Letters to the Editor

Is 13.5% the Right Number for Critical Bone Loss?

Glenoid bone loss and its association with a high recurrence of shoulder instability after arthroscopic labral repair were first identified in 2000 by Burkhart and De Beer.[1] They defined significant glenoid bone loss as an inverted pear-shaped appearance with the inferior half of the glenoid diameter smaller than the superior. Since then, extensive research has been dedicated to further investigation of this topic. This research has guided orthopaedic surgeons to suggest quantitative bone loss cutoffs as an indication for possible bone augmentation procedures. Recently, these suggested cutoffs have become more precise, even down to 13.5%.[2,3]

In the same year in which Burkhart and De Beer[1] published their findings, Itoi et al.[4] performed a cadaveric study to quantitatively evaluate anteroinferior bone loss that contributes to persistent instability after arthroscopic Bankart repair. They found that 21% glenoid width or greater loss was associated with post—Bankart repair instability. In 2006, Boileau et al.[5] noted clinical recurrence of instability to be associated with greater than 25% anterior glenoid bone loss. Then, in 2015, Shaha et al.[2] looked at "subcritical" glenoid bone loss of less than 20% in a younger, military population. They found worse Western Ontario Shoulder Instability (WOSI) scores and lower subjective clinical outcomes with bone loss greater than 13.5% and, thus, suggested this percentage as a cutoff for what is considered important bone loss in this patient population. It should be noted that although Western Ontario Shoulder Instability (WOSI) and outcome scores were lower in this cohort—what we typically consider "failures"—the rate of instability recurrence was 11% in this young, active military population, which many surgeons would not find unacceptably high for this type of procedure. Similarly, in 2017, Shin et al.[3] found that glenoid bone loss greater than 17.3% corresponded to lower shoulder function and Single Assessment Numeric Evaluation (SANE) scores as well as increased surgical failure after arthroscopic Bankart repair.

Since the publication of the 13.5% cutoff, several studies have used this as a new limit for consideration of bony augmentation or cited it in the discussion of treatment.[6-10] The average glenoid width is variable, depending on patient height and sex[11]; however, Lenart et al.[12] calculated an average of 24.4 mm. Therefore, 0.5% of an average glenoid equates to 0.1 mm. We think that this level of "precision" implies a greater accuracy than is generally possible.

In addition to our limited measuring capabilities, we should consider the propagation of error built into the system. The first source of error is the imaging modality. With the increased availability of computed tomography (CT) and, more recently, magnetic resonance imaging (MRI), these imaging modalities are more frequently used for glenoid bone loss measurements as compared with radiographs. Many glenoid bone loss studies have used 2-dimensional MRI or CT, but 3-dimensional (3D) CT is now accepted as the most accurate method of measurement.[13-15] If one assumes ubiquitous access to 3D CT scans, an error within the 3D CT measurement still exists. Patient positioning within the scanner can alter measurements.[16,17] Additionally, even with 3D imaging, glenoid measurements do not accurately account for the 3D aspects of the glenoid, particularly the glenoid concavity.[18]

Second, regarding error within the system, we must scrutinize the measurement technique. Verweij et al.[19] found 17 different methods of calculating glenoid bone loss, without an established gold-standard method. Parada et al.[20] found that the commonly used linear measurement percentage overestimates glenoid bone loss, potentially leading to glenoid bone loss meeting a surgical threshold. Wu et al.[21] also showed linear estimates overestimated glenoid bone defect measurements compared with area. Moreover, uninjured morphologically flat glenoids, when measured with the best-fit circle technique, fall within the subcritical bone loss range of values.[22] Shaha et al.[2] found the interobserver and intraobserver reliability of measuring glenoid bone loss to be 0.826 and 0.881, respectively. Chalmers et al.[23] looked at measurement variables (CT or MRI, linear or area, and individual measurers) and the effect on surgical indications. These differences in methods would result in different surgical recommendations 25% to 34% of the time. Given the range of measurement error, differentiating between 0.1 mm or 0.5% bone loss does not seem practical.

The third area of error is in the evaluation of the location of the bone loss. There have been numerous studies evaluating the glenoid track to attempt to incorporate this into determining the risk of recurrent instability after arthroscopic Bankart repair. Yamamoto et al.[24] introduced the concept of the glenoid track in

2007. Shaha et al.[25] validated the clinical application of "off-track" lesions and their relation to instability recurrence. Di Giacomo et al.[26] subsequently published a study testing a treatment algorithm—the Glenoid Track Instability Management Score (GTIMS)—that incorporates glenoid track measurements into the Instability Severity Index score algorithm. They found that 17.5% of patients were indicated for arthroscopic Bankart repair with the GTIMS who would have been indicated for the Latarjet procedure if the Instability Severity Index score algorithm had been used. This particular patient cohort had equivalent patient outcomes when compared with the other arthroscopic Bankart repairs. Similar to the subcritical bone loss concept, the concept of "near-track" lesions was developed by Li et al.,[27] who argued that, although still on track, there are Hill-Sachs lesions with short distance-to-dislocate measurements that increase the risk of recurrent dislocation after arthroscopic Bankart repair. Hill-Sachs lesions have also been found to have variable measurement reliability.[28-30] This introduces yet another level of potential measurement error in the imaging evaluation.

Aside from the difficulties with the quantitative evaluation of shoulder instability, there are qualitative variables that affect the risk profile. Patient characteristics—age, sex, sport involvement, activity level, and so on—have been cited as a contributing cause of recurrent instability since 1956.[31] In the effort to standardize and simplify indications for bony augmentation in shoulder instability, we risk removing important patient considerations from the evaluation. We could downplay the many subjective aspects of a patient. With the increased citation of subcritical bone loss measurements, we must acknowledge and remember that many variables affect shoulder instability and that these measurements, as objective as we try to make them, should serve only as guides that are applied to a much more subjective analysis of the patient.

Even just 2 months ago, Nakagawa et al.[32] stated that a glenoid defect of 13.5% "has become accepted as the definition of a large defect." By creating strict cutoffs for surgical indications that clearly are not reproducibly accurate to 0.1 mm and incorporate only 1 aspect of the patient picture, we oversimplify the matter and do not adequately address other variables present. We suggest that moving forward, we do not continue to cite a cutoff that implies an accuracy that we do not possess. Like Li et al.[27] and their development of the concept of near-track lesions, it would be more helpful to consider glenoid bone loss similarly. Perhaps a more useful system to evaluate high-risk recurrent instability would be a more global evaluation of a patient, such as the Instability Severity Index score or GTIMS scoring system.[26,33] Regardless, the current trajectory of using strict, minute bone loss measurements is a direction that needs careful evaluation. Although Shaha et al.[2] are to be congratulated on raising the issue of smaller glenoid bone loss affecting arthroscopic stabilization results, we believe it is not practical to hold 13.5% as different from 13% or 14% to a meaningful degree.

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Regarding "Tibial Tubercle Trochlear Groove/ Trochlear Width Is the Optimal Indicator for Diagnosing a Lateralized Tibial Tubercle in Recurrent Patellar Dislocation Requiring Surgical Stabilization"

I read with great pleasure the recently published study "Tibial Tubercle Trochlear Groove/Trochlear Width Is the Optimal Indicator for Diagnosing a Lateralized Tibial Tubercle in Recurrent Patellar Dislocation Requiring Surgical Stabilization."[1] I write this letter not only to praise Dr. Su and the coauthors but also to spotlight their study and draw more attention to it.