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Original Research

APPLICATION OF PRIMARY SUTURELESS REPAIR FOR OBSTRUCTED TOTAL ANOMALOUS OF PULMONARY VENOUS CONNECTION AT THE VIETNAM NATIONAL CHILDREN'S HOSPITAL

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ABSTRACT

Objectives: *This study evaluates the results of applying primary sutureless technique in surgical repair of total anomalous pulmonary venous connection at Children Heart Center, Vietnam National Children's Hospital.*

Methods: *A retrospective study was conducted to evaluate the short-term outcomes of primary sutureless repair for all patients diagnosed with obstructed total anomalous venous connection (TAPVC) from July 2015 to December 2016.*

Results: *There were 25 patients undergoing primary sutureless repair during the study period. The mean age and the mean weight are 77.00 ± 23.26 days and 3.93 ± 1.16 kg, respectively. There were 19/25 (76%) cases with preoperative respiratory failure with 14 cases (56%) requiring mechanical ventilation before surgery, of which 9 patients (36%) had life-threatening acute pulmonary edema from before emergency surgical repair. There were 17 cases admitted to the hospital with cardiogenic shock. Evaluation of transthoracic echocardiography showed 15 cases of supracardiac TAPVC, 5 cases of infracardiac TAPVC, 2 cases of intracardiac, 2 cases of mixed, and 1 case of partial TAPVC. The mean aortic cross-clamp time was 65.40 ± 23.34 minutes, the average cardiopulmonary bypass time was 119.72 ± 34.85 minutes, the mean surgery time was 200.04 ± 39.42 minutes. 9 cases underwent circulatory arrest and 7 cases underwent low-flow bypass during surgery. 3 patients died in the postoperative period, of which 2 from septic shock and multi-organ failure, 1 patient from respiratory failure after extubation due to laryngomalacia. The reoperation rate was 2/25 as a consequence of recurrent pulmonary vein stenosis.*

Conclusions: *The primary sutureless repair for obstructed anomalous pulmonary venous connection is safe and favorable. Long-term outcomes follow-up are essentially required.*

Keywords: *obstructed total anomalous venous connection, primary sutureless repair, outcomes*

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I. INTRODUCTION

Total anomalous pulmonary venous connection (TAPVC) is a rare congenital heart disease that occurs in approximately 2% of all children with congenital heart disease. Long - term results after conventional repair show a rate of about 11.9 - 16.9% of children who need to be re - operated depending on each study [1,2]. Recently, a number of centers around the world have started to apply the primary sutureless technique at the beginning of surgery to repair TAPVC, in the hope of reducing the reoperation rate of this disease. There has not been any research in Vietnan reporting about this new technique. We summarize the procedure

and the initial results of applying the primary sutureless technique, for the first time on surgical repair of obstructed total anomalous connection of pulmonary vein at Children's Heart Center, Vietnam National Children's Hospital.

II. METHODS

From July 2015 to December 2016, there were 25 cases of abnormal return of the pulmonary veins with obstructed TAPVC underwent primary sutureless repair. Long - term follow - up was performed on all surviving patients in the study group.

Criteria for an obstructed TAPVC was evaluated by echocardiography depending on demonstrating a narrow segment in the pulmonary venous pathway on cross-sectional images and/or detection of a nonphasic Doppler spectrum of pulmonary venous flow.

* Primary sutureless repair techniques:

The patient underwent a midline sternotomy approach with moderate hypothermia (24 - 280C). If the circulatory arrest is required, the patient will be continuously monitored for cerebral oxygen saturation with a tissue oximeter (NIRS). The sutureless technique is applicable to all forms of TAPVC. The lesion can be accessed through the transverse sinus between the superior vena cava and the aorta, or through the right side between the left atrium and the posterior pericardium, or the entire heart is lifted anteriorly in case of infracardiac TAPVC.

The confluence of the pulmonary veins is opened along the anterior surface to the junction of the right and left pulmonary veins. A part of the front wall of the confluence is excised to maximize the confluence opening. In some cases, concomitant stenosis of the peripheral pulmonary veins is also enlarged concurrently during the same surgery. The posterior left atrium is opened relative to the supraconfluent opening of the pulmonary veins. The posterior left atrium and posterior pericardial tissue around the mouth of the pulmonary venous confluence were joined with Corolene 7.0 suture to create a wide and sutureless anastomosis of the pulmonary venous confluence with the left atrium (primary sutureless). The atrial septal defect is patched and the foramen ovale is left open in most cases. For almost patients with preoperative obstructed TAPVC, the vertical vein is not be ligated.

During follow - up, all surviving patients were regularly examined with clinical examination and echocardiography. When a patient was suspected of having possible recurrent obstruction of the anastomosis or individual pulmonary veins, cardiac catheterization with selective pulmonary veins angiography and multi - slice computed tomographic (CT) angiography were electively performed to confirm or rule out an obstruction of these structures.

III. RESULTS

During the study period, there were 25 cases of obstructed TAPVC who underwent surgical repair using the primary sutureless technique. The mean age of the study group of patients was 77.00 ± 23.26 days, the oldest patient was 540 days old and the youngest was 1 day old. The mean weight of the patients was 3.93 ± 1.16 kg (of which the lowest patient was 1.7 kg, the highest was 8 kg). There were 19/25 (76%) cases with preoperative respiratory failure with 14 cases (56%) requiring mechanical ventilation before surgery, of which 9 patients (36%) had life - threatening acute pulmonary edema from admission. There were 17 cases admitted to the hospital with cardiogenic shock. Evaluation of transthoracic echocardiography showed 15 cases of supracardiac TAPVC, 5 cases of infracardiac TAPVC, 2 cases of intracardiac TAPVC, 3 cases of mixed TAPVC. The details of the patient characteristics are described in Table 1.

Table 1: Patient characteristics

Patient characteristics	n (%) or mean ± SD
Age (days)	77 ± 23.26
Sex	
Male	13 (52%)
Female	12 (48%)
Weight (kg)	3.93 ± 1.16
Type	
Supracardiac TAPVC	15
Intracardiac TAPVC	2
Infracardiac TAPVC	5
Mixed TAPVC	3
Preoperative ventilation	14
Preoperative pulmonary edema	9
Cardiogenic shock	17
Small left ventricular	14
Other lesions	0

TAPVC: total anomalous pulmonary venous connection

The first sutureless technique was applied to the patients in the study group with the mean aortic cross - clamp time was 65.40 ± 23.34minutes, the mean cardiopulmonary bypass time was 119.72 ± 34.85minutes, the mean operative time was 200.04 ± 39.42minutes, of which 9 cases required circulatory arrest and 7 cases required low flow bypass during the ischemic time. All patients in the study group were monitored for cerebrovascular oxygen saturation by transcutaneous tissue oximeter. Details related to surgery are described in **Table 2**.

Table 2: Intraoperative information

Intraoperative informations	n (%) or mean ± SD
Aortic cross-clamp time (min)	65.40 ± 23.34
Bypass time (min)	115.06 ± 40.33
Surgical time (min)	200.04 ± 39.42
Circulatory arrest	9 (36)
Mean time of circulatory arrest (min)	6.04 ± 10.75
Low-flow bypass strategy	7 (28)
Cerebral oxygenation evaluation by NIRS	25 (100)
Vertical vein ligation	3 (12)

Three patients died in the postoperative ICU, of which 2 died from septic shock and multi-organ failure, and 1 patient died due to respiratory failure after extubation with laryngomalacia. There were 2 patients who underwent reoperation due to stenosis of the anastomosis (because these surgeries were performed by another surgeon who had no experience in sutureless technique), both of these patients survived after reoperation surgery and were discharged from the hospital with the absence of pulmonary venous stenosis. The detailed postoperative information is described in **Table 3**.

Table 3: Post - operative information and complications

Post - operative information and complications	n (%) or mean ± SD
Mean post-op ventilation time (hours)	75.26 ± 176.58
Mean post-op ICU (days)	9.96 ± 11.54
Mean post-op hospital stays (days)	20.60 ± 13.73
Hospital stays (days)	23.24 ± 13.24
Complication	
Delayed sternal closure	1 (4)
Arrhythmia	7 (28)
Neurological events	1 (4)
Peritoneal dialysis	7 (28)
Wound infection	4 (16)
Diaphragm paralysis	1 (4)
Low cardiac output syndrome	6 (24)
Respiratory infection	4 (16)
Pressure gradient through the anastomosis	
< 4mmHg	22 (88)
4 - 8mmHg	1 (4)
> 8mmHg	2 (8)
Hospital mortality	3 (12)
Late mortality	1 (4)

IV. DISCUSSIONS

Obstructed TAPVC is an urgent surgical indication because pulmonary edema and cardiogenic shock are the leading causes of death in this particular group of patients. The mortality rate after surgery from other studies ranges from 31 - 38.5% depending on each study [3,4]. However, these studies included a group of obstructed TAPVC patients associated with other cardiac lesions, including single ventricle morphology. At the Vietnam National Children's Hospital, in the time before conducting this study, the majority of deaths after surgery in this specific group were related to the condition of stenotic of the anastomosis immediately after surgery, especially in patients who have a small confluence of pulmonary veins, or small individual pulmonary veins.However, after applying this technique, all cases with small confluence of pulmonary veins or small individual pulmonary veins were safely reconnected to the left atrium. Three hospital deaths in this study were not related to existing narrowing or obstruction of the pulmonary venous return or the stenosis of anastomosis.

A circulatory arrest or low-flow bypass strategies have greatly improved the ability to perform the anastomosis between the confluence

of the pulmonary veins and the left atrium. Recent studies have shown that the use of circulatory arrest is decreasing in order to minimize complications of circulatory arrest [4,5]. However, we still believe that the circulatory arrest can be safely used in a short time in order to create a clean surgical field so that will save surgeons more time to perform the widest possible anastomosis, for the purpose of avoiding narrowing of the anastomosis. In the study group, only 2 cases had stenosis of the left atrium-pulmonary veins confluence anastomosis, because the surgery was performed by surgeons with no experience in the primary sutureless technique.

The primary sutureless technique has many advantages including creating a wide, non - tensed, non-twisted anastomosis, no foreign objects suture at the wall of the pulmonary veins, and anastomosis's capability of growing with the child [6,7]. A study with larger sample size and longer follow-up time is needed to make more accurate conclusions about applying this technique in the repair of obstructed TAPVC and non - obstructed TAPVC patients.

The primary sutureless technique is initially difficult to apply, especially for young and inexperienced surgeons to repair pulmonary venous return abnormalities [8,9]. However, the initial results of using this technique for patients with critical conditions and a high risk of death have shown initial success. The rate of stenotic anastomosis as well as death from cardiovascular causes has decreased markedly after the successful application of this technique. We will continue to extend the application of this technique to all patients with TAPVC to provide a comprehensive and complete evaluation of this new technique.

V. CONCLUSIONS

The short-term results of applying the primary sutureless technique for obstructed TAPVC are good. However, a study with a longer follow-up time and a larger number of patients is needed to fully and accurately assess the true effectiveness of this newly studied approach.

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