Editorial Commentary: Can We Evaluate Glenoid Bone With Magnetic Resonance Imaging? Yes, If You Have the Right Sequence

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Abstract: Glenoid bone loss must be recognized when treating patients with shoulder instability to appropriately determine surgical treatment with either a soft-tissue stabilization or bony augmentation procedure. Three-dimensional reconstructions from computed tomography scans currently are the clinical gold standard for accurately evaluating glenoid bone loss. Novel advances in magnetic resonance imaging sequences and processing may allow for obtaining complete bony information from a single preoperative imaging study.

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Glenoid bone loss is essential to recognize preoperatively for appropriately managing patients with shoulder instability. Burkhart and DeBeer highlighted this issue with the report of high failure rates after soft-tissue stabilization in patients with a pear-shaped glenoid, thereby defining the concept of critical bone loss.[1] More recently, multiple authors have shown the influence of even subcritical bone loss on rates of recurrent instability or patient-reported outcomes after soft-tissue–based procedures.[2,3] This concept of subcritical bone loss has highlighted the need to precisely measure glenoid bone stock for clinical care. Given that measurement differences as small as 1 to 2 mm may impart influence on outcomes, it is imperative to have a readily available and highly reproducible method for measuring glenoid bone loss.

The glenoid shape is complex and difficult to fully capture with 2-dimensional imaging alone. Three-dimensional (3D) computed tomography (CT)-based reconstructions with an en face view of the glenoid are the current clinical gold standard and allow for full appreciation of glenoid bone shape for preoperative planning.[4] Magnetic resonance imaging (MRI), however, provides superior soft-tissue resolution to visualize the labrum, capsule, and rotator cuff. In clinical practice, patients may be asked to obtain both imaging studies, which increases cost and time spent on imaging. Surgeons may also overlook bony involvement due to the hesitancy of subjecting the usually young patients who experience shoulder instability to the ionizing radiation necessary for a CT scan. We are often faced clinically with potentially accepting incomplete information in preoperative planning by obtaining just one imaging modality or overusing imaging to ensure a comprehensive evaluation is performed. Ideally, information regarding the soft tissue and bone would be fully evaluated in a single imaging study.

In "Three-Dimensional Zero Echo Time Magnetic Resonance Imaging Versus 3-Dimensional Computed Tomography for Glenoid Bone Assessment," de Mello, Ma, Ashir, Jerban, Hoenecke, Carl, Du, and Chang[5] present an MRI-based method for generating 3D reconstructions of the glenoid in both cadaveric specimens and patients with shoulder instability.[5] MRI traditionally has limited contrast between bone and surrounding soft tissue, but a zero echo time (ZTE) MRI sequence provides excellent definition between cortical bone and soft tissue at the shoulder.[6] The authors should be commended on their innovative imaging approach, as well as the study design with evaluating measurements both in cadaveric specimens and patients with shoulder instability. In vivo measurements differed by 0.4 to 0.8 mm between MRI and CT scans, showing that this

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technique could reliably be used in a clinical setting. Also, the reported time for image processing to produce the 3D reconstructions was 33 to 64 seconds, which is fast and important to consider for potential implementation in clinical practice.

Previous MRI-based studies have shown that 3D reconstructions of the glenoid can be created with either manual processing or specialized sequences. Gyftopoulos et al.[7] used MRI combined with manual segmentation of the scapula to produce 3D reconstructions of the glenoid. These methods allowed for MR-based measurements that were within 0.5% to 2.2% of intraoperative measurements but required laborious manual segmentation to produce the reconstructions. This type of processing would not be feasible for routine application. Lansdown et al.[8] reported on Dixon fat-water separation sequence in allowing for automatic reconstructions of the glenoid. Bone loss measurements for patients with shoulder instability were, on average, within 1% to 2% of CT measurements. This technique, similar to the one presented by de Mello et al., allowed for quick and automated processing that could readily be implemented in clinical practice. The current study offers a similar technique to simplify the preoperative imaging and provide surgeons with complete assessment of the shoulder joint—including bony anatomy and soft tissue—with a single imaging modality. We are moving toward a single imaging modality providing a comprehensive preoperative evaluation for patients with shoulder instability, with future directions focused on finding a sequence or other image processing technique that allows for this combined imaging of bone and soft tissue to be readily available for patients and surgeons.

Although these results are encouraging in offering another method for glenoid bone evaluation without a CT scan, there are still some important considerations for clinical care. First, ZTE MRI may not be widely available at all imaging centers, especially outside of larger academic centers, and requires appropriate equipment to acquire the sequence. This technique also still requires requesting this sequence at the time of scanning, and the information cannot be recovered through postprocessing. Having access to 3D reconstructions of the glenoid for all patients, and not just ones in whom the surgeon has heightened concern or thinks to order bony imaging, will really be the step in the diagnostic workup that simplifies clinical care and advances research endeavors.

There is a clear clinical need for simplifying the preoperative evaluation for patients with shoulder instability. The current study shows that ZTE MRI is a potential option, when available, for obviating the need for a preoperative CT scan for glenoid bone evaluation.

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