

ORIGINAL ARTICLE

Minimally invasive cardiac surgery in pediatric patients

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Background. Currently, surgical techniques and extensive knowledge of anatomy and physiology in congenital heart defects allow the surgeon to innovate in surgical approaches, in order to offer the patients better cosmetic results and similar post-operative outcomes in comparison to traditional approaches. Since 2014, we started to perform minimally invasive congenital surgery for closure of atrial septum defects, ventricular septal defects, Scimitar Syndrome, mitral valve repair and tricuspid valve repair. The purpose of this article is to demonstrate the efficacy and safety of the minimally invasive approach in pediatric patients. **Material.** A 4-year retrospective cohort of minimally invasive surgeries in pediatric patients is presented. Post-surgical and 30 days outcomes after the procedure were documented. **Results.** This series include 31 patients with ages between 2 and 15 years. Average weight was 28 kg. Most frequent etiology in 71.1% ostium secundum type atrial septal defect. Superior and inferior sinus venosus type atrial septal defects in 16.1%, severe mitral insufficiency, severe tricuspid insufficiency due to precordial trauma, interventricular communication and Scimitar syndrome, individually in 3.2%. The average cardiopulmonary bypass time was 71 minutes, aortic cross-clamping time was 36 minutes. Average intensive care unit stay 1 day, in-hospital stay 5.64 days, mean chest drainage 141 cc, removal of drainages at 2 days. Mortality 0%, surgical site infection 0%. **Conclusions.** Minimally invasive cardiac surgery in pediatric patients is a safe approach. It offers similar results to traditional approaches with a mortality and infection of 0%. Cosmetic results offer patient satisfaction.

Key words: Cardiac Surgery; Minimally invasive cardiac surgery; Pediatric cardiovascular surgery.

Introducción. Actualmente, las técnicas quirúrgicas y el conocimiento amplio de la anatomía y fisiología en los defectos congénitos cardiacos permite al cirujano innovar en los abordajes quirúrgicos, ofreciendo al paciente mejores resultados cosméticos e iguales resultados posoperatorios a los abordajes tradicionales. Desde el 2014, en nuestro centro se han realizado cierres de defectos de tabique auricular, reparos mitrales y reparos tricuspídeos, por mínima invasión. La finalidad de este artículo es demostrar la eficacia y seguridad del abordaje de mínima invasión en pacientes en edad pediátrica. **Material.** Se presenta una casuística de 4 años de cirugías de mínima invasión en pacientes pediátricos. Estudio retrospectivo, observacional y descriptivo de los procesos realizados, resultados postquirúrgicos y a 30 días del procedimiento. **Resultados.** Se captaron 31 pacientes con edades entre los 2 a 15 años. Peso promedio 28 kg. Etiología mas frecuente en un 71,1%: Comunicación interauricular tipo ostium secundum, comunicaciones interauriculares tipo seno venoso superior e inferior 16,1%, insuficiencia mitral severa, insuficiencia tricúspidea severa por trauma precordial, comunicación interventricular y síndrome de Cimitarra, cada una en un 3,2%. El tiempo promedio de perfusión fue de 71 minutos, tiempo de isquemia de 36 minutos. Estancia promedio en unidad de cuidados intensivos 1 día, estancia hospitalaria 5.64 días, drenaje por sondas 141 cc, retiro de sondas a los 2 días. Mortalidad 0%, infección de sitio quirúrgico 0%. **Conclusiones.** La cirugía cardiaca de mínima invasión en pacientes pediátricos permite abordajes seguros. Ofrece resultados similares a los abordajes tradicionales con una mortalidad e infección del 0%. Los resultados cosméticos ofrecen mejor satisfacción subjetiva.

Palabras clave: Cirugía cardiaca; Cirugía cardiaca mínimamente invasiva; Cirugía cardiovascular pediátrica.

Cir Card Mex 2020; 5(4): 130-133.

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In pediatric cardiac surgery, low complexity surgeries such as closure of atrial or ventricular septal defects have traditionally been performed by sternotomy with the implications of postoperative management, recovery postoperative times, and aesthetic results that have been detrimental for

conventional congenital cardiac surgery [1]. Over the time and with the advent of new technologies, additional alternatives to the conventional procedure have been developed. However, doubts still remain about the complexity of performing an alternate approach, changing the traditional incision site, and fear about the deleterious consequences that this could cause on the patient's clinical outcome.

We describe our experience in minimally invasive approach by axillary lateral thoracotomy in pediatric patients.

MATERIAL

We performed an observational retrospective cohort study, which included all pediatric patients, ages between 2 to 15 years that underwent minimally invasive surgery during 2014 to 2017. The data were obtained from a database made by our staff department at our institution. The data was pooled in an Excel spreadsheet (Office 2019, institutional license). The variables included for the descriptive analysis were analyzed in the statistical software SPSS version 22 (institutional license). A descriptive analysis of the studied variables was performed. For quantitative variables, normality was determined with Shapiro Wilk test because the sample has less than fifty patients.

Surgical technique

The patient is positioned. We place a roll vertically on the right scapular area to give an angle of 30 to 45 degrees. Planning of the incisions is followed, drawing the intercostal spaces, as well as the incisions to be made. We begin by performing a right lateral axillary thoracotomy through the fourth or fifth intercostal space. Dissection to the pleural cavity is achieved by retracting the pectoral muscle and avoiding long thoracic nerve injuries. Alexis soft tissue retractor (Applied medical, Rancho Santa Margarita, CA) and chest retractor are inserted. If the patient weights more than 25 pounds, a double lumen endotracheal tube is used, if not, a monolumen endotracheal tube and the lung is retracted with a sponge. Dissection of the right thymus is performed. The pericardium is opened and sutured to the Alexis retractor with silk sutures. Dissection of the inferior and superior vena cavae is followed. The patient is heparinized. Arterial and venous femoral cannulation is done with multi-stage cannulas depending on the patient's weight. In case of surgery of right heart, the superior vena cava is cannulated through the thoracotomy. We proceed with the planned surgery. All of our patients are monitored with trans esophageal echocardiography at the time of femoral arteriovenous cannulation and after surgery to determine the presence of residual defects, to measure ventricular function and valvular residual lesions. Almost routinely, the femoral artery and vein are reconstructed in a transverse fashion by using two continuous sutures with 6-0 polypropylene. A



Figure 1. A: Position. The patient is in positioned with a vertical roll placed over the right scapula in order to elevate the thorax. The intercostal spaces, thoracotomy and femoral incisions are marked. B: Surgical field. Soft tissue and thoracic retractors are placed, pericardial retraction sutures and superior vena cava canula can be observed. C: Defect closure with bovine pericardial patch. D: Wound. Closed wounds are noted. Mediastinal and thorax chest tubes are placed as well as the temporary epicardial pacemaker.

Blake drain is placed in the pericardium and a right pleural chest tube. The pericardium is closed partially with separate sutures. The wound is closed (Fig. 1).

Unlike adults, in minimally invasive congenital surgery, we begin by performing the chest approach prior to femoral cannulation in order to reduce time of ischemia of the lower limb, since the femoral vessels in pediatric patients are usually the same size as the arterial cannula. Considering that there are generally short procedures, distal perfusion catheters are not placed.

RESULTS

The preoperative demographic characteristics can be seen in Table 1. The average age was 6.32 years (± 3.79), 80.6% were women; the diagnosis in order of frequency was atrial septal defect (ASD) ostium secundum type in 71.1%, followed by superior and inferior venous sinus type ASD in 16.2%, perimembranous ventricular septal defect (VSD) in 3.2% with this same frequency, correction of Scimitar syndrome, mitral and tricuspid valve repairs. The type of cannulation in 58.1% was arteriovenous femoral and superior vena cava via thoracic approach. The mean aortic cross clamp time was 36.6 minutes (± 21.5), the cardiopulmonary bypass time was 70.1 minutes (± 36.7). There were no conversions to sternotomy. The ICU length of stay was 1.23 days (± 0.5), the hospital length of stay was 5.65 days. (± 3.96) Chest tube drainage during the first 24 hours was 114.6 cubic centimeters (± 71.5). Regarding complications, serositis and febrile syndrome were presented with a frequency of 6.1%. One patient had diaphragmatic

Table 1. Demographic and operative variables, (n=31)

VARIABLE	
Age, mean (SD)	6.32 (± 3.79)
Gender, n (%)	
Male	6 (19.4)
Female	25 (80.6)
BMI, mean (SD)	28.43 (± 17.47)
Diagnosis, n (%)	
Ostium secundum ASD	22 (71.1)
Inferior sinus venosus ASD	4 (12.9)
Superior sinus venosus ASD	1 (3.2)
Perimembranous VSD	1 (3.2)
Severe mitral regurgitation	1 (3.2)
Traumatic tricuspid insufficiency	1 (3.2)
Scimitar syndrome	1 (3.2)
Size of the ASD, mm median (IQR)	18 (15-21)

SD: standard deviation, BMI: Body mass index ASD: atrial septal defect VSD: Ventricular septal defect, IQR: Interquartilic range; mm: milimeters.

paralysis. There were no surgical site infections nor 30-day mortality. No residual defects were reported on postoperative ultrasound (Table 2).

Table 2. Variables related to the procedure (n=31)

VARIABLE	
Surgeries by year, n (%)	
2014	4 (12.9)
2015	7 (22.6)
2016	14 (45.2)
2017	6 (19.4)
Type of surgery, n (%)	
ASD closure	22 (71)
Sinus venosus ASD closure	5 (16.2)
Perimembranous ASD closure	1 (3.2)
Redirection of venous pulmonary flow	1 (3.2)
Mitral valve repair	1 (3.2)
Tricuspid valve repair	1 (3.2)
Type of cannulation n (%)	
Central	8 (25.8)
Femoral artery and veins	5 (16.1)
Femoral artery and veins + superior vena cava	18 (58.1)
Aortic cross-clamping time in minutes, mean (SD)	36.6 (± 21.5)
Cardiopulmonary bypass in minutes, mean (SD)	70.1 (± 36.7)
ICU length of stay in minutes, mean (SD)	1.23 (± 0.5)
In-hospital total stay in days mean (SD)	5.65 (± 3.96)
Chest tube drainage in cc, mean (SD)	114.6 (± 71.5)
Total chest tube drainage in cc, mean (SD)	248.71 (± 242.29)
Complications n (%)	
Serositis	2 (6.1)
Febrile syndrome	2 (6.1)
Diaphragmatic paralysis	1 (3)

ASD: atrial septal defect; SD: standard deviation; CC: cubic centimeters; ICU: intensive care unit

DISCUSSION

Middle sternotomy is the standard approach for most congenital heart diseases. However, there are congenital cardiac diseases with a lesser degree of complexity, which have shorter cardiopulmonary bypass times that are potentially feasible to be performed by a minimal invasive approach [2]. Every time there are more cosmetic concerns, especially in females, in regard to the scar that a medium sternotomy confers. Minimally invasive surgery offers a safe alternative and excellent cosmetic results in patients with congenital heart disease of low complexity. Minimally invasive approach requires specific instrumentation and training, and especially stresses the surgeon to have experience in traditional approaches and to

be able to correct a possible complication of this approach without putting the patient's life in risk [3,4].

At our center, the minimally invasive approach in adult patients is the standard method for valvular pathologies, septal defects and atrial tumors. In pediatric patients, this approach has been implemented with the training of adult surgeons, plus the experience of congenital surgeons, offering safety and excellent post-operative recovery to our patients. We have shown with measured results, less ICU length of stay, lower hospital length of stay and lower rate of complications and infections, positively impacting the statistics of our service and especially the Colombian health system. There are more procedures that we can perform under this surgical ap-

proach, always bearing in mind that the most important thing is the patient safety. The cosmetic results are secondary, but they also have a very positive impact on patients and their families, adding all these benefits result on a better quality of life.

FUNDING: None

DISCLOSURE: The authors have no conflicts of interest to disclose.

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