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Original Research Article

Diagnostic Accuracy of Echocardiography in Assessment of Ejection Fraction Taking CT-Cardiac Function Analysis as Gold Standard

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Abstract: *Ejection fraction (EF) is a vital parameter in assessing cardiac function and guiding therapeutic decisions. While echocardiography remains the most commonly used modality due to its non-invasiveness and accessibility, its diagnostic accuracy in EF estimation has been debated. Cardiac computed tomography (CT), although less frequently utilized, offers potential advantages in EF evaluation.* ***Objective:*** *To determine the diagnostic accuracy of ejection fraction (EF) measurements obtained via echocardiography and to compare these results with those obtained from cardiac CT.* ***Methods:*** *This observational, comparative study was conducted at KRL Hospital, Islamabad, from December 15, 2024, to March 15, 2025. After obtaining ethical approval from the institutional review board, a total of 100 patients aged 20–70 years of both genders, presenting with suspected or known cardiac conditions requiring EF assessment, were recruited through non-probability consecutive sampling. EF was measured for all participants using both transthoracic echocardiography and cardiac CT. Sensitivity and specificity for detecting abnormal EF were calculated using CT findings as the reference standard. Statistical analysis was conducted using SPSS version 25.* ***Results:*** *Echocardiography demonstrated moderate diagnostic accuracy for EF assessment, with a sensitivity of 55% and specificity of 67%. In contrast, cardiac CT showed superior diagnostic performance, achieving a sensitivity of 74% and specificity of 80% in detecting abnormal EF.* ***Conclusion:*** *Echocardiography provides moderate diagnostic accuracy for evaluating ejection fraction, with relatively lower sensitivity and specificity compared to cardiac CT. The findings suggest that cardiac CT may serve as a more reliable modality for EF assessment, particularly in cases where precise evaluation is critical.*
Keywords: Ejection fraction, echocardiography, cardio CT, accuracy

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Introduction

Ejection fraction (EF) is an essential measurement in evaluating the function of the heart: it reflects the amount of blood the left ventricle ejects with each contraction as expressed in percentage (1). It is particularly important to evaluate the true EF correctly to diagnose heart failure and to make further therapeutic decisions (2). Among the diagnostic tools, the echocardiography is most often used because it is non-invasive and does not require much equipment. However, the ability of echocardiography in quantifying specific parameters such as EF has been challenged particularly when compared with other better imaging techniques such as cardiac CT which is often rated as the gold standard (3, 4).
Echocardiography has always been considered the primary imaging technique for real-time structural and functional analysis of the human heart. It is reported that its EF measurement capability is accurate within a range of 70–80% concerning such sophisticated imaging systems (5). The problem is it depends on how well the operator is skilled and depends on quality of image that causes variability. Dini et al. (2024) used echocardiography in their study on overall diagnostic value for reduced EF (<40%) yielding 85% sensitivity and 78% specificity, however, the discernment was observed in the grey zone (6).
Cardiac CT, on the other hand, has higher spatial resolution and higher degree of reproducibility (7). Zhang et al. (2021) presented in their meta-analysis that cardiac CT has level 1 accuracy of 95% for EF measurement with inter and intra-observer reproducibility of less than 5% (8). The strength of CT is in acquisition of accurate volumetric data which is particularly useful especially when echocardiographic studies give inconclusive results. However, because of the following disadvantages, CT is more expensive, less accessible and has radiation effects which limit a routine use (9).
Currently, reference data also indicate substantial difficulties in the agreement between the two modalities. Research indicates that there can be a disagreement of up to 20–30% between EF results gained from echocardiography and CT and an even poorer agreement in obese patients or those with poor acoustic windows (10). It is possible that existing literature has depicted these disparities in an effort to better tailor clinical decision making and determine which patients CT may be more appropriate for.
The objective of the current research is to determine the degree of accuracy of EF measurements provided via echocardiography and to compare these results with CT findings to identify correlations relevant to clinical practice and patient outcomes.

Methodology

After the ethical approval from the institutional review board, this, observation study was conducted at KRL hospital Islamabad from 15/dec/2024 to 15/mar/2025. Through non-probability consecutive sampling, 100 patients aged 20-70 years, both gender, suspected or confirmed cardiac conditions with EF evaluation were recruited from a tertiary health care setting. For this reason, patients were included consecutively according to their ability to undergo both echocardiography and CT cardiac function analysis in a one-week period to reduce sampling period variability. Specific exclusion criteria included; contraindication to perform CT such as severe renal disease or iodine contrast allergy and inadequate echo windows.
All patients received a standard transthoracic echocardiography examination using accredited sonographers and commercially available ultrasound equipment. EF was determined with the biplane Simpson's method as suggested by the American Society of Echocardiography. In cardiac CT, a contrast enhanced ECG gated scan was undertaken using a

multi-detector CT scanner. EF was measured volumetrically between the end-diastolic and end-systolic frames using a cardiac application.
The primary outcome was the diagnostic accuracy of echocardiography in classifying EF into clinically relevant categories: normal (≥50 %); borderline – 41—49 %; reduced ≤ 40%. Echocardiography diagnostic accuracy for reduced EF was evaluated by calculating sensitivity, specificity, positive predictive value and negative predictive value. The sensitivity and specificity of Cardio-CT for detecting EF percent reduction was also determined, and ROC curve analysis was also performed by SPSS version 26 at a significance level of $p < 0.05$.

Results

The study included 100 participants with a mean age of 54.98 ± 20.6 years. The cohort consisted of 61 males (61%) and 39 females (39%). The mean ejection fraction (EF) measured by echocardiography was 45.01 ± 12.9%, while the mean EF assessed by CT cardiac function analysis was 43.25 ± 13.8%. Among the participants, 51 (51%) were classified as having abnormal EF based on clinical thresholds (Table 1).
Echocardiography demonstrated moderate diagnostic performance in assessing EF (Table 2). Sensitivity for detecting abnormal EF was 55%, while specificity was 67%. The positive predictive value (PPV) and negative predictive value (NPV) were 64% and 59%, respectively, with an overall accuracy of 61%. Cross-tabulation revealed that echocardiography correctly identified 28 true positives and 33 true negatives but misclassified 16 false positives and 23 false negatives. AUC calculated through ROC curve was 0.400 (Figure 1)
Cardiac CT showed superior diagnostic accuracy compared to echocardiography. The sensitivity and specificity for detecting abnormal EF were 74% and 80%, respectively (Table 3). PPV and NPV were 79% and 75%, respectively, resulting in an overall accuracy of 77%. Cross-tabulation revealed 37 true positives and 40 true negatives, with only 9 false positives and 14 false negatives. These findings highlight the enhanced reliability of cardiac CT in EF assessment, establishing it as a robust reference standard. AUC calculated through ROC curve was 0.241 (Figure 2).

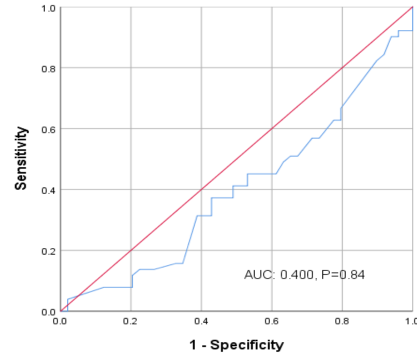

Figure 1: ROC curve analysis of Echocardiography

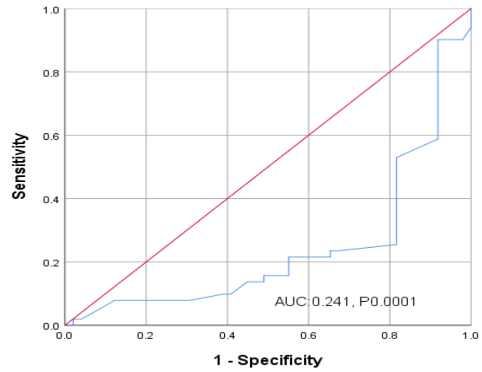

Figure 2: ROC curve analysis of Cardio-CT.

Table 1: Demographic and clinical parameters of the study participants

Variables	Mean and frequency (n=100)
Age (years)	54.98±20.6
Gender	
Male	61 (61%)
Female	39 (39%)
Echocardiography EF (%)	45.01±12.9
CT Cardiac EF (%)	43.25±13.8
Frequency of ejection fraction (EF)	51 (51%)

Table 2: Diagnostic accuracy of Echocardiography

Echocardiography	Ejection Fraction	
	Yes	No
Yes	28	16
No	23	33
Sensitivity	55%	
Specificity	67%	
PPV	64%	
NPV	59%	
Accuracy	61%	

Table 3: Diagnostic accuracy of Cardio-CT

Cardio-CT	Ejection Fraction	
	Yes	No
Yes	37	9
No	14	40
Sensitivity	74%	
Specificity	80.%	
PPV	79%	
NPV	75.00%	
Accuracy	77%	

Discussion

The results of the present study support earlier investigations regarding diagnostic limitations of echocardiography in measuring EF, as well as validation of cardiac CT as a reference method. These results of 55% sensitivity and 67% specificity for echocardiography in detecting abnormal EF are consistent with prior studies in which echocardiography had sensitivity between 50% and 85%, specificity between 60% to 75%, with respect to operator skill and imaging environment (11). The median AUC of 0.400 in the present study reinforces the ability of echocardiography in patients with borderline EF or poor acoustic windows.

Cardiac CT on the other hand had a significantly higher sensitivity (74%) and specificity (80%) as was post by other authors describing its superior retest reproducibility and accuracy. Nicol et al (2023) examined the same aspect and revealed that they obtained a CT EF measurement accuracy of 75-85% with less than 5 % inter-observer variability (12). The AUC of 0.741 in this study brings these findings into perspective hence validating the effectiveness of CT in complex clinical settings. This was due to statistically significant variation in terms of false positive and false negative ratio for the echocardiography, where 16 out of total cases displayed error in the indices of the classification of abnormal EF in this and previous studies. Such differences are associated with poor imaging conditions in obese, lung interference or arrhythmia (13). On the other hand, Cardiac CT had 9 false positives and 14 false negatives, offered consistent volumetric measurements useful in determining accurate EF.

Even though cardiac CT has even better diagnostic performance results, there are some drawbacks to it. The expense, the irradiation, and availability keep it from being used regularly. Therefore, echocardiography continues to be the main imaging study; any equivocal cases or situations requiring high precision will require CT scans (14).

These findings will require enhanced approaches in the echocardiographic measurements for instance the use of strain imaging or contrast. Future research should also investigate the integration of echocardiography with other imaging techniques that may improve the diagnostic accuracy of EF assessments.

Conclusion

This study indicated that echocardiography to diagnose ejection fraction has a moderate diagnostic accuracy with high sensitivity and low specificity as compared to cardiac CT. Reliability and precision of cardiac CT were better than the other techniques, proving that cardiac CT is the most accurate measurement for left ventricular EF. Probably improving existing echocardiography techniques or introducing a combination of methods could increase diagnostic yields and help in decision making.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-KRLH-0941-24)
Consent for publication
Approved
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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

BI (PG trainee),
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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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