Debranching Solutions in Endografting for Complex Thoracic Aortic Dissections

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Abstract

Background: **Conventional surgical repair of thoracic aortic dissections is a challenge due to mortality and morbidity risks.**

Objectives: **We analyzed our experience in hybrid aortic arch repair for complex dissections of the aortic arch.**

Methods: **Between 2009 and 2013, 18 patients (the mean age of 67 ± 8 years-old) underwent hybrid aortic arch repair. The procedural strategy was determined on the individual patient.**

Results: **Thirteen patients had type I repair using trifurcation and another patient with bifurcation graft. Two patients had type II repair with replacement of the ascending aorta. Two patients received extra-anatomic bypass grafting to left carotid artery allowing covering of zone 1. Stent graft deployment rate was 100%. No patients experienced stroke. One patient with total debranching of the aortic arch following an acute dissection of the proximal arch expired 3 months after TEVAR due to heart failure. There were no early to midterm endoleaks. The median follow-up was 20 ± 8 months with patency rate of 100%.**

Conclusion: **Various debranching solutions for different complex scenarios of the aortic arch serve as less invasive procedures than conventional open surgery enabling safe and effective treatment of this highly selected subgroup of patients with complex aortic pathologies. (Arq Bras Cardiol. 2014; 103(2):154-160)**

Keywords: **Aorta, thoracic / surgery; Heart Valve Prosthesis; Mortality.**

Introduction

Open surgery for complex thoracic aortic pathologies involving the aortic arch still carries a significant rate of mortality and morbidity. Open repair often involve cardiopulmonary bypass with hypothermic circulatory arrest and various cerebral preservation techniques[1-6]. Introduction and evolution thoracic endovascular aortic repair (TEVAR) techniques have contributed in treatment of a wider range of patients with higher comorbidity index[5,7]. Combining conventional surgical techniques with endovascular technology, the "hybrid" aortic arch repair minimizes the operation by either eliminating or significantly simplifying and shortening the arch reconstruction period, thus limiting the duration of circulatory arrest and cerebral ischemia. We assessed our institutional outcomes in patients undergoing Types I and II hybrid aortic arch repair with different debranching techniques.

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Methods

Between 2009 and 2013, 18 patients (the mean age of 67 ± 8 years-old) underwent type I or II hybrid aortic arch repair with different debranching approaches. The extent of debranching and the strategy of surgical approach were determined on individual patient pathophysiology requiring coverage of either landing zone 0 (Z0) or 1 (Z1)[1-3]. The hybrid arch concept essentially entails three main principles: (I) open debranching of the great vessels; (II) creation of proper proximal (zone 0 landing) and distal landing zones, and; (III) concomitant or delayed endovascular stent grafting of the aortic arch. The classification scheme for hybrid arch debranching procedures is based on the extent of proximal and distal landing zone reconstruction required, and thus the need and extent of cardiopulmonary bypass and circulatory arrest management strategies to be employed[2,3]. All patients were followed prospectively based on mortality, stroke, hospital stay, aneurysm diameter, patency of the bypass grafts and endostent-related morbidity. Type III aortic arch repairs and conventional TEVAR cases with or without subclavian artery coverage for distal aortic arch pathologies were not included. Descriptive statistics, including means and standard deviations for continuous measures and frequencies for categorical measures, were generated using SPSS 21.0 (Statistical Package for the Social Sciences, SPSS Inc.).

Results

From 2009 to present, 10 patients with a history of ascending aortic repair for an acute type A dissection, 7 patients with complex type B aortic dissection and 1 patient acute aortic arch dissection with initial tear at the level of brachiocephalic trunk underwent hybrid aortic arch repair. Endografting was performed on the following day of the debranching procedure in all patients except for the type A dissection patients in whom an ascending aortic repair with debranching of the supraaortic branches and TEVAR three weeks later when indicated. The mean aneurysmal diameter was 64 ± 5.29 millimeters (Table 1). All patients were followed prospectively. All received cerebrospinal fluid pressure monitoring and drainage system on a routine basis. 13 patients had a standard type I arch repair with debranching of the all three supraaortic vessels with a trifurcation graft (Figure 1). One patient had a bifurcation graft anastomosed to ascending aorta in an end-to side fashion as the aortic arch was highly dilated and left subclavian artery was unreachable through median sternotomy, thus an additional left caroticosubclavian bypass was performed (Figures 2 a and b.). This latter patient also had an aberrant right subclavian artery, which was the main determinant for conversion from conventional open arch repair to a hybrid approach. Two patients had ascending aortic aneurysm in addition to type B dissection with thoracic aortic diameters 62 and 66 millimeters, respectively. Type II arch repair was performed in these two patients with replacement of ascending aorta and the hemiarch with tri-branched 24-mm Dacron graft (Hemashield Platinum,Woven Double Velour; Boston Scientific Corporation, Wayne, NJ, USA) prior to retrograde TEVAR on the following day. One of the latter patients also had aortic valve replacement during ascending aorta replacement (Figure 3).

The remaining two patients had complicated type B aortic dissection with the initial tear involving subclavian artery in both patients. Both patients also had severe chronic obstructive lung disease with low functional capacity. Sternotomy was thus avoided and alternative debranching techniques were adopted to allow Z1 coverage. A right subclavian to left carotid artery bypass was performed in one of these patients (Figure 4). A carotid-carotid and bypass was performed in the other. Left subclavian bypass was not performed in the latter two patients. Neither developed adverse neurological events or stroke.

Table 1 – Patient characteristics

	Patients (n)
Type I Debranching	14
Type II Debranching	2
Type III Debranching	0
Extra-anatomical bypass	2
Age (Mean±standard deviation years)	67 ± 8
Followup (Median ± standard deviation months)	20 ± 8
Aneurysm Diameter (Mean±standard deviation milimeters)	64 ± 5.29
Hospital Stay (Mean±standard deviation days)	17.2 ± 14

All patients had control CT scans before discharge from the hospital, at 1 month, and every 3 months until the end of first year. Stent graft deployment rate was 100% after arch vessel debranching. No patients experienced stroke. One patient with total debranching of the aortic arch following an acute dissection of the proximal arch expired 3 months after TEVAR due to heart failure. There were no early to midterm endoleaks or migration. The mean length of hospital stay was 17.2 ± 14 days. The median follow-up was 20 ± 8 months. Patency of all bypasses was 100%. At the end of 12 months, 17 patients were alive with complete thrombosis of the false lumen in 12 patients. Partial thrombosis was observed in the remaining two patients with no aneurismal enlargement or malperfusion signs. 3 patients had re-entries at the level of abdominal aorta and are closely followed.

Discussion

Hybrid approaches for the treatment of aortic arch aneurysmal pathology are being performed with increasing frequency. This is a reflection of the increasing comfort level of the interventionists with endovascular technology, and the improving technology of endovascular platforms to successfully land stent grafts in the proximal thoracic aorta. In addition to the associated operative mortality of complex operations such as aortic arch hybrid procedures, the Achilles heel of this intervention remains neurologic complications. Several groups have shown that arch hybrid procedures can be performed with acceptable mortality, with very minimal postoperative and long-term endoleak rates[1,2,8,9]. In a recent systematic review of hybrid arch operations in 1886 patients, pooled mortality was 10.8%, with 15.1% mortality in diseases that extended to the ascending aorta[10]. In our experience, only one patient expired in the early (3rd month) period (12.5%) that had undergone a type I repair in the acute setting. No in-hospital deaths/stroke was observed.

A complication unique to the hybrid aortic arch cohort of patients is the occurrence of endoleaks. Data on endoleak rates with hybrid arch repair is not well defined, with long-term follow-up data being virtually absent. Endoleak rates have ranged from 0% to 15%[1-3,8]. Similar to TEVAR, hybrid arch operations associated with Types I and III endoleak are associated with greater morbidity than Type II endoleak. In a report by Kotelis *et al*[9], patients undergoing hybrid arch repair with zone 0 proximal landing had lower endoleak rates than zone 1 landing. In our overall experience with TEVAR as well as hybrid arch procedures, we have observed similar results mostly due atherosclerotic arch or the conic nature of the landing zones due to supraaortic branch ostia. Currently, we have adopted a type I repair strategy if Z1 coverage is not deemed to be satisfactory (Figure 5). Thus, atheromatous load on the landing zones inside the aortic arch is to be avoided leading to more satisfactory results. Additionally, satisfactory sealing of aorta with no resultant endoleaks allows the interventionist to cover shorter aortic segments with this strategy possibly leading to more favorable neurological outcomes. Patient with right subclavian to left carotid artery bypass was initially treated with straightforward TEVAR with coverage of left subclavian artery. He was referred to our team with proximal type I

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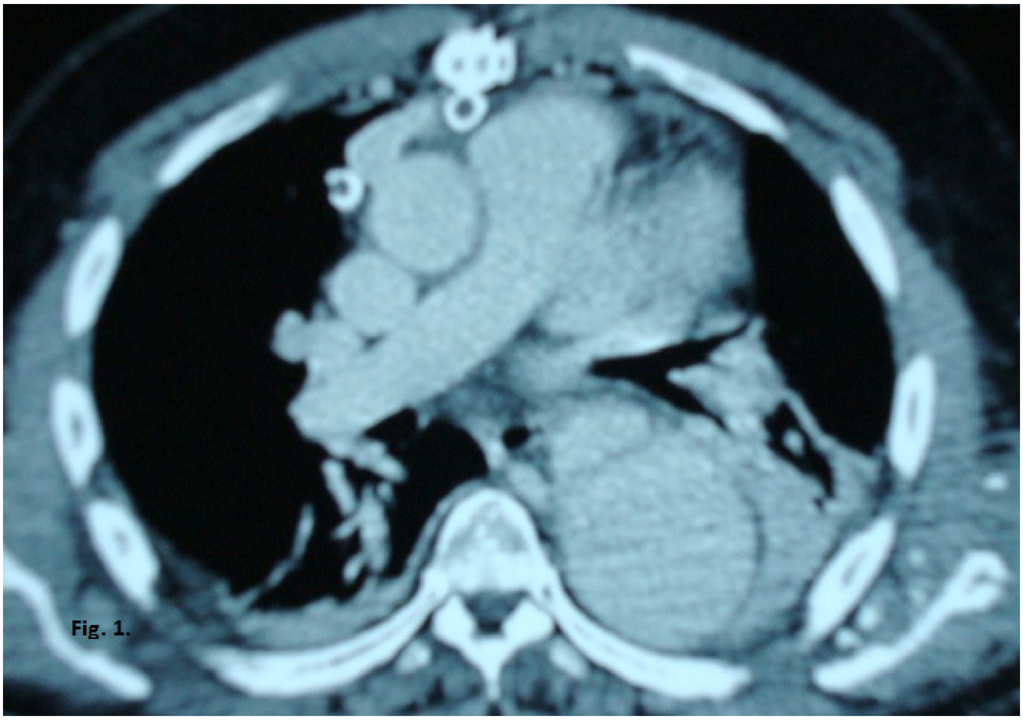

Figure 1 – *End-to-side anastomosis of a debranching graft at the level of ascending aorta.*

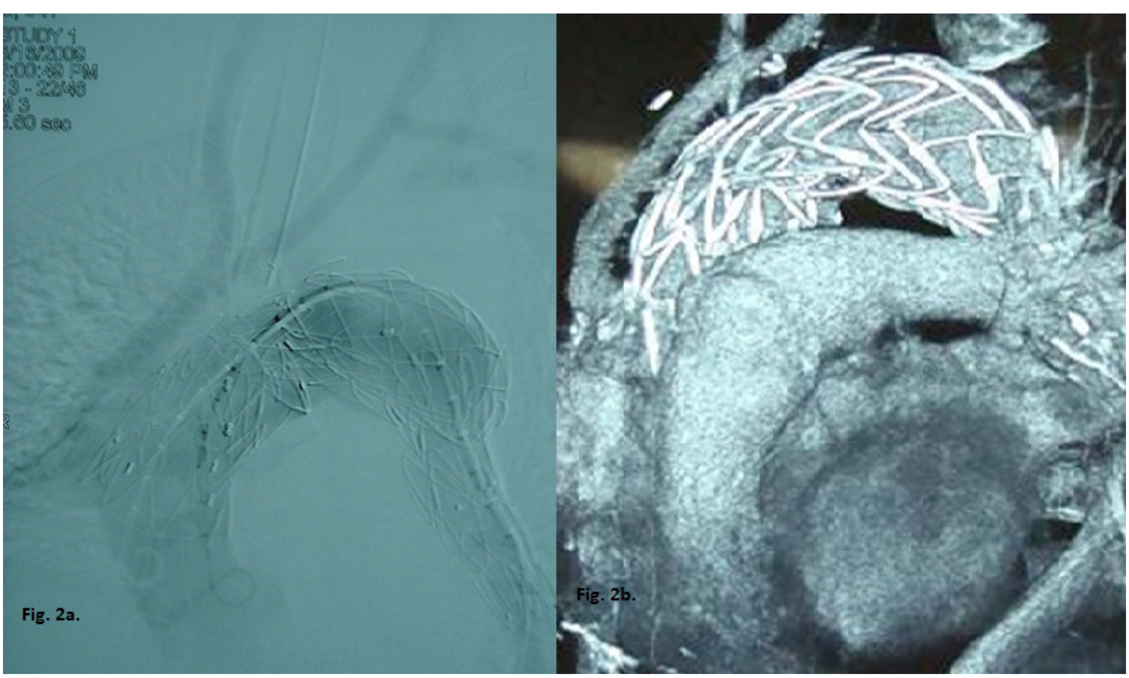

Figure 2 – *Digital substraction angiography yielding bifurcation graft from ascending aorta and left caroticosubclavian artery prior to thoracic endografting (a). CAT scan of the same patient (b).*

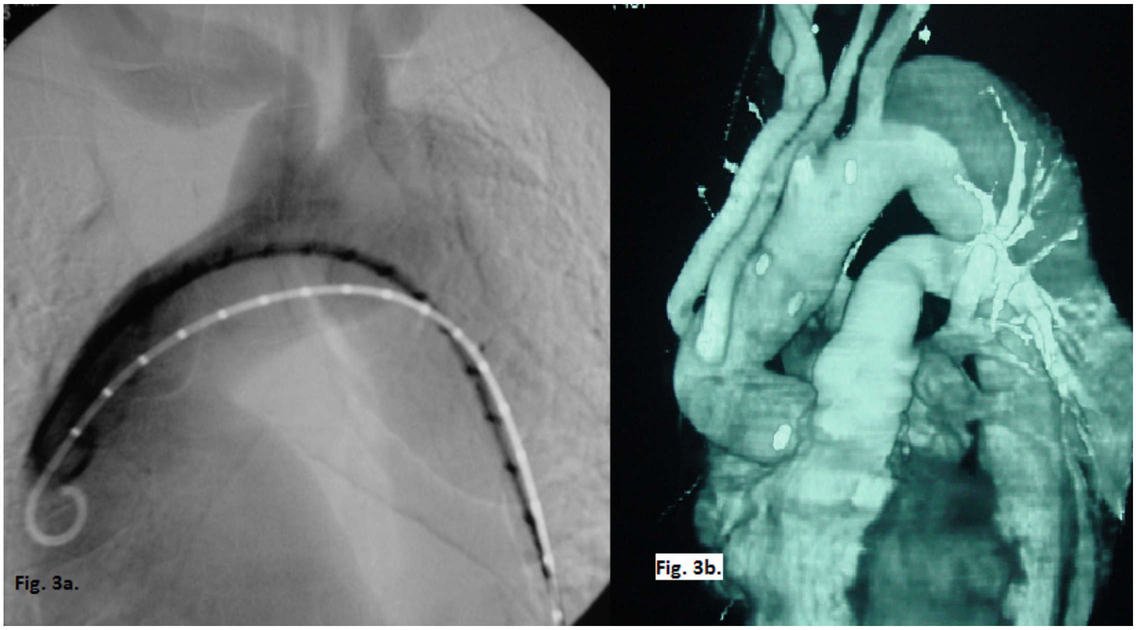

Figure 3 – *Preoperative digital subtraction angiography of the patient with ascending aorta and thoracic aortic dissection (a). Note that the distance between left carotid artery and the left subclavian artery is almost 1 centimeter and that left carotid artery and brachiocephalic truncus ostia are almost at the same level. A type II arch repair is anticipated to allow safe endografting on Z0. CAT scan of the same patient following ascending aortic replacement (b).*

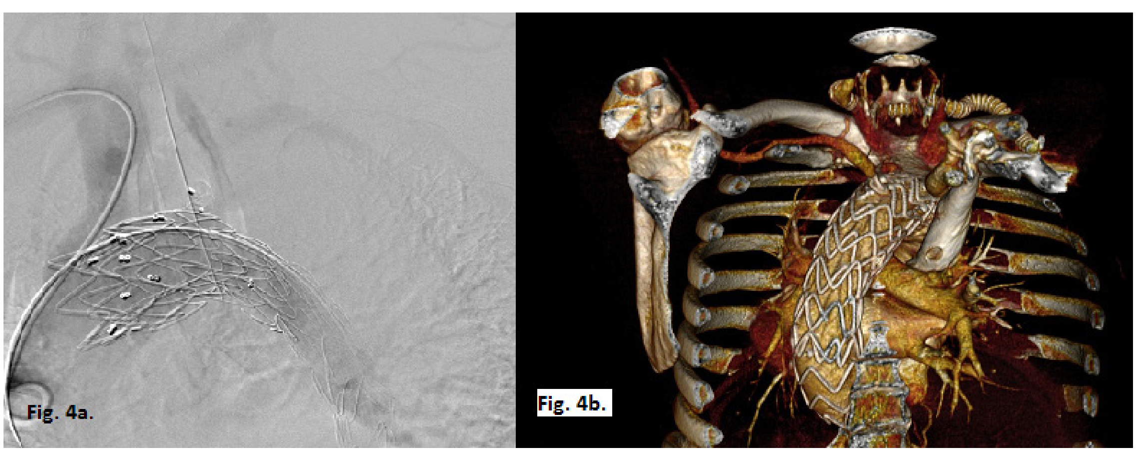

Figure 4 – *Perioperative angiogram of the patient with patent graft from right subclavian artery to left common carotid artery. Note that the false lumen in the thoracic aorta does not receive contrast-filling (a). Postoperative CAT scan of the patient (b).*

endoleak at the level of left carotid ostium. We managed this patient with severe chronic lung disease adopting a practical approach to extend the endograft as proximal as the brachiocephalic trunk ostium as described above.

A recent analysis elaborated on the retrograde dissection following endografting based on different endostent brands[11]. In this small group of patients, we have not observed retrograde aortic dissection and all patients received Valiant device (Medtronic, Minneapolis, MN).

Experience in a limited number of patients is not conclusive and presentation of selected patients may hinder a true outcome analysis. Lack of control group may also contribute in inconclusive results. Most studies in this field represent a balanced distribution between staged versus single- stage procedures[10,12,13]. Most authors have not included the staged or single-stage approach as a variable affecting the outcome[10,14]. More data is to be presented such as comparison of outcomes with open repair group as the experience grows. However,

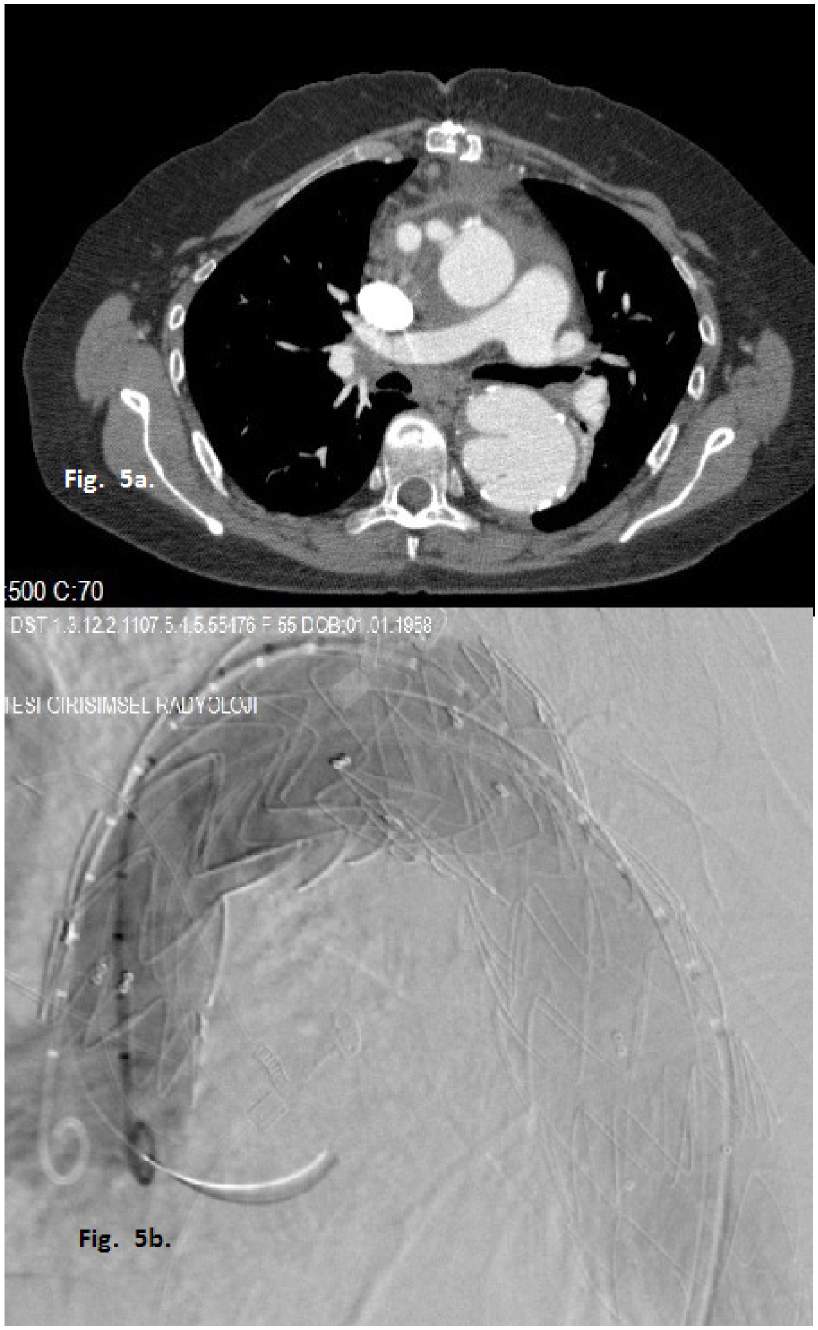

Figure 5 – *Pre- TEVAR CAT scan of the patient with a history of ascending aortic repair and debranching with a bifurcation graft for a type A aortic dissection (a). Periprocedural DSA of the patient with the patent debranching of the supra-aortic branches and TEVAR covering both ascending aortic graft, aortic arch and the descending aorta (b).*

presentation of different solutions in these complex situations and patients with comorbidities may serve as an insight in managing this pathology.

Conclusions

Hybrid approach for complex aortic arch dissections appears promising although the long-term results and the use in various clinical settings are to be evaluated. Close follow up is warranted due to complicating nature of the lesions.

Author contributions

Acquisition of data: Goksel OS, Guven K, Karatepe C, Gok E; Analysis and interpretation of the data: Goksel OS, Acunas B, Cinar B, Alpagut U; Writing of the manuscript: Goksel OS, Gok E; Critical revision of the manuscript for intellectual content: Goksel OS, Guven K, Alpagut U.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

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