Modified Stumper technique for acute postoperative bifurcation stenosis causing right ventricular failure after Ross procedure

Abhay A Divekar
Pediatric Cardiac Catheterization Laboratory, Division of Pediatric Cardiology, Stead Department of Pediatrics, University of Iowa Childrens Hospital, Iowa City, Iowa, USA

ABSTRACT

In this report, we describe a 15-year-old patient who underwent a Ross procedure for a regurgitant bicuspid aortic valve and ascending aortic dilation. After the operation was over, he could not be separated from cardiopulmonary bypass and was noted to have isolated right ventricular failure. This report takes the reader through the diagnostic evaluation, highlights the importance of invasive assessment in the immediate postoperative period, and discusses successful transcatheter intervention in the acute postoperative setting.

Keywords: Early postoperative transcatheter intervention, right ventricular failure, Ross procedure

INTRODUCTION

Failure to separate a patient from cardiopulmonary bypass after a Ross operation is usually related to left ventricular dysfunction secondary to coronary insufficiency. Infrequently, isolated right ventricular (RV) failure is the cause, but establishing the diagnosis of RV failure can be challenging. In this report, we discuss the etiology, diagnosis, and successful treatment of RV failure in such a situation.

CASE HISTORY

A 15-year-old boy with a regurgitant bicuspid aortic valve and dilated ascending aorta underwent a Ross procedure. After the procedure, he could not be weaned from cardiopulmonary bypass (bypass time 270 min, cross-clamp time 259 min, deep hypothermic circulatory arrest 26 min). The transesophageal echocardiogram (TEE) showed adequate left ventricular and autograft function, RV dilated with poor function, and the proximal RV to pulmonary artery (PA) conduit (26-mm pulmonary homograft) unobstructed. The distal conduit anastomosis could not be evaluated. Surgical exploration was concerned for a kink in the reimplanted right coronary artery (RCA) that caused acute RV failure. He was treated with a left saphenous vein bypass graft from the innominate artery to the RCA (additional bypass time of 286 min) but still could not be separated from cardiopulmonary bypass; the TEE findings were unchanged and there was no surgical concern for conduit obstruction. Therefore, he was placed on extracorporeal membrane oxygenation (ECMO) through the left femoral artery and left femoral vein for presumed myocardial stun.

Seventeen hours after returning from the operating room, he had persistent unexplained RV failure and need for ongoing ECMO support. Echocardiography was unchanged and therefore cardiac catheterization was recommended. As the patient already had coronary intervention, we elected to direct our attention to possible conduit obstruction first. Hemodynamics showed a 20-mmHg peak gradient across the distal RV-PA conduit (RV pressure 46/11, SBP 104/45) in the setting of severe RV dysfunction (ECMO flow reduced to 0.5 l/min during hemodynamic assessment and

Access this article online

Quick Response Code:

Website: www.annalspc.com

DOI: 10.4103/0974-2069.189108

How to cite this article: Divekar AA. Modified stumper technique for acute postoperative bifurcation stenosis causing right ventricular failure after ross procedure. Ann Pediatr Card 2016;9:248-50.

Address for correspondence: Dr. Abhay A Divekar, Director, Pediatric Cardiac Catheterization Laboratory, Division of Pediatric Cardiology, Stead Department of Pediatrics, University of Iowa Childrens Hospital, Iowa City, IA 52241, USA. Tel: 1-319-356-8831; fax: 1-319-356-4693; E-mail abhay-divekar@uiowa.edu

angiography); this increased to 32 mmHg after contrast administration (RV pressure 56/17, SBP 126/55). The RV-PA angiogram was suggestive but not conclusive for distal RV-PA conduit bifurcation stenosis [Figure 1a]; the appearance suggested that the distal conduit produced torsion and distal compression such that the bifurcation and proximal branch pulmonary arteries were narrowed (12.7 mm). The RV-PA conduit measured only 19 mm proximally (implanted size 26 mm). Therefore, initially, we decided to perform balloon sizing with a compliant [25-mm PTS sizing balloon (NuMed Inc., Hopkinton, NY)] and then with a noncompliant balloon [Atlas PTA balloon dilation catheter (Bard Peripheral Vascular Inc., Tempe, AZ)]. The compliant balloon well demonstrated the anatomy; the lesion was very compliant and an initial waist was noted at 8 mm that easily stretched to 14 mm with less than 1 atmospheric pressure [Figure 1b]. After multidisciplinary consultation, it was decided to attempt transcatheter intervention with onsite surgical backup. We elected not to perform testing for coronary artery and graft patency because of documented severe distal conduit obstruction sufficient to explain RV failure. We also did not perform testing for coronary compression based on the surgical description of the distance of the distal conduit from the coronary arteries, distal bifurcation rather than RVOT stenting, concern of dilating the severely stenotic fresh suture line without a stent as a scaffold (higher risk of catastrophic rupture), planned intentional undersizing of the final stent diameter (20 mm in a 26-mm conduit), and, finally, the reassurance that the patient was supported with ECMO. A 20-mm balloon was chosen to avoid aggressive dilation of the fresh suture line yet sufficiently relieve severe conduit stenosis. To avoid jailing the branch PAs during stent implantation, we used a technique described by Stumper *et al.*[1] that entails mounting the stent on two angioplasty catheters. To reduce the sheath size, the stent was mounted on an angioplasty balloon and a 4-Fr catheter instead of two angioplasty catheters as originally described by Stumper *et al.*[1] A 14-Fr sheath was advanced into the distal conduit over guidewires placed into each PA. A 26-mm EV3 LD Max stent (open cell design, eV3 Inc., Plymouth, MN) was predilated on a 12-Fr dilator and then mounted on a 20 mm × 4 cm angioplasty balloon and a 4-Fr catheter. A longer balloon was intentionally chosen and the stent was mounted near the proximal marker so that the distal 1 cm of the balloon would not be covered by the stent. Once securely mounted, the stent was advanced past the distal anastomosis protruding into the PA bifurcation such that the uncovered portion of the balloon and catheter were in the proximal right and left PAs, respectively [Figure 2a]. The stent was deployed at 14 atmospheric pressure to completely eliminate the waist. The distal uncovered balloon protected the RPA orifice and the distal stent opposed to the floor of the proximal RPA. A subsequent inflation in the LPA opposed the distal stent to the floor of the LPA. Angiography showed excellent positioning of the stent without jailing either branch PAs, and anatomic relief of stenosis without vascular injury; the final diameter was 19 mm for the entire conduit [Figure 2(b)]. There was immediate improvement in the RV function on TEE and angiography (ECMO flow turned down to 0.5 l/min for angiography and hemodynamic assessment) and peak distal RV to PA gradient was now 15 mmHg (RV pressure 52/17, SBP 120/52). From a hemodynamic standpoint, he was able to come off support shortly after the transcatheter intervention (30 min trial); however, he was electively weaned off ECMO later in the day (10 h later). After a rather prolonged convalescence, he was discharged home without any further surgical or transcatheter RV to PA conduit intervention. Cardiac catheterization was repeated 1 and 4 years later and showed a peak gradient of 30 mmHg, free pulmonary insufficiency, normal RV function, and patent venous graft as well as normal right and left coronary artery filling.

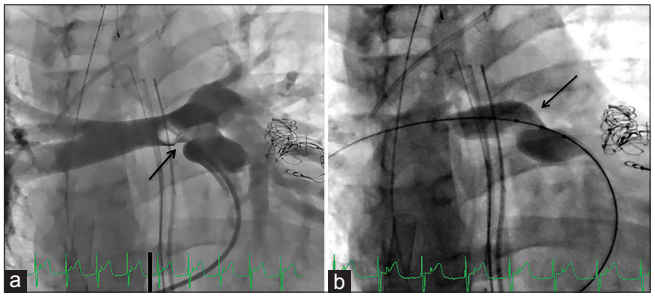

Figure 1: (a) Frontal projection of pulmonary artery angiogram showing suspicion for distal conduit stenosis (arrow). This area is seen as a radiolucent band at the bifurcation. (b) Frontal projection illustrating very low-pressure balloon sizing of the bifurcation stenosis. The angioplasty catheter is inflated at low pressure and shows an area of severe stenosis and tortuosity at the conduit insertion into the pulmonary artery bifurcation (arrow)

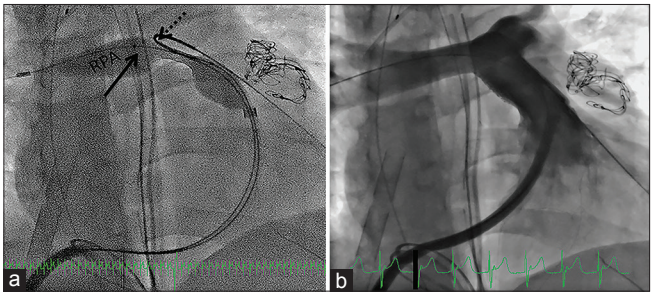

Figure 2: (a) Frontal angiogram showing the stent mounted on the angioplasty and a 4-Fr catheter, the distal uncovered angioplasty catheter (solid arrow), and a portion of the 4-Fr catheter (dashed arrow) in the proximal right and left pulmonary artery, respectively (arrow). (b) Frontal pulmonary artery angiogram showing final stent position without jailing the branch pulmonary arteries and complete relief of stenosis without evidence of vascular injury

DISCUSSION

Inability to separate a patient from cardiopulmonary bypass after undergoing a Ross procedure should prompt an exhaustive search for coronary insufficiency or either autograft or RV-PA conduit failure (stenosis or insufficiency). Isolated RV failure is either secondary to left heart dysfunction or primary and related to coronary insufficiency (intuitive) or acute increase in RV afterload (less well-known). Only when residual lesions are excluded, ventricular dysfunction can be presumed to be secondary to myocardial stun.

Postoperative TEE was not concerning for RV-PA conduit stenosis in our patient. However, one should remember that a low gradient alone may be falsely reassuring because contractile failure prevents generation of typical expected high pressure gradients. Short of exit angiography (not always feasible in the operating room), the etiology for primary RV failure after the Ross procedure may need to be solely based on surgical exploration.

A postoperative patient who cannot be separated from mechanical support has a high incidence of residual treatable lesion that must be identified; this frequently requires invasive evaluation.[2] During cardiac catheterization, the operator must be aware that stenotic lesions may not produce the typical high obstructive gradients and angiography can be challenging. In such situations, balloon sizing of the lesion can prove extremely beneficial; the goal is to inflate a compliant balloon at very low pressure so that the balloon takes the shape of the anatomy and delineates the stenotic area.

The decision for surgical versus transcatheter intervention is typically institution and patient specific. If transcatheter intervention is chosen, the catheterization team must immediately ensure availability of cardiopulmonary support (if not already supported), surgical and ideally multidisciplinary consultation, and onsite surgical backup for procedural success and patient safety. From our experience and based on the published literature, the safest and most effective treatment for postoperative vascular stenosis is stent implantation rather than balloon angioplasty alone.[3,4] Furthermore, as balloon sizing showed a very compliant lesion, balloon angioplasty alone was unlikely to provide sustained relief. The technique described by Stumper *et al.*[1] requires a large introducer to accommodate both the angioplasty catheters and additional 2–3 Fr sizes for the stent. Using a catheter instead of the second balloon allows for reduction in sheath size and access to perform sequential bifurcation stenting.

Although we had a good result, it is prudent to point out that evaluation for coronary and graft patency as well as testing for coronary compression is to be strongly encouraged because coronary compression can have catastrophic consequences.

This case report describes the importance of considering acute RV afterload as a cause for isolated RV failure after the Ross operation. As with any case report, the approach and treatment of our patient cannot be generalized, but the diagnostic pitfalls, the importance of invasive evaluation, and, finally, the potential for successful transcatheter intervention across a fresh suture line using a modified previously described technique will serve as a clinical vignette.

Acknowledgement

None.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Stumper O, Bhole V, Anderson B, Reinhardt Z, Noonan P, Mehta C. A novel technique for stenting pulmonary artery and conduit bifurcation stenosis. Catheter Cardiovasc Interv 2011;78:419-24.
2. Feltes TF, Bacha E, Beekman RH, 3rd, Cheatham JP, Feinstein JA, Gomes AS, *et al.* Indications for cardiac catheterization and intervention in pediatric cardiac disease: A scientific statement from the American Heart Association. Circulation 2011;123:2607-52.
3. Nicholson GT, Kim DW, Vincent RN, Petit CJ. Transcatheter interventions across fresh suture lines in infants and children: An 8-year experience. Catheter Cardiovasc Interv 2015;86:271-7.
4. Nicholson GT, Kim DW, Vincent RN, Kogon BE, Miller BE, Petit CJ. Cardiac catheterization in the early post-operative period after congenital cardiac surgery. JACC Cardiovasc Interv 2014;7:1437-43.