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THORACOSCOPY VERSUS STERNOTOMY IN THE CORRECTION OF A VENTRICULAR SEPTAL DEFECT: A SINGLE CENTER EXPERIENCE

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The authors declare that they have no conflicts of interest

Keywords:
minimally invasive heart surgery, thoracoscopy, ventricular septal defect, cardiopulmonary bypass

Abstract

Objective: *To compare the immediate outcomes of thoracoscopy and median sternotomy in patients undergoing ventricular septal defect repair.*

Materials and мethods. *We analyzed 59 patients diagnosed with VSD who were operated on at the SCCCST from 2012 to 2021. All patients were divided into two groups: group 1 included patients in whom thoracoscopic access was used (n=27), group 2 included the method of complete median sternotomy (n=32).*

Results. *There were no statistically significant differences in complications in the postoperative period and no in-hospital mortality. The duration of the procedure and the duration of cardiopulmonary bypass in the thoracoscopy group were longer than in the sternotomy group. Blood loss during and after surgery was lower in the thoracoscopy group than in the sternotomy group. Hence, less blood and plasma transfusion was required in the thoracoscopy group than in the sternotomy group. The length of stay in the intensive care unit, the time spent on mechanical ventilation, bed days after surgery, the use of analgesics were statistically lower in the thoracoscopy group than in the sternotomy group. It should be noted that the length of the skin incision in patients in the thoracoscopy group was significantly less than in the second group.*

Conclusion. *Thoracoscopic approach for VSD correction is an effective and low-traumatic method that does not increase the risk of surgical complications. Routine use of this technique requires a study on a larger sample of patients.*

Қарыншалық перде ақауын түзетудегі стернотомия мен торакоскопия әдістерін салыстыру: бір орталықтың тәжірбиесі

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Аңдатпа

Жұмыстың мақсаты *- қарыншалық перде ақауларын қалпына келтіретін науқастардағы* торакоскопияның тікелей нәтижелерін орта стернотомиямен саРесейлыстыру.

Материал мен әдістері. *Біз 2012-2021 жылдар аралығында Тараз қаласындағы кардиохирургия және трансплантология ғылыми-клиникалық орталығында ота жасалған қарыншалық перде ақау диагнозымен 59 науқасқа талдау жасадық. Барлық емделушілер екі топқа бөлінді: 1-топқа торакоскопиялық қолжетімділікті пайдаланған пациенттер (n=27), 2-топқа толық орта стернотомия әдісін қолданған пациенттер (n=32).*

Нәтижелер. *Операциядан кейінгі кезеңде және стационар ішілік өлім-жітімсіз асқынулар бойынша статистикалық маңызды айырмашылықтар болған жоқ. Операцияның ұзақтығы мен кардиопульмональды шунттау ұзақтығы торакоскопиялық топта стернотомия тобына қарағанда ұзағырақ болды. Операция кезінде және одан кейінгі қан жоғалту стернотомия тобына қарағанда торакоскопиялық топта төмен болды. Демек торакоскопиялық топта стернотомия тобына қарағанда аз қан және плазма азырақ құйылды. Реанимация бөлімінде болу ұзақтығы, өкпенің жасанды вентиляциясына кеткен уақыт, операциядан кейінгі төсек күндері, анальгетиктерді қолдану стернотомия тобына қарағанда торакоскопиялық топта статистикалық төмен болды. Айта кету керек, торакоскопия тобындағы науқастарда тері шрамы ұзындығы екінші топқа қарағанда айтарлықтай кіші болды.*

Қорытынды. *Хирургиялық асқынулардың қаупін арттырмайтын тиімді және төмен травматикалық әдіс ретінде қарыншалық перде ақау түзетудің торакоскопиялық әдісі қолданылады. Бұл әдісті күнделікті қолдану пациенттердің үлкен үлгісін зерттеуді талап етеді.*

Түйінді сөздер:
минималды инвазивті жүрек хирургиясы, торакоскопия, қарыншалық перде ақауы, жүрек-өкпе қан айдау аппараты

Торакоскопия против стернотомии при коррекции дефекта межжелудочковой перегородки: опыт одного центра

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Аннотация

Цель исследования *- сравнить непосредственные исходы торакоскопии со срединной стернотомией у пациентов перенесших коррекцию дефекта межжелудочоковой перегородки.*

Материалы и методы. *Анализированы 59 пациентов с диагнозом ДМЖП, которые оперированы в «Научно-клинический центр кардиохирургии и трансплантологии» г. Тараз с 2012 по 2021 гг. Все пациенты разделены на две группы: в 1 группу вошли пациенты, у которых использован торакоскопический доступ (n=27), во 2 группе применен метод полной срединной стернотомии (n=32).*

Результаты. *Не было статистически значимых различий осложнений в послеоперационном периоде и без госпитальной летальности Продолжительность операции и длительность искусственного кровообращения в группе торакоскопии были больше, чем в группе со стернотомии. Кровопотеря во время операции и после операции была ниже в группе в торакоскопии, чем в группе стернотомии. Следовательно, что потребовало меньше переливание крови и плазмы в группе торакоскопии, чем в стернотомии. Продолжительность пребывания в отделении реанимации, время нахождения на искусственной вентиляции легких, койко-дни после операции, применение анельгетиков были статистически ниже в группе торакоскопии, чем в группе стернотомии. Следует отметить, что длина кожного разреза у пациентов в группе торакоскопии был достоверно меньше, чем во второй группе.*

Заключение. *Торакоскопический доступ при коррекции ДМЖП используется как эффективный и малотравматичный метод, не увеличивающий риск хирургических осложнений. Для рутинного использования данной техники необходимо изучение на более большой выборке пациентов.*

Ключевые слова:
минимально инвазивная хирургия сердца, торакоскопия, дефект межжелудочковой перегородки, аппарат искусственного кровообращения

Introduction

Ventricular septal defect is one of the most common congenital heart defects, accounting for 10% or 1.5 cases per 1000 newborns [1]. In 1954, Lilehei performed the first VSD repair through a median sternotomy. For many years, the median longitudinal sternotomy has remained the standard approach to the surgical treatment of VSD, which shows good postoperative results and minimal mortality. However, this method has a number of disadvantages: greater trauma, increased risk of wound infection, and a long stay in the hospital [2].

In recent years, fully endoscopic techniques have been developed for VSD closure using robotic surgical systems and without the use of robotics. [3, 4, 5, 7, 8, 9, 10]. However, still there is insufficient evidence for the use of thoracoscopy in VSD repair. In addition, the thoracoscopic method is not robotic and very few people in the world use this technology.

Purpose: to study the safety and efficacy of thoracoscopic VSD closure. We compared the immediate outcomes of thoracoscopy and median sternotomy in patients undergoing ventricular septal defect repair.

Materials and methods

We analyzed 59 patients diagnosed with VSD who were operated on at the Scientific and Clinical Center of Cardiac Surgery and Transplantology from 2012 to 2021. All patients were divided into two groups: group 1 included patients in whom thoracoscopic access was used (n=27), group 2 included the method of complete median sternotomy (n=32). The choice of surgical approach was based on the joint decision of the surgeon and the patient (Figure 1).

Inclusion Criteria: isolated ventricular septal defect; age more than 5 years; body weight more than 15 kg.

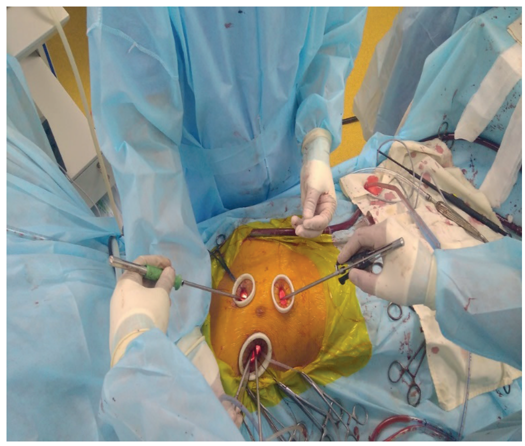

Figure 1. Correction of VSD through three ports

CPB was performed by cannulation of the right femoral artery and vein + right jugular vein under normothermia. To ensure adequate venous return, a vacuum was connected to the venous line, the negative pressure was uregulated from -20 to -40 mm Hg. The pericardium was dissected longitudinally, 3 cm above the phrenic nerve, from the ostium of the inferior vena cava to the ascending aorta. Then the superior and inferior vena cava were isolated, clamped with tourniquets.

CPB was carried out under normothermic conditions. The aortic clamp was placed on the ascending aorta through port 1. A Chitwood clamp was used to clamp the ascending aorta through port 1, but only to correct VSD. A cardioplegic cannula was passed through port 1 into the aortic root for blood cardiopelgia. Then, after cardiac arrest, an incision was made in the right atrium parallel to the atrioventricular sulcus, which were also taken on handles. A 3 mm long incision was made in the region of the oval fossa to relieve the left heart. The septal leaflet of the tricuspid valve was incisied towards the base to visualize a true VSD (Figure 2).

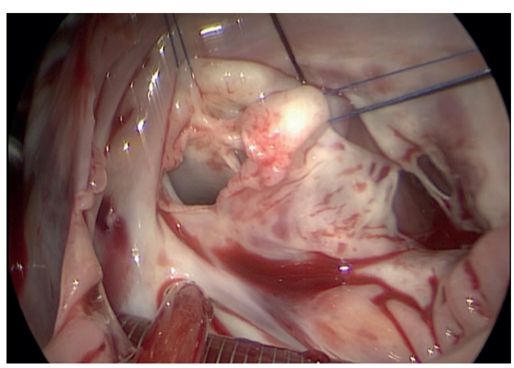

Figure 2. Perimembranous VSD

Next, VSD closure was performed using an autopericardium treated with glutaraldehyde. If the diameter of the defect was less than 4 mm, suturing was performed, if it was more than 4 mm, horizontal mattress stitches were placed on the linings using a 4/0 prolene threads. After closure of the VSD, the integrity of the septal leaflet of the tricuspid valve was restored (Figure 3).

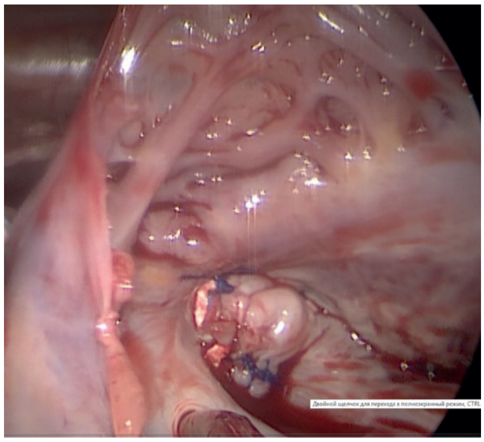

Figure 3.
VSD closure

Sealing the incision in the region of the oval fossa and the right atrium. Prevention of air embolism was carried out using negative pressure through a catheter located on the ascending aorta, additionally by carbon dioxide insufflation. The Chitwood clamp was removed from the ascending aorta, then, after hemodynamic stabilization, cardiopulmonary bypass was completed. Transesophageal echocardiography was performed to check the patch. After the protamine sulfate is given, hemostasis was performed, a drainage tube was installed in port 3. Decannulation of the right femoral vein and artery, the right jugular vein. Layered sutures on the wound.

Patients of the 2nd group were operated by the standard method - complete median sternotomy using conventional anesthesia, under cardiopulmonary bypass with central cannulation of the great vessels.

Statistical analysis

Statistical processing of the material was performed using the IBM SPSS Statistics 26 software package (Chicago, IL, USA) and Jamovi (Version 1.6.9) https://www.jamovi.org. All quantitative variables were checked for the type of distribution using the Shapiro-Wilk test. Quantitative traits with an approximate normal distribution were described in the form of mean value and standard deviation (M±SD), in the case of a non-normal distribution, as a median and 25th, 75th percentile (Me (Q1-Q3)). Categorical data were described with absolute values and percentages. Comparison of two groups in terms of a quantitative indicator having a normal distribution, under the condition of equality of variances, was performed using the Student's t-test, with unequal variances, it was performed using the Welch t-test. Comparison of two groups in terms of a quantitative indicator, the distribution of which differed from the normal one, was performed using the Mann-Whitney U-test. Comparison of percentages in the analysis of four-field contingency tables was performed using Pearson's chi-square test (for expected phenomena values greater than 10), Fisher's exact test (for expected phenomena values less than 10). Comparison of percentages in the analysis of multifield contingency tables was performed using Pearson's chi-square test.

Results

Demographic and preoperative clinical characteristics did not differ in both groups (Table 1)

Table 1.
Demographic and preoperative clinical characteristics

Variable	Thoracoscopy (Group 1, n=27)	Sternotomy (Group 2, n=32)	P-value
Age, years (Me (Q1-Q3)	12(8 – 20)	13(9 – 22)	0,653
Gender, men, n (%)	15 (55,6)	17 (53,1)	0,852
Weight, kg (Me (Q1-Q3)	35(24 – 59)	32(24 – 59)	0,921
BSA (Me (Q1-Q3)	1(1 – 2)	1(1 – 2)	0,796
CHF II according to NYHA, n (%) III по NYHA, n (%)	12 (44,4) 15 (55,6)	12 (37,5) 20 (62,5)	0,589
Qp/Qs (Me (Q1-Q3)	2 (2 – 2)	2(2 – 2)	0,048
LV EF % M ± SD с 95% CI	63 ± 4 (62 – 65)	65 ± 4 (64 – 67)	0,081
PAP (Me (Q1-Q3)	22 (20 – 25)	23 (20 – 25)	0,706
CT ratio M ± SD с 95% CI	52 ± 4 (50 – 54)	53 ± 7 (51 – 56)	0,356

Note: Data presented as mean ± SD or n (%); Abbreviations: BSA, body surface area; CHF, chronic heart failure; NYHA, New York Heart; Association; Qp/Qs, ratio of Pulmonary -to- Systemic flow; LVEF, left ventricular ejection fraction; PAP, pressure in the pulmonary artery; MS, CT, cardiothoracic; CI, confidence interval.

Intraoperative data are presented in Table 2. The duration of the operation and the duration of cardiopulmonary bypass in the thoracoscopy group were longer than in the sternotomy group. Blood loss during and after surgery was lower in the thoracoscopy group than in the sternotomy group. Hence, less blood and plasma transfusion was required in the thoracoscopy group than in the sternotomy group.

Table 2.
Intraoperative variables

Variable	Thoracoscopy (Group 1, n=27)	Sternotomy (Group 2, n=32)	P-value
Operating time, min M±SD c 95% CI	256±26 (246–267)	211±42(195–226)	< 0,001
Aortic cross-clamping, min M±SD c 95% CI	69±17 (63–76)	33±12 (29–38)	< 0,001
CPB, min (Me (Q1-Q3)	94 (73–110)	57(44–68)	< 0,001
Intra-op blood loss, ml (Me (Q1-Q3)	100(100–100)	150(100–212)	0,004
Packed red blood cell, n (%)	11 (40,7)	20 (62,5)	0,095
FFP, n (%)	0 (0,0)	14 (43,8)	< 0,001

Note: Data presented as mean ± SD or n (%); Abbreviations: CI, confidence interval; CPB, cardiopulmonary bypass; FFP, fresh frozen plasma

There were no statistically significant differences in complications in the postoperative period and no in-hospital mortality (Table 3). The length of stay in the ICU, the time spent on mechanical ventilation, bed days after surgery, the use of analgesics were statistically lower in the thoracoscopy group than in the sternotomy group.

Table 3.
Details of various postoperative findings and complications

Variable	Thoracoscopy (Group 1, n=27)	Sternotomy (Group 2, n=32)	P-value
ICU, hours (Me (Q1-Q3)	16 (14–18)	21 (19–22)	< 0,001
Lung ventilation (Me (Q1-Q3)	105 (70–115)	180 (135–218)	< 0,001
PAP post-op (Me (Q1-Q3)	20 (20–23)	20 (20–23)	0,514
Total blood loss post-op, ml (Me (Q1-Q3)	170 (120–190)	190 (140–250)	0,027
analgesics total for three days, mg (Me (Q1-Q3)	650 (575–675)	750 (650–850)	< 0,001
incision length, mm (Me (Q1-Q3)	50 (42–55)	150 (128–180)	< 0,001
bed days post-op, days (Me (Q1-Q3)	7 (6–8)	8 (7–9)	< 0,001
MI, n (%)	0	0	1
Stroke, n (%)	0	0	1
AKF, n (%)	0	0	1
Reoperation, n (%)	0 (0,0)	2 (6,2)	0,495
Residual shunts, n (%)	1 (3,7)	1 (3,1)	1,000
Wound infection, n (%)	0 (0)	2 (6,2)	0,495
Cannulation site complications, n (%)	1 (3,7)	0 (0,0)	0,458
Hydrothorax, n (%)	2 (7,4)	2 (6,2)	1,000
Atelectasis, n (%)	2 (7,4)	0 (0,0)	0,205
AV block post-op	0	0	1
Pericardial effusion	0	0	1
Hospital mortality, n (%)	0	0	1

Note: Data presented as mean ± SD or n (%); Abbreviations: ICU, intensive care unit; PAP, pressure in the pulmonary artery; MI, myocardial infarction; AKF, acute kidney failure.

It should be noted that the length of the skin incision in patients in the thoracoscopy group was significantly less than in the second group.

Discussion

Ventricular septal defects (VSDs) are the most common type of congenital heart disease, and when indicated, surgical closure is considered the gold standard of care. [1]. The elimination of VSD is of fundamental importance to perform at an early age, however, the natural course of the defect may be asymptomatic, and some patients undergo correction at an older age. There are various surgical methods to eliminate VSD [2, 3]. For many years, the median longitudinal sternotomy, which provides wide access to the heart, has remained the standard approach to the surgical treatment of VSD. However, this method has a number of disadvantages: greater trauma, lengthening of the patient's stay in the hospital, the likelihood of developing infectious complications, and a rough postoperative scar [3]. With the development of endovascular technologies, most VSDs can be eliminated using special devices, however, for patients who have some anatomical features: the chordal filaments of the tricuspid valve are attached to the edge of the VSD, the location of the VSD is close to the fibrous ring of the tricuspid and aortic valves, surgical treatment remains the main method of VSD closure [4]. As an alternative to complete sternotomy, many surgeons have begun to widely use thoracoscopic VSD correction using video endoscopic equipment [5,6]. Thoracoscopic access provides sufficient visualization of the main vessels of the heart and intracardiac structures, reduces pain, reduces the need for transfusion of blood components, preserves the anatomical integrity of the chest bone skeleton and can significantly reduce the skin incision, achieving an excellent cosmetic effect [7, 8].

Currently, many reports have shown that morbidity and mortality after thoracoscopic VSD correction is not inferior to other surgical approaches and is a feasible and safe procedure, while reducing surgical trauma, reducing blood loss, reducing postoperative pain and faster recovery [9,10]. The results of our experience confirm the same advantages in thoracoscopic correction of ASD and VSD in children and adolescents, although the average duration of CPB and aortic clamping in the thoracoscopy group was significantly longer than in the sternotomy group [11]. We attribute this to such features of thoracoscopy as a longer preparatory stage (cannulation of peripheral vessels, installation of ports), the use of long endoscopic instruments, work at a great depth of the wound at an unusual viewing angle of the operating surgeon through the monitor.

Indeed, the reduction in hospital days during VSD correction, which increases the throughput of the hospital as a result, reduces the consumption of hospital resources, however, at the initial stages of training, we encountered complications associated with cannulation of the femoral arteries to provide peripheral CPB.

Conclusion

Thoracoscopic approach for VSD correction is used as an effective and low-traumatic method that does not increase the risk of surgical complications. Routine use of this technique requires a study on a larger sample of patients.

References

1. Nakamura, Hiroto. Congenital Heart Defects : Etiology, Diagnosis and Treatment. Edited by Hiroto Nakamura. New York: Nova Biomedical Books, 2009
2. Lillehei, C. Walton. "Controlled Cross Circulation for Direct-Vision Intracardiac Surgery: Correction of Ventricular Septal Defects, Atrioventricularis Communis, and Tetralogy of Fallot." Postgraduate medicine 17, no. 5 (1955): 388–396.
3. Bergmann, M., C. P. Germann, J. Nordmeyer, B. Peters, F. Berger, and S. Schubert. "Short- and Long-Term Outcome After Interventional VSD Closure: A Single-Center Experience in Pediatric and Adult Patients." Pediatric cardiology 42, no. 1 (2021): 78–88.
4. Mirzai, Saeid, Narutoshi Hibino, Gianluca Torregrossa, and Husam H. Balkhy. "Adult Ventricular Septal Defect Repair Using a Robotic Totally Endoscopic Approach: A Case Report." Innovations (Philadelphia, Pa.) 15, no. 4 (2020): 372–375.
5. Fang, Ningning, Bingbing Ma, Kai Liu, Yuedong Hou, and Zengshan Ma. "Feasibility and Safety of Ultra-Fast Track Anesthesia for Totally Thoracoscopic Closure of Ventricular Septal Defect: A Randomized Controlled Trial." Heliyon 9, no. 5 (2023): e15741–e15741.
6. Tan, Tong, Haozhong Liu, Jianrui Ma, Jian Liu, Haiyun Yuan, and Huiming Guo. "Case Report: Total Thoracoscopic Repair of Sinus of Valsalva Aneurysm Combined with Ventricular Septal Defect." Frontiers in cardiovascular medicine 9 (2022).
7. Duong, Duc Hung, and Quoc Dat Pham. "Closure of Subarterial Ventricular Septal Defect with Minimally Invasive Surgical Technique: A Case Report." International journal of surgery case reports 58 (2019): 142–144.
8. Zhou, Kan, Liang Yang, Biao-Chuan He, Ying-Jie Ke, Yan-Chen Yang, Qian Yan, Ze-Rui Chen, and Huan-Lei Huang. "Total Thoracoscopic Repair of Ventricular Septal Defect: A Single-center Experience." Journal of cardiac surgery 36, no. 7 (2021): 2213–2218.

9. Dang, Huy Q., Huong T.Le. “Totally Endoscopic Ventricular Septal Defect Repair Using Bilateral Femoral Arterial Cannulation in an 8-Year-Old Girl.” International journal of surgery case reports 55 (2019): 4–6.
10. 1Liu, Huagang, Zhiwei Wang, Jun Xia, Rui Hu, Zhiyong Wu, Xiaoping Hu, and Wei Ren. “Evaluation of Different Minimally Invasive Techniques in Surgical Treatment for Ventricular Septal Defect.” Heart, lung & circulation 27, no. 3 (2018): 365–370
11. Mukhamedov I.I., Joshibayev S. “Results of thoracoscopic correction of atrial septal defects with cardiopulmonary bypass.” Medical News of North Caucasus 15, no. 4. (2020): 509-512