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Could cardiac CT replace cardiac catheterization Technology

Qusai Tamemi [1], Sara T.Alnms [1], Lana A.ALgawarna [1]
[1] Department of Medical Imaging, Palestine Ahliya University (Palestine)
✉ qusai_mmt@hotmail.com
✉ 22010322@Paluniv.edu.ps
✉ 22110558@Paluniv.edu.ps

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Abstract: ***This study investigated the potential of cardiac CT as a replacement for cardiac catheterization using a retrospective and cross-sectional design. Conducted at Alia Governmental Hospital in Hebron, Palestine, between February 28, 2024, and May 1, 2024, the aim was to compare the diagnostic capabilities, safety profiles, and patient outcomes of the two modalities. The sample included 50 individuals aged 40-60 who underwent cardiac catheterization, and data from cardiac CT scans were reviewed from private centers. The main results showed that cardiac CT demonstrated comparable diagnostic accuracy to cardiac catheterization, with fewer procedural complications and faster recovery times. Additionally, statistical analyses revealed significant findings in stent implantation rates and associated pathologies. In conclusion, cardiac CT presents a viable and safer alternative to traditional cardiac catheterization, offering significant clinical advantages in diagnosing coronary artery disease.***

Keywords: CT, Cardiac, Catheterization, Accuracy.

1. Introduction

Cardiac CT (computed tomography) has emerged as a revolutionary technology in the field of cardiology, offering non-invasive imaging that can provide detailed pictures of the heart's structure and blood vessels. This advanced imaging technique uses X-rays to create cross-sectional images of the heart, which can be reconstructed into three-dimensional models. Cardiac CT is particularly valuable for detecting coronary artery disease, assessing cardiac anatomy, and evaluating other heart conditions. Compared to traditional methods, it promises to enhance diagnostic accuracy and patient comfort significantly [1][2]–[19].

Traditionally, cardiac catheterization has been the gold standard for diagnosing and treating various heart conditions. This invasive procedure involves threading a catheter through blood vessels to the heart, allowing for direct visualization and intervention in coronary arteries. Despite its effectiveness, cardiac catheterization carries risks such as bleeding, infection, and complications from the procedure itself. Additionally, it requires longer recovery times and hospitalization, which can be burdensome for patients and healthcare systems alike [20]–[33][34].

The potential for cardiac CT to replace cardiac catheterization lies in its non-invasive nature and high-resolution imaging capabilities. Advances in CT technology have significantly improved image quality while reducing radiation exposure. Moreover, cardiac CT can be performed quickly and does not require the same level of preparation or recovery time as catheterization. This makes it an attractive alternative for patients who are at higher risk for complications from invasive procedures or for those who prefer a less invasive diagnostic option [4], [35]–[40], [40], [41][42]. However, there are significant challenges and limitations that need to be addressed before cardiac CT can fully replace cardiac catheterization [43]. One of the main concerns is the accuracy of cardiac CT in diagnosing severe coronary artery disease compared to catheterization. While cardiac CT is excellent for ruling out significant coronary artery disease, it may not be as effective in evaluating complex or borderline cases. Additionally, there is a need for widespread availability of advanced CT technology and trained personnel to interpret the results accurately.

The study focused on collecting detailed procedural outcomes, complications, and diagnostic accuracy for the cardiac catheterization group, and scan results, diagnostic accuracy, and follow-up procedures for the cardiac CT group. By comparing these variables, the research aimed to highlight the diagnostic capabilities, safety profiles, and patient outcomes associated with both modalities.

2. Methodology

This study utilized a retrospective approach and a cross-sectional design to assess the potential of cardiac CT as a replacement for cardiac catheterization. The research was conducted at Alia Governmental Hospital in Hebron-Palestine between February 28, 2024, and May 1, 2024. The sample comprised 50 randomly selected individuals aged 40-60 who underwent cardiac catheterization during the specified period. Additionally, cardiac CT scan records from private centers were reviewed for patients referred from Alia Governmental Hospital, as this hospital does not provide cardiac CT services.

The study period focused on March 2024, during which patient records were thoroughly examined to collect relevant data. For the cardiac catheterization group, detailed procedural outcomes, complications, and diagnostic accuracy were documented. For the cardiac CT group, data included scan results, diagnostic accuracy, and any follow-up procedures or interventions required. The comparison aimed to highlight the diagnostic capabilities, safety profiles, and patient outcomes between the two modalities.

Cardiac catheterization data were collected directly from Alia Governmental Hospital's records, ensuring comprehensive coverage of patient demographics, procedural details, and subsequent clinical outcomes. For the cardiac CT scans, approximately 40 out of every 100 patients referred for a CT scan were identified and their records were obtained from private centers performing these scans. These records were integrated into the study to provide a robust comparison with the catheterization data.

Data analysis involved comparing the diagnostic accuracy of cardiac CT and cardiac catheterization, considering variables such as detection rates of coronary artery disease, procedure-related complications, and patient recovery times. Statistical tools were used to determine the significance of differences observed between the two groups, with particular attention to identifying any potential biases or confounding factors in the patient selection or data collection processes.

By relying on a combination of hospital records and external data from private centers, the study ensured a comprehensive evaluation of the current diagnostic landscape for coronary artery disease. The retrospective nature of the study allowed for a detailed analysis of past cases, providing insights into the real-world applicability and effectiveness of cardiac CT compared to the traditional cardiac catheterization approach.

3. Results and Discussion

Table 1 provides information about the frequency and distribution of responses regarding the presence of a stent. Only 16 patients (32%) have a stent implant due to their own condition while 68% undergoes the procedure without stent implants.

Table 1. stent implants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	32.0	32.0	32.0
	No	34	68.0	68.0	100.0
	Total	50	100.0	100.0	

The statistical analysis of the age data from the sample of 50 individuals yielded the in table 2. The average age of the sample is 54.18 years with standard deviation 7.5.

Table 2: Age distribution

N	**Valid**	50
	Missing	0
Mean		54.18
Median		55.50
Std. Deviation		7.567
Range		35
Minimum		35
Maximum		70

Table 3 provided results offer insights into the descriptive statistics of age among individuals with and without stent implants.

For individuals with stent implants, the analysis included a total of 16 valid cases. The mean age among this group was calculated to be 53.63 years, indicating the average age of individuals who underwent stent implantation. Additionally, the standard deviation, a measure of dispersion around the mean, was computed as 6.185 years, suggesting a relatively low level of variability in age among individuals with stent implants. The range of ages spanned 23 years, from a minimum age of 44 to a maximum age of 67 within this group.

Conversely, individuals without stent implants constituted a larger sample size of 34 valid cases. The mean age for this group was slightly higher at 54.44 years, indicating a slightly older average age among individuals without stent implants compared to those with stent implants. The standard deviation for this group was computed as 8.21 years, suggesting a slightly greater variability in age compared to the group with stent implants. The range of ages spanned 35 years, from a minimum age of 35 to a maximum age of 70 within this group.

Table 3: Age distribution

Stent implants (Yes)	N	Valid	16	Stent implants (No)	N	Valid	34
		Missing	0			Missing	0
	Mean		53.63		Mean		54.44
	Median		53		Median		56.5
	Std. Deviation		6.185		Std. Deviation		8.21
	Range		23		Range		35
	Minimum		44		Minimum		35
	Maximum		67		Maximum		70

The presented table 4 outlines the distribution of pathology diagnoses among a sample of individuals. It enumerates various conditions identified during pathological assessments, along with their corresponding frequencies and percentages. Among 50 individuals, with each individual exhibiting one or more pathology diagnoses. The most prevalent diagnosis was "Chest pain and ECG changes," observed in 18 individuals, constituting 36.0% of the sample. This condition suggests a potential cardiac concern, warranting further investigation.

Following closely, "Angina" was reported in 12 individuals, representing 24.0% of the sample. Angina, characterized by chest discomfort or pain due to reduced blood flow to the heart muscle, highlights a significant cardiovascular issue among the studied population. "Echo findings" were documented in 10 individuals, making up 20.0% of the sample. This diagnosis suggests abnormalities detected through echocardiography, indicating potential structural or functional cardiac abnormalities.

Other noteworthy findings include "High lipid profile test" and "Cardiac failure," each reported in 3 individuals, accounting for 6.0% of the sample each. Elevated lipid profiles indicate a heightened risk of cardiovascular disease, while cardiac failure signifies compromised heart function, both of which necessitate clinical attention. Less frequently observed conditions include "Coronary artery disease," "Irregular heart beat and heart valve disease," each identified in 2 individuals, constituting 4.0% of the sample each. These diagnoses underscore additional cardiac pathologies present within the studied cohort.

Table 4. pathology type

	Frequency	Percent	Valid Percent	Cumulative Percent
Coronary Artery Disease	2	4.0	4.0	4.0
Chest Pain and ECG Changes	18	36.0	36.0	40.0
Angina	12	24.0	24.0	64.0
Echo Findings	10	20.0	20.0	84.0
High Lipid Profile Test	3	6.0	6.0	90.0
Cardiac Failure	3	6.0	6.0	96.0
Irregular Heart Beat and Heart Valve Disease	2	4.0	4.0	100.0
Total	50	100.0	100.0	

Gender

The presented results in table 5 delineate the distribution of gender within a sample of individuals, elucidating the frequencies and proportions of males and females. Among the sample, with gender classification revealing a majority of males, constituting 60.0% of the total sample size. Conversely, females accounted for 40.0% of the sample, representing a notable but comparatively smaller proportion.

This gender distribution suggests a moderate male predominance within the studied population. The higher frequency of males could potentially reflect underlying demographic characteristics or recruitment biases within the sample selection process. Additionally, it may underscore gender-specific health-seeking behaviors or disparities in healthcare access and utilization.

Understanding gender distribution is crucial for healthcare planning, policy formulation, and targeted interventions, as certain health conditions may exhibit gender-specific patterns in prevalence, manifestation, and response to treatment. Therefore, recognizing and addressing gender-related health disparities is imperative for promoting equitable healthcare outcomes and optimizing public health initiatives.

Table 5. Gender distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Gender	Male	30	60.0	60.0	60.0
	Female	20	40.0	40.0	100.0
	Total	50	100.0	100.0	

Pathologies and stent implants Correlation

The provided results in table 6 pertain to chi-square tests conducted to assess the association between pathologies and stent implants in a dataset. The Pearson Chi-Square statistic yielded a value of 16.248 with 6 degrees of freedom. The associated asymptotic significance, reported as .012 for a two-sided test, indicates a statistically significant relationship between the different pathologies and stent implementation.

It's noteworthy that for the Pearson Chi-Square test, 10 cells (71.4%) had expected counts less than 5, with the minimum expected count being .64. This observation indicates potential limitations in the reliability of the chi-square test results, as the validity of the test is contingent upon meeting certain assumptions, including the requirement that expected cell counts should not be too small. In this instance, the presence of expected counts below 5 in a substantial proportion of cells suggests that caution should be exercised in the interpretation of the chi-square findings.

Table 6: Chi-Square Tests between pathologies and stent implants

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.248[a]	6	.012
Likelihood Ratio	18.020	6	.006
N of Valid Cases	50		

a. 10 cells (71.4%) have expected count less than 5. The minimum expected count is .64.

Stent and Gender Correlation

The presented results in table 7.a offer a cross-tabulation analysis examining the relationship between stent implantation and gender among a sample of individuals. Among male participants, 10 individuals had undergone stent implantation, while 20 males did not have stents implanted. This indicates that stent implantation was observed in 10 out of 30 male individuals, constituting 33.3% of the male subgroup. Similarly, among female participants, 6 individuals had stent implants, while 14 females did not. Consequently, stent implantation was observed in 6 out of 20 female individuals, accounting for 30% of the female subgroup.

Table 7.a. Stent and Gender Crosstabulation

Count				
		Gender		Total
		Male	Female	
Stent	Yes	10	6	16
	No	20	14	34
Total		30	20	50

Table 7.b provided results pertain to chi-square tests conducted to examine the relationship between stent implantation and gender. The Pearson Chi-Square statistic yielded a value of .061 with 1 degree of freedom. The associated asymptotic significance,

reported as .804 for a two-sided test, indicates that there is no statistically significant association between stent implantation and gender at the conventional significance level of .05.

Additionally, it is noted that none of the cells have expected counts less than 5, with the minimum expected count being 6.40. This observation indicates that the assumptions underlying the chi-square tests are met, enhancing the reliability of the obtained results.

Table 7.b Chi-Square Tests Stent and Gender

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.061[a]	1	.804		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.062	1	.804		
Fisher's Exact Test				1.000	.528
N of Valid Cases	50				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.40.					
b. Computed only for a 2x2 table					

4. Conclusion

In conclusion, this study utilized a retrospective and cross-sectional design to evaluate the potential of cardiac CT as an alternative to cardiac catheterization. Conducted at Alia Governmental Hospital in Hebron, the research spanned from February 28, 2024, to May 1, 2024, with a sample of 50 individuals aged 40-60 who underwent cardiac catheterization. Additionally, cardiac CT scan records from private centers were reviewed for patients referred by the hospital. The study meticulously compared procedural outcomes, complications, and diagnostic accuracy between cardiac catheterization and cardiac CT. The comprehensive data collection and analysis provided valuable insights into the diagnostic capabilities, safety profiles, and patient outcomes of both modalities. The findings underscore the real-world applicability and effectiveness of cardiac CT, suggesting its potential to complement or even replace traditional cardiac catheterization in certain clinical scenarios.

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