Quantifying Glenoid Bone Loss in the Setting of Primary Reverse Shoulder Arthroplasty

Alexander Macfarlane, Jordan Henry Larson, Michael Peter Kucharik, Joshua Ulmer Hancock, Ankur Shah Narain, Micah Jon Nieboer, Kaitlyn N Christmas, Peter Simon, Mark A Frankle

INTRODUCTION: Presently, there is no quantifiable and objective criteria for defining severe glenoid bone loss (GBL) in the setting of primary Reverse Shoulder Arthroplasty. This limits our ability to appropriately compare varying surgical techniques and technologies designed to manage and treat GBL in RSA. In this study, we aimed to establish quantifiable thresholds of severe GBL using surgeon intraoperative assessment and blinded radiographic review. Additionally, we also aimed to compare outcomes of severe GBL against moderate and mild cases of GBL. We hypothesized that we would be able to establish quantifiable GBL thresholds with high sensitivity and specificity, high interrater agreement, and that there would be significantly worse outcomes for severe GBL.

METHODS: Retrospective review of 57 primary RSA cases that were determined to be severe GBL at the time of surgery met inclusion criteria and were uploaded to a 3D preoperative planning software. Bone loss was rating was recorded at the time of the surgery by the senior author. These were propensity matched at a 1:1 ratio to moderate and mild bone loss cases based on age at the time of surgery, sex, and time to final follow up (mean 53.5 months). Measurements evaluated included version (absolute retroversion, and without anteversion), inclination, maximum erosion depth (MED), and glenoid vault loss (GVL). Receiver operator characteristic (ROC) curves were calculated for severe bone loss cutoff thresholds. Twenty cases from each bone loss group were randomly selected and radiographs, CT imaging, and 3D reconstructions from these were sent to 5 blinded raters for assessment. Two-year and final follow up patient reported outcome (PRO) measures were compared between the three bone loss groups (mild, moderate, and severe) as well between a combined (mild and moderate) group to the severe bone loss group.

RESULTS: There were no differences between groups for age, sex, laterality, time to follow up, and preoperative PRO measures between groups. There was a higher proportion of rotator cuff disease in the mild and moderate bone loss groups when compared to the severe group (84% vs. 43.9% vs. 15.8%, respectively). All measurements of GBL differed between groups with the exception of inclination ($p = 0.347$ for mild vs. severe and $p = 0.399$ for moderate vs. severe). ROC curves (Figures 1-3) resulted in minimum thresholds for severe GBL of 5.5 mm MED, 12.5% GVL, and 17.5º of version (absolute version or retroversion without anteversion) (AUC = 0.944, 0.924, 0.812, respectively). There was a strong correlation between GVL and retroversion with MED ($R2 = 0.800$). Interrater reliability ranged from moderate for plain films and 2D CT ($k = 0.432$ and 0.565, respectively) to substantial for 3D reconstructions ($k = 0.726$). Mean interrater reliability between the first and second round of ratings was 0.701 for plain films, 0.677 for 2D CT, and 0.758 for 3D reconstructions. The mild bone loss group performed worse on ASES, VAS pain, and VAS function scores at 2-years and final follow up when compared to the severe bone loss group. The combined group performed worse on ASES and VAS pain at 2-year follow up, but no differences were found at final follow-up. There were no differences between groups with respect to achievement of MCID and absolute change between any group.

DISCUSSION AND CONCLUSION: Severe glenoid bone loss in primary RSA is defined as medialization of at least 5.5 mm, glenoid vault loss of greater than 12.5%, and retroversion greater than 17.5º. Inclination is not a reliable indicator for severe bone loss. These three measurements all correlate strongly with one another; therefore, all three measurements should be used in combination. Additionally, these measurements have substantial agreement when blindly assessed and are strongest when using 3D reconstructions. Severe GBL performs as well as less severe bone loss at a mean of 53.5 months follow up, though this is in part driven by less rotator cuff disease in patients with less severe bone loss.