Original Research

Return to Sports After Primary Reverse Shoulder Arthroplasty

Outcomes at Mean 4-Year Follow-up

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Background: With the expanding use of reverse shoulder arthroplasty (RSA) to treat various shoulder conditions, there has been a rise in the number of RSAs performed, especially in physically active patients. Limited information regarding sports after RSA is available to properly counsel patients on postoperative expectations.

Purpose: To assess the rate of return to sports as well as the ability to return to the same level of preoperative intensity, frequency, and duration of sport after primary RSA.

Study Design: Case series; Level of evidence, 4.

Methods: This was a retrospective review of patients who underwent primary RSA at our institution between 2014 and 2016. Shoulder motion, Subjective Shoulder Value score, American Shoulder and Elbow Surgeons score, pre- and postoperative sports activities, and barriers to return to sport were assessed in 109 patients after RSA (93 patients with unilateral RSA and 16 patients with bilateral RSA). The mean age at the time of surgery was 70 years (range, 34-86 years), with a mean follow-up of 3.9 years (range, 2-12 years).

Results: The mean rate of return to sports was 70.1% (range, 0%-100%). There was no difference in return to sports between those with uni- and bilateral RSA ($P = .64$). Fishing, swimming, elliptical/treadmill, and hunting were the most common sports after RSA with return rates of 91%, 73%, 86%, and 82% respectively. A majority of patients returned to the same level of preoperative intensity, frequency, and duration for all sports except for climbing and swimming. There was a lower mean rate of return for high-demand sports (62.9%) compared with low- and medium-demand sports (76.7%) ($P = .005$). The most common reasons for inability to return to sports included limited motion, fear of injury, and weakness.

Conclusion: Patients who had undergone primary uni- or bilateral RSA reported a 70.1% rate of return to sports with maintenance of the same level of intensity, duration, and frequency of preoperative sport participation. Rates of return to high-demand sports were lower than low- and medium-demand sports. Patients also had difficulty returning to overhead sports.

Keywords: reverse total shoulder arthroplasty; sports; activity

The number of reverse shoulder arthroplasty (RSA) surgeries performed continues to rise as the surgical indications expand to include pathologies such as irreparable massive rotator cuff tears, primary osteoarthritis with severe subluxation or bone loss, acute proximal humeral fractures, and proximal humeral fracture nonunions.[13,23-25,30] While pain relief and restoration of shoulder function for activities of daily living (ADLs) are often the main goals of RSA, physically active patients often ask their surgeon about activities and sports that they will or will not be able to perform after recovery from surgery. A study by Lawrence et al[15] reported that 53% of the patients who underwent an RSA were still able to perform high-demand activities, such as snow and dirt shoveling. Assenmacher et al[1] also found that after having both shoulders replaced with RSA, 55% of the patients were able to perform high-demand activities after surgery and had minimal difficulty with ADLs.

The ability to participate in sports after joint-replacement surgery is a common concern of patients regarding expectations after RSA, and it is important for patient quality of life. While return to sports after arthroplasty has been well-analyzed for anatomic total shoulder arthroplasty (TSA) and hemiarthroplasty (HA),[2,6-8,21,22,26] there are limited data evaluating the ability to return to sports after RSA. The reported return to sports rate after RSA has varied between 40% and 85%.[3-5,10,14,19,27,31] As patients remain

The Orthopaedic Journal of Sports Medicine, 9(6), 23259671211012393
DOI: 10.1177/23259671211012393

active later in life and the indications for RSA continue to rise, it is critical that we improve our understanding of recreation and sporting activity after RSA.

Accordingly, the primary purposes of this study were to assess the rate of return to sports after primary RSA and evaluate the ability to return to the same level of intensity, frequency, and duration of sport compared with before surgery. We hypothesized that patients would be able to consistently return to low- to moderate-demand sporting and fitness activities with fewer returning to high-demand sporting activities.

METHODS

Study Cohort

After institutional review board approval, our institution's total joint registry database was used to identify patients who had undergone RSA between 2014 and 2016 by 2 surgeons (J.S-S and M.E.M). Implants used included the Biomet Comprehensive reverse or Stryker ReUnion RSA, which are both lateralized designs. The study began in 2014 when both surgeons began using lateralized design implants. Patients were included if they underwent primary RSA with at least 2 years of follow-up. Patients were excluded if their index surgery at our institution was for revision RSA. A total of 219 consecutive patients met the criteria, and questionnaires were mailed to all potential participants with a cover letter explaining the purpose of the study as well as a consent form to be returned with the completed questionnaire in a prestamped, addressed envelope. To maximize the response rate, those who didn't respond received a second mailing 1 month later. Telephone reminders to nonresponders began 1 month after the second mailing. Telephone calls included 5 call attempts before a person was considered a noncontact.

A total of 109 patients (65 women and 44 men) responded to the survey, for a response rate of 50%. There was no response from 65 patients, 40 patients refused to participation, 4 patients stated they were either physically or mentally unable to complete the survey, and 1 patient was deceased. Of these 109 patients, 93 had undergone unilateral RSA (53 right shoulders and 40 left shoulders), and 16 patients had undergone bilateral RSA, for a total of 125 shoulders evaluated in this study. Ten shoulders were replaced using the Biomet Comprehensive reverse implant, and the remaining shoulders were replaced using the Stryker ReUnion RSA implant. The mean age at the time of surgery was 70 years (range, 34-86 years), and the mean follow-up time was 3.9 years (range, 2-12 years). The maximum follow-up range reported extends beyond the study period because 4 patients who underwent bilateral shoulder arthroplasties had 1 shoulder replaced before 2014. The underlying diagnosis for the 125 shoulders included in this study was cuff tear arthropathy in 65 shoulders, osteoarthritis in 30 shoulders, acute proximal humeral fracture in 9 shoulders, posttraumatic arthritis in 7 shoulders, fracture malunion in 5 shoulders, prior proximal humeral resection in 3 shoulders, dislocation associated with large cuff in 2 shoulders, failed prior internal fixation in 2 shoulders, rheumatoid arthritis with rotator cuff deficiency in 1 shoulder, and steroid induced avascular necrosis in 1 shoulder.

All patients underwent a similar postoperative rehabilitation program. Shoulders were supported in a shoulder immobilizer for 3 weeks postoperatively. At 3 weeks, passive and active assisted range of motion was initiated. Isometrics were added at week 8 and isotonic strengthening exercises at week 10 to 12. At 3 months, lightweights (<10 lb) were allowed. After recovery from surgery (at 4-6 months), patients were allowed to perform higher levels of activity but were advised to avoid more than occasionally heavier lifting (>25 lb) and to avoid activities with forceful impact.

Questionnaire Details

The methodology for this study was similar to that in previously published studies[1,15,33] evaluating patient-reported activities after anatomic TSA, HA, unilateral RSA, and bilateral RSA. A questionnaire was designed to evaluate the current athletic activity and ability to return to sports after reverse shoulder replacement. A previously assessed patient questionnaire, providing high levels of agreement with the surgeon's assessment, included closed-ended questions that required a participant to fill in a circle with respect to their operated shoulder.[28] This included a pain scale (0 represented no pain while 10 represented severe pain), current use of pain medication (none, over the counter, narcotic, or both over the counter and narcotic), a diagrammatic representation of range of motion (forward flexion in degrees, external rotation in degrees, and internal rotation scaled 1-8), and strength on a 10-point scale (where 0 is complete paralysis and 10 is normal strength).[28]

Added to the questionnaire were a choice of 43 sports about which patients could indicate (1) whether they participated in them before and/or after surgery; (2) their ability to return to the same level of intensity, frequency, and

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Final revision submitted November 1, 2020; accepted January 10, 2021.

One or more of the authors has declared the following potential conflict of interest or source of funding: J.T. has received hospitality payments from Synthes. C.L.C. has received educational payments and fees for services other than consulting from Arthrex. M.E.M. has received educational payments from Zimmer Biomet Holdings and Arthrex. J.S-S. has received consulting fees and royalties from Stryker, consulting fees and nonconsulting fees from Wright Medical Technology and Acumed, consulting fees from Exactech and Tornier, nonconsulting fees from Merck Sharp and Dohme Corporation, and educational payments from Arthrex. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval for this study was obtained from Mayo Clinic (study No. 19-002787).

duration of activity after surgery; (3) how soon they were able to return to sport postoperatively; (4) if sports participation motivated them to undergo surgery; and (5) their level of satisfaction with the function of their shoulder on a 10-point scale. For patients who could not return to sports, they were queried as to (6) reasons why they could not participate in sports. Sports activities were categorized subjectively by the authors into 3 groups, depending on the perceived demand on the shoulder replacement as low-, medium-, and high-demand activities. A low-demand sport involved activities that did not impose repetitive stress on the shoulder and did not involve heavy lifting but involve shoulder movements below shoulder height. A medium-demand sport was defined as the potential for repetitive stress, involving lifting loads up to 20 lb, and occasional overhead activity. A high-demand sport involved activities with repetitive stress, potential for loads >20 lb, and regular overhead movements (Table 1).

Statistical Analysis

Results from the questionnaire were tabulated, and statistical analysis was performed using SAS Version 8.2 (SAS Institute) by our Division of Biostatistics. Generalized estimating equations were used to assess the association between returning to any sport (yes/no) and both laterality (unilateral vs bilateral) and demand of sport. This analysis takes into account the fact that a patient may have participated in more than 1 sport and that, within a patient, one's response as to whether one returned to each sport may not be independent of each other.

RESULTS

Return to Sports After Surgery

Of the 109 patients who responded to the survey, 81 patients indicated that they participated in sports before undergoing an RSA. The overall mean rate of return to sports was 70.1%. The mean rate of return to sports for patients with uni- and bilateral RSA were 68.9% and 76.1%, respectively (odds ratio [OR], 0.70; 95% CI, 0.15-3.19; $P = .64$). Sports with the highest number of postoperative participations included fishing (n =30), swimming (n = 22), elliptical/treadmill (n = 19), and hunting (firearm or bow) (n = 18) (Table 1). Patients who participated in yoga, climbing, or Pilates preoperatively reported a 100% rate of return to their sport postoperatively; however, the number of patients in each sport was small. Activities with >75% rate of return, in descending order, included sailing (92%), fishing (91%), dancing (88%), weight training (88%), hiking (86%), elliptical/treadmill (86%), calisthenics (86%), hunting (82%), snowmobiling (80%), and snowshoeing (80%). Rates of return to swimming were 73% and 60% for golf and cycling, respectively. High-demand sports requiring significant overhead stresses or throwing motions such as basketball, tennis, volleyball, racquetball, and badminton had 0% rate of return. The mean rate of return for high-demand sports (62.9%) was lower when compared with return to low- and medium-demand sports (76.7%) (OR, 0.52; 95% CI, 0.33-0.82; $P = .005$). Table 2 summarizes the return to sports rate for each sport in patients with uni- and bilateral RSA.

TABLE 1
Patient-Reported Sports Participation Before and After RSA[a]

Activity Level and Sport	Before RSA	After RSA	% Return
Low-demand sports			
Horseshoe throwing	2	1	50
Elliptical/treadmill	22	19	86
Snowshoeing	5	4	80
Medium-demand sports			
Aerobics	11	8	73
Bowling	15	7	47
Dancing	16	14	88
Fishing	33	30	91
Golf	20	12	60
Hiking	22	19	86
Pilates	2	2	100
Running	9	5	56
Skiing/snowboarding	5	1	20
Swimming	30	22	73
Water aerobics	9	6	67
Yoga	3	3	100
High-demand sports			
Archery	5	2	40
Badminton	2	0	0
Baseball/softball	8	1	13
Basketball	5	0	0
Boxing	0	1	NA
Calisthenics (bodyweight exercises)	14	12	86
Canoeing/kayaking/rowing	18	12	67
Climbing	4	4	100
Cycling/biking	25	15	60
American football	1	0	0
Gymnastics	1	1	100
Horseback riding	4	2	50
Hunting	22	18	82
Racquetball/handball	1	0	0
Sailing/boating	12	11	92
Skating/ice skating	5	1	20
Snowmobiling	10	8	80
Tennis	3	0	0
Volleyball	2	0	0
Weight training	8	7	88

[a]NA, not applicable; RSA, reverse shoulder arthroplasty.

In patients who underwent RSA for cuff tear arthropathy or arthritis, the mean rate of return to sport was 74.5%. The mean rate of return was 73.8% in patients with unilateral RSA and 76.6% in patients with bilateral RSA (OR, 0.86; 95% CI, 0.17-4.34; $P = .86$). The mean rate of return for high-demand sports (68.6%) was also lower when compared with return to low- and medium-demand sports (80.1%) (OR, 0.54; 95% CI, 0.33-0.88; $P = .014$).

Of those who returned to their sports activities postoperatively, a majority of patients reported being able to return to the same level of preoperative intensity, frequency, and duration of sport (Figure 1). Of the total patients, 50% or

TABLE 2
Patient-Reported Sports Participation After Uni- and Bilateral RSA[a]

Activity Level and Sport	Unilateral RSA		Bilateral RSA
	Right Side	Left Side	
Low demand			
Horseshoe throwing	1 (50)		
Elliptical/treadmill	9 (90)	7 (88)	3 (75)
Snowshoeing	1 (100)	2 (67)	1 (100)
Medium demand			
Aerobics	5 (83)	3 (75)	0/1 (0)
Bowling	4 (50)	1 (25)	2 (67)
Dancing	8 (89)	6 (100)	0/1 (0)
Fishing	14 (100)	11 (79)	5 (100)
Golf	3 (38)	5 (71)	4 (80)
Hiking	9 (90)	6 (85)	4 (80)
Pilates	1 (100)	1 (100)	
Running	3 (40)	2 (67)	0/1 (0)
Skiing/snowboarding	0 (0)	1 (33)	
Swimming	13 (76)	5 (63)	4 (80)
Water aerobics	3 (75)	2 (50)	1 (100)
Yoga	2 (100)	1 (100)	
High demand			
Archery		0/1 (0)	2 (100)
Badminton		0 (0)	0/1 (0)
Baseball/softball	0/2 (0)	0/1 (0)	1 (33)
Basketball	0/2 (0)	0/1 (0)	0/1 (0)
Boxing		1	
Calisthenics (bodyweight exercises)	5 (83)	5 (83)	2 (100)
Canoeing/kayaking/rowing	7 (78)	3 (43)	2 (100)
Climbing	3 (100)		1 (100)
Cycling/biking	8 (73)	5 (50)	3 (75)
American football			0/2 (0)
Gymnastics	1 (100)		
Horseback riding	0/1 (0)		1 (50)
Hunting	6 (75)	6 (75)	6 (100)
Racquetball/handball		0/1 (0)	
Sailing/boating	4 (80)	2 (100)	5 (100)
Skating/ice skating	0/1 (0)	1 (33)	
Snowmobiling	1 (50)	5 (83)	2 (100)
Tennis	0/1 (0)		0/2 (0)
Volleyball	0/1 (0)	0/1 (0)	
Weight training	4 (80)	1 (100)	2 (100)

[a]Data are reported as No. of patients (% return). Blank cells indicate that no patient in this study practiced that particular sport before or after reverse shoulder arthroplasty. RSA, reverse shoulder arthroplasty.

less were able to return to the same level of intensity, frequency, and duration for swimming and climbing; 36% of the patients reported that they were able to return to sports 4 to 6 months after surgery; 20% of the patients returned to sports between 6 months and 1 year; and 10% of the patients returned after 1 year.

A minority of the study cohort (19 patients) reported that their desire to participate in sports motivated their decision to undergo a reverse shoulder replacement. Eighteen patients reported that they were still limited and unable to participate in sports activities after surgery. Restricted motion (22%), fear of injury (21%), and weakness (18%) were the most common reasons cited for inability to participate in sports.

Outcomes and Complications

Self-reported postoperative pain score, American Shoulder and Elbow Surgeons score, shoulder motion, and strength are summarized in Table 3. Mean (±SD) postoperative Subjective Shoulder Value were 76.7% ± 20% (range, 10-100%). Shoulder satisfaction on a scale of 0 (no satisfaction) to 10 (very satisfied) improved from a mean of 4.2 ± 3.9 preoperatively to 8.4 ± 2.1 postoperatively. Surgical complications included acromial stress fractures treated nonoperatively (2 shoulders), hematoma (2 shoulders), with transient ulnar neuropraxia (1 shoulder), and complex regional pain syndrome (1 shoulder).

DISCUSSION

The results of our survey study found an overall return to sports rate of 70.1% with no difference between those with uni- and bilateral RSA. Patients can expect to return to a similar level of play with higher rates of return for low- and medium-demand sports compared with high-demand sports; however, none of our patients was able to return to sports that required overhead rotational stress or throwing.

There have been several studies[3-5,14,19,27,31] assessing sports activities after RSA. A study by Simovitch et al[27] reported on the outcomes of 67 patients who participated in high- or low-impact sports after RSA. They found that 60% of the patients were able to sports with a 7% rate of complications. In contrast, Garcia et al[9] reported a higher rate of return to sport of 85.5% of a cohort of 76 patients with RSA. Patients were able to return to sports fully by a mean of 5.3 months, and 88.2% reported good to excellent satisfaction with sports postoperatively. They also found that age > 70 years was a significant predictor of decrease rate of return to sports. One explanation for the difference between our results is that a majority of patients in our cohort indicated that return to sports was not a motivating factor to undergo surgery. This may have affected their desire or attempt to play sports after surgery. We also found lower rates of return to high-demand sports. This was consistent with the findings reported by Fink Barnes et al[4] in a study of sports activities after RSA in 78 patients. They found that 23.1% of the patients were able to participate in high-intensity sports, such as kayaking and skiing, compared with 48.7% of the patients who were able to do moderate-intensity sports such as swimming or fishing.[4]

Patients with bilateral RSA had similar return to sport rates compared with patients with unilateral RSA. Our study is the first to report on sports activities in patients with bilateral RSA. Previous studies evaluating function after bilateral RSA have focused on ADLs. Levy et al[16] found all 19 patients in their study were able to perform perineal hygiene after RSA and most had no limitation in

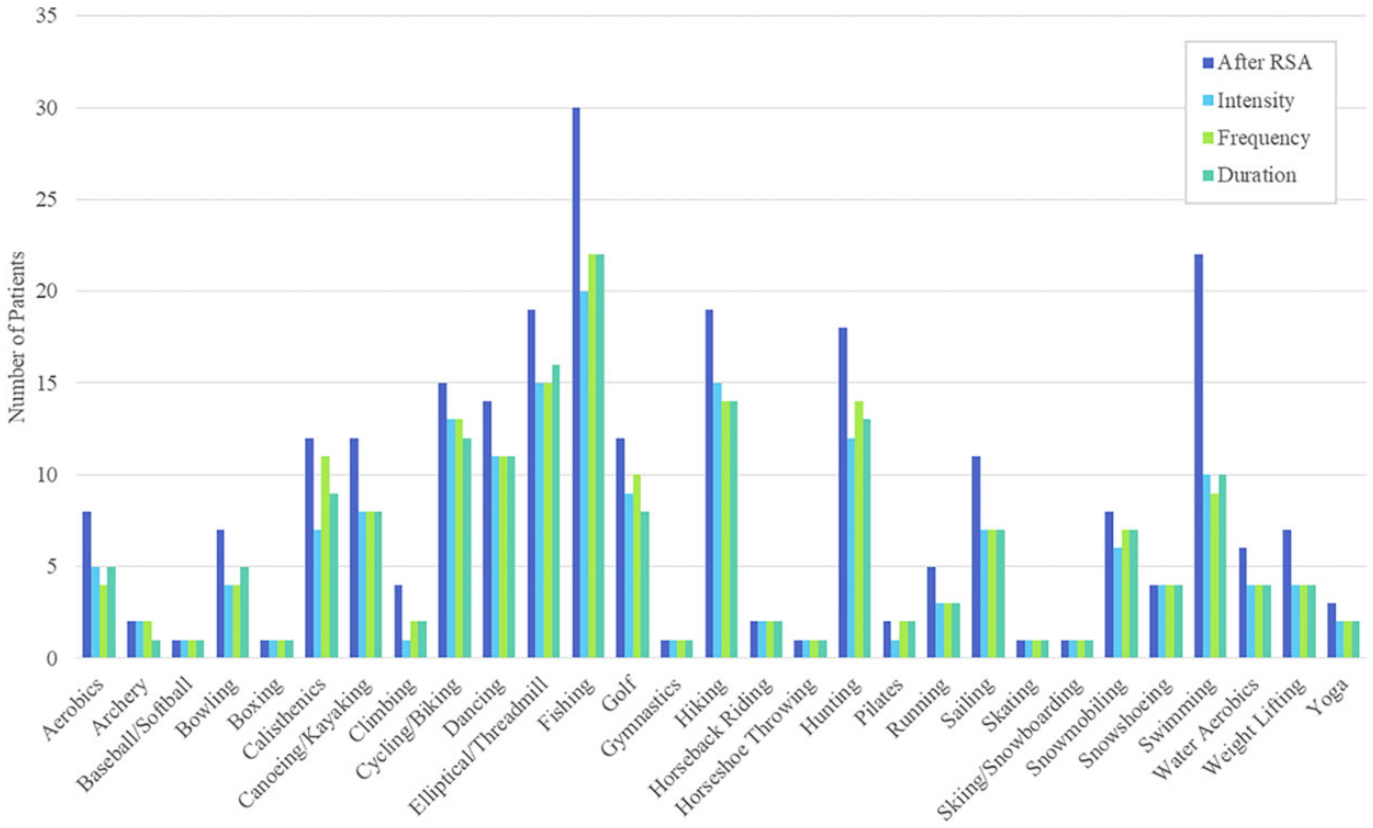

Figure 1. Patient ability to return to preoperative levels of sports intensity, frequency, and duration after reverse shoulder arthroplasty (RSA).

TABLE 3
Postoperative Patient-Reported Clinical Data

	Mean ± SD	Range
Pain (0 [no pain] to 10 [severe pain])		
Right	1.4 ± 1.2	0 to 9
Left	1.2 ± 1.8	0 to 7
ASES score (0-100)		
Right	80 ± 19	30 to 100
Left	79 ± 17	42 to 100
Forward flexion, deg		
Right	161 ± 30	40 to 180
Left	155 ± 32	60 to 180
External rotation, deg		
Right	52 ± 33	–50 to 90
Left	48 ± 31	–40 to 90
Internal rotation (1-8[a])		
Right	3.4 ± 1.9	0 to 8
Left	3.6 ± 1.8	1 to 8
Strength (0-10)		
Right	7.5 ± 2	2-10
Left	7.2 ± 2	1-10

[a]1 = level of greater trochanter; 8 = level of T3. ASES, American Shoulder and Elbow Surgeons.

ADLs or leisure activities. They also found improved range of motion in all planes including external and internal rotation. Assenmacher et al[1] had similar findings in their cohort of 31 patients who underwent bilateral RSA except limitation with activities that required extreme internal rotation, such as fastening a bra or washing their back.

Advances in implant design and surgical techniques continue to evolve with the goal of improving motion and function after RSA. Some studies report that a more lateralized RSA improves both external and internal rotation and minimizes impingement on the scapula. However, 3 studies[12,15,29] evaluating activity before and after RSA found less difference in those with a lateralized center of rotation compared with those with a medialized center of rotation. Godin et al[10] also evaluated the impact of subscapularis repairability on return to sports after RSA and found that patients with reparable subscapularis tendons had higher patient-reported outcomes and higher rates of return to activities. Patients who had reparable subscapularis tendons had a return to sports rate of 89.8% compared with 61.1% in patients with irreparable tendons.

Return to sports rates after RSA seem to be lower than the rates reported after anatomic TSA, but variable when compared with HA. A meta-analysis of 13 studies evaluating return to sports after shoulder arthroplasty found a significantly higher rate of return after anatomic TSA (92.6%) compared with RSA (74.9%; $P = .003$) and HA (71.1%; $P = .02$).[18] Another study by Wang et al[32] found that 95% of the patients in the anatomic TSA group were participating in at least 1 sport after surgery compared

with 40% in the RSA group and 76% in the HA group. In a study comparing 102 patients with RSA versus 71 patients with HA, Liu et al[17] found a higher rate of return to sports in the RSA group compared with the HA group (86% vs 67%; $P = .02$, respectively). Patients in the RSA group were also more satisfied with the ability to return to sports and had a higher likelihood of returning to sport if they were female, age <70 years, had surgery on a dominant extremity, preoperative diagnosis of arthritis with rotator cuff dysfunction, and fewer postoperative complaints. Commonly cited reasons for certain patients' inability to participate in sports activities after RSA have included medical comorbidities and shoulder limitations related to pain or stiffness. Postoperative restrictions for sports participation may also be imposed or recommended by the treating surgeon.[11,20] Golant et al[11] found that only 45.2% of the surgeons felt comfortable allowing patients to return to sports after RSA.

Sports participation can improve a patient's quality of life and may be a reason to undergo an RSA; however, increased demands on the implants, particularly with high-intensity or repetitive sports, may result in increased wear, notching, and fracture. Demand on the shoulder also varies with different activities, which may play a role in implant survivorship. This is of particular concern in younger patients who want to remain active after surgery. Although there are several studies[3-5,14,17,19,31] evaluating return to sports after RSA, the mean age of the patients in these studies is older, they have short- to midterm follow-up, and they are unable to comment on the long-term outcomes of sports on the longevity of the implant. One study by Simovitch et al[27] did include radiographic evaluation in their study. In a cohort of 41 patients with a mean age of 73 years and mean follow-up of 3.5 years, they found a 17% rate of radiographic lucency around the humeral stem and a 7% rate of glenoid notching but no cases of humeral or glenoid loosening. Long-term studies are needed to further assess the effects of postoperative sports participation on the implant survivorship.

Our study has several limitations, including the retrospective nature of the study and potential for patient recall bias. Surveys were conducted through mail, and although patients were contacted by telephone to remind them to complete their survey, our survey response rate was only 50%. This introduces the possibility of selection bias, and our results may not representative of all patients who undergo primary RSA. We also did not include a comparison group or radiographic review so we are unable to comment on the effects of return to sports on the radiographic outcomes of RSA. Shoulder range of motion and strength were measured by the patients as part of the survey questionnaire. The absence of radiographic outcomes may prevent surgeons from allowing their patients to resume sports activities; however, no patient in our study required revision shoulder surgery for implant failure, although most of our patients had <4 years of follow-up. Last, we did not perform a multivariate analysis to evaluate for the effect of age, sex, laterality, hand dominance, subscapularis tendon reparability, or preoperative diagnosis on a patient's ability to return to sports.

CONCLUSION

Patients undergoing primary RSA had a 70.1% rate of return to sports with no significant difference in rates between unilateral and bilateral RSA and no complications related to sports that required additional surgery. The rate of return to high-demand sports such as tennis or basketball was lower compared with low- and medium-demand sports such as fishing, swimming, or elliptical/treadmill; and no patients were able to return to overhead sports. Additional long-term studies are needed to further assess the potential for detrimental effects of continued sports activities on the longevity and survivorship of the RSA.

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