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Clinical Practice Study

Minimally invasive surgery of ventricular septal defect closure: comparison of vertical infraaxillary minithoracotomy and conventionel median sternotomy

Ventriküler septal defekt kapamada minimal invaziv cerrahi: vertikal infraaksiller minitorakotomi ile konvansiyonel medyan sternotominin karşılaştırılması

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ABSTRACT

This study aims to evaluate our results of as a minimally invasive surgery of ventricular septal defect closure with right vertical infraaxillary minithoracotomy and compared with conventional median sternotomy for repair ventricular defect closure.

The study designed as a retrospective between 2007 and 2017, 15 patients underwent ventriculer septal defect closure with right vertical infraaksiller minitorakotomi (Group1), 15 patients underwent closed ventricular septal defect closure with median sternotomy(Group2). Group 1 and Group 2 were compared statistically with regard to the age, sex, operation and cross clamp time, cardiopulmonary bypass time, transfused blood, extubation time, intensive care ünit stay time, hospital stay time, incision length. In the comprasion of normal variables between groups, the Chi-square test was used. All tests were mutual and $p<0.05$ was considered statistically significiant.

No perioperative or late death occured during the follow up in both groups. There was no statistically differences in age, sex, cardiopulmonary bypass time, aortic cross-clamp time. Total operation time was significantly shorter in Group 1 than Group 2(p: 0.004). Three patients in Group 1 extubated in the operating room and four patients in Group 1 was not transfused blood for operation. All patients in Group 1 discharged first 24 hours from intensive care unit to service room. Group 1 had less chest tube drainage first 24 hours (p: 0.003). The mean length of incision was significantly shorter Group 1 than Group 2(p: 0.001).

Additionally excellent cosmetic and psychological results ventricular septal defect closure of right vertical infraaxillary minithoracotomy technique, there are more important clinical results in minimal invasive ventricular septal defects surgery than conventional median sternotomy.

Keywords: Minimally invasive surgery, ventricular septal defect, minithoracotomy, sternotomy, treatment.

ÖZET

Bu çalışma, minimal invaziv bir ventriküler septal defekt kapatma cerrahisi olarak sağ dikey infraaksiller minitorakotomi ile sonuçlarımızı değerlendirmeyi ve ventrikül septal defektlerin kapatılması için uygulanan geleneksel medyan sternotomi ile karşılaştırmayı amaçlamaktadır.

2007-2017 yılları arasında retrospektif olarak tasarlanan çalışmada 15 hastaya sağ vertikal infraaksiller minitorakotomi ile ventrikül septal defekt kapatma (Grup 1), 15 hastaya median sternotomi ile ventrikül septal defekt kapatma (Grup 2) uygulandı. Grup 1 ve Grup 2 yaş, cinsiyet, ameliyat ve kros klemp süresi, kardiyopulmoner by pass süresi, kan transfüzyonu, ekstübasyon süresi, yoğun bakımda kalış süresi, hastanede kalış süresi, kesi uzunluğu açısından istatistiksel olarak karşılaştırıldı. Gruplar arası normal değişkenlerin karşılaştırılmasında Ki-kare testi kullanıldı. Tüm testler karşılıklıydı ve $p<0,05$ istatistiksel olarak anlamlı kabul edildi.

Her iki grupta da takip sırasında perioperatif veya geç ölüm olmadı. Yaş, cinsiyet, kardiyopulmoner baypas süresi, aortik kros klemp süresi açısından istatistiksel olarak fark yoktu. Toplam ameliyat süresi Grup 1'de Grup 2'ye göre anlamlı olarak daha kısaydı (p: 0,004). Grup 1'deki üç hasta ameliyathanede ekstübe edildi ve Grup 1'deki dört hastaya operasyon için kan transfüzyonu yapılmadı. Grup 1'deki tüm hastalar yoğun bakım ünitesinden servis odasına ilk 24 saat taburcu edildi. Grup 1'de ilk 24 saatte daha az göğüs tüpü drenajı vardı (p: 0,003). Ortalama kesi uzunluğu Grup 1'de Grup 2'ye göre anlamlı olarak daha kısaydı (p: 0.001).

Sağ dikey infraaksiller minitorakotomi tekniğinin mükemmel kozmetik ve psikolojik sonuçlarına ek olarak ventriküler septal defekt kapatma, minimal invaziv ventriküler septal defekt cerrahisinde konvansiyonel medyan sternotomiden daha önemli klinik sonuçlar vardır.

Anahtar kelimeler: Minimal invaziv cerrahi, ventriküler septal defekt, minitorakotomi, sternotomi ve tedavi.

INTRODUCTION

Procedures carried out with minimalIN intervention to the heart, which are performed with a lower number of incisions or incisions other than sternotomy, without using blood, pump oxygenator or using either of therefore-mentioned, may be defined as ‘minimally invasive cardiac surgery’ (1).

Minimally invasive interventions are limited in congenital heart surgery compared to adult cardiac surgery (2). Using thoracotomy incision and robotic surgery are the current minimally invasive approaches in atrial septal defect (ASD) surgery (3,4). However, robotic surgery cannot be used if the patient is under a certain weight or age. The operations performed with right thoracotomy or mini sternotomy are the only alternatives, except for hybrid surgery, in the treatment of minimally invasive ventricular septal defect (VSD) (5). Surgical approaches performed with this incision seem to yield better cosmetic and clinical outcomes, particularly in children above 10 kg. In our study, surgical interventions performed through a right vertical infra-axillary incision were seen to yield better clinical outcomes, namely using less blood, weaning from the respirator, discharge from the intensive care unit and the hospital compared to sternotomy incision, in addition to cosmetic and psychological outcomes. The present study is also suggested to be considerable due to being the first study conducted with this method in Turkey.

MATERIAL and METHOD

Study setting and design.

This retrospective study was conducted with 30 patients with isolated VSD who had undergone the operation . The patients who had undergone right vertical infra-axillary mini thoracotomy (RVIAM) were included in Group 1; patients who had undergone conventional median sternotomy (CMS) were included in Group 2. The patients were operated by the same surgeon. This work had been approved by the University Ethical Board. Informed consent was obtained from all parents.

All patients were evaluated with echocardiography in the pre-, per- and post-operative periods.Children who were over one month of age or above 10 kg, and those who had undergone the operation due to VSD (peri-membranous, sub-pulmonic, muscular) were included in the study. The patients who had undergone RVIAM constituted Group 1 and the patients who had undergone conventional sternotomy constituted Group 2. Patients who did not have sub-pulmonic VSD, persistent left superior vena cava or right pleural adhesion were included in Group 1. All patients were partially preserved from pulmonary hypertension and did not have mental retardation. All patients were re-evaluated with echocardiography by the surgeon in the per-operative period. Patients in Group 1 and Group 2 were compared with regard to age, gender, operative time, cross clamping time, cardio-pulmonary by-pass time, the amount of the blood used in the operation, intubation times, duration of intensive care unit stay, duration of hospital stay and length of the incision.

Anestehetic technique

All patients were examined preoperatively by the anaesthesiologist. The same anaesthetic technique was used in all patients. Fentanyl (3 micrograms/kg/h), vencuronium bromide (intubating dose 0.10 milligram /kg, a continuous infusion of 1 micrograms /kg/min) and inhalation agent (sevoflurane) were applied to the patients on cardiopulmonary by-

pass. Inotropic drugs (dopamine hydrochloride, dobutamine hydrochloride, milrinone lactate) were given if necessary. Children undergoing surgical repair of ventricular septal defect were received low-dose fentanyl (0.5 micrograms/kg/h), during postoperative 6 hours. All patients were evaluated for extubation in the post-operation recovery room. Extubation was attempted for the patients whose cross clamping time was under 20 minutes, whose ejection fraction was 60% or above on the per-operative echocardiography evaluation, whose operation duration was shorter than 3 hours, and those who did not have a rhythm problem. The patients who did not have agitation, and whose cardiac rhythm, blood pressure and respiration were normal, were transferred to the intensive care unit after being extubated.

Surgical technique

In Group I patients were positioned with the right side elevated about 60°. The right arm was put over the head, with shoulder-joint abducted approximately 120° and the elbow joint at a right angle. The incision was from the second intercostal space along right midaxillary line to the fifth intercostal space. An axillary vertical 5-7 cm incision was made (Figure 1). Entrance to the thoracic cavity was obtained through the fourth or fifth intercostal space, and the lung was retracted posteriorly to expose the pericardium. Vent was placed to the right pulmonary vein. The pericardium in the right side was suspended and the lungs were eliminated, so that a comfortable vision could be achieved. Double retractor was used during thoracotomy. While one of the retractors opened the ribs, another opened the skin and a more comfortable movement could be achieved. The left pericardium was suspended tightly for aorta cannulation and thereby, the aorta was proximated to the surgeon and cannulation was carried out more comfortably as opened 2 cm anterior to the phrenic nerve, and pericardial traction sutures were placed. This was critical for exposing and the cannulation of the aorta. The ascending aorta, inferior vena cava, and superior vena cava cannulation was performed through thoracotomy. VSD was closed through a right atriotomy incision in all patients in this group (Figure 2). In Group II, the patients underwent surgery through conventional sternotomy. For myocardial protection of the patients in both groups, systemic mild hypothermia at 32 °C and cold blood cardioplegia were applied.

Statistical analysis.

SPSS for Windows version 20Q pocket program (IBM SPSS) was used for the statistical analysis. Quantitative data were given as mean + standard deviation. In the comparasion of normal variables between the two groups, we used the Mann–Whitney U test; in the comparison of categorical variables between groups, the Chi-Square test was used. All tests were mutual and $p<0.05$ was considered statistically significant.

Figure 1: Axillary vertical incision.

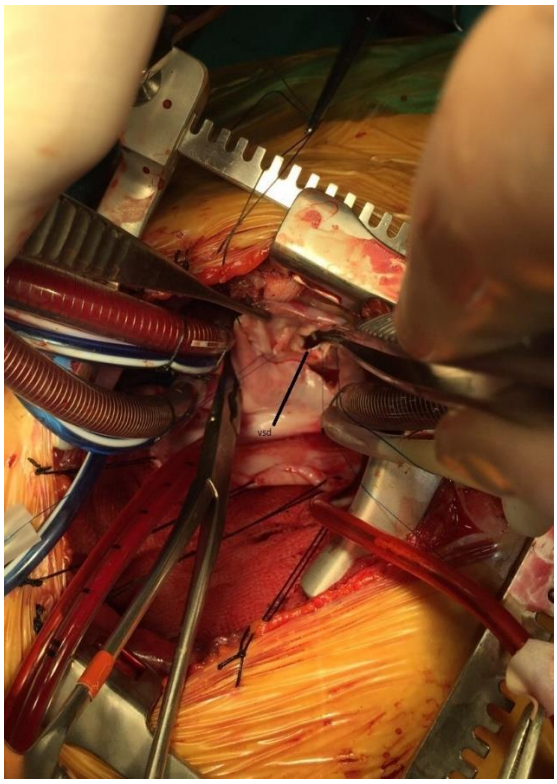

Figure 2: Peroperative imagine.

RESULTS

Study populations

The preoperative demographic and diagnostic data of the study groups are detailed in Table 1. There were 10 (%67) females and 5 (%33) males, with a mean age of 5.13+ 3.23 years, in the RVIAM group. There were 9 (%60) females and 6 (%40) males, with a mean age of 5.2 + 3.23 years, in the CMS group. Patient distrubition according to the diagnosis was 12 outlet VSD, 1 subpulmonic VSD, 2 muscular VSD in the RVIAM group, and 9 outlet VSD, 3 subpulmonic VSD, 3 muscular VSD in the CMS group.

No significant difference was determined between the groups with regard to age, gender and coexisting diseases (Table 1).

Operative data and clinical outcomes

Mortality or atrio-ventricular block was not observed in any of the groups. Post-operative residual shunting was not detected. The operative time was found to be significantly shorter in the RVIAM group (185.2+28.03 and 223+29.26, p<0.004). No significant difference was determined between the groups with regard to the CPB time (42.93 + 9.22 and 54.4 + 11.54) and aortic cross clamping time (29.73 + 7.82 and 40.07+ 11.47) (Table 2). Post-operative blood transfusion was not administered in 4 patients in Group 1. Blood transfusion was not given unless the hematocrit value was below 30%. The amount of drainage within the first 24 hours was found to be significantly lower in the RVIAM group (90+19.18 and 177+44.75, p<0.003). There was no significant difference between the groups with regard to the duration of being connected to the mechanic ventilator (7.73+5.38 and 11.93+9.52); however, this was significantly shorter in the RVIAM group. Three patients in Group 1 were extubated in the post-operative operation room. The duration of intensive care unit stay (18.5+ 11.15 and 56+ 23.42, p<0.001) and hospital stay (4.47+0.92 and 7,33+p<0.001) were found to be significantly shorter in the RVIAM group. The length of the incision was significantly shorter in Group 1 (6.33+0.49 and 11.53+0.99, p<0.001) (Table 2).

Table 1: Demographic data and patient diagnosis.

	Group 1	**Group 2**
Age (Year)	5.13+3.23	5.2+4.26
Body weight	18.23+6.93	19.13+8.27
Sex (Female)	10(%67)	9(%60)
Type of VSD (n)		
Perimembranous	12	11
Muscular	3	2
Subpulmonic	0	2
Comitant defects (n)		
Atrial septal defect	0	4
Patent foramen ovale	3	4
Tricuspid insuffiency	2	3
Aortic prolapses or insuffiency	8	6
Variables- Mean + SD (Range) or No		

Table 2: Operative and postoperative results.

Variables	Minimally invasive cardiac surgery (n:15)	Conventional median sternotomy (n:15)	p-value
Operation time (minute)	185.2±28.03	223±29.26	**<0.004**
Blood tranfused (ml)	173.75±62.78	258.93±68.95	0.008
Aortic cross clamp time (minute)	29.73±7.82	40.07±11.47	0.007
Cardio pulmonary bypass time (minute)	42.93±9.22	54.4±11.54	0.006
Intensive care unit stay (hr)	18.5± 11.15	56± 23.42	**< 0.001**
Mechanical ventilation time (hr)	7.73±5.38	11.93±9.52	0.08
İncision length (cm)	6.33±0.49	11.53±0.99	**<0.001**
Hospital stay (day)	4.47±0.92	7.33±2.09	**<0.001**
Qp/Qs	1.57±1.57	1.88±0.58	0.010
Chest tube drainage in first 24 hours (ml)	90±19.18	177±44.75	**<0.003**
Values are presented as mean+standart deviation.			

DISCUSSION

Median sternotomy has been considered as the standard approach for congenital heart defect repair with excellent results since the beginning of cardiac surgery. This approach allows good exposure of the surgical field and safe closure of the defect. Mini thoracotomy has some advantages and disadvantages. Both mini sternotomy and sub-xiphoid approaches enable the heart to be exposed anteriorly for cardiac surgeons. The heart is exposed from a different field in mini thoracotomy and all anatomical structures in the mediastinum are perceived with a different orientation. Furthermore, only a certain part of the heart can be visualized. While the right atrium can be observed in great detail, the right ventricle can be visualized to a certain extent, and the left ventricle cannot be seen. Aorta cannulation and inferior vena cava cannulation thereafter are most difficult when performing cannulation with mini thoracotomy. Aorta and vena cava inferior are seen to be proximate and cannulation is seen to be more comfortable when the pericardium suspensions are placed and kept tight. However, this condition can be overcome only after having gained experience. Another advantage of mini thoracotomies against the incisions providing anterior exposure to the mediastinum is the less likelihood of adhesion development between the posterior surface of the sternum and the mediastinal structures. No difference was determined between the groups with regard to extra-corporeal circulation times and cross clamping times as the same techniques were used for repair of the pathology, except for the incision type. There is no difference with sternotomy with regard to the operative times as the right atrium is directly exposed and the defect is closed through entranced through the right atrium although the procedure is performed through a limited space with mini thoracotomy (6,7). However, the overall operative time is shorter as bleeding control is achieved in a shorter time and incision closure is simple and rapid.

Axillary cardiac operations have usually been compared with median sternotomy with regard to cosmetic and psychological features (11). In our study, clinical data such as the amount of 24- hour drainage, weaning from the mechanic ventilator, and the time to discharge from intensive care unit were also evaluated and a significant difference was detected in the RVIAM group. The amount of drainage was less in the RVIAM group. This may be considered to have resulted from less hemorrhage as the sternum was not intervened and a smaller incision was made for the thoracotomy. Blood transfusion was not given in 4 patients. The duration of hospital stay and intensive care unit stay were shown to be shortened. Three patients in the thoracotomy group left the operating room without being on the ventilator. In that group, no patients stayed in the intensive care unit for longer than 24 hours. The incision length was found to be statistically significantly shorter in the RVIAM group (5-7 cm). The incision was not seen when looked from the anterior in all patients and patient satisfaction was excellent.

Minimally invasive surgical interventions are limited in VSD in children. Mini sternotomy, sub-xiphoid or hybrid interventions may be attempted in defects that cannot not be closedusing a catheter (8). Adhesion develops in mini sternotomy or subxiphoid interventions as sternotomy is performed and this may lead to a problem in reoperations (9,10). The structure of the septal defect may not be appropriate for hybrid interventions. Robotic surgery may be applied; however, its field of use is restricted as the organism gets smaller. For intracardiac repairs, the use of the da Vinci system has been limited to a small series of adult-size patients undergoing atrial septal defect (ASD) closure. Robotic interventions are very limited in VSD surgery and this chance gradually disappears as the organism gets smaller (4).

The disadvantage of RVIAM is working in a limited field. It may be closed partially if ventriculotomy is required, because the right ventricle stays distant to the surgeon. The position of VSD should be evaluated before the operation. It is easy to reach outlet VSDs and muscular outlet VSDs from the right atrium. Sub-pulmonic VSD is the most difficult to reach. In that case, ventriculotomy may be performed; however, it may be difficult to see the whole septum. Preoperative echocardiography is important and the position of VSD should be evaluated prior to the operation.

In conclusion, despite some limitations in VSD operations performed using the RVIAM technique, the clinical outcomes of the RVIAM technique were found to be significantly more satisfactory than the CMS technique, beside better cosmetic an advantages.

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