A 3D Window on the Achilles’ Heel of Transcatheter Aortic Valve Replacement*

Mark J. Monaghan, PhD

Although transcatheter aortic valve replacement (TAVR) is now an established procedure that is starting to compete with conventional surgical aortic valve replacement in selected patient groups, the presence of post-implantation aortic regurgitation (AR) is higher than in comparative surgical groups and is associated with worse outcomes (1). There have been significant technical advances in valve design to try and mitigate against post-implantation AR, and there is a greater appreciation of the importance of accurate valve sizing and aortic root morphology (2). However, paravalvular and, to a lesser extent, transvalvular AR remain important Achilles’ heels of the TAVR procedure.

Echocardiography plays a pivotal role post-implantation in documenting the presence and extent of AR and in helping to decide if further procedures, such as post-dilation, are required to reduce any significant leaks. Pre-procedure planning needs to take into account factors that may make AR more likely, especially as TAVR moves toward lower-risk patient groups where surgery is an alternative.

A number of factors such as the relationship between annulus dimension and valve size, eccentricity of the annulus, extensive and irregular annular calcification, under- or overexpansion of the valve, and incorrect valve positioning have all been shown to predict the presence of post-procedural AR (3). Most of these factors can be evaluated by multi-slice computed tomography (MSCT) and 3-dimensional (3D) transesophageal echocardiography TEE, provided that an experienced operator analyzes the images. The paper by Shibayama et al. (4) in this issue of JACC examines the role that 3D TEE may play in predicting the presence of trans- and paravalvular AR post TAVR. Because the aortic root and aortic valve are 3D structures that are frequently distorted in severe aortic stenosis, the use of 3D imaging technique is mandatory (5).

Shibayama et al. (4) analyzed the 3D TEE datasets from just over 200 TAVR patients to try and identify features that were associated with trans- and/or paravalvular AR. This study is important because it reinforces the important role that 3D TEE can play in procedural planning for TAVR and in predicting which patients are more likely to suffer from post-TAVR AR. It is the first study that highlights the practical use of 3D TEE in this way. MSCT is the preferred imaging modality for TAVR planning in many centers. However, because the imaging resolution of both of the techniques are similar and they both have software capable of generating multipane reconstructions from 3D datasets, I believe that, as previously mentioned, the skill and experience of the imaging expert analyzing the datasets are more important than the modality itself, and the results from this study, could probably translate to MSCT.

A mismatch between aortic annulus size, as analyzed by 3D TEE, and the size of the implanted TAVR valve and age were the most important predictors of paravalvular AR in this patient group, who received exclusively the Sapien or Sapien XT valve (Edwards Lifesciences, Irvine, California). Valve undersizing has been appreciated for a long time as the cause of paravalvular AR, and the significance of age may be related to more extensive calcification in the elderly population.

Predictors of transvalvular AR, as evaluated by 3D TEE, were valve overexpansion and an elliptical post-implant valve shape at the prosthesis commissure level. These are not surprising findings, as they both are likely to lead to failure of correct cusp coaptation. This in turn may result in increased valve cusp stress,

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premature calcification, and early valve failure, so they are important.

The more surprising finding from this study is the importance of nonanatomical alignment of the prosthesis. This essentially means that the commissures of the prosthetic valve should, according to the authors, be aligned in the same orientation as the commissures of the native aortic valve. This is not a factor that most implanting operators take into account. They are usually far more concerned with the implant height of the valve rather than the rotation, which appears to be important for correct anatomical alignment. The logic behind the importance of correct alignment or rotation is that, if the position of the commissures of the TAVR prosthesis match those of the native valve, then correct expansion of the valve is more likely to occur. However, whilst 3D TEE can demonstrate the cusp alignment post-implant, I’m not aware that this can be seen, or influenced during deployment. In addition, the incidence of transvalvular AR post-TAVR is relatively low (20 patients, 9% in this study). So, interesting as it is, I remain skeptical about the importance of this particular finding and the ability to influence it. Nevertheless, it adds another parameter to the ever-increasing list of useful features that can be evaluated by 3D TEE in TAVR patients.

**CONCLUSIONS**

Although the manufacturers of TAVR valves would have us believe that the issue of post-implant AR has largely been solved by newer valve design, it remains an important issue and will continue to be so as the technique competes with surgical alternatives. Imaging will continue to play a pivotal role in procedure planning and guidance and, as has been demonstrated by Shibayama et al (4), 3D TEE can be extremely useful for anticipating and potentially avoiding post-TAVR AR.

**REPRINT REQUESTS AND CORRESPONDENCE:** Prof. Mark Monaghan, Department of Cardiology, King’s College Hospital, Denmark Hill, London SE5 9RS, United Kingdom. E-mail: mark.monaghan@nhs.net.

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