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ORIGINAL ARTICLE

Atrioventricular Septal Defects Repair: Comparison of Classic Single Patch and Double-Patch Techniques

Atrioventriküler Septal Defekt Onarımı: Klasik Tek Yama ve Çift Yama Tekniklerinin Karşılaştırılması

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ABSTRACT

Objective: Different patch techniques were virtually always used in the surgery of pediatric patients with complete atrioventricular septal defects. In this study, we described our single center, single surgeon experiences and results about the classic single patch and double patch techniques to repair complete atrioventricular septal defects.
Materials and Methods: This retrospective descriptive study included 30 patients who underwent intracardiac repair of complete atrioventricular septal defect in Ankara Bilkent City Hospital Department of Pediatric Cardiovascular Surgery. The study was conducted between February 2019 to December 2021. Patients in group S underwent surgery using the traditional single-patch method, while group D included patients who underwent repair using the double patch approach (n = 10). Patients' demographic and clinical information was taken from institutional databases and medical records. Postoperative complications were recorded.
Results: When the preoperative/postoperative insufficiency levels of the valves were compared with the Wilcoxon Signed rank test, the findings were not statistically significant for the left atrioventricular valves, but were statistically significant for the right atrioventricular valves. (p=0.02) When we compared postoperative valve regurgitation of both techniques with the Kruskall-Wallis test, no significant difference was found between postoperative valve regurgitation and function, independent of preoperative findings.
Conclusion: Both operation techniques did not make a difference between operative or late mortality and morbidity. Depending on the surgeon's experience, ventricular septal defect size does not play a restrictive role in the selection of the technique to be used. The single-patch and double patch method as described here is methodical, comprehensible, repeatable, and reasonably long-lasting.

Keywords: Atrioventricular septal defect repair, different techniques for repair, endocardial cushion defects, pulmonary hypertension.

ÖZ

Amaç: Komplet atriyoventriküler septal defektli pediatrik hastaların cerrahisinde genellikle farklı yama teknikleri kullanılmıştır. Bu çalışmada, komplet atriyoventriküler septal defekt onarımında klasik tek yama ve çift yama teknikleri ile ilgili tek merkezli, tek cerrah deneyimlerimiz ve sonuçlarımız anlatılmaktadır.
Gereç ve Yöntem: Bu retrospektif çalışma, Ankara Bilkent Şehir Hastanesi Çocuk Kalp ve Damar Cerrahisi Kliniğinde Komplet atriyoventriküler septal defekt ile intrakardiyak onarımı yapılan 30 hastayı kapsamaktadır. Çalışma Şubat 2019 ile Aralık 2021 arasında gerçekleştirilmiştir. Grup S'deki hastalara geleneksel tek yama yöntemi ile opere edilmiştir. (n = 20) Grup D'deki hastalar ise çift yama tekniği ile opere edilmiştir.(n = 10) Hastaların demografik ve klinik bilgileri kurumsal veri tabanlarından ve tıbbi kayıtlardan alındı. Postoperatif komplikasyonlar kaydedildi.
Sonuçlar: Kapakların preoperatif/postoperatif yetersizlik düzeyleri Wilcoxon Signed rank testi ile karşılaştırıldığında sol atriyoventriküler kapak için istatistiksel olarak anlamlı değilken sağ atriyoventriküler kapak için istatistiksel olarak anlamlı bulundu. (p=0,02) Her iki tekniğin postoperatif kapak yetersizliğini Kruskall-Wallis testi ile karşılaştırdığımızda, ameliyat öncesi bulgulardan bağımsız olarak postoperatif kapak yetersizliği ve fonksiyon arasında anlamlı bir fark bulunmadı.
Tartışma: Her iki ameliyat tekniği de operatif veya geç mortalite ve morbidite arasında fark yaratmadı. Cerrahın tecrübesine bağlı olarak ventriküler septal defekt boyutu kullanılacak tekniğin seçiminde kısıtlayıcı bir rol oynamaz. Burada açıklanan tek yama ve çift yama yöntemi, metodik, anlaşılır, tekrarlanabilir ve oldukça uzun ömürlüdür.

Anahtar Kelimeler: Atrioventriküler Septal Defekt, Endokardiyal yastıkçık defektleri, Farklı tamir yöntemleri, Pulmoner Hipertansiyon.

Introduction

Complete atrioventricular septal defect is a congenital heart disease with different anatomical and morphological findings, which is frequently seen in patients with Down syndrome (1). Complete atrioventricular septal defect (CAVSD) constitutes 4%-5% of all the congenital heart defects (2). One of the three surgical techniques has been almost successful in treating pediatric patients with this congenital anomaly: the classic single-patch, double-patch or modified single-patch technique (3-5). First successful

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repair of CAVSD was reported by Lillehei et al. in 1955 (5). The single-patch technique was described by Maloney et al. in 1962, Trusler introduced the two-patch technique with a prosthetic patch for the ventricular septal defect (VSD), a pericardial patch for the atrial septal defect (ASD) and suture closure of the mitral "cleft" (4,5). The two-patch technique was reviewed in 1990s (6). All these techniques are used in CAVSD repair and have no proven superiority over each other.

The objective of this study was to assess the outcomes of CAVSD repair comparing classic single-patch technique to the double patch technique. Therefore, in this report we present our single center, single surgeon experiences with classic single patch and double patch techniques for the repair of CAVSDs.

Methodology

This retrospective study was conducted at a pediatric heart center between February 2019-December 2021. The study included 30 patients who underwent surgery for CAVSDs by the same surgical team. Pediatric heart team consisting of cardiologists and surgeons evaluated the patients and gave the decision for surgery together. Two groups of these patients were created: group D comprised of patients who had repair using the double patch technique (n = 10) and group S included patients who underwent repair using the classic single patch technique (n = 20). Regardless of the dimensions of the VSD, the surgical approach to be performed on the patient was chosen at random. All patients operated by the same surgical team for CAVSD between February 2019-December 2021were included in the study. Patients with concomitant congenital heart defects were excluded from the study.

Data including gender, age, body weight at the time of the surgery, surgical technique, preoperative atrioventricular (AV) valve insufficiencies, dimensions of VSD, diameter of ASD, presence of pulmonary hypertension, postoperative left and right AV valve insufficiency, cross-clamp (CC) time and the length of cardiopulmonary bypass (CPB), postoperative right ventricular systolic pressure, duration of inotropic support, duration of ventilation, length of stay in the intensive care unit (ICU), duration of stay in hospital and mortality rate, were all retrieved from the institutional databases and medical records. The study was carried out in compliance with the Declaration of Helsinki's guiding principles and the protocol was accepted by the institution's ethics committee (No: E2-21-1138, Date: 22/12/2021).

Surgical techniques

We performed all case with standard aortabicaval cannulation, mild to moderate hypothermia by CPB. In both techniques a xenograft pericardial patch was used to repair. The most important point in the classic single patch method is to divide the common superior AV valves and suture the patch at the level corresponding to the annulus. Afterwards the clefts on both leaflets are stitched with sutures one by one until the opposition zone. The primum ASD was closed with continuous suture technique.

In the double patch method, each septal defect is closed with a separate patch while superior and inferior bridging leaflets are stitched to the patch like a sandwich. After repair, valve competence was tested by saline solution in all patients. Primum ASD was closed with continuous suture technique.

Statistical Analysis

Continuous variables were expressed as 'mean values ± standard deviation (SD) or median and interquartile range (IQR) and categorical variables were expressed as numbers and percentages. The variables were investigated using visual (histograms, probability plots) and analytical methods (Kolmogorov–Smirnov/ Shapiro–Wilk test) to determine the normality of their distribution. Demographic characteristics, perioperative variables were compared using "independent samples t-test" or "Mann-Whitney-U test" for continuous variables and "chi-square test" or "Fisher's exact test" for categorical variables. Group differences between preoperative and postoperative valve insufficiencies were analyzed by Wilcoxon signed ranks test, and group comparison of postoperative valve functions were assessed by independent samples Kruskal Wallis test. A p-value of less than 0.05 was considered statistically significant for all statistical analyses, which were carried out using the SPSS for Windows version 25.0 program (SPSS Inc., Chicago, IL, USA).

Results

Between February 2019 and December 2021, a single surgeon performed surgery on thirty patients with CAVSD. Group S (n=20) and group D (n=10), respectively, consisted of patients who underwent surgery using the classic single patch technique and the double patch technique. The demographic and preoperative characteristics of both groups are summarized in Table 1, and none of them are statistically different from one another.

We repaired both right AV valve and left AV valve in all patients in both groups. When we examined the left AV valve insufficiency in the two-patch group (Group D), preoperative findings remained similar in seven patients, while left AV valve insufficiency increased in three patients. There was no decrease in left AV valve insufficiency of the patients.

When the right AV valve functions of this group were examined, right AV valve insufficiency decreased in six patients compared to preoperative valve functions, while valve insufficiency remained similar in four patients, and there was no increase in any patient.

When the preoperative/postoperative insufficiency levels of the valves were compared with the Wilcoxon Signed rank test, the findings were not statistically significant for the left AV valves, but statistically significant for the right AV valves. (p= 0.02)

In the classic single patch group (Group S), when we compared preoperative left AV valve functions with postoperative valve functions, valve regurgitation increased in six patients, decreased in four patients, and remained unchanged in twelve patients.

When we compared the preoperative right AV valve regurgitation with the postoperative findings, right AV valve regurgitation decreased in eleven patients, increased in three patients, and remained the same in eight patients. When the preoperative/postoperative insufficiency levels of the valves were compared with the Wilcoxon Signed rank test, these findings were not statistically significant. Operative and postoperative parameters of groups are presented in Table 2.

When we compared postoperative valve regurgitation of both techniques with the Kruskal-Wallis test, no significant difference was found between postoperative valve regurgitation and function, independent of preoperative findings.

We did not encounter any early hospital deaths in both groups. Eleven months after the operation, one patient in group S died as a result of a COVID-19 pneumonia. Operative mortality in both groups were 0%.

A patient in group D underwent reoperation because of hemodynamically significant residual VSD and systemic pulmonary hypertension 18 months after the first operation. There was no residual VSD in the echocardiogram (ECHO) performed after the first operation and the heart function was normal. During the operation patch dehiscence was detected and residual VSD was repaired. Operative complications after repair are shown in Table 3.

We did not encounter any persistent AV block, although temporary pacing was deemed required in two patients in each group. Mean length of intensive care (4.35 vs 6.2 days) and hospital stay (7.3 vs 15 days) were not significantly different in group S and D, respectively (p=0.248 vs p=0.424).

Table 1: Demographic and preoperative properties of the patients

Parameter	Classic single patch (n=20)	Double patch (n=10)	p value
Age, months	6.5 (7)	6.5 (7)	0.537
Body weight, kg	6.37±2.69	5.83±2.14	0.586
Trisomy 21, n(%)	17 (85%)	9 (90%)	0.232
Height of VSD	7.69±3.56	9.8±3.96	0.153
mPAB	26.1±14.59	34.3±13.52	0.149
RVSP	63.75±21.66	62.6±15.24	0.882
AV regurgitation degree			
Preoperative left			
mild	16 (80%)	6 (60%)	
moderate	2 (10%)	3 (30%)	
severe	2 (10%)	1 (10%)	
Preoperative right			
mild	8 (40%)	2 (20%)	
moderate	10 (50%)	6 (60%)	
severe	2 (10%)	2 (20%)	

Table 2: Operative and postoperative parameters of groups

Variable	Group S (n=20)	Group D (n=10)	P value
Cardiopulmonary bypass time (min)	94.20±27.40	91.20±24.30	0.772
Aortic cross clamp (min)	63.45±18.15	67.50±18.89	0.574
Mechanical ventilation (hours)	17.5 (31.5)	27 (48.5)	0.272
Chest tube drainage (ml)	50.50±28.92	59±24.24	0.432
Inotropic support (hours)	40 (57.5)	53.5 (56.25)	0.323
Intensive care unit stay (days)	3 (5)	3.5 (5.5)	0.248
Hospital stay (days)	10.5 (6.75)	10.5 (10.5)	0.349

Table 3: Operative complications after repair

Variable	Group S (n=20) (n%)	Group D (n=10) (n%)
Residual VSD	0 (0%)	1 (10%)
LVOT obstruction	0 (0%)	0 (0%)
Reoperation	0 (0%)	1 (10%)
ECMO	0 (0%)	0 (0%)

VSD: Ventricular Septal Defect, LVOT: Left Ventricle Outflow Tract, ECMO:Extracorporeal Membrane Oxygenator

Discussion

Over the years, new methods have merged in the repair of CAVSDs. The main purpose of all methods is to close the defects in the heart and repair the valves. As with any surgical procedure, each method has its own complications like AV block, residual defects, valve insufficiencies and left ventricle outflow track obstruction (6). Success in repair of AV valves in these patients is the most important factor determining the surgical outcome. In individuals with a CAVSD, AV valve incompetence is a key factor in surgical outcome. The effectiveness of all surgical techniques used in the repair of CAVSD is essentially evaluated according to repetitive interventions for AV valve dysfunction and mortality rates (7). Reintervention rates could be as high as 19.7% (8). Etiologies causing late valve dysfunction may be related to annular, chordal or valvular apparatus. In this case, despite valve repair, a normally functioning left AV valve cannot be formed and AV valve insufficiency occurs again in the long period (9).

Modified single patch method and double patch technique have been compared in many studies. In the study of Backer et al, the modified single patch method was concluded as a better option than the double patch method (10). In addition, in the study of Yıldırım et al., it is emphasized that the single patch method provides a significant advantage in patients with prolonged pulmonary hypertension due to shorter CC and CPB times (7). It is reported that dehiscence can be seen after the incision of anterolateral leaflet and posterolateral leaflet in the classical single patch technique, however dehiscence was not seen in any of our patients (11). In addition, according to the literature, residual VSD was seen more frequently with the classical single patch method than other techniques, but since we stitched the VSD crest to the

VSD patch with the continuous suture technique, no significant difference was observed between the two techniques in terms of residual VSD leakage. Incising the AV valve leaflets increases the risk of regurgitation and the propensity for subaortic blockage while shortening the valve leaflets and causing valve dehiscence (12). Contrary to what the literature emphasizes, complications caused by incising AV valve leaflets have not been encountered in our experience.

In our patient population, the mean values for Group D and Group S for the height of the VSD, which was assessed during end-diastole as the distance between the crest of the septum and the level of the AV valves, are 9.8 mm and 7.69 mm, respectively. We encountered ten cases whose VSD height was equal or more than 10 mm, and only four of them were repaired with the double patch technique. We did not specifically perform the classic single or double patch technique with regard to VSD height. Although Backer et al. advocated avoiding the modified single patch method in patients with a VSD length greater than 12 mm, we randomly applied the single patch method to patients without considering VSD diameter or any other criteria (10). The advantage of the single patch and double patch technique is that they can be safely applied to any patient, regardless of the patient's VSD size. Considering the anterosuperior height of the patients' VSD, the height of the patch is adjusted by the surgeon, and therefore left ventricle outflow tract stenosis develops less frequently in the follow-up.

The median age of our patients with CAVSD during operation was 12±14.422 and 9±6.272 months in group S and group D. Early surgery in CAVSD repair is recommended because it reduces mortality (13). One of the important factors affecting mortality is persistent pulmonary hypertension. In addition, preoperative AV valve insufficiency is also associated with pulmonary hypertension and is an important risk factor for mortality (4).

In our study, in the classic single patch group, two patients had severe and two patients had moderate valve insufficiency. In the double patch group, three patients had moderate and one patient had severe AV valve insufficiency. Although the technique used in the literature is thought to have an effect on valve regurgitation; in our study, there was no significant difference between the two groups according to the technique used.

The preoperative systolic mean pulmonary artery pressure was 26.10±14.59 mm-Hg in Group S (range 6-50 mm-Hg) and 34.3±13.52 mm-Hg in Group D (range 8-55 mm-Hg) respectively. Preoperative right ventricle systolic pressure was 63.75±21.66 mm-Hg in Group S and 62.60±15.24 in Group D. When we look at the postoperative values of these parameters postoperative mean pulmonary artery pressure was 20.20±10.81 in Group S and 18.70±10.25 in Group D. Postoperative right ventricle systolic pressure was 41.55±17.15 in Group S and 31.40±8.63 in Group D respectively. Although there was a decrease in postoperative mean pulmonary artery pressure and right ventricle systolic pressure, there was no significant difference between the two groups. However, these postoperative decreases show the effectiveness of the surgery. Postoperative pulmonary arterial pressure decrease is effective in patients with postoperative echocardiographically low valve regurgitation, which is successfully repaired regardless of the surgical technique.

Permanent AV block can develop independently of the technique. In the meta-analysis of Loomba et al. and Wu et al., it was stated that there was no significant difference in terms of permanent pacemaker needs in studies comparing modified single-patch and double-patch methods (14,15). In cases in whom permanent AV block develops, the only solution is the implantation of a permanent pacemaker. Although two of our patients needed a temporary pacemaker, the rhythm returned to normal sinus rhythm within two days in these patients, and none of our patients required a permanent pacemaker.

Conclusion

In conclusion, both operation techniques did not make a difference between operative or late mortality and morbidity. Depending on the surgeon's experience, both techniques can be applied regardless of the VSD size. The classic single patch and double patch method as described here is methodical, comprehensible, repeatable, and reasonably long-lasting. It is already possible to repair CAVSDs using classic single patch or double patch procedures with low operational mortality and morbidity.

Limitations

None.

Ethical Approval

Ankara Bilkent City Hospital Clinical Researches Ethics Committee, Ref No. E1-21-1138 Date:22/12/2021, has authorized all techniques used in this work, according to the authors, who claim that they adhere to the ethical norms of the 1975 Helsinki Declaration, as revised in 2008.

Conflict of Interest

Authors declared no conflict of interest.

Disclosure

None.

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Authors' Contributions

Conception: AA, KÖ, BST, Design: AA, BSTAA, Supervision: AA, Resource: BST, Materials: MY, ANE, Data Collection and/or Processing: AVK, Analysis and/or Interpretation: GSS, YÖŞ, Literature Review: BST, Writer: BST, Critical Review: AA,KÖ

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