

# Short-Term Projected Use of Reverse Total Shoulder Arthroplasty in Proximal Humerus Fracture Cases Recorded in Humana's National Private-Payer Database

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## Abstract

Indications for reverse total shoulder arthroplasty (RTSA) have been expanding, and there has been a recent trend in using RTSA to manage proximal humerus fractures. In this study, we used a large private-payer database to analyze this trend over the period 2010 to 2014 and project RTSA use through 2020. Results showed modest quarterly growth in use of RTSA (4.9% compound quarterly growth rate). The number of RTSAs was projected to more than triple by 2020. RTSA is becoming an increasingly popular treatment option for proximal humerus fractures.

## Take-Home Points

- RTSA is projected to triple by 2020.
- RTSA for fracture indication anticipates a 4.9% compound quarterly growth rate.
- RTSA is gaining in popularity likely due to unpredictable results of hemiarthroplasty in select patients.

Reverse total shoulder arthroplasty (RTSA) is an accepted treatment option for the pain and dysfunction associated with glenohumeral arthritis and severe rotator cuff pathology.<sup>1-3</sup> Recently, it has been gaining acceptance as an alternative to hemiarthroplasty (HA) and open reduction and internal fixation (ORIF) in the surgical management of complex proximal humerus fractures (PHFs) in elderly patients.<sup>4-6</sup> The advantages of RTSA over other PHF treatment options include a lower revision rate and superior range of motion.<sup>4,5</sup>

PHF remains one of the most common fracture pathologies in the United States.<sup>7</sup> Given the coun-

try's aging patient population, the popularity of RTSA likely will continue to increase.<sup>4,6</sup> The release of supercomputer data from individual private-payer insurance providers provides an opportunity to investigate trends in the surgical management of PHFs and to formulate models for predicting use. In this study, we used a large private-payer database to analyze these trends over the period 2010 to 2014 and project RTSA use through 2020.

## Methods

We used PearlDiver's supercomputer application to search the Humana private-payer database to retrospectively identify cases of PHF treated with the index procedure of RTSA. PearlDiver, a publicly available national database compliant with HIPAA (Health Insurance Portability and Accountability Act of 1996), compiles private-payer records submitted by Humana. These records represent 100% of the orthopedics-related payer records within the dataset. The database includes *International Classification of Diseases, Ninth Revision (ICD-9)* codes and *Current Procedural Terminology (CPT)* codes from 2007 to 2014.

RTSA cases were identified by ICD-9 codes 81.80 and 81.88 and CPT code 23472. PHFs were identified by ICD-9, *Clinical Modification (ICD-9-CM)* codes 812.00, 812.01, 812.02, 812.03, 812.09, 812.10, 812.11, 812.12, 812.13, 812.19, and 812.20. Holt-Winters quarterly (Q) projection analysis was performed on the RTSA-PHF data from Q1-2010 through Q4-2020 (Figure). Compound quarterly growth rate (CQGR) was calculated as well. Linear regression analysis was

**Authors' Disclosure Statement:** Dr. Levy reports that he is a paid consultant to and receives royalties from DJO Orthopaedics. The other authors report no actual or potential conflict of interest in relation to this article.

performed to determine the goodness of fit ( $R^2$ ) of the known and projected study data. Age-based subgroup analysis was performed and the results reported as incidence.

### Results

For the known study period Q1-2010 through Q3-2014, our search yielded 46,106 PHF cases, 4057 (8.8%) of which were surgically treated with RTSAs (Table 1). Mean (SD) age of these RTSA patients was 75 (7) years. For the period Q4-2014 through Q4-2020, RTSAs for the surgical treatment of PHFs were projected to total 12,898. Combining the data for the known and projected periods (Q1-2010 through Q4-2020) produced an overall total of 16,955 cases. The known period's CQGR was 6.5%, and the projected period's CQGR was 2.8%, giving an overall CQGR of 4.6%. Linear regression analysis revealed an  $R^2$  (coefficient of determination) of 0.94 for the known period and an  $R^2$  of 0.98 for the projected period, demonstrating strong goodness of fit for projection.

Age-based subgroup analysis revealed RTSA was performed primarily in the older-than-65 years patient population, with the highest percentage in the 70-to-74 years age group (24.4%), followed by the 75-to-79 years age group (21.6%) (Table 2).

### Discussion

Use of RTSA for the management of complex PHFs has increased tremendously over the past several years. The primary results of our study showed an upward trend in RTSA use in the Humana population. CQGR was 6.5% from Q1-2010 through Q3-2014 (the number of RTSAs increased to 294 from 95). Based on the Holt-Winters projection analysis, CQGR was projected to be 2.8% through 2020 (339 RTSAs in Q4-2014 increasing to 664 RTSAs in Q4-2020), resulting in an overall 10-year CQGR of 4.6%.

Recent studies have shown RTSA to be a viable alternative to HA in patients with PHFs. It has been suggested that RTSAs may have more reliable clinical outcomes without a comparative increase in complication rates.<sup>1,8,9</sup> HA has been associated with unpredictable motion, higher complication rates, and high rates of unsatisfactory results in patients older than 65 years.<sup>10-12</sup> In addition, studies have found that, compared with HA and ORIF, RTSA produces superior range of motion.<sup>8,9</sup> The reliability of clinical outcomes in the early transition to use of RTSA for complex fractures suggests that use of RTSA for PHF management

is trending upward. Results of the present study showed a steady increase in RTSA use. This trend

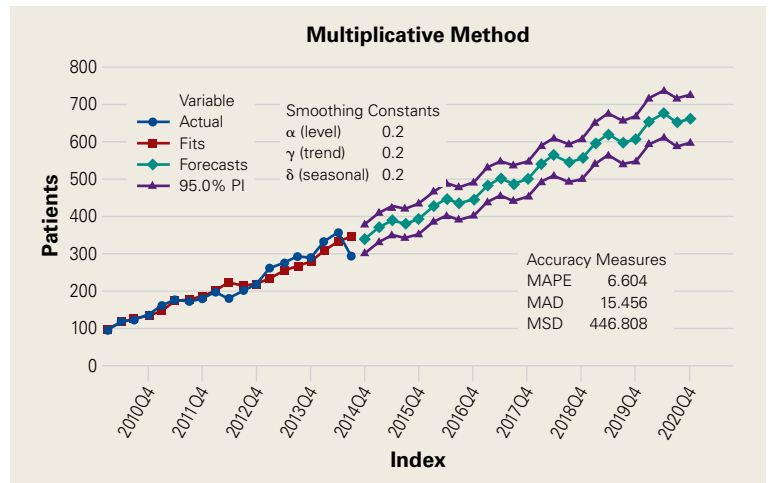


Figure. Holt-Winters projection model of reverse total shoulder arthroplasty for proximal humerus fractures.

Abbreviations: MAD, mean absolute deviation; MAPE, mean absolute percentage error; MSD, mean squared deviation; PI, prediction interval; Q, quarter.

Table 1. Quarterly Use of Reverse Total Shoulder Arthroplasty for Proximal Humerus Fractures

Study Period	Year	Q1	Q2	Q3	Q4	Annual	
Known	2010	95	119	122	135	471	
	2011	161	174	172	180	687	
	2012	198	180	202	217	797	
	2013	260	276	294	290	1120	
	2014	331	357	294	—	982	
	Total						4057
	CQGR					6.5%	
Projected	2014	—	—	—	339	339	
	2015	371	389	381	394	1535	
	2016	428	447	436	448	1759	
	2017	485	505	490	502	1982	
	2018	542	562	545	556	2205	
	2019	599	620	599	610	2428	
	2020	656	677	653	664	2650	
	Total						12,898
		CQGR					2.8%
	Overall CQGR						4.6%

Abbreviations: CQGR, compound quarterly growth rate; Q, quarter.

**Table 2. Known Reverse Total Shoulder Arthroplasty for Proximal Humerus Fracture by Age**

Age, y	Year <sup>a</sup>					Total n	Incidence, %
	2010	2011	2012	2013	2014		
45-49	-1	-1	-1	-1	-1	—	—
50-54	-1	-1	-1	-1	-1	—	—
55-59	-1	-1	-1	-1	25	25	0.6
60-64	-1	62	48	58	48	216	5.3
65-69	87	101	125	216	142	671	16.5
70-74	153	168	198	253	216	988	24.4
75-79	83	152	177	236	230	878	21.6
80-84	51	88	118	166	188	611	15.1
85-89	-1	-1	40	107	92	239	5.9
≥90	11	40	-1	13	-1	64	1.6

<sup>a</sup>Negative 1 (-1) indicates n < 11.

is further supported by a recent study finding on national trends in RTSA use in PHF cases: 12.3% annual growth during the period 2000 to 2008.<sup>6</sup>

Our study results showed a continued steady quarterly increase in use of RTSA for PHFs, projected to triple by Q4-2020 (Table 1). The increasing popularity of RTSA may be attributable to its better clinical outcomes and to the procedural instruction given to newly trained orthopedic surgeons during residency. A recent study found a substantial increase in the use of RTSA for PHFs—from 2% in 2005 to 38% in 2012—among newly trained orthopedic surgeons.<sup>13</sup> Another possible driver of the increase is cost. Although RTSA implant costs are often a multiple of the costs of other treatment options, different findings were reported in 2 recent studies that used quality-adjusted life-years (QALY) to determine RTSA cost-effectiveness. Coe and colleagues<sup>14</sup> compared RTSA with HA and found RTSA to be cost-effective but highly dependent on implant cost. They determined that an implant cost of over \$13,000 put RTSA cost-effectiveness at just under \$100,000 QALY, whereas an implant cost of under \$7000 brought QALY down to under \$50,000. Renfree and colleagues<sup>15</sup> used the same QALY benchmark but found RTSA to be at the highly cost-effective threshold of under \$25,000 QALY.

Current literature recommends RTSA be performed primarily for elderly patients.<sup>1,2,16,17</sup> Guery and colleagues<sup>2</sup> suggested limiting RTSA to patients who are older than 70 years and have low functional demands. In 2 studies of RTSA use in complex humeral fractures, Gallinet and colleagues<sup>16,18</sup> found an increased rate of scapular notching in younger patients and recommended restricting RTSA to patients 70 years or older. PHFs in patients older than 70 years often have more complex fracture patterns and poor-quality bone, which makes fracture healing more challenging in HA and ORIF settings. As tuberosity healing is crucial to functional outcomes of surgically treated PHFs, RTSA has been advanced as a more reliable option in patients in whom tuberosity healing is expected to be unreliable. The present study's finding that 68.5% of the RTSA patients in the Humana population were older than 70 years further supports the literature's emphasis on reserving RTSA for patients over 70 years.

This study had its limitations. The PearlDiver database depends on accurate ICD-9 and CPT coding, and there was potential for reporting bias. In addition, a new, specific ICD-9 code for RTSA was introduced in 2010 and may not have been immediately used; data reported during this time could have been affected. Furthermore, the data were primarily represented by a single private-payer organization (Humana) and therefore may not have fully encapsulated the entire US trend. Projection in this study did not account for US Census-predicted population growth and therefore may have underestimated the true projected use of RTSA for PHFs.

This study benefited from the completeness of the data used. PearlDiver represents 100% of Humana claims data, providing a large patient population for analysis and capturing data as recent as 2014. To our knowledge, no other large database studies have used such up-to-date data.

## Conclusion

RTSA is becoming an increasingly popular treatment option for PHFs. Modest overall quarterly growth in use of RTSA for PHFs (CQGR, 4.6%) is predicted through Q4-2020. Number of RTSAs performed for PHF management is projected to more than triple by 2020.

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