

**Significant Variability Exists in Preoperative Planning Software Measures of Glenoid
Morphology for Shoulder Arthroplasty**

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ABSTRACT

Introduction: Total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RTSA) are mainstays of definitive management of both degenerative and acute shoulder conditions. Studies of glenoid component malpositioning in TSA and in RTSA have demonstrated malpositioning to adversely affect both clinical and radiographic outcomes. Three-dimensional (3D) imaging has become increasingly relied upon during preoperative planning in an effort to improve component positioning in shoulder arthroplasty with multiple vendors offering programs designed for shoulder arthroplasty planning. We sought to assess the reliability of four different shoulder arthroplasty 3-dimensional preoperative planning programs with additional comparison to manual measurements conducted by two fellowship-trained musculoskeletal radiologists.

Methods: A retrospective review of computed tomography (CT) scans of patients undergoing shoulder arthroplasty was undertaken. 76 CTs were separately analyzed for glenoid version and inclination by four templating software systems (VIP, Blueprint, TrueSight, ExactechGPS). Inter-rater reliability was assessed via intra-class correlation coefficient (ICC). For those shoulders with glenohumeral arthritis (58 of 76), ICC was also calculated when sub-grouping by modified Walch classification. Lin's concordance correlation coefficient (CCC) was calculated for each system with a musculoskeletal-trained radiologist's measurements.

Results: Intra-rater reliability for the two MSK radiologists' measurements of glenoid version were 0.987 (95% CI: 0.966-0.995) and 0.937 (95% CI: 0.843-0.975) indicating excellent reliability. Intra-rater reliability for the 2 MSK radiologists' measurements of glenoid inclination were 0.950 (95% CI: 0.840-0.982) and 0.966 (95% CI: 0.915-0.987) also indicating excellent

reliability. Measurements of glenoid version and inclination differed between at least two programs by 5°-10° in 75% and 92% of glenoids respectively, and by >10° in 18% and 45% respectively. ICC was excellent for version but only good for inclination. ICC was highest among Walch A glenoids for both version (near excellent) and inclination (good), and lowest among Walch D for version (near poor) and Walch B for inclination (moderate). When measuring version, VIP had the highest concordance with radiologists' measurements; Blueprint had the lowest. For inclination Blueprint had the highest concordance while ExactechGPS had the lowest.

Conclusion: There is significant variability in CT-based measures of glenoid version and inclination between four frequently utilized shoulder arthroplasty templating softwares which worsens with glenoid deformity. Software concordance with radiologists' measurement is also variable. Further research is needed to understand how this variability should be accounted for during shoulder arthroplasty preoperative planning.

Level of Evidence: Level III Retrospective Comparative Study

Keywords: Total shoulder arthroplasty, reverse shoulder arthroplasty, glenoid deformity, patient specific instrumentation, glenoid version, glenoid inclination, 3-dimensional computed tomography