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Cardiac CTA for evaluation of prosthetic valve dysfunction

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LETTER TO THE EDITOR

Cardiac CTA for Evaluation of Prosthetic Valve Dysfunction

The objective of the study was to evaluate the accuracy of cardiac computed tomography angiography (CTA) for the diagnosis of prosthetic valve dysfunction (PVD) compared with surgery.

Patients after heart valve repair who were referred for clinically indicated CTA (coronary artery or bypass graft evaluation, suspected PVD with or without paravalvular involvement, or other surgical planning) were included in our retrospective multicenter study (4 centers). All patients underwent surgery. CTA was compared to transesophageal echocardiography (TEE) in a subset of patients who had Core-Lab TEE within 8 days, using a standardized protocol (1) by an observer with >10 years of experience.

A 64- or 128-slice CTA was performed, and images were transferred to the Core-Lab. Multiphase data sets (entire cardiac cycle) were analyzed by 2 independent and blinded observers (>10 years' and >1 year of experience) by using multiplanar reformations (MPR), 3-dimensional volume rendering technique (VRT) and 4-cine loops for:

1. paravalvular leakage: visible contrast agent outflow at the annulus or from above to below (<1 cm);
2. pseudoaneurysm: round cavity of >1 cm filled with contrast agent;
3. paravalvular abscess: dense paravalvular infiltration with 0 to 40 Hounsfield units (HU) with or without a surrounding layer of tissue with contrast uptake ("definite") or ("uncertain" >40 HU);
4. mass: hypodense lesion ("vegetation," "thrombus/pannus," or "unclear");
5. dehiscence: loosening of the prosthesis anchor within the annulus (>10°);
6. structural bioprosthetic valve degeneration, leaflet thickening with or without calcification, and "restricted leaflet motion"; and
7. mechanical "stuck valve," resulting in <70° leaflet opening angle.

A total of 51 patients (65.4 ± 12.1 years of age; 23.5% female) with 58 prosthetic heart valves (PHV) (37.5% mechanical, 57.1% bioprosthetic, 5.4% mitral annuloplasty) were included. The time interval between CTA and surgery was 29.2 ± 42.6 days and 4.06 ± 2.8 days between TEE and CTA. Mean PHV age was 7.7 ± 5.2 years (range 0.5 to 27.0 years), and infection rate was 29.4%.

CTA VERSUS SURGERY (51 PATIENTS)

The concordance of CTA for diagnosis of PVD was kappa = 0.81 (95% confidence interval [CI]: 0.54 to 1.1) per patient and a kappa = 0.93 (95% CI: 0.83 to 1.03) per lesion.

CTA detected 12 of 13 paravalvular leaks (92.3%) and 10 of 10 pseudoaneurysms (100%). Two pseudoaneurysms were not visualized by TEE (n = 1 large cranial extension/ascending aorta; n = 1 basal/posterior mitral annulus).

CTA identified 10 abscesses (4 false positives rated as "uncertain"), whereas ^{18}F-labeled fluorodeoxyglucose positron emission tomography (2) correctly excluded 2 abscesses.

CTA diagnosed 22 of 25 masses (88%; 13 thrombi/pannus, 8 vegetations, and 1 unclear (ruptured chordae with retracted papillary muscle). Six panni could not be visualized by TEE due to metal reverberation artifacts, although an increased transvalvular pressure gradient was observed. Two panni (n = 1 patient of with 2 bioprosthetic valves) were incorrectly diagnosed by CTA as a "beam hardening artifact" (2 mm) and vegetation (3 mm size), respectively.

Twelve of 12 dehiscences (100%) were correctly diagnosed by CTA. In 4 patients, the full circumferential extent was underestimated by TEE, although "paravalvular leak" was reported.

Sixteen of 17 instances of structural bioprosthetic valve degeneration (94.1%) were detected by CTA, as were 2 of 2 mechanical "stuck valves" (100%) and 3 of 3 abnormalities (100%) after mitral annuloplasty, respectively.

CTA AND TEE VERSUS SURGERY (23 PATIENTS)

The accuracy of TEE was c = 0.735 (95% CI: 0.54 to 0.88) and c = 0.912 (95% CI: 0.74 to 0.98; p = 0.003, receiver operating characteristic analysis) for CTA.

In summary, our data show a high accuracy of CTA for detecting PVD, using surgery as the reference standard, particularly for the assessment of paravalvular pathologies (paravalvular leakage, abscess,

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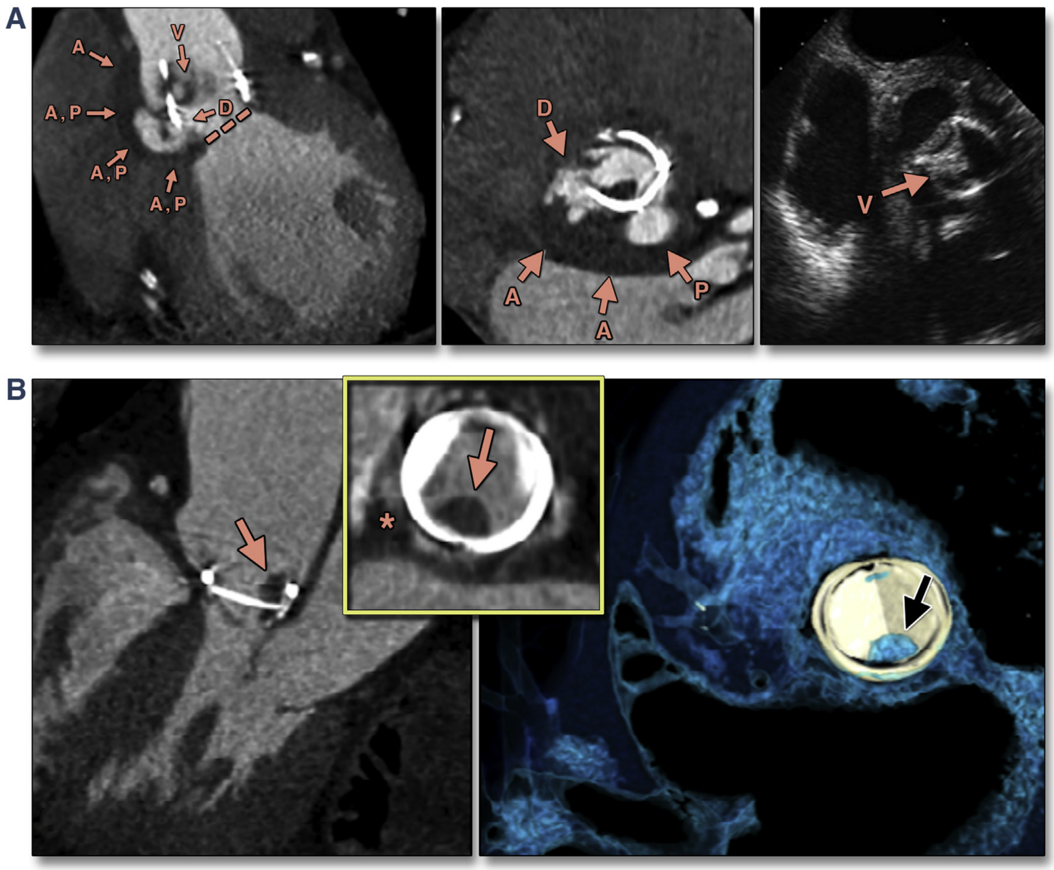
FIGURE 1 **Prosthetic Valve Dysfunction**



(A) A 79-year-old man with an infected bioprosthesis. CTA (left/mid) shows paravalvular abscess, A; pseudoaneurysm, P; dehiscence, D; and vegetation, V. Two-dimensional TEE is shown **(right)**. **(B)** A 72-year-old man with a mechanical prosthesis experiencing increased transvalvular pressure gradient. CTA is shown as mixed thrombus/pannus **(arrow)**, MPR **(left)** and 3D-VRT **(right)**. CTA = computed tomography angiography; MPR = multiplanar reformations; TEE = transesophageal echocardiography; VRT = volume rendering technique.

pseudoaneurysm, or dehiscence) (Figure 1A) and identification of thrombi/pannus. CTA further clarified the cause of increased transvalvular pressure gradients (Figure 1B, thrombus/pannus) on echocardiography. CTA added value to 2-dimensional TEE for the visualization of the full circumferential extent of dehiscence. In addition, CTA allowed for complementary evaluation of native coronary arteries and bypass grafts.

The study was limited by the absence of 3-dimensional TEE, which should be superior to 2-dimensional TEE for PHV visualization and diagnostic performance.

In conclusion, we advocate TEE as the primary imaging tool for PVD in alignment with the American Heart Association scientific statement (3), with CTA as part of a multimodality diagnostic work-up, with specific recommendations for suspected paravalvular involvement, to characterize pathologies and to fully define the involved anatomic territory; unclear PHV dysfunction on TEE (e.g., increased pressure gradient) without a morphological correlate for thrombus/pannus detection; and PHV mass characterization (thrombus/pannus, vegetation vs. calcification). In view of the high risk of PHV revision surgery, multimodality imaging may be justified in these subgroups.

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