Determination of Positivity of Computed Tomographic Angiography in Poorly Visualized Left Anterior Descending Artery on Conventional Angiography

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ABSTRACT

Objective: To determine the positivity of CT angiography in visualization of poorly visualized left anterior descending artery (LAD) on conventional angiography for decision of its surgical revascularization.
Study Design: Descriptive study.
Place and Duration of Study: Department of Cardiac Surgery, Faisalabad Institute of Cardiology, Faisalabad, from July 2014 to March 2015.
Methodology: This study involved 55 patients who had non-graftable LAD on conventional coronary angiography (CCA). All patients underwent computed tomography angiography (CTA). Patients having graftable LAD on CTA then underwent coronary artery bypass grafting (CABG). Peroperatively, the characteristics of LAD such as diameter, calcification and graftability were also recorded.
Results: The mean age of the patients was 52.76 ±8.52 years. There were 45 (81.8%) male and 10 (18.2%) female patients. Out of 55 patients, CTA revealed graftable LAD in 33 (60%) cases while LAD was non-graftable in 22 (40%) cases. Out of 33 patients having graftable LAD, 26 (78.79%) patients underwent CABG; whereas, remaining 7 (21.21%) patients had different reasons like other associated diseases and refusal from surgery. Among those who underwent surgery, LAD was graftable in all the patients (100%) peroperatively. Peroperatively 11 (42.3%) patients had mild calcification followed by severe calcification in 9 (34.6%) and moderate calcification in 6 (23.1%) cases. Fifteen (57.7%) patients had LAD caliber >1.5 mm while 11 (42.3%) patients had LAD caliber between 1.25 - 1.5 mm peroperatively.
Conclusion: Positivity of the CT angiography for poorly visualized LAD on conventional angiography was 60% in the present study.

Key Words: *Left anterior descending artery, Graftability, Coronary computed tomographic angiography.*

INTRODUCTION

Conventional coronary angiography (CCA) is the gold standard for identifying ischemic heart disease (IHD) and selection of patients for coronary artery bypass grafting (CABG). Distal coronary segments may be under-visualized due to manual contrast injection lacking simultaneous antegrade retrograde filling of both left and right coronary ostia.[1] It is estimated that despite of having severe coronary artery disease (CAD), 9.6% of the catheterization laboratory population are rejected for coronary revascularization.[2] Currently, selection for CABG is based upon the pattern of distal coronary artery disease in CCA. It is a fact that diffuse distal CAD affects surgical mortality.[3] Thus, severe disease involving distal coronary segments and their poor visualization in CCA, result in deferral for surgical revascularization and a poor patient outcome.[4] Recently, computed tomography coronary angiography (CTA) has been developed into a reliable modality that noninvasively evaluates coronary morphology.[5] As there is a venous contrast injection in CTA, distal coronary arteries are better visualized due to retrograde filling *via* collaterals. Moreover, longer injection time and high dose of contrast injection followed by a saline flush, results in better assessment of distal coronary segments. There are other CTA advantages which include three-dimensional image reconstruction, assessment of coronary calcifications and absence of foreshortening effects. Therefore, CTA may have an edge as compared to CCA in visualizing distal coronary segments.[6] To predict the graftability in cases of chronic total occlusions, the presence of a precise imaging modality is necessary. A few reports have demonstrated the importance of CTA in delineating distal coronary occlusions not visualized by CCA. These studies have concluded that CTA performs better in visualization of the occluded LAD. Furthermore, arterial intramyocardial course and multiple occlusion sites are also detected.[7-9] The rationale of the study is to determine the ability of CTA to delineate the anatomy of poorly visualized LAD on CCA. Although studies have been done on comparison between CTA and CCA but data is not sufficient at national level. Therefore,

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the results of our study will be valuable to our clinical knowledge at national level.

The objective of this study was to determine the positivity of CT angiography in visualization of poorly visualized LAD on conventional angiography for decision of its surgical revascularization.

METHODOLOGY

The study was conducted at Department of Cardiac Surgery, Faisalabad Institute of Cardiology, which is a tertiary care center in Faisalabad (Punjab). But CTA was done and reported in Punjab Institute of Cardiology (PIC), Lahore (Punjab). Duration of study was eight months from 09/07/2014 to 08/03/2015. Non-probability purposive sampling was done. The sample size was estimated 55 with 95% confidence level, 10% margin of error, and 90% anticipated positivity of CTA.[10]

Patients of both genders and all ages with poorly visualized LAD on CCA were included in the study. Patients having fixed perfusion defect of the anterior wall on a single photon emission computed tomographic scan (SPECT scan), patients with respiratory problems i.e. inability to hold a breath for fifteen seconds, and patients with serum creatinine level more than 2.0 mg/dl were excluded.

A total of 55 patients fulfilling the inclusion criteria were included in the study; and informed consent was taken. All patients underwent coronary angiography on standard angiography system (Axiom Artis, Siemens, Forchheim, Germany). Five different standard views with different projections for the left coronary artery, and two views for the right coronary artery with long cineangiography were obtained. Poorly visualized LAD on CCA was defined as complete occlusion of LAD without antegrade filling of the distal segments other than through collaterals. These patients were referred to Punjab Institute of Cardiology (P.I.C) for CTA.

All patients underwent CTA on a 64-slice scanner (GE, Light speed, and VCT, WI, USA). Calcium scoring was done with an initial non-enhanced ECG gated scan. Smart prep technique was used for coronary angiographic scan, i.e. real time contrast monitoring and initiation of scan at peak of root of aorta opacification. A total of 65-70 ml of contrast injection (Iomeron, Braco Italy, iodine content 400 mg/ml) was given at the rate of 5 ml/s followed by a saline flush of 40 ml. The patient was instructed to maintain an end-inspiratory breath hold as soon as the signal density in the ascending aorta reached a threshold of 100 Hounsfield units (HU) during which the CT volume data set and ECG trace was acquired.

Configuration of the detector was 64 mm × 0.625 mm slices with collimation of 40 mm, 350 ms was rotation

time, tube voltage was 120 kV, ECG modulated effective 200-800 mA, volumetric CT index was 59 mGy with resolution of 0.4 mm, single slice thickness of 0.6 mm, a temporal resolution of 175 ms with single sector reconstruction. The estimated effective radiation dose was 13 mSv for men and 18 mSv for women. Electro-cardiographically gated data sets were used to reconstruct images automatically at 75% of the R-R cycle length and 35% of the R-R cycle length to determine end-systole and end-diastole, respectively. The imaging of the entire coronary tree was possible due to simultaneous acquisition of 64 parallel cross sections in a single breath holding of about 6-8 seconds.

CTA was then analyzed on a 3D workstation (Advantage Windows 4.2, GE Healthcare, WI, USA) with a combination of different modalities such as axial images, multiplanar reconstruction, curvilinear reconstruction with vessel tracking, straight vessel views, cross sectional views and 3D volume rendered images. Vessel diameters were measured using straight views with electronic caliper and also in cross-sectional views using the best cross-section of the vessel for verification and quantification of stenosis. Graftable LAD on CTA was a vessel having diameter of at least 1.5 mm with no diffuse calcification of LAD.

All patients having graftable LAD then underwent CABG. Peroperatively, the characteristics of LAD such as diameter, calcification and graftability were also recorded. CCA findings and CTA were entered.

All the collected data were entered into SPSS version 20. Numerical variables i.e. age was presented by mean ±SD. Categorical variables i.e. gender, LAD caliber and positivity of LAD on CTA were presented by frequency and percentage.

RESULTS

The age of the study patients ranged from 37 years to 71 years with a mean of 52.76 ±8.52 years. There were 45 (81.8%) male and 10 (18.2%) female patients giving a male to female ratio of 4.5:1. On CCA, 30 (54.5%) patients had mild calcification of LAD followed by moderate calcification in 18 (32.7%) and severe calcification in 7 (12.7%) cases.

Computed tomographic angiography (CTA) was performed in all these patients and graftability of LAD was evaluated. Out of 55 patients, positivity of CTA was observed in 33 (60%) cases. Table I shows the findings of CTA regarding graftability, calcification and LAD caliber diameter.

Out of 33 patients having graftable LAD, 26 (78.79%) patients underwent CABG; whereas, remaining 7 (21.21%) patients had different reasons like other associated diseases and refusal from surgery. Among those who underwent surgery, LAD was graftable in all

Table I: CTA findings (n = 55).

Graftability	
Yes 33 (60%)	
No 22 (40%)	
Calcification	
Mild 28 (50.9%)	
Moderate 11 (20%)	
Severe 16 (29.1%)	
LAD caliber	
1.25-1.5 mm 25 (45.5%)	
>1.5 mm 30 (54.5%)	

Table II: CABG findings (n=26).

Calcification	
Mild 11 (42.3%)	
Moderate 6 (23.1%)	
Severe 9 (34.6%)	
LAD caliber	
1.25-1.5mm 11 (42.3%)	
>1.5 mm 15 (57.7%)	

the patients (100%). Table II represents the peroperative findings of CABG.

DISCUSSION

Coronary angiography provides a qualitative assessment of coronary blood flow and helps in identification of collateral vessels, thus finalizing the treatment modality, i.e. percutaneous intervention or coronary artery bypass grafting (CABG) in patients with coronary heart disease. However, the diagnostic value of conventional coronary angiography (CCA) in the assessment of distal coronary segments may be imperfect due to manual contrast injection inadequately filling both coronary ostia concurrently.[1]

Currently, modern multi-detector computed tomography (MDCT) is utilized for successful imaging of coronary arteries. There is ECG gating of the images with triggering for freezing the motion leading to fast enough acquisition for covering the heart in a few heart beats.[5,11]

The use of intravenous iodinated contrast empowers direct conception of coronary stenosis with MDCT. A large number of studies have been accomplished delineating the role of 64-section MDCT technology to detect CAD. The negative predictive values of the method approach to 100% in at least six meta analyses, which suggest that MDCT can dependably rule out the presence of hemodynamically significant CAD. There is overestimation of detected stenoses in MDCT, due to which its positive predictive value is still under question.[12-16]

There are considerable limitations of MDCT, with 64-section MDCT. Thus 3-11% of coronary artery segments cannot be assessed.[17-22] The accuracy for stenosis detection depends highly on image artifacts. False-positive and false-negative elucidations were credited to image artifacts in 91% to 100%,[19,20] the major cause was the coronary artery calcification.

Thus, computed tomography angiography (CTA) may be superior to CCA in visualization of occluded left anterior descending artery (LAD) for its graftability. However, due to limited local research, the purpose of the current study was to determine the positivity of CT angiography in visualization of poorly visualized LAD on conventional angiography for decision of its surgical revascularization.

This study involved 55 patients who had non-graftable LAD on conventional coronary angiography (CCA). Written informed consent was taken from every patient. The mean age of the patients was 52.76 ±8.52 years. There were 45 (81.8%) male and 10 (18.2%) female patients in the study group giving a male:female ratio of 4.5:1. On CCA, 54.5% patients had mild calcification of LAD, followed by moderate calcification in 32.7% and severe calcification in 12.7% cases.

On CTA, 50.9% cases had mild calcification followed by severe calcification in 29.1% and moderate calcification in 20% cases. Moreover, 54.5% patients had LAD caliber >1.5 mm while 45.5% patients had LAD caliber between 1.25 - 1.5 mm on CTA. Out of 55 patients, CTA revealed graftable LAD in 33 (60%) cases while LAD was non-graftable in 22 (40%) cases.

Out of 33 patients having graftable LAD, 26 patients underwent CABG; whereas, remaining 7 patients had different reasons like other associated diseases and refusal from surgery. Among those who underwent surgery, LAD was graftable in all the patients (100%) peroperatively. Peroperatively, 42.3% patients had mild calcification followed by severe calcification in 34.6% and moderate calcification in 23.1% cases. Peroperatively, 57.7% patients had LAD caliber >1.5 mm, while 42.3% patients had LAD caliber between 1.25 - 1.5 mm.

Thus, positivity of the CT angiography for poorly visualized LAD on conventional angiography was 60% in the present study, which is considerably lower than that of Maksymilian *et al.* who observed positivity of CTA to be 90%. A possible explanation for this conflict can be the difference in the sensitivity of the hardware used in these studies.[10] It is better than a very recent study published by Abazid *et al.* who found that CTA can predict successful LAD graftability during CABG surgery in almost one fourth of the patients deferred from LAD bypass grafting because of incomplete visualization.[23]

This study is first of its kind in local population and advocates the use of CTA for evaluation of poorly visualized LAD on conventional coronary angiography.

CTA increases the detection of graftable LAD and thus favors CABG in patients which, otherwise, seem poor candidates on conventional angiography thereby increasing the survival of patients with coronary heart disease.

A very important limitation of the present study is that we only used it in patients who had poorly visualized LAD on conventional coronary angiography. Whether CTA can replace CCA, and can it be performed in routine in place of CCA, which is an invasive procedure; requires comparison between the two modalities in all the patients with CAD and possible candidates of CABG to determine its sensitivity, specificity, positive and negative predictive values and accuracy while taking per-operative findings as gold standard in local population. Therefore, such a study in future is highly recommended.

CONCLUSION

Positivity of the CT angiography for poorly visualized LAD on conventional angiography was 60% in the present study.

Disclosure: The study is based on a thesis submitted at the University of Health Sciences, Lahore as a prerequisite for Masters of Cardiac Surgery degree.

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