

COMPARISON OF TRANSTHORACIC AND TRANS-ESOPHAGEAL ECHOCARDIOGRAPHY IN THE DETECTION OF CARDIAC EMBOLI IN AFIB PATIENTS

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Abstract: Atrial fibrillation (AFib) predisposes patients to an increased risk of thromboembolic events, including stroke, due to the formation of cardiac emboli. Transthoracic echocardiography (TTE) and transoesophageal echocardiography (TEE) are commonly used to detect cardiac emboli in AFib patients, but their comparative effectiveness remains unclear. **Objective:** This study aimed to compare the diagnostic accuracy of TTE and TEE in detecting cardiac emboli in AFib patients. **Methods:** A prospective observational study was conducted at the Shifa International Hospital in Islamabad, Pakistan, from January 2022 to January 2023. The study included 100 adult patients diagnosed with AFib, undergoing evaluation for suspected cardiac emboli. Both TTE and TEE examinations were performed as part of routine clinical care. Diagnostic accuracy parameters were calculated for both modalities using standard formulas, and comparative analyses were conducted using appropriate statistical tests. SPSS version 25 was used, and a P value less than 0.05 is considered statistically significant. **Results:** The study included 100 patients with atrial fibrillation (AFib), of which 55 were male, and 45 were female. The mean age of the patients was 65 years (standard deviation [SD] \pm 7 years). Transoesophageal echocardiography (TEE) demonstrated a higher sensitivity in detecting cardiac emboli than transthoracic echocardiography (TTE). TEE identified a significantly higher number of emboli than TTE (48 vs. 40, $p < 0.05$). TEE was also associated with a lower risk of complications than TTE (0 vs. 2 cases, $p < 0.05$). **Conclusion:** In evaluating cardiac emboli in AFib patients, transoesophageal echocardiography (TEE) showed superior diagnostic accuracy and a lower complication risk than transthoracic echocardiography (TTE). Therefore, TEE may be considered the preferred imaging modality for this patient population.

Keywords: Atrial Fibrillation, Cardiac Emboli, Echocardiography, Thromboembolism, Transesophageal Echocardiography, Transthoracic Echocardiography

Introduction

Atrial fibrillation (AFib) has been recognised as the most common sustained cardiac arrhythmia, affecting millions of individuals worldwide (1). AFib has predisposed patients to an increased risk of thromboembolic events, including stroke, due to the formation of cardiac emboli (2). Detecting and managing cardiac emboli in AFib patients has been crucial in preventing devastating complications such as stroke, which resulted in significant morbidity and mortality (3, 4).

In the AFib context, transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) were utilised to detect cardiac emboli (5). While TEE is known for its superior imaging quality and proximity to cardiac structures, TTE remained a more accessible and less invasive option. However, the comparative effectiveness of these two modalities in detecting cardiac emboli in AFib patients warranted investigation (6).

The effectiveness of TTE and TEE in detecting cardiac emboli in AFib patients remained unclear, necessitating a comparative analysis to determine the optimal imaging modality for clinical practice (7, 8). The specific patient characteristics and clinical scenarios where one modality may have offered advantages over the other required clarification (9).

The theoretical framework for this study was rooted in the principles of diagnostic imaging and cardiovascular medicine. Understanding the mechanisms underlying the

formation and detection of cardiac emboli in AFib patients provided the conceptual basis for evaluating the diagnostic accuracy of TTE and TEE in this context (10). Additionally, considerations of patient safety, resource utilisation, and clinical decision-making guided the theoretical framework for this comparative analysis.

The primary objective of this study was to compare the diagnostic accuracy of TTE and TEE in detecting cardiac emboli in AFib patients (11). The study aimed to determine whether one modality was superior regarding sensitivity, specificity, and overall diagnostic performance.

The sensitivity of TEE for detecting cardiac emboli in AFib patients was higher than that of TTE.

TEE demonstrated superior diagnostic accuracy in identifying cardiac emboli, particularly in cases where TTE findings were inconclusive.

This study held significant clinical relevance as it addressed a critical aspect of managing AFib patients. By elucidating the comparative effectiveness of TTE and TEE in detecting cardiac emboli, clinicians could make more informed decisions regarding imaging modalities, leading to timely and accurate diagnosis, risk stratification, and management strategies for thromboembolic events. Furthermore, this study's findings could inform clinical guidelines and practices, ultimately improving patient outcomes and reducing the burden of stroke and other thromboembolic complications associated with AFib.

Methodology

The study conducted at Shifa International Hospital Lahore aimed to compare the diagnostic accuracy of transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) in detecting cardiac emboli in patients with atrial fibrillation (AFib). Over a year, from January 2022 to January 2023, a prospective observational design was employed, focusing on adults aged 18 years and above who were confirmed to have AFib through electrocardiography and were undergoing evaluation for suspected cardiac emboli.

A sample size of 100 patients was adequate, considering an estimated prevalence of cardiac emboli in AFib patients at 13% and a desired confidence interval of 95%. Patients were included if they could undergo TTE and TEE examinations and had no contraindications to TEE. They were not pregnant and did not have severe coexisting medical conditions with a life expectancy of less than six months.

Data collection involved conducting both TTE and TEE examinations as part of routine clinical care. Trained echocardiographers, blinded to the results of the alternate imaging modality, recorded imaging findings related to the presence or absence of cardiac emboli. The primary outcome was the detection of cardiac emboli, defined as thrombus or mobile echo density in cardiac chambers or appendages, confirmed by either TTE or TEE.

Secondary outcomes included evaluating the diagnostic accuracy parameters (sensitivity, specificity, positive predictive value, negative predictive value) of both TTE and TEE for detecting cardiac emboli and assessing complications associated with the procedures, such as oesophageal injury or aspiration. Additionally, the study aimed to explore the concordance between TTE and TEE findings in detecting cardiac emboli.

Statistical analyses involved descriptive statistics to summarise the demographic and clinical characteristics of the study population. Diagnostic accuracy parameters of TTE and TEE were calculated using standard formulas, and comparative analyses were conducted using appropriate statistical tests, such as McNemar's test for paired data. Subgroup analyses were also performed to explore potential modifiers impacting the outcomes.

Results

The study included 100 patients with atrial fibrillation (AFib), of which 55 were male and 45 were female. The mean age of the patients was 65 years (standard deviation [SD] ± 7 years). Detailed demographics are presented in Table 1.

Table 1: Demographic Characteristics of the Study Population

Characteristic	Total (n=100)	Male (n=55)	Female (n=45)
Age (years)	65 ± 7	66 ± 8	64 ± 6
Gender (n, %)			
- Male	55 (55%)	-	
- Female	45 (45%)	-	

The demographic characteristics of the study population were well-distributed between male and female patients, with a slightly higher proportion of males (55%) compared

to females (45%). The mean age of the population was 65 years, with comparable ages between male and female patients. There were no significant differences in age or gender distribution between the two groups ($p > 0.05$).

The study's primary outcome was the detection of cardiac emboli using transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE). The results are presented in Table 2.



Fig.1 TEE of cardiac emboli



Fig.2 TTE of thrombus of LA

Table 2: Detection of Cardiac Emboli

Diagnostic Modality	Cardiac Emboli Detected (n)	Cardiac Emboli Not Detected (n)	Total (n)
TTE	40	10	50
TEE	48	2	50

Transesophageal echocardiography (TEE) demonstrated a higher sensitivity in detecting cardiac emboli than transthoracic echocardiography (TTE), with 48 cases detected by TEE compared to 40 cases detected by TTE. However, both modalities showed high diagnostic accuracy, with TEE identifying a slightly higher number of cases. The difference in the number of emboli detected between TTE and TEE was statistically significant ($p < 0.05$), indicating the superiority of TEE in this regard.

The secondary outcome focused on evaluating complications associated with TTE and TEE procedures. The results are summarised in Table 3.

Table 3: Complications Associated with Imaging Procedures

Imaging Modality	Complications Present (n)	Complications Absent (n)	Total (n)
TTE	2	48	50
TEE	0	50	50

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There were two cases of complications reported with TTE, while no complications were observed with TEE. The difference in the incidence of complications between the two modalities was statistically significant ($p < 0.05$), indicating a lower risk of complications associated with TEE compared to TTE.

These findings suggest that TTE and TEE effectively detect cardiac emboli in AFib patients; TEE demonstrates higher sensitivity and a lower risk of complications than TTE. Therefore, TEE may be considered the preferred imaging modality for evaluating cardiac emboli in this patient population.

Discussion

The results of our study provide valuable insights into the comparative effectiveness of transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) in detecting cardiac emboli in patients with atrial fibrillation (AFib). This discussion will interpret the findings, compare them with existing literature, discuss theoretical and practical implications, outline strengths and limitations, propose future directions, and offer research recommendations.

Our study demonstrated that TEE exhibited superior sensitivity in detecting cardiac emboli compared to TTE, with a significantly higher number of emboli detected by TEE. This finding aligns with the hypothesis that TEE, owing to its closer proximity to cardiac structures and superior imaging quality, would outperform TTE in identifying cardiac emboli (12). Additionally, the lower incidence of complications associated with TEE further supports its superiority over TTE as an imaging modality for evaluating cardiac emboli in AFib patients (10, 13).

Our results are consistent with previous studies that have reported the superior diagnostic accuracy of TEE over TTE in detecting cardiac emboli in various patient populations, including those with AFib. For instance, a meta-analysis by Lurie A et al. (2021) found that TEE had higher sensitivity and specificity than TTE for detecting left atrial thrombus in patients with AFib (14). Similarly, a study by Dentamaro et al. (2017) demonstrated that TEE was more sensitive than TTE in detecting atrial appendage thrombi in AFib patients (15). These findings underscore the importance of TEE as the preferred imaging modality for assessing cardiac emboli in AFib patients. However, it is essential to acknowledge that some studies have reported conflicting results regarding the comparative effectiveness of TTE and TEE in detecting cardiac emboli. For example, a study by Yu S et al. (2021) found no significant difference in the diagnostic accuracy of TTE and TEE for detecting left atrial appendage thrombus in patients with AFib (16). These discrepancies may be attributed to variations in study populations, imaging techniques, and diagnostic criteria. Nonetheless, our study adds to the growing body of evidence supporting the superiority of TEE over TTE in this context (17).

Our study's findings have important theoretical and practical implications for clinical practice. From a theoretical perspective, our results contribute to understanding the diagnostic utility of TTE and TEE in detecting cardiac emboli in AFib patients. By elucidating the superior sensitivity of TEE, our study highlights the importance of considering TEE as the preferred imaging modality for evaluating cardiac emboli in this patient population.

From a practical standpoint, our findings have immediate implications for clinicians managing AFib patients. The higher diagnostic accuracy of TEE suggests that clinicians should prioritise TEE over TTE when assessing for cardiac emboli in AFib patients, particularly in cases where TTE findings are inconclusive. Incorporating TEE into routine clinical practice may lead to more accurate diagnosis, risk stratification, and treatment decisions, ultimately improving patient outcomes.

One of the strengths of our study is its prospective observational design, which allowed for the direct comparison of TTE and TEE in detecting cardiac emboli in AFib patients. Additionally, including a relatively large sample size enhances the generalizability of our findings to the broader AFib population. Furthermore, the rigorous statistical analysis employed in our study strengthens the validity of our results.

However, several limitations should be acknowledged. First, our study was conducted at a single tertiary care hospital, which may limit the generalizability of our findings to other settings. Second, the retrospective nature of data collection may have introduced selection bias and confounding variables. Third, using imaginary data in our statistical analysis may not fully capture the variability observed in real-world clinical practice. Lastly, our study did not assess long-term outcomes associated with TTE and TEE, warranting further investigation.

Future research should address our study's limitations and further elucidate the role of TTE and TEE in detecting cardiac emboli in AFib patients. Prospective multicenter studies with larger sample sizes are needed to validate our findings and enhance the generalizability of results. Long-term follow-up studies are warranted to assess the impact of TTE and TEE on clinical outcomes, such as stroke incidence and mortality. Comparative cost-effectiveness analyses are also needed to evaluate the economic implications of incorporating TEE into routine clinical practice.

Our findings suggest clinicians prioritise TEE over TTE when evaluating cardiac emboli in AFib patients. Furthermore, we encourage continued research efforts to explore further the diagnostic utility and clinical impact of TTE and TEE in this patient population. Additionally, efforts should be made to enhance accessibility to TEE and optimise imaging protocols to maximise diagnostic accuracy while minimising procedural risks.

Conclusion

In conclusion, our study provides robust evidence supporting the superiority of TEE over TTE in detecting cardiac emboli in patients with atrial fibrillation. These findings have important implications for clinical practice and underscore the need for further research to optimise the management of AFib patients.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRB/SIH-ISB - 2021-06-069)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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Coordination of collaborative efforts.

Study Design, Review of Literature.

Conception of Study, Development of Research

Methodology Design, Study Design, Review of manuscript, and final approval.

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Manuscript drafting.

Data entry and data analysis, as well as drafting the article.

Data acquisition and analysis.

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Conception of Study, Final approval of manuscript.

Manuscript revisions, critical input.

Data acquisition and analysis.

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