Editorial

Transcatheter aortic valve replacement in patients with high aortic anguation

Kai Zhu[1,2], Xiao Liu[3], Jun Li[1,2]

[1]Department of Cardiac Surgery, Zhongshan Hospital, Fudan University, Shanghai 200032, China; [2]Shanghai Institute of Cardiovascular Disease, Shanghai 200032, China; [3]Key Laboratory for Biomechanics and Mechanobiology of the Ministry of Education, School of Biological Science and Medical Engineering, Beihang University, Beijing 100191, China

Correspondence to: Dr. Kai Zhu and Dr. Jun Li. Department of Cardiac Surgery, Zhongshan Hospital, Fudan University, Shanghai 200032, China. Email: zhu.kai1@zs-hospital.sh.cn; li.jun@zs-hospital.sh.cn.

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Increasing procedures of transcatheter aortic valve replacement (TAVR) have been performed worldwide since the approval of transcatheter valve. It has emerged as a safe and effective treatment strategy for patients with severe symptomatic aortic valve diseases who are deemed to have high surgical risk (1,2). Currently, two types of transcatheter valves are mainly used in clinical trials: balloon expandable valve (BEV) and self-expanding valve (SEV). Both of them have been reported with data of safety and efficacy from the well-conducted multicenter randomized controlled trials (RCTs), indicating favorable short- and long-term outcomes following procedure (3-7).

As a technical composite endpoint, device success characterizes the acute device and procedural factors that underlie vascular access, delivery, and performance of the TAVR system. In a comparison of transcatheter heart valves in high risk patients with severe aortic stenosis (CHOICE) trial (ClinicalTrials.gov Identifier: NCT01645202) that compared the outcomes following SEV and BEV implantations, results revealed that clinical outcomes of both SEV and BEV were not statistically significantly different (8,9). Although BEV exhibited higher rate of the device success than SEV in this trial, the selected patients were anatomically suitable for treatment with both BEV and SEV. However, anatomic variation in patients may affect the selection of BEV or SEV.

The detailed case planning based on the anatomic characteristics has become an important part before TAVR. Multimodal imaging tools, such as magnetic resonance imaging, two-dimensional and three-dimensional echocardiography and cardiovascular multidetector computed tomography (MDCT), have been used for precise anatomic measurements of the aortic valvular complex (10,11). Amongst them, MDCT has become a prerequisite before TAVR procedure. One of the most important pre-procedure parameter is the measurement of aortic angulation (AA). AA is an index of an unfolded or "horizontal" aorta, representing an angle between the plane of the aortic valve annulus and horizontal plane/vertebrae. Due to anatomic variation, AA could exhibits increased degree in some patients and could make accurate positioning of the bio-prosthesis during TAVR procedure more challenging, particularly in cases of a horizontal aortic root along with a vertical aortic annulus. Usually, patients with AA degree of >70° is an exclusion criteria of SEV in clinical trials (4).

In the recent study by Abramowitz *et al.*, patients were divided into two groups: AA ≤48° (low) and AA ≥48° (high) (12). In patients who underwent BEV, the results showed similar high procedure success, including device success, paravalvular regurgitation, need for post-dilation or a second valve, major complications, and mortality in high and low AA groups. However, the results also demonstrated an independent significant correlation between increased

AA and reduced procedural success in patients who underwent SEV. It seems that BEV may be preferred in patients with higher AA. Due to the shorter stent frame of BEV, the greater flexibility provides less resistance to device advancement through the angulated aorta, thus minimizing the anatomic effect on acute procedural success. Moreover, the delivery system of BEV enables active flexion and extension during valve advancement, which can help operators deal with the challenging aortic anatomy unhurriedly. In contrast, the longer valve stent frame in SEV device creates a more rigid delivery system, which may result in difficult operation and subsequent less accurate positioning of the valve in the setting of increased AA, thus adversely affecting acute procedural success. However, another recent study reported that careful attention to the best practice techniques could mitigate the effect of AA on procedural outcomes in clinical scenario (13). Best practice technique involved multiple concepts, including pre-procedural MDCT screening, detailed case planning, and careful implantation practices. It can help to reduce the residual aortic regurgitation due to appropriate bioprosthetic sizing. Besides that, pre-procedural sizing of the aortic root and identification of the origin of the coronary arteries also reduce the occurrence rate of coronary occlusion during the procedure.

Technological advancements, with flexible valve frames and more accurate valve positioning, may also improve the procedural success. In a recent report, newer generation of SEV designs may expand the use of this bioprosthesis into patients with high AA (14). The new device enables the valve with ability to resheath and reposition during deployment procedure by turning the delivery handle, in turn contributing to the overall good clinical outcomes observed in this study. Besides that, the reduced overall profile by the built-in sheath makes the whole system more comfortable in challenging cases. Future studies with a larger number of patients, longer term of follow-up, and use of different valve types may further validate the favorable outcomes. With the advancement of technology, more flexible and functional characteristics could be developed on devices to overcome the hurdle of anatomic difficulty.

Although transfemoral approach is less invasive, the transapical or direct aortic approach using mini-thoracotomy could also be considered as alternatives in the setting of challenging cases with high AA before the idealist transfemoral device iterations appears (15,16). These alternatives can not only avoid the risks related to cardiopulmonary bypass in open surgery, but also secure and ease the proper position of implanted valves. In a recent single-center retrospective study, left ventricular ejection fraction worsened in a small number of patients after transapical transcatheter approach, but this change was not associated with worse postoperative outcomes (17). And the progressive reduction of sheath diameter does not have a significant effect on LVEF changes. Therefore, transapical or direct aortic approach is a safe and effective strategy to enhance the procedural success.

Another intriguing strategy to enhance procedural success is the application of patient-specific analyses using computational simulation models during TAVR case planning. Finite-element models analyses can both refine patient selection and characterize device mechanical performance in TAVR, thus enhancing the safety and efficacy in high-risk patients (18). In the setting of high AA, this simulation model could provide operator with potential implications before TAVR procedure. Although computational simulation models are still not widely used in clinical practice, it would be a milestone on the way to personalized, patient-specific healthcare in the near future.

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Footnote

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