Percutaneous closure of a post-myocardial infarction ventricular septal defect guided by real-time three-dimensional echocardiography

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We present an adult patient who had an acute myocardial infarction complicated by a ventricular septal defect and had it repaired percutaneously. Real-time three-dimensional echocardiography (RT3D) before and during the closure procedure were performed. RT3D provided anatomical and functional information of the defect as well as real-time guidance during the procedure. This case highlights the utility of three-dimensional echocardiography in guiding transcatheter procedures.

KEYWORDS
Ventricular septal defect; Ventricular septal rupture; Echocardiography; Three-dimensional echocardiography; Percutaneous VSD closure

Introduction

The incidence of ventricular septal defect (VSD) as a complication of an acute myocardial infarction has dropped significantly from ~1–3% to <1% since the introduction of early reperfusion techniques.1,2 Nevertheless, post-infarct VSD still carries a significant mortality of 45% after surgical rescue attempts, and 90% with medical treatment alone.3 Post-infarct VSD represents a dynamic ischaemic perforation that tends to have a complex architecture, including multiple orifices and twisted tunnels. Thus, visualization of the defect’s orifice and calculation of shunt flows are suboptimal using two-dimensional methods such as the conventional two-dimensional transthoracic echocardiogram or cardiac catheterization. Real-time three-dimensional (RT3D) echocardiography allows acquisition of a pyramidal-shaped data block that is amenable for further online and offline processing. This in turn allows visualization of structures from angles and views that are unavailable when using standard two-dimensional echocardiography.

In recent years, there is a growing number of reports of successful percutaneous closure of post-infarct VSDs using an Amplatzer septal occluder.4,5 This treatment approach does not necessitate the direct manipulation of the necrotic myocardial tissue surrounding the defect. Also, there is some suggestion that there may be a lower mortality rate when compared with the classical surgical approach,5 likely related to avoiding high-risk surgery during the immediate post-infarction period.

We present a case in which RT3D echocardiogram provided a comprehensive anatomic evaluation of a post-infarction VSD. On the basis of this assessment, the patient was referred for a percutaneous closure procedure under RT3D transoesophageal guidance.

Case presentation

An 80-year-old man was admitted with an acute anterior myocardial infarction. Cardiac catheterization, done immediately upon admission, revealed significant two-vessel disease with total occlusion of the left anterior descending (LAD) artery and severe narrowing in the left circumflex (LCX) artery. Percutaneous coronary intervention with drug eluting stent placement in the LAD was performed (the non-infarct LCX vessel was left untreated). Initial transthoracic echocardiogram showed mild dilatation of the left ventricle, akinesia of the antero-septal and apical segments, mildly reduced systolic function, and estimated ejection fraction of 40%. On the fourth hospital day, the patient developed a new murmur and a post-infarct VSD in the antero-apical septum with left-to-right shunt was diagnosed by echocardiography. The patient remained haemodynamically stable.

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RT3D echocardiogram was performed. An apical septal wall thinning with septal rupture near the apex was visualized (Figure 1A; Supplementary data, Movie clip 1). Continuous wave Doppler tracing across the VSD showed a systolic wave that reached 5.5 m/s and a continuous diastolic wave with end-distolic velocity of 1.8 m/s (Figure 1B). Using full-volume acquisition, the interventricular septum was demonstrated in an ‘en-face’ view. This allowed direct visualization of the entire defect from both the left ventricular and right ventricular perspectives (Figure 1C; Supplementary data, Movie clip 2). The defect size measured to be 1.2 x 2.5 cm (Figure 1D). The left-to-right shunt ratio (Qp:Qs) was calculated to be 1.6:1. The patient was referred for a percutaneous closure of the VSD.

Under transoesophageal echocardiogram (TEE) surveillance, catheters were passed through the VSD, followed by the placement of a 4 cm Amplatzer occluder device in the VSD (Figure 2; Supplementary data, Movie clips 3 and 4). At the end of the procedure, colour Doppler imaging showed no evidence of any residual shunt. There were no complications, and the patient was discharged home the next day.

**Discussion**

The use of RT3D echocardiography for assistance in the evaluation and performance of percutaneous closure of a post-infarction VSD is shown here to be valuable. RT3D echocardiography allows accurate evaluation of the VSD with detailed assessment of the VSD size and geometry, which are not readily available using conventional two-dimensional techniques. The three-dimensional zoom mode and the full-volume acquisitions allow en-face visualization of the interventricular septal defect, enabling accurate measurements and precise anatomic definition. This in turn helps identify appropriate candidates for a percutaneous closure procedure. The orifice size as measured by RT3D provides the basis for decision regarding the Amplatzer size to be used. In addition, during the closure procedure itself, RT3D echocardiography provides accurate guidance for catheter manipulations as well as for positioning and deployment of the occluder device. It allows continuous visualization of all the catheters in their entire length, thus permitting safe manipulation and positioning by the operator. A few limitations for the use of RT3D TEE include expensive equipment and a learning curve for the use of the technique. Occasionally, echo ‘drop out’ may mimic an area of a tissue defect. However, the use of colour Doppler (both on RT3D TEE and two-dimensional imaging) as well as the use of spectral Doppler allow easy differentiation between these artefacts and true tissue defects.

**Conclusion**

This case highlights the importance of RT3D echocardiography in the diagnosis of acute septal rupture in the setting of acute myocardial infarction and in guidance during transcatheter occlusion procedure.
Figure 2  Real-time three-dimensional (RT3D) transoesophageal echocardiogram (TEE) during percutaneous ventricular septal defect (VSD) closure procedure. (A) Real-time three-dimensional transoesophageal echocardiogram image showing a guiding catheter placed via a retrograde approach (from the aorta through a femoral puncture) into the left ventricle. (B) Real-time three-dimensional transoesophageal echocardiogram image showing a guiding catheter placed into the right ventricle. (C) Two-dimensional transoesophageal echocardiogram image showing a successfully placed Amplatzer occluder device in the apical ventricular septal defect. Colour Doppler imaging showed no evidence of residual left-to-right shunt. (D) Real-time three-dimensional transoesophageal echocardiogram image clearly demonstrating the Amplatzer device in the apical intraventricular septum. LV, left ventricle and RV, right ventricle.

Supplementary data

Supplementary data are available at European Journal of Echocardiography online.

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