Journal of Cardiovascular Disease Research

Journal of Cardiovascular Disease Research, 12 (1)
ISSN: 0975-3583, 0976-2833
10.31838/jcdr.2021.12.01.06

Right thoracotomy – an alternative surgical access in the surgery of congenital heart defects

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Received: 20 October 2020; Accepted: 2 January 2021; Published: 14 March 2021

Abstract

Background: In this report presented the results of surgical correction in septal defects associated with congenital heart defects from right-sided lateral thoracotomy. Carried out comparative assessment of perioperative indicators, such as the duration of the operation, the duration of artificial circulation, the duration of artificial ventilation of the lungs, the time of staying patients in the intensive care unit and postoperative hospital days in patients operated from right-sided lateral thoracotomy and standard longitudinal sternotomy.

Methods: Were analyzed the results of surgical treatment of 150 patients with isolated heart septal defects, a combination of heart septal defects with pulmonary artery stenosis, with anomalies of the inflow of the pulmonary veins, with atrioventricular valve pathologies, as well as with aortic valve insufficiency. All patients were divided into two groups of equal number of patients. I - group (main group) of 75 patients operated on from a right-sided lateral thoracotomy. II - group (control group) 75 patients operated on from a median longitudinal sternotomy.

Results: In the group of patients operated from lateral thoracotomy, there was a significant reduction in the total duration of operation, a shortening of the time of artificial lung ventilation, the length of stay of patients in the intensive care unit and reduction of postoperative hospital days. The duration of cardiopulmonary bypass among patients of both groups did not differ significantly, being 35.6 ± 3.45 minutes in the main group, and 39.48 ± 3.48 minutes in the control group, $p = 0.43$.

All performed operations from right-sided thoracotomy access proceeded without technical difficulties, and the stages of elimination of existing defects were carried out in full according to the standard protocol. In no case was there a need for conversion. Patients were particularly satisfied with the achieved cosmetic effect.

Conclusions: Based on the obtained results, the authors of the report came to the conclusion that right-sided thoracotomy can be used as an alternative surgical access to the standard sternotomy access in the surgery of septal defects and some congenital heart defects associated with it in conditions of artificial circulation. This access is less traumatic, better tolerated by patients and subsequently gives fewer complications.

Keywords: congenital heart defects, heart septal defects, cardiopulmonary bypass, right thoracotomy, median sternotomy.

Introduction

During the development of surgery for congenital heart defects, like other areas of "open" cardiac surgery, longitudinal median sternotomy was and remains the standard surgical access to the heart. The longitudinal median sternotomy, which is recognized as the "gold standard" in cardiac surgery under conditions of extracorporeal circulation, cannot be optimal for a number of reasons. Longitudinal sternotomy is accompanied by extensive trauma to the sternum, soft tissues, as well as vessels and nerve endings located in this anatomical region. Sternotomy in the postoperative period can be cause of intense and prolonged pain syndrome.[1,2] Chronic pain syndrome after cardiac surgery can be one of the main factors worsening the general condition of patients, increases the rehabilitation period and worsens the quality of life.[3] Transsternal approach is also characterized by a rather high frequency of purulent postoperative complications. Thus, a number of studies have shown that post-sternotomy mediastinitis occurs in 0.4–5.0% of cases and is a serious and potentially life-threatening condition.[4–6] In this case, fatal outcomes according to the literature range from 10% to 47% or more.[6-8] Another of the serious complications after operations performed by the transsternal approach is sternal dehiscence, which may require additional surgical intervention. Sternotomy wound healing is a long process. Delayed or impaired healing of the sternotomic wound, as well as the divergence of the edges of the sternum and associated infectious complications occur in 0.15-19%.[9,10] In the late postoperative period, in a certain part of the operated patients, a rough keloid scar develops over the sternum (Figure 1a), which, being a pronounced cosmetic defect, often leads to psychoemotional disorders and a decrease the quality of life.[11,12] Also, a certain part of the operated patients through the transsternal approach, is noted the development of deformity of sternum (Figure 1b).

The use of a standard approach, regardless of the volume and nature of the surgical intervention, and the purpose of reducing the trauma of the operation and preventing the development in the postoperative period of various negative aspects of the use of longitudinal sternotomy in the form of mediastinitis, sternum diastasis, deformity of the sternum and gross keloid scars, led to the search for alternative approaches that excluded these postoperative complications.

In general, as the technologies of surgery in surgery for congenital heart defects, as well as interventional cardiology, have improved in recent years, a search and development of minimally invasive methods has been carried out, eliminating the negative aspects of using standard sternotomy access.

Considering the above, over the past few years in the Republican Specialized Scientific-Practical and Medical Center of Surgery named after academician

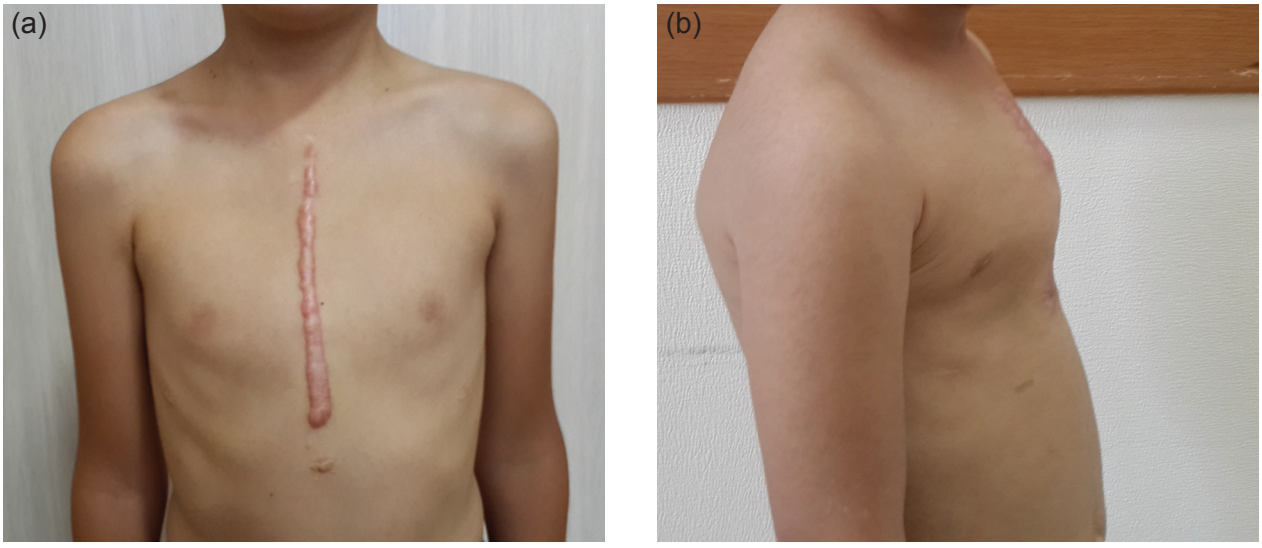

Figure 1 (a) A rough keloid scar formed 9 months after median sternotomy. (b) Deformation of the sternum developed in 12 months after median sternotomy.

V. Vakhidov, radical correction of septal defects of the heart and congenital heart defects combined with them were carried out from the right-sided lateral thoracotomy.

Currently, the Department of Congenital Heart Disease Surgery has experience in more than 400 operations performed by access to the heart from a right-sided thoracotomy during surgical correction of septal defects combined with congenital heart defects.

The purpose of this study is to analyze the results of the use of right-sided thoracotomy in the surgery of septal defects and congenital heart defects combined with it in conditions of artificial circulation, performed at the Republican Specialized Scientific-Practical and Medical Center of Surgery named after academician V. Vakhidov.

Patients and methods

The results of surgical treatment of 150 patients with isolated heart septal defects, a combination of heart septal defects with pulmonary artery stenosis, with anomalies of the inflow of the pulmonary veins, with atrioventricular valve pathologies, as well as with aortic valve insufficiency, operated at the Department of Congenital Heart Disease Surgery were analyzed.

All patients were divided into two groups of equal number of patients. Group I (main group) of 75 patients operated on from a right-sided lateral thoracotomy along the fourth intercostal space. Group II (control group) 75 patients operated on from a median longitudinal sternotomy.

The age of the operated patients in the main group ranged from 5 to 47 years, averaging 17.25 ± 2.21 years. In terms of sex ratio, female patients prevailed – 57 (76%), male patients – 18 (24%). Such a large difference in the sex ratio is mainly due to the achieved cosmetic effect of using this access, which is more relevant for females.

Table 1 Anthropometric indicators

No	Criteria	Main group (n=75)	Control group (n=75)
1	Averaging age (years)	17.25 ± 2.21	16.04 ± 2.58
2	Sex, male/female	18/57	35/40
3	Weight (kg)	45.94 ± 2.93	40.62 ± 3.18
4	Height (cm)	151.40 ± 1.64	144.86 ± 2.12

Anthropometric indicators of patients of the studied groups are presented in Table 1.

Patients of both groups were operated on in the period from 2001 to 2019, and all operations were performed with the standard connection of patients to a heart-lung machine.

Of the total number of patients in the main group, patients with an isolated defect of the interatrial septum made up the bulk of the operated patients, in whom contraindications to the use of the endovascular technique based on anatomical features were previously stated in the preoperative period. Further in frequency, there were different types of partial abnormal drainage of the pulmonary veins, and isolated defects of the interventricular septum. Patients operated on with septal defects in combination with congenital heart defects such as stenosis of the pulmonary artery, pathology of atrioventricular valves, aortic valve and anomalies of the inflow of pulmonary veins amounted to 36% (27 patients) of the total number of those operated.

The distribution of patients according to the operations performed in both groups is presented in Table 2.

In group I, the main stage of the operation was performed in 52 cases under conditions of artificial circulation with pharmaco-cold cardioplegia. The elimination of atrial septal defects in 19 cases was eliminated in the conditions of artificial circulation on the contracting heart. Also, in 4 cases, atrial septal defects with valvular stenosis of the pulmonary artery were eliminated by suturing the defects and instrumental dilatation of the stenosis under extracorporeal circulation on the beating heart.

Results

All operations in the main group were performed from right-sided lateral thoracotomy along the 4th intercostal space. The length of the skin incision varied from 5 to 12 cm, depending on the age and type of constitutional build. In female patients, a skin incision was made along the skin fold, bending around the right mammary gland.

All operations proceeded without technical difficulties, sufficient visualization for surgical correction of the great vessels, heart and intracardiac structures was noted. The main stages of elimination of existing defects were carried out in full according to the standard protocol. There was no need for conversion in any observation.

Table 2 Distribution of patients by performed operations.

No	Types of surgery	Right thoracotomy (n = 75)	Median sternotomy (n = 75)
1	Suturing ASD without CP	19	8
2	Autopericardial patch plasty of ASD under CPB and CP	13	18
3	Total correction of supracardial form of PAPVC under CPB and CP	6	3
4	Suturing of VSD under CPB and CP	4	13
5	Suturing of VSD and suturing foramen ovale under CPB and CP	4	1
6	Suturing ASD with instrumental dilatation of valvular PS without CP	6	1
7	Synthetic patch plasty of VSD under CPB and CP	3	2
8	Suturing ASD under CPB and CP	4	12
9	Suturing ASD, infundibular resection RVOT at PS with instrumental dilatation of valvular PS under CPB and CP	2	—
10	Total correction of cardial form of PAPVC under CPB and CP	2	3
11	Suturing ASD with instrumental dilatation of valvular PS under CPB and CP	—	2
12	Synthetic patch plasty of VSD and suturing foramen ovale under CPB and CP	2	—
13	Total correction of incomplete form of atrioventricular canal under CPB and CP	2	8
14	Ksenopericardial/synthetic patch plasty of VSD and plasty of aortic valve by Trusler under CPB and CP	1	1
15	Synthetic patch plasty of VSD and plasty of tricuspid valve under CPB and CP	1	—
16	Synthetic patch plasty of VSD, infundibular resection RVOT at PS with instrumental dilatation of valvular PS under CPB and CP	1	—
17	Synthetic patch plasty of VSD with infundibular resection RVOT at PS under CPB and CP	1	—
18	Suturing of VSD with infundibular resection RVOT at PS under CPB and CP	1	—
19	Autopericardial patch plasty of ASD and open valvuloplasty PS under CPB and CP	1	1
20	Synthetic patch plasty of VSD with instrumental dilatation of valvular PS under CPB and CP	1	—
21	Autopericardial patch plasty of ASD without CP	—	1
22	Autopericardial patch plasty of ASD with instrumental dilatation of valvular PS under CPB and CP	—	1
23	Suturing of VSD, infundibular resection RVOT at PS with instrumental dilatation of valvular PS under CPB and CP	1	—
Total		75	75

Note: ASD – atrial septal defect; CP – cardioplegia; CPB – cardiopulmonary bypass; PAPVC – partial anomalous pulmonary venous connection; PS – pulmonary stenosis; RVOT – right ventricle outlet tract; VSD - ventricular septal defect.

The following indicators were analyzed: the duration of the operation (from the skin incision to suturing the skin), the duration of artificial circulation, the duration of artificial lung ventilation (after the transfer of the patient to the intensive care unit), the time of patients staying in the intensive care unit and after operating bed-days, Table 3.

Analysis of the total duration of the operation shows a significant decrease in time in the group of patients operated on from the right-sided thoracotomy access, averaging 179.46 ± 3.62 minutes, which in the control group was 195.2 ± 3.52 minutes, p = 0.02. The indicator of the duration of artificial circulation among the comparable groups did not differ significantly.

It should be noted that in the group of those operated on via thoracotomy access, the immediate postoperative period was characterized by early activation of patients with an early transition to spontaneous breathing. All patients were extubated within the first hours after surgery. At the same time, the average duration of artificial lung ventilation was 377.54 ± 9.73 minutes, and the time of stay of patients in the intensive care unit was 1384.25 ± 33.46 minutes.

So, when we were analyzing postoperative staying in hospital, was noted a significant reduction of this indicator. Most of the patients in the main group were discharged from the hospital in 5-7 days after the operation. Wherein the indicator after the operating bed-day averaged in the main group 7.89 ± 0.51 days, and 10,98±0,61 days in control group, p = 0.001.

Patients of the control group were operated on by access from a longitudinal median sternotomy

Table 3 Comparison criteria of thoracotomy vs sternotomy.

Criteria	Patients operated from right side lateral thoracotomy (n = 75)	Patients operated from median sternotomy (n = 75)	p
Surgery duration (min)	179.46 ± 3.62	195.2 ± 3.52	0.02
Cardiopulmonary bypass time (min)	35.6 ± 3.45	39.48 ± 3.48	0.43
Time of artificial lung ventilation (min)	377.54 ± 9.73	436.73 ± 10.25	0.001
Length of stay in intensive care unit (min)	1384.25 ± 33.46	1514.93 ± 16.84	0.001
Postoperative staying in hospital (day)	7.89 ± 0.51	10.98 ± 0.61	0.001

according to the standard technique under conditions of artificial circulation, moderate hypothermia and pharmaco-cold cardioplegia. The average duration of the operation was 195.2 ± 3.52 minutes. The duration of cardiopulmonary bypass was on average 39.48 ± 3.48 minutes and the duration of intensive care unit stay was 1514.93 ± 16.84 minutes. All patients of both groups were discharged from the hospital in satisfactory condition.

Thus, the analysis of our own results of the use of right-sided lateral thoracotomy led to a decrease in the total duration of the operation, a significant reduction in the time of mechanical ventilation and the length of stay of patients in the intensive care unit, as well a decrease of postoperative hospital days.

It should be noted that all patients were satisfied with achieved cosmetic effect, which presented in Figure 2a, 2b, 2c and 2d.

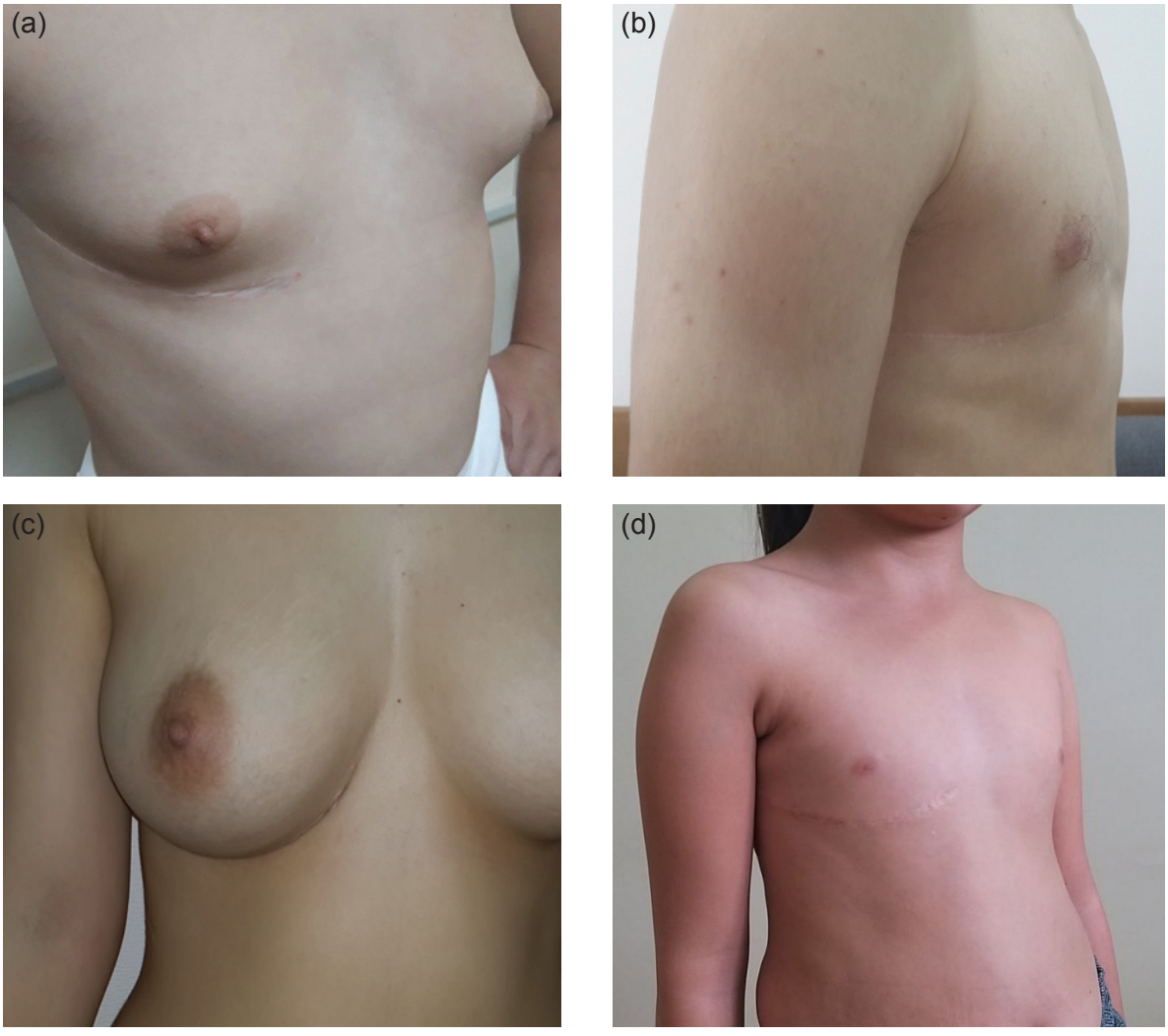

Figure 2 (a) Cosmetic result after 2 months of surgery. (b) Cosmetic result after 4 months of surgery. (c) Cosmetic result after 6 months of surgery. (d) Cosmetic result after one year of surgery.

Discussion

Today, the median sternotomy remains the access of choice for operations on the heart and great vessels in the conditions of artificial circulation. Among the approaches to the heart, the longitudinal median sternotomy is considered the most universal and rational approach, providing the surgeon with an opportunity to perform adequate surgical procedures on the heart for various forms of its pathology. This surgical approach provides exceptional opportunities for approaching various parts of the heart and great vessels, allows you to obtain the best exposure of the operated area, and it is easy to revise and reconstruct any anatomical zone, extra- or intracardiac structures from it. However, an analysis of the literature data in the study of the results of using sternotomy shows that longitudinal median sternotomy cannot be considered optimal. There are a number of reasons for this. The most important of these reasons can be considered a large invasiveness of the access, violation of the integrity of the musculoskeletal frame of the chest and the divergence of the edges of the sternum with the onset of instability followed by the formation of diastases.

In favor of the particular trauma of sternotomy is evidenced by a pronounced pain syndrome, which is often chronic in nature and requires repeated use of analgesics.[1-3]

Of a number of negative aspects of longitudinal median sternotomy, it is necessary to note a rather high incidence of postoperative proinflammatory complications, which, according to many studies, reaches up to 5%.[4,5] The most formidable of the infectious complications are mediastinitis and osteomyelitis of the sternum and ribs. Mortality in the group of patients with mediastinitis reaches from 47% to 50%.[6-8]

Unfortunately, the treatment of infectious complications from a sternotomy wound is a complex and multicomponent task. So, for the surgical treatment of severe forms of sternomediastinitis and associated complications are of particular importance for medical and economic importance. When observing one or another complication of sternotomy, the patient's stay in the hospital is increased. Treatment of these complications leads to lengthening of bed-days and a significant increase in treatment costs.[4,13]

Considering the aforementioned negative aspects of longitudinal median sternotomy, and as the technology of heart operations improves, cardiac surgeons are constantly searching for and developing new surgical techniques that provide less traumatic operations that exclude the above negative aspects of trans-sternal access. The solution to this problem is difficult, since the heart and great vessels are protected by a powerful musculoskeletal frame of the chest and are located at a considerable depth, between the pericardium and the chest wall there is a lung.

Today, cardiac surgery is more focused on reducing the invasiveness of the operations performed. In an effort to reduce the surgical trauma, for the purpose of early rehabilitation of patients and in order to achieve a good cosmetic effect, few researchers from large cardiac surgery centers in the world eliminate isolated defects of the heart septum and some congenital defects associated with them using different options for right-sided thoracotomy.[14-21] The use of this approach, in contrast to the longitudinal median sternotomy, preserves the musculoskeletal frame of the chest, reduces surgical trauma, reduces the frequency of purulent-septic complications, gives a good cosmetic effect, shortens the patient's stay in the hospital, accelerates rehabilitation, and, consequently, reduces treatment costs.

The analysis shows that our results are largely similar to the results of studies conducted in other clinics around the world. In a series of our operated patients from the right-sided thoracotomy approach, a statistically significant decrease in the total duration of the operation, a decrease in the duration of artificial lung ventilation and the time spent in the intensive care unit, also reduction of postoperative hospital days. In analyzing the duration of cardiopulmonary bypass among comparable groups, there was no statistically significant difference, being 35.6 ± 3.45 minutes in the main group, and 39.48 ± 3.48 minutes in the control group, $p = 0.43$. Thus, analyzing our results and data from other cardiac surgery centers in the world, we can conclude that right-sided thoracotomy can be successfully used as an alternative approach in the surgery of septal defects and congenital heart defects combined with it in conditions of artificial circulation. This access is less traumatic, better tolerated by patients and subsequently gives fewer complications.

Based on our own material and experience, we can come to the following conclusions:

1. Total correction of defects of the septum and/or congenital heart defects in combination with

cardiopulmonary bypass can be successfully performed from right-sided thoracotomy;
2. Right-sided thoracotomy is an alternative surgical approach to medium sternotomy for surgical correction defects of the septum and other types of surgeries of congenital heart defects associated with cardiopulmonary bypass;
3. Right-sided thoracotomy provides sufficient visualization of areas for performing surgical procedures for isolated defects of the atrial and interventricular septum, as well as congenital heart defects, such as anomalous pulmonary venous connection, pulmonary artery stenosis and atrioventricular valves pathology;
4. Applying of right-sided thoracotomy approach in the surgery of septal and congenital heart defects allows to reduce the traumatism of surgery, shorten the rehabilitation of patients, and leads to a positive cosmetic result.

Conflicts of interest

The authors declare that they have no conflict of interest.

Financial support

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgments

All authors participated in the research process and data collection.

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