

EDITORIAL

The old and the new: the pivotal role of TTE in TAVI

Mehdi Eskandari MD FRACP and Mark Monaghan PhD FRCP FACC FESC

Cardiology Department, King's College Hospital, London, UK

Correspondence
should be addressed
to M Monaghan
Email
mark.monaghan@nhs.net

Transcatheter aortic valve implantation (TAVI) has undeniably revolutionised the field of interventional cardiology regarding the treatment of aortic stenosis (AS). With promising outcomes from the recently published PARTNER 2 trial (1), involving patients at intermediate risk for surgical treatment, further growth of an already rapidly expanding field is expected. Echocardiography has a pivotal role in transcatheter therapies from the early steps when the clinical diagnosis of a valvular disease is made to the postprocedural long-term follow-up. Although the role of transoesophageal echocardiography (TOE) for either pre-procedural planning or intraoperative guidance in TAVI has been the subject of several reviews and debates, the role of the older member of the family, transthoracic echocardiography (TTE), has not been given the attention it deserves. In this issue of *Echo Research and Practice*, Fryearson and coworkers review the role of TTE before and following TAVI and discuss as how it helps inform clinical decision-making in TAVI (2).

TTE remains the main imaging modality of choice in the diagnosis of severe aortic stenosis and is initially used for screening TAVI candidates. There are also other echocardiographic parameters that may have potential impact on TAVI outcomes such as left ventricular (LV) function and concomitant valvular disease that are discussed in detail in the review article (2). Bicuspid aortic valve, although not an absolute contraindication for TAVI, has important implications such as a higher risk of paravalvular aortic regurgitation (PAR) (3) and an increase in permanent pacemaker requirements (4). The extent and distribution of aortic valve calcification is known to be a predictor of successful valve deployment and outcome and can be assessed by TTE. Notably, significant septal hypertrophy, which can be detected by TTE and may result in dynamic left ventricular outflow tract (LVOT) obstruction, is a contraindication to TAVI.

However, TTE falls short in assessing the aortic valve annulus, which is key to procedural planning. Advances in three-dimensional (3D) imaging have led to the understanding that in the majority of cases, the LVOT and aortic annulus are elliptical and that any measurement of the annulus diameter obtained by TTE in the parasternal long-axis view often reflects the minor axis. Therefore, either 3D TOE or multi-slice computed tomography is routinely used to guide TAVI valve sizing. Furthermore, the assumed circular geometry of the LVOT in the continuity equation may result in an underestimation of aortic valve area, a recognised source of error and uncertainty in grading the severity of AS. As discussed in the review article by Fryearson and coworkers (2), this becomes crucial when there is a discrepancy between gradients across the aortic valve and the calculated aortic valve area resulting in uncertainty as to whether the patient has moderate- or low-gradient severe AS? Thus, a multi-parametric approach in defining the severity of AS is crucial, as it is in other valvular pathologies, to reduce variability.

The importance of a multi-parametric approach in echocardiographic assessment of valvular diseases is even more important in regurgitant lesions, when almost always a single parameter approach fails to accurately grade the severity of the valvular regurgitation. Although a multi-parametric approach caters for variation in image quality between two sequential studies, the absence of a hierarchical approach may still result in discordance and variability. Such a hierarchical approach in assessing aortic regurgitation has been shown to improve concordance between expert readers (5). Assessment of aortic regurgitation after TAVI poses an even more challenging problem. Not only there is a lack of a hierarchical approach in quantification of PAR, but also the recommended methods in surgically treated

patients have been extrapolated to the TAVI population with no further validation and are not often used comprehensively, even in the setting of clinical trials (6). Recent magnetic resonance imaging (MRI) studies have shown that although TTE is excellent in excluding PAR, it is insensitive in accurate grading of its severity, especially in the presence of multiple jets. Ribeiro and coworkers reported only a modest correlation between TTE and CMR where TTE underestimated the severity of PAR in almost 60% of patients by one grade. Interestingly, the commonly used approach that adopts the circumferential extent of the PAR jet to determine severity showed a poor correlation with CMR regurgitation volume and fraction ($R=0.32$, $P=0.084$; $R=0.36$, $P=0.054$, respectively) (7). Such an underestimation of PAR by TTE may well explain why even mild AR on echocardiography has been shown to be associated with adverse outcomes. Considering the clinical impact of PAR on the patient's outcome, further studies with a focus on developing a hierarchical multi-parametric algorithm in interpretation of post-TAVI aortic are needed. This should improve accuracy and minimise inter- and intra-observer variability.

Finally, similar to surgical aortic valve replacement, follow-up TTE studies after TAVI are clearly needed to detect early and late complications. Fryearson and coworkers referred to expert consensus agreement that recommends performing TTE at 30 days, 1 year, and annually thereafter (8). However, as highlighted by the authors, this approach lacks evidence. Ongoing clinical trials and TAVI registries stipulate post-TAVI follow-up TTE at prespecified intervals that are more frequent. In an era of much emphasis on appropriateness and cost-effectiveness of cardiovascular imaging tests, the data should be used to strengthen the evidence for recommendations on the optimal frequency of follow-up TTE in TAVI patients.

Echocardiography has contributed immeasurably to cardiovascular medicine for over half a century, and although at times threatened by high-tech modalities of a shorter history, it remains the most accessible and least expensive imaging technique that is and will be an inseparable part in novel transcatheter therapies.

Declaration of interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of this editorial.

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