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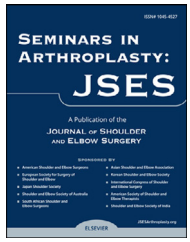

Analysis on revision rates of shoulder arthroplasty at a single referral center in Canada

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ABSTRACT

Background: The aim of the present report is to study a historic cohort on revision rates and indications from our local shoulder arthroplasty registry over the last 16 years.
Methods: An overall population of 1545 in the period of 2005 and 2021 was analyzed, identifying 149 shoulder arthroplasty revisions, from which 26.1% were resurfacing hemiarthroplasty, 40.9% stemmed hemiarthroplasty, 14% total shoulder arthroplasty (TSA), and 18.7% reverse shoulder arthroplasty (RSA).
Results: The overall revision rate identified in our population was 7.7% (n = 149/1545). This was distributed between stemmed hemiarthroplasty with a revision rate of 14.2% (n = 61/428), 13.4% (n = 39/291) for resurfacing hemiarthroplasty, 8.6% (n = 28/324) for RSA, and 4.2% (n = 21/497) for TSA. Glenoid erosion was the main revision indication in 38.9% of the cases, followed by aseptic loosening in 19.46% and instability in 15.44%. Only 12 cases (8.05%) were revised due to infection and 2 of those required two-staged procedure. The most common implant type used in revisions was RSA with 41.61% followed by TSA in 34.23% of the cases. Thirty patients (20.1%) required more than one revision procedure and 43% (n = 13/30) of them were revised to RSA. Acute fracture (adjusted odds ratio = 2.67, 95% confidence interval 1.66-4.29; $P < .01$) and avascular necrosis (adjusted odds ratio = 2.18, 95% confidence interval 1.03-4.63; P .043) were associated with an increased risk of revision surgery.
Discussion: The main implants revised were stemmed and unstemmed hemiarthroplasties. RSA was the most frequent implant used for revisions.
Level of evidence: Level IV; Retrospective Case Series

Nova Scotia Health Authority Research Ethics Board approved this study (NSHA REB ROMEO File #: 1024626).

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Shoulder arthroplasty has increased significantly in the last decade and therefore, so have its complications and revision surgeries.[3,15,22] The annual prevalence of shoulder arthroplasties has increased in the last decade. It is the most common type of arthroplasty after total hip and knee arthroplasty.[5,15,22] Recent prediction data show that by 2030 the need for shoulder arthroplasty will increase by 755% in the 55-year-old and older population and almost 333% in younger and more active patients.[15,17,19]

With the increased number of reverse shoulder arthroplasties (RSAs) performed worldwide, a proportional amount of complications and revision surgery has been reported.[3] Australian and some European countries registries report mid-term to long-term outcomes based on large databases with an overall revision rate of 8%-12%.[6–8,14,18,20,21] Kennedy et al performed a recent systematic review where they identified a 19% revision rate after RSA.[12] The difference between reported revision rates can be attributed to the variability in defining a revision surgery.[9]

Most North American–based studies have come from the United States;[10,11,13,23] to diversify this area of study, a historic cohort of shoulder arthroplasty revision rates and indications were analyzed at a single referral center in the Maritime Provinces of Canada over a 16-year period.

Materials and methods

After institutional ethics board approval, an analysis was performed on all of the prospectively collected patients from the Joint Database Registry at the Halifax Infirmary, which is the main referral center for shoulder arthroplasty in the Maritime Provinces of Canada.

All patients who required a revision shoulder arthroplasty after primary resurfacing hemiarthroplasty (RHA), stemmed hemiarthroplasty (SHA), total shoulder arthroplasty (TSA), or RSA in the period from January 1, 2003 to December 31, 2021 were included. Revision surgery was defined as removal of any previous arthroplasty components, implantation of new components, polyethylene exchange, and addition of a glenoid component in SHA. Primary to revision procedure interval was classified as early if it occurred less than 12 months since the primary shoulder arthroplasty.

Exclusion criteria included bony or soft tissue tumor of the shoulder that required resection and reconstruction or bone-tumor–related fractures requiring shoulder arthroplasty of any type. Insufficient information was also considered as exclusion criteria; the lack of sufficient electronic information from 2003 to 2004 led to the elimination of all the patients from this period.

Pooled descriptive analysis of collected data was used to understand patient demographic details such as age, gender, operative side, and procedure performed. Indications for surgery were included in the case of single or multiple revision procedures. The data were analyzed using descriptive statistics. Median and interquartile range were used for non-normal distribution data. Yearly rate and delay to reintervention surgery according to implant type (RHA, SHA, TSA, or RSA) were compared using Student's *t*-test.

A comparison of revision surgery risk according to surgical primary indication with logistic regression analysis controlling for age, gender, and surgeon was performed. A *P* value of .05 was considered significant. The results are presented as odds ratios (ORs) and 95% confidence intervals (CIs) for risk of revision surgery. Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 27 (SPSS; IBM Corp, Armonk, NY, USA).

Results

A total of 1545 cases from 2005 to 2021 were analyzed. One hundred and forty nine shoulder arthroplasty revisions were identified in this group (Fig. 1). All the procedures were performed with a standard deltopectoral approach at a single center. Of the 1396 cases of primary shoulder arthroplasty reported in the study period, 83% (n = 1159) were performed by 2 upper extremity surgeons, 11.9% (n = 166) were performed by 3 other surgeons with experience in shoulder surgery, and 71 cases were performed by general orthopedic surgeons. Of the 149 cases of revision arthroplasty, 96% (141) were performed by the 2 surgeons assigned to Surgery of the Upper Limb Department, while only 8 cases were operated on by other orthopedic surgeons.

The mean age for revision surgery was 64.54 ± 10.21 years, with a male:female ratio of 1:0.99. Operated side had a similar distribution for right or left. The median time from primary arthroplasty to revision procedure was 24.3 months (Table I).

Indications for primary shoulder arthroplasty included degenerative osteoarthritis (47.7%), followed by acute proximal humerus fracture (22.8%) and rotator cuff tear arthropathy (14.8%). This distribution was similar for RHA, SHA, and TSA. For RSA, the main diagnosis at primary surgery was rotator cuff arthropathy (Table I).

The overall revision rate identified in our population was 7.7% (n = 149/1545). This was distributed in SHA with a revision rate of 14.2% (n = 61/428), 13.4% (n = 39/291) for RHA, 8.6% (n = 28/324) for RSA, and 4.2% (n = 21/497) for TSA. This distribution did not change over time (Fig. 2). Using logistic regression analysis, having adjusted for age, gender, and surgeon, a primary indication for arthroplasty of an acute proximal humerus fracture (adjusted OR = 2.67, 95% CI 1.66-4.29; $P < .01$) or avascular necrosis (adjusted OR = 2.18, 95% CI 1.03-4.63; *P* .043) (Fig. 3) were associated with an increased risk of revision surgery.

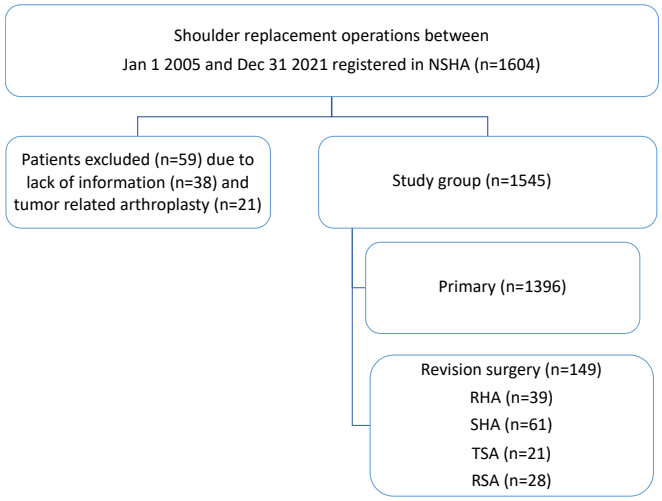

Figure 1 – Flowchart of patient selection from the Joint Database Registry and data included in the study. *NSHA*, Nova Scotia Health Authority; *TSA*, total shoulder arthroplasty; *RSA*, reverse shoulder arthroplasty; *RHA*, resurfacing hemiarthroplasty; *SHA*, stemmed hemiarthroplasty.

Table I – Demographic data of the study population according to primary implant.

Patient characteristics	RHA (n = 39)	SHA (n = 61)	TSA (n = 21)	RSA (n = 28)	Overall
Mean age at revision surgery (mean, SD)	61.18 (9.8)	62.52 (9.05)	65 (10.1)	73.25 (8.5)	64.54 (10.21)
Sex M:F	1.6	0.91	0.4	1.15	0.99
Right (n, %)	31 (79.5)	30 (49.2)	11 (52.4)	14 (50)	86 (57.7)
Left (n, %)	8 (20.5)	31 (50.8)	10 (47.6)	14 (50)	63 (42.3)
Single stage revision (n, %)	35 (89.7)	47 (77)	17 (81)	20 (71.4)	119 (79.9)
Multiple revisions (n, %)	4 (10.3)	14 (23)	4 (19)	8 (28.6)	30 (20.1)
Primary arthroplasty surgery indication (n, %)					
Degenerative OA	32 (82.1)	23 (37.7)	16 (76.2)	-	71 (47.7)
Acute fracture	-	22 (36.1)	3 (14.3)	9 (32.1)	34 (22.8)
Rotator cuff arthropathy	2 (5.13)	6 (9.84)	-	14 (50)	22 (14.8)
Avascular necrosis	1 (2.56)	6 (9.84)	1 (4.76)	2 (7.14)	10 (6.71)
Painful nonunion	-	2 (3.28)	-	3 (10.7)	5 (3.36)
Inflammatory arthritis	2 (5.13)	1 (1.64)	1 (4.76)	-	4 (2.68)
Postfracture OA	2 (5.13)	1 (1.64)	-	-	3 (2.01)
Primary to revision interval (median, IQR)	31.6 (14.6-59.9)	17.2 (9.2-50.0)	48.9 (16.5-91.7)	14.6 (0.8-28.85)	24.3 (9.8-58.5)

RHA, resurfacing hemiarthroplasty; *SHA*, stemmed hemiarthroplasty; *TSA*, total shoulder arthroplasty; *RSA*, reverse shoulder arthroplasty; *OA*, osteoarthritis; *SD*, standard deviation; *IQR*, interquartile range.

Indications for revision surgery differed depending on the type of implant, with glenoid erosion accounting for 38.9% of all the cases, followed by aseptic loosening and instability. In RHA and SHA cases, glenoid erosion was the main indication for revision. Aseptic loosening accounted for 47.6% of TSA revisions and instability was the principal diagnosis for RSA revisions. Twelve cases (8.05%) were revised due to infection and a two-staged procedure was required in 2 cases (Table II).

Thirty percent of the patients were identified as early revision. Most of them were secondary to instability, glenoid erosion, and infection (37.8%, 24.4%, and 13.3%, respectively) (Table III).

RSA was used for revisions in 41.61% of cases, followed by TSA in 34.23% of the cases. The majority of SHA were revised to RSA, whereas RHA was revised mostly to TSA. Some revision patients had severe glenoid bone loss that required a revision to SHA in 20.81%. Most of these patients had a TSA previously. The data of initial and final implant in the last follow-up after revision can be assessed in Table IV.

Almost 80% of the patients required a single-stage revision procedure. Thirty patients (20.1%) required more than one revision procedure and 43% (n = 13/30) of them were revised to RSA.

The majority of the cases (61.08%) required either the humeral head only or the complete humeral component to be revised, while 21.48% of the cases required revision of both glenoid and humeral components (Table V).

Discussion

In this study, we report a single Canadian referral center's experience in shoulder arthroplasty over 16 years. Revision surgeries that were included in this report were performed by

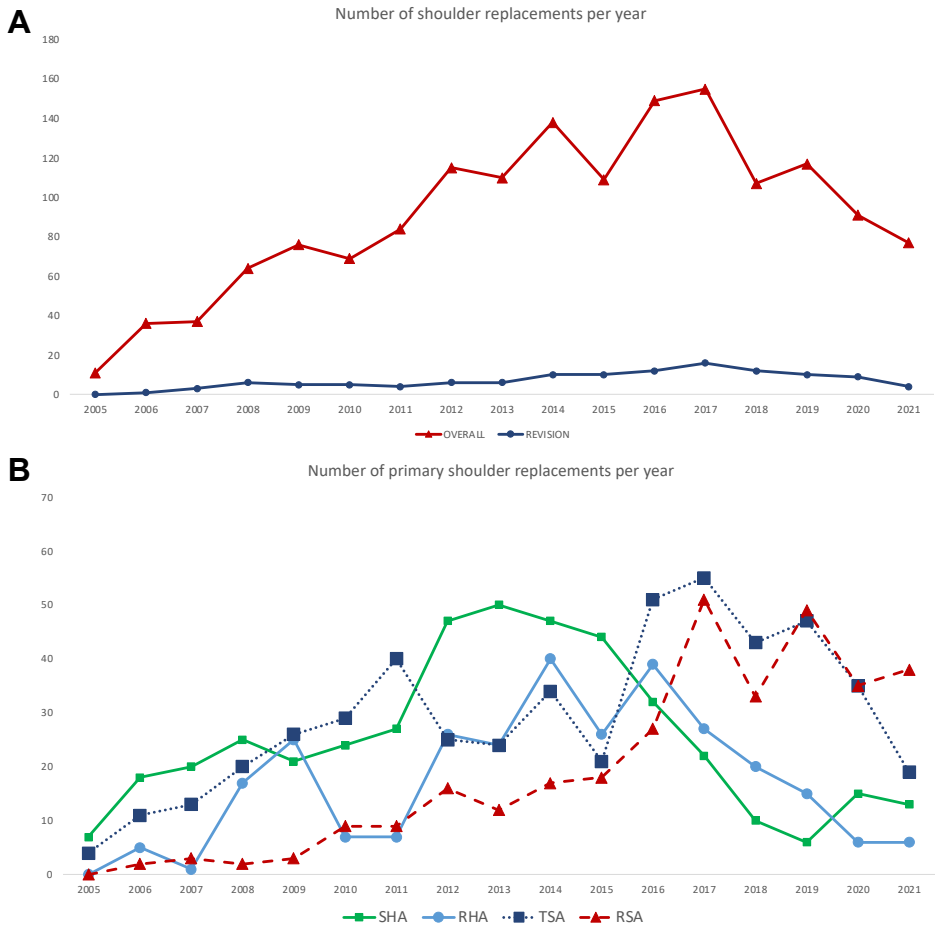

Figure 2 – (A) Line graph illustration number of cases per year of shoulder arthroplasty and revision surgery from 2005 to 2021. (B) Line graph illustrating the annual number of primary shoulder replacements for type of implant. *TSA*, total shoulder arthroplasty; *RSA*, reverse shoulder arthroplasty; *RHA*, resurfacing hemiarthroplasty; *SHA*, stemmed hemiarthroplasty.

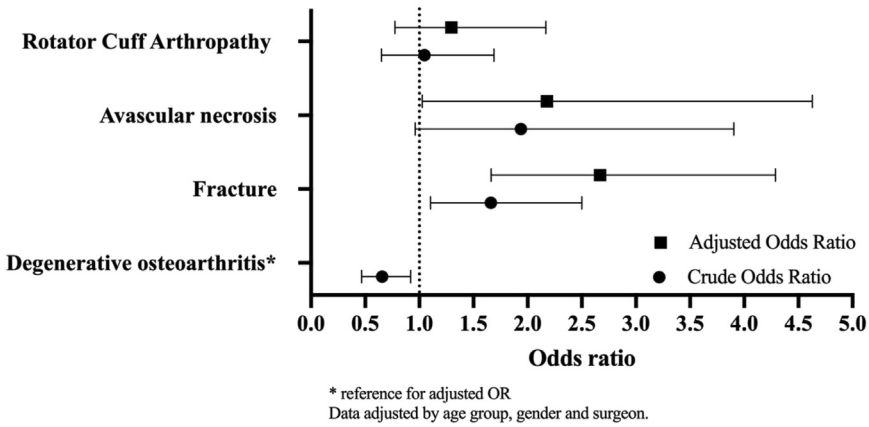

Figure 3 – Forest plot showing odds ratio associated with revision surgery according to indication of primary surgery.

2 experienced fellowship-trained upper extremity surgeons in a decentralized, universal, publicly funded healthcare system. We found that glenoid erosion was the main indication for revision in shoulder hemiarthroplasties (Table V). This is consistent with a long-term European cohort study (glenoid erosion in 29% of hemiarthroplasty revision cases).[6] Knowles et al[15] showed in a systematic review that the most common revision indication was glenoid arthritis with a prevalence as high as 20% of the cases in North America.

The overall revision rate identified in our population was 7.7%. This is consistent with one of the largest cohort studies in Europe that reported <10% in 9 shoulder database

Table II – Indications for first revision surgery according to type of primary arthroplasty.

Reason for revision	RHA, N = 39	SHA, N = 61	TSA, N = 21	RSA, N = 28	Total
	n (%)	n (%)	n (%)	n (%)	n (%)
Glenoid erosion	28 (71.79)	30 (49.18)			58 (38.93)
Aseptic loosening	3 (7.69)	10 (16.39)	10 (47.62)	6 (21.43)	29 (19.46)
Instability		9 (14.75)	2 (9.52)	12 (42.86)	23 (15.44)
Rotator cuff tear	5 (12.82)	6 (9.84)	2 (9.52)		13 (8.72)
Infection	2 (5.13)	5 (8.20)	2 (9.52)	3 (10.71)	12 (8.05)
Pain NYD			4 (19.05)	6 (21.43)	10 (6.71)
Second stage		1 (1.64)		1 (3.57)	2 (1.34)
Fracture	1 (2.56)	0 (0.00)	1 (4.76)		2 (1.34)

TSA, total shoulder arthroplasty; *RSA*, reverse shoulder arthroplasty; *RHA*, resurfacing hemiarthroplasty; *SHA*, stemmed hemiarthroplasty; *NYD*, not yet diagnosed.

Table III – Etiologies for first revision surgery according to early or late presentation.

Reason for revision	Early revision	Late revision	Total
	n (%)	n (%)	n (%)
Glenoid erosion	11 (24.4)	44 (44.4)	55 (38.2)
Aseptic loosening	4 (8.9)	24 (24.2)	28 (19.4)
Instability	17 (37.8)	5 (5.05)	22 (15.3)
Rotator cuff tear	2 (4.4)	11 (11.1)	13 (9.03)
Infection	6 (13.3)	6 (6.06)	12 (8.33)
Pain NYD	3 (6.7)	7 (7.07)	10 (6.94)
Second stage	1 (2.2)	1 (1.01)	2 (1.39)
Fracture	1 (2.2)	1 (1.01)	2 (1.39)
Overall	45	99	144

NYD, not yet diagnosed.
5 patients did not have time data. Early revision ≤12 months after primary procedure. Late revision >12 months after primary procedure.

Table IV – Distribution of implants at last follow-up.

Type of implant	Implant at last follow-up, n (%)			
	SHA	TSA	RSA	Spacer
First implant				
SHA	12 (19.7)	16 (26.2)	30 (49.2)	3 (4.9)
RHA	3 (7.7)	26 (66.7)	10 (25.6)	0 (0.0)
TSA	8 (38.1)	9 (42.9)	3 (14.3)	1 (4.8)
RSA	8 (28.6)	0 (0.0)	19 (67.9)	1 (3.6)

TSA, total shoulder arthroplasty; *RSA*, reverse shoulder arthroplasty; *RHA*, resurfacing hemiarthroplasty; *SHA*, stemmed hemiarthroplasty.

Table V – Frequency of type of implant removed at revision surgery.

Revision: components removed	n (%)
Humeral head only	49 (32.89)
Humerus only	42 (28.19)
Humerus and glenoid	32 (21.48)
Glenoid only	10 (6.71)
Poly exchange	9 (6.04)
None	4 (2.68)
Antibiotic spacer	3 (2.01)

registries.[2] However, there are some discrepancies when cohorts are stratified by type of implant (Table VI). Regarding RHA, there were only 2 studies with percentage between 7.5% and 12%.[16,20] For SHA, 3 cohorts had results with lower percentages than our data (6.2%, 6.7%, and 12.6%). We hypothetize that humeral-sided component revision and the native glenoid surface erosion were important factors that increased the number of revisions of hemiarthroplasties (Table II). This finding is similar to the data identified in recent systematic reviews.[15,22] Hemiarthroplasties are often used in younger and more active patients and it is often easier to perform a revision to other implant designs (Table IV).

Anatomic TSA had a lower revision rate (4.2%). A systematic review[4] from 2020 reports a 7.7% incidence of revision in TSA. Most of the cohorts presented higher percentages of revision for TSA (Table VI). We explained this pattern by considering 2 factors, the low prevalence of infection in our population and the time frame of the studies. Some of the studies were completed 2 decades earlier, so the implants available may be biomechanically different. In contrast to TSA, we had an increased proportion of RSA revision rates compared to other studies (Table VI). RSA revision surgery was associated instability and aseptic loosening of the glenoid component. Early revisions were related to instability, while revisions performed 12 months after the primary surgery were related to aseptic loosening (Table II). Longer term cohorts including Scandinavian, Australian, and New Zealand national registries also found instability and aseptic loosening to be the primary cause of revision sugery.[24]

Thirty patients required multiple-stage revision surgery. In the majority of cases, SHAs were the components requiring revision (14/30). As previously discussed, this pattern was likely associated with the increased options to revise hemiarthroplasties. Three patients with SHA required an antibiotic spacer due to infection with a delayed definitive replacement.

Our study has some limitations. First, complications as well as reinterventions other than revision surgery and survivorship were not analyzed in our cohort. Second, although these data come from the Joint Database Registry of the province with prospective data collection, this is still a single-center study and patients may have been lost to follow-up or may have undergone revision at other centers. Both issues underestimate the

Table VI – Revision rate comparison between shoulder arthroplasty studies.

Author	Years studied	n	Revision rate				
			Overall (%)	RHA (%)	SHA (%)	TSA (%)	RSA (%)
Our data	2005-2021	149/1545	7.70	13.40	14.20	4.20	8.50
Gauci et al[6]	1993-2013	268/4295	6.20		12.6	6.7	3.9
Rasmussen et al[21]	2006-2010	79/1096		7.50	6.20		
Holschen et al[25]	2010-2012	44/563	10.70				
Ödquist et al[16]	1999-2009	92/1140	8.10	12	6.7		
Kiet et al[13]	2008-2011	10/152				11	9
Aibinder et al[1]	2004-2020	304/8580				4.70	2.40
Singh et al[24]	1976-2008	212/2588				8.10	

TSA, total shoulder arthroplasty; *RSA*, reverse shoulder arthroplasty; *RHA*, resurfacing hemiarthroplasty; *SHA*, stemmed hemiarthroplasty.

results. Therefore, it is necessary to involve other provinces throughout the country to improve completeness of the registry.

The aim of this study was to evaluate revision rates, indications, and type replacement implanted. It was not part of the scope of this research to evaluate preoperative and postoperative functional scores, radiographs, or other patient outcomes. The strengths of our report are the comparable results identified with other national registries and systematic reviews. It is necessary to expand our evaluation performing a further survivorship and risk factor analysis on these data.

Conclusion

Overall shoulder arthroplasty revision rate in our cohort was 7.7%. The main implants revised were stemmed and unstemmed hemiarthroplasties. RSA was the most frequent implant used for revisions. Eighty percent of the patients required a single revision procedure.

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