Cardiology in the Young

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Challenging a dogma: left ventriculotomy can be used safely in children

Safak Alpat[1,2], Timucin Sabuncu[1,2], Ahmet Aydin[2], Recep Oktay Peker[2], Murat Guvener[1,2], Riza Dogan[1,2] and Mustafa Yilmaz[1,2]

[1]Division of Paediatric Cardiac Surgery, Department of Cardiovascular Surgery, Hacettepe University Faculty of Medicine, Ankara, Turkiye and [2]Department of Cardiovascular Surgery, Hacettepe University Faculty of Medicine, Ankara, Turkiye

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Author for correspondence:
Safak Alpat, Division of Paediatric Cardiac Surgery, Department of Cardiovascular Surgery, Hacettepe University Faculty of Medicine, Ankara, Turkiye. Tel: +903123051774. E-mail: safakalpat@hacettepe.edu.tr

Abstract

Objective: We aimed to discuss our unit's experience performing left ventriculotomies on children. *Methods:* Between 2000 and 2022, we identified paediatric patients who required left ventriculotomy. Relevant information was gathered retrospectively. *Results:* There were eight patients who underwent surgical procedure including left ventriculotomy. The range of weight and age was between 4.5 and 50 kg and 5 months to 17 years, respectively. Left ventriculotomy was primarily performed for the excision of cardiac masses in all but one who had pseudoaneurysm repair. There were no deaths that occurred early or late. Pre-operative and post-operative ejection fractions and fractional shortening values were comparable. There was no arrhythmia detected post-operatively. *Conclusions:* We conclude that an apical left ventriculotomy does not compromise the function of the left ventricle, even in young infants. In selected patients, it may be used safely for surgical access to the left ventricle.

In paediatric cardiac surgery, a left ventriculotomy is not performed nearly as frequently as other, more common types of incisions that are made on the right side of the heart. The left ventricle is generally regarded as a no-touch zone among most cardiac surgeons. It is a common misconception that incisions made on the left ventricle pose a threat to the systolic performance of the left ventricle and may increase the risk of morbidity and mortality as a result. Studies conducted on animals or clinical research conducted on adults provided the vast majority of the information that was gathered about left ventriculotomy.[1–3] As a result, the purpose of this report is to discuss the experience that our unit has had performing left ventriculotomy on paediatric patients.

Materials and methods

Cohort

From 2000 to 2022, eight paediatric patients needed a left ventriculotomy to correct various abnormalities. Informed consent was obtained, and the institutional review board approved the study. We collected relevant demographic data, diseases' features, operational data, and post-operative factors such as vasoactive inotrope scores, rhythm traces, and critical care stay lengths from patients retrospectively.

Left ventricular ejection fraction and fractional shortening were used as markers of left ventricle function and documented with echocardiogram at three different points: preoperatively, postoperatively at the time of hospital discharge and at the most recent follow-up.

Surgical technique

In all patients requiring left ventriculotomy due to underlying cardiac pathology, the incision was designed preoperatively using echocardiographic data. All procedures were performed with cardiopulmonary bypass under moderate hypothermia. The cardioplegia solution was cold crystalloid. After cardioplegia was administered and the heart was full with the solution, a limited longitudinal incision on the left ventricle apex was performed. It aided us in the preservation of the mitral valve apparatus, particularly the papillary muscles. The incision was parallel to the left anterior descending coronary artery but at least 5 mm away from it. Stay sutures were used, and traction was administered. This prevented further surgical trauma caused by the use of retractors. Before the repair, the mitral valve apparatus and interventricular septum were thoroughly evaluated. Once the repair was done, the ventriculotomy was closed primarily in two layers, reinforced with a thin piece of Teflon pledget.[4]

Statistical analysis was performed using Jamovi Version 2.3.18.0 (Jamovi Projects). Descriptive statistics of continuous data were presented as median and IQR.

Table 1. Demographic and clinical characteristics of patients.

Patient	Age	Weight	Diagnosis	Co-morbidity	Surgery	Pathology	MV time (hrs)	ICU stay (days)
1	17 months	8 kg	Thrombus	Down syn + ASD + PDA	Excision + ASD closure + PDA ligation	Infected thrombus	3	4
2	17 years	50 kg	Thrombus	Anti-phospholipid syndrome	Excision	Thrombus	2	28
3	5 years	17 kg	Cyst	Multiorgan hydatid cyst	Excision	Hydatid cyst	4	3
4	7 years	20 kg	Cyst	Multiorgan hydatid cyst	Excision	Hydatid cyst	5	2
5	2 months	4.5 kg	Tumour	Gorlin syndrome?	Excision	Fibroma	2	2
6	3 months	5 kg	Tumour	–	Excision	Inflammatory myofibroblastic tumour	5	9
7	7 years	23 kg	Tumour	–	Excision	Fibroma	6	3
8	4 months	5.5 kg	Pseudoaneurysm	Post perventricular VSD closure	Excision + Recons with bovine pericardium	–	2	5

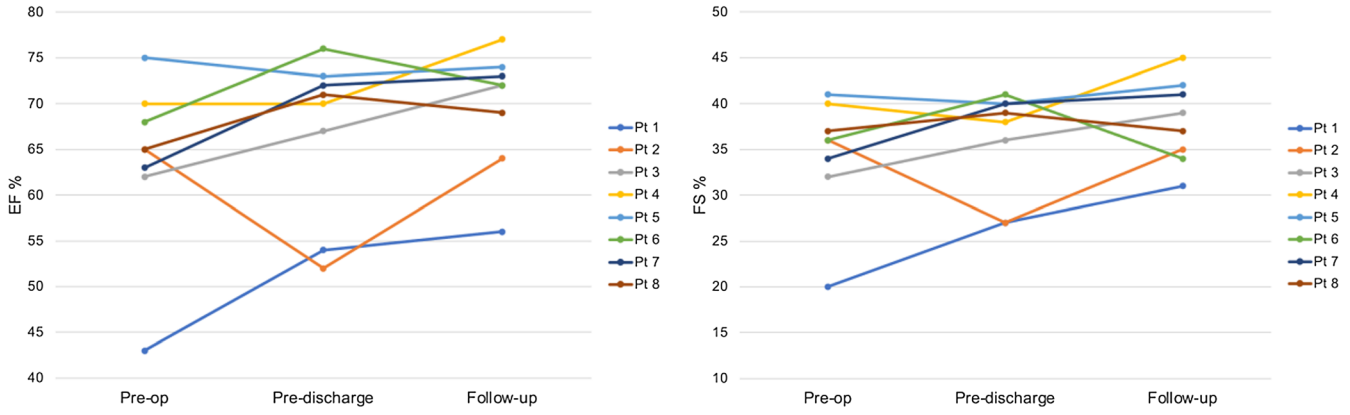

Figure 1. Changes in EF and FS values of patients.

Results

Eight patients had left ventriculotomies, six of them were females (75%) and two of whom were males (25%). At the time of repair, the median age and weight were 38.5 months (2 months–17 years) and 12.5 kg (4.5–50 kg), respectively. Table 1 summarises the demographic and clinical characteristics of patients. Diagnoses were as follows; two thrombi, two hydatid cysts, three tumours, and one pseudoaneurysm. The median cardiopulmonary bypass and aortic cross-clamp durations were 67 min (60–96 min) and 40.5 min (40–67 min), respectively. Except for the patient with an iatrogenic left ventricle pseudoaneurysm who underwent bovine pericardium reconstruction, all thrombi, cysts, and tumours were removed and did not require additional reconstruction. One patient with Down syndrome who presented with an left ventricle thrombus had concomitant atrial septal defect (ASD) closure and patent ductus arteriosus (PDA) ligation.

In all patients, the post-operative course was uncomplicated. Despite the fact that half of the patients required inotropic support, with a median vasoactive inotropic score of 7.5 (5–15), all inotropes were discontinued by the 12th hour postoperatively. There was no evidence of ventricular arrhythmia. We were able to extubate all patients within the first 6 hours of their recovery, and the median length of stay in the ICU was 3.5 days (2–28 days). One patient spent more time in the ICU due to transient haematologic and renal issues caused by the underlying antiphospholipid syndrome, which were all addressed medically. During the median follow-up of 30 months (6–102 months), there was no surgical mortality, and all patients survived without arrhythmia documented with Holter recordings.

Left ventricle ejection fraction (EF) and fractional shortening (FS) values at the time of discharge and at the last follow-up did not differ significantly from preoperative values (Fig 1). One patient, who also had prolonged ICU stay, had marginally decreased EF and FS at discharge compared to pre-operative values. However, at the follow-up, those values were found to be comparable to pre-operative values. In addition, all EF values at discharge and the most recent follow-up were greater than 50%, and all FS values remained greater than 25%.

Discussion

Traditionally, cardiac surgeons avoided making an incision on the left ventricle surface for fear of jeopardising ventricular function,

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increasing the risk of aneurysm formation, and causing ventricular arrhythmia.[5] The concern arose as a result of traditional animal experiments. Benzing et al. reported at least moderate LV function depression.[1] Waldhausen et al., similarly, demonstrated depressed left ventricle function with longitudinal incision and more pronounced depression with transverse incision.[3] Another animal study, on the other hand, supported the idea of preserved ventricular function after left ventriculotomy.[2] Recently, it was demonstrated that apical left ventriculotomy only impairs major axis function and is expected to be better tolerated.[6] Aside from the experimental data, the first clinical data came from patients undergoing subaortic muscular stenosis repair with left ventriculotomy, who had postoperatively preserved left ventricle function.[7,8] The Mayo Clinic group recently published their experience with left ventriculotomy for 'apical myectomy' with good outcomes.[9] Similarly, with acceptable morbidity and mortality rates, intracardiac repair of multiple ventricular septal defects began to be performed via left ventriculotomy.[10,11]

Two major contributing factors for the negative effects of left ventriculotomy were identified in studies. First, the spiral muscle fibres are disrupted, and myocardial architecture is destroyed. Second, the coronary blood supply to the affected myocardium is interrupted.[6] We demonstrated that left ventriculotomy had no negative effect on postoperative ventricle function, as represented by EF and FS. We believe that our meticulous surgical technique, which included a short and limited longitudinal incision on the left ventricle apex parallel to the left anterior descending (LAD) while preserving the LAD and its branches, reduced risks. Furthermore, we believe that excessive traction on the ventricular wall during repair contributes to myocardial injury. Thus, we believe that using stay sutures on the edges rather than direct application of retractor prevents iatrogenic injury. Because we required a left ventriculotomy to remove various cardiac masses in children, a small incision and soft traction with stay sutures provided adequate exposure. One might wonder if the same standards apply when the incision is used for ventricular septal defect (VSD) closure, which necessitates more traction and surgical manipulation around the incision. We did not include any patients with multiple VSD in our cohort because we prefer a 'hybrid' approach for these patients. In a study of 23 patients published by Wollenek et al., there were no adverse effects on ventricular function and satisfactory late follow-up results were reported.[12] A more recent study reported their experience in five patients, three of whom had VSD closure. They also demonstrated that left ventriculotomy had no negative effect on ventricle function.[13]

Particularly regarding the arrhythmia complication, no arrhythmia was detected during the post-operative period or at the most recent follow-up. Myocardial fibrosis was thoroughly studied as the underlying mechanism of ventricular arrhythmia after left ventricle incision. It certainly warrants long-term monitoring, but the absence of arrhytmia after almost 2.5 years of surveillance is encouraging.

In spite of the widespread negative perception of left ventriculotomy among cardiac surgeons, we demonstrated in this study that meticulously made incisions on the left ventricle did not compromise ventricular function after surgery and during follow-up. The post-operative course followed current trends in the care of these patients. Also, other potential side effects such as arrhythmia and pseudoaneurysm were not observed. Therefore, left ventriculotomy can safely be applied in appropriately selected patients.

The limitations of this study include its single centre, retrospective, and observational nature, as well as the small number of subjects. Furthermore, longer-term follow-up is inevitably needed; however, we believe the current study contributes to a body of knowledge that challenges the myth that left ventriculotomy is dangerous. From our experience, we would advise that when indicated, left ventriculotomy for access to the left ventricle, is a safe, well-tolerated incision with minimal negative short- or medium-term effect.

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Conflicts of interest. None.

Competing interests. The author(s) declare none.

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