Doubly Committed Subarterial Ventricular Septal Defects Closure Using Minimal Mid-Partial Sternotomy

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Background: Repair of doubly committed subarterial ventricular septal defects (DCVSD) via a minimal mid-partial sternotomy has not been reported. We aimed to evaluate the feasibility and safety of this procedure.

Methods: We retrospectively reviewed all patients with a clinical diagnosis of DCVSD and underwent repair via minimal mid-partial sternotomy at our institution. Patient characteristics, perioperative, and follow-up data were collected.

Results: A total of 13 patients who underwent minimal mid-partial sternotomy DCVSD repair were analyzed. Postoperative echocardiogram revealed that no patient had the residual shunt. No patient reported adverse event during postoperative course. There was no perioperative or late death during follow-ups. All patients were satisfied with the inconspicuous scar.

Conclusions: Minimal mid-partial sternotomy is a safe and effective approach for DCVSD repair with satisfied treatment outcomes and cosmetic benefits.

Keywords: doubly committed subarterial ventricular septal defects, congenital heart disease, minimally invasive surgery, cosmetic result

Introduction

Doubly committed subarterial ventricular septal defects (DCVSD) account for 10% of ventricular septal defects. It is associated with a low tendency to spontaneous closure and the high possibility of complications such as aortic leaflet prolapse and insufficiency.1–3) Because of the imbalance in medical resources, some patients with DCVSD were not found in infant and young child period in a developing country.

Conventionally, open-heart surgery with full sternotomy is the standard surgical approach for repairing DCVSD. However, patients are always perplexed by its long skin scarring.4) Minimal mid-partial sternotomy had been performing to repair DCVSD in our institution, of which the operative visual fields are similar to that of standard full sternotomy and the procedure is easier to learn and manipulate.

Patients and Methods

In all, 13 DCVSD repairs were conducted via this approach in our institution. Of 13 patients (7 males and 6 females), the mean age was 27.3 ± 4.2 years (range: 13–46). The mean size of the ventricular septal defect (VSD) was 8.3 ± 2.8 mm (range: 6–12).
Surgical techniques

Under general anesthesia, patients were placed in supine position. A small vertical-curve skin incision, usually 4–6 cm in length depending on the body size of the patient was performed. The mid-partial sternotomy was made in the median sternum with left extension to the second and the third intercostal space with a handheld oscillating bone saw (Fig. 1A and 1B). Usually, there is no need for dividing the left internal thoracic artery. A short thoracic retractor was used to open the sternum. The access would adequately expose the main pulmonary artery, the infundibulum of the right ventricle and the ascending aorta, which made it possible to repair the DCVSD through this 5 cm access incision.

After full systemic heparinization was achieved, cannulation for cardiopulmonary bypass (CPB) was performed from the femoral artery and vein. Purse-string suture was done to cannulate the antegrade cardioplegia cannula, meanwhile, to drag ascending aorta to facilitate aortic cross-clamping. The surgical visualization of minimal mid-partial sternotomy is clear (Fig. 2A and 2B). Carbon dioxide at 0.3–0.5 L/min was used until the septal defects were closed. After de-airing the right heart with clamping the venous drainage temporally, the pulmonary artery incision was closed in standard fashion. After confirming the absence of intracardiac air and the quality of repair by transesophageal echocardiographic (TEE), the CPB was gradually discontinued. After completion of the procedure, decannulation and hemostasis were performed. Sternum was closed with stainless steel wires.

Results

Intracardiac repair could be completed in all patients through this minimal mid-partial sternotomy. Patch closure was used in all patients. The mean incision length...
was 5.6 ± 2.3 cm (range: 4.3–7.1). CPB time was 55.6 ± 7.5 minutes (range: 46–69), and aortic clamp-time was 31.2 ± 7.5 minutes (range: 23–44). Pericardial tube drainage for 24 hours was 41.8 ± 22.1 mL (range: 30–80). The mean ventilation time was 4.5 ± 2.3 hours (range: 3–7), and postoperative hospital stay was 5 ± 1 days (range: 4–6).

Postoperative echocardiograms revealed that no patient had residual shunt after the surgery. All patients had an uneventful postoperative course, without any recorded malignant arrhythmia or reoperation. There were no perioperative or late deaths during the follow-up in this cohort. The follow-up was 37.3 ± 10.4 months (range: 6–65) for all patients. No evidence of increase in aortic valvular regurgitation and no appearance of pulmonary valve regurgitation in any case was detected in the follow-up. There was neither malunion nor asymmetry of the sternum and chest was noted (Fig. 3). All patients satisfied with the cosmetic result.

**Comment**

Surgical repair has been considered as the gold standard for the treatment of congenital heart disease (CHD) with outstanding results. However, the psychological burden associated with annoying scarring from a traditional full sternotomy should be taken into consideration, especially for children, teenagers, and young adults. Hence, several minimally invasive surgical repairs have been developed to achieve the same quality of repair with cosmetically superior results. However, exposing an acceptable vision to close DCVSD is arduous through those approaches because of the special location of the defect. Unwarranted operating risks maybe raise when the procedure is performed with insufficient optimal view of the operating field. Transverse skin incision has been reported used in repairing DCVSD, but this incision may hurt arteria mammaria interna and pleura. Besides, we think mid-partial sternotomy incision can provide a better surgical field to doctor. Catheter-based repair also become popular alternative to the surgical

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**Fig. 2** Intraoperative view. (A) Picture indicates antegrade cardioplegia cannula (venting tube) and the blocking clamp. (B) A short thoracic retractor was used to open the sternum and expose the operative field. A 3 cm vertical incision was made in the main pulmonary artery, the surgical visualization was clear. Procedure of closing DCVSD is similar to median sternotomy. DCVSD: doubly committed subarterial ventricular septal defects (For Fig. 2, supplementary material, Movie 1 is available at ATCS online.)

**Fig. 3** Postoperative wound: Upper limb activity was normal after the operation. No nonunion or limb shortening deformity occurred.
repair for its minimally invasive appeal and favorable cosmetic outcome although at the cost of suboptimal result sometimes.11-13)

To our knowledge, the minimal mid-partial sternotomy we used to repair DCVSD is novel. This approach could fully expose the main pulmonary artery, the infundibulum of the right ventricle and the ascending aorta. The repair of DCVSD was all accomplished through pulmonary artery incision.

There is neither in normal daily activity nor case of mediastinitis reported among our patients. Follow-up transthoracic echocardiography (TTE) showed no residual shunt. The surgical visualization and operating procedure of minimal mid-partial sternotomy is analogous to that of classical sternotomy. So, this surgical technique is advantageous to handle and apply. Minimal mid-partial sternotomy is evident in reducing the chance of pleural damage, which consequently avoids the common complications in minimally invasive approaches such as pneumorrhagia, postoperative atelectasis, and lung adhesion, those likely to occur when the pleura is injured. Avoiding one-lung ventilation is good for decannulating. In addition, mid-partial sternotomy can be easily extended for a regular full medium sternotomy, without an additional incision or even a rearranging of the operating room, which insures the security of the operation. Admittedly, the minimal invasive sternotomy of this approach is favorable at postoperative analgesia and rehabilitation. According to the data, no complications were developed related to this new procedure. Therefore, this approach with a cosmetic result is safe and cost-effective. It could become a new approach of choice to repair DCVSD. Moreover, this approach has been successful performed in pulmonary valve replacement in our institution.

However, this approach would exclude every patient with an associated cardiac defect like atrial septal defect (ASD). Besides, femoral cannulation is not feasible for children who weigh less than 30 kg. So, open-heart surgery with full sternotomy is still necessary for children under 30 kg or some DCVSD-patients-associated cardiac defect.

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Disclosure Statement

All authors have no conflicts of interest to declare.

References