Is there a role for multislice computed tomography in aortic stenosis?

Helmut Bamgartner

Department of Cardiology, Vienna General Hospital, Medical University of Vienna, Währinger Gürtel 18-20, A-1090 Vienna, Austria, Europe

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This editorial refers to 'Diagnosis of aortic valvular stenosis by multislice cardiac computed tomography' by E. Bouvier et al., on page 3033

Over the recent years, a number of papers have addressed the use of multislice computed tomography (MS-CT) in patients with aortic stenosis (AS). The ability of the technique to detect and quantify calcifications was the first reason for its application to calcific AS. Indeed, quantification of valvular calcification first by electron-beam tomography and later on by MS-CT has been well validated by studying patients prior to surgery and comparing the results with examinations of the pathological specimen. The methods have been shown to be reasonably accurate although examination may require special care. The question is whether this quantification of calcification has any clinical impact. Several studies reported a significant relation between the extent of calcification and the severity of the stenosis as defined by transvalvular gradient, aortic valve area (AVA) or both, whereas other investigators could not find a close association. It is obvious that such a relation can only be expected for calcific AS but not for other aetiologies such as congenital or rheumatic. Although some relation would make sense in the calcific form, it is of course highly unlikely that a certain cut-off can allow to distinguish between severe and non-severe AS with reasonable accuracy and that there could be any clinical relevance of quantifying AS by calculating the amount of calcium in an aortic valve. Nevertheless, the increase in calcification reflects the progression of the disease in an individual patient with AS. Therefore, such techniques have been used to study the effect of statines and ACE-inhibitors on the progression of AS and they certainly will continue to be a valuable tool for research with this regard. The extent of valve calcification has also been shown to be a significant predictor of outcome in AS. However, only the combination of the extent of calcification with the haemodynamic progression rate, which can only be provided by echocardiography, could be shown to yield information that may influence clinical decision making in AS. Thus, the assessment of aortic valve calcification by MS-CT has so far gained a role for research purposes but not for clinical practice.

AVA is a key variable for assessment of AS severity. It can be obtained invasively by heart catheterization, but in current clinical practice, echocardiography is mostly used to provide this measurement non-invasively. Both, magnetic resonance imaging and MS-CT have been studied as alternative techniques with this regard. Feuchtner et al. earlier this year, reported a good correlation and reasonable agreement between AVA calculated by MS-CT and echocardiography in 30 patients with AS (mean difference $\pm$0.04 cm$^2$, limits of agreement, 0.29; -0.20 cm$^2$). Bouvier et al. confirmed these results. Using standard electrocardiography-gated 16-slice CT, they were able to calculate AVA by planimetry in 103 of 107 patients. With a mean interobserver difference of 0.05 cm$^2$ measurements were reproducible but the considerable data scatter (2SD, 0.32 cm$^2$) is noteworthy (see subsequently). In a subset of 30 patients, AS was present by echocardiography. In these patients, AVAs obtained either by continuity equation (trans-thoracic echo) or by planimetry (transoesophageal echo) were compared with those provided by MS-CT. Mean difference between MS-CT and echo was only 0.07 cm$^2$ but again the scatter was considerable (2SD, 0.33 cm$^2$). Nevertheless, the authors report that MS-CT and echo grading according to ACC/AHA classification matched in 21 of 30 patients and differed by only one class in the remaining nine. However, the small sample size and the fact that 26 of the 30 patients had severe AS limit any conclusions with regard to the accuracy of MS-CT in AS grading and its ability to correctly identify patients with severe AS. Considering the fact that trans-thoracic echo using the continuity equation provides the effective AVA which should be only 70-80% of the anatomic AVA measured by MS-CT, it surprises in any case that the difference between the two techniques was so small and may indicate that MS-CT systematically underestimates the anatomic AVA. In addition, the data scatter for the comparison between methods as well as between measurements of different investigators or repeat measurements by the same observer reflects that AVA estimates by MS-CT are at least unlikely to be more precise than currently used techniques.

Despite these concerns, MS-CT may offer some advantages: currently available technique with 16-slice and even more 64-slice CTs offers good spatial resolution which may
be relevant, in particular, in patients who are difficult to image with ultrasound. The easily obtainable 3D data set allows to choose any plane and therefore the ideal plane for planimetry of the AVA. MS-CT may to some degree be less sensitive to calcium artifacts than ultrasound and finally it may provide additional important information on coronary arteries and on the ascending aorta.

On the other hand, there remain a considerable number of disadvantages: time resolution remains a problem; blooming artifacts due to calcifications may limit the accuracy; arrhythmias, in particular, atrial fibrillation, still preclude the application of the technique; high heart rates at least limit it and the use of β-blockers to lower heart rate may be particularly undesirable in patients with AS; rendering techniques may bias the measurements; radiation exposure is similar to invasive coronary angiography and at least limits repeat use during follow-up; contrast media if they are used, have the potential of renal and allergic complications; the examination time (including post-processing) for only one piece of information regarding AS assessment is long, 20–30 min.

Of major importance is the intrinsic limitation that MS-CT can only yield AVA, but no additional haemodynamic data. Although valve area is the ideal measurement from a theoretical point of view, none of the currently available techniques including MS-CT are precise enough to provide proper evaluation of AS by looking at AVA estimates only. It has to be taken into account that a change of only 0.2 cm² in valve area can result in dramatic haemodynamic changes making the difference between severe and non-severe. Thus, gradient measurements—the certainly more robust variable—and consideration of flow status are in general required in addition. This information, however, can be provided non-invasively only by echocardiography. Thus, MS-CT can certainly not be considered an alternative method to quantify AS even if it can be demonstrated that valve area calculation is feasible. The clinical impact of such a finding could only be that MS-CT can give a rough idea of the presence and degree of AS in patients who undergo CT for other reasons (evaluation of ascending aorta or coronary arteries) and it may at best provide an additional piece of information in patients with uncertain echocardiographic findings concerning AS. Although CT may provide additional information on LV size and function, it cannot provide other important information such as additional valvular regurgitation and pulmonary artery pressure.

Another role of MS-CT in AS that has recently been proposed is the pre-operative assessment of coronary arteries as an alternative to invasive angiography. On the basis of a recent study that specifically addressed this question16 as well as on the general literature on MS-CT and coronary artery disease (CAD), the technique appears to allow exclusion of significant CAD, in case all important segments are visible and definitely normal. In case of high calcium scores or any positive finding of stenosis, invasive angiography will be unavoidable as the next step. Thus, MS-CT is likely to be helpful in this setting only in patients with low likelihood of CAD.

In conclusion, the role of MS-CT in AS is limited at the present time. Quantification of calcification can be used in research studies of treatment that is hypothesized to interfere with the progression of AS. In clinical practice, however, echocardiography remains the preferred method for detection and quantification of AS. In patients with inadequate and inconclusive echocardiograms, MS-CT may serve as an alternative to obtain AVA. However, the evaluation will remain incomplete as the method does not yield additional haemodynamic information such as transvalvular pressure gradients, presence of regurgitation and additional valve disease, and pulmonary artery pressure. Finally, MS-CT may gain a role for the pre-operative exclusion of CAD but so far only in patients with low likelihood of atherosclerosis.

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References


