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ORIGINAL ARTICLE

Diagnostic accuracy of 160-slice CT coronary angiography as compared to invasive coronary angiography keeping invasive coronary angiography as gold standard in patients of coronary artery disease.

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ABSTRACT… Objective: To determine diagnostic accuracy of 160 –Slice Computed Tomography (CT) in detection of coronary artery disease in patients with known or suspected coronary artery disease as compared to coronary angiography as a gold standard. **Study Design:** Cross sectional prospective study. **Setting:** Tertiary Care Hospital Sargodha. **Period:** February 2024 to December 2024. **Method:** The study evaluated 100 patients of both genders with age range of 40 to 80 years, reported with history of angina. The study comprised of patients having known coronary artery disease or suspected coronary artery disease. The patients reported with other cause of chest pain were excluded. Positive angiography was considered to be a significant stenosis of 50 percent or more of lumen diameter. Correlation analysis was used to determine the correlation between Coronary Computed Tomography Angiography (CCTA) and Coronary Invasive Angiography (CIA). **Results:** 160 – Slice CT was used for 100 patients (70 % male (n=70) and 30 % females (n=30) with mean age 67.4 ± 9.03 years). Oral beta blockers were administered before the scan. Mean interval between Coronary Artery stenting or Bypass Grafting (CABG) surgery and CTA was 9.59 ± 2.7 (range 0 to 20) years. Mean heart rate during scanning was 65.04 ± 4.04 (range 48 to 92) beats/min. 64 % (n=64) patients were CCTA positive and 60 % (n=60) were CIA positive. In comparison to CIA, CCTA showed sensitivity of 95 %, specificity of 82.5 % and accuracy of 90%. **Conclusion:** 160 – slice CT is a reliable and accurate while performing CCTA in detection of coronary artery stenosis (CAS). Premedication of oral beta blockers improves the study accuracy. CCTA is also reliable in assessing stents and grafts patency. With the help of CCTA, the number of invasive procedures can be reduced.

Key words: CIA (Coronary Invasive Angiography), CCTA (Coronary Computed Tomography Angiography), CT (Computed Tomography), CABG (Coronary Artery Bypass Grafting), Coronary Artery Stenosis (CAS).

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INTRODUCTION

Coronary artery disease (CAD) is the leading cause of patient death worldwide up till now. For decades, conventional invasive angiography (CIA) has been considered as a gold standard for diagnosing CAD.[1] Diagnostic ability of CIA for severity of coronary obstructive lesions remains very high.[2] However, CIA is not an ideal choice in certain cases due to reason of its complications like arrhythmia, myocardial infarction, stroke and complex invasive nature.[3] Therefore, invasive procedure is no longer a standard choice while diagnosing CAD, whereas, such cases could be benefited from a non-invasive approach to ascertain the disease severity.[4]

Investigation of (CAD) using positron emission Computed Tomography (CT) tests are regarded as highly established non-invasive methods.[5] Specificity and sensitivity of these tests in CAD is not ideal. Literature suggests that myocardial perfusion, ETT has specificity and sensitivity of 87% and 64%, 68% and 77 %, respectively.[6]

CCTA has now been an alternate diagnostic procedure for checking coronary artery obstructions. Diagnostic values have also been improved with the advancements in technology.[7] The evolution of a new generation of CT scanner machines with superior image quality has challenged the need for CIA, thus reducing the invasive procedures worldwide.[8]

The aim of our study is to determine the diagnostic

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accuracy of 160 – slice CT scan machine and its results in comparison with the coronary invasive angiography as a gold standard. This study will also check if CCTA can replace the conventional invasive angiography for detection of CAS.

METHODS

This cross-sectional study was conducted from February 2024 to December 2024, at the department of Radiology in Tertiary Care Hospital Sargodha. Necessary approvals were obtained from the institutional ethical committee (letter number MSF (H)/308/3/1/Trg) before the study was commenced. Data was analyzed using International Business Machines

Corporation (IBM Corp.) Statistical Package of Social Sciences (SPSS) version 29.0: New York, the United States of America (USA). Canon 160 slice Aquilion (AQ) prime CT scan system was tested with scan slice thickness of 0.5mm x 160, pitch and rotation time were calculated using the software of the apparatus.

The study included a total of 100 patients from both genders, aging between 40 to 85 years having history of chest pain, with no previous history of CAD. All patients were stable with vitals that are blood pressure (BP), less than 140/100 mmHg and pulse less than 75 bpm. Patients referred with clinically suspected CAD were included. Patients having pregnancy (contraindications to radiation exposures), difficulty in lying flat, high heart rate more than 75 bpm, contraindicated to beta blockers, arrythmias including atrial fibrillation, acute myocardial infraction, severe chronic obstructive pulmonary diseases, inability to hold breadth for more than 15 secs, obesity, abnormal kidney functions with high creatinine levels more than 1.5mg/dL, were excluded from the study. Patients having electrocardiogram (ECG) with ST segment elevation were also not included. Written consent from all patients undergoing CT examination was taken as a formal record. Patients were advised not to eat or drink for at least 8 hours before conducting study. Patients received beta blockers (Metoprolol) dosing 50- 100mg at bedtime and the same dose in morning 1hr before conducting study. Non contrast calcium scoring was done as a primary step with slice thickness of 3mm. Single dose of glyceryl trinitrate 0.5mg was given per oral before conducting contrast study. 80 – 100 ml nonionic iodinated contrast medium with dose of 1ml/kg body weight was given to subjects via I/V access, 18 Guage intra-venous cannula, with flow rate 4-5ml per second. 50 – 60 ml of normal saline was injected by power injector.

Ten high resolution volume phases were acquired from axial, coronal and sagittal images by using retrospective ECG gating with 160 x slice canon AQ prime superior performance CT scanner. Data volumes were reconstructed at 75% of Rhythm-Regularity (R-R) interval (late diastolic phase) to eliminate motion artifacts. Axial, coronal and sagittal images, post processed three-dimensional images and multi planner reconstructions were used to assess CAS at CT workstation by qualitative and quantitative stenosis estimate by following gradings. The presence or absence of the CAD was established by looking at Right Coronary Artery (RCA), Acute Marginal (AM) branch of RCA, Posterior Descending Artery (PDA), Posterior Lateral Branch (PLB), Left Main stem (LM), Left Anterior Descending artery (LAD), diagonal branches of LAD, Left Circumflex artery (LCX), Obtuse Marginal (OM) branches of LCX and Obtuse Marginal (RI) branch, in case it was present.

TABLE-I

Grading scale for stenosis severity[9]

"Degree of luminal diameter stenosis	Terminology
No visible stenosis	0%
Minimal stenosis	1-24%
Mild stenosis	25-49%
Moderate stenosis	50-69%
Severe stenosis	70-99%
Occluded	100%"

Routine CIA procedures were performed in different setups according to patient desire and convenience. Patients were followed and the reports were obtained. Comparisons were made between CCTA and CIA.

RESULTS

Table-II gives demographics of the patients of the study.

TABLE-II	
Demographics of the patients	
"Parameter	**Value**
Gender	
Male	70 (70%)
Female	30 (30%)
Mean age (years)	67.4 ± 9.03
Mean interval between CABG and CTA (years)	9.59 ± 2.7
Mean heart rate during scanning (bpm)	65.04 ± 4.04
Heart rate range (bpm)	48 – 92"

Table-III shows metric calculations for CCTA.

TABLE-III		
Metric calculations		
Metric	**Formula**	**Value**
Sensitivity	TP / (TP + FN)	95%
Specificity	TN / (TN + FP)	82.5%
Accuracy	(TP + TN) / (TP + TN + FP + FN)	90%

Table-IV shows correlation between CIA and CCTA to be 0.79, which shows a positive and strong correlation between the two modalities. Moreover, the p value is <0.0001, which means this relationship is significant.

TABLE-IV			
Correlation			
Modalities	**Positive Patients**	**Correlation Coefficient**	**P-Value**
CIA	60 (60%)	0.79	<0.0001
CCTA	64 (64%)		

DISCUSSION

The present study on CAD patients shows that CCTA has high diagnostic accuracy with sensitivity of 95%, specificity of 82.5% and diagnostic accuracy of 90%. Moreover, the strong and positive correlation between CIA and CCTA (r=0.79) shows that its results are statistically significant (p<0.05) to the standard.

A sensitivity of 95% indicates that CCTA can be relied on for identification of patients with CAD, making it a suitable tool with high negative predictive value. A specificity of 82.5% shows capability of modality to avoid false positives. An overall diagnostic accuracy of 90% lies within acceptable clinical threshold, which indicates that CCTA can be used as a safe substitute of invasive angiography for first assessment. The high correlation coefficient indicates that there exists a diagnostic agreement between the CCTA and CIA. Thus, their results must be almost same. Thus, the findings of present research work are supportive of 160-slice CCTA in diagnostic pathways of CAD as a non-invasive modality used before invasive coronary angiography. However, there are certain limitations to this study which are to be considered when interpreting the results. Firstly, this study was carried out with a limited sample size, thus restricting the generalizability of the results to cover more diverse population. Secondly, presence of previous stents or surgical clips in patients with CABG may interfere with interpretation of results. Thirdly, factors such as high heart rates and patient related motion artifacts may have affected image quality which potentially impact the diagnostic accuracy. High amount of calcium in coronary arteries may result in overestimation of degree of stenosis resulting in high number of false positives results and unnecessary invasive procedures. Anyhow, the factors like high heart rate can be addressed by administrating beta blockers before conducting study to enhance specificity.[10] The specificity may vary in accordance with patient selection, calcium burden, scanner type and reader experience.[11] But the present study with fewer false positives shows that the protocols and scanners used were optimized.

Literature indicates that CCTA is a non-invasive modality with high image resolution and patient comfort. It offers least procedural risk. Multi slice CT has been noted with high sensitivity (82-100%) and specificity (90-98%) as compared to ICA.[12] A 160-slice CCTA presents further advancement with high spatial resolution and volumetric coverage accompanied by shorter scan times.[13] These factors are highly critical in cardiac imaging. On the other hand, with enhanced spatial and temporal resolution, better stenosis assessment can be done especially in movable segments.[14] The modality with greater detector coverage removes the problem of single heartbeat volumetric acquisition that limits misregistration artifacts found in multi-beat scanners.[15] The modality with iterative reconstruction and high- definition CT shows better

lumen delineation, particularly for small stents or heavily calcified vessels. This clearly suggests that 160-slice CTCA can reach 95–100% sensitivity and 90– 95% specificity per patient, and 85–90% per segment accuracy.[16]

CONCLUSION

It can be concluded that CCTA is a reliable technique to detect CAS and can be used as an alternative non-invasive modality for patients in which invasive procedures are difficult to carry out. It can also be used as reliable technique for evaluation of coronary artery bypass grafts and patency of coronary artery stents.

LIMITATIONS

The present study had limitation that it was single center based with moderate sample size, which may affect generalizability. Moreover, the presence of graft & stent may limit the diagnostic accuracy of 160-slice CT coronary angiography in assessing the degree of stenosis. Patients with arrhythmias, asthma and obesity are unsuitable for this study.

FUTURE DIRECTIONS

The future studies should be designed based on larger multicenter trials, investigation of advanced technologies and cost-effectiveness analysis. Moreover, by combining CCTA with Anatomical imaging, specificity and functional relevance can be increased. Similarly, AI integration may enhance sensitivity and specificity per patient.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
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2	**Salahuddin Balooch:** Drafting.
3	**Naila Mumtaz:** Literature search.
4	**Shabana:** Data entry.
5	**Wajeeha Ahad:** Data analysis.
6	**Rida Fatima:** Critical revisions.