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Review Article

Contribution of Three-Dimensional Transesophageal Echocardiography in the Assessment of Atrial Septal Defects (ASD)

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Abstract: The article examines the contribution of real-time three-dimensional transesophageal echocardiography (3D TEE) in the assessment of ostium secundum atrial septal defects (ASD) in adults. 3D TEE provides a precise and comprehensive view of cardiac anatomy, enabling the evaluation of size, shape, and border quality of the ASD. In a series of 27 cases, 3D TEE demonstrated a strong correlation between 3D-measured ASD parameters and the size of the closure device required. This technique is crucial for accurate pre-interventional evaluation, enhancing the success and safety of percutaneous or surgical interventions for ostium secundum ASD. Three-dimensional transesophageal echocardiography represents a significant advancement in cardiovascular imaging for complex structural heart abnormalities.

Keywords: Three-dimensional transesophageal echocardiography, atrial septal defects, ostium secundum, pre-interventional evaluation, cardiovascular imaging.

INTRODUCTION

Three-dimensional Transesophageal Echocardiography (3D TEE) in real-time has become a revolutionary innovation in cardiovascular imaging, as it allows for significantly improved anatomical evaluation of cardiac structures, such as atrial septal defects (ASD). Due to the complex and morphologically unpredictable three-dimensional anatomy of the atrial septum, 3D TEE visualization adds considerable value to the assessment of ASDs and the oval fossa by providing a more precise determination of the maximal diameter, overall size, and shape of the ASD openings compared to the limited imaging capability of conventional 2D methods [1]. This advantage is even more appreciated in complex septal defects where selecting the best closure device is very challenging [2]. In this study, we aim to demonstrate the utility of three-dimensional Transesophageal Echocardiography in the pre-interventional evaluation of adult atrial septal defects.

DESCRIPTION

We report a retrospective observational study of a series of 27 patients examined at our echocardiography laboratory, all presenting with secundum atrial septal defects (ASD). The age of the patients ranged from 17 to 60 years, with a female predominance (4/1). The main symptom observed was dyspnea (63%), followed by palpitations (57%). In the vast majority of cases, the clinical examination was unremarkable. Electrocardiograms (ECGs) often showed pathological findings consistent with cardiac chamber overload, notably right bundle branch block and right ventricular hypertrophy. The diagnosis of ASD was most frequently made using transthoracic echocardiography (TTE). However, all patients underwent transesophageal echocardiography (TEE) to confirm the diagnosis in doubtful cases, obtain a better anatomical analysis, assess the extent of the lesion pre-therapeutically, and evaluate its impact (Figure 1). The use of 3D TEE was especially valuable when facing difficulties in conventional echocardiography, providing insights into the size, shape, and quality of the ASD borders (Figure 2, 3). The results showed that in 3 cases, the defect was partially closed by the septum primum, with the oval shape being the most frequent. The smallest diameter observed was 8 mm, but in the majority of cases, large ASDs were found (22-36 mm). Percutaneous closure was indicated in 24 patients, while 3 patients underwent surgical intervention either due to multiple defects or edges not amenable to percutaneous closure. The

comparison of ASD diameter measured using 3D TEE and the diameter of the closure device showed a close agreement (92%) between the pre-interventional measurements of the ASD diameter.

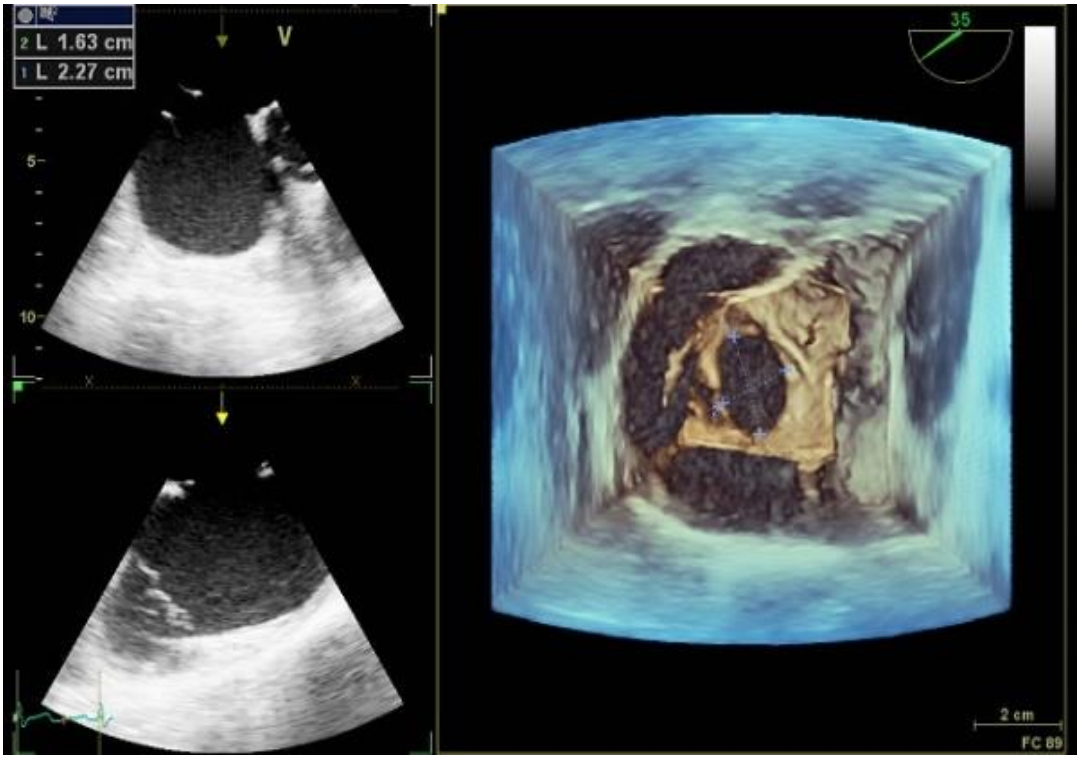

Figure 1: 2D TEE, combined with color Doppler, visualizes the left-to-right shunt of an ostium secundum atrial septal defect (ASD)

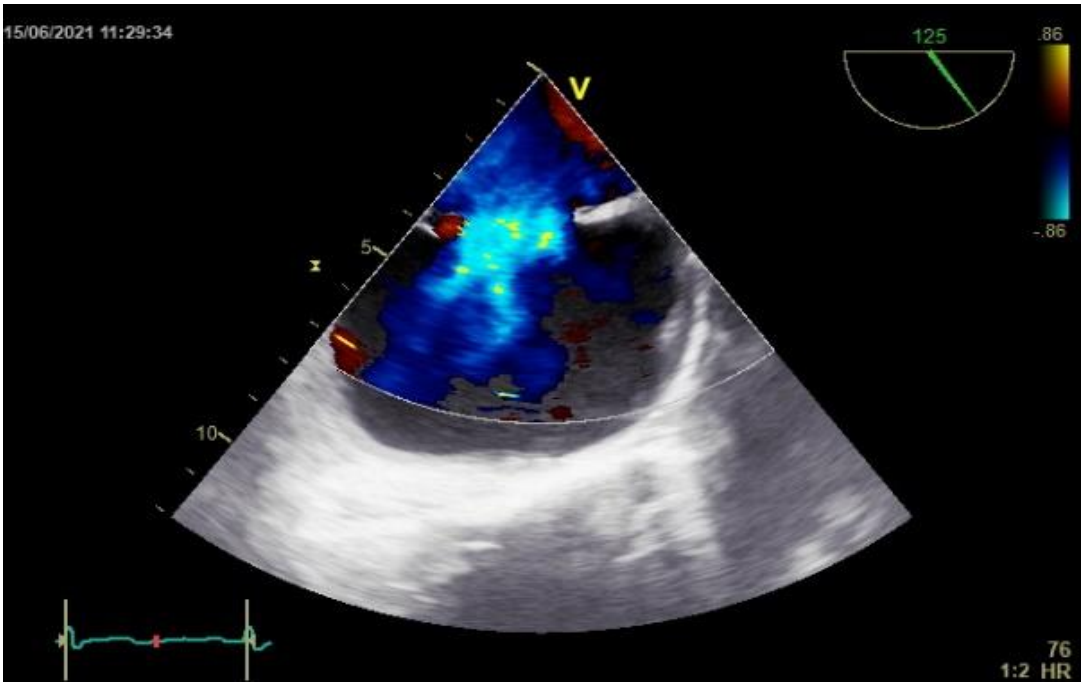

Figure 2: 3D TEE provides a comprehensive assessment of an ostium secundum atrial septal defect (ASD), including a complete measurement of its dimensions

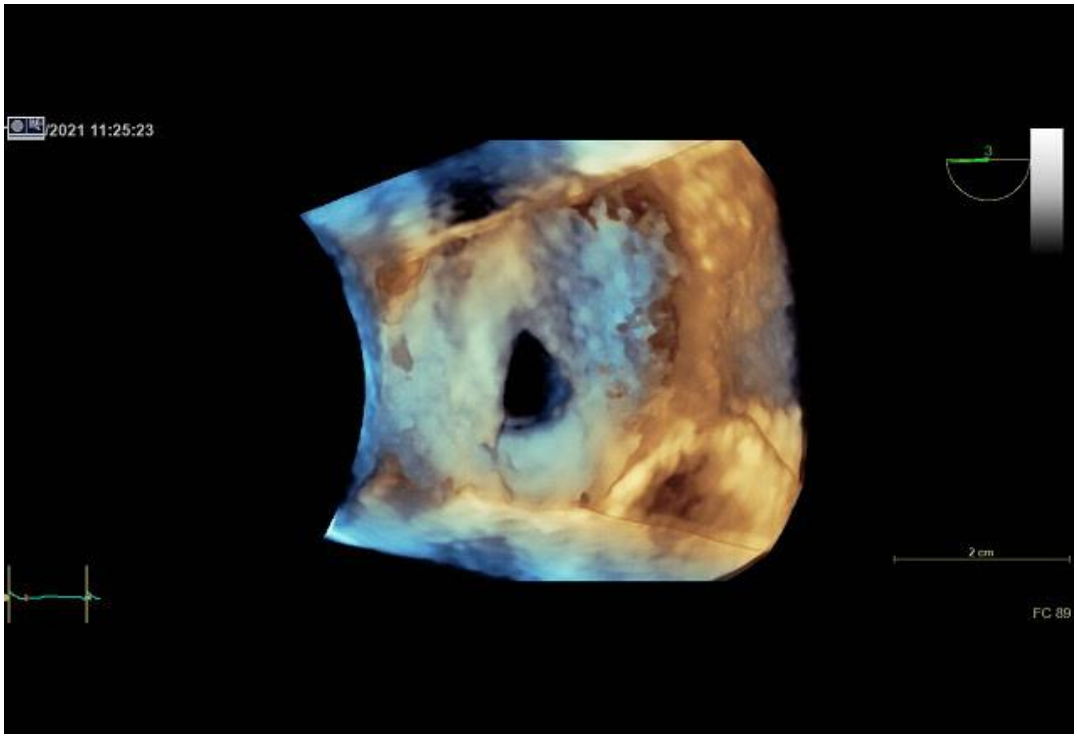

Figure 3: The 3D TEE view of an ostium secundum atrial septal defect (ASD) shows its borders and anatomical relationships

DISCUSSION

Atrial septal defect (ASD) represents a congenital anatomical defect in the mid-portion of the atrial septum, most commonly occurring as an ostium secundum type (the most frequent form). The atrial septum can be explored using transthoracic echocardiography (TTE), two-dimensional transesophageal echocardiography (2D TEE), and three-dimensional transesophageal echocardiography (3D TEE). In TTE, the atrial septum can be examined using various 2D views. However, false images of ASD in the apical four-chamber view corresponding to the low echogenicity of the oval fossa should be avoided. In 2D TEE multiplanar views, the atrial septum can be visualized in different incidences. The 110° view, called "bi-cave," is particularly useful for assessing the oval fossa [3]. In real-time 3D TEE, the atrial septum can be comprehensively and precisely analyzed. The unique "en face" view of the atrial septum (from the left atrium) allows for perfect visualization of the septum primum and the identification of possible septal defects (patent foramen ovale, ASD). Real-time 3D TEE has several advantages over 2D TEE. It enables a precise analysis of the anatomy and morphology of the ASD [4]. Unlike 2D TEE, which requires analysis in multiple views, 3D TEE provides an "en face" visualization of the ASD, providing detailed information [5]:

- The anatomical variant of the ASD (ostium secundum, ostium primum, sinus venosus, sinus coronarius).
- The shape of the septal defect (circular or oval).
- The exact size of the ASD (measured by planimetry or using multiplanar reconstruction software).
- The single or multiple character of the ASD.
- The quality of the ASD borders.
- The presence of any associated anomalies with the ASD (mitral valve prolapse, pulmonary stenosis, abnormal pulmonary venous return, etc.).
- Color Doppler 3D allows for visualization of the interatrial shunt (direction, spatial extension) and its quantification [3].

Three-dimensional echocardiography offers the possibility of shorter and safer interventional procedures. It likely improves patient outcomes by enhancing procedural success [6]. All this additional information is particularly useful for planning a potential closure of the ASD, whether percutaneous or surgical [7]. This examination is indicated when complex anatomy is difficult to evaluate by conventional echocardiography to improve the accuracy of the initial diagnostic evaluation and reduce complications during percutaneous closure, which significantly impacts the success and safety of ASD interventions [8].

CONCLUSION

Based on these results, three-dimensional transesophageal echocardiographic measurements of various ASD parameters show strong and highly significant correlations between the 3D-derived ASD area and circumference and the size of the device used for closure. Three-dimensional transesophageal echocardiography proves to be an indispensable imaging technique for the pre-interventional evaluation of ostium secundum ASD in adults, particularly when the anatomy is complex and challenging to evaluate by conventional echocardiography. It enhances the accuracy of the initial diagnosis and reduces complications during percutaneous or surgical closure, which significantly impacts the success and safety of ASD interventions. Three-dimensional transesophageal echocardiography offers precise dynamic visualization of complex structural heart malformations, such as ASDs, enabling clinicians to make more informed therapeutic decisions. The information provided by 3D TEE, including size, shape, borders, and any associated anomalies with the ASD, is essential for selecting the optimal closure device and planning a tailored intervention for each case. In conclusion, 3D TEE represents a major advancement in cardiovascular imaging, playing a crucial role in the evaluation and treatment of ostium secundum ASDs. Thanks to its real-time three-dimensional imaging capabilities, it provides a more precise and comprehensive view of cardiac anatomy, thereby contributing to more successful and safer interventions for patients with ASDs.

Disclosure: No conflicts of interest.

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