Cardiology in the Young

cambridge.org/cty

A single centre experience with an evolving approach for the repair of coarctation of the aorta

Kelly Costopoulos, Joseph Philip, Dalia Lopez-Colon, Giridhar Kaliki, Arun Chandran and Mark Bleiweis

Congenital Heart Center, UF Health Shands Children's Hospital, University of Florida, Gainesville, FL, USA

Original Article

Cite this article: Costopoulos K, Philip J, Lopez-Colon D, Kaliki G, Chandran A, and Bleiweis M (2019) A single centre experience with an evolving approach for the repair of coarctation of the aorta. *Cardiology in the Young* **29**: 885–887.
doi: 10.1017/S104795111900101X

Received: 22 February 2019
Accepted: 9 April 2019
First published online: 12 July 2019

Key words:
Coarctation of the aorta; sternotomy

Author for correspondence:
Mark S. Bleiweis, MD, Congenital Heart Center, University of Florida, 1600 SW Archer road, PO Box 100297 UFHSC, Gainesville, FL 32610, USA.
Tel: (352) 273-7770; Fax: (352) 273-273-5927;
E-mail: bleiweis@ufl.edu

Abstract

Background: Isolated coarctation of the aorta can be repaired by either lateral thoracotomy or sternotomy approach with end-to-end anastomosis. Most commonly, neonates with coarctation of the aorta also have hypoplasia of the arch, requiring median sternotomy and extended end-to-side anastomosis with arch augmentation. The aim of this study was to describe our experience as the institution adopted the median sternotomy approach for repair, by reviewing complications, mortality, and reintervention. *Methods:* Retrospective chart review of 66 patients aged 0–1 year who had arch repair performed by a single surgeon over an 8-year period was performed. Median age at surgery was 22 days (4–232) and median weight was 3.08 kg (1.25–8.0). Forty-one (62%) patients underwent median sternotomy. *Results:* There was 1 death from a noncardiac cause. Eighteen per cent of our patients were ≤2.5 kg. Vocal cord paresis occurred in 16% of patients under 2.5 kg and 9.5% of patients 2.5 kg or above at the time of surgery. Hypertension at 6-month follow-up was greater in patients under 2.5 kg (44%) than patients 2.5 kg or above (15%). Total surgical reintervention rate was 6%. For patients above 2.5 kg, the surgical reintervention rate was 5.4% and for patients below 2.5 kg, the surgical reintervention rate was 8.3%. *Conclusion:* We concluded that for neonates with coarctation of the aorta and hypoplastic arch, median sternotomy is a safe surgical approach with low morbidity and mortality with the possible advantage of reduced surgical re-intervention and mortality in the population below 2.5 kg.

Introduction

Coarctation of the aorta is the narrowing of the aorta seen typically at the isthmus distal to the origin of the left subclavian artery and near the insertion of the ductus arteriosus. Coarctation of the aorta accounts for 4–10% of congenital heart anomalies[1–3] and many of those affected present in the neonatal period. Isolated coarctation of the aorta does occur, but most neonates present with more complex anatomy. Aortic arch hypoplasia is present in 60–80% of patients with neonatal Coarctation of the aorta.[4] Coarctation of the aorta is also commonly associated with bicuspid aortic valve, with or without left ventricular outflow tract obstruction, and ventricular septal defect (VSD).

A variety of surgical approaches have been used to repair coarctation of the aorta.[5] While lateral thoracotomy is the more common approach for isolated coarctation of the aorta, extended end-to-side anastomosis with arch augmentation can reduce the recurrence of re-coarctation.[6,7] Although this technique is more invasive, requiring median sternotomy and cardiopulmonary bypass, it allows for more extensive arch repair and can be used as a single-stage approach for the repair of other cardiac anomalies. This is the preferred approach at our centre. Herein, we have described our experience of coarctation of the aorta repair over an eight-year period, focusing on post-operative complications and reintervention.

Materials and methods

Patients 0–1 years of age with coarctation of the aorta and/or hypoplastic arch with and without concomitant VSD were included. Patients were operated on by a single surgeon between January 2006 and December 2014. Following Institutional Review Board approval, data were gathered retrospectively from medical records. Data included demographics, pre-operative and post-operative course, operative approach, complications, outcomes, and reinterventions. Arch hypoplasia was defined as a transverse arch cross-sectional dimension with a value <−2 Z score for BSA. Patients with interrupted arch or additional significant intracardiac comorbidities were excluded. Complications assessed included vocal cord injury (paresis = cord weakness or lack of full mobility, palsy = cord immobility), post-operative chylothorax, G-tube requirement due to

CAMBRIDGE UNIVERSITY PRESS

feeding difficulty, wound infections, sepsis, and hypertension at 6 months. Reintervention for hemodynamically significant re-coarctation was defined as balloon catheter dilatation or operative repair following initial surgery.

Results

Sixty-six patients met inclusion criteria; patient demographics are summarized on Table 1. A total of 15 patients (23%) underwent lateral thoracotomy with repair by end-to-end anastomosis while 51 patients (77%) underwent median sternotomy with extended end-to-side anastomosis and cardiopulmonary bypass. Cardiac anatomy is described in Table 2 for both groups. Median post-operative length of stay was 6 days [5, 9.5] for patients who had thoracotomy and 18 days [8, 29.25] for those who had sternotomy. Patients ≤2.5 kg had a median post-operative length of stay of 27 days [14, 48.5]. Post-operative LOS for patients >2.5 kg was 10 days [6, 21.25] (Table 3).

Complications

There was one death occurring secondary to non-cardiac causes (airway complication) during recovery in the CICU. Complications included chylothorax in 5 (9.8%), G-tube feeding requirement in 8 (12.1%), vocal cord palsy in 2 (3%) and vocal cord paresis in 10 (15%) (Table 4). Additionally, one patient became septic secondary to staphylococcal epidermidis PICC line infection. This patient also accounted for the only incision site infection during post-operative hospitalization. A second patient developed gram-negative sepsis. All infections were resolved with antibiotic treatment. Data for post-operative hypertension were available for 33 patients. Of these, 10 (30.3%) developed systemic hypertension at six months post-op. Among those, 4 were patients weighing ≤2.5 kg (33%) at the time of surgery and 6 were patients >2.5 kg (9%) ($p < 0.05$).

Reintervention

Nine patients (13.6%) required any form of reintervention and four (6%) required surgical reintervention. Three of these patients underwent balloon angioplasty alone, one had redo sternotomy with arch repair using homograft patch augmentation, and two underwent balloon angioplasty and later required surgical reintervention with aortic arch patch augmentation. When classified by weight, one patient weighing ≤2.5 kg (8.3%) and three patients weighing >2.5 kg (5.4%) required surgical reintervention. In the sternotomy group, four patients (11.1%) required surgical reintervention, while in the thoracotomy group, two patients (13.3%) required surgical reintervention.

Discussion

There has always been the belief that some degree of aortic hypoplasia often exists with coarctation of the Aorta. As the neurodevelopmental outcomes continue to be no worse among patients undergoing short-length cardiopulmonary bypass, there is more confidence in the midline approach as the latter might result in no residual arch gradients compared to a focal thoracotomy.

Our data indicate the relative safety of the procedure with the only mortality related to an airway event post-procedure. As cardiac centres gain more experience in the context of complex cardiac lesions, surgical times and procedures during cardiopulmonary bypass continue to decrease with lesser complications. Among short-term complications, vocal cord paresis and paralysis (15%) were the most common. This is lower than currently published literature with some reports noting a 25–30% degree of vocal cord dysfunction and need for a Gastrostomy tube.[8] In our cohort, 12% of our population needed a G-tube. Pham et al. when comparing vocal cord dysfunction and associated dysphagia post-Norwood repair and isolated coarctation repair noted similar degrees of dysphagia, indicating this complication inherent to the site of instrumentation rather than the complexity of repair.[8] There were no patients who required a tracheostomy following the operation.

Table 1. Patient demographics.

Variable	Incidence (n = 51)
Males, n (%)	31 (61%)
Hispanic, n (%)	3 (6%)
Caucasian, n (%)	36 (71%)
African American, n (%)	6 (12%)
Median weight at surgery, kg	3.08 [2.61, 3.55]
Range	(1.25–8.00)
Median BSA at surgery, m^2	0.21 [0.19, 0.23]
Range	(0.12–0.40)

Table 2. Summary of cardiac anatomy per group.

Diagnosis	Thoracotomy (n = 15)	Sternotomy (n = 36)	All (n = 51)
Isolated coarctation	10	9	19
Hypoplastic arch	1	12	13
Coarctation + VSD	3	2	5
Hypoplastic arch + VSD	1	13	14

Table 3. Mean age and length of stay summarized by weight.

Variable	<2.5 kg (n = 9)	≥2.5 kg (n = 41)	All (n = 51)
Median age at surgery, days	33 [20, 50]	20.5 [13, 39]	22 [13, 44]
Range	(12–85)	(4–232)	(4–232)
Post-op length of stay, days	21 [13, 55]	10.5 [6, 23.5]	12 [6.5, 26.5]

Table 4. Summary of post-surgery non-cardiac complication.

Complication	Thoracotomy (n = 15)	Sternotomy (n = 36)
Vocal cord palsy, n (%)	0	3 (8%)
Chylothorax, n (%)	2 (13%)	3 (8%)
G-tube, n (%)	1 (7%)	4 (11%)
Hypertension at 6 months*, n (%)	3 (37.5%)	8 (32%)
Wound infections, n (%)	0	1 (3%)
Sepsis, n (%)	1 (7%)	1 (3%)

https://doi.org/10.1017/S104795111900101X Published online by Cambridge University Press

Long-term complications related to residual systemic hypertension were present in 30% of the studied population. The incidence (although not statistically significant) was slightly lower in the sternotomy group. Re-intervention rates were comparable in the thoracotomy group although numbers are limited in this group. The re-intervention rates were also higher in smaller babies probably related to smaller arches taking a longer time to grow even after initial repair.

In the cohort <2.5 kg, the smallest child was 1.25 kg. Re-intervention rates were higher in this particular group compared to the larger babies at time of surgery with a similar degree of residual hypertension. This is in contrast to Bursch et al. who noted in their evaluation of 197 patients that low weights did not affect outcomes in re-intervention rates after coarctation repair in neonates and infants less than 3 months of age.[9]

Our data are similar to other centres that there is an increasing trend towards the use of median sternotomy in the repair of isolated neonatal coarctation. The advantages of the decreased rate of re-coarctation as well as post-operative systemic hypertension continue to evolve with a decreasing trend towards the same. The incidence of other post-operative complications continues to be slightly higher in the sternotomy and this needs to be factored in whenever such a decision is made with regard to surgical approach. There needs to be ongoing assessment of multicentre data to assess if the recent shift in strategy to use a midline approach confers the benefit that an isolated thoracotomy traditionally accomplished.

Limitations

Limitation of this study is its retrospective nature. Over the period of the study, the surgical team had a gradual change in strategy to median sternotomy for coarctation of the aorta repair. In addition, over the last three years of the data period, patients are cared for in a paediatric cardiac intensive care unit (ICU) as opposed to a general paediatric ICU. Consistent data on the use of antihypertensive medications are not available as some patients have left the medical system.

Acknowledgments. This project was partially funded by the NCATS grant UL1 TR000064.

References

1. Reller MD, Strickland MJ, Riehle-Colarusso T, Mahle WT, Correa A. Prevalence of congenital heart defects in metropolitan Atlanta, 1998–2005. J Pediatr 2008; 153: 807–813. ISSN 1097-6833. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/18657826
2. Hoffman JI, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol 2002; 39: 1890–1900. ISSN 0735-1097. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/12084585
3. Rothman A. Coarctation of the aorta: an update. Curr Probl Pediatr 1998; 28: 33–60. ISSN 0045-9380. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/9551314
4. Conte, S, Lacour-Gayet F, Serraf A, et al. Surgical management of neonatal coarctation. J Thorac Cardiovasc Surg 1995; 109: 663–674; discussion 674–675. ISSN 0022-5223. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/7715213
5. Ungerleider RM, Pasquali SK, Welke KF, et al. Contemporary patterns of surgery and outcomes for aortic coarctation: an analysis of the Society of Thoracic Surgeons Congenital Heart Surgery Database. J Thorac Cardiovasc Surg 2013; 145: 150–156; discussion 157–158. ISSN 1097-685X. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/23098750
6. Rakhra, SS, Lee M, Iyengar AJ, et al. Poor outcomes after surgery for coarctation repair with hypoplastic arch warrants more extensive initial surgery and close long-term follow-up. Interact Cardiovasc Thorac Surg 2013; 16: 31–36. ISSN 1569-9285. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/23059853
7. Sakurai, T, Stickley J, Stümper O, et al. Repair of isolated aortic coarctation over two decades: impact of surgical approach and associated arch hypoplasia. Interact Cardiovasc Thorac Surg 2012; 15: 865–870. ISSN 1569-9285. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/22833510
8. Pham, V, Connelly D, Wei JL, Sykes KJ, O'Brien J. Vocal cord paralysis and dysphagia after aortic arch reconstruction and Norwood procedure. Otolaryngol Head Neck Surg 2014; 150: 827–833. ISSN 1097-6817. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/24515967
9. Burch, PT, Cowley CG, Holubkov R, et al. Coarctation repair in neonates and young infants: is small size or low weight still a risk factor? J Thorac Cardiovasc Surg 2009; 138: 547–552. ISSN 1097-685X. Disponível em https://www.ncbi.nlm.nih.gov/pubmed/19698833

https://doi.org/10.1017/S104795111900101X Published online by Cambridge University Press