

Three-Dimensional Scapular Orientation: A Comparison of Glenohumeral Osteoarthritis and Cuff Tear Arthropathy to the Normal Shoulder

Andrew Jawa, Ryan Lohre¹, Teja S. Polisetty, Evan Andrew Glass, Daniel Patrick Swanson, Paul-Anthony John-Joseph Hart, Ward Bartels², Sanne Vancleef, Bassem T Elhassan³, Jacob Kirsch⁴

¹University of British Columbia, ²Materialise, ³Massachusetts General Hospital, ⁴Boston Sports and Shoulder Center

INTRODUCTION: Scapular orientation may play an important role in preoperative planning for shoulder arthroplasty, however there are currently no systems to produce standardized three-dimensional measurements. The purpose of this study is to develop a reproducible measurement system of scapular orientation and to evaluate differences between normal shoulders and those with diagnoses of primary glenohumeral arthritis (GHOA) and rotator cuff tear arthropathy (CTA).

METHODS: Patients receiving computed tomography (CT) scans for preoperative shoulder arthroplasty planning were enrolled prospectively. Thin sliced axial images that included bilateral shoulders and the thorax were reformatted. The pathology of the bilateral glenohumeral joints were defined as GHOA, CTA, or normal shoulder pathology. Scapular orientation was defined relative to the thorax using three-dimensional models to define the protraction, rotation, and tilt angles. Univariate analysis was performed to compare demographics and scapular measurements between patients with GHOA, CTA, and normal shoulder pathology. Multivariate linear regression analysis was performed to identify independent predictors of scapular orientation.

RESULTS:

One-hundred-fifty-eight shoulders, comprising 79 patients were included. Twenty-seven percent (n = 21/79) of patients had a normal contralateral shoulder. Shoulders with GHOA had significantly greater downward scapular rotation (-14 ± 7 degrees) than both normal shoulders (-8 ± 7 degrees; P < 0.001) and those with CTA (-7 ± 8 degrees; P < 0.001). Increased downward scapular rotation was predicted by a shoulder pathology of GHOA in multivariate analysis (beta - 7.09; P < 0.001). The magnitude of side-to-side difference was greatest in scapular rotation for patients with GHOA compared to CTA, with no significant differences in tilt or protraction.

DISCUSSION AND CONCLUSION: Scapular rotation varies by shoulder pathology, with greater downward rotation seen in patients with primary GHOA. These findings underscore the need for awareness of scapular orientation in addition to glenoid morphology when evaluating and planning shoulder arthroplasty cases.

The collage contains several elements:

- Diagrams:** Anatomical diagrams showing the scapula's position relative to the thorax, and 3D models illustrating the measurement of protraction, rotation, and tilt angles.
- Statistical Tables:**

Parameter	Normal	GHOA	CTA
Protraction (degrees)	-1.5 ± 3.5	-1.2 ± 3.8	-1.8 ± 3.2
Rotation (degrees)	-8.0 ± 7.0	-14.0 ± 7.0	-7.0 ± 8.0
Tilt (degrees)	15.0 ± 5.0	14.5 ± 5.5	15.5 ± 4.5

Pathology	Mean Protraction	Mean Rotation	Mean Tilt
Normal	-1.5	-8.0	15.0
GHOA	-1.2	-14.0	14.5
CTA	-1.8	-7.0	15.5