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Case Report

Premature Balloon Rupture During Stent Implantation for Aortic Re-Coarctation - Nightmare Case

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Abstract

Coarctation of the aorta is a congenital heart defect (CHD) consisting of narrowing of the descending aorta and comprises 5 to 8% of all CHDs. Native coarctations are treated either with surgery or balloon angioplasty depending upon on the age at which they present and institutional preferences. Re-coarctations occur both with surgical and balloon therapy. Both post-surgical and post-balloon re-coarctations in adolescents and adults are largely dealt with stent implantation across the re-coarctation site. In this report we present a case in which the balloon ruptured during the stent implantation with resultant non-expansion of the stent. This case report consists of how to address such a complication. The objective is to implant the stent at the intended site and such objective was achieved in this case and details of the procedure were enumerated. The conclusion was that the interventionalist should take every effort to place the stent at the intended site and that this complication is unlikely to occur following the use of BIB catheters to implant stents.

Keywords: *Coarctation of the Aorta; Stent; Balloon Rupture; Balloon Angioplasty*

Introduction

Coarctation of the aorta is a congenital anomaly of the heart in which obstruction to blood flow in the descending aorta occurs. It consists of narrowed aortic segment with localized medial thickening and enfolding of the media and superimposed neointimal tissue [1-3]. A shelf-like structure or a membranous curtain-like structure may be seen with either an eccentric or a central opening. The prevalence of coarctation is in the order of 5 to 8% of children born with congenital heart disease. Although there are differences in institutional practices, surgical repair in neonates and infants, balloon angioplasty in children and stent deployment in adolescents and adults has become a standard practice in the management of native aortic coarctation [2-8]. Aortic re-coarctations following surgery in children, however are commonly addressed with balloon angioplasty [9-13] while such re-coarctation in adolescents and adults are treated with stents [2,7,14-17]. In this report, the author presents a nightmare case which was encountered while attempting to implant a stent in a teenager with aortic re-coarctation and how it was resolved.

Case Report

A sixteen-year-old teenager underwent cardiac catheterization and selective cine-angiography preparatory to stent implantation for aortic re-coarctation.

History

This teenager was found to have severe aortic coarctation at the age of 10 days and underwent surgical repair at that time with subclavian flap angioplasty procedure. He improved clinically and was followed by periodic clinical evaluation. At the age 8 years, severe valvar aortic stenosis developed requiring surgical aortic valvotomy. He was again followed clinically; at the age of 12 years, subaortic membranous stenosis of severe degree was diagnosed by the primary cardiologist. Cardiac catheterization and selective cineangiography revealed subaortic membrane with a peak-to-peak systolic pressure gradient of 82 mmHg. There was a 15-mmHg peak-to-peak gradient across the site of coarctation repair without significant angiographic narrowing. Balloon angioplasty of subaortic membrane was performed as described previously [18] and the peak gradient was reduced from 82 mmHg to 32 mmHg. The coarctation gradient did not change. Periodic clinical evaluation along with echo-Doppler studies continued. At the age of 16 years, he complained of exercise intolerance and echo-Doppler evaluation revealed 25 mmHg gradient across the left ventricular outflow tract and 36 mmHg peak-to-peak gradient across the re-coarctation site.

Cardiac catheterization

Right and left heart catheterization was performed percutaneously with the intent to evaluate his hemodynamic status and to consider for stent implantation across the aortic re-coarctation site. No intracardiac shunts were detected. The right heart pressures were normal with no evidence for any gradient across the mitral valve. A 25-mmHg peak-to-peak gradient was recorded across the left ventricular outflow tract (subaortic ridge and aortic valve). There was also a 28-mmHg peak-to-peak gradient across the site of aortic re-coarctation. Left ventricular angiography revealed a small subvalvar muscular ridge and thickened aortic valve leaflets with minimal doming. Aortography (Figure 1) reveled aortic re-coarctation; the coarcted segment measured 10 mm and the aorta proximal to the coarctation segment measured 19.6 mm while the descending aorta distal to the coarctation site measured 22 mm. It was concluded that there is no need to intervene to address left ventricular our flow tract obstruction since the gradient was low (25 mmHg) but, enlargement of the re-coarcted aortic segment may be beneficial. Stent implantation across the re-coarcted aortic segment was contemplated.

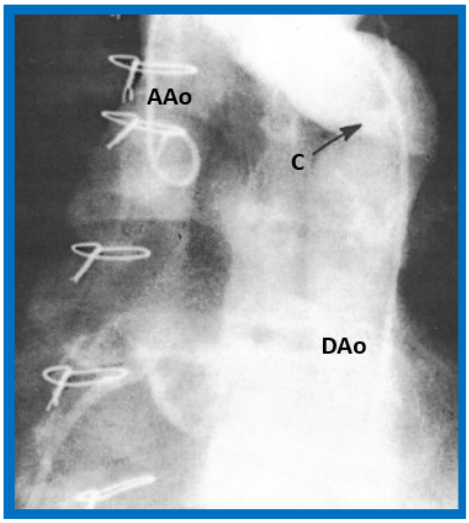

Figure 1: *Selected cine-angiographic frame of an aortogram in 30^0 left anterior projection showing coarctation segment (C) (arrow). The visualization of coarcted segment is partially blocked by the dilated aorta. Sternal wires related to past surgery were seen, but not labelled. Tip of the pigtail catheter is seen in the ascending aorta (AAo). DAo: Descending Aorta.*

Stent implantation procedure

Initially, a 0.035", extra-stiff, J-tipped, Amplatz guide wire (Cook, Bloomington, IN) was positioned deep into the right subclavian artery with the aid of a #5F right coronary artery (RCA) catheter (Cordis, Miami Lakes, FL). Once the guidewire was in place, the RCA catheter was removed. The femoral arterial sheath used for the diagnostic study was replaced with a 9F blue Cook sheath (Cook Medical, Bloomington, IN) with a radio-opaque marker at its tip over the extra-stiff, J-tipped, Amplatz guide wire already in place. The tip of the sheath was initially positioned proximal to the coarcted aortic segment. A 30 mm-long Palmaz stent (Cordis Endovascular, Mokena, IL) was hand-crimped onto a 22-mm diameter, 4-cm long balloon of a balloon angioplasty catheter (Meditech, Natick, MA). An umbilical tape was used to finish crimping onto the balloon. The stent/balloon assembly was slowly eased across the valve of the 9F sheath to prevent inadvertent displacement of the stent from the balloon and then advanced up to the tip of the sheath. The stent was held in place and the sheath was slowly withdrawn to uncover the stent and the tip of the radio-opaque sheath is positioned distal to the site of coarctation, resulting in positioning the stent across the coarctation segment (Figure 2). A test angiogram via the side arm of the sheath confirmed good position of the stent. The procedure of stent implantation was similar that described in the author's prior publications [7,19].

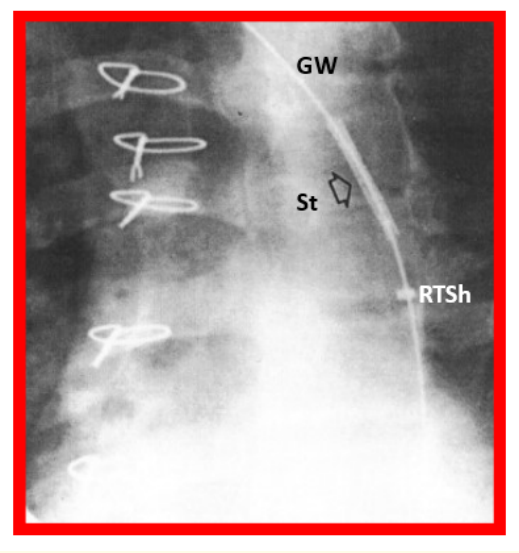

Figure 2: *Selected cine-radiographic frame in 30^0 left anterior projection showing position of the unexpanded stent (St) across the coarctation segment. Sternal wires related to past surgery were seen, but not labelled. GW: Guidewire; RTSh: Radio-Opaque Tip of the Sheath.*

Failure of stent expansion

The balloon was inflated with the intent of implanting the stent across the coarctation site. No stent expansion was observed on fluoroscopy; the contrast material appears to leak out. Presumably, the balloon on which the stent was mounted has ruptured.

Rescue

Initially attempts were made to withdraw the stent/balloon assembly into the sheath. This was not possible, presumably related to slight flaring of the lower end of the stent. Then, forceful inflation of the balloon was undertaken which resulted in only minimal additional flaring of the lower end of the stent. With some manipulation, the balloon catheter was extricated out of the stent and then out of the

patient. During this process the stent was held in place over the wire with support at its lower end with tip of the sheath. The extracted balloon was inspected and the balloon material was found intact, but torn. A 6-mm-diameter, 2-cm-long Meditech balloon catheter (Meditech, Natick, MA) was introduced over the wire, but through the sheath and positioned in the lower two-thirds of the stent and the balloon was inflated. This resulted in expansion of the lower half of the stent (Figure 3).

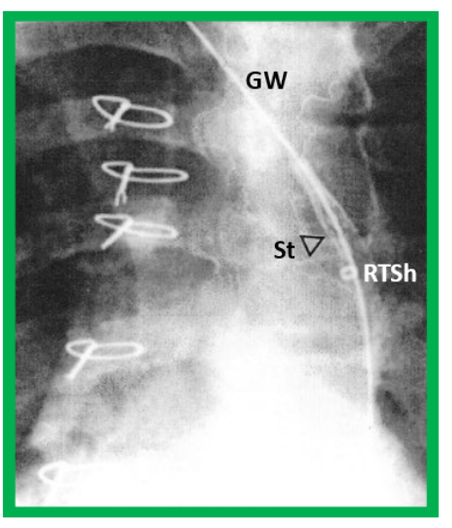

Figure 3: *Selected cine-radiographic frame in 30⁰ left anterior projection showing the position of the partially expanded stent (St) (arrowhead) following dilatation with a 6-mm-diameter balloon. Sternal wires related to past surgery were seen, but not labelled. GW: Guidewire; RTSh: Radio-Opaque Tip of the Sheath.*

Another 22-mm diameter, 4-cm long balloon of a balloon angioplasty catheter (Meditech) was advanced through the stent and the balloon was inflated. Again, this balloon ruptured before full expansion of the stent (Figure 4).

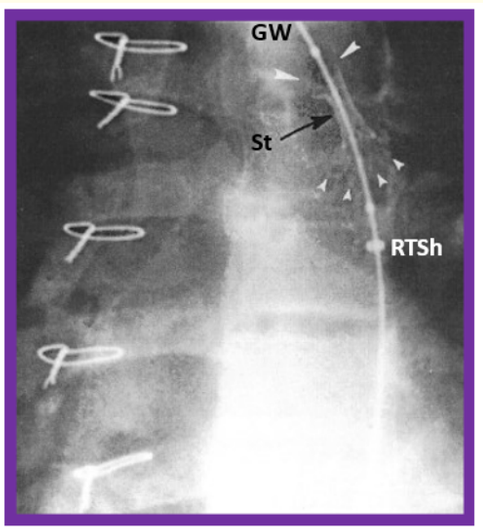

Figure 4: *Selected cine-radiographic frame in 30⁰ left anterior projection showing position of the partially expanded stent (St) (arrow) following attempted dilatation with a 22-mm-diameter balloon. There was minimal expansion of the upper part of the St (large arrowheads) while there was a greater dilatation of the lower end of the St (small arrowheads). Sternal wires related to past surgery were seen, but not labelled. GW: Guidewire; RTSh: Radio-Opaque Tip of the Sheath.*

After failure to achieve satisfactory results with the 22-mm balloon, an 18-mm-diameter XXL balloon (Meditech) was introduced and placed across the entire length of the stent and the balloon was inflated; this resulted in complete expansion of the stent (Figure 5A). The stent was further expanded with a 22-mm-diameter, 6-cm long balloon (Figure 5B) resulting in an excellent relief of aortic re-coarctation (Figure 6).

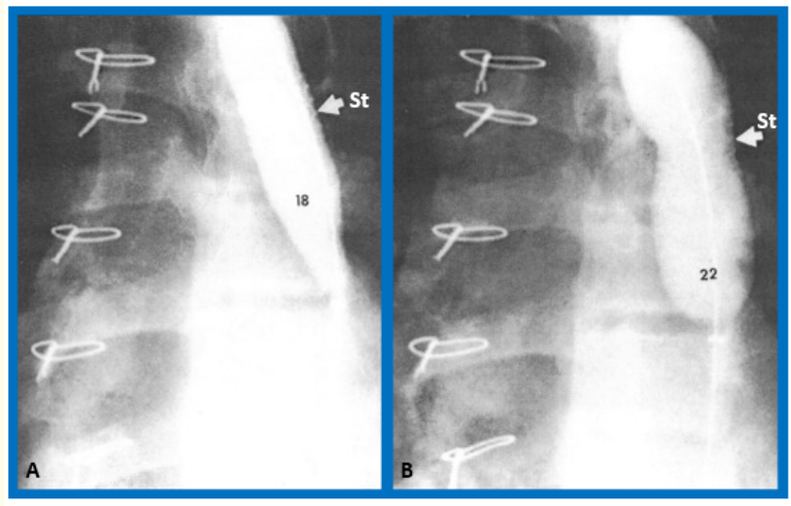

Figure 5: *Selected cine-radiographic frame in 30⁰ left anterior projection showing the position of the expanded stent (St) (arrow) following dilatation with an 18-mm-diameter balloon. B. Selected cine-radiographic frame in 30⁰ left anterior projection showing position of the expanded stent (St) (arrow) following dilatation with a 22-mm-diameter balloon. Both images show complete expansion of the St (arrowheads). Numbers "18" and "22" indicate the size of balloon used to dilate the St. Sternal wires related to past surgery were seen, but not labelled.*

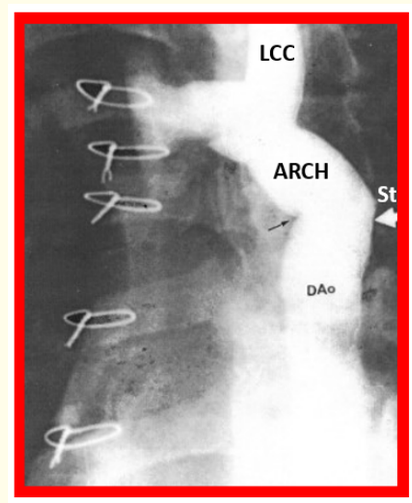

Figure 6: *Selected cine-angiographic frame in 30⁰ left anterior projection showing position of the fully expanded stent (St) (large white arrow) following dilatation with an 18- and then a 22-mm-diameter balloon, as shown in figure 5. There was a full expansion of the St (large white arrow). The small black arrow points to the junction aortic arch (ARCH) with the descending aorta (DAo). Sternal wires related to past surgery were seen, but not labelled. There is no visualization of the left subclavian artery; this is related prior subclavian flap surgery during infancy. LCC: Left Common Carotid Artery.*

Following the completion of the procedure, as described above, there is angiographic improvement (Figure 6). On a pressure pullback tracing, there was only a 4-mmHg peak-to-peak gradient across the arch, stent and descending aorta. Follow-up echo-Doppler studies on the day following the procedure and at 3 months after the procedure revealed no Doppler evidence of residual obstruction across the aortic arch, stent and the descending aorta. The patient also did not have symptoms of exercise intolerance that he had prior to the procedure.

Discussion

A number complications including rupture of the aorta [20], stent displacement [20-23], balloon rupture [21,24,25], stent fracture [26], and aneurysm formation [24,27] have been reported during the procedure of stent implantation, but fortunately, these complications are infrequent. In the series from the Congenital Cardiovascular Interventional Study Consortium (CCICS) database [28], successful stenting of coarctation was reported in 98.6% (580 out of 588) patients. Complications occurred in 11.7% cases. Significant complications in this series were aneurysms (2.2%), aortic dissection (1.5%), stroke (1%), femoral vessel injury (2.6%), and death in 0.3%. In the author's own personal experience with stent deployment in 75 consecutive patients during a six-year period, complications that occurred included balloon rupture in 8% and stent displacement in 4%; these complications were reduced (14% vs. 8%) following the introduction of more flexible (less rigid) stents [29,30].

The description of the procedure in the section titled "Rescue" illustrates how balloon rupture resulting in non-expansion of the stent was addressed. First and foremost, don't panic. Second, keep the stent on the guidewire. Forceful balloon inflation of the balloon was attempted, but that was not effective; such procedure seems to be effective in small-balloon stents such as coronary stents. The prime objective is to implant the stent at the intended site as described above and is the most desirable outcome. If that is not possible, implantation of the stent in the iliac artery or in the descending aorta below the level of renal arteries is another way of getting out of trouble. At the present time we use balloon-in-balloon (BIB) catheters (NuMed, Hopkinton, NY) for stent implantation and since using BIB catheters to implant the stents, the author has not encountered balloon rupture or any other stent-related complications [7,17,19,30].

Summary and Conclusion

Coarctation of the aorta is a relatively common congenital heart defect comprising 5 to 8% of all congenital heart anomalies. The treatment of coarctation is largely dependent on the age at presentation (neonates, infants, children, adolescents, and adults) and the type of coarctation (native or post-surgical or post-balloon angioplasty re-coarctation). Stenting has emerged as the treatment of choice for aortic re-coarctations in adolescents and adults. The case presented illustrates balloon rupture resulting in non-expansion of the stent and how such a complication was managed with the final result of stent implantation at the intended site. It was concluded that every effort should be made to implant the stent at the intended site and that the described type of complication is likely to be eliminated following the introduction of BIB catheters to implant stents.

Bibliography

1. Rao PS. "Coarctation of the aorta". In: Secondary Forms of Hypertension, Ram CVS (ed), Seminars in Nephrology, Kurtzman NA (ed), W.B. Saunders, Philadelphia, PA 15.2 (1995): 81-105.

2. Rao PS. "Coarctation of the aorta". *Current Cardiology Reports* 7.6 (2005): 425-434.

3. Rao PS. "Coarctation of the aorta". Medscape Reference (2018).

4. Tynan M., *et al*. "Balloon angioplasty for treatment of native coarctation: Results of Valvuloplasty and Angioplasty of Congenital Anomalies Registry". *American Journal of Cardiology* 65.11 (1990): 790-792.

5. Rao PS. "Balloon angioplasty of native aortic coarctation". In. Rao PS (ed): Transcatheter Therapy in Pediatric Cardiology, Wiley-Liss, New York, NY (1993): 153-196.

6. Rao PS. "Should balloon angioplasty be used instead of surgery for native aortic coarctation? (Editorial)". *British Heart Journal* 74.6 (1995): 578-579.

7. Rao PS. "Stents in the management of congenital heart disease in the pediatric and adult patients". *Indian Heart Journal* 53.6 (2001): 714-730.

8. Forbes TJ., *et al*. "Comparison of surgical, stent, and balloon angioplasty treatment of native coarctation of the aorta: an observational study by the CCISC (Congenital Cardiovascular Interventional Study Consortium)". *Journal of the American College of Cardiology* 58.25 (2011): 2664-2674.

9. Kan JS., *et al*. "Treatment of restenosis of coarctation by percutaneous transluminal angioplasty". *Circulation* 68.5 (1983): 1087-1094.

10. Rao PS. "Balloon angioplasty of aortic recoarctation following previous surgery". In: Rao PS (ed): Transcatheter Therapy in Pediatric Cardiology, Wiley-Liss, New York, NY (1993): 197-212.

11. Rao PS., *et al*. "Immediate and follow-up results of balloon angioplasty of postoperative recoarctation in infants and children". *American Heart Journal* 120.6 (1990): 1315-1320.

12. Siblini G., *et al*. "Long-term follow-up results of balloon angioplasty of postoperative aortic recoarctation". *American Journal of Cardiology* 81.1 (1998): 61-67.

13. Reich O., *et al*. "Long-term (up to 20 years) results of percutaneous balloon angioplasty of recurrent aortic coarctation without use of stents". *European Heart Journal* 29.16 (2008): 2042-2048.

14. Diethrich EB., *et al*. "Endovascular techniques in adult aortic coarctation: The use of stents for native and recurrent coarctation repair". *Journal of Endovascular Surgery* 2.2 (1995): 183-188.

15. Harrison DA., *et al*. "Endovascular stents in the management of coarctation of the aorta in the adolescent and adult: One year follow up". *Heart* 85.5 (2001): 561-566.

16. Erdem A., *et al*. "Cheatham-Platinum stent for native and recurrent aortic coarctation in children and adults: Immediate and early follow-up results". *Anadolu Kardiyoloji Dergisi* 11.5 (2011): 441-449.

17. Rao PS. "Percutaneous management of aortic coarctation". In. Vijayalakshmi IB, Ed. Cardiac Catheterization and Imaging (From Pediatrics to Geriatrics), Jaypee Publications, New Delhi, India (2015): 433-471.

18. Rao PS., *et al*. "Balloon dilatation for discrete subaortic stenosis: Immediate and intermediate-term results". *Journal of Invasive Cardiology* 2.2 (1990): 65-71.

19. Sahu R and Rao PS. "Transcatheter stent therapy in children: An update". *Pediatrics and Therapeutics* 1.S5 (2012): 001.

20. Suarez de Lezo J., *et al*. "Balloon expandable stent repair of severe coarctation of the aorta". *American Heart Journal* 129.5 (1995): 1002-1008.

21. Magee AG., *et al*. "Stent implantation for aortic coarctation and re-coarctation". *Heart* 82.5 (1999): 600-606.

22. Hamdan MA., *et al*. "Endovascular stents for coarctation of the aorta: Initial results and intermediate-term follow-up". *Journal of the American College of Cardiology* 38.5 (2001): 1518-1523.

23. Amirghofran AA., *et al*. "A wandering stent in the ascending aorta". *Journal of Cardiovascular Medicine (Hagerstown)* 9.9 (2008): 969-970.

24. Thanopoulos B., *et al*. "Long segment coarctation of the aorta: Treatment with multiple balloon-expandable stent implantation". *American Heart Journal* 133.4 (1997): 470-473.

25. Marshall AC., *et al*. "Early results and medium-term follow-up of stent implantation for mild residual or recurrent aortic coarctation". *American Heart Journal* 139.6 (2000): 1054-1060.

26. Rohit MK., *et al*. "Stent fracture after stent therapy for aortic coarctation: Nightmares in invasive cardiology". *Indian Heart Journal* 59.1 (2007): 77-79.

27. Suarez de Lezo J., *et al*. "Immediate and follow-up findings after stent treatment for severe coarctation of the aorta". *American Journal of Cardiology* 83.3 (1999): 400-406.

28. Golden AB and Hellenbrand WE. "Coarctation of the aorta: Stenting in children and adults". *Catheterization and Cardiovascular Interventions* 69.2 (2007): 289-299.

29. Rao PS., *et al*. "Clinical comparison of rigid with flexible stents in the management of vascular obstructive lesions in children". Poster Presentation at the Annual Scientific Meeting of Society of Cardiac Angiography and Interventions, May, 2003. Catheterization and Cardiovascular Interventions 59 (2003): 153.

30. Rao PS. "Stents". In. Rao PS. Pediatric Cardiology: How It Has Evolved Over The Last 50 Years. Cambridge Scholars Publishing, New Castle upon Tyne, ISBN 13: 9781527548886 (2020): 510-559.

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