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Brief Report

Surgical closure of multiple large apical ventricular septal defects: how we do it

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Abstract The management of apical ventricular septal defects continues to be challenging because of the difficulty in achieving a complete closure without a left apical ventriculotomy. In this study, we present our innovative technique of closing multiple and/or large muscular apical ventricular septal defects through a right atriotomy. We operated three patients with multiple apical muscular trabecular ventricular septal defects ("Swiss cheese") using a technique that involved exclusion of the right ventricular apex. Their ages ranged between 2 months and 13 years. The VSDs were approached through right atriotomy. The trans right atrial approach using a 5–0 polypropylene purse-string suture or a two-patch procedure is a novel method of closing large apical ventricular septal defects. It was found to be effective with no persistent residual defects and did not have the disadvantages of a ventriculotomy.

Keywords: Ventricular septal defect; Swiss cheese; congenital cardiac surgery; multiple apical ventricular septal defects

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Despite the improvement in surgical techniques in children with CHDs, the optimal management of large apical ventricular septal defects remains controversial. This article describes a new surgical strategy to close apical ventricular septal defects, avoiding either a right or a left ventriculotomy or sectioning the major trabeculae or the moderator band.

Methods

We operated three patients for muscular apical ventricular septal defects (Table 1) and associated cardiac malformation. The median age was 6.3 months (with a range from 2 to 13 months). Their body surface area and weight ranged from 0.24 to 0.45 m^2 (median, 0.32 m^2) and 4.6 to 9 kg (median, 6.4 kg), respectively (Fig 1).

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Surgical technique

The surgery was performed through a median sternotomy with mild hypothermic cardiopulmonary bypass. After aortic cross-clamping, a right atriotomy was performed.

To close the large apical or multiple ventricular septal defects in two patients, we used one or two pericardial patches. The objective was to create a new floor in the right ventricle, leaving the multiple ventricular septal defects on the left side. The first bovine pericardial patch was sutured at the upper edge of the ventricular septal defect and the septum marginalis moderator band using a 6–0 polypropylene running suture. A second pericardial patch was used to close the large apical ventricular septal defect. It was sutured between the moderator band and the anterior wall of the right ventricle with a 6–0 polypropylene running suture (Fig 1).

In the third patient, a 5–0 polypropylene purse-string suture was used to exclude the apical portion of the right ventricle, thereby occluding multiple defects between the muscular bands in the right ventricle (Table 1). A bovine pericardial patch was used to close

Table 1. Patients characteristics.

Patients	Age (months)	Weight (kg)	BSA (m^2)	Associated anomaly	Anatomical localisation of ventricular septal defects	Patch	Cross-clamp time (minutes)	CPBP time (minutes)	Extubation time (hour)	Discharge time (day)
1	13	9	0.45	Debanding	Apical	2	106	74	120	9
2	2	4.6	0.24		Multiple apical	1	85	47	12	9
3	4	5.5	0.28	PM para influenza	Multiple apical	1	82	45	240	22

BSA = body surface area; PM = perimembranous

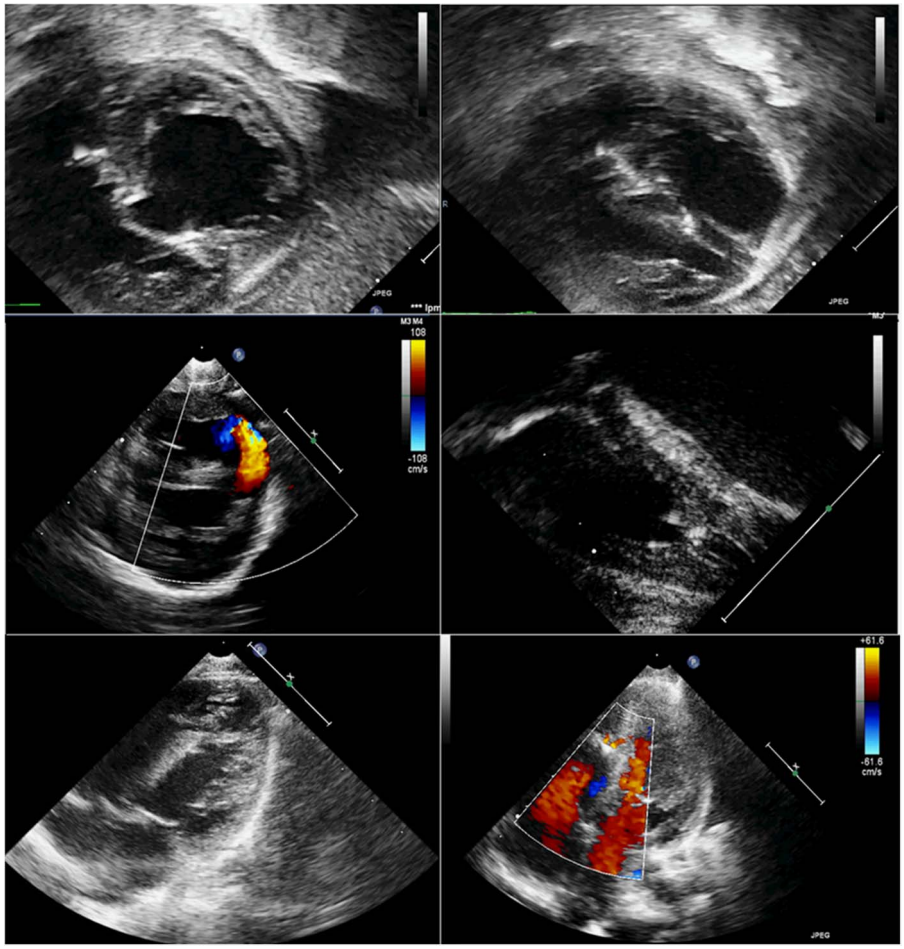

Figure 1.
Preoperative and postoperative echocardiogram.

the perimembranous ventricular septal defect with a 7–0 polypropylene running suture in this patient.

The moderator band was kept intact in all cases.

With both techniques, the apical portion of the right ventricular apex was excluded from the rest of the right ventricular circulation.

Results

The mean cross-clamp time and cardiopulmonary bypass time were 55.3 ± 16.2 and 91.0 ± 13.1 minutes, respectively. There was no hospital mortality. At the postoperative echocardiography evaluation, the left ventricular ejection fraction was within the normal range in all patients, without any residual shunt.

Discussion

The management of patients with large apical ventricular septal defect remains controversial. Interventional catheter techniques, palliative surgery, or primary closure have been used with variable success, but specific management guidelines remain undefined.

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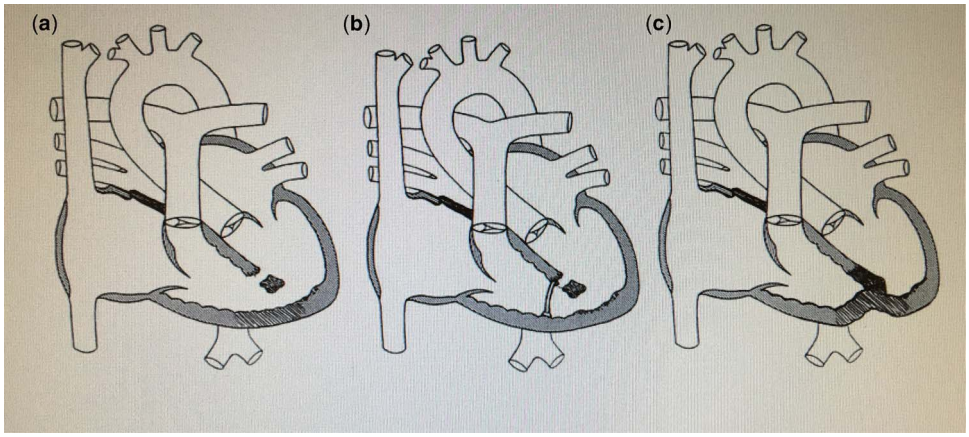

Figure 2.
Surgical technique. (a) Anatomical view of an apical muscular VSD. (b) Closure of an apical VSD with a pericardial path. (c) Closure of an apical VSD with a suture.

The results are less than optimum, although interventional catheter technology is being used for treating these defects.[1]

Some authors[2] consider the right atrial approach as the most difficult way to achieve the closure of multiple apical ventricular septal defects; therefore, they recommend a palliative surgery with a pulmonary artery banding to prevent congestive heart failure in early infancy and allow the heart cavities to grow. Pulmonary artery banding operation, however, has high mortality in the early postoperative period and in addition causes progressive right ventricular hypertrophy and diastolic dysfunction.

The muscular septal defects located in the apical portion of the septum are difficult to approach even through the right or left ventricle.[3] The presence of the moderator band and the multiple trabeculations in this area hide these defects despite extensive resection of muscular trabeculations.[4]

In 2003, Ootaki et al.[5] developed a technique for the closure of trabecular muscular defects by sandwiching the septum between two polyester felt patches placed on the left and right ventricles. The outcome with this technique was satisfactory. Although the surgical access through a left ventriculotomy helps in visualising the defects more easily, this approach has its own complications in the form of ventricular dysfunction, dyskinesis, apical aneurysm, and ventricular arrhythmias.

We used a transatrial approach in order to avoid the disadvantages of ventriculotomy, ventricular dysfunction, arrhythmias, and possible aneurysm formation.[6] When a very large apical ventricular septal defect is present, two patches are needed. The first one is sutured between the upper edge of the apical ventricular septal defect and the septomarginal moderator band, and the second one is sutured between the moderator band and the free anterior right ventricular wall. This approach for complete correction of an apical complex ventricular septal defect offers very good initial results, avoiding complications associated with left ventriculotomy as well as with palliative pulmonary artery banding.

More patients with a longer duration of follow-up are needed to reach a meaningful conclusion. Further experience and precise evaluation of the right ventricular function are also necessary to assess the safety and efficacy of this approach in small infants (Fig 2).

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Conflicts of Interest

None.

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