ARTICLE

ENDOVASCULAR MANAGEMENT OF THORACOABDOMINAL ANEURYSMS

ABSTRACT:

Introduction: The endovascular treatment of thoracoabdominal aortic aneurysms is limited to centers of excellence, considering that conventional treatment involves high mortality and endovascular treatment is of first choice.

Aim: To propose an endovascular classification of thoracoabdominal aortic aneurysms (TAAAs); to provide recommendations for their diagnosis and endovascular treatment options.

Materials and method: Under evidence-based medicine (EBM), agreement was reached on different aspects of TAAAs thus creating recommendations on the various aspects.

Conclusions: TAAA endovascular treatment constitutes an extremely complex procedure with high morbidity and mortality rates, even in highly experienced centers.
TAAA endovascular treatment should be performed by teams highly trained in endovascular and open techniques.
This therapeutics should be performed in qualified centers with high-resolution technological equipment and imaging storage according to the procedure complexity.

Palabras Clave: Thoracoabdominal aneurysms, endovascular treatments, fenestrated endoprosthesis, branched endoprosthesis, hybrid procedures

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INTRODUCTION

First, and since the topic relates to the endovascular management of thoracoabdominal aortic aneurysms (TAAAs), the following consensus items regarding open treatment were established:

- It is limited to a few centers of excellence (mortality @ 5%).
- Mortality in common centers of the United States is extremely high, with rates reaching 26%.
- Although there are no statistics on the subject in Latin America, this panel considers that morbidity and mortality rates are high and that open surgery should be reserved to the few renowned specialized centers.
- Recent endovascular techniques of TAAA repair show, at initial and mid-term stages, less incidence on the complication rate.
- Endovascular procedures in the thoracoabdominal area represent the most appropriate therapeutic alternative for the region.

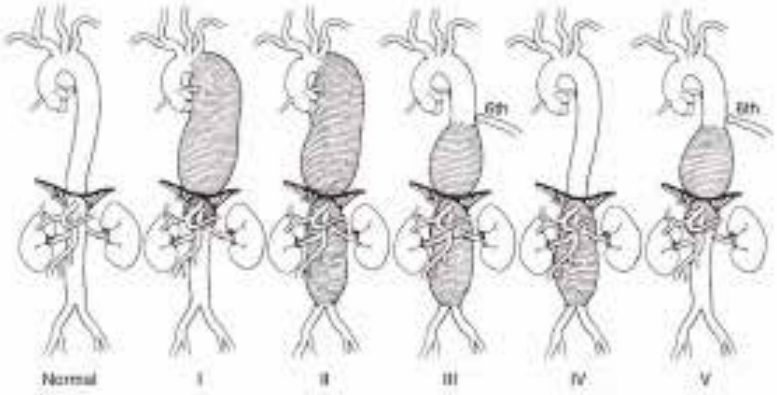


Figure 18-1. Modified Crawford anatomic classification of TAAAs. (From Rutherford RB: Vascular surgery ed 6. Philadelphia: 2005, Saunders, p 1491, Fig 103-2.)

CLASSIFICATION OF THORACOABDOMINAL ANEURYSMS

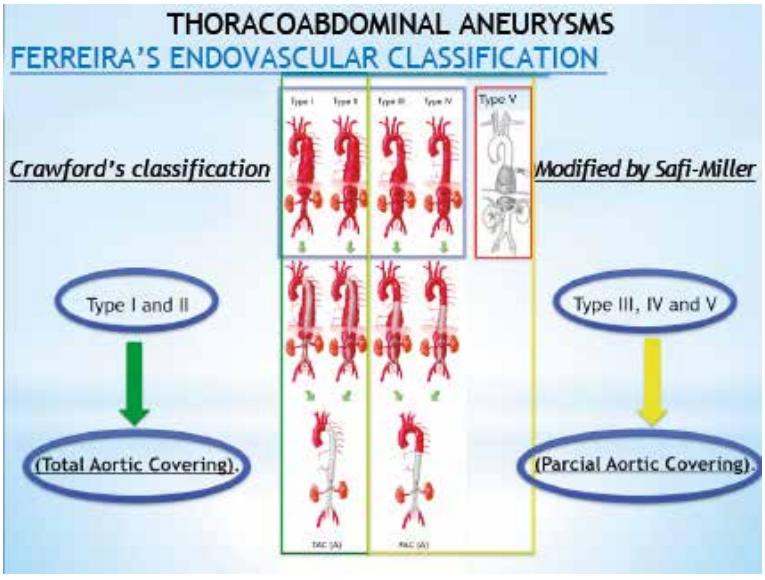
There is a 5-type classification:

- Type 1: Extends from the left subclavian artery to the renal arteries.
- Type 2: Extends from the left subclavian artery to the aortic bifurcation.
- Type 3: Extends from the sixth intercostal space to the aortic bifurcation.
- Type 4: Extends from the diaphragmatic aortic hiatus to the aortic bifurcation.
- Type 5: Extends from the sixth intercostal space to the renal arteries.

This classification is common for Crawford and was modified by Safi-Miller (type 5).

MARCELO FERREIRA'S ENDOVASCULAR CLASSIFICATION

This classification is in line with the topic as it covers the endovascular treatments that should be performed in TAAAs, depending on the Crawford/Safi/Miller type.
Therefore, for patients with TAAA types 1 and 2, the endovascular procedure to be performed includes total aortic covering (TAC). For types 3, 4 and 5, the endovascular procedure to be performed includes partial aortic covering (PAC).

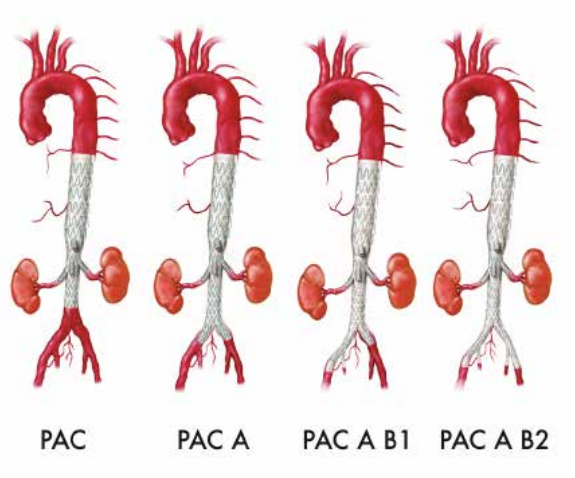


Marcelo Ferreira's classification covers those TAAAs associated with iliac aneurysms.

EWIC'S MODIFICATION 2015 adds those TAAAs that tactically require the covering of the left subclavian artery. We called this category TACs (total aortic covering including the subclavian artery).

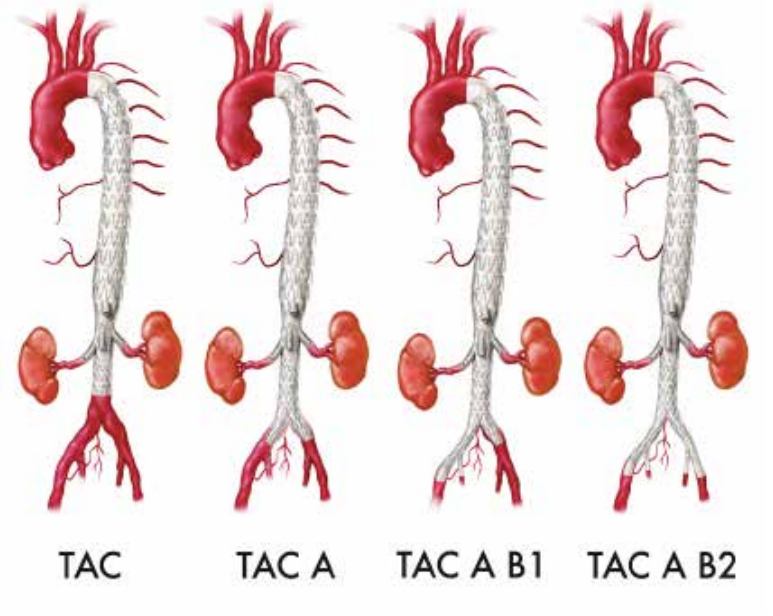
PAC SUBCLASS

- PAC: endovascular repair includes part of the descending aorta and the visceral aorta.
- PAC A: PAC that includes the aortic bifurcation and common iliac arteries.
- PAC A B1: PAC that includes branched endoprosthesis repair of one of the hypogastric arteries.
- PAC A B2: PAC that includes branched endoprosthesis repair of both hypogastric arteries.



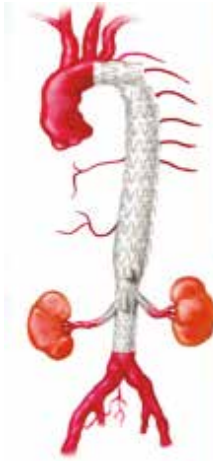
TAC SUBCLASS

- TAC: endovascular repair of the complete descending aorta and the visceral aorta.
- TAC A: TAC that includes the aortic bifurcation and common iliac arteries.
- TAC A B1: TAC A that includes endovascular correction of one of the hypogastric arteries with branched endoprosthesis.
- TAC A B2: TAC A that includes endovascular correction of both hypogastric arteries with branched endoprosthesis.



EWIC 2015 adds to this classification the TACs subgroup for any of the above options in case the left subclavian artery should be covered, leaving the type of revascularization to the discretion of the operator.

EWIC 2015 RECOMMENDATIONS FOR DIAGNOSTIC EXAMINATION



The study par excellence in terms of diagnosis and planning for the examination of a patient with TAAA is the multi-slice angiotomography.

Its characteristics should include:

- Axial sections equal to or less than 1 mm.
- Scanning of supra-aortic vessels to femoral arteries.
- Dicom® imaging.
- Workstation to process digital images.

A previous neurological vascular study is advisable, if the revascularization of the left subclavian artery (TAAA TACs) is needed.

A detailed preoperative evaluation of physiological, hematological, cardiac, pulmonary and renal function reserves should be included.

If there is an associated coronary disease (16% - 30%), a detailed cardiac evaluation with transthoracic echocardiography and functional test is recommended. For patients requiring a previous coronary angioplasty, we do not recommend the use of drug therapy stents.

Regarding preoperative studies of spinal cord irrigation, we have not determined any benefit, whether by digital angiography, NMR or angio-tomography. It will not change the strategy of endovascular therapy.

INDICATIONS FOR ENDOVASCULAR REPAIR

This panel has reached the following recommendations for TAAA endovascular repair:

- Asymptomatic TAAA greater than or equal to 60 mm in diameter in its entire length or in some parts.
- Asymptomatic or complicated TAAA of any diameter.
- Fast-growing TAAA, i.e., greater than 5 mm in 6 months.
- TAAA associated with connective tissue disease greater than 50 mm.

CONTRAINDICATIONS AND POSSIBLE TECHNICAL DIFFICULTIES RELATED TO ENDOVASCULAR REPAIR

- Anatomies with atheroembolism.
- Anatomic variations of aorta visceral branches.
- Excessive aortic tortuosity.
- Stenotic-occlusive aortoiliac arteriopathy.
- Comorbidity associated with life expectancy of less than 2 years.

TAAA ENDOVASCULAR THERAPEUTIC OPTIONS

- Branched or combined devices Branched/Fenestrated
- Use of parallel branches.
- Hybrid procedures.
- Bag sealing devices + Parallel branches.
- Flow diverter device.

It should be mentioned that:

- Results are directly related to the experience and volume of the treating center.
- It is a high-complexity procedure that requires multi adjuvant maneuvers.
- Proper imaging technology should be available.
- Multidisciplinary work is necessary during pre, intra and postoperative therapy.
- Costs of devices and other materials are expensive.

Branched or combined devices Branched/Fenestrated

This consensus panel considers that this is the endovascular option associated with the greatest technical success and the lowest complication rate.

- There are CUSTOM-MADE devices that are more anatomically accurate, whose design/construction/availability delay between 3 and 4 months.
- There are standard devices (T-BRANCH®) applicable approximately to 80% of the anatomies.
- The procedure may be performed in stages

Chuter TAM, Gordon RL, Reilly LM, et al: An endovascular system for thoracoabdominal aortic aneurysm repair, J Endovasc Ther 8:25-33, 2001.

Chuter TA, Schneider DB, Reilly LM, et al: Modular branched stent graft for endovascular repair of aortic arch aneurysm and dissection, J Vasc Surg 38:859-863, 2003.

Use of parallel branches

- The options described include chimneys, snorkels, periscopes, sandwiches.
- The published series include a reduced number of cases and short-term follow-up, or are limited to "case reports".
- The main indication is in acute patients not eligible for surgery or custom-made devices, due to the latency time until material availability.
- They have higher incidence of endoleaks in relation to the number of parallel branches (type 1 endoleak).
- Technically, they are easier to be performed.

Ohrlander T, et al: The chimney graft: a technique for preserving or rescuing aortic branch vessels in stent.graft scaling zones. J Endovasc Ther 15:427-432, 2008

Hybrid procedures

- These procedures imply debranching for visceral revascularization + endoprosthesis placement.
- They represent major abdominal surgery with great surgical approaches.
- Some series report high morbidity and mortality rates.
- They are prescribed for very selected cases and for those patients with unfavorable anatomy for the other endovascular methods already mentioned.
- The complication rate is associated with the number of revascularized vessels.

Black SA, Wolfe JH, Clark M, Hamady M, Cheshire NJ, Jenkins MP: Complex thoracoabdominal aortic aneurysms: endovascular exclusion with visceral revascularization. J Vasc Surg 43: 1081-1089, 2006.

Böckler D, Kotelis D, Geisbüsch P, Hyhlink-Dürr A, Klemm K, von Tengg-Kobligk H, Kauczor HU, Allenberg JR: Hybrid procedures for thoracoabdominal aortic aneurysms and chronic aortic dissections- a single center experience in 28 patients. J Vasc Sterg 47:724-732, 2008.

Bag sealing device + parallel branches

- This procedure implies the use of Nellix® device + parallel branches.
- It is a recently known technique that seems to present better apposition and thus better sealing among endobags and chimneys.
- Few reports.

Flow diverter or modulating device

- Limited use.
- Option for patients with contraindication to the other methods mentioned above.
- Recent publications describe a higher complication rate in those cases where the guidelines of use established by the device manufacturer were not followed.

ENDOVASCULAR TREATMENT COMPLICATIONS

These complications include:
- Renal failure.
- Spinal cord ischemia.
- Endoleaks.
- Visceral vessel complications.
- Lower limb ischemia.
- Stroke.

Verhoeven E, et al: Results of endovascular repair of TAAA in the first 50 patients. Zeneralbl Chir 136: 451-457, 2011.

RENAL FAILURE

- Multifactorial etiology.
- There is nephrotoxicity due to the use of higher doses of contrast material.
- Renal branches occlusion.
- Iatrogenic lesion due to instrumentation within the vessels.
- Embolization.

Recommendations

- 12-24 hour hospital stay before the procedure.
- Generous endovenous hydration.
- N-acetyl cysteine 1,200 mg every 12 hours during 48 hours before and after the procedure.
- Bicarbonate 70 meq/kg before the procedure.

SPINAL CORD ISCHEMIA

- Multifactorial etiology.
- Arterial hypotension.
- Aortic covering above 20 cm.
- Occlusion of left subclavian artery and/or hypogastric artery(ies).
- Previous abdominal aortic surgery.

Recommendations

- 48-hour PO monitoring of spinal cord pressure.
- Keep such pressure lower than 12 cm of h2o (10 mmHg).
- Avoid arterial hypotension and use of drugs with pressure lowering effects.
- Perform procedures in sequential stages.
- Temporary perfusion of the bag by a spinal cord branch (closure two weeks later with plug).
- Revascularization of subclavian/hypogastric artery.

VISCERAL ISCHEMIA

- Multifactorial etiology.
- By branch occlusion.
- Iatrogenic lesion by instrumentation.
- Atheroembolism.
- Renal ischemia is more frequent than mesenteric artery ischemia (due to collateral circulation and mesenteric arteries network).

Etz CD, et al: Staged repair significantly reduces paraplegia rate after extensive thoracoabdominal aortic aneurysm repair. J Thorac Cardiovasc Surg 139:1464-1472, 2010.

Griepp RB, et al: Spinal cord perfusion and protection during descending theracic and thoracoabdominal aortic surgery: the collateral network concept. Ann Thorac Surg 83:S865-S869, 2007

Recommendations

- Special attention in tortuous arteries.
- Use of non-covered stents for vessel alignment, in case it is bend.
- Dual antiplatelet therapy.
- First tomographic control after 30 days.
- Video-laparoscopy or colonoscopy in case of clinical and lab diagnostic suspicion.

LOWER LIMB ISCHEMIA

-This ischemia is more common in cases that require hemostatic introducers of greater caliber (22-24 French) as in fenestrated endoprostheses.

- It is associated with extended time of the procedure.

Recommendations

- Minimize surgery time.
- Monitor anticoagulation time (to keep ACT in more than 200 seconds).

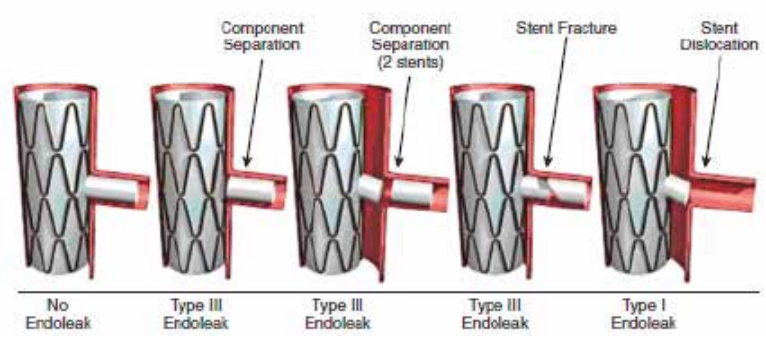
ENDOLEAKS

-Type 1 proximal and distal endoleak is less frequent in branched devices (there is a greater safety margin in anchorage areas).

- TYPE 1 D, corresponding to the insufficient sealing of the stent graft of a branch in the visceral artery, is added to the endoleak classification.
- TYPE 1C was added in the second EWIC, defining the retrograde leak due to the insufficient sealing of the contralateral occlusive plug in the corrections of abdominal aneurysms with con aorto-uniliac devices.
- Type 3 endoleak means the disconnection between the visceral branch of the endoprosthesis and the stent graft.
- Type 1 proximal and distal endoleak is more frequent when using parallel branches.

Recommendations

- Adequate planning.
- 1-mm oversizing for visceral branches.
- Overlapping of 2 cm within the visceral branch and 2 cm within the endoprosthesis branch.
- Stent grafts flaring in the fenestrated entoprosthesis.
- Generous overlapping in parallel prosthesis.



TYPE 1 C ENDOLEAK. THIRD EWIC 2015.

STROKE

-Related to the instrumentation of the aortic arch.

- Related to the covering of the left subclavian artery.

Recommendations

-Single preoperative antiplatelet therapy.

- Anticoagulation monitoring.

- Dual antiplatelet therapy.

- Revascularization of left subclavian artery (TACs).

FOLLOW UP

Recommendations

- The study to be performed is the angio-tomography.

- The recommended frequency is after 30 days, 6 months, 1 year and once a year for life.

- Simple radiology and digital arteriography are methods that can be used to evaluate possible progressive complications.

LATIN AMERICAN REALITY

-TAAA endovascular treatment constitutes an extremely complex procedure with high morbidity and mortality rates, even in highly experienced centers.

- TAAA endovascular treatment should be performed by teams highly trained in endovascular and open techniques.

- This therapeutics should be performed in qualified centers with high-resolution technological equipment and imaging storage according to the procedure complexity. ■