

# Postoperative Clinical and Economic Outcomes of Patients with Reverse or Anatomic Total Shoulder Arthroplasty at One Year: A Retrospective, United States Hospital Billing Database Analysis

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## OBJECTIVES

- There is little evidence available on hospital costs and hospital-related revisits, revisions, and complications of Anatomic TSA (ATSA) and Reverse TSA (RTSA).
- A better understanding of the real-world contemporary postoperative hospital burden of RTSA/ATSA procedures may assist providers and payors in identifying additional opportunities for improving patient quality of care while simultaneously reducing healthcare costs.
- Thus, the study objective was to evaluate the one-year postoperative revision, complication and economic hospital outcomes after RTSA and ATSA.

## METHODS

**Study Design:** Retrospective, noncomparative cohort study of ATSA RTSA patients.

**Data Source:** Premier Healthcare Database, a US-based hospital database, October 1, 2015 to December 31, 2021.

**Study Population:**

- Inclusion:** Adult (18+ years) primary, elective ATSA or RTSA cases, with primary diagnosis of shoulder osteoarthritis or rotator cuff tear
- Exclusion:** Fracture/trauma, infection or cancer of the upper arm/shoulder at index; OR evidence of shoulder revision one-year prior or at index; OR contralateral TSA, both RTSA/ATSA concurrently or bilateral surgery at index/follow-up

**Outcomes:**

- Occurrence and cost of one-year post-operative:
  - hospital all-cause revisits,
  - shoulder/non-shoulder complications,
  - revision-related events with and without infection.

**Statistical Analysis:**

- RTSA and ATSA cohorts were analyzed separately.
- Costs were inflation adjusted to 2022.
- Generalized linear models (GLM) with appropriate link and distribution, depending on the outcome for factor analysis.
- Marginal standardization with GLM for adjusted incidence and incremental cost.

## RESULTS

- Table 1** presents patient characteristics of the ATSA and RTSA cohorts.

**Table 1. Baseline characteristics of patients undergoing TSA**

| Patient Characteristic | Overall         | RTSA            | ATSA            |
|------------------------|-----------------|-----------------|-----------------|
| N                      | 86,101 (100.0%) | 51,478 (100.0%) | 34,623 (100.0%) |
| Age, n (%)             |                 |                 |                 |
| Age 18 to 54           | 4,265 (5.0%)    | 1,237 (2.4%)    | 3,026 (8.8%)    |
| Age 55 plus            | 18,093 (21.0%)  | 8,271 (16.1%)   | 9,822 (28.4%)   |
| Age 65 to 74           | 37,933 (44.0%)  | 22,899 (44.5%)  | 14,977 (43.2%)  |
| Age 75 Plus            | 25,869 (30.0%)  | 19,071 (37.0%)  | 6,789 (19.6%)   |
| Female                 | 46,293 (53.8%)  | 29,385 (57.1%)  | 16,908 (48.8%)  |
| Race, n (%)            |                 |                 |                 |
| Asian                  | 374 (0.4%)      | 234 (0.5%)      | 140 (0.4%)      |
| Black                  | 4,559 (5.3%)    | 2,895 (5.6%)    | 1,664 (4.8%)    |
| Other                  | 3,441 (4.0%)    | 1,967 (3.8%)    | 1,474 (4.3%)    |
| Unable to Determine    | 912 (1.1%)      | 533 (1.0%)      | 379 (1.1%)      |
| White                  | 76,815 (89.2%)  | 45,849 (89.1%)  | 30,966 (89.4%)  |
| Payor n (%)            |                 |                 |                 |
| Medicare               | 62,944 (73.1%)  | 40,986 (79.6%)  | 21,958 (63.4%)  |
| Commercial             | 16,290 (18.9%)  | 6,606 (12.8%)   | 9,684 (28.0%)   |
| Medicaid               | 2,554 (3.0%)    | 1,288 (2.5%)    | 1,266 (3.7%)    |
| Other                  | 4,313 (5.0%)    | 2,598 (5.0%)    | 1,715 (5.0%)    |
| Hypertension           | 62,388 (72.5%)  | 38,848 (75.5%)  | 23,540 (68.0%)  |
| Diabetes               | 20,153 (23.4%)  | 13,060 (25.4%)  | 7,093 (20.5%)   |
| Rheumatoid Arthritis   | 5,762 (6.7%)    | 4,011 (7.8%)    | 1,751 (5.1%)    |
| Tobacco Use            | 34,568 (40.1%)  | 21,240 (41.3%)  | 13,328 (38.5%)  |
| Indication, n (%)      |                 |                 |                 |
| Osteoarthritis         | 72,914 (84.7%)  | 38,455 (74.4%)  | 34,459 (99.5%)  |
| Rotator Cuff Tear      | 13,187 (15.3%)  | 13,023 (25.3%)  | 164 (0.5%)      |

- 45.0% of RTSA and 42.3% of ATSA returned for a hospital visit after surgery.
- The twelve-month total hospital costs of RTSA and ATSA were mean (SD) \$25,225 (\$15,911) and \$21,520 (\$13,531), respectively.
- The most expensive cost per visit was for revision procedures and device removals, \$22,920 (\$18,652), RTSA and \$26,911 (\$18,619), ATSA.
- Patients with infection complications requiring revision had the highest one-year hospital costs (~\$60,000).
- Tables 2a to 2c** present the incidence and costs of the study outcomes.
- Significant factors associated with a high risk of revision-related events and complications included chronic comorbidities and noncommercial insurance (**Figures 1 to 4**).
- Significant factors associated with higher costs of revision events and complications included age, race, chronic comorbidities, and noncommercial insurance (**Table 3**).

**Table 2a. RTSA and ATSA, index and total postoperative hospital costs**

|  | RTSA              |   | ATSA              |   |
|--|-------------------|---|-------------------|---|
|  | N (%) of patients | Mean (SD) Cost per patient <sup>1</sup> | N (%) of patients | Mean (SD) Cost per patient <sup>1</sup> |
| Index procedure, from admission to discharge           | 51,478 (100%)     | \$20,988 (\$8,600)                      | 34,623 (100%)     | \$18,218 (\$8,128)                      |
| 12-month hospital all-cause revisit (total post-index) | 23,778 (45.0%)    | \$4,237 (\$12,954)                      | 14,066 (42.3%)    | \$3,302 (\$10,422)                      |
| 12-month total (revisit + index)                       | 51,478 (100%)     | \$25,225 (\$15,911)                     | 34,623 (100%)     | \$21,520 (\$13,531)                     |

<sup>1</sup>Cost across entire cohort

**Table 2b. RTSA and ATSA, breakdown of occurrence, hospital utilization and hospital cost per visit of revision-related events and complication**

|  | RTSA                   |  |                                 | ATSA                   |  |                                 |
|--|------------------------|--|---------------------------------|------------------------|--|---------------------------------|
|  | Incidence (%) n=51,478 | Mean (SD) count of visits <sup>1</sup> | Mean (SD) postop cost per visit | Incidence (%) n=34,623 | Mean (SD) count of visits <sup>1</sup> | Mean (SD) postop cost per visit |
| Irrigation and debridement visits <sup>2</sup>               | 0.1%                   | 2.1 (1.7)                              | \$5,843 (\$4,327)               | 0.2%                   | 1.8 (1.4)                              | \$5,957 (\$4,743)               |
| Revision procedure and device removals <sup>2</sup>          | 2.1%                   | 1.8 (1.4)                              | \$22,920 (\$18,652)             | 1.9%                   | 1.7 (1.4)                              | \$26,911 (\$18,619)             |
| Shoulder/non-shoulder complications no revision <sup>2</sup> | 17.8%                  | 1.9 (1.5)                              | \$5,718 (\$11,842)              | 14.4%                  | 1.9 (1.4)                              | \$5,193 (\$11,711)              |
| Shoulder complications no revision <sup>2</sup>              | 12.4%                  | 1.9 (1.4)                              | \$4,085 (\$14,115)              | 9.9%                   | 2.1 (1.6)                              | \$3,666 (\$11,245)              |

<sup>1</sup>Only patients with the outcome;

<sup>2</sup>Includes other postoperative complication-related visits in addition to the visit where revision occurred

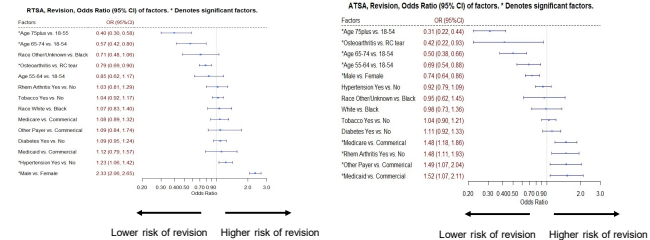
<sup>3</sup>All visits over 12 months

**Table 2c. RTSA and ATSA, Total hospital cost associated with revision-related events and infection. Revision-related events includes revision procedures, device removals, and irrigation and debridement.**

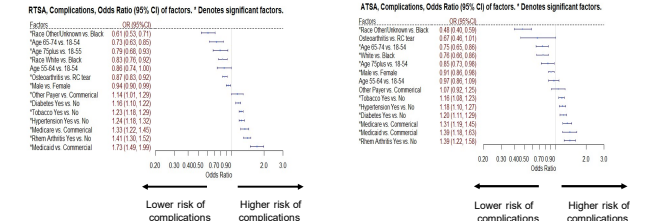
|                            | RTSA                               |   |   | ATSA                               |                                   |                                  |
|----------------------------|------------------------------------|---|---|------------------------------------|-----------------------------------|----------------------------------|
|                            | Incidence (%) of patients n=51,478 | Mean (95% CI) total hospital cost (index + all-cause) | Mean (95% CI) difference in cost <sup>1</sup> | Incidence (%) of patients n=34,623 | Mean (95% CI) total hospital cost | Mean (95% CI) difference in cost |
| Revision with infection    | 0.6%                               | \$60,887 (\$56,951, \$64,823)                         | \$36,148 (\$32,210, \$40,086)                 | 0.2%                               | \$59,478 (\$52,312, \$66,644)     | \$38,426 (\$31,258, \$45,593)    |
| Revision without infection | 1.7%                               | \$41,985 (\$40,384, \$43,585)                         | \$17,246 (\$15,641, \$18,851)                 | 1.9%                               | \$40,112 (\$38,335, \$41,888)     | \$19,060 (\$17,278, \$20,841)    |
| Infection without revision | 0.5%                               | \$44,772 (\$41,740, \$47,804)                         | \$19,659 (\$16,624, \$22,694)                 | 0.4%                               | \$41,184 (\$37,292, \$45,077)     | \$19,754 (\$15,859, \$23,650)    |

<sup>1</sup>Estimates represent the difference in cost compared to patients without the outcome.

**Figures 1 and 2. Factors associated with revision among patients undergoing RTSA/ATSA\***



**Figures 3 and 4. Factors associated with complications among patients undergoing RTSA/ATSA\***



**Table 3. Generalized linear model output indicating associations between patient variables and outcome costs expressed as cost ratio with 95% Confidence Intervals. Statistically significant cost ratios are bolded.**

| Characteristic*                      | Revision                 |                   | Complications            |                          |
|--------------------------------------|--------------------------|-------------------|--------------------------|--------------------------|
|                                      | ATSA                     | RTSA              | ATSA                     | RTSA                     |
| Age 55-64 vs. 18-54                  | 1.12 (0.95, 1.32)        | 1.17 (0.92, 1.48) | 1.22 (0.98, 1.51)        | 0.82 (0.62, 1.08)        |
| Age 65-74 vs. 18-54                  | 1.06 (0.88, 1.26)        | 1.04 (0.80, 1.32) | 1.28 (1.00, 1.62)        | 0.80 (0.61, 1.06)        |
| Age 75 Plus vs. 18-54                | 1.01 (0.81, 1.26)        | 1.01 (0.77, 1.29) | <b>1.60 (1.23, 2.07)</b> | 0.98 (0.74, 1.29)        |
| Male vs. Female                      | 1.00 (0.90, 1.10)        | 0.96 (0.87, 1.06) | 1.00 (0.89, 1.12)        | 1.01 (0.93, 1.11)        |
| White vs. Black                      | 1.03 (0.83, 1.26)        | 1.17 (0.95, 1.43) | 0.84 (0.66, 1.05)        | <b>1.20 (1.01, 1.42)</b> |
| Race Other/Unknown vs. Black         | 0.98 (0.74, 1.31)        | 1.10 (0.81, 1.51) | 1.10 (0.77, 1.58)        | 1.10 (0.85, 1.45)        |
| Medicaid vs. Commercial              | <b>1.41 (1.13, 1.79)</b> | 1.10 (0.84, 1.44) | 0.97 (0.74, 1.29)        | 1.07 (0.82, 1.41)        |
| Medicare vs. Commercial              | <b>1.22 (1.05, 1.41)</b> | 1.08 (0.93, 1.24) | <b>1.20 (1.01, 1.43)</b> | 1.16 (0.97, 1.36)        |
| Other vs. Commercial                 | 1.14 (0.92, 1.42)        | 1.15 (0.94, 1.41) | 1.16 (0.88, 1.57)        | 1.09 (0.85, 1.39)        |
| Diabetes Yes vs. No                  | 1.04 (0.92, 1.18)        | 1.03 (0.93, 1.14) | <b>1.17 (1.02, 1.34)</b> | <b>1.33 (1.21, 1.47)</b> |
| Hypertension Yes vs. No              | 1.06 (0.95, 1.19)        | 1.02 (0.90, 1.14) | <b>1.27 (1.10, 1.44)</b> | <b>1.30 (1.16, 1.45)</b> |
| Rhem Arthritis Yes vs. No            | 1.08 (0.90, 1.30)        | 0.87 (0.73, 1.05) | 1.18 (0.94, 1.48)        | <b>1.29 (1.10, 1.47)</b> |
| Tobacco use Yes vs. No               | 0.94 (0.85, 1.04)        | 1.00 (0.91, 1.10) | 1.11 (0.99, 1.25)        | <b>1.13 (1.04, 1.24)</b> |
| Osteoarthritis vs. Rotator Cuff Tear | 0.95 (0.57, 1.48)        | 1.02 (0.92, 1.13) | 1.36 (0.64, 2.50)        | 1.00 (0.91, 1.10)        |

\*Reference categories for Figures 1 to 4 and Table 3 are 18-54 years; Female, Black, Commercial, No and Rotator cuff tear.

## CONCLUSIONS

- Postoperative healthcare burden within the hospital setting persists for patients who undergo RTSA or ATSA procedures.
- This study highlights the need for technologies and surgical techniques that may help reduce TSA healthcare utilization and economic burden.

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