Dual-Source Computed Tomography Angiography in Aortic Stenosis: Comparison with Transthoracic Echocardiography

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The diagnostic performance of dual-source computed tomography (DSCT) angiography was evaluated in this study and compared to transthoracic echocardiography (TTE), which is commonly used as the reference standard, in the assessment of aortic valve morphology, measurement of aortic valve area (AVA) and classification of aortic valve stenosis. Forty subjects were recruited, with 20 diagnosed with aortic stenosis (AS) and the remaining 20 identified with normal aortic valve. Morphological findings of the aortic valve were compared between these two modalities. Maximum AVA was measured planimetrically in mid-systole with DSCT angiography (AVA_DSCT) and compared with TTE-derived AVA (AVA_TTE). There was more than 90% concordance of valve morphology between DSCT angiography and TTE (sensitivity 91.7%, specificity 100%). There was excellent correlation between AVA_DSCT and AVA_TTE (r = 0.98, p < 0.001). Bland Altman analysis showed good inter-modality agreement (95% confidence interval [CI]: –0.26–0.51 cm²) with slight overestimation of AVA (+0.13 cm²) by DSCT. Very good correlation was observed between AVA_DSCT and the mean as well as peak transvalvular pressure gradients (r² = 0.82 and 0.84 respectively). It was concluded that DSCT angiography can be used as a reliable, non-invasive and accurate imaging modality to evaluate the aortic valve morphology.

Keywords: Dual Source Computed Tomography, Echocardiography, Aortic Stenosis, Aortic Valve Area, Coronary Artery Disease.

1. INTRODUCTION

Aortic stenosis (AS) is a common heart disorder seen clinically in about one-fourth of all patients with chronic valvular heart disease. The most common cause of AS is the calcification of normal trileaflet or congenital bicuspid valve. Aortic valve area (AVA) measuring less than 1.0 cm² is considered severe AS. Patients with severe AS are at high risk for developing cardiac arrest or sudden death. Currently, anatomy and function of aortic valve are routinely assessed and followed up using transthoracic echocardiography (TTE) due to its wide availability, non-invasiveness, lack of radiation exposure and relative affordability. However, the TTE-based measurements on aortic valve area and transvalvular pressure gradient are often operator-dependent, thus, presenting a challenge for acquisition of images from patients with chest wall deformity or intrathoracic pathology. In these patients, measuring AVA may be possible using transesophageal echocardiogram (TEE) by direct planimetry, but this approach has the disadvantage of being semi-invasive since it requires intubation and hence causes patient discomfort. In addition, since the AVA is calculated using the continuity equation, small errors in measuring linear dimension will be confined in the final formula.

Electrocardiogram (ECG)-gated CT coronary angiography is a widely used less-invasive imaging modality for diagnosis of cardiac disease with very high negative predictive value reported in the literature. Currently, it is widely used to exclude the presence of coronary artery disease as a reliable screening tool. With retrospective ECG-gating technique and multiplanar reconstructions, additional reconstruction of cardiac images at systolic phase permits imaging of the aortic valve during its opening and measurement of the valve area. Furthermore, CT is very sensitive for detecting calcification. This property has been
This study demonstrates an inverse relationship between the AVA and transvalvular pressure gradient readings. As the size of aortic orifice reduced, the transvalvular pressure gradient initially increased in an almost linear pattern. However, as the aortic orifice narrowed further to moderate-severe degree, the transvalvular pressure gradient increased drastically in an exponential manner. This pattern of pressure gradient change was not surprising and could be explained by general hydrodynamic formula whereby gradient is an inverted squared function of the cross-sectional area.25 This would explain that a change in a smaller area of orifice would cause a larger magnitude of gradient change in comparison to a similar rate of change at a larger orifice area.

This study has some limitations that should be acknowledged. Firstly, the main limitation was the small sample size. In a clinical setting, many of the patients with AS are old with multiple concomitant medical problems including renal impairment and arrhythmia, which were excluded from this study. Therefore the results should be interpreted with caution. Second, with the exception of one patient, the sample population did not include patients with impaired systolic function and patients with arrhythmia. In these cases, it is postulated that the severity of AS will be overestimated as the aortic valve may not open fully and may give a falsely lower A V A measurement. Thirdly, radiation dose associated with DSCT angiography could be explained by general hydrodynamic formula whereby gradient is an inverted squared function of the cross-sectional area.25 This would explain that a change in a smaller area of orifice would cause a larger magnitude of gradient change in comparison to a similar rate of change at a larger orifice area.

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Table V. ACC/AHA grading of aortic stenosis according to DSCT and TTE (n = 40).

<table>
<thead>
<tr>
<th>DSCT-based aortic stenosis grading</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>20</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>24</td>
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<tr>
<td>Mild</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>8</td>
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<tr>
<td>Moderate</td>
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<td>1</td>
<td>4</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Severe</td>
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<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>13</td>
<td>4</td>
<td>3</td>
<td>40</td>
</tr>
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</table>

References and Notes