Analysis of the Alteration of the Glenohumeral Center of Rotation after Reverse Total Shoulder Arthroplasty

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INTRODUCTION:

The original Grammont reverse total shoulder arthroplasty (RTSA) design intentionally medialized the postoperative center-of-rotation (COR) of the glenohumeral joint. Later generation RTSA designs introduced the concept of lateralization. However, when discussing RTSA designs, the term "lateralization" is not specific and can hold various meanings. Lateralization can refer to 1) the change in COR of the glenohumeral joint, 2) the medial-to lateral change in the humerus relative to the scapula, or 3) the design of the glenoid baseplate and/or glenosphere that extends further laterally from the glenoid compared to standard first-generation, Grammont RTSA components.

Previous studies have examined the interaction between the 1) medial-to-lateral change in humerus relative to the scapula and 2) the lateralized design of the glenoid baseplate and how these concepts affect patient-reported outcomes. However, to the best of knowledge there are no studies that examine the influence of the change in the COR after reverse total shoulder arthroplasty on patient outcomes. In addition, it is not clear if the use of a lateralized glenoid design actually lateralizes the glenohumeral COR or if there is just less medialization of the COR compared to standard, Grammont reverse total shoulder arthroplasty components (a relative "lateralized" COR).

The hypotheses of this study were 1) that all reverse total shoulder arthroplasties regardless of a) the amount of humeral lateralization that occurred postoperatively or b) the use of lateralized components will still have a medialized, COR compared to the preoperatively measured COR, 2) the change in COR will correlate with the amount and direction the humerus is translated in the medial-to-lateral position relative to the scapula, 3) patients with lateralized or augmented glenoid baseplates will have less medialization of the COR compared to standard baseplates, 4) the change in COR measurements will correlate with patient-reported outcomes, and 5) the change in COR will influence the incidence and types of complications after reverse total shoulder arthroplasty.

METHODS: Preoperative and postoperative radiographs from RTSA patients were used to calculate the 1) change in the COR with respect to the lateral edge of the acromion and 2) medial-to-lateral humeral translation with respect to the lateral edge of the acromion. The Western Ontario Osteoarthritis Score (WOOS), American Shoulder and Elbow Surgeons score (ASES), and Single Assessment Numeric Evaluation (SANE) were recorded at baseline, 1 year, and 2 years. $P<0.05$ was utilized to determine significance.

RESULTS:

Two-hundred-and-thirty-eight patients with a mean age of 71 ± 8 were included. There were 126 male patients (53%). All patients had a medialized COR after reverse total shoulder arthroplasty (100%). The mean amount of medialization of the COR was 18 ± 7 mm (range =2.2 to 38.5). The mean humeral lateralization was 1 ± 8 mm (range -19 to 22 mm). There was a strong inverse relationship between the change in COR and humeral translation ($R=-0.51$; $p<0.0001$). Patients with lateralized or augmented baseplates (n=189) had less medialization of the COR compared to standard baseplates without lateralization or augmentation (N=49) (17 ± 7 vs 23 ± 6; $p<0.0001$).

There were weak inverse relationships between the amount of medialization of the COR and the 1) WOOS at 2 years ($R=-0.22$, $p=0.03$), 2) the change in WOOS compared to baseline ($R=-0.21$; $p=0.04$) and 3) SANE at 2 years ($R=-0.20$; $p=0.03$). When stratifying the cohort into 1) the 50% with the greatest amount of medialization of the COR and 2) the 50% with the lowest amount of medialization of the COR, there were better WOOS (85 ± 14 vs. 78 ± 20; $p=0.04$), ASES (79 ± 13 vs 70 ± 24; $p=0.01$), and SANE (81 ± 17 vs 74 ± 22; $p=0.04$) at two years in the patients with less medialization of the COR.

There was significantly greater COR medialization in those with any complication (n=34) compared to those without a complication (21 ± 8 vs 18 ± 7 mm; $p=0.02$) and those with a postoperative dislocation (n=9) compared to those without a dislocation (23 ± 4 vs 18 ± 7; $p=0.04$). COR medialization was not different in patients with scapular notching (n=12) compared to those without scapular notching (21 ± 8 vs 18 ± 7 mm; $p=0.11$) and those with an acromial fracture (n=9) compared to those without a fracture (21 ± 12 vs 18 ± 7 mm; $p=0.18$).

DISCUSSION AND CONCLUSION: It is important that we clearly define what we are referring to when we discuss lateralization in reverse total shoulder arthroplasty. Whereas the humerus is often lateralized after RTSA, the COR is not lateralized after RTSA even when using "lateralized constructs". Rather, the COR is "less medialized" or "relatively lateralized" when utilizing augmented or lateralized baseplates compared to standard baseplates. Less medialization of the COR resulted in improved patient-reported outcomes. COR medialization was greater in patients with 1) any complication and 2) postoperative dislocations compared to patients without complications or postoperative dislocations.