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# **Endovascular Treatment of Ascending Aorta: The Last Frontier?**

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Alexandre do Canto Zago

Additional information is available at the end of the chapter

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## **1. Introduction**

The treatment of ascending aorta diseases is usually performed by traditional surgery with median sternotomy and cardiopulmonary bypass. However, in some patients, the operative risk of this approach may be prohibitive. In these instances, endovascular approaches to the ascending aorta may be an alternative.

Endovascular approaches are being increasingly utilized to treat a variety of thoracic aortic diseases including aneurysms, pseudoaneurysms, dissections, penetrating aortic ulcers, traumatic aortic rupture, coarctation and abdominal aortic aneurysms [1].

Ascending aorta has several limitations for the endovascular approach, such as its larger diameter and the presence of the aortic valve and the coronary arteries.

## **2. Access and technique**

The endovascular procedure is usually performed through the femoral arteries [1-3]. Sometimes this access is impossible or not recommended because of small size vessels, obstruction, calcification, dissection or extreme tortuosity.

The feasibility of endovascular treatment depends on many anatomic factors, including the diameter and the disease state of the access vessels [4,5]. Stenosis, calcifications, tortuosity, small size or dissection in both femoral and iliac arteries can make introduction of large sheath hazardous or impossible.

Endoprosthesis deployment in the ascending aorta usually requires large diameter and long sheath. There is always possibility of damaging the aortic valve, since the nose of the commercially available devices is designed for descending and/or abdominal aorta. The vascular prosthesis should be large enough to oversize by 15-20 % the aortic diameter and short in length to fit between the coronary arteries and the brachiocephalic trunk. This length usually measures 8 cm or less. The endovascular technique would have several advantages over the open surgical alternatives if the right tools for the procedure were available. Current thoracic aortic stent-grafts are too long, while abdominal aortic stent-grafts are too short and narrow. Moreover, abdominal aortic delivery systems are too short to traverse the long and tortuous path from the femoral artery to the ascending aorta.

Several different approaches have been presented and published over the last years as an attempt to solve very dramatic situations stretching the limits of the current technology [6-8].

The technique should be carefully planned. Rapid pacing and adenosine are useful to lower blood pressure and allow precise deployment. A rigid (Landerquist or super stiff) and long (260 cm) guidewire is usually placed in the left ventricle to give adequate support near the coronary arteries. This is similar to what we use when performing transcatheter aortic valve implantation (TAVI). One important tip is to perform a “wide J-shape” at the end of the rigid guidewire in order to prevent left ventricle perforation and, consequently, cardiac tamponade or left ventricular pseudoaneurysm.

Similar to other endovascular procedures, besides careful planning, patient selection and technical expertise are crucial to obtain satisfactory results. In this setting multidetector computed tomography (MDCT) plays an important role in selecting the patients suitable for the procedure and allows a careful and detailed step by step preoperative planning.

We have recently published a series of five clinical cases and described the technique in which the axillary artery was used to deliver the endograft for the treatment of different thoracic aortic diseases [9]. We also demonstrated the possibility of concomitant treatment of ascending aorta disease and coronary stent implantation [10,11].

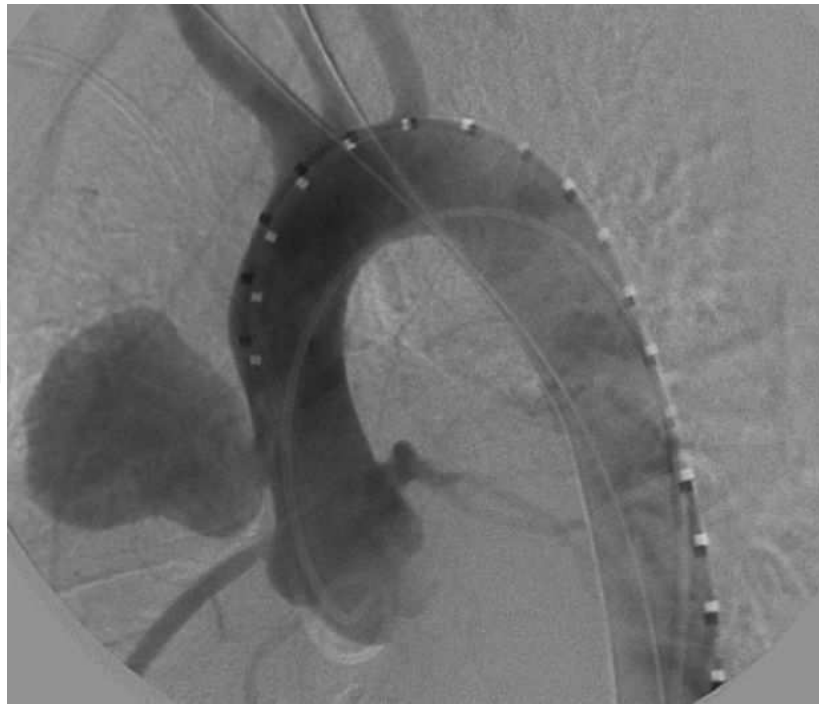
Transcarotid is another alternative access and, recently, transapical approach through a small left thoracotomy has been described.

### 3. Clinical cases

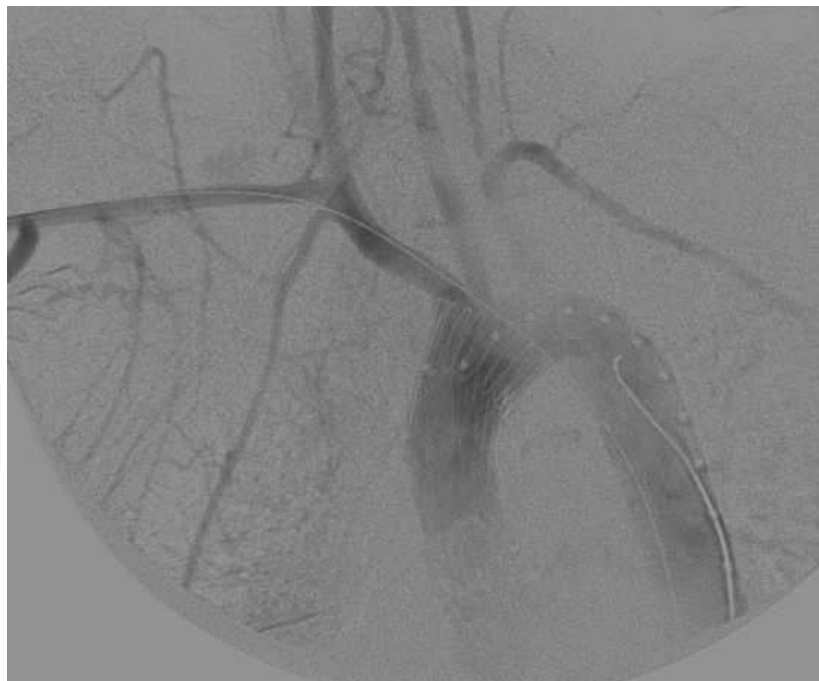
In this part we will discuss clinical cases of endovascular treatment of ascending aortic diseases showing different approaches and techniques.

#### 3.1. Clinical case 1

A 32-year-old female presenting cardiogenic shock (Figures 1-2).



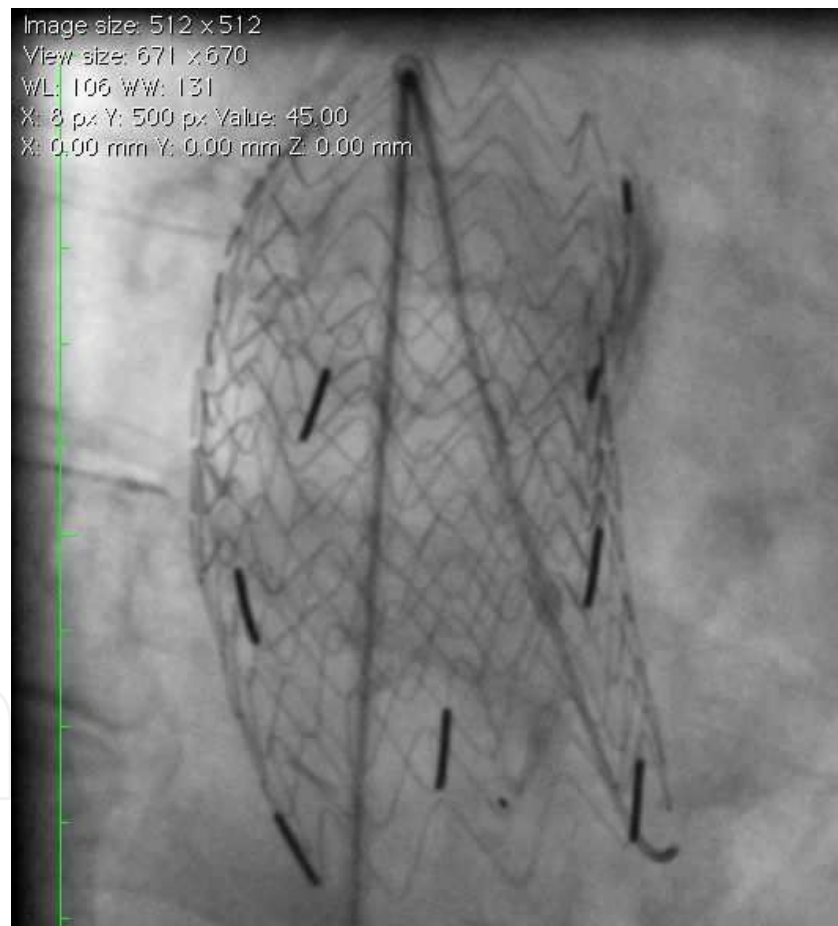
**Figure 1.** Aortogram showing bovine trunk and a pseudoaneurysm in the anterolateral wall of the ascending aorta 1 cm above the ostium of the right coronary artery.



**Figure 2.** Final aortogram of emergency endovascular correction of a pseudoaneurysm through transfemoral implantation of a Cook endoprosthesis. The shorter device we had available was a 8 cm length endoprosthesis. In order to preserve flow in the brachiocephalic trunk and left carotid artery (bovine trunk) we had to use a chimney (snorkel) technique in this two vessels arch using two Viabahns to preserve flow.

### 3.2. Clinical case 2

A 57-year-old female underwent coronary artery bypass graft in another hospital with left internal mammary artery to the left anterior descending and saphenous vein graft to the right coronary artery. The patient developed mediastinitis and had 7 reinterventions resulting in acute bleeding through the sternum. She was sent to our hospital in cardiogenic shock and manual compression of the bleeding site in the sternum. Previous computed tomography showed ruptured pseudoaneurysm at the proximal anastomosis of saphenous vein graft to the (Figures 3-6).



**Figure 3.** Emergency endovascular deployment of two abdominal extension cuffs (Gore-Tex) in the ascending aorta between the coronary ostium and the brachiocephalic trunk through the left axillary artery. The bleeding stopped immediately and the patient became stable.



**Figure 4.** Right coronary angiography demonstrating severe stenosis. Once saphenous vein graft to the right coronary artery had occluded by the endoprosthesis, the native right coronary artery had to be treated.



**Figure 5.** Deployment of three stents in the right coronary artery.

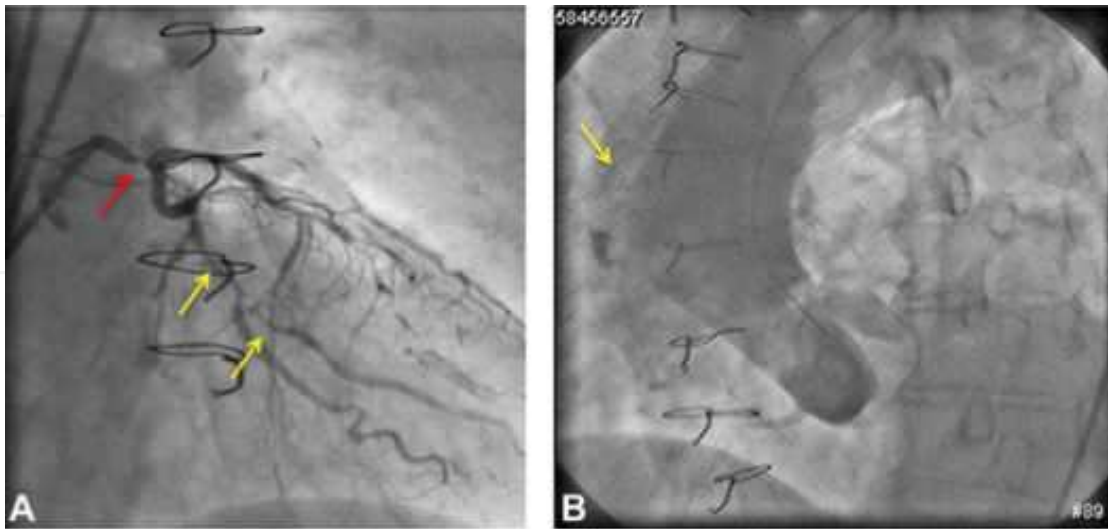




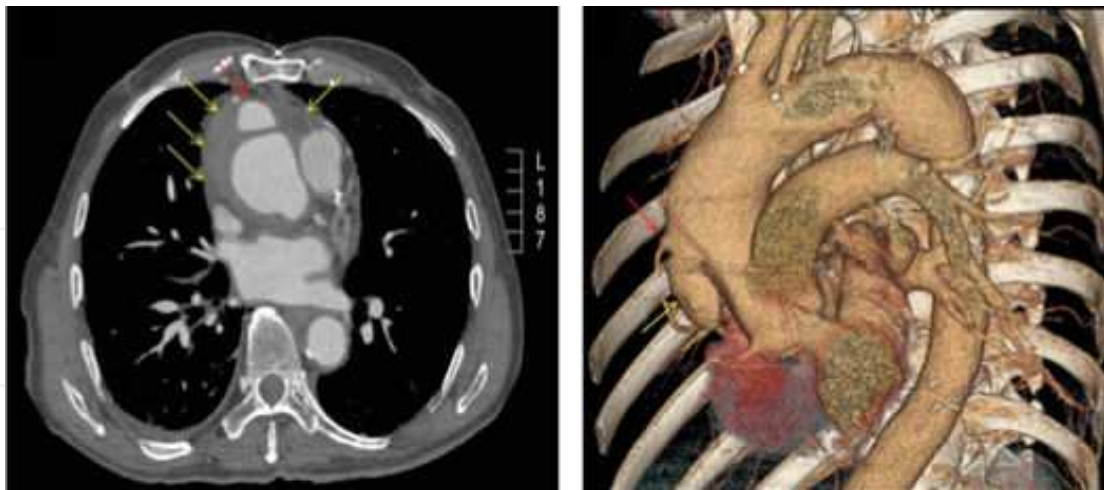
**Figure 6.** Computed tomography showing the two extension cuffs in the ascending aorta and the three stents in the right coronary artery.

### 3.3. Clinical case 3

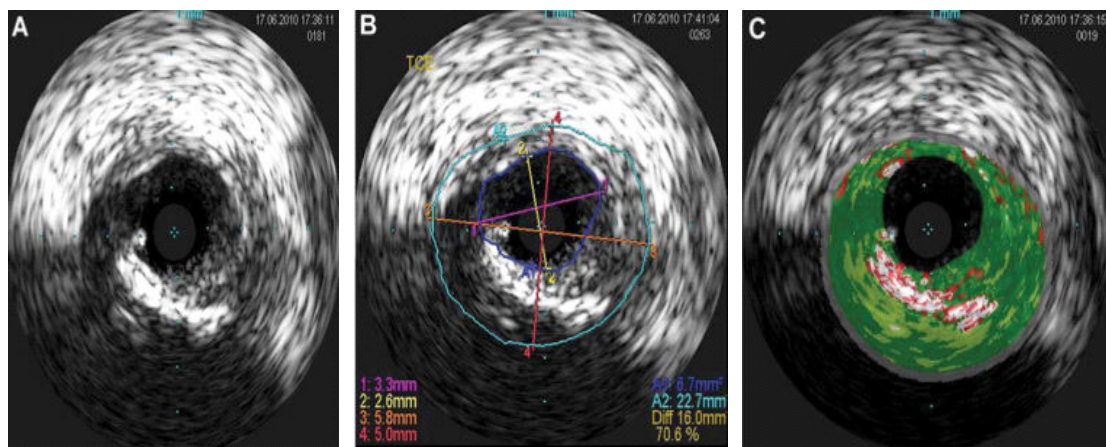
A 74-year-old male with previous coronary artery bypass graft presented with iatrogenic ascending aortic pseudoaneurysm that occurred during angiography. The patient was at very high risk for surgical treatment, therefore an (Figures 7-9).



**Figure 7.** A) Coronary angiogram showing left main bifurcation with severe stenosis and circumflex with severe stenosis extending to large marginal branch. (B) Aortic angiogram demonstrating ascending aorta dilatation and image suggesting dissection at the saphenous vein graft ostium.



**Figure 8.** Computerized tomographic angiography showing a 3.4-cm pseudoaneurysm with partial thrombosis in ascending aorta and surrounding intramural hematoma.



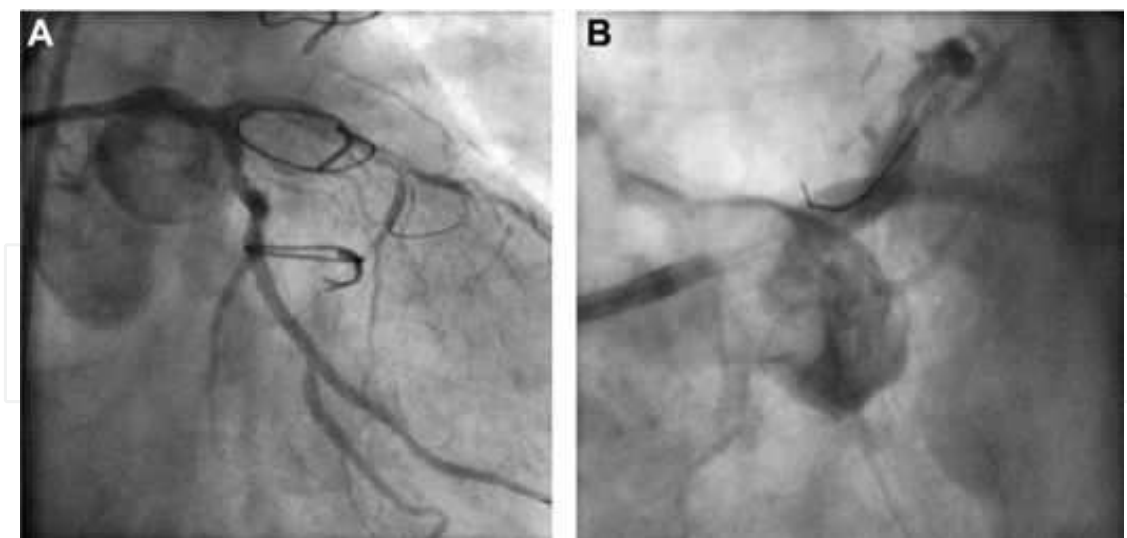
**Figure 9.** A) Intravascular ultrasound of left main artery evidencing significant stenosis due to calcified plaque. (B) Intravascular ultrasound measurements confirming the presence of a large left main artery and significant plaque burden. (C) Virtual histology showing predominantly fibrous plaque and superficial calcium arch.

Both procedures were successfully performed and the patient was discharged without (Figures 10-12). At 6 months and 1 year clinical follow-up the patient had no symptoms as well as no other adverse cardiovascular events.

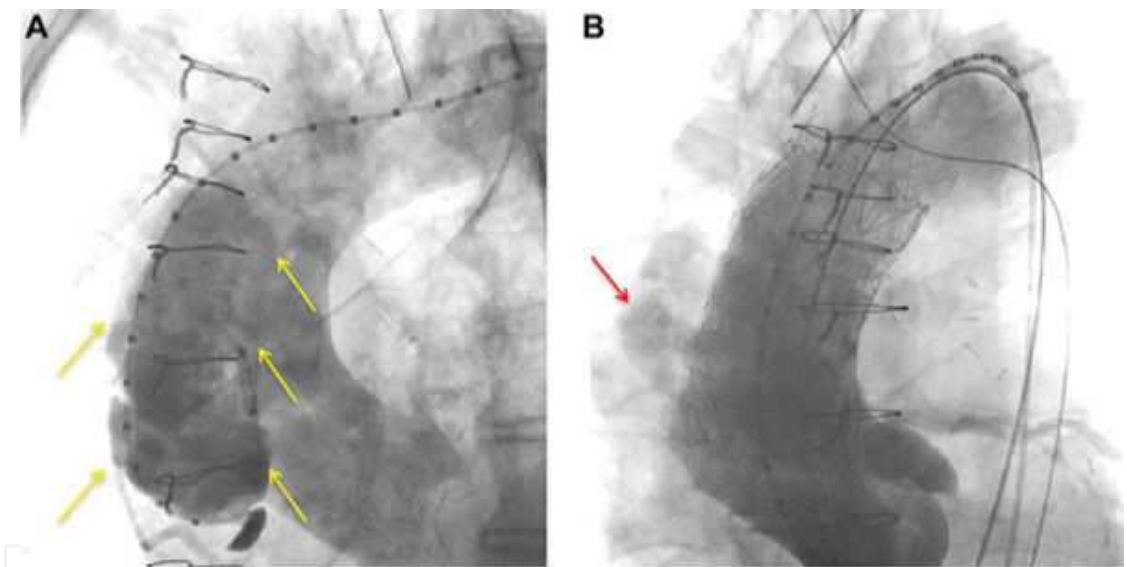
#### 4. Target diseases

There are several pathologies of the ascending aorta that can be potentially addressed by the endovascular approach. Pseudoaneurysms or saccular aneurysms in the mid-ascending aorta are adequate for this technique because they usually appear with a sufficient proximal and





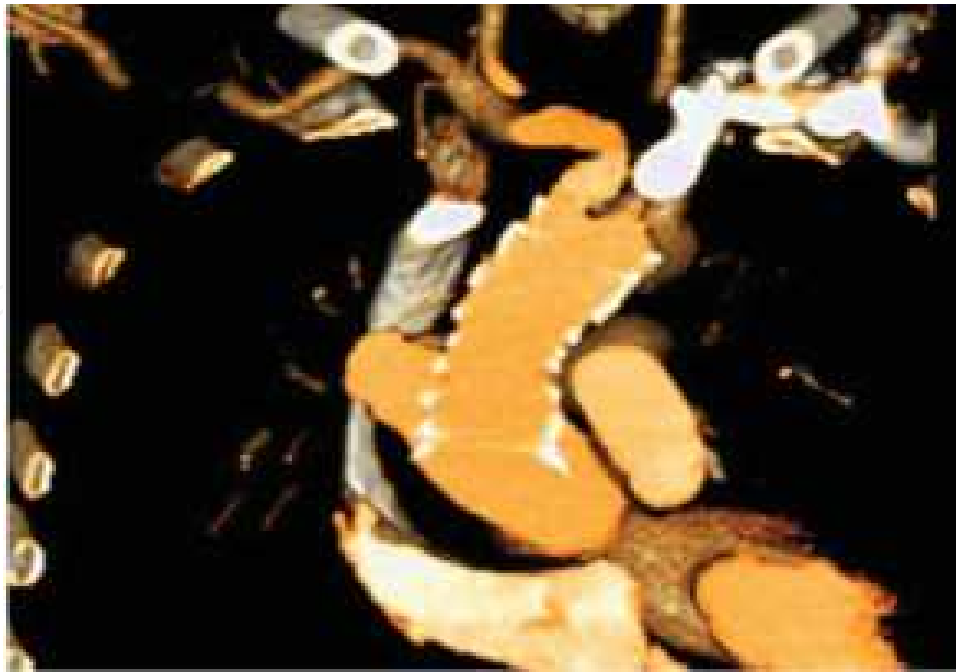
**Figure 10.** Coronary angiogram showing final result in right anterior oblique projection (A) and spider view (B).



**Figure 11.** (A) Ascending aorta angiogram before endoprosthesis deployment showing a large pseudoaneurysm (yellow arrow). (B) Ascending aorta angiogram after endoprosthesis deployment evidencing sealed pseudoaneurysm and a type 1 endoleak (red arrow).

distal landing zone. On the other hand, fusiform aneurysms have the limitation of lacking a sufficient landing zone in many cases.

Thoracic endovascular stent grafting has revolutionized the treatment of distal [type B] acute aortic dissection. Endovascular surgeons are now seeking the ways to improve the treatment of type A dissection by offering endovascular techniques to replace conventional surgical therapy. Less invasive endovascular therapy, obviates the need for sternotomy and cardiopulmonary bypass, reduces perioperative morbidity, and offers an alternative solution for



**Figure 12.** Computerized tomographic angiography showing final result after endoprosthesis deployment.

those patients not eligible for conventional intervention due to co-morbidity or severe complications of the disease.

Thoracic stent grafting in the ascending aorta presents specific challenges and the role of uncovered stents is unclear in this situation. The majority of patients with acute type A aortic dissection has the intimal tear originated in the sinotubular junction. More than 90% of patients with this disease does not have sufficient proximal or distal landing zone required for secure fixation. Therefore, the site of the intimal tear as well as aortic valve insufficiency and aortic diameter >38mm are major factors limiting the use of endovascular therapy for acute type A dissection. Current available stents in use to treat type B aortic dissection do not address anatomical constraints present in type A aortic dissection in the majority of cases, hence the development of new devices is required.

## 5. Technical limitations

Endovascular approach of the ascending aorta has several limitations and is still in its beginning phase.

The diameter of the ascending aorta is usually larger than the rest of the aorta and the proximity with the aortic valve and the presence of the coronary arteries pose special challenges.

The length of the delivery system, which is designed for the abdominal aorta, does not allow to reach the ascending aorta through the groin.

Finally, the length of the endoprosthesis itself for descending aorta may be too long to be positioned between the coronary ostia and the brachiocephalic trunk.

## 6. Conclusions

Despite the fantastic progress in this field and the clear advantages of endovascular approaches for the ascending aorta in some clinical situations, one must bear in mind the high level of risk that these procedures entail.

Long-term data are not available to establish the safety and durability of stent-graft repairs. The cases described represent an off-label use of this technology and should be considered with the above mentioned limitations in mind.

The surgeon will need special skills in open aortic surgery and catheter based interventions to be able to plan the procedure carefully, to properly deliver the devices and to manage the potential serious complications [12].

Challenges in endograft design are the development of branched endografts and of pathology-specific endografts [13]. However, the unique composition of the proximal thoracic aorta and the associated mechanical properties have to be taken into account and make this effort by far more complex than initially expected. Moreover, there is a need for reducing the stent-graft devices profile as well as for increasing conformability and trackability.

We believe that future advances with devices specifically designed for the treatment of ascending aorta diseases will allow this technique to be incorporated into routine medical practice.

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## References

- [1] Melissano, G, Bertoglio, L, Civilini, E, Marone, E. M, Calori, G, Setacci, F, & Chiesa, R. Results of Thoracic Endovascular Grafting in Different Aortic Segments. *J Endovasc Ther* (2007). , 14, 150-157.
- [2] 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. *Circulation* (2010). ee369., 266.
- [3] Nienaber, C. A, Rousseau, H, Eggebrecht, H, Kische, S, Fattori, R, Rehders, T. C, Kundt, G, Scheinert, D, Czerny, M, Kleinfeldt, T, Zipfel, B, & Labrousse, L. Ince HS for the INSTEAD Trial. Randomized Comparison of Strategies for Type B Aortic Dissection. *Circulation* (2009). , 120, 2519-2528.
- [4] Alric, P, Canaud, L, Branchereau, P, Marty-ané, C, & Berthet, J. P. Preoperative assessment of anatomical suitability for thoracic endovascular aortic repair. *Acta Chir Belg* (2009). , 109(4), 458-64.
- [5] Almeida, R. M, Leal, J. C, Saadi, E. K, & Braile, D. M. Rocha AST, Volpiani J, Centola C, Zago A. Thoracic endovascular aortic repair- a Brazilian experience in 255 patients over a period of 112 months. *Interact CardioVasc Thorac Surg* (2009). , 524-528.
- [6] Uchida, K, Imoto, K, Yanagi, H, Machida, D, Okiyama, M, Yasuda, S, et al. Endovascular Repair of Ascending Aortic Rupture: Effectiveness of a Fenestrated Stent-Graft. *J Endovasc Ther* (2010). , 17, 395-398.
- [7] Lin, P, Kougias, P, Huynh, T, Huh, J, & Coselli, J. S. Endovascular Repair of Ascending Aortic Pseudoaneurysm: Technical Considerations of a Common Carotid Artery Approach Using the Zenith Aortic Cuff Endograft. *J Endovasc Ther* (2007).
- [8] Chuter TAM Endovascular Repair in the Ascending Aorta: Stretching the Limits of Current Technology. *J Endovasc Ther* (2007). , 14, 799-800.
- [9] Saadi, E. K, Dussin, L. H, Moura, L, & Machado, A. S. The axillary artery--a new approach for endovascular treatment of thoracic aortic diseases. *Interact Cardiovasc Thorac Surg*. (2010). Nov;; 11(5), 617-9.
- [10] Zago, A. C, Saadi, E. K, & Zago, A. J. Endovascular approach to treat ascending aortic pseudoaneurysm in a patient with previous CABG and very high surgical risk. *Catheter Cardiovasc Interv*. (2011). Oct 1;; 78(4), 551-7.
- [11] Saadi, E. K. Moura Ld, Zago A, Zago A. Endovascular repair of ascending aorta and coronary stent implantation. *Rev Bras Cir Cardiovasc*. (2011). Jul-Sep;; 26(3), 477-80.

- [12] Saadi, E. K. Is it possible to train an endovascular surgeon? *Rev Bras Cir Cardiovasc.* (2007). Jan-Mar;22(1):III-IV.
- [13] Greenberg, R, Eagleton, M, & Mastracci, T. Branched endografts for thoracoabdominal aneurysms. *J Thorac Cardiovasc Surg* (2010). S, 171-8.

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