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Case Report

A single atrial septal defect masquerading as multiple defects due to a refraction artifact – A cautionary note

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ABSTRACT

Echocardiography is useful for making a diagnosis of atrial septal defect (ASD) by directly visualizing the shunt flow. Herein, we present a case in which a single ostium secundum type ASD masqueraded as multiple defects on color flow imaging by transthoracic echocardiography. We confirmed by transesophageal echocardiography that this patient actually had a single ASD. An echocardiographic refraction artifact was considered to be the cause of this phenomenon. We need to be aware of the existence of this artifact to avoid misdiagnosis.

〈**Learning objective:** Echocardiography is useful for making a diagnosis of atrial septal defect (ASD). We present the case with a single ostium secundum type ASD which masqueraded as multiple defects on color flow imaging due to a refraction artifact. Refraction artifacts can make multiple false flow signals on color imaging. This case emphasizes the importance of an understanding of the existence of this artifact in not only B mode imaging but also color Doppler imaging.〉

Introduction

Echocardiography is an essential tool to make a diagnosis of atrial septal defect (ASD). Transcatheter device closure has now become an accepted alternative to surgical repair for ostium secundum type ASD [1,2]. The defect morphology determines the indication for transcatheter treatment. In cases of multiple defects, percutaneous device closure is not generally indicated [3,4]. We report a case in which a single ostium secundum type ASD masqueraded as multiple defects on color flow imaging due to a refraction artifact. This artifact made the decision regarding indication for transcatheter closure difficult.

Case report

A 60-year-old woman presented to our hospital with a chief complaint of dyspnea. A chest X-ray showed cardiomegaly with a cardiothoracic ratio of 68%. Dilatation of the pulmonary artery was also evident. Transthoracic echocardiography (TTE) using iE33 (Philips, Andover, MA, USA) with a S5-1 transducer (1–5 MHz variable frequency) revealed dilatation of the right atrium (RA), left atrium (LA), and right ventricle (RV). A parasternal short-axis view showed flattening of the interventricular septum during diastole, indicating RV volume overload. Ostium secundum type ASD with a single LA-to-RA shunt was detected on color Doppler imaging in parasternal RV inflow and apical 4-chamber views (Fig. 1A and B). However, in subcostal view, multiple color flow signals traversing from the LA into the RA through the defects were visualized (Fig. 1C and D). This finding raised the possibility of multiple shunt ASD. For further evaluation, we performed transesophageal echocardiography (TEE) using a S7-3t transducer (3–7 MHz variable frequency). Both 2D-TEE color flow imaging and 3D-TEE revealed a centrally located single ASD with a single LA-to-RA shunt flow (Fig. 2A–C, respectively). Since there was discrepancy regarding

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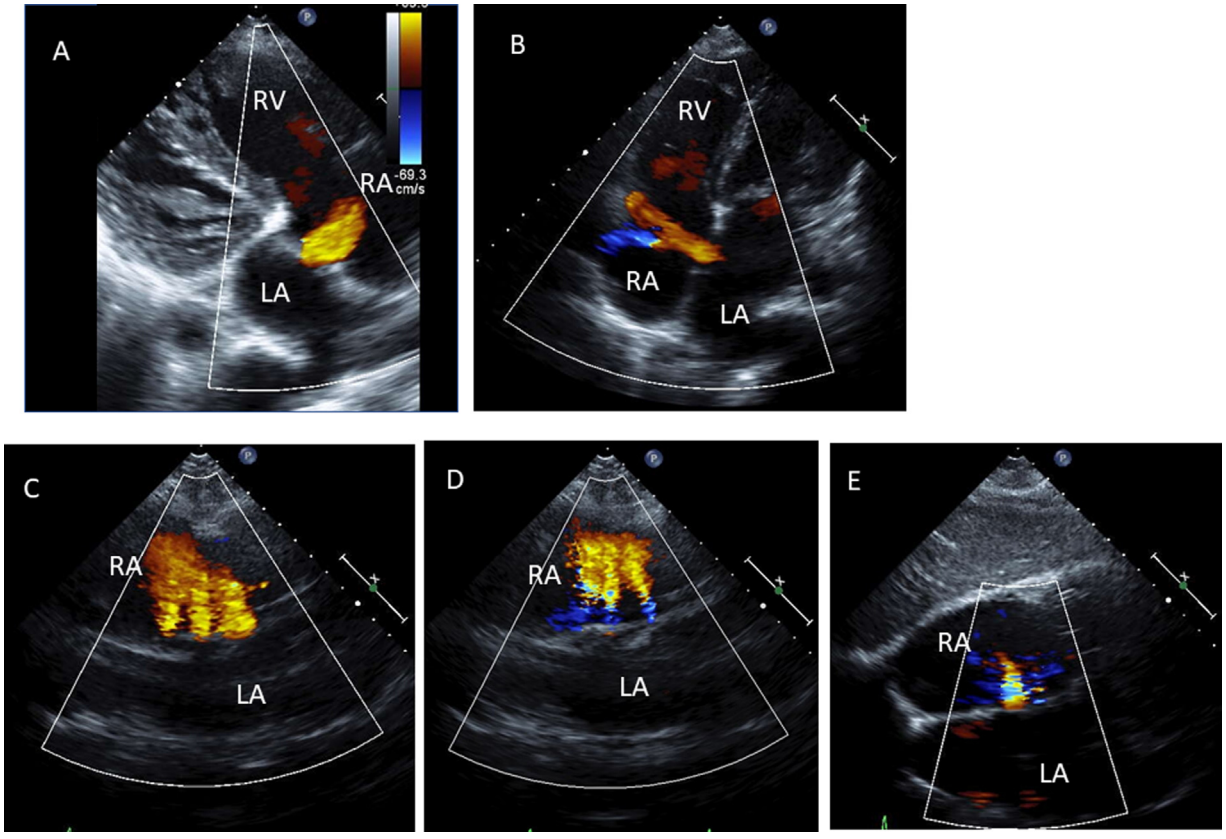

Fig. 1. Color Doppler imaging showed a single shunt flow across a secundum atrial septal defect in parasternal right ventricular inflow view (A) and apical 4-chamber view (B). In subcostal view, multiple color flow signals transversing from the LA into the RA were visualized on color Doppler imaging (C and D). Notice that multiple flow signals lie in a row at the same depth showing the same flow velocity pattern. With correct positioning and angulation of the probe in a subcostal view, multiple flow signals disappeared and a single atrial septal defect shunt flow was detected (E). LA, left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.

the number of defects between TTE and TEE, we performed TTE again to search for possible explanations. The echocardiographer who performed the patient's TTE had difficulty in obtaining good images in subcostal view. When the echocardiographer slightly moved the transducer away from the sternum and changed the tilting angle of the probe to get better visualization, the image quality improved dramatically compared to the previous imaging (Fig. 1E). In this view, the multiple flow signals on color Doppler disappeared and only a single shunt flow was detected. Based on this result, we concluded that multiple shunts were phantoms due to an artifact. This artifact was observed only in subcostal view but not in other views. Further close observation revealed that these phantom flow signals were moving parallel in a row at the same depth and showed the same flow velocity pattern, suggesting that they are artifacts (Fig. 1C and D). The patient later underwent successful transcatheter ASD device closure.

Discussion

Here we present a case of a single ASD shunt masquerading as multiple defects on color flow imaging due to a refraction artifact.

Artifacts arise due to the physical properties of ultrasound. They are commonly encountered in daily routine echocardiographic examinations and are sometimes misdiagnosed as pathologic structures [5,6].

Among the various type of artifacts, a refraction artifact refers to the false duplication of an object behind a structure that acts as a wave refractor [7–10]. Ultrasound waves directed through the structure are refracted toward the object (in this case, a shunt flow of ASD) and then re-refracted back to the original direction of transmission on the return path. This results in a duplicate (or even triplicate) image of the object in the original direction of the beam because the transducer assumes all echoes have traveled along an original path (Fig. 3A) (modified from [7]). As a result, multiple color flow signals appear in a row at the same depth (Fig. 3B). Sternum, costal cartilage, fascial structures and fat, and pleural and pericardial surfaces can be a refractor of the ultrasound wave [7,8]. In our case, we speculate that the sternum acted as the refractor. Duplication artifacts of cardiac valves or the left ventricle by refraction of the ultrasound beam are well known in B mode echocardiography [8–10]. However, the phenomenon for multiplication of flow signals occurring in color Doppler imaging due to a refraction artifact has rarely been reported [8,9]. Therefore, we need to be aware of the existence of this artifact to avoid misdiagnosis in color flow imaging.

Whether our patient had a single ASD or multiple defects was critically important to determine the indication for transcatheter device closure. A clue to correct diagnosis in this case lies in the fact that multiple flow signals moved in parallel at the same depth in a row showing the same flow velocity pattern. Once the possibility of the artifact has been considered, the multiplication artifact can be eliminated by appropriate movement of the transducer's position and angle.

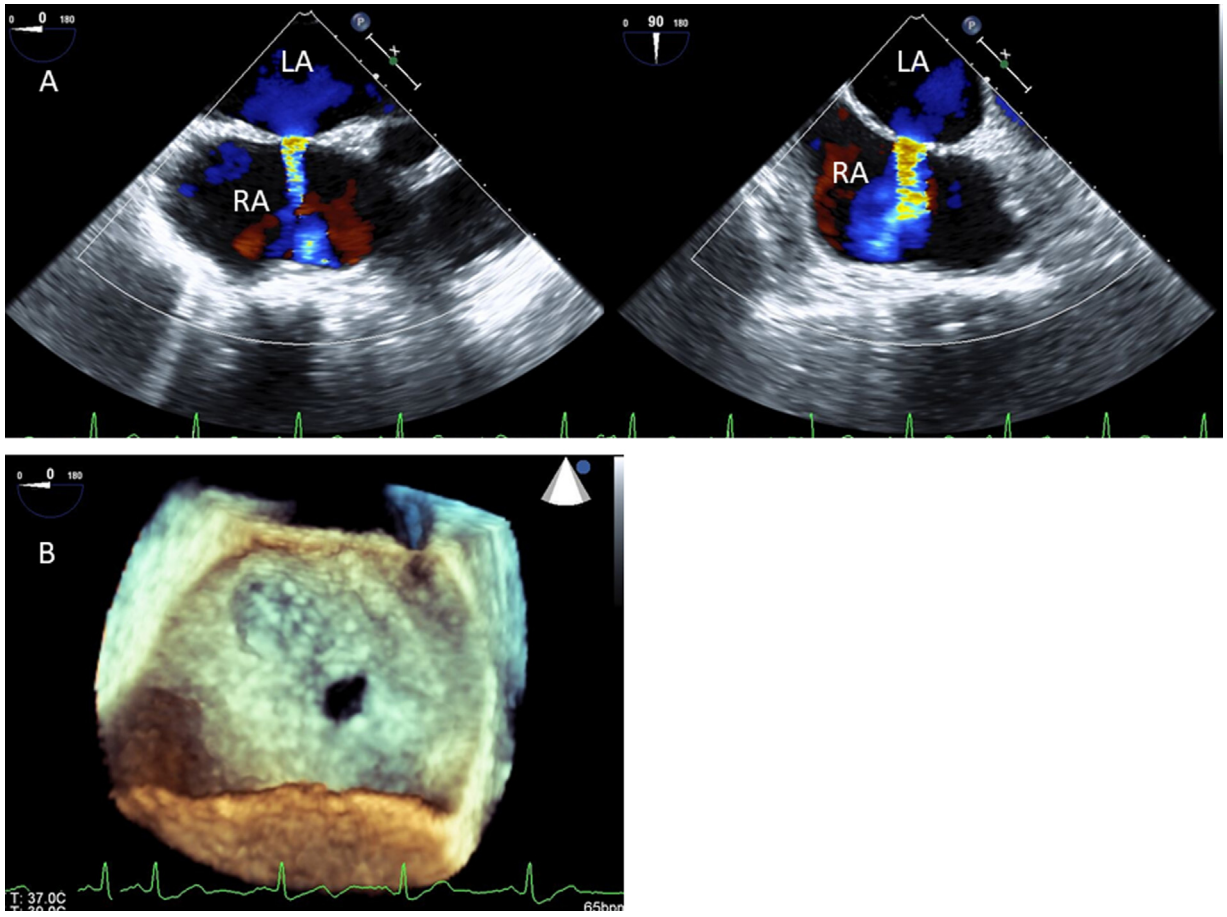

Fig. 2. Two-dimensional transesophageal echocardiography (TEE) showed a single atrial septal defect with a single shunt flow (A) (left: 0°, right: 90°). Real-time 3D-TEE showed one central hole in the interatrial septum (B). LA, left atrium; RA, right atrium.

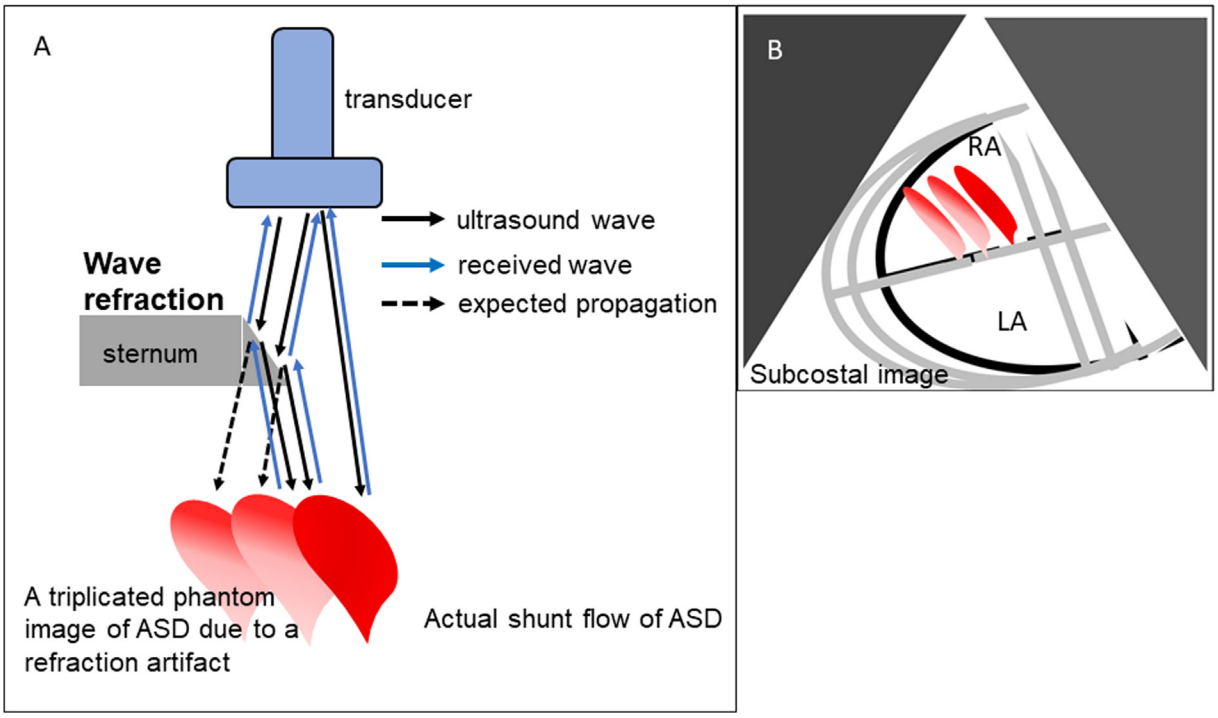

Fig. 3. Mechanism by which phantom color flow signals occurred in our case due to a refraction artifact (A and B). ASD, atrial septal defect; LA, left atrium; RA, right atrium.

Conclusions

We reported a case of a single ASD masquerading as multiple shunts due to a refraction artifact on color Doppler imaging. We need to be aware that this artifact can make multiple false flow signals in order to avoid misdiagnosis.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgments

None.

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