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Complications rates, reoperation rates, and the learning curve in reverse shoulder arthroplasty

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Background: Reverse shoulder arthroplasty (RSA) has ushered a new era in shoulder surgery. However, the results of RSA also described the complication rates associated with the procedure as inordinate and a learning curve associated with the incidence of complications.

Methods: The records of 112 patients who underwent 114 RSA procedures by the senior author (G.I.G.) were reviewed for complications related to a RSA. Of these, 93 RSA procedures were the primary treatment for the shoulder, and 21 were revisions.

Results: The total complication rate for the entire group was 7%. Complications included 3 periprosthetic fractures, 3 hematomas, 1 acromion fracture, and 1 deep infection. The complication rate was 19% in the revision RSA group and 4.3% in the primary RSA group ($P \leq .02$). Complication rates in the initial RSA patients in this series did not differ from the final procedures in this series ($P = .96$). The total reoperation rate was 5.3%, and was 19% in the revision RSA group vs 2.2% in the primary RSA group ($P \leq .02$).

Conclusion: Complications and reoperations associated with a RSA, although significant, occurred at much lower rate than in previous reports. This series demonstrates a significant difference in complication rates and reoperation rates between primary and revision RSA. Revision RSA complications and reoperations were far more common than in primary RSA procedures. No evidence of a learning curve related to surgical experience was demonstrated in this series.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Complication; reverse shoulder arthroplasty; learning curve; periprosthetic fracture; infection; seroma; scapular fracture

Reverse shoulder arthroplasty (RSA) opened a new chapter in the treatment of rotator cuff arthroplasty when promoted by Professor Grammont beginning in the mid-1980s.[17] The indications for use of the procedure have continued to expand to include failed hemi and total shoulder arthroplasty, fractures and fracture sequela, and insufficiency of the rotator cuff in inflammatory arthritis or rotator cuff tears.[1-3,5,11,14-16,18,20,22,25-29,34-36] Numerous reports have documented significant improvements in pain, motion, and function in patients treated with RSA.[1-3,10,14,22,25,26,36,37,39]

These reports also detail a worrisome aspect of RSA: a vast array of complications and reported high rates of complications associated with the procedure. Complication rates as high as 75% have been reported in series of RSA.[38] There has been disagreement regarding the role of revision surgery and its relation to complication rates in RSA.[16,26,35,37] The concept that these complications are

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part of a surgical learning experience has been detailed in other reports.[21,33,38] The purpose of the current study was to report the incidence of initial complications in a consecutive series of patients treated with a RSA.

Materials and methods

The senior author (G.I.G.) treated 114 shoulders in 112 patients (36 men and 76 women) with RSA between 2006 and 2011. The records of these patients were analyzed for complications and reoperations associated with a RSA. The average age at the time of operation was 64 years (range, 53-86 years). Seventy-three RSAs were performed for patients with painful pseudoparesis caused by a massive irreparable rotator cuff tear. Twenty RSAs were performed for patients with 3- or 4-part proximal humeral fractures and associated greater tuberosity osteopenia. Twenty-one RSAs were performed for revision of a failed procedure, including 3 failed open reduction and internal fixations, 4 failed total shoulder arthroplasties, and 14 failed shoulder hemiarthroplasties. The average length of follow-up was 26 months (range, 12-48 months).

The prostheses used in this series included 7 Delta III (DePuy, Warsaw, IN, USA), 9 Delta Extend (DePuy), and 98 Reverse Shoulder Prostheses (DJ Orthopedics, Austin, TX, USA). Glenosphere prosthesis size included 4 that were 36 mm, 9 that were 38 mm, and 3 that were 42 mm in the Delta 3/Extend system. Glenosphere size in the Reverse Shoulder Prosthesis series included 22 that were 32 mm neutral, 64 that were 32-4, 10 that were 36 mm neutral, and 2 that were 36-4.

All prostheses were implanted through a deltopectoral approach, with the patient in the beach chair position, and with the use of regional anesthesia, general anesthesia, or a combination of both. In all patients with a preserved subscapularis tendon, this was repaired at the end of the procedure. All humeral components in this series were implanted with use of bone cement. A suction drain was used and left in place for 48 hours postoperatively.

The patient was placed into an abduction sling for the first 2 weeks after surgery. This was replaced at 2 weeks with a standard sling to be worn in public and at night. A physician-directed therapy program was initiated, which included passive range of motion. The patient was also instructed to use the extremity for light activities of daily living. The sling was discontinued at 6 weeks postoperatively, and a strengthening program was initiated at 10 weeks.

Statistical analysis of the results was performed using the Pearson χ^2 test, with the Yates correction for continuity used in conjunction. The significance level was set at $P = .05$.

Results

The complication rate and reoperation rate for all patients are reported in Table I and Table II, respectively. A complication occurred in 8 RSA procedures, for a complication rate of 7% for the entire group. Complications for the entire group included 3 periprosthetic fractures (2 type B and 1 type C).[19] There were also 3 postoperative hematomas, 1 scapular fracture (Fig. 1), and 1 deep infection.

Table I Complications of primary and revision reverse shoulder arthroplasty

Type of surgery	Complication	Patients (No.)
Primary	Deep infection	1
Primary	Scapular fracture	1
Primary	Seroma/hematoma	1
Primary	Periprosthetic fracture	1
Revision	Periprosthetic fracture	2
Revision	Seroma/hematoma	2

Table II Reoperations of primary and revision reverse shoulder arthroplasty

Type of surgery	Complication	Procedure	Patients (No.)
Primary	Deep infection	Irrigation and debridement; component exchange	1
Primary	Seroma/hematoma	Irrigation and debridement	1
Revision	Periprosthetic fracture	Open reduction and internal fixation	2
Revision	Seroma/hematoma	Irrigation and debridement	2

A repeat operation was performed in 6 shoulders, giving a reoperation rate of 5.3% for the entire group. Reoperations for the entire group after a RSA included 2 open reduction and internal fixation procedures for type B periprosthetic humeral fractures (Fig. 2). Two irrigation and debridements were performed for postoperative hematomas. One irrigation and debridement was coupled with associated polyethylene and glenosphere exchange for deep infection. The infection occurred within 3 weeks of the primary procedure and resolved with surgical debridement and antibiotics, without further intervention.

Complication and reoperative rates differed significantly when comparing primary reverse shoulder arthroplasty and revision RSA (Table II). The complication rate was 19% in the revision RSA group and 4.3% in the primary RSA group ($P = .02$). The reoperation rate was 19% in the revision RSA group vs 2.2% in the primary RSA group ($P = .02$).

The complication rate for the initial 20 RSA procedures was the 0%. The complication rate in the final 20 procedures in this series was 5% (1 postoperative periprosthetic fracture that was treated nonoperatively; Fig. 3). Complication rates in the initial RSA procedures did not differ significantly vs the final RSAs performed ($P = .96$).

At latest follow-up, scapular notching was observed in 9 of the Delta III and Delta Extend prosthesis. We recorded 5 cases of type I and 4 cases of type II notching.[3] We observed scapular notching on the anteroposterior view of 4 Reverse Shoulder Prosthesis. The notching was classified as type I in all cases.

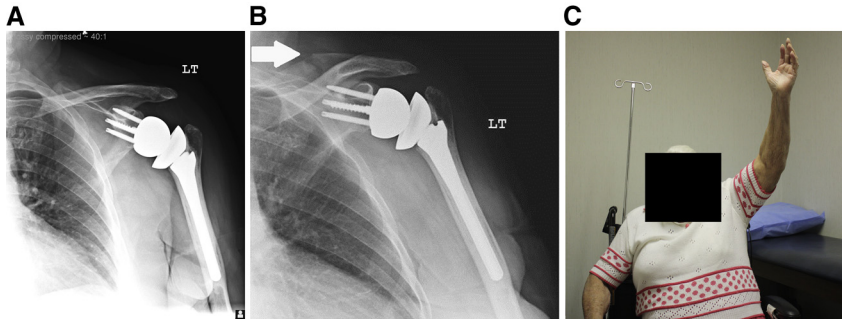

Figure 1 (**A**) Radiograph of 71-year-old patient after primary reverse shoulder arthroplasty. (**B**) Radiograph at 10 months after reverse shoulder arthroplasty shows a fracture of the scapular spine (*white arrow*). (**C**) Clinical elevation 4 months after scapular spine fracture.

Discussion

RSA has evolved to become the dominant option for patients who have substantial shoulder pain coupled with an irreparable rotator cuff and glenohumeral arthritis.[1,3,14,38,39] The indications for RSA have expanded beyond those for rotator cuff arthropathy. These surgical indications now include failed shoulder hemiarthroplasty or total shoulder arthroplasty, failed treatment of proximal humeral fractures, treatment for 3-part or 4-part proximal humeral fractures associated with greater tuberosity osteopenia, and select patients with massive irreparable rotator cuff tears associated with pain and shoulder dysfunction.[1-3,5,11,14-16,18,20,22,25-29,34-37]

RSA has truly ushered in a new era of shoulder surgery. However, the complication rate for RSA exceeds 50% in studies that include major and minor complications.[37,38] Other authors note that reports of lower complication rates did not include minor complications such as postoperative hematoma or incidents that did not require additional surgery.[6,16,24] We reported all complications in this series for 2 reasons. First, even minor complications, such as hematoma, have been associated with more serious issues such as infection.[7] Second, a complete reporting of complications would be helpful in identifying trends in RSA and in detailing surgical risks with patients preoperatively.

Our complication rate is lower than previous series, with rates reported as high as 68%.[38] Although previous reports have noted an increased intraoperative complication rate early in a surgeon's operative experience,[21,33,38] we did not, mirroring reports by Levy and Blum.[24] Our data also differ from most previous series in noting a complication rate of 4.3% after primary RSA compared with 19% after revision RSA, which was significantly different. This difference was reflected again in the reoperation rate of 19% after revision RSA compared with 2.2% after primary arthroplasties. Other authors[25,36] have noted a similar stratification in complication and reoperation rates, whereas others have detected no difference.[24,38]

Although identifying the causes of this reduced rate in complications is beyond the scope of this report, some associations can be noted. A deep infection rate of 1% to 10% after RSA has been reported.[2,6,10,38] The RSAs in this series were performed in standard operating rooms using positive-pressure ventilation, without the use of ultraviolet lights or body exhaust suits.

Nowinski[32] recently reported a significant reduction in infection when antibiotic-impregnated cement was compared with standard cement in RSA procedures. The senior author (G.I.G.) has used antibiotic cement in all RSAs during the past 3 years and has also used a dilute Betadine (Purdue Pharma LP, Stamford, CT, USA) irrigation solution before wound closure. Brown et al[4] noted a significant decrease in deep postoperative infections after use of a dilute 0.35% Betadine solution before wound closure in hip/knee arthroplasty. The single deep infection reported in this series occurred before the implementation of these techniques.

We observed no patients with instability in this series. Instability after RSA has been reported in a range of 2.4% to 31%.[6] The role of surgical approach has been ascribed to alter the rate of dislocation,[16] with recommendations that a superior approach yields a lower dislocation rate than the deltopectoral approach. All surgical exposures in this series were performed through a deltopectoral approach.

Clark et al[8] noted no significant change in instability rates with the addition of a repair of the subscapularis tendon associated with an RSA procedure. We agree that the biomechanics of a lateralized RSA can improve compression across glenosphere cup interface. However, we continue our practice of repair of the subscapularis tendon in all shoulders in this series when the subscapularis tendon was intact.[12]

Alternatively, the decrease in instability rates may be affected by the postoperative rehabilitation program. The postoperative rehabilitation program outlined in this series includes a slower progression and incorporation of a physician-directed program. Previous reports have detailed good outcomes associated with physician-directed rehabilitation associated with shoulder arthroplasty.[31] Other authors have noted a trend for less aggressive early motion, even in arthroscopic surgery.[23]

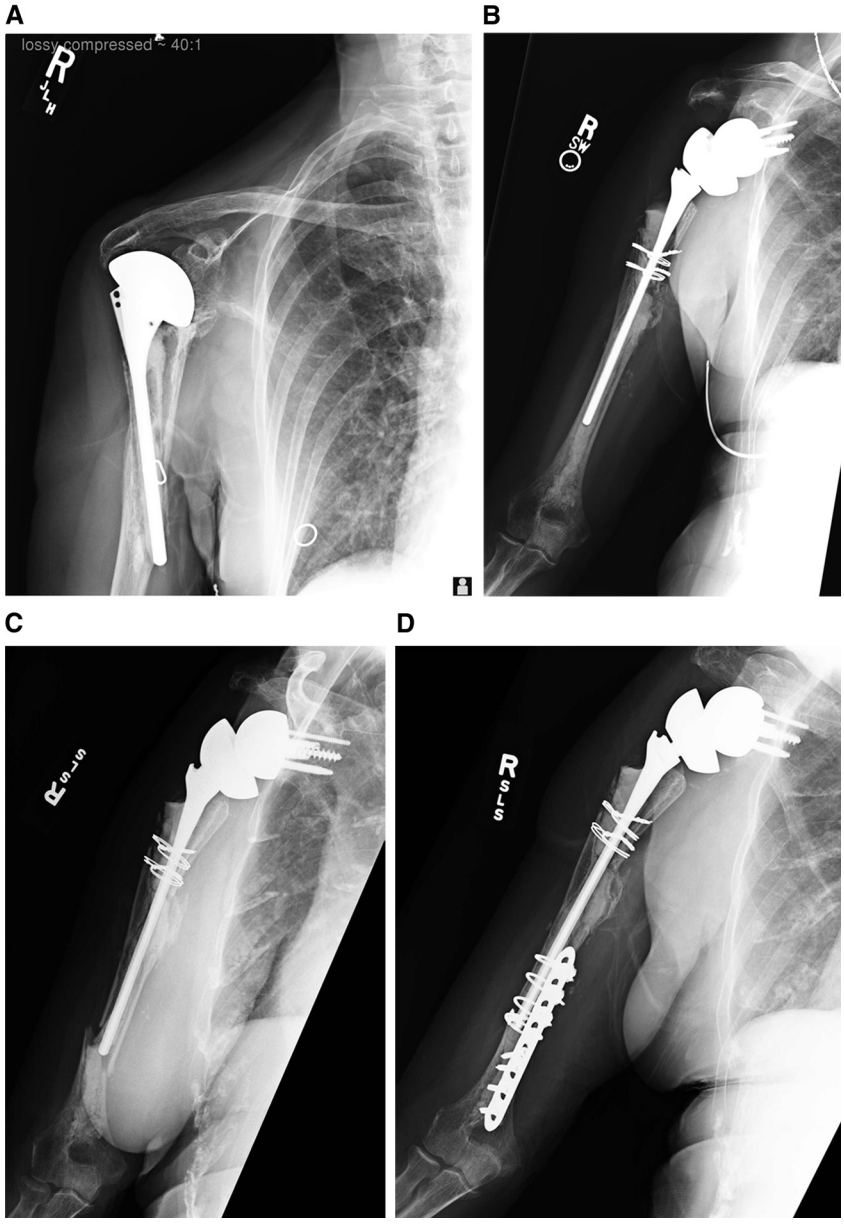

Figure 2 (**A**) Radiograph shows a 72-year-old patient with a failed hemiarthroplasty and periprosthetic fracture performed 11 years before revision by the senior author (G.I.G.). (**B**) Postoperative radiograph after revision to a long-stem reverse shoulder arthroplasty. (**C**) Radiograph 18 months after revision and subsequent fall with a type B periprosthetic fracture. (**D**) Radiograph after open reduction and internal fixation.

Three periprosthetic fractures occurred in this series. No fractures occurred intraoperatively. All stems in this series were cemented, which may have decreased the incidence of intraoperative fracture due to excessive reaming with press fit implants.[19] No glenoid fractures occurred. Hand reaming of the glenoid was used, which may be a more effective strategy for decreasing the incidence of intraoperative fractures than use of power reamers. Hand reaming may be less likely to over-ream an osteopenic glenoid face and does not need to be initiated before contact with the glenoid.[6]

Two of the periprosthetic fractures were displaced with stable humeral implants. Both were treated with open reduction and internal fixation (Fig. 2). The remaining fracture occurred 6 weeks after a primary RSA as a type C fracture[19] (Fig. 3) and was well aligned and treated with a fracture brace. Periprosthetic fractures in RSA, although uncommon, appear to respond to the same treatment algorithms associated with total shoulder arthroplasty.[19]

One scapular fracture occurred during this series that responded to nonoperative management, although the fracture was through the scapular spine. Since this fracture

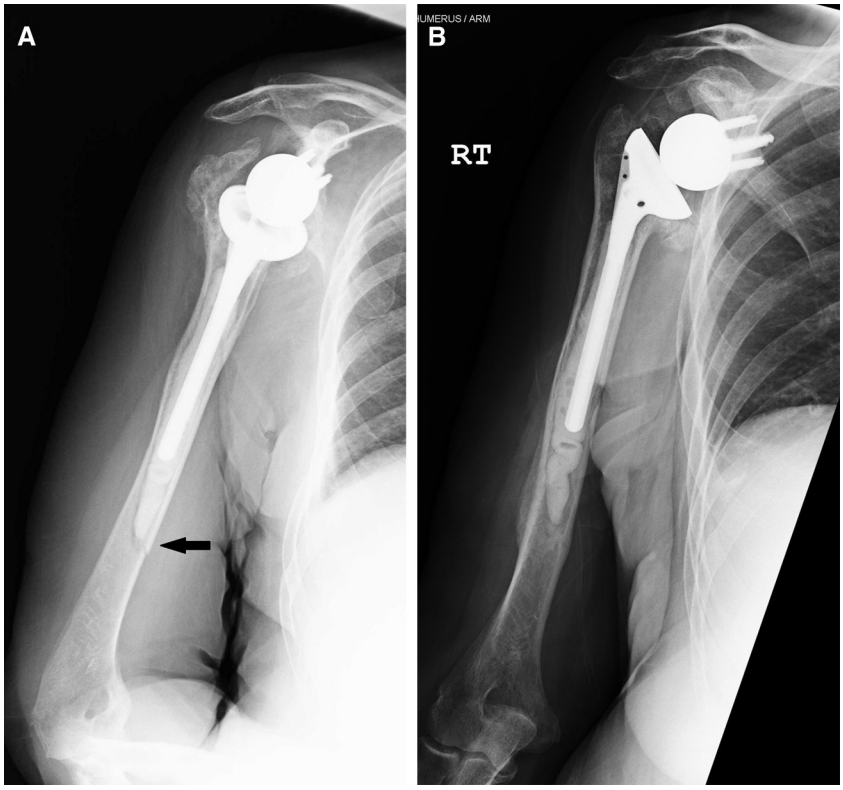

Figure 3 (**A**) Radiograph shows a patient 6 weeks after primary reverse shoulder arthroplasty and subsequent fall, with the *arrow* indicating a type C periprosthetic fracture. (**B**) Radiograph 18 weeks after primary reverse shoulder arthroplasty shows the fracture has healed.

occurred, we have limited the use of the superior locking screw length in the RSA to less than 26 mm in males and 22 mm in females to prevent penetration.[6] No further scapular spine fractures have occurred since implementation of this change. Crosby et al[9] detailed their experience in incidence, classification, and treatment of scapula fractures after RSA.

No baseplate failures occurred in this series. No prosthesis revisions were required due to scapular notching. The incidence of scapular notching appears to be similar to other reports, although categorization of this finding continues to be controversial.[6,30] The role of surgical technique and prosthetic design in the incidence of this finding remain to be further elucidated.[6,13,30]

Among the limitations of the present study were its retrospective nature, which does not allow direct comparisons of different methods of treatment used in RSA. All procedures were performed by a single experienced shoulder surgeon at 1 institution, which may have biased the results in favor of experienced vs nonexperienced shoulder surgeons. The senior surgeon had more than 10 years of experience with anatomic shoulder replacement after a shoulder fellowship before initiating reverse shoulder procedures. There may be crossover skills between anatomic and RSA that improved the author's complication rate. Further, implant design and surgical technique evolved during the course of this report and may have affected outcomes.[19]

Conclusion

The overall complication rate and reoperation rate for RSA appears to have a lower occurrence than previously reported. However, the complication rate and reoperation rate were significantly higher in revision RSA than in primary RSA. We did not experience a surgical learning curve related to complications in RSA.

Disclaimer

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