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ORIGINAL ARTICLE

Evaluation of Different Minimally Invasive Techniques in Surgical Treatment for Ventricular Septal Defect

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Background Minimally invasive cardiac surgery is becoming a safe and cosmetic alternative to standard median sternotomy (SMS). This retrospective study reviews our results and experience with the lower mini-sternotomy (LMS) technique and the right lateral thoracotomy (RLT) technique for ventricular septal defect (VSD) closure compared with SMS.

Methods Between January 2013 and Dec 2015, 198 patients underwent repair VSD through lower mini-sternotomy (LMS Group, n = 66), right lateral thoracotomy (RLT Group, n = 59), standard median sternotomy (SMS Group, n = 73). Cardiopulmonary bypass was achieved directly in the three different approaches.

Results Procedures were performed successfully in all patients among the three groups and no in-hospital mortality occurred. No patient was reverted to standard median sternotomy in the LMS Group and RLT Group. The CPB time was 37.73 ± 11.46 mins in the LMS Group, 41.3 ± 13.97 mins in the RLT Group and 36.99 ± 10.84 mins in the SMS Group ($p = 0.078$); the cross-clamp times were 23.85 ± 9.78 mins in the LMS Group, 22.54 ± 9.08 mins in the RLT Group and 19.23 ± 6.92 mins in the SMS Group ($p = 0.009$). The total incision length of the procedure in the SMS Group (7.45 ± 1.54 cm) was longer than the other groups (LMS Group, 5.58 ± 0.8 cm and RLT Group, 5.96 ± 1.48 cm) and the difference was significant ($p<0.001$).

Conclusions Both the LMS and RLT approach can perform with favourable cosmetic and acceptable clinical results for closing VSD. They are the promising alternatives to standard median sternotomy and merit further study.

Keywords Congenital heart disease • Ventricular septal defect • Minimally invasive surgery

Introduction

Ventricular septal defect (VSD) is one of the most common congenital heart diseases, which make up approximately 20% of all incidences of congenital cardiac disease [1]. The most common type is the perimembranous VSD (around 70%), which involves the membranous septum and the adjacent portion of the muscular septum [2]. Transcatheter device closure of VSD has become a standard treatment and excellent results have been reported, especially for perimembranous defects and muscular defects [3]. However, it is nonetheless associated with several adverse effects, such as arrhythmia, vascular complications and injury to the tricuspid or aortic valve. Thus, primary

Abbreviations: CPB, Cardiopulmonary bypass; LMS, Lower mini-sternotomy; RLT, Right lateral thoracotomy; VSD, Ventricular septal defect; TEE, Transoesophageal echocardiography; SMS, Standard median sternotomy

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surgical repairs are still needed for large secundum defects and complex VSDs.

A median sternotomy has been the traditional approach in correcting VSD, which has been widely accepted with minimal operative mortality. However, this conventional approach is associated with morbidity, postoperative discomfort, and a large thoracotomy scar, which may evoke psychological distress, especially in young patients [4]. Therefore, transition from standard median sternotomy to a minimally invasive incision in cardiac surgery is very important. Recently, minimally invasive surgery has been used in cardiac surgery, including right thoracotomy [5,6], mini-sternotomy [7,8], port-access surgery [9,10], and video-assisted methods [11,12].

In our centre, lower mini-sternotomy (LMS) and right lateral thoracotomy (RLT) have been employed to repair congenital heart defects for several years to avoid a median sternotomy and its related discomfort. This retrospective study reviews our results and experiences with the LMS technique and RLT technique for the treatment of VSD compared with SMS.

Materials and Methods

This study was approved by the Institutional Review Board of WuHan University and was in compliance with Health Insurance Portability and Accountability Act regulations and the Declaration of Helsinki. The Institutional Review Board waived the need for individual patient consent. All the recruited patients had their operations during the same time period and the choice of incision primarily depended on the preference of the surgeon. The associated cardiac defects were uncomplicated anomalies, such as patent ductus arteriosus (PDA), pulmonary valve stenosis, mitral incompetence, double chamber of the right ventricles and left superior vena cava (LSVC). Patients unable to give informed consent were excluded from this study. All patients underwent VSD closure by the same surgical team.

Between January 2013 and December 2015, 198 patients underwent elective VSD closure. In accordance with the patient's preference, and after discussion in our cardiologic/surgical conference, surgical access was made using a lower mini-sternotomy technique (LMS Group, n = 66), right lateral thoracotomy (RLT Group, n = 59), or standard median sternotomy (SMS Group, n = 73). Patient characteristics general data concerning age, sex, weight, cardiothoracic ratio, and the size of the defect were collected for analysis of any differences between the three groups prior to the operation (Listed in Table 1).

Operative Technique

LMS Group

Patients were positioned in a supine position as with conventional cardiac procedures. A transoesophageal echocardiograph (TEE) probe was inserted routinely to assess the surgical result as well as to detect possible intra-cardiac air. A skin incision was carried out from the xiphoid process to the inter-nipple line in children or 2 cm above this line in adult patients. The sternotomy was performed from the xiphoid appendix up to the level of the skin incision, without any left or right extension. A sternum retractor and Bookwalter retractor were used in the cephalic region. Central cannulation, low hypothermic cardiopulmonary bypass with aortic cross-clamp and anterograde cardioplegia were undertaken in children. The cardiopulmonary bypass was established by peripheral arterial and venous cannulating in adult patients. CO_2 was used to remove intra-cardiac air during the procedure. The VSD was closed with 5-0 prolene directly or with an autologous pericardium patch based on the size of the defect. The cannula was removed after weaning from cardiopulmonary bypass. Two chest tubes were placed to drain effusion and air. [Figure 1].

RLT Group

In patients who underwent RLT (right lateral thoracotomy), the patients were positioned with the right side elevated 45–60 degrees and the right arm was put over the head in a natural position. A skin incision ranging from 5 to 6 cm, varying depending upon patient's physical characteristics and the type of lesion being treated, was created obliquely between the anterior and posterior axillary folds with the

Table 1 Clinical characteristic of patients

Variables	LMS Group (n = 66)	RLT Group (n = 59)	SMS Group (n = 73)	F/χ^2 Value	P Value
Mean age (D ± SD)	3.6 ± 2.79	4.17 ± 2.92	5.63 ± 3.88	4.19	0.123
Sex ratio (F/M)	42/24(63.6%)	36/23(60.02%)	34/39(43.03%)	7.42	0.02
Weight (kg)	14.44 ± 4.48	16.96 ± 8.79	12.88 ± 4.53	9.801	0.007
Size of defect (mm)	6.77 ± 2.69	7.41 ± 2.63	7.61 ± 3.72	1.997	0.368
Cardiothoracic ratio	0.58 ± 0.08	0.59 ± 0.09	0.56 ± 0.09	3.203	0.202

SD: standard deviation.

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