Redo Aortic Surgery

Joseph S. Coselli, MD
The Texas Heart Institute at St. Luke's Episcopal Hospital and the Division of Cardiothoracic Surgery, Baylor College of Medicine, Houston, Texas

Over the last half-century, outcomes of aortic surgery have continuously improved. Refined strategies and new surgical techniques have increased patients' chances of surviving an aortic repair. Contemporary results for many types of elective aortic repair are outstanding. In 2009, Brown and colleagues reported national outcomes of isolated aortic valve replacement in 108,687 patients, and toward the latter part of their reporting period, the overall mortality rate was 2.6%. At specialized centers, outcomes of isolated aortic valve replacement are even better; for example, Malaisrie and colleagues reported no early deaths in a contemporary series of 190 patients. Outcomes of aortic root replacement and composite valve graft (CVG) replacement procedures have similarly improved, with mortality rates ranging from 0 to 8%. Factors generally understood to increase operative risk are emergency repair and acute aortic dissection.

Patients with completed aortic repair face continued challenges because there is an incomplete understanding of how and why aortic disease progresses. Life-long imaging and surveillance are needed to detect any late aortic events. New aneurysms may form in previously healthy aortic tissue or result from dilatation in previously dissected and weakened aortic tissue. Because late complications of primary aortic repair may occur months to years after the operation, it is difficult to assess the incidence of late complications that necessitate reoperation. Factors to include in such an assessment are the number of primary aortic repairs, the number of late complications detected through surveillance protocols, and the number of deaths that may have resulted from undetected late complications.

Over the years, as surgical experience has accumulated, techniques have been refined not only to improve early survival but also to reduce the risk of late aortic complications. An example of this is the refinement of the original 1968 Bentall procedure for replacing the aortic valve and varying portions of ascending aorta with a composite mechanical valve and Dacron graft. In this procedure, an inclusion technique was used in which the distal aortic anastomosis was performed inside the intact aorta, and the aortic wall was then wrapped around the replacement graft. The ostia of the coronary arteries were then attached side-to-end to the wrapped proximal aorta. Although the Bentall procedure revolutionized aortic root repair, with sufficient patient-observation years, it became clear that excessive tension on the coronary arteries could cause them to pull away from the graft, promoting aneurysm formation in the wrapped aortic section. Pseudoaneurysm and frank dehiscence of the coronary arteries were also reported by numerous surgeons. In 1981, Cabrol and colleagues modified this technique by interpositioning a short, small-diameter graft between the coronary arteries and the ascending aorta replacement graft. However, the Cabrol procedure was also associated with coronary artery pseudoaneurysm formation. In 1991, Kouchoukos and colleagues described an open button technique of coronary artery reattachment during CVG insertion. This technique, which its inventors associated with reduced coronary artery pseudoaneurysm, has become the dominant mode of coronary artery reattachment. Other techniques of coronary attachment may be needed, especially during redo aortic root repair, when it may not be possible to isolate the coronary arteries on buttons of tissue. Also, the use of interposition grafts or saphenous veins is not uncommon in redo CVG repair.

Indications for Redo Proximal Aortic Repair

Pseudoaneurysms may form, not only in the coronary arteries, but also at any suture line, particularly in patients with uncontrolled hypertension, which over time places additional stress on anastomoses. Another indication for redo proximal aortic repair is the formation of aneurysms just distal to the previously replaced graft or distal to isolated aortic valve replacement. In the most recent guidelines for the diagnosis and treatment of patients with thoracic aortic disease, the threshold for proximal aortic repair has been lowered to 4.5 cm (from 5.5 cm) in patients undergoing concomitant aortic valve repair or replacement.

Additional indications for redo proximal aortic repair include infection (eg, endocarditis), degeneration, failure of valve-sparing root replacement procedures, and acute aortic dissection. In a review of 6 contemporary reports of “true” aortic root reoperations, preoperative infection rates ranged from 35 to 73%. Infection is usually treated by administering intravenous antibiotics, removing the infected CVG, and replacing it with either another CVG or a homograft. In our previously reported experience, we found that patients who received a homograft were more likely to survive the infection; additionally, we reported the successful treatment of a patient’s infected CVG with only antibiotics and a pedicled omental flap. Of note, a few contemporary studies have shown that preoperative infection does not increase operative risk in redo repairs, whereas other studies show increased operative risk. Late degeneration of an aortic root repair may occur, particularly if a homograft, biologically-valved CVG, or bioroot is used. It is estimated that 30% of homografts will need redo repair within 12 years, and the long-term durability of bioprostheses remains unclear. As for valve-sparing approaches, in our collaborative outcomes study of 252 patients with Marfan syndrome, 1 patient required reoperation because of a kinked coronary artery. However, it should be noted that these patients are quite young, with an average age of 33 years, and it is possible that the need for late reoperation may present as these patients age.

Contemporary Outcomes of Redo Proximal Aortic Repair

Regarding the previously mentioned contemporary reports of “true” aortic root reoperation, early mortality ranged from 0 to 9%, stroke rates ranged from 2 to 12%, and rates of heart block necessitating the placement of a pacemaker ranged from 13 to 19%. Additionally, contemporary single-center comparisons between redo proximal operations and primary proximal operations were reviewed. In Etz and colleagues’ 2008 report, reoperative proximal root procedures had a higher hospital mortality (7%) than did primary root/ascending aortic procedures (3%) [$P = 0.07$]. Similarly, Silva and colleagues found that reoperative proximal root procedures were associated with higher hospital mortality (12.1%) than primary root/ascending aortic procedures (6.8%) [$P = 0.18$]. Although neither of these differences was statistically significant, the trend toward higher mortality rates in redo proximal aortic repair is not unexpected because reoperation is inherently more complicated, partly by the risk of rupture or other bleeding complication when the chest is re-entered.

Reducing the Need for Late Redo Aortic Repair

There is great interest in understanding the natural history of survivors of proximal aortic repair, because such an understanding would enable us to improve technical aspects of the primary repair so as to reduce the need for late redo aortic repair. Currently, there is considerable controversy regarding whether the proximal aorta should be resected at an earlier stage in patients with bicuspid aortic valve (BAV) than in patients with tricuspid aortic valve. Studies by Yasuda and colleagues indicate that after an isolated BAV replacement, the ascending aorta continues to expand. Similarly, Borger and colleagues found worse outcomes in BAV patients with ascending aortic diameters between 4.5 and 4.9 cm who underwent isolated valve replacement; the freedom from future aortic complications (aneurysm, dissection, or sudden death) was 43 ± 15% at 15 years, which was roughly half of what could be expected for BAV patients with ascending aortic diameters less than 4.0 cm. Recently published guidelines for the diagnosis and treatment of thoracic aortic disease indicate that patients with a BAV (including those who have previously undergone aortic valve replacement) are at heightened risk for thoracic aortic disease. In asymptomatic patients with degenerative thoracic aneurysm, these guidelines suggest lowering the threshold for repair from the standard 5.5-cm aortic diameter threshold used in most asymptomatic patients to between 4.0 to 5.0 cm, depending on conditions, to avoid acute aortic dissection or rupture.

Another significant challenge in repairing an acute aortic dissection is preventing the need for a redo aortic repair. Reporting on their 20-year experience with aortic dissection, DeBakey and colleagues found that late aneurysms developed in 30% of patients with type I dissection, as compared to only 14% of patients with type II dissection. Many clinicians believe that extending the primary repair of a DeBakey type I dissection to include full arch replacement—which, ideally, would remove the originating dissecting tear—is worth the increased risk of death, stroke, and other complications during the primary repair because it will reduce the likelihood of late aortic complications. Proponents of this approach, such as Urbanski, argue that the added risk during the primary repair is minimal because there have been many recent improvements in cannulation and circulatory arrest with moderate hypothermia. Additionally, extending the repair into the arch may facilitate thrombosis of the distal false lumen. As a result, patients should expect more than survival; they should also expect freedom from reoperation. This is particularly true for young patients with connective tissue disorders. Opponents of this approach, such as Geirsson, state that it unnecessarily increases operative risk during the primary repair and that most persons with connective tissue disorders are not diagnosed until after acute dissection occurs. They also argue that the variation in patients selected for extended repair makes its success difficult to determine. Additional strategies to prevent redo repair in survivors of acute proximal aortic dissection include hybrid elephant trunk procedures; this technique combines classic elephant trunk repair with endovascular antegrade or retrograde deployment of a stent-graft into the elephant trunk, hanging within the descending thoracic aorta, to prevent late aneurysmal expansion. This approach is off-label, and its use as a prophylactic repair, rather than as a secondary repair once an aneurysm develops, is somewhat controversial.

Suggested Reading

1. Bachet J, Pirotte M, Laborde F, Guilmet D. Reoperation for giant false aneurysm of the thoracic aorta: how to reenter the chest? Ann Thorac Surg 2007;83:1610-4.
2. Bentall H, De Bono A. A technique for complete replacement of the ascending aorta. Thorax 1968;23:338-9.
3. Borger MA, Preston M, Ivanov J, et al. Should the ascending aorta be replaced more frequently in patients with bicuspid aortic valve disease? J Thorac Cardiovasc Surg 2004;128:677-83.
4. Brown JM, O'Brien SM, Wu C, Sikora JA, Griffith BP, Gammie JS. Isolated aortic valve replacement in North America comprising 108,687 patients in 10 years: changes in risks, valve types, and

outcomes in the Society of Thoracic Surgeons National Database. J Thorac Cardiovasc Surg 2009;137:82-90.
5. Cabrol C, Pavie A, Gandjbakhch I, et al. Complete replacement of the ascending aorta with reimplantation of the coronary arteries: new surgical approach. J Thorac Cardiovasc Surg 1981;81:309-15.
6. Crawford ES, Coselli JS, Safi HJ. Treatment dissection of ascending aorta and aortic arch based upon a study of patients requiring reoperation. Contemporary Surgery 1986;29:13-31.
7. Crawford ES, Crawford JL, Safi HJ, Coselli JS. Redo operations for recurrent aneurysmal disease of the ascending aorta and transverse aortic arch. Ann Thorac Surg 1985;40:439-55.
8. Dapunt OE, Easo J, Holzl PP, et al. Stentless full root bioprosthesis in surgery for complex aortic valve-ascending aortic disease: a single center experience of over 300 patients. Eur J Cardiothorac Surg 2008;33:554-9.
9. DeBakey ME, McCollum CH, Crawford ES, et al. Dissection and dissecting aneurysms of the aorta: twenty-year follow-up of five hundred twenty-seven patients treated surgically. Surgery 1982;92:1118-34.
10. Etz CD, Plestis KA, Homann TM, et al. Reoperative aortic root and transverse arch procedures: a comparison with contemporaneous primary operations. J Thorac Cardiovasc Surg 2008;136:860-7, 867 e1-3.
11. Geirsson A. Extended arch resection in acute type A aortic dissection: CON. Cardiol Clin 2010;28:343-7.
12. Hahn C, Tam SK, Vlahakes GJ, Hilgenberg AD, Akins CW, Buckley MJ. Repeat aortic root replacement. Ann Thorac Surg 1998;66:88-91.
13. Hiratzka LF, Bakris GL, Beckman JA, et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the diagnosis and management of patients with thoracic aortic disease. A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine. J Am Coll Cardiol 2010;55:e27-e129.
14. Joudinaud TM, Baron F, Raffoul R, et al. Redo aortic root surgery for failure of an aortic homograft is a major technical challenge. Eur J Cardiothorac Surg 2008;33:989-94.
15. Kouchoukos NT, Wareing TH, Murphy SF, Perrillo JB. Sixteen-year experience with aortic root replacement: results of 172 operations. Ann Surg 1991;214:308-20.
16. LeMaire SA, DiBardino DJ, Köksoy C, Coselli JS. Proximal aortic reoperations in patients with composite valve grafts. Ann Thorac Surg 2002;74:S1777-80.
17. LeMaire SA, Green SY, Sharma K, et al. Aortic root replacement with stentless porcine xenografts: early and late outcomes in 132 patients. Ann Thorac Surg 2009;87:503-13.
18. Malaisrie SC, McCarthy PM, McGee EC, et al. Contemporary perioperative results of isolated aortic valve replacement for aortic stenosis. Ann Thorac Surg 2010;89:751-6.
19. Malvindi PG, van Putte BP, Heijmen RH, Schepens MA, Morshuis WJ. Reoperations on the aortic root: experience in 46 patients. Ann Thorac Surg 2010;89:81-6.
20. Milewski RK, Jassar AS, Pochettino A, et al. The reoperative aortic root: degenerative failure vs. infectious destruction—outcomes of the “true redo-root” reconstruction. Aortic Surgery Symposium 2010, New York, NY, April 29-30, 2010.
21. Moorjani N, Modi A, Mattam K, et al. Aortic root replacement using a biovalsalva prosthesis in comparison to a "handsewn" composite bioprosthesis. J Card Surg 2010;25:321-6.
22. Murzi M, Tiwari KK, Farneti PA, Glauber M. Might type A acute dissection repair with the addition of a frozen elephant trunk improve long-term survival compared to standard repair? Interact Cardiovasc Thorac Surg 2010;11:98-102.
23. Raanani E, David TE, Dellgren G, Armstrong S, Ivanov J, Feindel CM. Redo aortic root replacement: experience with 31 patients. Ann Thorac Surg 2001;71:1460-3.
24. Schepens MA, Dossche KM, Morshuis WJ. Reoperations on the ascending aorta and aortic root: pitfalls and results in 134 patients. Ann Thorac Surg 1999;68:1676-80.
25. Shrestha M, Khaladj N, Baraki H, et al. Aortic root reoperation: a technical challenge. J Heart Valve Dis 2010;19:177-81.

26. Silva J, Maroto LC, Carnero M, et al. Ascending aorta and aortic root reoperations: are outcomes worse than first time surgery? Ann Thorac Surg 2010;90:555-60.
27. Szeto WY, Bavaria JE, Bowen FW, et al. Reoperative aortic root replacement in patients with previous aortic surgery. Ann Thorac Surg 2007;84:1592-9.
28. Uchida N, Katayama A, Tamura K, et al. Long-term results of the frozen elephant trunk technique for extended aortic arch disease. Eur J Cardiothorac Surg 2010;37:1338-45.
29. Urbanski PP, Heinz N, Zhan X, Hijazi H, Zacher M, Diegeler A. Modified bio-Bentall procedure: 10-year experience. Eur J Cardiothorac Surg 2010;37:1317-21.
30. Urbanski PP, Lenos A, Schmitt R, Diegeler A. Extended arch resection in acute type A aortic dissection: PRO. Cardiol Clin 2010;28:335-42.
31. Volguina IV, Miller DC, LeMaire SA, et al. Valve-sparing and valve-replacing techniques for aortic root replacement in patients with Marfan syndrome: analysis of early outcome. J Thorac Cardiovasc Surg 2009;137:1124-32.
32. Yasuda H, Nakatani S, Stugaard M, et al. Failure to prevent progressive dilation of ascending aorta by aortic valve replacement in patients with bicuspid aortic valve: comparison with tricuspid aortic valve. Circulation 2003;108 Suppl 1:II291-4.