Three-Dimensional Zero Echo Time Sequences Correlate to Three-Dimensional Computed Tomography for Evaluation of Glenoid Bone Loss

Scott Feeley, Shankar Thiru, Rachel Ester Cherelstein[1], Christopher Kuenze, Udit Rawat, Edward S Chang
[1]Inova Health System

INTRODUCTION: Quantification of glenoid bone loss in cases of shoulder instability can help to guide surgical management and identify the need for a bone block augmentation procedure. However, computed tomography (CT) is considered the gold standard for quantification and is often obtained in addition to magnetic resonance imaging (MRI), exposing patients to potentially unnecessary cost and radiation exposure. Our purpose was to correlate three-dimensional (3D) reconstruction of Zero Echo Time (ZTE) MRI sequences with 3D CT for evaluation of glenoid bone loss (GBL). A secondary objective was to determine if a 3D ZTE reconstruction had a higher correlation to the gold standard of 3D CT than the commonly used 2D proton density fat-saturation (PD FS) MRI sequence and if there are differences in agreement between imaging modalities across the spectrum of GBL.

METHODS: We identified all patients at a single institution who had obtained MRI with ZTE and PD FS sequences in addition to 3D CT of the ipsilateral shoulder (Figure 1). We excluded patients if there was a documented instability event between imaging studies. Medical records were reviewed to document history of instability events. Two raters calculated the primary outcome of glenoid bone loss by the perfect-circle linear method (Figure 2). Interrater reliabilities were calculated and we analyzed concordance between modalities. Excellent reliability was defined as intraclass correlation coefficients >0.9 and strong concordance as concordance correlation coefficients >0.7.

RESULTS: Six patients were included for analysis. Of the six patients, five (83.3%) had three or more instability events prior to imaging. Overall mean GBL by imaging modality was 12.8 ± 11.3% on PD FS, 13.0 ± 11.8% on 3D ZTE, and 12.7 ± 11.7% on 3D CT. The primary outcome of GBL had excellent interrater reliabilities (>0.9) on all modalities (Table 1). For GBL, concordance correlation coefficients were 0.994 (95% CI 0.961-0.999) for PD FS versus 3D CT and 0.999 (95% CI 0.990-1.000) for 3D ZTE versus 3D CT.

DISCUSSION AND CONCLUSION: Three-dimensional Zero Echo Time magnetic resonance sequences are a suitable alternative to three-dimensional computed tomography for measurement of glenoid bone loss, potentially saving cost and radiation exposure to patients.

Figure 1: Axial images of a patient with critical glenoid bone loss, Hill-Sachs and reverse Hill-Sachs lesions on (A) Zero Echo Time magnetic resonance sequence and (B) computed tomography.

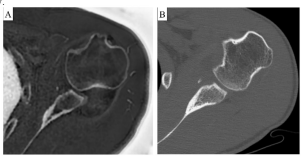

Figure 2: En face views of a patient with critical glenoid bone loss on (A) 3D ZTE MRI and (B) 3D CT. (C) Best-fit circle linear method for measurement of native glenoid diameter and linear defect to calculate glenoid bone loss (% GBL = Defect Width / Glenoid Diameter *100). The red circle matches the contour of the posteroinferior glenoid and the green line corresponds to the defect width.

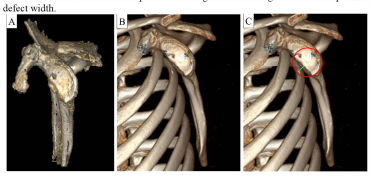

Table 1: Interrater reliability for measurement of glenoid bone loss by modality

Modality	ICC	95% CI
PD FS	0.913	0.669-0.982
3D ZTE	0.986	0.938-0.997
3D CT	0.983	0.926-0.996