The Use of an Intraluminal Aortic Ring for Treatment of Diseases of the Aorta: 13-Year Experience

Luciano Matar Miranda, Fernando Antonio Roquette Reis Filho, Luiz Cláudio Moreira Lima, Ernesto Lentz da Silveira Monteiro, Rodrigo Gil Guimarães, Wanderbilt Duarte de Barros Neto, Jefferson Francisco de Oliveria, Charles Da Silva Pires, Dirceu De Queiroz Amaral, and Rodrigo De Castro Bernardes

From Heart Institute of Madre Teresa Hospital, Belo Horizonte, MG, Brazil

Surgical management of aortic disease usually is followed by high rates of morbidity/mortality. The patient who is elderly and debilitated and often with changes in various organs and systems caused by the acute disease itself presents the most serious challenge. Conventional surgery requires complex coadjuvant techniques such as prolonged cardiopulmonary bypass (CPB), deep hypothermia, total circulatory arrest with prolonged aortic cross-clamping time. In 1988, in an attempt to reduce the surgical aggression on a feeble patient, we developed an intraluminal ring.[1,2] The intraluminal ring we developed resulted in a marked decrease in operative time, CPB time, and aortic clamping. It often eliminated the need for deep hypothermia resulting in easy, rapid, safe, and hemostatic anastomosis. From March 1988 to March 2001, 706 patients underwent surgical treatment of dissections or aneurysms of the aorta at our institute. The intraluminal ring with anastomosis was used in 378 patients. Five hundred sixty rings were used. Diseases included type A acute aortic dissection (149), type B acute aortic dissection (38), ascending aortic aneurysms (90), aortic arch aneurysms (10), descending aortic aneurysms (31), thoracoabdominal aneurysms (19), and abdominal infra-renal aneurysms (41). Overall, mortality was 11.11%. Outpatient follow-up ranged from 13 years to 90 days. The actuarial survival curve in 13 years was 57.3%. We did not observe any complications described in the literature such as embolism, formation of pseudoaneurysms, ruptures, or steonsis. At our institute, the use of the intraluminal ring simplifies surgery, shortens the time necessary for anastomosis, and reduces bleeding. There was a reduction in mortality and better survival over the long term.

The concept of intraluminal prosthesis was introduced by Carrel,[3] in 1912, suggesting aneurysm correction with glass tubes and metal. Later, Hufnagel,[4] and Blakemore et al.,[5] described the technique in animals. In 1978, Dureau et al.[6] and Ablaza et al.[7] published their experience with intraluminal prosthesis without suture. The initial experience with the intraluminal prosthesis presented such complications as: thrombosis and embolism, stenosis, ruptures, and formation of pseudoaneurysms in addition to migration of the prosthesis. As a result the technique was virtually abandoned. In 1982, Lemole et al.[8] published a series of 14 patients reporting excellent results. In 1988, we developed our model of the intraluminal ring, designing a device that eliminated the complications described in the literature and which could be used in any type of vascular prosthesis at a low cost. After the experimental studies, we observed that the intraluminal prosthesis provided fast, easy, and safe anastomosis. In animal studies, we did not observe any complication as described in the literature. We started to use the intraluminal prosthesis for surgical treatment of aortic diseases in 1988. The objective of this arti-

Address for correspondence: Luciano Matar Miranda, Rua Almirante Alexandrino 181/102 Gutierrez, 30430-020, Belo Horizonte, MG, Brazil, Fax: e-mail: lubao51@hotmail.com

J CARD SURG
2002;17:125-130

cle is to present our 13-year experience with the technique and to evaluate the results.

CASUISTRY AND METHODS

The intraluminal ring

The ring has the capability to transform a common vascular prosthesis of any size, diameter, material, or form into an intraluminal prosthesis. The ring is 25 mm long, which facilitates its manipulation and positioning in the true lumen of the aorta. The groove is 10 mm wide and 2.5 mm deep, which provides easy localization and safety for suturing on the groove, even when the aortic tissue is thick, avoiding migrations or bleeding.

Casuistry

From March 1988 to March, 2001, 706 patients were admitted for surgical treatment of aortic disease in our institute. In 378 patients we used the intraluminal ring as the anastomosis technique. A total of 560 rings were used. The average age was 68.3 years (18 to 93 years). There were 237 male patients. Patients included: 149 carriers of type A acute aortic dissection, 38 of type B acute aortic dissection, 90 patients were carriers of ascending aortic aneurysm, 10 were carriers of aortic arch aneurysm, 31 were carriers of descending aortic aneurysm, 19 of thoracoabdominal aneurysm, and 41 were carriers of abdominal infrarenal aneurysm.

Intraluminal prosthesis preparation

The prosthesis is prepared during surgery. After the opening of the diseased aorta, we carefully measure the true lumen of the aorta and choose the appropriate ring size for the aorta. We then pass the prosthesis by the inner side of the lumen of the ring and inverted over the groove, transforming a common vascular prosthesis into intraluminal prosthesis.

Surgical technique

To perform an anastomosis with an intraluminal prosthesis, we examined the aorta externally and chose the probable points, proximal and distal, where we would accomplish the anastomosis. Then, with minimum dissection and manipulation, the aorta was outlined with thick caliber threads (Ethibond 5) in the places chosen for the anastomosis. After heparinizing and clamping the aorta, we accomplished an aortotomy carefully so we did not get too close to the aortic clamping. We removed the thrombus and measured the true lumen of the aorta or the collum of the aneurysm, always choosing a ring that would penetrate smoothly in the aortic lumen. We then prepared the intraluminal prosthesis. To position the ring inside the lumen of the aorta, we clamped the lateral borders of the aneurysm close to the anastomosis point. The assistant promoted a contrary traction and soon after we positioned the intraluminal prosthesis. We proceeded with the circumferential extravascular ligature over the groove of the ring, which is easily found as it is wide and deep.

RESULTS

The global mortality in the immediate postoperative period was 11.11%. The cause of death in the 42 patients that died was not directly related to the use of the intraluminal ring. The most frequent cause of death was failure of multiple organs. In the patients with type A acute aortic dissection, using two rings in the proximal and distal anastomosis (Figs. 1 and 2), the mean time of CPB was 26 minutes and the mean time of aortic cross-clamping was 15 minutes. In patients that presented with intimal rupture very close to the coronarian ostium, we used the plasty of the aortic root with double "patch" and resuspension of the valve, using the ring for the distal anastomosis. In these cases, the mean time of CPB was 54 minutes and the mean time of aortic cross-clamping was 34 minutes. We replaced the aortic valve us-

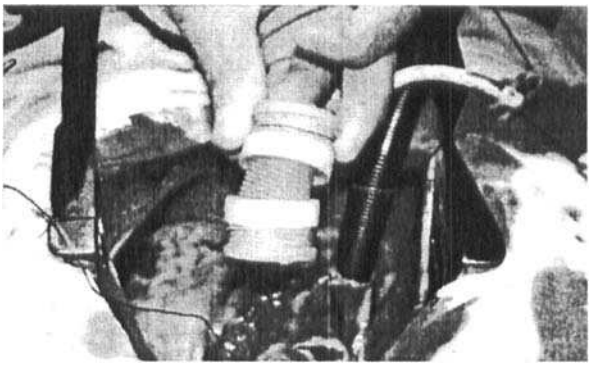

Figure 1. *Surgical treatment of type A acute aortic dissection. Preparation of the intraluminal prosthesis with two rings.*

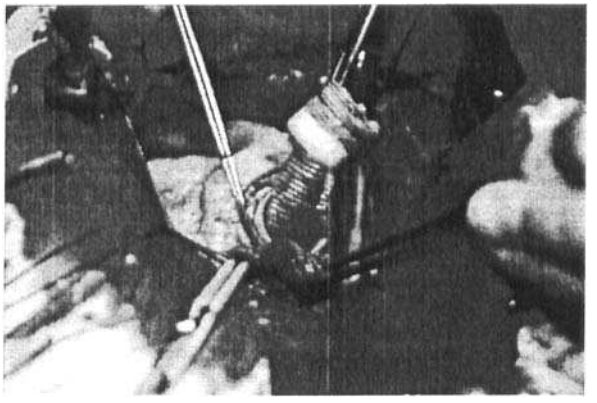

Figure 2. *Surgical aspect of the intraluminal ring anastomosed proximally above the coronary ostium. Distal ring prepared to implant.*

ing composite graft and Bentall-DeBonno techniques (1 patient developed definitive BAVT) or Cabrol in only 12.5% of patients. The average of replacement of blood was 710 ml/patient. Only 2.5% of the patients came back to the surgical center for hemostasis review. The mean time of mechanic ventilation was 11.7 hours and permanence in CTI was 4.4 days. The 31 patients admitted for descending aortic aneurysmectomy had a mean aortic cross-clamp time of 8 minutes. There was one (3.2%) case of paraplegia. In the 19 patients with thoracoabdominal aneurysm treatment, we used the ring in the proximal anastomosis when possible and always in the distal anastomosis, reducing aortic cross-clamp time and visceral and medular ischemia. There was one (5.3%) case of paraparesis, with total recovery on day 5. Long-term follow-up of these patients varied from 13 years to 90 days. We did not observe any complication related to the use of the intraluminal ring. Two patients submitted to treatment in the acute phase of type A acute aortic dissection, using two rings, developed postoperative aortic valvar insufficiency for dilatation of the aorta in the long term postoperative. One patient developed endocarditis of the composite graft and two patients developed prosthesis infection and died. The actuarial survival curve of the patients' with intraluminal prosthesis shows a survival of 57.3% in 13 years.

COMMENTS

The intraluminal prosthesis without suture was introduced for anastomosis in aortic surgery 20 years ago,[6,7] claiming to be the best technical alternative to accomplish a fast and safe operation. But during the initial phase of the experience, there were complications, including migration, formation of pseudoaneurysm, hemolysis, and stenosis at the level of the anastomosis.[9] In our opinion, these complications are related to the type of ring used in the first anastomoses.

These rings were short and did not have very deep grooves, which made positioning difficult. In addition suturing under the thick tissue of the aorta was difficult, leading to inefficient closure and, consequently, migration and rupture. Lemole's group[10,11] indicated that the major problem of the intraluminal prostheses results from the prosthetic material used. The intraluminal ring we use can be used with any prosthesis type and prepared during the operation. The design of the ring allows an easy anastomosis, and the migration of the prosthesis is impossible after the suturing.

In a patient with type A acute aortic dissection, we seek a fast and precise diagnosis, immediate surgical treatment, and a less aggressive approach that will provide the best result.[12] All patients are operated with CPB in normothermia. After the aorta clamping we use cold cardioplegia direct in the coronary ostium. We then do a brief circulatory arrest (in normothermia) and observe the aortic arch. We only approach the aortic arch when there is rupture or laceration of the initima. In that case we used hypothermia at 18° C (only in 10.5% of the cases).

Aortic valvar insufficiency (moderate/serious) was present in 57% of our patients. We were unable to conserve the valve through plasty of the aorta or resuspension returning the support lost by the suturing of the ring proximal in only 12.5% of these patients. The mean time of cardiopulmonary bypass and aortic cross-clamp was low due to the easiness and simplicity of anastomosis with the intraluminal ring. With this unaggressive approach, we reduced the mortality rate to 11.5%. To the patient carriers of type B acute aortic dissection, we only indicate surgery when the patient presents with serious complications. When the patient does not present with rupture of the aorta, we prefer to avoid the manipulation of the sick and friable aortic tissue, using the "elephant trunk" technique described by Borst et al.[13] adapted by Buffolo and Palma,[14] and modified by us with the use of the intraluminal ring (Fig 3).[15]

We operated on these patients in mild hypothermia, 25°C. Brief circulatory arrest allows

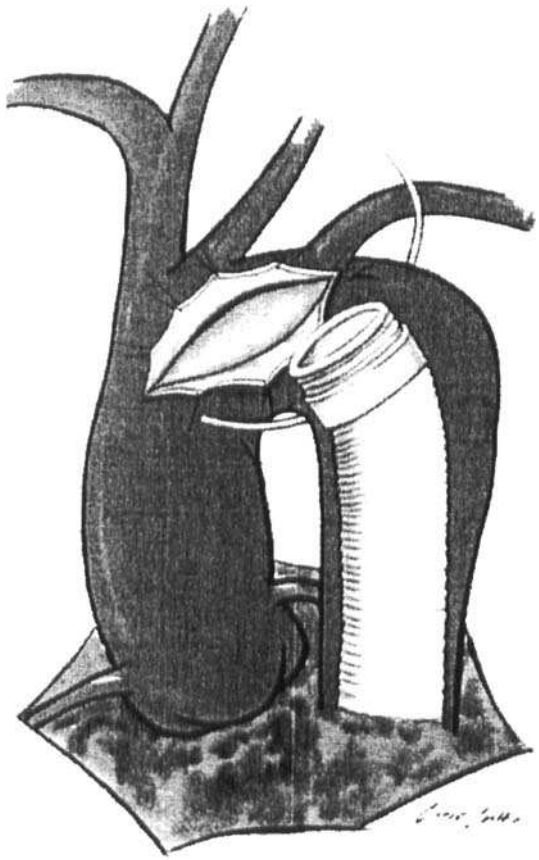

Figure 3. *"Elephant trunk" technique modified by the use of the intraluminal ring.*

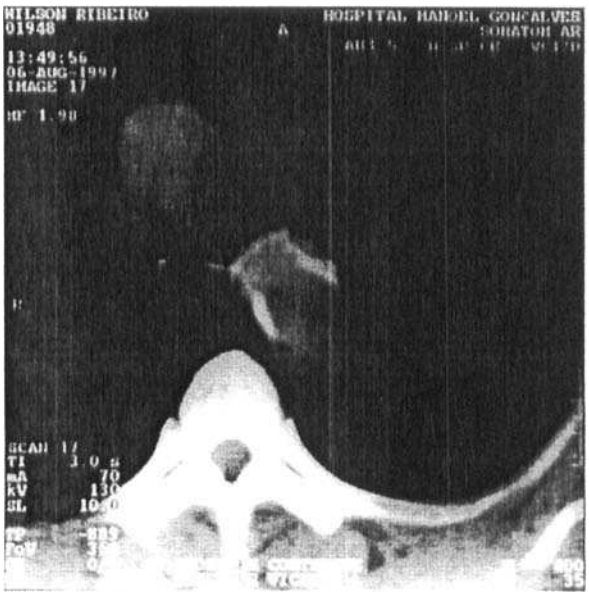

Figure 4. *Long-term tomographic control of a patient with correction of type B acute aortic dissection. Note the intraluminal ring after the origin of the left subclavian artery.*

enough time for opening the aortic arch and positioning the prosthesis with the proximal ring. The mean time of circulatory arrest was 5 minutes. We operated on 22 patients. There were complications with the positioning of the prosthesis in the descending aorta in four of these patients. Three patients died and one patient was successfully reoperated for thoracotomy. Only one of the patients submitted to operation with the "elephant trunk" technique maintained the flow in the false lumen with dilatation being used as an adjunct to thoracotomy. The 16 remaining patients were operated by direct approach of the descending aorta. There were four deaths. Two patients with type B acute aortic dissection operated on due to paraplegia had total recovery of movement postoperatively (Figs 4 and 5). In patients with ascending aortic aneurysms, we used the ring in the distal anastomosis to reduce bleeding and aortic cross-clamp time.

In patients with aortic arch aneurysm we used the ring in the proximal and distal anastomosis using the conventional anastomosis of the base vessels, decreasing the time of total circulatory arrest. In all patients who had aneurysm treatment or dissection of the descending thoracic aorta, thoracoabdominal and abdominal, medullar protection was not used and we had a paraplegia rate of 1.3%. This perhaps is due to the reduced time of medullar ischemia. One of the most interesting applications of the intraluminal ring is the treatment of the ruptured thoracoabdominal aneurysm (Figs. 6-8), approaching only the aorta ruptured segment.[16]

Anastomosis with an intraluminal ring in the aneurysmatic tissue is easy and safe. This method offers the patient a less aggressive treatment, avoiding thoracofrenolaparotomy, a longer time of visceral ischemia and bleeding during the acute phase, leaving the definitive treatment of the rest of the aneurysmatic aorta for another time, with the patient stable, a good clinical condition. Another interesting application of the intraluminal prosthesis was described by Sadahiro et al.[17] in aneurysm correction with calcified aorta. In long-term follow-up (13 years to 90 days, average: 71 months), we did not observe any complication regarding the use of the intraluminal ring for the short and long term.

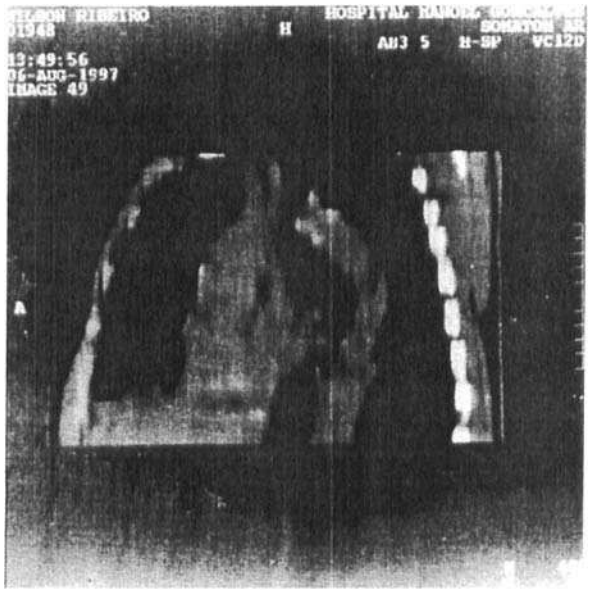

Figure 5. *Long-term tomographic control of a patient with correction of type B acute aortic dissection by the "elephant trunk" technique. Observe regression of the false lumen and total recanalization of the distal aorta.*

Three patients developed prosthesis infection and died. Two patients treated for type A acute dissection of the aorta developed aortic valvar insufficiency for dilatation of the aorta. During reoperation, we found the rings completely incorporated onto the aorta, with accentuated fibrosis on the suturing point. In these two cases, we substituted the aortic valve and beginning of the aorta, using a composite graft, anastomosing it in the old intraluminal prosthesis, maintaining the previous intraluminal distal anastomosis. One of the patients with correction of type B acute aortic dissection maintained the false lumen with dilatation, and it was reoperated 3 years later. It was done via a left thoracotomy approach and we only anastomosed the distal extremity of the "elephant trunk" using a 24-mm ring in its distal portion.

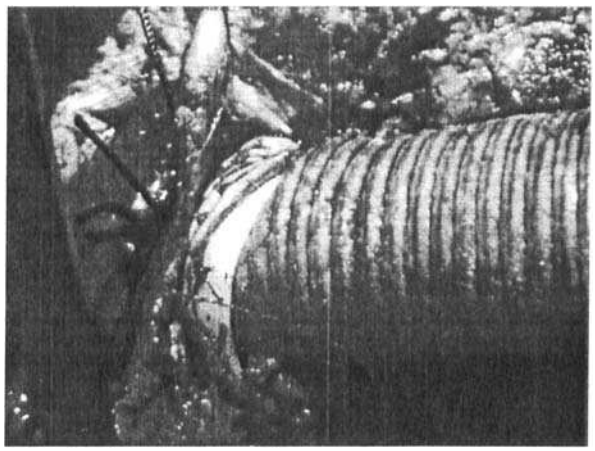

Figure 7. *Anastomosis with the intraluminal ring in aneurysmatic aortic tissue.*

CONCLUSION

The use of the intraluminal ring provides a hemostatic anastomosis that is easy, fast, and safe, and can be accomplished even in centers with few resources. Anastomosis with intraluminal prosthesis proved to be an efficient, less aggressive

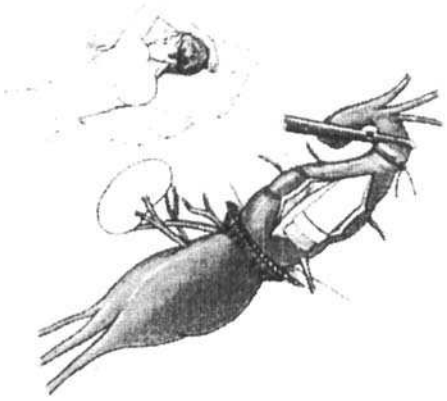

Figure 6. *Surgical treatment of the thorocoabdominal aneurysm opening only the ruptured segment of the aneurysm.*

Figure 8. *Long-term arteriographic control of the patient in Figure 7, treated only the thoracic portion of the ruptured thorocoabdominal aneurysm.*

technique, reducing surgical time; providing technical easiness, reduction of the mortality, and good long-term survival. It should therefore be part of all cardiovascular surgeons' therapeutic arsenal for use in selected cases.

REFERENCES

1. Bernardes RC, Reis FR, Rabelo RC, et al: Surgical correction of the aneurysms of the aorta: New device that transforms any type of intraluminal prosthesis. Rev Bras Cir Cardiovas 1994;9:54-59.
2. Bernardes RC, Reis Filho FA, Marino RL, et al: Surgical correction of aortic disease using intraluminal, crimped bovine pericardial graft. Ann Thorac Surg 1995;60(Suppl.):316-321.
3. Carrel A: Results of the permanent intubation of the thoracic aorta. Surg Gynecol Obstet 1912;15:245-248.
4. Hufnagel AH: Aortic plastic valvular prosthesis. Bull Georgetown Univ Med Ctr 1951;4:128-129.
5. Blakemore AH, Lord JW, Stefco PL: The severed primary artery in the war wounded. Surgery 1942; 12:488-508.
6. Dureau G, Villard J, George M, et al: New surgical technique for the operative management of acute dissections of the ascending aorta: Report of two cases. J Thorac Cardiovasc Surg 1978;76:385-389.
7. Ablaza SG, Ghosh SC, Grana VP: Use of a ringed intraluminal graft in the surgical treatment of dissecting aneurysms of the aorta: A new technique. J Thorac Cardiovasc Surg 1978;76:390-396.
8. Lemole GM, Strong MD, Spagna PM, et al: Improved results for dissecting aneurysms: Intraluminal sutureless prosthesis. J Thorac Cardiovasc Surg 1982;83:249-255.
9. Lemole GM: Aortic replacement with sutureless intraluminal grafts. Tex Heart Inst 1990;17:302-309.
10. Oz MC, Ashton RC Jr, McNicholas KW, et al: Sutureless ring graft replacement of ascending aorta and aortic arch. Ann Thorac Surg 1990;50:74-79.
11. Oz MC, Ashton RC Jr, Lemole GM: As originally published in 1990: Sutureless ring graft replacement of ascending aorta and aortic arch: updated in 1998. Ann Thorac Surg 1998;65:1186-1887.
12. Bernardes RC: Acute dissection of aorta. Precocious surgical treatment with smaller aggressiveness: Larger survival chance. Rev Soc Bras Terap Intens 1996;8:68-74.
13. Borst HG, Walterbusch G, Schaps D: Extensive aortic replacement using "elephant trunk" prosthesis. Thorac Cardiovasc Surg 1983;31:37-40.
14. Buffolo Palma H: "Elephant trunk" modified in the aorta dissections. Rev Soc Cardiol Estado São Paulo. 1994;5:467-482.
15. Bernardes RC, Rabelo RC, Reis FR, et al: Surgical treatment of the acute dissections of the aorta type B: "Elephant trunk" technique modified by the employment of intraluminal prosthesis without suture. Rev Bras Circ Cardiovasc 1996;11:12-7.
16. Bernardes RC, Reis FR, Lima LCM, et al: Surgical treatment of the thoraco-abdominal aneurysm broken in two times using intraluminal prosthesis without suture. Rev Bras Circ Cardiovasc 1997;13:41-46.
17. Sadahiro M, Oda K, Togo T, et al: Sutureless ringed graft replacement of descending thoracic aorta with extensive calcification. Ann Thorac Cardiovasc Surg 1998;4:96-98.