Combined percutaneous closure of ventricular septal defect and atrial septal defect via lower ministernotomy

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Abstract

Background: Minimally invasive approaches such as percutaneous closure of ventricular septal defects (VSD) have been applied for the surgical correction of congenital heart defects in order to avoid disadvantages related to median sternotomy with a cardiopulmonary bypass (CPB). However, reports remain scarce regarding combined percutaneous closure of VSD and atrial septal defects (ASD) via minimally invasive approaches, such as lower ministernotomy.

Results: The authors have operated on 5 patients who were diagnosed with VSD in association with ASD, successfully realizing percutaneous closure via lower ministernotomy.

Conclusion: The proposed technique proved to be safe and effective.

Keywords: Ventricular septal defect, Atrial septal defect, Percutaneous closure

Background

Ventricular septal defects (VSD) are some of the most frequent congenital heart anomalies, estimated to account for 20–30% of all congenital cardiac malformations [1, 2]. In the last decade, percutaneous approaches have been successfully applied for the closure of various types of VSD, with promising preliminary results [3–5]. However, to date, no reports are available regarding the combined percutaneous closure of VSD and atrial septal defects (ASD) via minimally invasive approaches, such as lower ministernotomy.

Methods

We studied five patients (two boys and three girls) diagnosed with VSD and ASD who underwent operation at the West China Hospital. Answer: We have added the content as follow in the manuscript: All the patients were perimembranous VSD less than 8 mm that was not adjacent to the conduction bundle and aortic valves and the secundum ASD less than 15 mm. Table 1 presents the baseline data of patients.

After adequate pre-oxygenation, the procedure was performed under general anaesthesia with a standby cardiopulmonary bypass (CPB) machine available. Following a skin incision of approximately 4–5 cm, a partial lower ministernotomy was performed. After surgical exposure of the anterior free wall of the right ventricle, the optimal puncture site was selected per the routine method. Next, we performed percutaneous VSD closure under transoesophageal echocardiographic (TEE) guidance using SQFDQ II and SQFDQ IV occlusion devices (MemoPart VSD Occlusion Device; Lepu Medical Technology, Shanghai Shape Memory Alloy Co., Ltd., Shanghai, China) (Fig. 1a), as described in previous reports [6–8]. Then, a 20 G needle was introduced into the right ventricle, and directed up towards the ASD. Then, a 0.025-in. straight-tipped guide wire was introduced through the needle and maneuvered across the tricuspid valve and ASD into the left atrium. Next, the needle was exchanged with a short 12 F sheath over the wire (Fig. 1b). Finally, the sheath was positioned across the ASD with its tip in the left atrium, and the ASD occluder was placed (MemoPart ASD Occlusion Device; Lepu Medical Technology, Shanghai Shape Memory Alloy Co., Ltd., Shanghai, China) (Fig. 1c).
Results
Surgery was successful in all patients, with no in-hospital mortality or complications. Mean ‘skin-to-skin’ time was 62 ± 31.6 min. No blood infusions or inotropic support were needed in any patient. Mean ventilation support time was 4.2 ± 6.7 h. No rhythm or atrioventricular conduction disorders occurred. No sternal or rib deformations were observed at the time of discharge, and the small skin incision yielded excellent cosmetic results. Mean hospitalization time was 6.5 ± 2.8 days.

Discussion
Conventionally, most congenital heart defects are treated using CPB via median sternotomy. With the development of percutaneous interventional techniques, various simple congenital structural heart defects may be repaired with comparable results, possibly providing advantages over conventional surgery in some cases [9]. However, transcatheter shunt closure does not appear to be optimal when the patients present other congenital heart diseases. This new technique should be applied with caution in some subtypes of VSDs like perimembranous VSDs adjacent to the conduction bundle and aortic valves and subarterial VSDs; When the ASDs are too small, the angle through the fourth intercostal space to the ASDs will be hard, another left fourth intercostal space will be recommended to close the ASDs. With improvements in device closure techniques, perventricular device closure of VSD under guidance of transesophageal echocardiography (TEE) has been successfully applied in the surgical correction of congenital defects, with promising preliminary results [4]. Based on this technique, we proposed a new approach for combined perventricular closure of VSD and ASD via lower ministernotomy.

Conclusions
Compared with conventional surgical repair or femoral transcatheter shunt closure, the advantages of this procedure are obvious. It appears to be safe, associated with less operative trauma, and does not require CPB, fluoroscopy or contrast. In selected patients, perventricular device closure of VSD complicated with ASD is effective, and may either substitute or complement conventional surgical closure.

Abbreviations
ASD: Atrial septal defect; CPB: Cardiopulmonary bypass; TEE: Transesophageal echocardiography; VSD: Ventricular septal defect

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Availability of data and materials
Datasets used or analysed during the current study are available from the corresponding author on reasonable request.

Authors’ contributions
LYF designed the research. LYF and FQ were involved in diagnostic evaluation and surgery. QYJ and WY wrote the paper. All authors read and approved the final manuscript.

Ethics approval and consent to participate
Not applicable

Consent for publication
The relevant patient provided informed consent for publication of the images in Fig. 1.

Competing interests
The authors declare that they have no competing interests.

Table 1 Baseline data of patients

| Patient NO | Age (month) | Weight (kg) | VSD (mm) | ASD (mm) | VSD occluder (mm) | ASD occluder (mm) |
|------------|-------------|-------------|----------|----------|-------------------|-------------------|
| 1          | 19          | 12          | 4        | 6        | 6                 | 12                |
| 2          | 14          | 10          | 5        | 5        | 7                 | 12                |
| 3          | 26          | 13          | 6        | 8        | 8                 | 14                |
| 4          | 18          | 12          | 5        | 7        | 7                 | 14                |
| 5          | 20          | 12          | 4        | 10       | 7                 | 16                |

VSD: ventricular septal defect, ASD: atrial septal defect

Fig. 1 a Perventricular VSD closure under TEE guidance. b The 12F sheath was positioned across the ASD with its tip in the left atrium. c ASD occluder was employed under TEE guidance.
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