Peer Review File

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Reviewer A

Comment 1: Lines 64-67: Please include some brief commentary on the problems associated with lateralization as well (such as shear force glenoid/implant interface and acromial stress fracture). I know you touch on this later, but consider adding to the introduction as well
Response: Thank you for your comment. We have added these concepts to the manuscript.
Modified text: "However, lateralization has also been associated with increased shear forces across the baseplate interface, leading to failure, and increased the stress on the scapula, resulting in acromial stress fractures (11,12)." [Lines 54–56]

Comment 2: Line 94: Please add some references regarding these factors (higher neck shaft angle and a medialized glenoid, medialized humerus implant design)
Response: Thank you, a reference has been added to support these claims.
Modified text: "However, lateralization has also been associated with increased shear forces across the baseplate interface, leading to failure, and increased the stress on the scapula, resulting in acromial stress fractures (11,12)." [Lines 54–56]

Comment 3: Lines 95-102: Please add some references to support these claims. Frankle's group has published most extensively on the initial failures of the lateralized glenoid design and improvements in fixation that led to higher success rates
Read "Glenoid loosening and migration in reverse shoulder arthroplasty",
"Reverse shoulder arthroplasty for the treatment of rotator cuff deficiency: a concise follow-up, at a minimum of 10 years, of previous reports",
"Initial glenoid component fixation in "reverse" total shoulder arthroplasty: A biomechanical evaluation"
Response: Thank you, these references have been added.
Modified text: [References added to lines 81 and 242]

Comment 4: Lines 110-113: Please provide references to support these claims.
Response: These design changes are specific to certain commercial brands of rTSA. To reduce the possibility of bias in the manuscript, we prefer not to mention the exact systems.
Modified text: No change made.

Comment 5: Lines 128-129: Please elaborate on the reason for associated acromial stress fracture (likely over-lateralization of the glenoid).
Response: This sentence was deleted as we could not find a suitable reference for this exact claim; upon re-review we felt the sentence was unnecessary.
Modified text: The text "this option is also associated with the risk of scapular stress fracture" was deleted.

Comment 6: Lines 133: Does that study by Collin et al mention how the rTSA group achieved lateralization? Or what type of implant they used? It would be important to mention if their

results were a lateralized glenoid or medialized glenoid design in comparison to the BIO-RSA which tends to lateralize.
Response: We appreciate this comment and have updated/clarified the text.
Modified text: "A retrospective comparative cohort study by Collin et al. (25) compared the results of traditional rTSA and BIO-RSA performed by a single surgeon *with a single medialized glenoid implant design."* [Emphasis added; Lines 144–146]

Comment 7: Lines 140-142: Important to note that in cases of deformity, even maximal amounts of "lateralization" from an augmented baseplate or lateralized baseplate may only be correcting the native joint line to neutral. So in this case you are lateralizing, but if the starting deformity is significantly medialized then you may end still neutral or even medial to "native". This makes studies comparing lateralization in deformity scenarios difficult.
Response: Thank you for making this important point. We have added an explanation of the difference between lateralizing the COR of the glenoid and lateralizing the true COR.
Modified text: "It is important to note, however, that moving the COR of the glenosphere refers to the sphere and not to the true COR of the glenoid. Most glenoids have significant bony erosion, making the true COR medialized to begin with, so that a lateralized glenoid component may be bringing the COR of the glenosphere closer to the true COR. Similarly, reaming the glenoid to a flat surface cannot technically be called moving the COR medially; rather, the glenoid surface has been moved medially. This distinction makes it difficult, when discussing the COR on the glenoid side, to compare one study to another." [Lines 116–123]

Comment 8: Line 148: please remove one of the "available" so as not to be redundant.
Response: Thank you for bringing this to our attention. We have rewritten the sentence in question.
Modified text: "Other concerns regarding augmented glenoid components are cost and that they are not available for use in every currently marketed implant system." [Lines 167–169]

Comment 9: Line 152: please remove "(inclination)".
Response: We have removed the noted text.
Modified text: "Lateralization of the humeral component can more accurately be called *humeral offset*, which the angle at which the implant sits to the humeral tray on the surface of the humeral cut and whether it is recessed more shallowly vs more deeply in the proximal humerus (47) (Figure 1)." [Lines 172–175]

Comment 10: Lines 152: Figure 1 is not comparing neck-shaft angle. It is comparing inlay vs only humeral tray. Please change accordingly.
Response: Thank you for this comment. We have made this change.
Modified text: "Lateralization of the humeral component can more accurately be called *humeral offset*, which the angle at which the implant sits to the humeral tray on the surface of the humeral cut and whether it is recessed more shallowly vs more deeply in the proximal humerus (47) (Figure 1)." [Lines 172–175]

Comment 11: Lines 157-159: Please clarify. If you intend "vertical" to mean higher angle (e.g. 155 vs 135), then it actually decreases the impingement-free ROM. Also, please mention the fact that notching also occurs mostly in external rotation, not just adduction

Read "Scapular notching after reverse total shoulder arthroplasty: prediction using patient-specific osseous anatomy, implant location, and shoulder motion".
Response: Thank you for this comment, we removed the word vertical to avoid misunderstanding. We have also added the suggested reference.
Modified text: "…, although scapular notching occurs mostly in external rotation (51)." [Line 195]

Comment 12: Line 229: Please add some evidence to support the lack of need for subscap repair E.g. "Comparison of reverse total shoulder arthroplasty outcomes with and without subscapularis repair".
Response: Thank you for your comment. The text has been clarified and the suggested reference added.
Modified text: "First, the subscapularis tendon is not reattached in the majority of cases, and the *configuration of the rTSA* does not depend upon subscapularis attachment for stability (67)." [Emphasis added; Lines 267–269]

Reviewer B
Comment 1: I think that this study could be useful and relevant as there does appear to be quite a bit of confusion among orthopedic surgeons about the biomechanical implications of achieving lateralization with rTSA through the glenoid, humerus, or both. However, the authors do not adequately summarize the literature and as such do not do an adequate job of describing these concepts. This is particularly true as it relates to the newer literature published since 2020…most of the papers that the authors reference are from the last decade. Because of this, the authors have left out the most recent literature and several important concepts. They also failed to reference many relevant and important papers, for example, Routman et al in 2015 HJD Bulletin which created the rTSA design classification system which is the basis of this summary paper. Some of these issues and also other corrections are mentioned below in the line-by-line response. The authors need to rewrite this paper to address these issues before this summary paper is appropriate for publication:
Response: Thank you. Multiple changes have been made to the manuscript as a result of this and other comments made. In addition, we have incorporated newer literature as suggested.
Modified text: "Early studies suggested that, although scapular notching was a prevalent finding in rTSA, its clinical significance was unclear (24,25). Subsequent studies of the impact of scapular notching suggested that notching can lead to implant failure. Spiry et al. found that, in patients with grade 3 or 4 notching, implant survivorship was 60% at 10 years and 43% at 15 years postoperatively (26). Clinical results measured with patient-reported outcomes (the Constant Score and the American Shoulder and Elbow Score) and range of motion were, in a meta-analysis of 11 studies by Jang et al., found to be negatively affected (27). However, the authors recognized that their review was limited by deficiencies and variability in the existing literature, which was inconsistent in terms of implant design, especially as it relates to lateralization of the glenoid or different NSAs of the humeral components in different studies." [Lines 81-91]. "It is important to note, however, that moving the COR of the glenosphere refers to the sphere and not to the true COR of the glenoid. Most glenoids have significant bony erosion, making the true COR medialized to begin with, so that a lateralized glenoid component may be bringing the COR of the glenosphere closer to the true COR. Similarly, when conducting

studies in which the glenoid is reamed to a flat surface, this cannot technically be called moving the COR medially; rather, the glenoid surface has been moved medially. This distinction makes it difficult, when discussing the COR on the glenoid side, difficult to compare one study to another." [Lines 116–123]

Comment 2: Lines 50-54. I think the wording of this should change as the labeled usage for rTSA has not "expanded", though the patients whom surgeons select for treatment have changed. As such, I would recommend that the authors not use the phrase "expanded indications" but instead state that the clinical use for rTSA has increased.
Response: We disagree with the reviewer but have made the appropriate change to reflect the meaning of the sentence
Modified text: "…successful applications for a myriad of indications…" [Lines 35–36]

Comment 3: Line 61-63 is inaccurate. Scapular notching did not exist in historical rTSA designs so the phrase "did not prevent" is not accurate. Scapular notching is an artifact of impingement associated with Grammont's innovation to medialize the CoR.
Response: It is unclear what the reviewer means by "historical rTSA designs." If the Reviewer means those predating the Grammont design, there was no notching as they all failed because of poor glenoid fixation. If the reviewer means the early Grammont-type prostheses, which were designed in the 1990s, then his comment is incorrect, as scapular notching was found to be an issue even prior to the release of rTSA in the United States in 2004. Finally, it is not correct to call it an "artifact," as it was a *consequence* of the Grammont design, meaning that the innovation to medialize the COR was a result of that change in design (and not an artifact).
Modified text: No change made

Comment 4: Line 90 is not clear. The use of the word "striking" is not accurate. The authors should simply state that scapular notching is due to contact of the humeral liner with the scapular neck.
Response: Thank you. We have made this change.
Modified text: "It is caused by the humeral component impinging the inferior and posterior part of the neck of scapula." [Lines 80–81]

Comment 5: Lines 92-94 is not accurate and such claims just continue bad science. There is now ample literature which demonstrates that scapular notching does indeed negatively impact clinical outcomes and those studies also demonstrated that the early papers which originally claimed that scapular notching did not negatively impact clinical outcomes were in-fact under-powered to statistically make such claims. The authors should delete this sentence and reference the studies which now demonstrate that scapular notching does negatively impact clinical outcomes.
Response: We agree with the reviewer and added current literature on this topic
Modified text: "Early studies suggested that, although scapular notching was a prevalent finding in rTSA, its clinical significance was unclear (24,25). Subsequent studies of the impact of scapular notching suggested that notching can lead to implant failure. Spiry *et al*. found that, in patients with grade 3 or 4 notching, implant survivorship was 60% at 10 years and 43% at 15 years postoperatively (26). Clinical results measured with patient-reported outcomes (the

Constant Score and the American Shoulder and Elbow Score) and range of motion were, in a meta-analysis of 11 studies by Jang *et al*., found to be negatively affected (27).” [Lines 81-88]

Comment 6: Lines 96-102: This needs to be deleted, this wording is specific to design changes made by one manufacturer (DJO) and it really has no real relevance to this paper.
Response: This has been removed.
Modified text: N/A.

Comment 7: Lines 109-126. The downside of glenoid lateralization needs to be better described. Biomechanically, lateralizing the CoR reduces the deltoid abductor moment arm, which increases the force required by the deltoid to elevate the arm. This reduction in biomechanical efficiency is one of the reasons that lateralized glenospheres have an elevated scapular fracture rate, with reports in the literature upwards of 6 to 12%, which is substantially more than grammont reverse shoulder designs and also onlay reverse shoulder designs. Lateralized glenosphere designs are also associated with increased risks of aseptic glenoid loosening relative to medialized CoR glenosphere designs. There are numerous papers in the literature which should be included here for this as well.
Response: We added a brief discussion of scapular fractures to lines 54-56.
Modified text: “However, lateralization has also been associated with increased shear forces across the baseplate interface, leading to failure, and increased the stress on the scapula, resulting in acromial stress fractures (11,12).” [Lines 54-56]

Comment 8: Lines 127-139. The authors do not mention the rates of bone graft resorption and bone graft failure/fracture. This should be discussed, there are numerous papers form the literature that could be referenced as well.
Response: Thank you, we have modified the text slightly and added the appropriate references.
Modified text: However, performing a bone graft on the native glenoid can be a challenging procedure when there are severe deformations, *with rates of graft resorption reported up to 40%* (38, 39). [Emphasis added; lines 140–142]

Comment 9: Lines 140-142, there are more published papers on the success of glenoid baseplate augments than there are for glenoid bone grafting. The authors need to do a better job performing a comprehensive literature review before writing such a paper. There are several papers published in the last few years which demonstrate the superiority of augments vs bone grafting for treating various types of glenoid defects.
Response: Thank you for this comment, the text has been updated with appropriate references.
Modified text: “Augmented baseplates are used mainly in glenoids with bone loss that do not require bone grafting, although in larger glenoid defects it has been suggested that they can be successfully implanted, with complication rates at 5 years equivalent to those in patients without augments (43). Metal augmentation baseplates can also serve as a form of lateralization, as the glenoid will be lateralized in-line with the thickness of the baseplate. Van de Kleut et al. (44) compared 2-year follow-up results of BIO-RSA and metal-augmented baseplates. The authors did not observe any significant differences between the two groups except that there was increased active internal rotation in the BIO-RSA group. Levin et al. analyzed 171 patients with glenoid bone loss who underwent rTSA with and without augmented baseplates with greater than 5-year follow-up and found improved outcome scores and range of motion in patients with

augments, with no difference in rate of complications (45). As when the glenoid face is moved laterally with bone grafting, the increased stress on the bone–implant interface may lead to baseplate failure (46). Other concerns regarding augmented glenoid components are cost and that they are not available for use in every currently marketed implant system." [Emphasis added; Lines 155–169]

Comment 10: The primary benefit of a medialized CoR glenoid component and a lateralized humerus is that it is the most biomechanically efficient design configuration which maximizes the deltoid abductor moment arm and also increases deltoid wrapping. There are numerous publications in the literature which describe this and should be included.
Response: Thank you. We have provided references on deltoid wrapping
Modified text: The authors of the present review prefer a minimally lateralized glenoid component (2 mm) with a lateralized (*onlay*) humeral component. The primary benefit of a medialized or slightly lateralized glenoid component and a lateralized humerus is that it is the most biomechanically efficient design configuration and maximizes the deltoid abductor moment arm and also increases deltoid wrapping (17,65,66). [Emphasis added; lines 261–265]
Augmented baseplates are used mainly in glenoids with bone loss that do not require bone grafting, although in larger glenoid defects it has been suggested that they can be successfully implanted, with complication rates at 5 years equivalent to those in patients without augments (43). Metal augmentation baseplates can also serve as a form of lateralization, with the outcomes previously mentioned. Van de Kleut *et al.* (44) compared 2-year follow-up results of BIO-RSA and metal-augmented baseplates. The authors did not observe any significant differences between the two groups except that there was increased active internal rotation in the BIO-RSA group. Levin *et al.* analyzed 171 patients with glenoid bone loss who underwent rTSA with and without augmented baseplates with greater than 5-year follow-up and found improved outcome scores and range of motion in patients with augments, with no difference in rate of complications (45). As when the glenoid face is moved laterally with bone grafting, the increased stress on the bone–implant interface may lead to baseplate failure (46). Other concerns regarding augmented glenoid components is cost and that they are not available for use in every currently marketed implant system. [Emphasis added; lines 155–169].

Comment 11: Line 227-228. This statement needs to be paired back. Over-lateralization is a real issue and there are not to my knowledge many successful clinical outcomes studies in such a design configuration (for example, a bio-rsa with an onlay rtsa humeral system).
Response: This has been done; the reviewer is confusing lateralization of the sphere by around 2 mm, and not more lateralization as seen in a bio-RSA. This is particularly true when utilizing eccentric reaming rather than bone grafting or augmented glenoid components. We have published 5-year data that supports this approach. As this is my opinion, which is supported in the literature, no changes will be made.
Modified text: N/A

Comment 12: Lines 228-236. This is all true for lateralization achieved using either the glenoid or humerus. Not necessarily for both though.
Response: Thank you, we have made a small adjustment in wording to clarify this.
Modified text: This combination of lateralization of either the glenoid or humeral components has several theoretical advantages. First, the subscapularis tendon is not reattached in the

majority of cases, and the configuration of the rTSA does not depend upon subscapularis attachment for stability (67). [Lines 266–269]