

## Peer review file

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### Reviewer A

**Comment 1:** Through the manuscript, the number of hemiarch replacement was 44 and that of total arch replacement was 15. However, in the study population part (line 67-69), it was stated that the number of hemiarch was 45 and that of total arch was 14.

Was that a mistake?

**Reply 1:** We are sorry for some mistakes of numbers. We have corrected that sentence.

**Changes in the text:** *Study Population and Definitions (Page5, Line75-76)*

Of 59 patients, 44 underwent hemi-arch replacement (hemiarch group) whereas the remainder (n=15) underwent total arch replacement (total arch group).

**Comment 2:** I was confused with the description of hemiarch replacement (line 74-75). Looking at Figure 2, your distal anastomosis was not beyond innominate artery.

Could you go beyond innominate artery, but not involve the arch vessels?

**Reply 2:** We found that the Figure 2 may cause confusion regarding the technique of hemiarch replacement. We modified the figure to clarify our surgical technique.

**Changes in the text:** Figure 2

**Comment 3:** For the conversion case, what was the etiology of bleeding from diagonal coronary artery? LV vent caused coronary artery bleeding?

**Reply 3:** We appreciate reviewer's comment on this issue for further clarification. We added some information of the conversion case. During conversion to full sternotomy, there was massive bleeding caused by epicardium laceration around the diagonal coronary artery, which was controlled by multiple pledgetted mattress sutures on this area. Soon after postoperative manage at intensive care unit, she underwent second operation to control bleeding and we identified the bleeding from the adjacent area of the prior repair site. At this moment, we speculated the possibility of LV perforation caused by LV vent (positioned in the LV cavity), and under this assumption, we made full-layer pledgetted purse string sutures of the myocardium in two layers, which was

successful to control the bleeder.

**Changes in the text:** *Operative profiles* (Page 9-10, Line 163-173)

There was one case of intraoperative full sternotomy conversion to manage massive bleeding in the LV. This case was a 71-year-old woman who underwent aortic valve replacement concomitantly with replacement of the ascending aorta and hemiarch.

After decannulation, bleeding from the left lateral side of the heart was detected, which was not fully identifiable by mini-sternotomy. Conversion to full-sternotomy allowed the identification of the bleeder at the antero-lateral side of the LV, and this was controlled by multiple pledgetted sutures. Four hours after the surgery, however, she required second operation due to delayed bleeding, cause of which then being speculated as the LV perforation by the LV vent during the initial operation. At this time, bleeding site was repaired by full-layer pledgetted purse string sutures of the myocardium, which was reinforced by bovine pericardium patch application on the surface.

**Comment 4:** For the mortality case, should you have converted to sternotomy? Low

cardiac output was caused by coronary ostial problem?

**Reply 4:** In this particular case, there was very severe underlying LV hypertrophy by longstanding severe aortic stenosis. As the aortic root tissue was compromised during the root conserving AVR, we immediately converted to Bentall operation.

Unexpectedly and unfortunately, however, the LV did not recover after the second CPB. During the intraoperative TEE examination by expert cardiologist, we identified patent left main and right coronary ostial flow, and therefore, we assumed that the case experienced primary post-cardiotomy low cardiac output syndrome.

Nevertheless, we could not perform invasive coronary angiography to exclude structural coronary lesions postoperative because of unstable clinical courses.

**Changes in the text:** *Perioperative Outcomes* (Page 10-11, Line 192-200)

Bleeding from the aortic root was identified immediately after the release of the aortic clamp, after which a disruption of the thin-walled aortic root was identified.

Thereafter, conversion to the Bentall procedure was attempted immediately, but without the need for conversion to full-sternotomy. Despite the successful conversion to the Bentall procedure, the patient failed to be weaned from CPB and suffered from

its associated coagulopathy. An extracorporeal membrane oxygenator was applied intraoperatively, and was maintained in the intensive care unit; however, the patient eventually died of multi-organ failure on the third postoperative day despite rigorous efforts to resuscitate this patient.

**Comment 5:** There were 2 re-explorations due to bleeding. Did you take care of these by sternotomy?

**Reply 5:** First patient maintained upper sternotomy and the bleeding focus was identified as sternal oozing. During the sternal re-exploration through prior mini-incision, there was not a need for active bleeding control procedure in this particular case. Another case is described in detail at our answer to #3 comments (required sternotomy conversion). Please refer to the response to #3 comments.

**Changes in the text:** No changes.

**Comment 6:** I did not understand line 207-208. Did you mean sternotomy was only required for concomitant mitral valve procedures or CABG?

**Reply 6:** We found that our expression could be misleading. We tried to emphasize that mini-access was available even in complex cases, but limited to patients requiring mitral valve surgery or CABG, not to argue that sternotomy should be considered only for those who undergoing concomitant mitral valve procedure of CABG. We modified the manuscript to clarify this point.

**Changes in the text:** *Discussion* (Page11, Line 210-214)

Even in patients who necessitated concomitant major cardiac procedures (i.e. aortic root replacement), mini-access aortic arch surgery could be undertaken safely and efficaciously, yet its utilization is limited in cases where concomitant mitral valve repair or coronary artery bypass grafting are required.

**Comment 7:** Line 226-227, the sentence of “aortic arch surgery should be used in the setting of mini-access” did not make sense.

**Reply 7:** We appreciate reviewer’s kind comment. We found that our expression was misleading. We revised the statement.

**Changes in the text:** *Discussion* (Page 12-13, Line 239-242)

The early clinical outcomes of our preliminary experiences on mini-access arch repair were satisfactory, and based on these results, this approach may be a useful alternative of conventional sternotomy in the open repair of the arch pathologies.

**Reviewer B**

I suggest the following changes to be included in your nice work

**Comment 1:** Justify sample size.

**Reply 1:** We appreciate reviewer's thoughtful comment. As we described at limitations, we recognize the small sample size as one major limitation. 59 cases of mini-access arch surgery is undoubtedly a small experience, however, delaying publication of our experiences until the satisfactory sample size may lower the value of our data where timely reporting is pivotal in the evolving field of CV surgery. Pending the further studies with larger cohorts from our own and by others, we believe more robust papers will further validate the usefulness of the surgical strategy shared by this paper. We believe that several technical tips and excellent results have certain values distinguished from other prior papers on the similar issue despite a

relatively small sample size. We appreciate if the reviewer views our present paper in this perspective.

**Changes in the text:** No changes.

**Comment 2:** Minor language editing

**Reply 2:** We have received the English correction.

**Comment 3:** For each table, provide the method to find out the p value and mention in the table the other statistic to support the observed p value in a column(s) just before the p value column in each of the table

**Reply 3:** We mentioned about this point at page 8, line 131-136.

**Changes in the text:** No changes.

**Comment 4:** Update the references till date.

**Reply 4:** We updated references to reflect recent advances as you recommended.

**Changes in the text:** Reference (Page 16, Line335-342)



## **Reviewer C**

**Comment 1:** The title might be misinterpreted. Indeed, most patients underwent a construction of the distal anastomosis (seemingly in zone 0: see Figure 2) according to the open-technique following a repair of proximal aorta (ascending +/- root) and only 15/59 patients benefited from a true aortic arch replacement. I therefore recommend that the title should avoid mentioning arch repair. A more appropriate title would be for instance « Mini-Access Aortic Surgery with Open Arch Technique ».

**Reply 1:** We appreciate reviewer's suggestion. Hemi-arch replacement is generally defined as the replacing the aorta beyond the level of the innominate artery but not involving the arch vessels, which usually involved lesser curvature of the arch and this definition was adopted in the present paper (Page 6, line 80-83). In addition, majority of the ascending aorta replacement do not require circulatory arrest while hemiarch repair inevitably involves circulatory arrest and open distal anastomosis. The hemiarch repair described in this paper well fits to this concept and this is why

entitled as “mini-access open arch surgery.” By this, we believe we can emphasize that historically perceived high-risk procedures (requiring circulatory arrest) can be handled in the mini-incision safely and efficiently.

However, if the reviewer still believes that “Mini-Access Aortic Surgery with Open Arch Technique” is more appropriate title, we are quite open to accept your recommendation.

**Changes in the text:** No changes.

**Comment 2:** The series includes elective cases operated on between August 2015 and April 2020. A former paper from the same institution (which is cited in references) included elective and urgent cases operated on between January 2012 and April 2017 but do not mention the mode of thoracic entry. It is required that the authors make it clear if some of the patients presented here were included into the former published series.

**Reply 2:** We appreciate the reviewer’s comment. We agree that it is important to clarify on this at least in order to avoid the “duplicated work” issue. In the revision we

clarified this in the Method section as below.

**Changes in the text:** *Study Population and Definitions* (Page 5, Line 80-81)

The study subjects include 8 patients who were included in our published paper on cerebral perfusion strategy in arch surgery.<sup>1</sup>

**Comment 3:** The authors should choose the same denominator when presenting percentages in the description of upper sternal separation (1/58 for the second intercostal space) but 30/59 and 27/59 for the third and fourth respectively.

**Reply 3:** We found that we made a mistake in entering figures in the table, and we corrected the error.

**Changes in the text:** *Table 2. Operative profile*

**Comment 4:** If I can assume that LV venting was performed through the left superior pulmonary vein (because of the issue of LV insult by the vent cannula in one case), I found nowhere in the manuscript a description of the technique used for venous drainage which is a worthy information. A word of explanation for a dual arterial

cannulation (innominate + femoral arteries) in 4/15 cases of total arch replacement could also be useful.

**Reply 4:** We appreciate reviewer's valuable comment. We added relevant descriptions as follows in Operative Technique section.

**Changes in the text:** *Operative Technique* (Page 7-8, Line 124-132)

“In selected cases of total arch repair (n=5), femoral artery cannulation in addition to main cannulation (innominate artery) was made to allow lower body perfusion after distal anastomosis. This procedure was conducted as a replacement of using side-branch of the main aortic graft for lower body perfusion.”

“For efficient bloodless exposure of the AV, inserting LV vent cannula through right upper pulmonary vein was a standard approach in cases where concomitant AV/root procedures were combined, while isolated aortic surgeries without concomitant AV procedures were performed by engaging small vent cannula into the LV through the AV from the proximal aortotomy site.”

**Comment 5:** I suggest that the authors would include into the discussion a seemingly

surprising result which is that an upper L shaped sternal separation through the third ICS was significantly more frequent (80%) than a J shaped sternal separation through the same ICS (41%), probably because the aortic repair was more extended towards the aortic roots in patient with a so-called hemi-arch repair.

**Reply 5:** Thank you for a very sharp point. There was a chronological difference in making the incisions down to 3<sup>rd</sup> or 4<sup>th</sup> intercostal spaces, in that we started with making larger incision (down to 4<sup>th</sup> ICS) in our earlier experiences when we had not yet performed total arch replacement through mini-incision. After then, we have gained confidence in this surgery and we moved on to make smaller incision (down to 3<sup>rd</sup> ICS). This is when we started performing total arch replacement through mini-incision. By this reason, most of total arch repairs were conducted by smaller incision while roughly latter half of hemiarch repairs were done in this way. J-shape sternal separation was our default approach with the exception of deep total arch repair, in which the distal arch is better exposed by L-shape incision.

**Changes in the text:** Discussion (Page12, Line223-231)

In this study, there was a chronological difference in making the incisions down to

3rd or 4th intercostal spaces; in that we started with making larger incision (down to 4th ICS) in our earlier experiences when we had not yet performed total arch replacement through mini-incision. After then, we have gained confidence in this surgery, when we started making smaller incision (down to 3rd ICS). Around this time and thereafter, mini-access surgery has expanded to total arch replacement. By this reason, most of total arch repairs were conducted by smaller incision (down to 3rd ICS) while roughly latter half of hemiarch repairs were done in this way. J-shape sternal separation was our default approach with the exception of deep total arch repair, in which the distal arch is better exposed by L-shape incision.

**Comment 6:** As I mentioned above I feel uncomfortable with the term hemi-arch technique as described by the authors. In fact, I even wonder if it is possible to perform safely a beveled inverted anastomosis in a very short time of circulatory arrest. Since Figure 2 clearly describes a straight inverted anastomosis in zone 0, I can hardly caution that the concavity of the arch has been removed and replaced which is the aim of a true hemi-arch technique. Therefore, I recommend that the authors

replace all mentions of hemi-arch by « Open Arch Zone 0 Anastomosis » within the manuscript and Tables.

**Reply 6:** We appreciate reviewer's thoughtful comments. Please refer to our responses to Reviewer D #1 question. To add, we have used the same terminology in our prior publication, and we have not been questioned on the use of "hemiarch repair" in the same circumstance by any of Editor, Reviewers and readers. <sup>1</sup>

**Changes in the text:** No changes.

## **Reference**

1. Park SJ, Jeon BB, Kim HJ, Kim JB. Aortic arch repair under moderate hypothermic circulatory arrest with or without antegrade cerebral perfusion based on the extent of repair. J Thorac Dis 2018;10:1875-83.