



ACCURACY OF COMPUTED TOMOGRAPHIC ANGIOGRAPHY FOR THE DETECTION OF CORONARY COLLATERALS AS COMPARED TO CONVENTIONAL INVASIVE ANGIOGRAPHY

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ABSTRACT

OBJECTIVE: To determine the accuracy of CT coronary angiography for visualization of collaterals in chronic totally occlusive coronary arteries in comparison to conventional invasive coronary angiography.

MATERIAL AND METHOD: This cross sectional survey was conducted at Punjab Institute of Cardiology from August 2013 to February 2014. 185 patients were included in the study with total chronic occlusion of coronary arteries on conventional angiography. All patients underwent both conventional angiography and CT angiography. Different demographic variables were recorded for each patient. The statistical analysis was done using SPSS package version 19. Descriptive analysis was done i.e. frequencies and percentages for categorical variables like sex, coronary collaterals, and mean and standard deviation for the continuous variables like age was carried out. Sensitivity, Specificity, Positive and Negative predictive values and diagnostic accuracy of CT Angiography for presence and extent of coronary collaterals against Invasive Coronary Angiography were calculated by using 2/2 table.

RESULTS: In our study, 185 patients were studied, mean age was calculated as 54 ± 8 years, 135 (73 %) male and 50 (27%) were female. Mean weight of the patients was 74.25 ± 13 kg. Invasive Coronary angiography and CT angiography was performed in all the patients to compare the visualization of collaterals by taking Invasive Coronary Angiography as gold standard. Collaterals were visualized in 123 (66.5%) patients with Invasive Coronary Angiography while CT coronary angiography was able to pick the collaterals in 108 (58.4%). Sensitivity of CT was 84.5% and specificity of 93.5%. Positive predictive value was 96.3% and negative predictive value was 75.3%. Accuracy was calculated as 87.5%.

CONCLUSION: Efficacy of CT is good with high sensitivity and specificity. CT is a noninvasive test as compared to invasive coronary angiography. So CT is a useful modality to be considered when necessary to visualize coronary collaterals for patients undergoing CABG/PCI.

KEYWORDS: Coronary artery disease, Coronary artery collaterals, Multi-detector computed tomography, Coronary angiography

INTRODUCTION:

Coronary artery collaterals form as a result of a supply demand mismatch between coronary blood flow and oxygen consumption in the demanding myocardium if the blood flow is insufficient¹. Cardiovascular prognosis is predicted by the presence of collaterals on angiogram.² The coronary collateral circulation has shown benefits regarding several clinical endpoints in patients with myocardial infarction such as infarct size and left ventricular remodeling. The presence and extent

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of coronary collateralization often determines the necessity for revascularization of occluded vessels as well as the method of revascularization (i.e. PCI vs. CABG)¹. Multidetector computed tomography (MDCT) has recently become a popular modality for noninvasive coronary artery imaging. Recent technical advances in MDCT, particularly 64 slice MDCT; have enhanced image quality by improving spatial and temporal resolution³.

MATERIALS AND METHODS:

SETTING OF STUDY: This study was conducted at the Punjab Institute of Cardiology, Lahore from August 2013 to February 2014.

STUDY DESIGN: Descriptive, Cross-sectional survey

SAMPLE SIZE: The sample size estimated was 185.

SAMPLING TECHNIQUE: Non-probability consecutive sampling

INCLUSION CRITERIA:

- All patients of both sexes who were referred to the

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CT Angiography department for CT assessment of coronary collaterals having total occlusion in one or more major coronary arteries on Conventional Angiography.

- CT coronary angiography and Invasive coronary angiography were done within four weeks.

EXCLUSION CRITERIA:

- Acute Myocardial Infarction.
- Cardiac Arrhythmias at the time of study.
- History of contrast hypersensitivity.
- Nephropathy.
- Patients unable to hold breath during the procedure.

DATA COLLECTION PROCEDURE:

Patients were enrolled from CT Angiography department of Punjab Institute of Cardiology who came to have CT Angiogram for visualization of total occlusive artery before CABG or Angioplasty. CT Angiography is a routine investigation before CABG or Angioplasty in total occlusive vessel to visualize the vessel. Principal investigator took informed consent and history from the patients. Invasive Coronary Angiography was done on Toshiba Angiography Machine. Patients' right radial/femoral approach was used. Each coronary vessel was recorded in at least two views. CT Angiography was done on GE 64 slice Multidetector CT. At least two images of each coronary vessel was taken and interpreted by consultant cardiologist. Non Ionic contrast was used for both Invasive and CT coronary angiography.

DATA ANALYSIS

The statistical analysis was performed by using SPSS software version 19. Most of the results were presented in percentages, however relevant descriptive statistics, frequency and percentage were computed for qualitative variable i-e gender, mean and standard deviation was computed for quantitative variables (age, weight). The accuracy of CT was given in terms of sensitivity, specificity, positive and negative predictive value and accuracy against the invasive coronary angiography.

RESULTS

One hundred and eighty five patients fulfilling the inclusion criteria were included in the study. There were 135 (73%) males and 50 (27%) females. The mean age was 54±8 (Table 1). Mean weight was 74±13. Collaterals were visualized in 123 (66.5%) patients with Invasive Coronary Angiography while collaterals were absent in 62 (33.5%) patients (Table 2). CT was able to pick the collaterals in 108 (58.4%) and absent in 77(41.6%)

Table No. 1: Demographic variables (n=185)

Gender	135 (73%) male
	50 (27%) female
Age	54±8 (35-77 years)
Weight	74±13 (46-124 Kg)

Table No. 2: Frequency of coronary collaterals on invasive coronary angiography (n=185)

	Frequency	Percent
Absent	62	33.5
Present	123	66.5
Total	185	100.0

Table No. 3 : Frequency of coronary collaterals on CT angiography (n=185)

	Frequency	Percent
Absent	77	41.6
Present	108	58.4
Total	185	100.0

Table 4: Frequency of coronary collaterals visualized by invasive and CT coronary angiography. (n=185)

		Collaterals seen on CT		Sensitivity / Specificity
		Absent	Present	
Collaterals seen on C.Angio	Absent	58 (true negative)	4 (False positive)	93.5% Specificity
	Present	19 (False Negative)	104 (True positive)	84.5% Sensitivity
Total		77(41.6%)	108(58.4%)	

patients (Table 3). 104 patients had true diagnosis of collaterals by CT as compared to Invasive angiography, 58 had true negative, 04 had false positive and 19 patients had false negative. Sensitivity of CT as compared to invasive angiography was calculated to be 84.5% and specificity of 93.5% (Table 4). Positive predictive value of CT as compared to invasive angiography was 96.3% and negative predictive value of 75.3%.

DISCUSSION:

In the human heart, coronary collaterals development serves as a conduit, bridging the significant stenosis or totally occluded coronary arteries, and thus constitutes a natural bypass system⁴. Currently, routine invasive coronary angiography reveals about 20%–30% of patients with significant coronary artery disease had chronic total occlusion (CTO). Rise in this number is expected as a result of better survival of patients with ischemic heart disease, and rapid advances in interventional therapy



and medical facilities for patients with coronary artery disease⁵. The frequency of myocardial infarction in areas subtended by chronic total occlusion varies considerably despite of the complete interruption of blood flow antegradely. The degree of myocardial injury in the area of supply of epicardial chronic total occlusion is inversely proportional with the degree of angiographic coronary collateral circulation⁶. Meier et al. showed the presence of well-developed collaterals resulted in 36% lower mortality risk in long term as compared with poorly developed collaterals⁷.

Flow through collaterals is adequate to reduce ischaemia during coronary occlusion amounts 20-25% of the normal flow through the open vessel. Myocardial infarct size depends upon the coronary artery occlusion time, area at risk for infarction, and the degree of collaterals.⁸

Usually imaging evaluation of coronary collaterals is done with Invasive coronary angiography. It's an invasive procedure and uses intravenous contrast and radiation exposure and is also time consuming. It is also known for its complications due to invasive nature of the procedure and also require a lot of operator expertise. These considerations have led us to the use of other modalities such as Multidetector Computed Tomography (MDCT) for the assessment of coronary collaterals. The angiographic presence of coronary collaterals is a clinical predictor of cardiovascular prognosis. The coronary collateral circulation has shown benefits regarding several clinical endpoints in patients with myocardial infarction such as infarct size and

left ventricular remodeling. The presence and extent of coronary collateralization often determines the necessity for revascularization of occluded vessels as well as the method of revascularization (i.e PCI vs CABG).⁹

Only few studies have determined the sensitivity and specificity of CTCA to detect the presence and extent of coronary collaterals.¹⁰

Positive predictive value of CTCA as compared to invasive angiography was 96.3% and negative predictive value of 75.3%. In Rieber et al¹. The presence of any collaterals was accurately detected in 21/23 patients (sensitivity 91%) and the absence in three patients (specificity 100%). Only 26 individuals were included in this study who met the inclusion criteria¹.

The results of the current study may be considered as primary and more trials must be done to confirm the findings as we have limited data on the subject and few studies have done with wide variation in their results, moreover, no study has been conducted to assess the coronary collaterals in chronic occlusive vessels in Pakistani population. However, as a rule in future this high risk population should be assessed in more detail regarding this issue to get the better insight of it.

CONCLUSION:

Efficacy of CTCA is good with high sensitivity and specificity. CTCA is a noninvasive test as compared to invasive coronary angiography. So it is a useful modality to be considered when necessary to visualize coronary collaterals for patients undergoing revascularization procedure like CABG/PCI.

Author's Contribution

ZA: Conducted the study and wrote the article.
TN: Helped in conducting the study and was research coordinator. SAG: Re-analyzed data, reviewed and corrected the article.



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