Multidetector-row computed tomography imaging of prosthetic heart valves: clinical and experimental aspects
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CHAPTER 3

Quadruple Valve Replacement: Visualization with 256-Slice Computed Tomography

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CASE PRESENTATION

A 51-year-old female was referred to our institution for the evaluation of aortic prosthetic obstruction. She had undergone aortic and mitral valve replacement 9 years before (Carbomedics 21 and 25 mm respectively, Carbomedics Inc., Austin TX) for severe regurgitation of both valves due to ergotamine use for severe migraine. Six years before she underwent a tricuspid valve replacement (Edwards Perimount 29 mm, Edwards Lifesciences., Irvine, CA) due to severe tricuspid regurgitation complicated by an AV block for which a pacemaker was implanted with an epicardial ventricular and transvenous atrial lead. Four years before severe tricuspid regurgitation recurred due to interference with a redundant atrial pacemaker lead followed by repositioning of the lead. There was moderate residual tricuspid regurgitation. In the months prior to evaluation there was increased fatigue and chest pain. An increased transprosthetic aortic gradient of 80 mmHg was found and she was referred to our institution for further evaluation.

Transthoracic echocardiography revealed a maximal transprosthetic gradient of 63, mean 34 mmHg, and an EOA 1.1 cm$^2$ (continuity equation) for the aortic valve, a peak gradient of 13 and mean 9 mmHg (pressure half-time 69 msec) over the mitral prosthesis, a mean gradient of 9 and mean of 6 mmHg over the tricuspid prosthesis with severe regurgitation, and severe regurgitation of the pulmonary valve. Transesophageal echocardiography revealed narrowing of the left ventricular outflow tract (LVOT), a normally functioning mitral prosthesis and severe tricuspid regurgitation. A retrospectively ECG-gated CT scan was performed on a 256-slice scanner (Philips iCT, Cleveland, OH) with 128 x 0.625 mm collimation (flying focal spot), pitch of 0.2, gantry rotation of 270 milliseconds, 120 kVp tube voltage and 600 mAs tube current. Images were reconstructed at every 5% of the R-R interval. Radiation dose was 10.3 mSv.

With CT, a narrowed LVOT was found with protruding tissue under the aortic prosthesis (arrows panels A and B). The periprosthetic anatomy of the mitral valve was normal and there were normal opening and closing angles of the leaflets. There was no thickening or calcification of the tricuspid prosthetic leaflets. An indication was found for the replacement of the aortic and tricuspid prostheses, and replacement of the native pulmonary valve.

At surgery a circumferential rim of pannus tissue was found under the aortic prosthesis (panel C) and there was central malcoaptation of the tricuspid pericardial prosthesis without evidence of the leaflet degeneration. The Carbomedics aortic prosthesis was removed and replaced with an ON-X 19 mm valve (ON-X Life Technologies Inc., Austin, TX). The tricuspid prosthesis and the native pulmonary valve were replaced with a 27 mm ON-X and a 23 mm Sorin Bicarbon (Sorin Group Inc., Arvada, CO) prosthesis respectively.
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The postoperative course was uncomplicated and the patient was discharged home after 10 days. Postoperative echocardiography found a peak gradient of 43 and mean 26 mmHg (AVA 1.1 cm²) for the aortic prosthesis, 17 and mean 11 mmHg for the mitral, 11 and mean 4 mmHg for the tricuspid and 10 mean 5 mmHg for the pulmonary prosthesis. There were no periprosthetic or abnormal prosthetic leaks.

Another CT scan was performed to assess the anatomy. The LVOT under the aortic prosthesis was wide, no periprosthetic masses were found and leaflet excursions were normal. The aortic prosthesis demonstrated an important deviation from the normal aortic annular plane and was found to be tilted in relation to the axis of the LVOT (panels D and E).

For the mitral, tricuspid and pulmonary prostheses, there were normal leaflet excursions and no prosthetic masses or abnormalities of the periprosthetic anatomy were found. Volume rendered images demonstrated the differences in radiopaque structure of the prostheses (panels E,G). During regular echocardiographic follow-up, there was no evidence of abnormal prosthetic or periprosthetic leakage and Doppler gradients remained unchanged. The patient currently has no exertional dyspnoea or chest pain.
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F
SYSTOLE

G
DIASTOLE
DISCUSSION

Transthoracic and transesophageal echocardiography are essential for the evaluation of prosthetic valve function. In some cases, however, the entire periprosthetic anatomy cannot be assessed due to acoustic shadowing. For example, interfering masses on the ventricular side of a mitral prosthesis may be challenging to detect echocardiographically. In such patients and especially in patients suspected of prosthetic valve obstruction, ECG-gated computed tomography may complement echocardiographic findings and uncover obstructive masses (1,2). In this patient with three and subsequently four prosthetic valves, CT detected pannus tissue under the aortic prosthesis and later found a tilted position of the novel aortic prosthesis in relation to the axis of the LVOT which can cause an increased transprosthetic gradient.

Despite artifacts related to cardiac motion and radiopaque components of the valve prostheses (3,4), current CT scanners produce images of sufficient temporal and spatial resolution to provide details of periprosthetic anatomy that are “off limits” to echocardiography. For modern prostheses made of carbon and titanium and bioprostheses good CT imaging quality has been reported (3,4). In addition, post-processing techniques allow the evaluation of leaflet motion for each of the valves without interference of the other three. In this case, CT found a plausible cause for an increased postoperative transprosthetic gradient in an otherwise correctly functioning prosthetic valve. In selected patients, CT imaging may elucidate functional abnormalities by identifying morphological abnormalities that cannot be found otherwise.
REFERENCES


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