Author's response to reviews

Title: Effect of baseplate size on primary glenoid stability and impingement-free range of motion in reverse shoulder arthroplasty

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Author's response to reviews: see over
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Catia Cornacchia
Executive Editor
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Dear Dr. Cornacchia:

Thank you for giving us an opportunity to revise our manuscript titled “Effect of baseplate size on primary glenoid stability and impingement-free range of motion in reverse shoulder arthroplasty”. We also thank the referees for their detailed and specific comments. We believe that their insightful comments have allowed us to substantially improve the manuscript, and now hope the manuscript is at the level of quality appropriate for your esteemed journal.

Our answers to the reviewers’ comments have been provided below.

Thank you for your consideration. I look forward to hearing from you.

Sincerely,

Soung-Yon Kim
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E-mail: singsingkr@yahoo.co.kr
Reviewer number 1(Dr. Julien Berhouet)
Reviewer's report: Major Compulsory Revisions
Level of interest: An article whose findings are important to those with closely related research interests
Quality of written English: Acceptable
Statistical review: No, the manuscript does not need to be seen by a statistician.

General comments:
This is a well written study aiming to analyze the biomechanical effect of a 25-mm baseplate positioning on its stability and on the expected range of motion. Management of glenoid shape with appropriate component seems to be challenging in Asia due to the smaller morphotype of its population. The problematic remains the same for caucasian patients with cuff tear arthropathy presenting also smaller anatomy than other patients with other shoulder disabilities. The topic and the questions exposed in this paper are consequently updated and interesting to be investigated. Nevertheless, there are several important edits to achieve before accepting this paper for publication.
The main concern of this study is the lack of accuracy about the surgical procedure for preparing and placing each type of baseplate on glenoid surface. Please read below the comment highlighted in red I wrote about this issue....

Response: In accordance with your suggestion, we have added a more precise description of the surgical procedure for preparing and placing each type of baseplate on the glenoid surface. In addition, references related to the baseplate overhanging position have been added to the manuscript, as suggested below.

Detailed comments:
Title:
Is it a study about the effect of the baseplate size on the primary stability only, or on the stability and range of motion? Along the full manuscript those both biomechanical criteria are analyzed. There is a mismatch between the title and the contents of the manuscript. Please clarify.

Response: Our aim was to evaluate any possible effect of the baseplate size on primary stability, as indicated in the original title. Impingement-free range of motion is critical not only for function but also for implant stability and survivability. Of particular concern, scapular notching can result from adduction deficit and in turn lead to baseplate loosening. Hence, we evaluated impingement-free abduction and adduction arc of motion in our study. However, based on the reviewer’s later recommendation of testing the rotation, which can generate anterior and posterior impingement (as also noted later by the reviewer), we have added the results of the impingement-free rotation arc of motion to the revised manuscript. Thus, the title of the article has been revised as follows: “Effect of baseplate size on primary glenoid stability and impingement-free range of motion in reverse shoulder arthroplasty”.

Background:
P4L57: please correct: « still high (8). Glenoid... »

Response: Thank you for noting our error. The manuscript has been corrected.
P4L59: please correct: « design (10, 11), glenoid... »

Response: The manuscript has been corrected.
P4L63: please correct: « (14,15). Surgeons... »
Response: The manuscript has been corrected.

The last part of the introduction is not very clear, from L68 to the end. There is a mismatch between the goal of the study and the hypothesis. You describe one purpose of the study and then you introduce the hypothesis with 2 questions: stability of the baseplate and effect of the baseplate on the range of motion in the scapular plane. Please reorganize or clarify this part.

Response: This last part of the introduction has been revised according to the reviewer’s suggestion.

The sentence from the L71 to the L73 has to be removed from the introduction or to be placed at the end of the introduction, because you start to expose the methodology you are going to use for your study.

Response: As suggested, this sentence has been placed at the end of the introduction (page 4, line 75, to page 5, line 78).

Methods:
P5L84: please correct: ≪anteroposterior diameters≫

Responses: The manuscript has been corrected.

What was the version of the glenoid component positioning?

Response: The version of the glenoid component was 0°. We have added this information to the manuscript (page 5, lines 97–98).

How was the inferior tilt of the scapula after its embedding in the resin block?

Response: The scapula had no inferior tilt after its embedding in the resin block. To clarify this to the reader, we have revised the manuscript as follows: “The scapula with the implant was embedded in a rectangular resin block so that the glenoid-glenosphere interface was parallel to the floor” (page 6, lines 116–118).

In addition, we have provided here intra-experimental photographs to illustrate the positioning of the scapula with the implant. However, unless otherwise indicated, we do not believe these images would add substantially to the manuscript and have not included them as a figure in the manuscript.

How did you check the neutral inclination during the baseplate implantation?

Response: In the same manner as in clinical surgery, the implantation of the baseplate and glenosphere at a neutral inclination was accomplished using the neutral tilt central guide hole included with the prosthesis instrumentation. This guide hole allows the insertion of a guide pin tilted at 0° neutral relative to the glenoid surface. We have added this information to the manuscript (page 5, line 99, to page 6, line 102).
Main concern: In placing the baseplate after reaming in order to be fully supported by the glenoid bone, does it mean the baseplate backside was totally in contact with the glenoid bone? does it mean that the baseplate positioning didn't overhang below the inferior glenoid rim? If yes, that means the inferior rim of each baseplate tested (25-mm and 29-mm) was at the same level; it was consequently impossible to create inferior offset after assembling the 36-mm glenosphere. The study doesn't make sense anymore. That you explained in the discussion (L207-211) about the 3.5 and 5.5 mm inferior offset you can get in using the 25 or the 29-mm baseplate is relevant only if you used the 12-mm rule of Kelly for the initial positioning of your central guide pin! I doubt you use this technical recommendation in your protocol study? There isn't any reference to this paper in your manuscript. Maybe you finally compare 2 different baseplate with a same positioning, and consequently with a final prosthetic inferior offset... It could be the reason why there was no difference in the motion analysis between the both baseplate. Please clarify.

Response: Before starting this study, we had reviewed the article by Kelly et al. (Kelly JD, Humphrey CS, Norris TR. Optimizing glenosphere position and fixation in reverse shoulder arthroplasty, Part One: The twelve-mm rule. J Shoulder Elbow Surg 2008, 17:589-594). We took into consideration and implemented the suggestion of Kelly et al. of positioning the baseplate as inferiorly as possible relative to the scapula while still allowing it to be fully supported by bone. To align the lower border of the baseplate with the inferior glenoid rim, the drill hole was positioned 11.5 and 9.5 mm above the inferior glenoid rim for the 29- and 25-mm baseplates post prior to the glenoid reaming based on the recommendation of Kelly et al. Hence, the drill hole for the baseplate post and the final hole of the baseplate post were not the same between the 25- and 29-mm baseplates. Therefore, we were able to align the lower border of the baseplate with the inferior glenoid rim irrespective of the baseplate size. Based on this particular method, we believe that our description (page 5, line 99 to page 6, line 106) is accurate with respect to the 3.5- and 5.5-mm inferior offset for the 29- and 25-mm baseplates, respectively. We have added this description to the manuscript and provided references related to the baseplate overhanging position, as suggested.

Because of the reviewer’s reasonable concerns that we failed to use the technical recommendations of Kelly et al. in our protocol study, we provide here our intra-experimental photographs showing that we aligned the lower border of the baseplate with the inferior glenoid rim for both the 25- and 29-mm baseplates.

<25-mm baseplate and glenosphere position>

<29-mm baseplate and glenosphere position>

How were placed the screws for the different scapulae involved? Did you try to apply the same
goal of positioning (directions)?

Response: We inserted the screws for the fixation of the 25- and 29-mm baseplates according to the manufacturer’s recommended surgical technique. The anterior screw was inserted at a trajectory that was superior and towards the middle of the baseplate. The posterior screw was inserted at a trajectory that was inferior and towards the middle of the baseplate. The inferior screw was positioned into the pillar of the scapula and was generally situated downwards in the vertical axis of the glenoid at an angle of ~20°. The superior screw was positioned into the base of the coracoid process and was generally situated superiorly in the vertical axis of the glenoid at an angle of ~20° and anteriorly in the transverse axis of the glenoid at an angle of ~10°. We attempted to fix the 25- and 29-mm baseplates in the same direction as the screws. This description has been added to the manuscript (page 6, lines 107–115).

Why was the testing loading operated at 60° of abduction?

Response: Our testing position at 60° abduction was determined based upon the following considerations. The review articles from which these considerations were derived are provided below each one:

(1) The glenohumeral joint at 60° of abduction is a motion commonly used in daily activities.


(2) A position of 60° abduction will produce loading with a maximum shear force component parallel to the face of the glenoid.


(3) There is variation in the glenohumeral joint testing position in studies analyzing the stress or stability of reverse shoulder prosthesis. However, some recent studies evaluating glenohumeral abduction have examined the glenohumeral joint position at 45°, 55°, or 60° abduction.


It would have been interesting to test and discuss shear forces which are the main cause of glenoid component stability and loosening.

Response: Unfortunately, we did not conduct a stress analysis in this study. Our study was aimed at evaluating the effects of baseplate size on primary stability and impingement-free range of motion through assessing micromotion at the glenoid-glenosphere interface in biomechanical testing and impingement-free range of motion in a simulated computer model. We believe that testing and discussing the shear force is suitable in a finite element study and that additional experiments for analyzing shear force would be beyond the scope of this study.

For the motion analysis with the computer model, it would have been interesting to test also the rotations, which can generate anterior and posterior impingement, as well as shear forces.... Could you add these extradas in the paper?

Response: As suggested, we have added the results of the impingement-free rotation arc of motion in the revised manuscript. However, as noted in the previous response, we believe that additional experiments for analyzing shear force would be beyond the scope of this study.

Results:
Same comments than above, about the criteria considered for placing the baseplate. If the methodology is inaccurate, there is no sense for the results about free-impingement range of motion (L160-166).

Response: Based on our response provided above with respect to the methodology, we now believe a sufficient explanation has been provided for the accuracy of the study methodology. As noted above, we have added a description to the revised manuscript to clarify our methodology for placing the baseplate.

Discussion - Conclusion:
Main critic: You are not allowed to write there was a beneficial effect of the 25-mm baseplate for stability and adduction-abduction motions, because of the lack of significance of your results. At last, there was no statistically difference between both baseplates. Could you discuss the results about the length of the screws used for each baseplate fixation?

Response: We concur with the reviewer’s comment. Accordingly, we have revised the relevant statements regarding the biomechanical interpretation in the discussion and conclusion sections to avoid over interpretation of the results (page 11, lines 237–239; page 13, lines 279–283).

We have also added in the discussion section a description of the results on the length of the screws used for each baseplate fixation (page 12, lines 243–248).

Maybe add some writings about the role of the scapular pillar and acromion anatomy for the free-impingement range of motion.

Response: Only two published studies focused on morphological scapular features are of relevance to the implantation of reverse shoulder prosthesis, as follows.


Torrens C, Corrales M, Gonzalez G, Solano A, Cáceres E: Cadaveric and three-dimensional

These two studies focused on reducing the scapular notching or optimizing the inferior glenoid overhanging, and have differing opinions and conclusions on the scapular anatomy as related to reverse shoulder prosthesis implantation.

Unfortunately, we did not analyze the scapular pillar and acromion anatomy as related to the impingement-free range of motion in this study. Therefore, we believe that mentioning the role of these components with respect to impingement-free range of motion would be beyond the scope of this study.

The rest of the discussion remains critical because of the doubt of the methodology used for placing every baseplate.

Response: We have responded as above regarding this comment and now believe a sufficient explanation has been provided regarding the accuracy of the study methodology.

Reviewer number 2 (Dr. Gunther H. Sandmann)
Reviewer's report: Major compulsory revisions
General remarks:
This biomechanical study is the attempt to find out, whether a smaller base plate has an effect on primary glenoid stability after reverse shoulder arthroplasty compared to a standard sized base plate. The biomechanical study uses fresh frozen cadaver shoulders and tested two different sized base plates for micromotion of glenoid components.

Special remarks:
Abstract:
The abstract is clearly structured and gives all the necessary information.

Introduction/ Methods:
Well written and guiding to the topic. Nevertheless, I have some points:
Line 79:
„Seven pairs of human scapulae were dissected from 7 fresh- frozen cadavers ...“
Where did you get the fresh frozen cadaver shoulders from? Did you have an IRB approval of your local ethics committee?

Response: We received the fresh frozen cadaver shoulders from the Department of Anatomy, The Catholic University of Korea School of Medicine, Seoul, South Korea. My co-author, Dr. Seung-Ho Han, worked at this institution at the time the experiment was conducted (Dr. Seung-Ho Han is now at the Department of Anatomy, College of Medicine, Chung-Ang University, Seoul, South Korea).

The IRB of the Catholic University of Korea School of Medicine has enacted the following provision: “Research involving cadavers, autopsy material or bio-specimens from deceased individuals do not meet the regulatory definitions of human research and do not need IRB review. The Catholic University of Korea School of Medicine has a consent form cadaver donor whose donated bodies is available for research purposes.”

The IRB of The Catholic University of Korea has received AAHRPP accreditation and complies with its ethics. The IRB does not review cadaver studies in which it is not possible to identify the individuals and which do not use personal information. Our cadaver study complied with these conditions. Additionally, The Catholic University manages all cadavers by due process of law in Korea. The university keeps all permissions and records for the cadaver donation program, which can
be opened upon official request. In accordance with your comment, we have added statements to the methods section clarifying this information (page 5, lines 85–87).

Do you think that a cyclic testing with 100 cycles is sufficient? Why did you choose this biomechanical setup?

Response: We agree this is an important concern. The description regarding the amount of loads and the loading cycle used in our study was previously mentioned in the original manuscript (Page 12, line 261 to page 13, line 266 in the revised manuscript). Of particular relevance, the two articles referenced in the manuscript and provided below have shown the number of cycles has a negligible influence on the testing results.


Statistics
This part is well written and fulfills the common statistic criteria.

Results/Conclusion:
In general these paragraphs are well written. Nevertheless, I have some remarks:
As you write in line 151–153 the glenoids „...had a smaller width than the 29mm-baseplate as well as insufficient bone stock to fix the anterior or posterior screw for fixation of the 29mm-baseplate.“ Do you think that the lower biomechanical stability of the 29mm baseplates might be due to the fact that there was an insufficient bone stock for the larger 29mm baseplates and that there was no possibility to fix the important anterior and posterior screws? Please comment on that!

Response: Based upon these observations, we assumed the insufficient bone stock of the small glenoid for fixation of the larger 29-mm baseplates, particularly for the anterior and posterior screws, might influence the biomechanical stability of the 29-mm baseplate on the small glenoid. As suggested, we have added this description in the manuscript (page 12, lines 243–248).

In addition the screw lengths were different in the two groups?

Response: As shown in Table 1, the mean lengths of the anterior, posterior, and superior screws were longer in the 25-mm baseplate group than those in the 29-mm baseplate group. However, the screw lengths were not statistically different between the two groups. We have added this information to the manuscript (page 9, lines 179–181).

How did you choose screw lengths? Were the screws bicortical and did you use locking and cortical screws- as usually used in the Tornier base plate?

Response: Indeed, the screws were bicortical, and we used locking and cortical screws as typically used in the Tornier baseplate. The baseplate and screws were fixed to each scapula according to the standard surgical technique. Screw lengths were determined by measuring the screw length with screw depth gauge in the same manner as in clinical surgery.

Level of interest: An article whose findings are important to those with closely related research
interests
Quality of written English: Acceptable
Statistical review: Yes, but I do not feel adequately qualified to assess the statistics.