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ORIGINAL ARTICLE

Coronary Evaluation by Computed Tomography versus Coronary Angiography in Patients undergoing Valve Surgery

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ABSTRACT

Objective: To assess the efficacy of coronary computed tomography angiography (CCTA) for coronary evaluation in patients undergoing valvular surgery, using invasive coronary angiography as the gold standard.

Study Design and Setting: Prospective study conducted in the Department of Cardiology, CPEIC Multan, from September 2022 to September 2023.

Material and Methods: A total of 100 patients with valvular heart disease undergoing preoperative coronary evaluation were included. All patients underwent CCTA and coronary angiography within 7 days of admission. Angiography was performed by cardiologists with at least 10 years of catheterization experience, via the common femoral or radial artery. CCTA was performed using a dual-source 64-slice CT system with non-ionic, low-osmolar contrast. Each of the 18 coronary segments was evaluated separately, the main coronary arteries were assessed as a whole, and significant stenosis was evaluated per patient.

Results: Of 1800 segments evaluated, 270 were excluded as absent, leaving 1530 for final comparison. On CCTA, 1056 (68.3%) were normal, 459 (30%) had insignificant stenosis, 77 (5%) had significant stenosis, and 10 (0.6%) were completely occluded.

For detecting significant stenosis at the segment level, CCTA showed a sensitivity of 88.3%, specificity of 98.5%, positive predictive value of 86.6%, negative predictive value of 98.5%, and overall accuracy of 98.9%.

At the vessel level, overall sensitivity was 85%, specificity and positive predictive value were 100%, and negative predictive value was 98%, with an overall accuracy of 98%.

Conclusion: CCTA has high diagnostic accuracy for detecting coronary artery disease and stenosis in patients before valvular surgery.

Keywords: Angiography, Computed tomography, Stenosis, Valvular disease

INTRODUCTION

Coronary artery stenosis is primarily assessed by coronary angiography before valvular surgery. It is a standard safe procedure but due to its invasiveness it can cause complications in coronary artery disease patients and susceptible populations.[1] Patients are also required to be admitted to the hospital for some time for the procedure which can be expensive and unpleasant. In addition, it is not a recommended tool to detect significant CAD.[2]

A non-invasive alternative, coronary computed tomography has been proved to have satisfactory efficacy for assessing CAD.[3] It is also effective in identifying obstructive CAD because of high negative predictive value.[4]It is easier, safer and more cost-effective than coronary angiography. CCTA is also useful for assessment of cardiac structure, lungs and mediastinum that contributes to timely diagnosis.[5]

This study was conducted to assess the efficacy of coronary computed tomography for coronary evaluation in patients undergoing valvular surgery, keeping coronary angiography as gold standard.

MATERIAL AND METHODS

A prospective study was conducted in the Department of Cardiology of CPEIC Multan from September 2022 to September 2023. A total of 100 patients with valvular heart disease undergoing preoperative coronary evaluation were included in the study. Pregnant patients, those with irregular heart rate & rhythm, renal dysfunction, previous history of CAD and acute heart failure were excluded. All patients provided their informed consent and ethical committee approved the study.

All patients underwent computed tomography angiography and coronary angiography within 7 days of admission. Angiography was performed prior to CCTA. If the heart rate was higher than 65 beats per minute one hour before CCTA, an attempt was made to manage it by 2.5-10 mg oral bisoprolol, if ineffective 1-2 mg bolus dose of IV propranolol was administered. All patients were given 0.5 sublingual nitroglycerin prior to scan. Findings of both scans were assessed by separate operators blinded to alternate results.

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Angiography was performed by cardiologists with at least 10 years or more experience of catheterization. Common femoral artery or radial artery were used as a puncture site. Quantitative coronary angiography was performed for sections with 50% or more stenosis for orthographic assessment. Coronary artery segments were divided based on degree of stenosis into normal, atherosclerotic or stenotic.

Dual source 64 CT system with non-ionic, low-osmolar contrast was used to perform CCTA. Before contrast, a non-contrast CT was done to calculate Agaston score to assess atherosclerosis. The scan was synchronized with ECG which retrospectively collects data and reconstruct it at 75% R-R interval. Since angiography was used as gold standard, each 18 segment of coronary artery was evaluated separately, main coronary artery was assessed as a whole and significant stenosis in each patient evaluated. In addition to assessment of trans-axial images, multiplanar reconstruction, maximum intensity projection and curved multiplanar reconstruction were also used. Coronary segments were classified into significant stenosis or insignificant stenosis and compared between CCTA and CCA by Braunwald coronary anatomic modes.

Data analysis was done by MedCalc 15. Descriptive statistics was employed to calculate numeric and categorical parameters. T-test and McNemar test were performed to compare numerical and categorical data, respectively. 2x2 contingency tables were used to compare diagnostic accuracy of both procedures.

RESULTS

A total of 100 patients undergoing valve surgery were included in the study with a mean age of 50 ± 8.2 years. 55 (55%) patients were males and 45 (45%) were females (Table I). The mean heart rate was 68.2 ± 18.0 bpm during CCTA. The duration of CAG was 840 ± 288 s which was significantly longer than duration of CCTA i.e. 11 ± 4 s. CCTA scan caused complications in 15 (15%) patients among whom 8 (8%) experienced flushing, 6 (6%) had dyspnea, 2 (2%) had renal dysfunction and 8 (8%) had contrast allergy. CAG caused complications in 25 (25%) patients among whom 20 (20%) had hematoma during puncture, 3 (3%) suffered vasovagal reaction and 10 (10%) had contrast allergy.

In total, 1800 segments were evaluated, among which 270 were excluded due to being absent, hence, 1530 segments were used for final comparison. 107 segments (7%) unevaluable by CAG while evaluation was successful in all cases by CCTA. 1056 (68.3%) were normal, 459 (30%) had insignificant stenosis, 77 (5%) had significant stenosis and 10 (0.6%) were completely occluded on CCTA (Table II).CCTA had a sensitivity of 88.3%, sensitivity of 98.5%, positive predictive value of 86.6%, negative predictive value of 98.5% and overall accuracy of 98.9% for identification of significant stenosis in segments.

Vessel-wise analysis of CCTA and CGA is also shown in Table III. 10 (10%) vessels of right coronary artery, 9 (9.7%) vessels of left anterior descending artery and 7 (7.4%) vessels of left circumflex artery had significantly CAD or complete occlusion as shown on CCTA. Same results were seen on CGA except greater number of vessels i.e. 15 (16.3%) in left anterior descending artery had significant stenosis. The overall sensitivity for all vessels was 85%, specificity & positive predictive value was 100% and negative predictive value was 98% indicating excellent accuracy of 98%.

Table1: Patients' characteristics with respect to prevalence of CAD detected by CCTA and CAG

Risk factor	N (%) (n=100)	Coronary artery disease on CCTA	Coronary artery disease on CAG
Diabetes	15 (15%)	9 (9%)	9 (9%)
Hypertension	40 (40%)	30 (30%)	25 (25%)
Smoking status			
Ex-smokers	18 (18%)	14 (14%)	12 (12%)
Current smokers	18 (18%)	5 (5%)	12 (12%)
Dyslipidemia	5 (5%)	5 (5%)	5 (5%)
Valve procedure	3 (3%)	-	-
Stroke	3 (3%)	3 (3%)	3 (3%)
Transient ischemia attack	10 (10%)	2 (2%)	2 (2%)
Peripheral vascular disease	3 (3%)	3 (3%)	3 (3%)
Previous continued treatment			
Anti-ischemic	30 (30%)	26 (26%)	22 (22%)
Anti-failure	5 (5%)	2 (2%)	2 (2%)
Both	10 (10%)	5 (5%)	5 (5%)
Family history of CAD	25 (25%)	23 (23%)	23 (23%)
Skin or drug allergy	10 (10%)	5 (5%)	5 (5%)
Asthma	10 (10%)	8 (8%)	8 (8%)

Table 2: Classification of coronary segments as assessed by CCTA and CGA (n=760)

	CCTA	CAG
No significant stenosis		
Normal segments	1056 (68.3%)	1071 (70%)
Less than 50% lesion	459 (30%)	368 (24%)
Significant stenosis		
50% or more lesion	77 (5%)	46 (3%)
Totally occluded	10 (0.6%)	10 (0.6%)
Unevaluable	-	107 (7%)

Table 3: Per-vessel analysis of severity of CAD

	CCTA		CAG	
	Normal	Significant stenosis or complete occlusion	Normal	Significant stenosis or complete occlusion
Right coronary artery	90 (90%)	10 (10%)	90 (90%)	10 (10%)
Left main coronary artery	96 (100%)	-	96 (96%)	-
Left anterior descending artery	83 (90.3%)	9 (9.7%)	77 (83.7%)	15 (16.3%)
Left circumflex artery	87 (92.6%)	7 (7.4%)	87 (92.6%)	7 (7.4%)

DISCUSSION

This study was conducted to evaluate the diagnostic accuracy of CCTA in comparison with the gold standard, CGA for incidence of CAD in patients with valvular disease. The results showed a high accuracy of 98.9% in a segment-based analysis with sensitivity of 88.3%, sensitivity of 98.5%, positive predictive value of 86.6% and negative predictive value of 98.5%. Our findings are in agreement with previous literature.[6, 7, 8]

Randhawa et al conducted a study in more than 1300 patients admitted on suspicion of CAD and evaluated with 16 segments CCTA and CAG.[9] It was reported that a high sensitivity of 95%, specificity of 98%, positive predictive value of 87% and negative predictive value of 99% was noted in segment wise evaluation. Sahin et al evaluated 63 patients with coronary artery disease with a 15-slice CCTA and invasive angiography.[10] The sensitivity, specificity, positive predictive value and negative predictive value of CCTA was 90.8%, 95%, 82.7% and 97.5% in a segment analysis.

Meier et al analyzed significant and severe CAD in 127 patients undergoing transcatheter aortic valve implantation.[11] At vessel level, the diagnostic accuracy was 87.1% and 94.4% for significant and severe CAD, respectively. A high negative predictive value of 97.5% and 96.3% was also found, respectively. Xiong et al reported a high accuracy of CCTA in patients with coronary stenosis i.e. 88.6% with a sensitivity of 87.3%, specificity of 94.4%, positive predictive value of 98.1% and negative predictive value of 65.1%.[12]

This study is limited in various aspects. The sample size was small and we only selected patients undergoing elective procedures. We excluded patients at high-risk like with history of stenting or CABG, atrial fibrillation so our accuracy may not be applicable to those patients. Lastly, we excluded non-evaluable segments in the final analysis.

CONCLUSION

Coronary computed tomography angiography has a high diagnostic accuracy for detecting coronary artery disease and stenosis in patients before valvular surgery.

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