same or improve for both cohorts. Among rTSA patients, outcomes did not differ by diagnosis (GHOA vs. RCA). These findings support aTSA and rTSA as viable surgical options for patients seeking to maintain an active lifestyle through golf after shoulder arthroplasty.

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## Supplementary Data

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