TABLE 1. *Ninth International Conference Awards*

Award	Awardee	Title of Manuscript
John A. Waldhausen, MD, Young Investigator Award	Conrad Krawiec, MD	Impact of pulsatile flow on hemodynamic energy in a Medos Deltastream DP3 pediatric extracorporeal life support system
William S. Pierce, MD, Young Investigator Award	Hyoung Woo Chang, MD	Five-year experience with mini-volume priming in infants <5 kg: Safety of significantly less transfusion volume
Aydin Aytaç, MD, Young Investigator Award	Sertaç Haydin, MD	Initial experiences with Medos Deltastream DP3 pediatric extracorporeal life support system
Special Travel Award	Musthafa Moosa, MD	For travelling the longest distance for the attendance of conference

now the official journal of the International Society for Pediatric Mechanical Cardiopulmonary Support (7).

FINANCIAL SUPPORT

This year, we are proud to say we received educational support and funds from the International Society for Pediatric Mechanical Cardiopulmonary Support. Although this unique society was only established in 2010 during the Sixth International Conference in Boston, it covered over 97% of all expenses for the Ninth International Conference.

Dr. Ündar also contributed from his personal funds to balance the budget during the past three events.

In addition, financial support was received from companies including Medos Medizintechnik AG (Germany)—Platinum level supporter; Covidien, Inc. (USA), Maquet Medical Systems (USA), Syncardia Systems, Inc. (USA), Terumo Cardiovascular Systems (USA), and Wiley Blackwell (USA)—Bronze level supporters.

EDUCATIONAL CREDITS

The Ninth International Conference was approved for the following educational credits: 24.5 American Medical Association Physician's Recognition Award Category 1 Continuing Medical Education (CME) credits, 34.5 Category 1 Continuing Education Unit hours by the American Board of Cardiovascular Perfusion, and 24.6 Category 1 Continuing Education Unit hours by the California Board of Registered Nursing. These very valuable educational credits demonstrate the high quality scientific program we provide year after year.

SUMMARY

Once again, our annual conference was an overwhelming success. We are encouraged by the volume of scholarly work published as a result of our conference, and we look forward to continuing to provide opportunities for the leading investigators in CPB and MCS systems to share their research and encourage further studies to improve the lives of pediatric patients. To date, a total of 870 presentations have been made at our conferences, and over 400 peer-reviewed articles have been published based on the conference proceedings. All of the details regarding the Ninth International Conference, as well as the previous eight events and information on future events, can be found at our conference website: http://pennstatehershey.org/web/pedscpb/home. As we prepare for the Tenth International Conference in 2014, we continue to set our sights on the goal of publishing over 500 peer-reviewed manuscripts and having over 1000 presentations in the first 10 years of our conference.

Acknowledgments: We would specifically like to thank Bonnie Weaver, MSN, RN, for leading the preconference events, including the tours of the Cardiac Care/ICU facilities and the new Penn State Children's Hospital. Additionally, Tami Rosenthal, BS, CCP, MBA, and David Palanzo, CCP, are to be thanked for the time they spent selecting and organizing the new pediatric devices used in the hands-on ECLS workshop. In addition, we sincerely appreciate all the conference organizational support we receive from the Pediatric Clinical Research Office at Penn State Hershey. Special thanks go to Heather Stokes, Jennifer Stokes, Erlee Meyers, Jessica Beiler, Julie Vallati, Amy Shelly, Gabrielle H. Murray, and Shigang Wang, MD, of the Pediatric Cardiovascular Research Center at Penn State Hershey who were instrumental in organizing this event from start to finish. We also appreciate Ann Hagan's invaluable help organizing CME from the Department of Continuing Medical Education of The Children's Hospital of Philadelphia.

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REFERENCES

1. Ündar A: Welcome to the 9th International Conference on Pediatric Mechanical Circulatory Support Systems & Pediatric Cardiopulmonary Perfusion. *Artif Organs* 2013;4: 354–6.
2. Ündar A, Akçevin A, Alkan-Bozkaya T, et al. Outcomes of the eighth international conference on pediatric mechanical circulatory support systems and pediatric cardiopulmonary perfusion [Guest Editorial]. *Artif Organs* 2013;37:1–9.
3. Wang S, Kunselman AR, Ündar A. Novel pulsatile diagonal pump for pediatric extracorporeal life support system. *Artif Organs* 2013;37:37–47.
4. Krawiec C, Wang S, Kunselman AR, Ündar A. Impact of pulsatile flow on hemodynamic energy in a Medos Deltastream DP3 pediatric extracorporeal life support system. *Artif Organs* 2014;1:19–27.
5. Wang S, Kunselman AR, Ündar A. In vitro performance analysis of novel pulsatile diagonal pump in simulated pediatric mechanical circulatory support system. *Artif Organs* 2014 (in press).
6. Wang S, Ündar A. Current devices for pediatric extracorporeal life support and mechanical circulatory support systems in the United States [Invited Review]. *Biomed Mater Eng* 2013;23:57–62.
7. Malchesky PS. International Society for Pediatric Mechanical Cardiopulmonary Support selects Artifical Organs as its official journal [Editorial]. *Artif Organs* 2013;37:115.

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Usefulness of Balloon Angioplasty for the Right Ventricle-Pulmonary Artery Shunt with the Modified Norwood Procedure

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Objective: We sought to evaluate the efficacy of balloon angioplasty (BA) for severely desaturated patients due to a stenotic right ventricle (RV) to pulmonary artery (PA) shunt following modified Norwood procedure. Methods: Of 87 patients who underwent a Norwood procedure with the RV-PA shunt between February 1998 through March 2010, 22 (25%) patients underwent BA. The efficacy of BA was assessed by angiographic measurement of the changes in the internal diameters of the stenotic portions of the shunt, changes in arterial saturation and clinical outcomes. Results: BA was performed for stenotic RV-PA shunts following stage I palliation (n = 17, 77%), or those placed as an additional blood source (n = 5, 23%, 3 patients awaiting biventricular repair, 2 patients following stage II palliation). The location of the BA was at the distal anastomosis in 12 (54.5%), proximal anastomosis in 21 (95.4%) and in the mid-portion of the shunt in 11 (50%) cases. The diameters of these three shunt portions were measured from the anterior–posterior and lateral angiographic images, increasing significantly after BA ($p < 0.0001$) in all. Arterial saturation significantly improved after BA in all cases (66.5 ± 4.3% to 79.4 ± 3.4%, $p < 0.0001$). Freedom from reintervention was 100%. All patients underwent subsequent elective planned surgery at an appropriate age with no mortality. Conclusions: A BA-alone strategy for a stenotic RV-PA shunt was effective for all three shunt portions, minimizing shunt-related premature surgical intervention.

Key words: balloon angioplasty; rv-pa shunt; hypoplastic left heart syndrome; Norwood

BACKGROUND

Since Norwood and colleagues described neonatal open-heart palliation for patients with hypoplastic left heart syndrome (HLHS) [1], the clinical outcome of this procedure has improved dramatically [2,3]. One recent modification, the use of a right ventricle (RV)-to-pulmonary artery (PA) shunt instead of a modified Blalock-Taussig (BT) shunt in stage I palliation, appears to offer more stable hemodynamics by avoiding diastolic run off [4]. A recent randomized trial comparing the two shunt types for stage I palliation showed a significantly higher 1-year transplant-free survival in patients with the RV-PA shunt than those with a BT shunt [5]. However, it also revealed a significantly higher requirement for reintervention in the RV-PA shunt group prior to stage II palliation compared to the BT shunt group [5].

Early stenosis of the RV-PA shunt following stage I palliation has been a well-documented phenomenon [6–10]. The mechanisms of stenosis include kinking or compression of the shunt, distal anastomotic stenosis

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Conflict of interest: Nothing to report.

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with or without branch PA stenosis, proximal stenosis related to muscular growth or endothelial growth within the shunt lumen. As such, progressive desaturation between stages mandates either early conversion to bidirectional Glenn (BDG) anastomosis or catheter intervention to a stenotic RV-PA shunt. Although there are a few case studies describing the efficacy of stent placement in the RV-PA shunt [6,11–14], limited data exist regarding efficacy and durability of balloon angioplasty (BA) alone. In this study, we reviewed our institutional experiences of BA on the RV-PA shunt focusing on the effectiveness of the procedure, reintervention and subsequent timing of stage II palliation.

SUBJECTS AND MATERIALS

Between February 1998 to March 2010, 87 infants underwent the Norwood procedure with a RV-PA shunt at Okayama University Hospital. The subjects of this study were 22 (25.2%) of the 87 patients who had RV-PA conduit stenosis and severe desaturation.

Surgical Techniques and Institutional Policy

The technique of modified Norwood procedure with a RV-PA shunt has been described elsewhere [4,15]. Briefly, the RV-PA shunt [expanded polytetrafluoroethylene (ePTFE), Gore-Tex, W.L Gore & Associates, Flangstaff, AZ] was created with a distal cuff to minimize the distal anastomotic stenosis and/or branch PA stenosis. All shunts were anastomosed to the stump of the central branch PA, which was inserted into the left side of the reconstructed aorta. A 5 mm ePTFE was used in the majority (20/22 patients, 90%), and 6 mm shunt was used in two patients. In seven cases with excessive pulmonary blood flow, a hemoclip was placed on the RV-PA shunt to restrict the pulmonary blood flow either intraoperatively or at the time of delayed chest closure. The Norwood procedure was used as initial palliation for potential biventricular repair in three patients and at stage II palliation, the RV-PA shunt was left in place providing an additional pulmonary blood flow in 17 patients.

Our institutional policy is to perform stage II palliation at 6 months of age with a body weight of more than 5 kg. Therefore, we used a strategy to treat severely desaturated patients following stage I palliation with a BA. Indications for BA were severe desaturation (arterial saturation less than 70%) clearly related to a RV-PA shunt stenosis. The patients with severe desaturation were investigated by echocardiography [α10 (ALOKA), Vivid 7 (GE Yokogawa Medical Systems), IE33 (PHILIPS)]. Presence of stenosis was evaluated by morphology and flow velocity near and inside the shunt.

Catheterization Techniques

All procedures were performed under general anesthesia. Measurement of the PA pressure was often not performed as the patients were unstable. Biplane angiography was performed using either an INTEGRIS BH5000 (PHILIPS) or Infinix Celeve-I INFX-8000V (TOSHIBA) angiographic system. Several different balloons were used including Wanda, Sasuga, Sterling (Boston Scientific, Natic, MA, USA) or Lacross (GOODMAN CO., LTD, Gifu, Japan) of 5 or 6 mm in diameter and 15–40 mm in lengths. A 5 mm balloon was used in the 5 mm ePTFE shunts, while a 6 mm balloon used in the two 6 mm shunts. The RV-PA shunt was approached from the femoral vein in all cases. A 4-French Judkins right coronary catheter was used to cannulate the conduit, a 0.014"-0.018" inch guide wire was then placed in one of the PA branches. The balloon was inserted into the shunt as quickly as possible and inflated. Multiple inflations were often performed until the waist of the balloon at the stenotic site disappeared. Subsequent effectiveness of BA was evaluated based on increase in the internal diameter of the shunt on the post-BA angiogram and also an increase in the arterial saturation. Imaging was performed again after BA and the diameter of the stenotic portion was measured. Typical images for each of three portions, before and after BA are shown in Fig. 1.

Angiographic Evaluation

The image analysis software Elk C. View version 1.7 (Elk) was used for measurement of the diameter of the stenotic portions. All original angiographic images were retrospectively analyzed off line. Sites of stenosis were divided into 3 groups: RV-PA shunt connection to the central branch PA (distal portion), site of RV-PA shunt connection to the RV (proximal portion), and inside the RV-PA shunt (inside portion). The angiograms were obtained in the anterior-posterior (AP) and lateral projections, with the children in isocenter for magnification correction. The diameter of the stenotic portion was measured independently and compared before and after BA.

Clinical Evaluation

We analyzed data regarding age at the time of BA, body weight, changes in arterial saturation before and after BA, and subsequent postoperative course including time to the next operation.

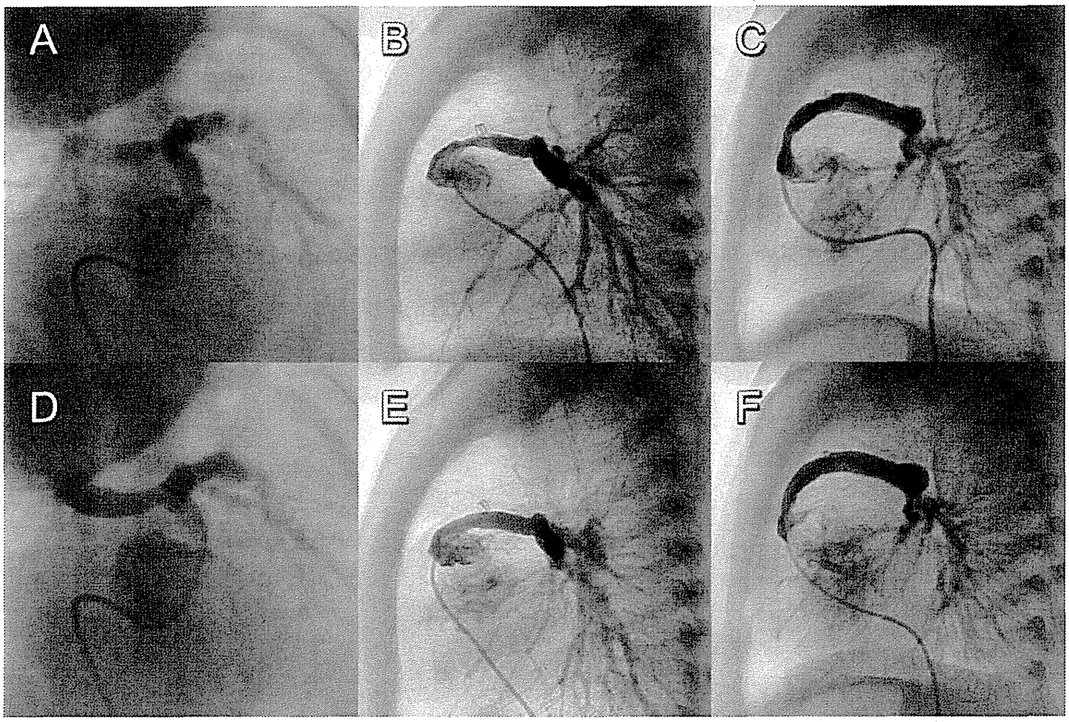

Fig. 1. Figure shows the typical images for each of three portions, before and after BA. A: Distal portion, pre BA, B: Proximal portion pre BA, C: In-stent pre BA, D: Distal portion, post BA, E: Proximal portion, post BA, F: In-stent, post BA.

Statistical Analysis

SPSS II (IBM, United States) was used for statistical analyses. A paired T test was used for comparison of data before and after BA and $p < 0.05$ was considered statistically significant.

RESULTS

Patient Characteristics

Seventeen patients (77%) underwent BA following stage I palliation for single ventricle palliation. The mean age and body weight was 137 days and 4.9 kg, respectively. Five patients had the RV-PA shunt as an additional source of pulmonary blood flow: three awaiting biventricular repair in whom a BT shunt (4 mm) had already been placed and two patients following stage II palliation. The mean age and mean weight of these patients was 547 days and 7.7 kg, respectively.

Efficacy of Balloon Angioplasty

BA was performed at the distal anastomosis in 12 (54.5%), at the proximal anastomosis in 21 (95.4%) and inside the RV-PA shunt in 11 (50%) cases. Eighteen (82%) patients had multiple stenoses. Of 11 patients who underwent BA for the stenosis inside the shunt, seven had a previous hemoclip placed at stage I palliation. The mean fluoroscopy and total procedure times were 28 and 173 min, respectively.

The internal diameters of the RV-PA shunts increased significantly after BA in all three portions ($p < 0.0001$ for all) (Fig. 2). In all cases, arterial saturation also significantly improved (66.5 $\pm$ 4.3% to 79.4 $\pm$ 3.4%, $p < 0.0001$). During the procedure, transient arrhythmias occurred in two cases with no hemodynamic compromise. There were no other complications during the procedures.

Clinical Outcomes

All 17 patients who underwent BA following stage I palliation had a stable arterial saturation (75.6 $\pm$ 2.5%) with favorable weight gain. None of the patients required further catheterization or surgical intervention and underwent an elective BDG with no mortality. The mean age and body weight at surgery was 198 days and 5.6 kg, respectively. Six out of 17 patients completed a TCPC and the remaining 11 patients are awaiting a TCPC completion with no late mortality.

Among the five patients who had an RV-PA shunt as an additional source of pulmonary blood flow, subsequent biventricular repair was performed in three

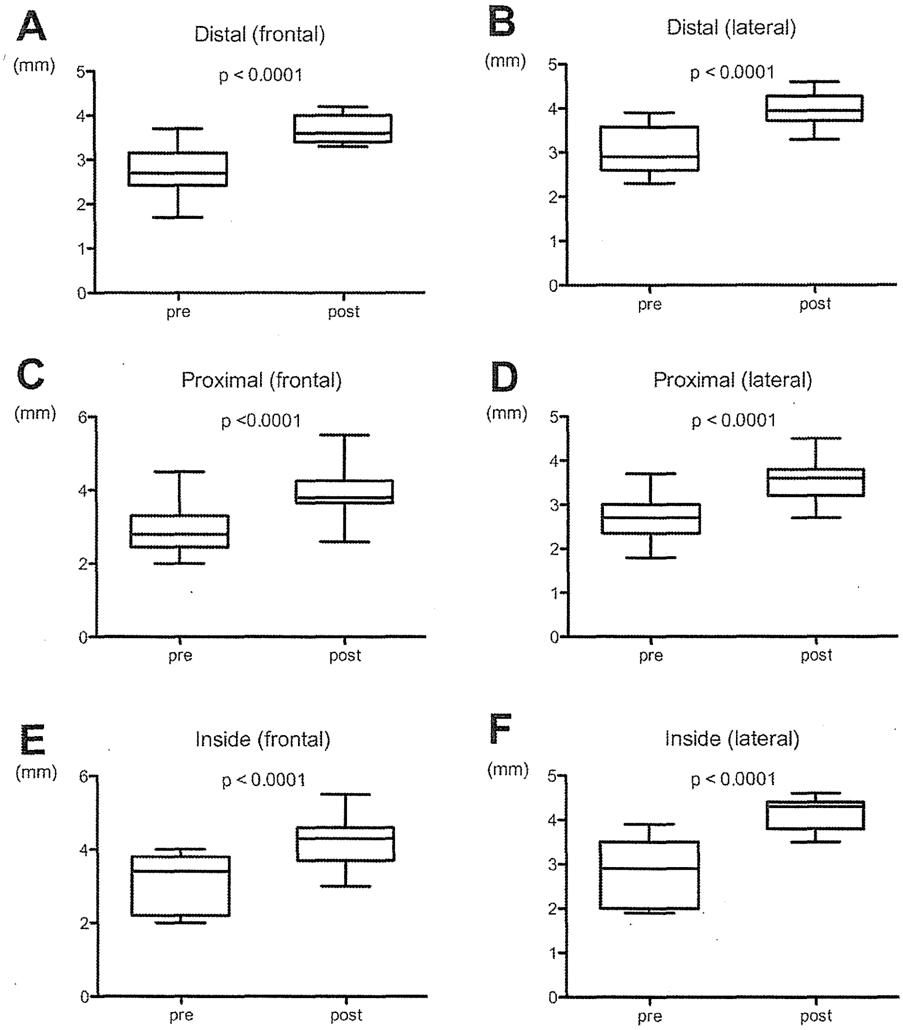

Fig. 2. The changes in the internal diameters before and after BAP. A: Comparison of distal portion in the AP image (2.7 ± 0.6 vs. 3.7 ± 0.3 mm), B: Comparison of distal portion in the lateral image (3.0 ± 0.6 vs. 4.0 ± 0.4 mm), C: Comparison of proximal portion in the AP image (2.9 ± 0.6 vs. 4.0 ± 0.6 mm), D Comparison of proximal portion in the lateral image (2.7 ± 0.5 vs. 3.6 ± 0.4 mm), E Comparison of inside portion in the AP image (3.1 ± 0.8 vs. 4.2 ± 0.7 mm), F Comparison of inside portion in the lateral image (2.9 ± 0.7 vs. 4.1 ± 0.4 mm).

with no mortality with preoperative arterial saturations of 74.3 ± 2.5%. Of the two patients who underwent BA following a BDG, one patient underwent TCPC completion (arterial saturation 78% and body weight 11 kg at the age of 4 years) and the other patient is awaiting TCPC completion (arterial saturation 77%). As a whole, none of the patients experienced desaturation episodes after BA (freedom from reintervention, 100%).

DISCUSSION

Early stenosis of the RV-PA shunt following the modified Norwood procedure is a critical factor contributing to inter-stage mortality and morbidity [3,5]. Progressive desaturation during this period necessitates urgent intervention to re-establish adequate pulmonary blood flow in order to avoid a premature second stage procedure. Our results clearly show that BA was effective in dilating all three portions of stenosis without major complications. Arterial saturations increased significantly and remained stable through the next planned surgical intervention, despite having no stent placed within the shunts. In addition, this strategy worked well for three different clinical situations, i.e., following stage I palliation, an RV-PA shunt as additional pulmonary blood source following stage II palliation and for those having future biventricular repairs.

Balloon Angioplasty for the Distal Anastomotic Stenosis

Ino et al. suggested the main mechanism of balloon dilatation for a stenotic PA was due to non-stretch mechanisms such as tearing, flap formation, or dissection [16]. The same mechanism may apply if a RV-PA shunt is anastomosed to the native PA without patch augmentation on the central branch PA. In our series, a large ePTFE cuff was pre-anastomosed to the RV-PA shunt. Therefore, there is a large area of ePTFE at the distal anastomosis, which may have made BA more amenable on this particular lesion. In other words, the balloon may have stretched mainly the ePTFE graft and cuff rather than actual native PAs.

Balloon Angioplasty for Proximal Anastomotic Stenosis

Given the nature of the proximal anastomosis, where the shunt takes off with a sharp angle from the small right ventriculotomy, the proximal anastomosis was a common stenotic site in our series (95%). Potential mechanisms include a kinking of the shunt in the AP direction, muscle growth at the ventriculotomy or fibromuscular proliferation into the shunt. We speculated that BA might not be effective at dilating in the AP direction due to the structural kinking; however, our results showed that BA dilated the shunt in the lateral direction rather than in the AP direction.

Balloon Angioplasty for In-Stent Stenosis

The majority (7/11, 63%) of in-stent stenosis in this series was "intentional," created by a hemoclip placed at the time of stage I palliation to control pulmonary blood flow. Progression of desaturation was expected for those patients and therefore more meticulous follow-up was implemented. We believe that this strategy represents an effective means to manipulate the amount of pulmonary blood flow through the RV-PA shunt, thereby preventing sudden circulatory collapse due to pulmonary overcirculation in the immediate postoperative period. The mechanism of stenosis in the remaining 4 patients was not related to hemoclip placement, and may be due to tissue proliferation associated with the procedure and/or minor kinking of the shunt. BA was also effective for this lesion partly because of the nature of ePTFE since the material itself is expandable by pressure [17].

Balloon Angioplasty vs. Stent Placement

A large number of reports suggest stent placement efficacious for stenotic RV-PA shunts following stage I palliation [6,7,11–14]. Re-intervention rates after stent placement are low. Potential disadvantages of stent placement include: distortion of the branch PA bifurcation, erosion of the anastomotic sites, in-stent stenosis and complications related to stent removal at the time of the next operation. None of these potential complications became an issue using a BA-alone strategy. If BA is not effective to improve the internal diameter and/or arterial saturation, stent placement or early surgical intervention can be considered as the future options.

Balloon Angioplasty Following Stage I palliation

Even though a substantial body of evidence shows that early stage II palliation can be safely performed as early as the age of 3 months [18], we still believe that the physiology of cavopulmonary connection can be achieved in the safest manner when the pulmonary vasculature is fully matured. In addition, it is possible that a stenotic RV-PA shunt does not supply sufficient pulmonary blood flow to facilitate normal growth of peripheral pulmonary vasculature, leaving premature lung vasculature with or without a vulnerable pulmonary vascular resistance. Therefore, we think that gaining an additional 2–3 months by BA could be beneficial. All 17 patients underwent a BDG at the standard time and had favorable postoperative clinical outcomes.

Balloon Angioplasty for RV-PA shunt as an Additional Pulmonary Blood Source

We have a rather unique surgical strategy, where a RV-PA shunt is left in place at the time of a BDG, serving as an additional pulmonary blood source. This shunt may be beneficial in terms of facilitating further native PA growth and potentially preventing development of arteriovenous fistula by providing hepatic factors. However, we do recognize that the presence of an additional pulmonary blood source following stage II palliation is controversial. Our limited experience (two patients) showed that BA for RV-PA shunt stenosis following BDG was effective and also in patients who were awaiting biventricular repair [19].

Study Limitation

The major limitations of this study are due to the retrospective non-randomized nature of the patient cohort. Since our institutional policy has been consistent during the study period, there is no comparison group. Lastly, there were no follow-up angiograms to document the medium-term results of BA. Our measure of success comes from immediate post-operative angiographic results and clinical outcomes.

CONCLUSIONS

The BA-alone strategy for stenotic RV-PA shunts in severely desaturated patients was effective in all three shunt portions. Premature surgery was avoided and all patients underwent elective operations at an appropriate age with good clinical outcomes. This strategy can be considered effective to minimize shunt-related premature surgical intervention.

REFERENCES

1. Norwood WI, Lang P, Casteneda AR, Campbell DN. Experience with operations for hypoplastic left heart syndrome. J Thorac Cardiovasc Surg 1981;82(4):511–519.
2. Mahle WT, Spray TL, Wernovsky G, Gaynor JW, Clark BJ, 3rd. Survival after reconstructive surgery for hypoplastic left heart syndrome: A 15-year experience from a single institution. Circulation 2000;102(19 Suppl 3):III136–41.
3. McGuirk SP, Griselli M, Stumper OF, Rumball EM, Miller P, Dhillon R, de Giovanni JV, Wright JG, Barron DJ, Brawn WJ. Staged surgical management of hypoplastic left heart syndrome: a single institution 12 year experience. Heart 2006;92(3):364–370.
4. Sano S, Ishino K, Kawada M, Arai S, Kasahara S, Asai T, Masuda Z, Takeuchi M, Ohtsuki S. Right ventricle-pulmonary artery shunt in first-stage palliation of hypoplastic left heart syndrome. J Thorac Cardiovasc Surg 2003;126(2):504–509; discussion 509–510.
5. Ohye RG, Sleeper LA, Mahony L, Newburger JW, Pearson GD, Lu M, Goldberg CS, Tabbutt S, Frommelt PC, Ghanayem NS and others. Comparison of shunt types in the Norwood procedure for single-ventricle lesions. New Engl J Med 2010;362(21):1980–1992.
6. Dahnert I, Riede FT, Razek V, Weidenbach M, Rastan A, Walther T, Kostelka M. Catheter interventional treatment of Sano shunt obstruction in patients following modified Norwood palliation for hypoplastic left heart syndrome. Clin Res Cardiol 2007;96(10):719–722.
7. Muyskens S, Nicolas R, Foerster S, Balzer D. Endovascular stent placement for right ventricle to pulmonary artery conduit stenosis in the Norwood with Sano modification. Congen Heart Dis 2008;3(3):185–190.
8. Rumball EM, McGuirk SP, Stumper O, Laker SJ, de Giovanni JV, Wright JG, Barron DJ, Brawn WJ. The RV-PA conduit stimulates better growth of the pulmonary arteries in hypoplastic left heart syndrome. Eur J Cardiothorac Surg 2005;27(5):801–806.
9. Griselli M, McGuirk SP, Ofoe V, Stumper O, Wright JG, de Giovanni JV, Barron DJ, Brawn WJ. Fate of pulmonary arteries following Norwood procedure. Eur J Cardiothorac Surg 2006;30(6):930–935.
10. Pruetz JD, Badran S, Dorey F, Starnes VA, Lewis AB. Differential branch pulmonary artery growth after the Norwood procedure with right ventricle-pulmonary artery conduit versus modified Blalock-Taussig shunt in hypoplastic left heart syndrome. J Thorac Cardiovasc Surg 2009;137(6):1342–1348.
11. Desai T, Stumper O, Miller P, Dhillon R, Wright J, Barron D, Brawn W, Jones T, DeGiovanni J. Acute interventions for stenosed right ventricle-pulmonary artery conduit following the right-sided modification of Norwood-Sano procedure. Congen Heart Dis 2009;4(6):433–439.
12. Eicken A, Genz T, Sebening W. Stenting of stenosed shunts in patients after a Norwood-Sano operation. Catheterization and cardiovascular interventions. Off J Soc Cardiac Angiograph Intervent 2006;68(2):301–303.
13. Nigro JJ, Bart RD, Derby CD, Sklansky MS, Starnes VA. Proximal conduit obstruction after Sano modified Norwood procedure. Ann Thorac Surg 2005;80(5):1924–1928.
14. Petit CJ, Gillespie MJ, Kreutzer J, Rome JJ. Endovascular stents for relief of cyanosis in single-ventricle patients with shunt or conduit-dependent pulmonary blood flow. Catheter Cardiovasc Interv 2006;68(2):280–286.
15. Sano S, Huang SC, Kasahara S, Yoshizumi K, Kotani Y, Ishino K. Risk factors for mortality after the Norwood procedure using right ventricle to pulmonary artery shunt. Ann Thorac Surg 2009;87(1):178–185; discussion 185–186.
16. Ino T, Kishiro M, Okubo M, Akimoto K, Nishimoto K, Yabuta K, Kawasaki S, Hosoda Y. Dilatation mechanism of balloon angioplasty in children: assessment by angiography and intravascular ultrasound. Cardiovasc Intervent Radiol 1998;21(2):102–108.
17. Salzmann DL, Yee DC, Roach DJ, Berman SS, Williams SK. Effects of balloon dilatation on ePTFE structural characteristics. J Biomed Mater Res 1997;36(4):498–507.
18. Jaquiss RD, Siehr SL, Ghanayem NS, Hoffman GM, Fedderly RT, Cava JR, Mussatto KA, Tweddell JS. Early cavopulmonary anastomosis after Norwood procedure results in excellent Fontan outcome. Ann Thorac Surg 2006;82(4):1260–1265; discussion 1265–1266.
19. Bradley SM, Erdem CC, Hsia TY, Atz AM, Bandisode V, Ringewald JM. Right ventricle-to-pulmonary artery shunt: alternative palliation in infants with inadequate pulmonary blood flow prior to two-ventricle repair. Ann Thorac Surg 2008;86(1):183–188; discussion 188.