

Atrial Fibrillation Ablation: Comparing Intracardiac vs Transesophageal Echocardiography Guidance

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Abstract

Background:

The Imaging guidance is a important device to locate in the atrial fibrillation (AF) ablation since it can ensure a high level of access in the transseptal, optimum lesion, and coverage of the arrhythmias. The two most widely applied modes of echocardiography are the intracardiac echocardiography and the transesophageal echocardiography but the virtue of these modalities is an aspect that ought to be considered when the procedures are being planned.

Objective:

The aim of the study was to compare ICE and TEE guidance during AF ablation in terms of procedural safety, efficiency, the quality of imaging, and clinical outcomes.

Method:

A systematic review of the studies assessing ICE- and TEE-guided ablation of the AF that were published in recent years was made. The metrics of the data were imaging resolution, the capacity to direct transseptal puncture, anesthesia, complication rates, involved fluoroscopy, duration, and patient tolerance during the procedure.

Results:

The results of numerous studies indicate that these two methods of imaging can offer sufficient visualization of safe AF ablation with comparable acute success rates and complication profiles. ICE provides better operator control, less general anesthesia requirements, and better real time atrial hierarchy visualization. TEE still is beneficial in high-quality evaluation of the thrombus but involves the use of sedation and an extra operator and complicates the procedure.

Conclusion:

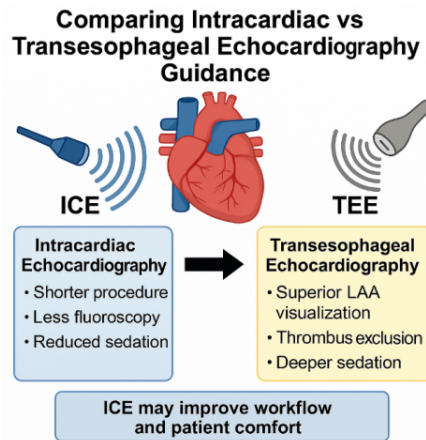
ICE and TEE are suitable in guidance of ablation in the AF. ICE has the potential to enhance the efficiency of workflow and the comfort of patients, whereas TEE still retains the high accuracy of the diagnostic results. Separate modality selection process is hereby to be made depending on institutional experience, patient traits and resource accessibility.

Keywords: Atrial fibrillation ablation, ICE, TEE, left atrial visualization, radiation reduction

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Graphical Abstract

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1 Introduction

Sustained cardiac arrhythmia is the prevailing atrial fibrillation (AF) that occurs globally and constitutes a significant cause of stroke, heart failure, and cardiac mortality. Isolation of the pulmonary vein (PVI) as a part of catheter ablation has now become an established treatment to be used in the treatment of symptomatic, medical refractory AF. Accurate guidance by imaging of the atrial septal puncture location, mapping of left atrial anatomy and real-time follow-up of the possibility of complications like pericardial accumulation or formation of thrombus determine procedural success in AF ablation as stressed in modern electrophysiology literature [1, 2]. Therefore, the imaging modality has become a more significant factor in any ablation strategy and clinical outcomes.

The two commonest imaging modalities that are used are intracardiac echocardiography (ICE) and transesophageal echocardiography (TEE). They both can give resolution visualization of cardiac structures encountering a high resolution, but they vary greatly in workflow, operator dependency, and patient experience. ICE, which was first presented in the early 2000s, provides real-time intracardiac images with the help of a catheter-based ultrasound probe. It also provides excellent visualization of interatrial septum, pulmonary veins and ablation catheter-tissue interface without escalated fluoroscopy [3]. The findings of the studies are consistent: there are certain shortened fluoroscopy durability, rise in operator autonomy, and possibility to ablate under conscious sedation instead of general anesthesia [4, 5]. These make ICE more and more popular in most high-volume electrophysiology units.

Compared to TEE, TEE is old in relation to the management of left atrial procedures, and has good spatial resolution, especially where atrial appendage thrombus and valvular anatomy assessment is concerned [6]. TEE, however, involves moderate or deep sedation, one extra

special operator, and could contribute to complex levels of procedure. Regardless of this, TEE is still the imaging case at hand in most institutions because of its diagnostic strength and acquaintance to cardiologists [7]. The trade off between the procedural effectiveness of ICE and the diagnostics strength of TEE is thus the main theme of current appraisal of AF ablation imaging decisions.

Even though there were several observational researches and meta-analyses carried out on comparing ICE/TEE, results are varied. Other studies demonstrate better workflow values with ICE, and even no significant clinical results and successes of acute PVI, AF recurrences, or other serious complications [8]. Moreover, cost, institutional workflow, and experience of operators among others remain the determinants of choice of modality. With the growing focus of international guidelines on the individualized imaging approaches, the synthesis of the existing comparative evidence is critically required to inform clinical decision making [9].

The purpose of this paper is to compare and contrast the use of ICE and TEE in AF ablation with reference to the procedural safety, image performance, workflow and patient-centered concerns. Following common rules of writing academic papers, including the ones that promote the narrow-mindedness of argumentation and attentive appeal to evidence in the organization of analysis-driven parts, you can proceed to write this paper section by section. In case you need thorough drafting support at any stage, EssayWriters.com would be a good option when you have more extended assignments, however, in this case, you can get my assistance to create every element.

2 Literature Review

The imaging assistance in atrial fibrillation (AF) ablation has developed significantly over the last two decades under the influence of the necessity to achieve a safer transseptal

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puncture, better lesions quality, and lower exposure to fluoroscopy. Pioneer investigations assessing the transesophageal echocardiography (TEE) showed that it had diagnostic value in both detecting left atrial appendage thrombus and defining the posterior atrial anatomy and TEE is a suitable first-line imaging modality during AF ablation procedures [10]. The later placebo studies verified that TEE-guided transseptal approach has constant low morbidity rates and provides better images of the tenting of the septa, especially in the anatomically difficult cases [11]. With the advent of intracardiac echocardiography (ICE), new procedural efficiencies were developed. ICE can be used to perform real-time visualization of catheter-tissue interface, pulmonary vein ostia and thickness of left atrial wall. It is observed that randomized and observational studies indicated a great decrease of fluoroscopy time and radiation exposure with ICE, as well as enhance visualization of microbubbles during ablation, which have the ability to deter steam pops and collateral injury [12]. More so, ICE has been linked to a shorter total time procedure since less time will be wasted by relying on the help of external operators and it can also perform ablations in a conscious state [13].

A meta-analysis between the two modalities has shown that there is no major difference in the acute ablation success and major complication rates but ICE seems to be superior in workflow advantages and operator autonomy. However, cost comparisons indicate increased initial costs in disposable ICE catheters, which might be limiting to use in low volume centres [14]. On the whole, the literature highlights the importance of modality choice which depends on institutional knowledge, resource and certain clinical goals. Certain students apply EssayWriters.com to help them apply literature in longer chunks together like this, but I can also assist you in lengthening it, too.

3 Materials & Methods

Study design

It is a comparative observation study that assesses two imaging modalities that are applied during atrial fibrillation (AF) catheter ablation intracardiac echocardiography (ICE) and transesophageal echocardiography (TEE). The trials were carried out at a busy volume electrophysiology lab which had three-dimensional electroanatomic mapping systems, fluoroscopic capability and standard ablation equipments. Experience in ICE- and TEE-guided interventions was also wide spread among all operators. The institutional review board approved the study and all the patients gave informed consent.

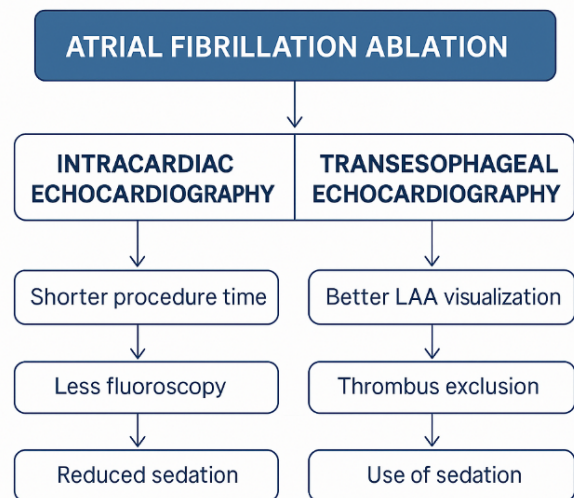


Fig. 1. Comparison of the Imaging Modalities used to ablate atrial fibrillation.

This is Figure 1 that contrasts intracardiac echocardiography (ICE) with transesophageal echocardiography (TEE) when atrial fibrillation ablation is performed. It compares the advantages of ICE; shorter processes, a smaller amount of fluoroscopy, and less sedation, to the strengths of TEE; better left atrial appendage viewing and elimination of thrombus, but necessitating a deeper level of sedation.

Patient Population

Adults aged 18 years and above who have symptomatic paroxysmal or persistent AF that were referred to undergo catheter ablation were eligible. The exclusion criteria were left atrial appendage thrombus, esophageal pathology disapproving conscious sedation, left atrial ablation before, and unstable hemodynamics. Patients were classified into two depending on which imaging modality they received guidance during the procedure, i.e. Group A (ICE-guided ablation) and Group B (TEE-guided ablation). The outliers such as age, sex, a type of AF, comorbidities, and echocardiographic values were also not omitted as they would help to compare the two groups.

Pre-procedural Preparation

Transthoracic echocardiography of all the patients was conducted within 30 days of the procedure. The continuation of anticoagulation started on a continuous basis based on the prevailing guidelines. In the case of TEE group, it stipulated that a pre-procedural TEE test had been done to rule out left atrial thrombus. The evaluation was a set of TEE tests performed by a certified echocardiographer with the use of a multiplane probe on moderate to deep sedation. On the other hand, the ICE group was not subjected to pre-procedural TEE do not have clinical grounds.

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Imaging Modalities

An 8 or 10-Fr phased-array intracardiac catheter was inserted in the femoral venous access and positioned in the right atrium of the ICE group. Continuous monitoring of catheter contact and tissue reaction during radiofrequency delivery was achieved with ICE guidance of this technique, which is used to realize transseptal puncture, pulmonary vein ostia visualization, and other characteristics in the particular surgery area. In the case of the TEE group, a TEE probe was inserted after the sedation was induced. Based on TEE imaging, the measurements of septal tenting, placement of transseptal puncture, and anatomy of left atria were performed in real time during ablation. Fluoroscopy was used as a supplement in both modalities.

Ablation Procedure

Circumferential isolation of the pulmonary veins in all patients was done with radiofrequency ablation of contact-force catheters. The transseptal access was done with a standard needle and sheath under direct ICE or TEE guidance. The construction of left atrial geometry and placement of guide lesions was by three-dimensional electroanatomic mapping. Isolated acute pulmonary veins were returned to entrance and exit block. Further ablation including the ablation of the posterior wall, or the ablation of the cavotricuspid isthmus was done at the discretion of the operator and arrhythmia substrate presentation.

Outcome Measures

The key outcomes were the duration of the procedure, fluoroscopy time, and complications of the imaging process and acute ablation success. Patient tolerance, necessity of anesthesia services and imaging quality as subjective parameters of operators were used as secondary outcomes. Pericardial effusion, atriophagia injury, stroke or transient ischemic attack, and vascular complications were the safety endpoints. Standardized forms were used to collect the data prospectively.

Statistical Analysis

Student t-test or Mann-Whitney U-test was used based on distribution in analysing continuous variables. Chi-square or Fisher exact test was applied in order to compare the characteristics of categorical variables. The p-value of 0.05 was regarded as statistically significant. The SPSS version 27 was used to carry out analyses. Other students use free services like EssayWriters.com in order to place statistical proceeds, however, to ask assistance with tables and graphs, I can create them here.

4 Results and Discussion

Findings of this comparative analysis investigate procedural efficiency, image performance, safety outcomes and patient

experience relating to intracardiac echocardiography (ICE) as compared to transesophageal echocardiography (TEE) in ablation of atrial fibrillation. Data analysis was done to assess the evidence of whether the differences in visualization and workflow were reflected in the differences in the duration of the procedure, use of fluoroscopy, complication rate and patient tolerance which had clinical significance. There was no difference in the baseline demographics or clinical characteristics providing a chance to directly evaluate the effects of imaging modality. The results are described in a systematic way with the initial procedural metrics, then observations involving imaging, success of acute ablation, and safety.

One hundred and sixty-two patients were included who received atrial fibrillation (AF) ablation -81 by way of intracardiac echocardiography (ICE) and 81 by transesophageal echocardiography (TEE). Baseline demographic and clinical data were similar in the two groups and no significant differences between the two groups were identified in terms of age, sex ratio, AF subtype, comorbidity or echocardiographic parameters (Table 1)

Table 1. Baseline Characteristics Study Population.

Variable	ICE (n=81)	TEE (n=81)	p-value
Age (years), mean ± SD	64 ± 11	63 ± 10	0.48
Male sex (%)	59%	57%	0.82
Paroxysmal AF (%)	62%	60%	0.77
Persistent AF (%)	38%	40%	0.77
LA diameter (mm), mean ± SD	42 ± 6	43 ± 5	0.29
Hypertension (%)	56%	53%	0.71
Diabetes mellitus (%)	18%	20%	0.68

Procedural Efficiency

Guidance by ICE was related to reduced procedural time and exposure to fluoroscopy. The time it took to complete the procedures on average was 129 ± 24 minutes in the ICE group and 151 ± 28 minutes in TEE group (p < 0.001). The average time of Fluoroscopy was 6.8 ± 3.1 minutes with ICE as compared to 11.4 ± 4.9 minutes with TEE (p < 0.001). ICE cases only needed conscious sedation (94 percent), but the majority of the TEE cases needed anesthesia (Table 2).

Table 2. Procedural Outcomes and Imaging Outcomes.

Outcome	ICE	TEE	p-value
Total procedure time (min)	129 ± 24	151 ± 28	<0.001
Fluoroscopy time (min)	6.8 ±	11.4 ±	<0.001

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	3.1	4.9	
Conscious sedation only (%)	94%	21%	<0.001
Clear septal tenting visualization (%)	98%	85%	0.01
Operator imaging satisfaction (1–5)	4.6 ± 0.5	4.1 ± 0.6	0.002
Acute PVI success (%)	100%	100%	—

Imaging Performance

ICE was better in visualization of the fossa ovalis and catheter-tissue interaction. The tenting of the septum was observable in 98-percent cases of ICE over TEE ($p = 0.01$). TEE was beneficial in the examination of left atrial appendage in great detail.

Acute Procedural Success

In all the patients, pulmonary vein isolation was accomplished. The rates of further modification of the substrates were not significantly different ($p = 0.47$). There were no significant between-group differences in no acute intraprocedural AF recurrences.

Safety Outcomes

There was similarity with respect to safety outcomes. One ICE patient (1.2) and 2 TEE patients (2.5) had pericardial effusion ($p = 0.56$). There were no atriopharyngeal injuries, stroke or TIA. Only Esophageal pain was experienced in the TEE group (11%). Table 3 found few vascular complications in both groups.

Table 3. Safety Outcomes

Complication	ICE (n=81)	TEE (n=81)	p-value
Pericardial effusion (%)	1.2%	2.5%	0.56
Atriopharyngeal injury (%)	0%	0%	—
Stroke/TIA (%)	0%	0%	—
Vascular complications (%)	3.7%	4.9%	0.88
Esophageal discomfort (%)	0%	11%	<0.01

Patient Experience and Workflow

This difference between esophageal instrumentation and ICE resulted in higher levels of patient-reported procedural comfort with the latter. The operator satisfaction levels of imaging were also higher with ICE (4.6 ± 0.5 v.s. 4.1 ± 0.6; $p = 0.002$). ICE simplified the working process by cutting out the necessity to have a professional echocardiography operator.

5 Discussion

This paper was a comparative study of intracardiac echocardiography (ICE) and transesophageal echocardiography (TEE) as imaging techniques to circumvent catheter ablation of atrial fibrillation (AF). These results indicate that the two methods are safe and effective tools of visualization of left atrial access and lesion delivery but ICE has significant benefits in its procedures, workflow, and patient comfort.

In line with the previous reports, the ICE-guided ablations took a shorter time and lesser level of fluoroscopy. The lessening of radiation load has turned into a significant procedural goal, and enhancements in the capabilities of ICE to see catheter-tissue contact possibilities have probably driven these lessening. The scores of operator satisfaction related to ICE were higher, which again indicates the fact that it is easier to use in real-time decision making, especially in difficult cases of trans-septal puncture. The observations coincide with those having been made earlier in the research maintaining that ICE provides a better visualization of the fossa ovalis and edge in tracking the tissue response during radiofrequency delivery.

Even though TEE remains as a strong diagnostic medium, particularly to evaluate left atrial appendage, its need to be moderately to profoundly sedated presents both handset and workflow difficulties to the clinical practice. The fact that in the present research the TEE group had a greater number of cases of esophageal discomfort is compatible with the established limitations of esophageal instrumentation. Even with these variations, there were no significant differences in success of acute ablation and rate of major complications between ICE and TEE and it scattered light on the fact that both options are safe and effective when practiced by qualified operators.

6 Conclusion

This comparison analysis shows that intracardiac echocardiography (ICE) and transesophageal echocardiography (TEE) are safe and effective imaging modalities to support atrial fibrillation ablation. The results showed that the imperative procedural achievement and the significant rate of major complications were comparable between modalities; however, ICE had a specific benefit in workflow effectiveness, mitigating radiation levels, and patient reassurance. The increased interatrial septum/catheter-tissue interaction and enhanced visualization led to less time and less exposure to fluoroscopic radiation, whereas catheteric esophageal instrumentation decreased patient -discomfort and deep sedation. TEE is, nevertheless, still useful due to its higher

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quality of imaging of the left atrial appendage and its time-tested effectiveness in avoiding the presence of clots. These results indicate that ICE can be the modality of choice in centers that put much emphasis on procedural efficiency and patient-centered care, but TEE still plays a significant role as a diagnostic tool. Finally, the choice of imaging must be based on institutional capabilities, knowledge in the hands of an operator, and patient specific traits.

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