Comparative Outcomes Between the First and Second Operated Shoulders in Bilateral Shoulder Arthroplasty

Derek D. Berglund, MD
Jennifer Kurowicki, MD
Jacob J. Triplet, DO
Samuel Rosas, MD
Molly Moor, PhD, MPH
Brandon Horn, DO
Jonathan C. Levy, MD

From the Department of Orthopedic Surgery, Holy Cross Orthopedic Institute, Fort Lauderdale, FL (Dr. Berglund, Dr. Kurowicki, Dr. Triplet, Dr. Rosas, Dr. Moor, Dr. Horn, and Dr. Levy); the Department of Orthopaedic Surgery, Seton Hall University, School of Health and Medical Sciences, South Orange, NJ (Dr. Kurowicki); the Department of Orthopedic Surgery, OhioHealth Doctors Hospital, Columbus, OH (Dr. Triplet); the Department of Orthopaedic Surgery, Wake Forest School of Medicine, Winston-Salem, NC (Dr. Rosas); and the Department of Orthopaedic Surgery, Witham Orthopaedic Associates, Lebanon, IN (Dr. Horn).

Correspondence to Dr. Levy: jonlevy123@yahoo.com

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Abstract

Introduction: Studies that report outcomes after staged bilateral shoulder arthroplasty (BSA) are limited. This study compared the overall improvement between the first and second operated shoulders after BSA.

Methods: Preoperative and postoperative motion and patient-reported outcomes for function, pain, and general health were assessed for patients who underwent BSA with a 2-year follow-up. Ultimate outcomes and the efficacy of treatment were compared between the first and second operated shoulders.

Results: Seventy-three patients met the inclusion criteria (mean follow-up, 51.4 months). There were no notable differences between the first and second operated shoulders for all preoperative and postoperative variables except for the preoperative 12-item Short-Form Physical Component Score, which was greater in the second shoulder ($P = 0.005$). The efficacy of treatment was not markedly different except for the Physical Component Score ($P = 0.001$) and forward elevation ($P = 0.01$), which were greater after the first surgery.

Discussion: Improvements in function, pain, and motion were not markedly different between the first and second shoulder arthroplasty surgeries.

Unilateral total shoulder arthroplasty (TSA) and reverse shoulder arthroplasty (RSA) have been shown to produce favorable outcomes in the management of a variety of shoulder pathologies.1,2 However, conditions such as osteoarthritis, rheumatoid arthritis, and rotator cuff arthropathy occasionally have bilateral involvement that may necessitate the use of staged bilateral shoulder arthroplasty (BSA) to alleviate pain and improve shoulder function.

There have been some concerns among surgeons regarding patients’ ability to perform activities of daily living after BSA because of a potential loss of rotational movement, especially in procedures that involve RSA.3 Furthermore, patients may have questions regarding their recovery and functional outcomes as they pertain to
their second surgery versus their first. Outcomes after staged knee arthroplasty have been extensively studied, and differences have been shown between the first and second operated knees. There have been a number of previous studies that evaluated overall outcomes in BSA, but little is known regarding differences between the first and second operated shoulders. The purpose of this study was to compare the efficacy and overall improvement in function, pain, general health, motion, and satisfaction between the first and second operated shoulders in patients with BSA. We hypothesized that patients would demonstrate greater improvement after their second shoulder surgery.

### Methods

A retrospective analysis of data collected from a Western Institutional Review Board (WIRB)-approved Levy Elbow and Shoulder Surgical Repository (WIRB Study #1138999, WIRB Protocol #20130731). An institutional review board exemption was determined (Protocol No. BILATS1) before the initiation of this research. The inclusion criterion was patients who underwent any combination of BSA with anatomic TSA or RSA (TSA/TSA, RSA/RSA, or TSA/RSA) and had at least 2-year follow-up for each shoulder. The exclusion criterion was patients who had unilateral shoulder arthroplasty, BSA with any combination that included hemiarthroplasty, or <2-year follow-up.

Patient-reported outcome measures (PROMs) for shoulder pain (visual analog scale [VAS] pain), function (simple shoulder test, single assessment numerical evaluation, VAS function, and American Shoulder and Elbow Surgeons score), and subjective general health (Physical Component Score [PCS] and Mental Component Score components of 12-item Short-Form [SF-12]) collected preoperatively and at the most recent follow-up appointment were analyzed for each shoulder. Patient satisfaction was rated as “unsatisfactory,” “satisfactory,” “good,” or “excellent” based on the patient’s perceived satisfaction with the surgery. Range of motion (ROM) assessments (active forward elevation [FE], active external rotation, and active internal rotation) were performed via best-effort goniometer measurements. For analytical purposes, internal rotation was quantified using a 10-point scale derived from the Apley scratch test. Patients were assigned 10 points for reaching T1-7, eight points for reaching T8-12, six points for reaching L1-3, four points for reaching L4-sacrum, and two points for reaching the buttock/greater trochanter. Comparisons of the first and second surgeries were made based on the preoperative evaluation, most recent postoperative evaluation, and overall efficacy of treatment (change from preoperative evaluation to most recent postoperative evaluation).

All patients who underwent anatomic TSA were treated with either the DJO Turon TSA (DJO Surgical) or Encore Foundation TSA (DJO Surgical). Patients who underwent RSA were treated using the DJO Reverse Shoulder Prosthesis (DJO Surgical). An identical postoperative rehabilitation protocol was implemented for all patients.

Descriptive statistics including mean values and SDs were computed for all variables. Categoric data were analyzed using chi-square tests, and continuous data were evaluated using Student t-tests to compare patients’ first and second shoulder surgeries. Data were analyzed using SPSS version 23 (IBM). All tests were two tailed, and P < 0.05 was considered statistically significant.

### Results

Of the 90 patients who were treated with BSA between 2007 and 2014, a total of 73 met the inclusion criteria, with a minimum 2-year follow-up. The overall mean follow-up was 51.4 months (range, 24 to 118 months). The mean follow-up was 60.8 months for the first shoulder and 42.6 months for the second shoulder. The mean age at final follow-up was 76.8 years (range, 57.4 to 90.4 years). The average time between the first and second surgeries was 21.1 months (range, 2.1 to 64.7 months).

There were 47 patients (64.4%) treated with bilateral TSA (TSA/TSA) (mean follow-up, 50.9 months; range, 24 to 102.2 months), 17 patients (23.3%) treated with bilateral RSA (RSA/RSA) (mean follow-up, 51.5 months; range, 24.2 to 117.6 months), and 9 patients treated with a combination of TSA and RSA (TSA/RSA) (mean follow-up, 54.0 months; range, 24.1 to 98.8 months).

The average time between the surgeries for patients with TSA/TSA, RSA/ RSA, and TSA/RSA was 19.1 months (range, 2.1 to 61.2 months), 26.5 months (range, 4.4 to 64.7 months), and 21.7 months (range, 8.4 to 54.6 months), respectively. No notable differences existed in the percentage of patients who received TSA or RSA...
between the initial shoulder and the contralateral shoulder ($P = 0.856$). In addition, the percentage of surgeries performed on the dominant shoulder did not differ markedly between the first and second shoulders ($P = 0.406$) (Table 1).

Preoperatively, there were no notable differences in the baseline measured motion or PROMs between the first and second operated shoulders except for PCS, which was greater in the second operated shoulder ($P = 0.005$) (Table 2).

Postoperatively, there were no notable differences between the first and second shoulders for measured motion and all PROMs related to pain and function. More than 90% of patients reported “good” or “excellent” satisfaction with their surgery in both groups (Table 3).

The effectiveness of treatment (difference between preoperative and postoperative outcomes) was no different between the first and second shoulder arthroplasties for nearly all variables (Table 4). The only variables found to have a notable difference in efficacy were SF-12 PCS ($P = 0.001$) and FE ($P = 0.010$). The effectiveness of treatment (difference between preoperative and postoperative outcomes) was no different between the first and second shoulder arthroplasties for nearly all variables (Table 4). The only variables found to have a notable difference in efficacy were SF-12 PCS ($P = 0.001$) and FE ($P = 0.010$). The effectiveness of treatment (difference between preoperative and postoperative outcomes) was no different between the first and second shoulder arthroplasties for nearly all variables (Table 4). The only variables found to have a notable difference in efficacy were SF-12 PCS ($P = 0.001$) and FE ($P = 0.010$).

### Discussion

Previous studies that involve patients who require bilateral knee arthroplasty have placed an emphasis on whether procedures should be performed simultaneously or staged.10,11 Several studies have reported mixed results when comparing the first and second knee arthroplasties. Gabr et al4 showed a shorter length of stay along with improved walking aid requirement and psychological well-being (SF-12) in the second knee. Kim et al5 reported greater VAS pain and analgesic requirement in the second knee, whereas Sun et al6 showed that VAS pain was initially greater in the second knee, but that no difference existed in pain at 72 hours after surgery.

Although bilateral knee arthroplasty has been extensively studied, only recently has there been an emphasis on the literature regarding BSA. Several studies have shown favorable outcomes for pain and function after staged bilateral TSA and RSA.7–9 However, little is known about the outcomes after the second operated shoulder compared with the first. Similar to patients who undergo bilateral knee arthroplasty, concerns exist regarding a patient’s ability to recover similarly from the second shoulder arthroplasty.

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### Table 1

Comparison of Descriptive Characteristics Between the First and Second Operated Shoulders

| Variable                     | First Shoulder (n = 73) | Second Shoulder (n = 73) | P  |
|------------------------------|------------------------|--------------------------|----|
| Age (yrs)                    | 71.3 ± 7               | 73.0 ± 7                 | 0.179|
| Surgery performed            |                        |                          |    |
| TSA                          | 52 (71.2)              | 51 (69.9)                | 0.856|
| RSA                          | 21 (28.8)              | 22 (30.1)                | 0.406|
| Surgery on the dominant handa | 36 (49.3)              | 31 (42.5)                | 0.406|

RSA = reverse shoulder arthroplasty, TSA = total shoulder arthroplasty

a Six patients did not report having a dominant shoulder. One patient reported the nondominant shoulder as being operated on first but did not report having a dominant shoulder at the time of the second surgery.

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### Table 2

Comparison of Preoperative PROMs and Measured Motion Between the First and Second Operated Shoulders

| Preoperative Variables | First Shoulder (n = 73) | Second Shoulder (n = 73) | P  |
|------------------------|------------------------|--------------------------|----|
| SST                    | 2 ± 2                  | 3 ± 3                    | 0.157|
| SF-12 PCS              | 33 ± 8                 | 38 ± 9                   | 0.005|
| SF-12 MCS              | 51 ± 13                | 55 ± 10                  | 0.135|
| SANE                   | 37 ± 23                | 37 ± 24                  | 0.976|
| VAS pain               | 7 ± 2                  | 7 ± 2                    | 0.392|
| VAS function           | 3.5 ± 2                | 4 ± 2                    | 0.263|
| ASES function          | 16 ± 11                | 15 ± 12                  | 0.757|
| ASES total             | 30 ± 15                | 31 ± 20                  | 0.910|
| Active ER              | 15 ± 20                | 21 ± 22                  | 0.078|
| Active FE              | 83 ± 32                | 94 ± 37                  | 0.069|
| Active IRa             | 4 ± 2                  | 4.5 ± 3                  | 0.060|

ASES = American Shoulder and Elbow Surgeons, ER = external rotation, FE = forward elevation, IR = internal rotation, MCS = Mental Component Score, PCS = Physical Component Score, PROM = patient-reported outcome measure, SANE = single assessment numeric evaluation, SF-12 = 12-item Short-Form, SST = simple shoulder test, VAS = visual analog scale

a Active internal rotation was evaluated on a 10-point scale: two points = buttock/greater trochanter, four points = sacrum-L4, six points = L3-1, eight points = T12-8, and 10 points = T7-1.
Patients often question whether the same result can be achieved with the opposite shoulder.

Results from the present study showed nearly equivalent outcomes for the first and second arthroplasties for pain, function, and motion; thus, our original hypothesis was refuted. This was true for the ultimate postoperative outcome and improvement from preoperative to postoperative status (efficacy). The only variable that demonstrated a difference was the PCS (SF-12 PCS), which was greater after the first shoulder arthroplasty. The greater improvement in SF-12 PCS seen after the first shoulder surgery was likely due to the markedly lower preoperative SF-12 PCS scores observed before the first shoulder surgery. It can be surmised that the preoperative SF-12 PCS would be markedly greater in the second shoulder surgery as positive results from the first shoulder surgery likely increased each patient’s sense of

| Table 3 |
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| **Comparison of Postoperative Outcomes Between the First and Second Operated Shoulders** |

| Postoperative Variables | First Shoulder (n = 73) | Second Shoulder (n = 73) | P |
| --- | --- | --- | --- |
| SST | 9 ± 3 | 9 ± 3 | 0.755 |
| SF-12 PCS | 44 ± 12 | 44 ± 12 | 1.000 |
| SF-12 MCS | 53 ± 9 | 53 ± 9 | 1.000 |
| SANE | 79 ± 27 | 80 ± 24 | 0.766 |
| VAS pain | 1 ± 3 | 1 ± 2 | 0.891 |
| VAS function | 8 ± 2 | 8 ± 2 | 0.935 |
| ASES function | 38 ± 13 | 39 ± 11 | 0.594 |
| ASES total | 81 ± 23 | 82 ± 19 | 0.658 |
| Active ER | 45 ± 15 | 45 ± 17 | 0.980 |
| Active FE | 140 ± 20 | 136 ± 25 | 0.209 |
| Active IRa | 7 ± 2 | 7 ± 2 | 0.683 |
| Patient satisfaction | | | |
| Excellent or good | 68 (94.4) | 67 (91.8) | 0.635 |
| Satisfactory | 4 (5.6) | 4 (5.5) | — |
| Unsatisfactory | 0 | 2 (2.7) | — |

| Table 4 |
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| **Comparison of the Efficacy of Treatment Between the First and Second Operated Shoulders** |

| Efficacy of Treatment | First Shoulder (n = 73) | Second Shoulder (n = 73) | P |
| --- | --- | --- | --- |
| Preoperative to Postoperative Change in Variables | Mean ± SD | Mean ± SD | P |
| SST | 7 ± 3 | 6.5 ± 3 | 0.281 |
| SF-12 PCS | 13 ± 10 | 5 ± 11 | 0.001 |
| SF-12 MCS | 3 ± 12 | −1 ± 11 | 0.083 |
| SANE | 45 ± 30 | 42 ± 31 | 0.661 |
| VAS pain | −6 ± 3 | −5 ± 3 | 0.221 |
| VAS function | 5.3 ± 2 | 4.6 ± 3 | 0.165 |
| ASES function | 23 ± 15 | 24 ± 14 | 0.848 |
| ASES total | 52 ± 22 | 50 ± 25 | 0.681 |
| Active ER | 29 ± 21 | 23 ± 24 | 0.095 |
| Active FE | 56 ± 28 | 41 ± 41 | 0.010 |
| Active IRa | 1.7 ± 1 | 1.3 ± 2 | 0.067 |

ASES = American Shoulder and Elbow Surgeons, ER = external rotation, FE = forward elevation, IR = internal rotation, MCS = Mental Component Score, PCS = Physical Component Score, SANE = single assessment numerical evaluation, SF-12 = 12-item Short-Form, SST = simple shoulder test, VAS = visual analog scale

Table 3

Patients often question whether the same result can be achieved with the opposite shoulder.

Results from the present study showed nearly equivalent outcomes for the first and second arthroplasties for pain, function, and motion; thus, our original hypothesis was refuted. This was true for the ultimate postoperative outcome and improvement from preoperative to postoperative status (efficacy). The only variable that demonstrated a difference was the PCS (SF-12 PCS), which was greater after the first shoulder arthroplasty. The greater improvement in SF-12 PCS seen after the first shoulder surgery was likely due to the markedly lower preoperative SF-12 PCS scores observed before the first shoulder surgery. It can be surmised that the preoperative SF-12 PCS would be markedly greater in the second shoulder surgery as positive results from the first shoulder surgery likely increased each patient’s sense of
physical wellness, resulting in a higher PCS.

The current study also showed that the mean ROM improved for both the first and second shoulder arthroplasties. There were no differences in overall improvement in ROM between the first and second shoulders except for FE, which improved to a greater extent in the first shoulder. Regardless, both shoulders exceeded the necessary degree of active elevation (121° ± 6.7°) required to adequately perform functional tasks as described by Namdari et al.12 Therefore, although FE in the second operated shoulder in bilateral arthroplasty may improve to a lesser degree than the first shoulder, patients can expect satisfactory recovery of functional ability. This is reflected in the equivalent postoperative PROMs between the first and second operated shoulders in the current study and the observation that >90% of patients reported “good” or “excellent” satisfaction scores.

The overall improvement in both shoulders seen in the current study is in agreement with Grusen et al13 and Stevens et al14 who showed improvements in pain and functional scores for both the first and second operated shoulders in patients who underwent BSA. Grusen et al13 reported no differences in postoperative outcomes between the first and second operated shoulders. Our results also agree with those reported by Morris et al,15 which revealed no notable difference in preoperative to postoperative improvement in functional scores or mobility between the first and second operated shoulders of patients who underwent RSA for rotator cuff arthropathy. However, Grusen et al,13 Stevens et al,14 and Morris et al15 each analyzed a much smaller group of patients (26, 15, and 11 patients, respectively) compared with the current study (73 patients) and were limited to patients with bilateral TSA (Grusen et al13) or bilateral RSA (Stevens et al14 and Morris et al15).

A key strength of the current study is the large number of patients (n = 73) treated with BSA and the inclusion of various combinations of TSA and RSA (TSA/TSA, TSA/RSA, and RSA/RSA). Also, first and second shoulder groups were well matched. No notable differences in the percentages of TSA, RSA, or dominant shoulder surgeries were noted between each group; thus, any differences in outcomes due to the procedure type or shoulder dominance were accounted for. Finally, as a single surgeon series, many variables were standardized including the same implants for all TSA and RSA procedures, the same surgeon performing all surgeries, and the identical rehabilitation protocol for all patients.

There were several limitations in our study. A single surgeon performed the procedures, and outcomes were evaluated prospectively. Therefore, although FE in the second shoulder in bilateral RSA was the large number of patients (n = 73) treated with BSA and the inclusion of various combinations of TSA and RSA (TSA/TSA, TSA/RSA, and RSA/RSA). Also, first and second shoulder groups were well matched. No notable differences in the percentages of TSA, RSA, or dominant shoulder surgeries were noted between each group; thus, any differences in outcomes due to the procedure type or shoulder dominance were accounted for. Finally, as a single surgeon series, many variables were standardized including the same implants for all TSA and RSA procedures, the same surgeon performing all surgeries, and the identical rehabilitation protocol for all patients.

In conclusion, patients who undergo staged BSA can expect similar improvements in pain, function, ROM, and overall satisfaction after the first and second surgeries.

References

Reference 5 is a level I study. Reference 16 is a level II study. References 3, 4, 6, 7, 9, and 15 are level III studies. References 1, 8, 11, 13, and 14 are level IV studies. References 2 and 10 are review articles. Reference 12 is a basic science study.

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