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Outcomes after a Grammont-style reverse total shoulder arthroplasty?

Robert Z. Tashjian, MD[a], Bradley Hillyard, BA[a], Victoria Childress, BA[a], Jun Kawakami, MD, PhD[a], Angela P. Presson, PhD[b], Chong Zhang, MS[b], Peter N. Chalmers, MD[a,]*

[a]*Deptartment of Orthopaedic Surgery, University of Utah, Salt Lake City, UT, USA*
[b]*Division of Epidemiology, Department of Medicine, University of Utah, Salt Lake City, UT, USA*

Background: The purpose of this study was to determine the factors associated with outcomes after reverse total shoulder arthroplasty (RTSA).
Methods: We retrospectively evaluated all RTSAs performed by the senior author between January 1, 2007, and November 1, 2017. We evaluated pain visual analog scale (VAS), Simple Shoulder Test (SST), and American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES) scores and complication and reoperation rates at a minimum of 2-year follow-up. We evaluated preoperative and 2-week postoperative radiographs for glenoid inclination (GI), medialization as distance between the center of the humeral head or glenosphere and the line of the deltoid, and distalization via the acromial–greater tuberosity distance. We performed inter- and intrarater reliabilities via intraclass correlation coefficients (ICCs) and conducted a multivariable analysis.
Results: We included 230 RTSAs in the analysis, with 70% follow-up at a median of 3.4 years. Reliability was acceptable with all ICCs $>.678$. Increased postoperative GI was significantly associated with increased VAS pain postoperatively ($P = .008$). Increased distalization was associated with an increased rate of complications and reoperations ($P = .032$). Younger age ($P = .008$), female gender ($P = .009$), and lower body mass index (BMI) ($P = .006$) were associated with worse ASES scores. Female gender ($P < .001$) and lower BMI ($P = .039$) were associated with worse SST scores. Female gender ($P = .013$) and lower BMI ($P = .005$) were associated with worse VAS-pain scores.
Conclusion: Age, gender, and BMI are associated with outcome after RTSA. In this retrospective analysis of a Grammont-style RTSA, superior inclination is associated with increased pain postoperatively, whereas excessive arm lengthening is associated with increased risk for complication or reoperation.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Reverse total shoulder arthroplasty; shoulder replacement; radiographic analysis; lateralization; patient-reported outcomes; medical comorbidities

Although reverse total shoulder arthroplasty (RTSA) generally has low reoperation rates[31] and excellent long-term outcomes,[2,11,21,35] not all patients have an excellent long-term outcome postoperatively.[1] Conceptually, RTSA with a Grammont-style design shifts the center of rotation (COR) medially and distally.[4,22] Alteration of the COR changes the deltoid and infraspinatus function.[4] This shift has been suggested to be important for postoperative shoulder function.[4] However, designs with less of a shift in the COR also have good long-term outcomes.[12,17,18,34]

Biomechanically, glenosphere or baseplate lateralization may be a trade-off between impingement-free range of

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This study was performed under the University of Utah Institutional Review Board as approved protocol 46622. Informed consent for participation in the study was obtained from all subjects.
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*Reprint requests: Peter N. Chalmers, MD, Department of Orthopaedic Surgery 590 Wakara Way, Salt Lake City, UT, USA.
E-mail address: p.n.chalmers@gmail.com (P.N. Chalmers).

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motion[47] and deltoid forces.[28] Although lateralization increases stability,[16] it does so by creating increased joint loads and deltoid forces.[23] It also increases back-side forces on the baseplate.[14] In addition, although lateralization may reduce notching, it may not be as effective as inferior overhang.[48]

Clinically, lateralization may also be a trade-off. Baseplate lateralization may reduce notching[19] but may impair postoperative outcomes with subscapularis repair.[46] Lateralization improves external rotation but may do so at the expense of elevation[30] and abduction.[5] A prior systematic review found no significant differences in postoperative outcomes between patients with medialized and lateralized COR implants.[27] Another prior retrospective study demonstrated significantly worse outcomes with lateralized implants.[30] Finally, a randomized clinical trial between a lateralization design and a medialized one demonstrated no significant differences in postoperative outcomes.[25] Finally, baseplate inclination, glenosphere size, and glenosphere inferior overhang may also influence postoperative outcomes.[3,37,42,43,48]

Thus, there is a gap within our current knowledge. This gap remains in part because there is anatomic variation in the preoperative position of the COR and variation in surgical technique with reaming and implant positioning. The same implant, placed in different patients by different surgeons using different technique, may be more or less distalized and medialized and inclined.

The purpose of this study was to determine the factors associated with outcome after Grammont-style reverse total shoulder arthroplasty (RTSA). Following Grammont's original concept,[4] we hypothesized that increased medialization and distalization would be associated with improved postoperative outcomes.

Methods

Included patients

This is a retrospective case series. A single surgeon (R.Z.T.) performed all procedures using the same technique and postoperative protocol. We obtained informed consent from all included subjects. We performed this study after approval by our Institutional Review Board. We searched the operative logs of the (University of Utah) for all patients who underwent a surgical procedure by a single surgeon (R.Z.T.) between January 1, 2007, and November 1, 2017, using the Common Procedure Terminology code 23472 to capture all patients who underwent reverse total shoulder arthroplasty. We excluded patients who were known to have become deceased.

Data collection

We collected demographics, body mass index (BMI), Charlson comorbidty index at the time of the index surgery,[8,9] indication for surgery, version of the humeral component as assessed and documented by the surgeon intraoperatively (not as measured radiographically), glenosphere size, documented intraoperative complications, documented postoperative complications, and reoperations. We contacted all patients, and the following outcomes were collected: American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES) score, Simple Shoulder Test (SST) score, and visual analog scale for pain (VAS) score and whether complications or reoperations had occurred. When patients were willing to return for an in-person evaluation, this was preferred; otherwise, these outcomes were collected via mail and phone. To maximize follow-up, we contacted patients on multiple occasions at different times of the day via different phone numbers and using all available contact methods available, including an electronic service that provides updated contact information.

On preoperative and 2-week postoperative 2-dimensional imaging, we made the following measurements: (1) glenoid inclination (complement of the β angle[36]), as previously described[29]; (2) acromial–greater tuberosity distance (AGT); and (3) the center of rotation medialization (CORM; Fig. 1). We used AGT to measure humeral distalization. To determine the interobserver reliability of these measurements, 2 attending orthopedic surgeons fellowship trained in shoulder and elbow surgery analyzed 50 radiographs. To determine the intraobserver reliability of these measurements, one attending orthopedic surgeon fellowship trained in shoulder and elbow surgery analyzed 50 radiographs twice separated by 1 month. From these measurements, we calculated intraclass correlation coefficients (ICCs) using a single-rating, absolute-agreement, 2-way mixed effect model. We interpreted ICCs based on prior guidelines.[10] As this was a retrospective analysis, we took no a priori steps to adjust for magnification. To ensure that there were no magnification effects, we measured glenosphere size on 50 radiographs and compared the measured glenosphere size to the known true glenosphere size as provided by the manufacturer using ICCs and a mean difference analysis. We made all measurements using the measurement tools provided within the Picture Archiving and Communication Systems program in our hospital system (IntelliSpace 4.4, Philips, Andover, MA, USA).

Statistical analysis

We summarized patient demographics, clinical variables, and outcomes (SST, ASES, and VAS scores) descriptively (Tables I and II). We summarized continuous variables as mean (standard deviation), median (interquartile range), and range, and categorical variables were summarized as frequency and percentage.

We descriptively summarized preoperative and 2-week postoperative radiographic outcomes for GI, CORM, and AGT shoulder measures. We tested differences between preoperative and postoperative measures using paired *t* tests.

We performed univariable and multivariable regressions to assess relationships between postoperative shoulder measures and patient outcomes. The distribution of each outcome variable dictated the type of regression model, where for ASES and SST we used linear regression, as these variables were approximately normally distributed, and for reoperation we used logistic regression, which is common for binary outcomes.[24] For VAS, we used negative binomial regression, because of its heavy skew and notable fraction of 0 values (30%).[38] Multivariable models

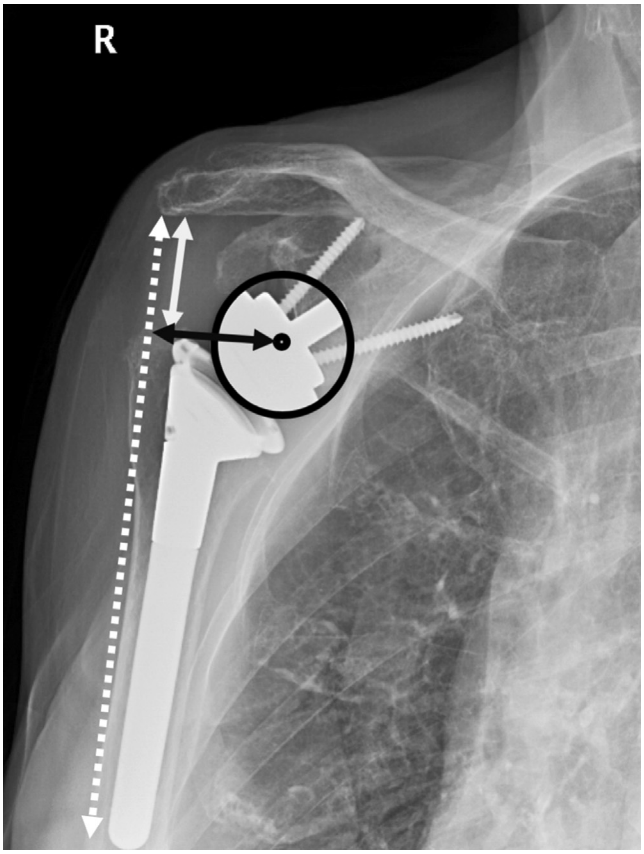

Figure 1 Radiographic measurement technique. The *solid white line* demonstrates the acromial–greater tuberosity distance (AGT), a measure of humeral distalization, which was measured as the shortest distance between the greater tuberosity and the acromion. The *dashed white line* shows the line of pull of the deltoid, and the *solid black line* shows the medialization of the center of rotation relative to the line of pull of the deltoid (CORM), which was measured as the distance between the center of the best-fit circle of the humeral head or glenosphere on preoperative and postoperative radiographs and a line between the most lateral aspect of the acromion and the deltoid tuberosity

adjusted for age, sex, BMI, Charlson comorbidty index, implant company, humeral version, length of follow-up, and postoperative diagnosis—except for reoperation, which was limited by the number of events (we adjusted for age, sex, Charlson comorbidty index, and length of follow-up).[45] We reported results from linear regression models as mean differences, results from logistic regression models as odds ratios (ORs), and results from negative binomial models as ratios. We reported 95% confidence intervals (CIs) and *P* values with all point estimates from the regression models. We examined potential nonlinear relationships between shoulder measures and outcomes. We assessed statistical significance at the 0.05 level, and all tests were 2-tailed. We conducted these analyses in R, version 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria).

Sample size determination

The authors assumed that an association with the strength for a correlation coefficient of 0.3 would be clinically significant, as it is consistent with multiple prior shoulder arthroplasty radiographic and outcome association analysis studies.[7,32] To have a 90% chance to find an association of at least a value of *r* equal to 0.3, should one exist, a sample size of 112 patients would be needed. Based on an expected loss to follow-up rate of 30%, our target sample size was 160, and thus this was our minimum target sample size.

Table I Demographics of the included patients

Variable	Mean±SD, median (IQR), or % (n/N)
Age, yr	70±10
Body mass index (n=222)	29±7
Charlson comorbidty index (n=225)	2.8±1.2
Length of follow-up, yr, median (IQR)	3.4 (2.5, 5.2)
Female sex, % (n/N)	71 (163/230)
Right operative side, % (n/N)	69 (158/229)
Implant, % (n/N)	
Wright Medical	64 (146/229)
Zimmer	36 (82/229)
Humeral version, % (n/N)	
<10°	16 (33/203)
10°-20°	74 (150/203)
20°	10 (20/203)
Indication for surgery, % (n/N)	
Degenerative	63 (143/228)
Rotator cuff tear arthropathy	39 (89/228)
Glenohumeral osteoarthritis (GHOA)	9 (21/228)
Rotator cuff tear (RCT)	8 (17/230)
GHOA+RCT	7 (16/228)
Failed arthroplasty	24 (54/228)
Traumatic	14 (31/228)
Acute proximal humerus fractures	4 (10/228)
Proximal humeral fracture sequelae	8 (17/228)
Other	2 (4/228)

Results

Study cohort

During the 10-year period in question, the senior author performed 369 RTSAs, of which 40 patients were deceased at the time of follow-up and 99 were lost to follow-up. Of the 329 eligible for follow-up, 230 had patient-reported outcome scores available at a minimum of 2-year follow-up, providing a rate of follow-up of 70% at a minimum of 2 years, a maximum of 12 years, and a mean ± standard deviation of 4.0±1.9 years. We performed these procedures on 216 unique patients, with 14 patients undergoing bilateral RTSA. This cohort was elderly, mostly female, and mostly right-sided (Table I). Rotator cuff tear arthropathy was the most common indication for surgery in 46% of patients, with 24% of patients being revision arthroplasties and 8% being fractures or their sequelae. The senior author used Aequalis (Wright Medical Technology, Memphis TN, USA) and Trabecular Metal Reverse (Zimmer, Warsaw, IN, USA) components during the study period, in which most humeral components were placed in 10°-20° retroversion. Both systems are Grammont-style RTSAs with inlay, medialized humeral components and without glenosphere lateralization options. For the initial 3 years, we performed the Zimmer RTSA exclusively and then we switched to implants manufacturered by Wright Medical exclusively after that point.

At final follow-up, the SST score was 7±3 (range 0-12, data available for 210/230 patients), the ASES score was 67±21 (5-100, data available for 224/230 patients), the VAS score was 2±3 (0-1, data available for 224/230 patients). Of the included shoulders, 18% (41/230) suffered either a complication or reoperation postoperatively; 3.4% of shoulders had postoperative instability (8/230). One percent of shoulders developed a recurrence of a prior known infection (3/230), and 4% (9/230) of shoulders suffered a new postoperative infection (3 in primary RTSAs and 6 in revision RTSAs). Of these, 1% (3/230) were deep infections requiring operative irrigation and débridement and the other 3% (6/230) were superficial infections responding to antibiotics. Three percent of shoulders had a postoperative acromial fracture (7/230), and none of these patients had a history of trauma. One percent of shoulders had persistent pain at the strap tendon requiring operative release (3/230), and 1% of shoulders had postoperative hematomas (2/230). Two percent of shoulders had glenoid loosening (2 in the context of a glenoid bone graft and 1 in the context of infection, 4/230). One percent (3/230) of shoulders had nerve injuries (1 median, 1 ulnar, and 1 diffuse plexopathy), all of which resolved. Two percent of shoulders (5/230) had other complications including a postoperative seizure, a postoperative fall with a glenoid neck fracture, and postoperative thromboembolic events.

Table II Reliability analysis for the included radiographic measures

Variable	Inter-rater ICC (95% CI)	Intrarater ICC (95% CI)
GI	0.948 (0.910, 0.970)	0.981 (0.967, 0.989)
CORM	0.803 (0.678, 0.883)	0.914 (0.854, 0.951)
AGT	0.971 (0.949, 0.983)	0.973 (0.953, 0.985)

GI, glenoid inclination, measured as the complement of the β angle; *CORM*, center of rotation medialization; *AGT*, acromial–greater tuberosity distance; *ICC*, intraclass correlation coefficient; *CI*, confidence interval.

Table III Radiographic measures

Variable	Preoperative, mean ± SD	Postoperative, mean ± SD	Change, mean ± SD	*P* value
GI, degrees	102±8	93±8	–9±10	<.001
CORM, mm	20±8	44±8	24±8	<.001
AGT, mm	9±6	38±8	29±9	<.001

GI, glenoid inclination, measured as the complement of the β angle; *CORM*, center of rotation medialization; *AGT*, acromial–greater tuberosity distance; *SD*, standard deviation.

Radiographic measures

Inter- and intrarater reliability was generally excellent for all radiographic measures (Table II). There were minimal effects from magnification, as the ICCs comparing the radiographically measured glenosphere size and the recorded glenosphere size had an ICC of 0.79 (95% CI 0.652, 0.877) with a mean difference of 0.104 (95% CI –0.014, 0.222) mm. GI changed 9° into a more inferior inclination (range 15° superior to 40° inferior), CORM change was 24 mm medial (11 mm lateralization to 55 mm medialization), and AGT increased 29 mm (0 to 51 mm); all of these changes were statistically significant (Table III).

Associations with outcomes

There were no notable nonlinear relationships between shoulder measures and outcomes. Our multivariable regression analyses found no associations between any of the measured radiographic factors and functional outcomes as measured with the ASES or SST scores at final follow-up (Table IV). However, there were multiple patient factors associated with outcome. Adjusting for the other variables in the model, a 1-year increase in age was associated with a 0.6-point increase in ASES score (95% CI 0.2, 1.1, $P = .008$); women had on average an 11-point lower ASES score relative to men (95% CI –2.7, –18.4, $P = .009$), and a 1-point increase in BMI was associated with a 0.7-point increase in ASES score (0.2 to 1.2, $P = .006$). Adjusting for the other variables in the model, females had a 2.1-point reduced SST score relative to males (–0.83 to –3.3, $P < .001$), and a 1-point increase in BMI was associated with a 0.1-point increase in SST (0.0 to 0.2, $P = .039$).

Postoperative pain was associated with postoperative GI, sex, and BMI. Adjusting for the other variables in the model, a 1° increase in postoperative GI into superior inclination was associated with a 3% (95% CI 1%, 6%, $P = .008$) increase in VAS pain, female gender was associated with a 95% (95% CI 11%, 343%, $P = .013$) increase in VAS pain, and a 1-point increase in BMI was associated with a 4% (95% CI 1%, 7%, $P = .005$) decrease in VAS pain.

Postoperative distalization was associated with reoperation or complication. Adjusting for the other variables in the model, a 1-mm increase in distalization was associated with a 6% increased odds of reoperation or complication (95% CI 1.01, 1.11, $P = .032$; Table IV). Postoperative

Table IV Results of multivariate regression analyses to determine associates with each final outcome variable

Variable	ASES		SST		VAS		Reop./Complication*	
	Coefficient	*P* value	Coefficient	*P* value	Ratio	*P* value	OR	*P* value
GI	−0.26 (−0.67, 0.14)	.200	−0.01 (−0.07, 0.05)	.760	**1.03 (1.01, 1.06)**	**.008**	1.01 (0.97, 1.07)	.550
CORM	0.05 (−0.40, 0.50)	.830	−0.01 (−0.08, 0.06)	.710	1.00 (0.98, 1.03)	.800	0.97 (0.92, 1.02)	.260
AGT	0.03 (−0.38, 0.44)	.890	−0.01 (−0.07, 0.06)	.830	1.00 (0.98, 1.03)	.850	**1.06 (1.01, 1.11)**	**.032**
Age	**0.64 (0.17, 1.12)**	**.008**	0.04 (−0.04, 0.11)	.330	0.99 (0.96, 1.02)	.460	0.98 (0.92, 1.04)	.520
Sex	**−10.52 (−18.37, −2.66)**	**.009**	**−2.05 (−3.25, −0.84)**	**<.001**	**1.95 (1.11, 3.43)**	**.013**	0.46 (0.20, 1.06)	.070
BMI	**0.68 (0.20, 1.16)**	**.006**	**0.08 (0.00, 0.15)**	**.039**	**0.96 (0.93, 0.99)**	**.005**	NA	NA
CCI	−3.15 (−6.66, 0.35)	.080	−0.43 (−0.98, 0.11)	.120	0.93 (0.74, 1.16)	.520	0.68 (0.39, 1.08)	.130
Implant	0.56 (−7.86, 8.99)	.900	0.68 (−0.61, 1.98)	.300	0.90 (0.53, 1.52)	.700	NA	NA
Vers. >20°	−3.29 (−16.05, 9.46)	.610	0.33 (−1.62, 2.28)	.740	1.91 (0.86, 4.39)	.110	NA	NA
FU length	−0.48 (−2.34, 1.38)	.610	−0.02 (−0.30, 0.26)	.880	0.98 (0.87, 1.09)	.700	0.95 (0.77, 1.17)	.640
Reop Diag.	−4.78 (−12.83, 3.28)	.240	−1.15 (−2.38, 0.07)	.060	0.90 (0.53, 1.53)	.680	NA	NA
Frx. Diag.	0.69 (−8.82, 10.21)	.890	0.04 (−1.39, 1.46)	.960	0.68 (0.36, 1.33)	.230	NA	NA

GI, glenoid inclination, measured as the complement of the β angle; *CORM*, center of rotation medialization; *AGT*, acromial–greater tuberosity distance; *BMI*, body mass index; *CCI*, Charlson comorbidity index; *Vers.*, Version; *FU*, follow-up length; *Reop Diag.*, indication for surgery of a failed arthroplasty; *Frx Diag.*, indication for surgery of a fracture or fracture sequelae; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form; *SST*, Simple Shoulder Test score; *VAS*, visual analog scale for pain; *Reop.*, reoperation; *OR*, odds ratio; *NA*, not applicable.

For ASES and SST, we performed linear regression and have shown coefficient and 95% confidence intervals. For VAS, we performed negative binomial regression and have shown ratio and 95% confidence intervals. For reoperations and complications, we performed logistic regression but reduced the number of covariates because only 41 of these events occurred. Statistically significant differences are bolded.

* Because of the limited number of events, only variables significantly associated with the outcome in the univariable analysis and length of follow-up were included.

glenoid inclination was not associated with any change in the odds of reoperation or complication (OR 1.01, 95% CI 0.97, 1.07, $P = .550$; Table IV). There were no differences in outcomes or reoperation rates between implant manufacturers (Table IV).

Discussion

We analyzed 230 RTSAs with a minimum of 2-year, short-term, follow-up but with an average of 4-year, medium-term, follow-up, with patient-reported outcomes. Baseplate superior inclination was associated with increased postoperative pain ($P = .008$), and distalization was associated with increased reoperations and complications ($P = .032$). There were also significant associations between patient factors and patient-reported outcomes. Overall, these analyses suggest that preoperative patient demographics and comorbidities are important for outcome after RTSA. Older, higher-BMI, men with inferiorly inclined baseplates and without excess distalization had the best outcome and the lowest risk for reoperation or complication.

Association between outcomes and radiographic implant position

Our study demonstrated overall excellent outcomes and low complication and reoperation rates after RTSA. Multiple prior studies have similarly demonstrated excellent outcomes and low reoperation rates using a Grammont-style implant.[2,11,21,35] In addition, although our study demonstrated an overall medialization and distalization of the COR and tilt into inferior inclination, we found substantial variation in these factors, with 55° variation in inclination change, 66-mm variation in medialization change, and 51-mm variation in distalization change. A prior study demonstrated similar variation.[41] We also found a wide variation in postoperative outcomes, with ASES scores ranging from 5-100, suggesting that the outcome after RTSA does vary widely. Inferiorly inclined baseplates demonstrated decreased pain postoperatively. The authors speculate that this association is due to the decreased impingement at the inferior glenoid with an inferiorly inclined baseplate. We also found that excess distalization led to an increased risk for reoperation or complication. The authors speculate that this association is due to the increased soft tissue tension, which may increase the risk for acromial fractures, strap tendonitis, and nerve injuries. As each of these individual complications is uncommon, likely multicenter studies will be necessary to better elucidate the associations between each and distalization. However, our data set demonstrates that excess distalization does increase the risk for reoperation or complication. Since collection of this series and based on this experience, the senior author has decreased intraoperative tension, particularly in elderly individuals who are at risk for acromial fractures, strap tendonitis, and nerve injuries.

Association between demographics and outcome

Within our study, patient factors were associated with patient-reported functional outcome after RTSA but implant position was not. Prior studies have demonstrated sex[20,35] and age to be a predictor of patient-reported outcomes after RTSA.[20,26] A prior study demonstrated male sex to be associated with complications after RTSA,[44] partially because *Cutibacterium acnes* is more common in males.[6] Preoperative patient expectations predict outcomes,[39] and these likely differ depending on patient demographics and medical comorbidities. Workers' compensation status, which is associated with patient demographics, also affects outcome and complication rates after shoulder arthroplasty.[13] However, some studies have demonstrated BMI, gender, age, or medical comorbidities to either have no association with postoperative outcome or to be associated in directions different from those seen in our own studies.[15,33,46,49] Also, one study demonstrated significantly better pain with more medialization.[40] The difference in our findings and the findings of these studies may be explained by the different patient populations, smaller sample sizes, dichotimization of outcome variables, and use of logistic regression within these study designs.[15,33,46,49]

Limitations

Our study has several limitations. This was a retrospective study and thus no standardized protocol was used to follow-up prospectively for preoperative radiographs, surgical technique, postoperative rehabilitation, postoperative radiographs, etc. Although this is a single-surgeon series using all Grammont-style implants, there were likely subtle changes in surgical technique, postoperative rehabilitation, etc during the study period. The authors have maximized the study period to maximize sample size. In particular, the angle of arm abduction was not standardized. Because the arm rotates about the COR, abduction moves the shortest distance from the COR to the line of pull of the deltoid proximally, and thus substantially reduces any effect of abduction on this distance (Fig. 2). In addition, this is a single-surgeon, single-institution study, and thus our findings may not be generalizable. In particular, during the study period, the author exclusively used a medialized-COR, valgus neck-shaft angle implant design. Our findings thus may not apply to lateralized (humerus or glenosphere) or varus neck-shaft angle implant designs. However, substantial variation was seen in both distalization and medialization of the COR (CORM change varied from 11-mm lateralization to 55-mm medialization, and AGT change varied from 0-51 mm), which mitigates this limitation. We also did not analyze radiographic position relative to the predeformity or "normal" scapula. Our study does not include radiographs at final follow-up and thus does not allow us to assess for loosening, notching, and other radiographic complications. Two implant designs are included to maximize the sample size, and they do differ slightly, although we have included implant manufacturer as a covariate in our multivariate analysis and it was not associated with outcome. Some patients were lost to follow-up and the population included is heterogeneous, although diagnosis is included as a covariate in our analysis. It also is an assessment of immediate postoperative radiographic implant position and not radiographic implant position at final follow-up. It is thus possible that some implants may have shifted in position. Clinically, it has been the authors' experience that substantial shifts in implant position in the setting of RTSA are almost always associated with clinical symptoms and reoperation, and thus this limitation likely contributes minimal bias. Finally, humeral version is based on the surgeon's intraoperative assessment, and thus no reliability data are presented for this variable. We did not measure glenoid version as it was not felt that this could be reliably or accurately measured on axillary radiographs.

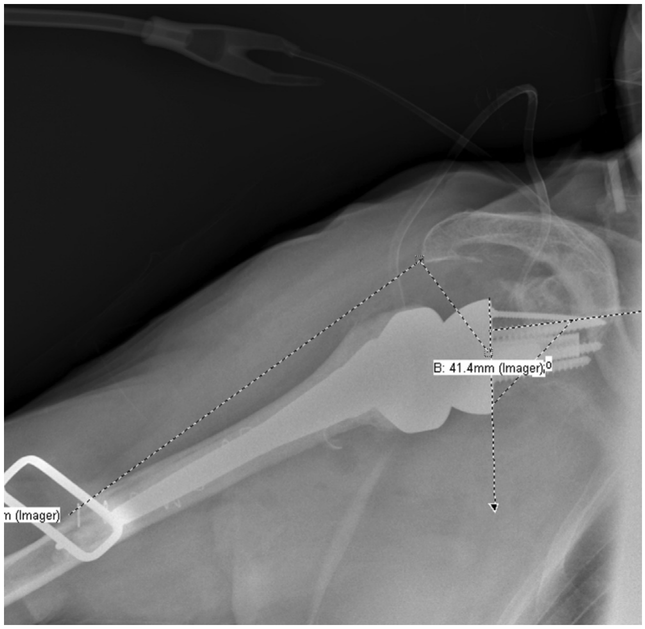

Figure 2 Example of robustness of center of rotation measurement to angle of glenohumeral abduction.

Conclusion

Age, gender, and BMI are associated with outcome after RTSA. In this retrospective analysis of a Grammont-style RTSA, superior inclination is associated with increased pain postoperatively, whereas excessive arm lengthening is associated with increased risk for complication or reoperation.

Disclaimer

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Disclosure

Peter Chalmers is a paid consultant for Arthrex and Mitek, is paid speaker for DePuy, serves on the editorial board for the *Journal of Shoulder and Elbow Surgery*, receives intellectual property royalties from DePuy, and has received other support from Tornier.

Robert Tashjian is a paid consultant for Zimmer/Biomet, Wright Medical, and DePuy-Mitek; has stock in Conextions, INTRAFUSE, Genesis, and KATOR; receives intellectual property royalties from Wright Medical, Shoulder Innovations, and Zimmer/Biomet; receives publishing royalties from Springer and the *Journal of Bone and Joint Surgery*, and serves on the editorial board for the *Journal of Shoulder and Elbow Arthroplasty* and the *Journal of the American Academy of Orthopaedic Surgeons*.

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