Aortic remodeling after thoracic endovascular repair of acute uncomplicated type B aortic dissection

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Introduction
The classical treatment of type B aortic dissection is based on either medical treatment for uncomplicated aortic dissection or open surgery. Now with improvements in endovascular intervention, it seems to be more effective, safe, and with favorable effects on aortic remodeling.
Patients and methods
This is a retrospective study that aimed to evaluate the effect of thoracic endovascular repair (TEVAR) on remodeling in uncomplicated acute type B aortic dissection. Serial contrast-enhanced computed tomography scans of 32 patients with acute type B aortic dissection were performed and the data were collected between March 2018 and October 2018. Thirteen patients received best medical therapy only and 19 patients received best medical therapy and TEVAR, and the effect of TEVAR on aortic remodeling was compared by a computed tomography scan.
Results
Data of 32 patients (20 men and 12 women) with a median age of 59 years were collected; the median follow-up period was 6 months. TEVAR resulted in an increase in the true lumen diameter (from 2.0085 to 3.039 cm) and a decrease in the false lumen diameter (from 1.8767 to 0.785 cm). However, in the medical group only, the diameters remained almost unchanged (true lumen diameter ranged from 1.9024 to 2.3898 cm and false lumen diameter ranged from 1.9045 to 1.7245 cm).
Conclusion
TEVAR for acute type B aortic dissection resulted in a significant increase in the true lumen diameter and decrease in the false lumen diameter.

Keywords:
dissection, remodeling, type B, uncomplicated

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Introduction

Acute type B aortic dissection is a life-threatening disease, with a 5-year mortality of 30–40% [1]. Most of the patients with acute uncomplicated type B aortic dissection (uTBAD) can be treated by intensive medical treatment. However, about 20% of the patients develop complications such as aneurysmal dilatation, rupture, branch-vessel mal perfusion, and refractory pain, which need urgent surgical or interventional therapy [2,3]. Aggressive and careful control of blood pressure are recommended as standards for the treatment of uTBAD, which seems to be safe, but the long-term results are less than ideal [4]. Clinical studies of thoracic endovascular repair (TEVAR) for aortic remodeling have shown better and favorable outcomes at the 1-year follow-up and improvement in aortic-related mortality [5].

Patients and methods

This study was carried out in 32 patients who presented with acute type B aortic dissection and analyzed as morphological remodeling, evidenced by false lumen thrombosis-shrinking false lumen – absence of aortic diameter progression.

Patients' selection

Only patients with nontraumatic uncomplicated acute type B aortic dissection (uATBAD) treated with best medical therapy (BMT) or TEVAR plus BMT were included in this study.

Treatment

All cases of uATBAD received BMT with close monitoring of their hemodynamics in the ICU with invasive blood pressure monitoring. Pain was treated with narcotic analgesics. Heart rate and hypertension were controlled aggressively with β-blockers, angiotensin-converting enzyme inhibitors, and calcium

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channel blockers, and arterial vasodilators were also administered for refractory hypertension. Targeted heart rate was around 60 beats/min and blood pressure was below 120 mmHg. TEVAR as a primary management was performed when (a) the Initial aortic diameter was 4 cm or more with patent false lumen and (b) the initial false lumen diameter was equal to or more than 22 mm in the proximal descending aorta. Conversion to TEVAR was performed in case of (a) refractory hypertension and/or recurrent pain, (b) aneurysmal degeneration, and (c) increase in aortic diameter more than 1 cm per year.

Study plan

CTAs obtained pretreatment, at discharge, and upon return for follow-up visits at 1 month, 3 months, 6 months, and yearly.

Morphological evaluation

All the images were analyzed using a DICOM software (Pixmeo SARL, Geneva, Swiss) that was used to produce 3D reconstruction of the axial cuts. Diameters perpendicular to the centerline were determined for the following reproducible location for both study groups (aortic diameter at the left subclavian artery and the left carotid artery, maximum aortic diameter, diameters of true lumen and false lumen at the maximum aortic diameter, aortic diameter at the levels of the celiac artery, right, and left renal arteries). For the TEVAR group, the following measurements were also performed: length of stent graft, mid, and end stent diameters.

Statistical analysis

Data were processed using the SPSS/PC software. Means and SD, medians, and ranges were used to describe continuous variables; absolute numbers and percentage frequencies were used for categorical factors.

Table 1 Epidemiological factors of the two groups

	TEVAR+BMT	BMT only
Male	13	7
Female	6	6
Mean age	59.2	63.1

Results

This study included 32 patients (20 men and 12 women) who presented with acute uTBAD. Thirteen (40.6%) patients received best medical therapy only and 19 (59.4%) patients received BMT and TEVAR.

Table 1 shows the distribution of epidemiological factors between the two groups.

In terms of the risk factors, there was no significant difference between the two groups (Table 2).

Table 3 shows the evaluation of measurments at different levels of the aorta of the patients at first presentation.

There was no significant difference between the two groups in any of the means of the evaluated measurments on the patient's first presentation.

Procedures

In the TEVAR group, right femoral access was used in 14 (73.6%) patients, whereas left femoral access was used in five (26.4%) patients. One stent graft was inserted in 15 (78.9%) patients, two stents in three

Table 2 Risk factors of the two groups

Risk factor	TEVAR+BMT (%)	BMT only (%)	*P* value
Hypertention	97	100	0.236
Coronary disease	8	14	0.325
COPD	11	14	0.673
PAD	5	12	0.193
Smoking	31	26	0.257
DM	7	14	0.193

BMT, best medical therapy; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; PAD, peripheral arterial disease; TEVAR, thoracic endovascular repair.

Table 3 Evaluation of measurments at different levels of the aorta of the patients at first presentation

Measurments (cm)	BMT		TEVAR+BMT	
	Mean	SD	Mean	SD
Diameter of the arch at LSA	3.0519	0.47257	3.1885	0.60592
Diameter of the arch at LCA	3.1381	0.45406	3.1897	0.49122
Maximum aortic diameter	3.9745	0.63851	4.1144	0.61214
Diameter of the true lumen at the maximum aortic diameter	1.9024	0.63775	2.0085	0.84311
Diameter of the false lumen at the maximum aortic diameter	1.9045	0.77893	1.8767	0.83927
Diameter at the celiac trunk	3.0283	0.48629	2.9512	0.41889
Diameter at the right renal artery	2.5843	0.51796	2.5579	0.39387
Diameter at the left renal artery	2.5818	0.52394	2.5453	0.39281

BMT, best medical therapy; LCA, left carotid artery; LSA, left subclavian artery; TEVAR, thoracic endovascular repair.

(15.7%) patients, and three stents in one (5.4%) patient. Gore C-TAG stent was inserted in 16 (84.2%) patients, the Zenith TX2 stent was used in two (10.5%) patients, and Valiant Captiva was used in one (5.3%) patient. The left subclavian artery was covered with the stent graft in three (15.8%) patients (Table 4).

Table 4 Access, type, and number of stents and coverage of the left subclavian artery

Stent graft per patient	1.23 (1–3)
Number of stent grafts used	
Gore C-TAG	52 (84.2)
Zenith TX2	6 (10.5)
Valiant Captiva	3 (5.3)
Femoral access	
Right	14 (73.6)
Left	5 (26.4)
Coverage of the left subclavian artery	3 (15.8)

Aortic remodeling: The median follow-up period was 6 months (range: 3–18); 11 patients received follow-up for more than 12 months and three of these received follow-up for more than 18 months.

Table 5 shows the evaluation measurments at follow-up.

The statistical analysis of the follow-up data showed that there was a significant difference between the two groups in the false lumen diameter (Fig. 1), which was reduced to 0.7850 cm in the TEVAR group (from 1.87 at presentation) versus an insignificant reduction in false lumen diameter to 1.725 cm (from 1.9 cm at presentation) in tne BMT group (P=0.000).

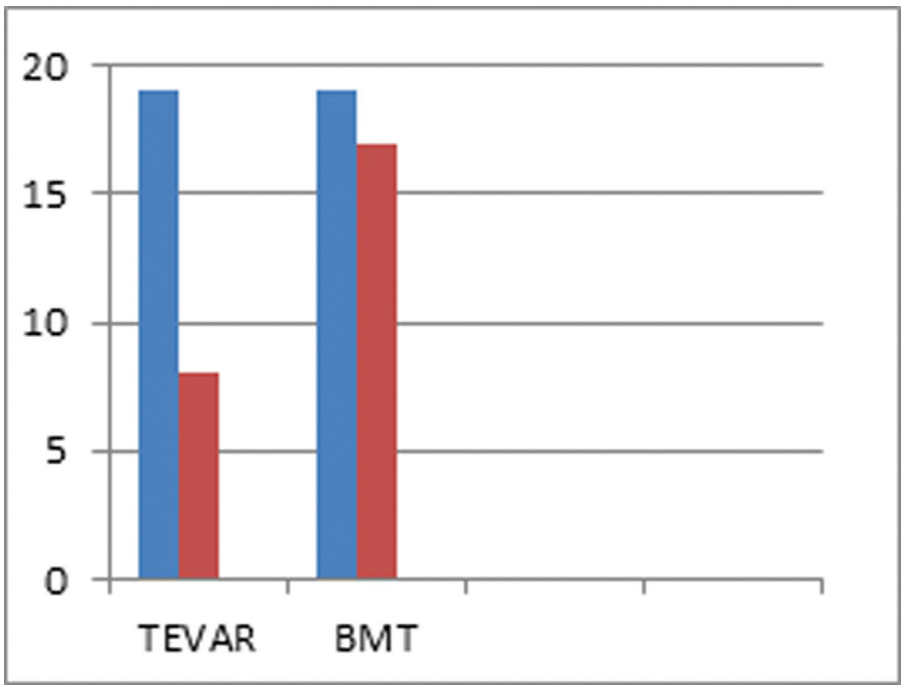
There was also a significant difference between the two groups in the true lumen diameter (Fig. 2), which

Table 5 Evaluation of measurments at different levels of the aorta of the patients at follow-up

Measurements (cm)	BMT		TEVAR+BMT		*P* value
	Mean	SD	Mean	SD	
Diameter of the arch at LSA	3.0773	0.49665	3.1316	0.47011	0.614
Diameter of the arch at LCA	3.1459	0.5126	3.1846	0.48555	0.723
Maximum aortic diameter	4.2497	0.86351	3.9646	0.7057	0.085
Diameter of the true lumen at the maximum aortic diameter	2.3898	0.89832	3.039	0.73551	0
Diameter of the false lumen at the maximum aortic diameter	1.7245	1.10584	0.785	0.94221	0
Diameter at the celiac trunk	3.0811	0.53198	2.9622	0.5118	0.229
Diameter at the right renal artery	2.5847	0.5737	2.5921	0.46359	0.949
Diameter at the left renal artery	2.5617	0.55443	2.5636	0.45257	0.68

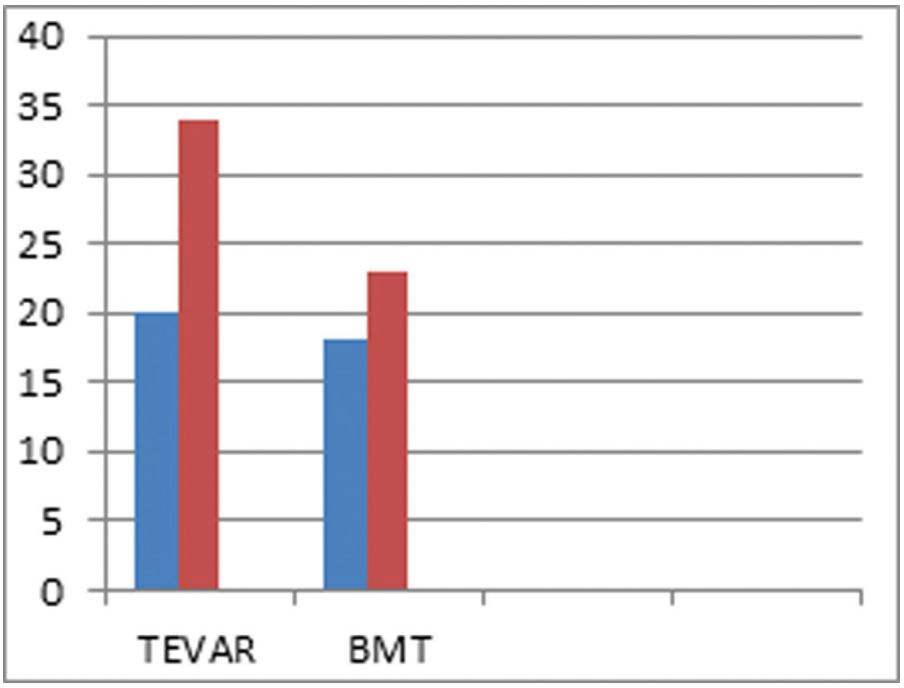
BMT, best medical therapy; LSA, left subclavian artery; TEVAR, thoracic endovascular repair.

Figure 1



Changes in the mean false lumen diameter.

Figure 2



Changes in the mean true lumen diameter.

increased to 3.04 cm in the TEVAR group (from 2.1 cm at presentation) versus an insignificant increase to 2.3898 (from 1.9 cm at presentation) in the BMT group (P=0.000).

The maximum aortic diameter was reduced to 3.9646 cm in the TEVAR group (from 4.11 cm at presentation), whereas it was increased to 4.2497 cm in the BMT group (from 3.97 cm at presentation), but the difference between the two groups did not reach clinical significance (P=0.085).

In terms of the false lumen thrombosis, the TEVAR group showed a significant advantage over the BMT group in terms of inducing complete false lumen thrombosis (P=0.007).

Figure 3 shows computed tomography angiography of a patient who presented with acute type B aortic dissection and immediately after TEVAR and at the 1-year follow-up.

Discussion

The results of the study showed the safety and efficacy of the new trends in the treatment of acute uTBAD and challenge the results of the default medical management alone with a focus on blood pressure control.

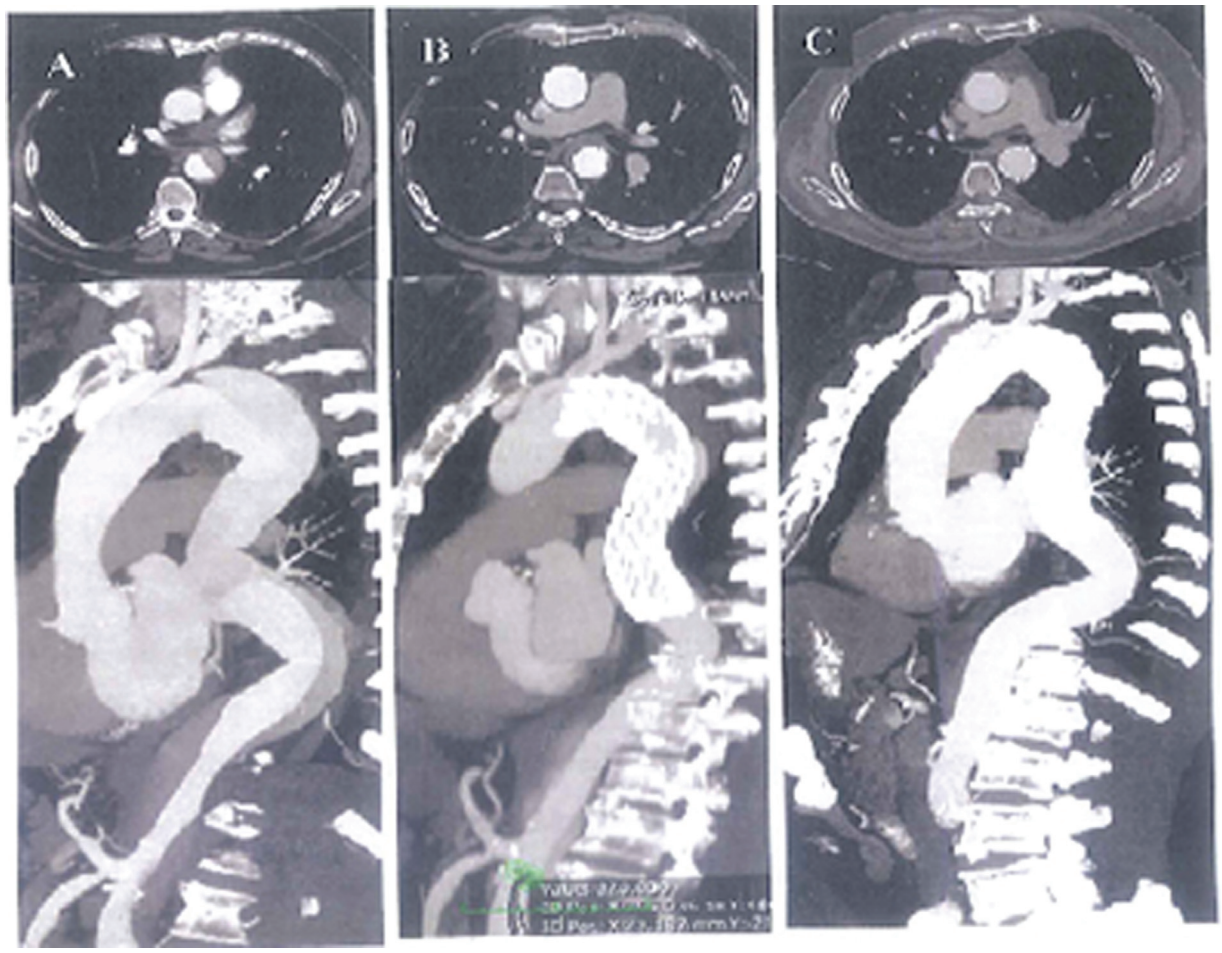
Long-term results of the INSTEAD-XL trial challenge the current consensus on management of acute uTBAD, for example, usual medical management with a focus on control of blood pressure and surveillance because the long-term prognosis of acute type B aortic dissection showed a mortality rate of 20–42% at 5 years [6,7].

Medical management alone may at best delay progressive expansion. TEVAR in the subacute stage of aortic dissection induces aortic remodeling and a decrease in aortic-related mortality at 5 years compared with the best medical treatment, with the option of crossover to TEVAR or open surgery when complications occur [8,9].

Several studies have shown the limited ability of medical treatment alone in inducing aortic remodeling, preventing the progression of aortic diameter and false lumen diameter, or in inducing thrombosis of false lumen compared with TEVAR [8–12].

Studies carried out on the cohort of complicated type B aortic dissection showed not only decreased early complications and mortality rates with TEVAR but also TEVAR-induced remodeling of the aorta with a progressive reduction in the maximum aortic diameter, increased true lumen diameter, reduction of the diameter of false lumen, and complete or partial thrombosis of false lumen [10–12].

Figure 3



Remodeling of the aorta after TEVAR. (a) Computed tomography angiography (CTA) of a patient who presented with acute type B aortic dissection. (b) Immediate postoperative CTA showing successful coverage of the entry tear. (c) CTA at 1 year showed complete expansion of the stent graft and involution of the false lumen.

The results of the two studies carried out on the cohort of uTBAD showed the intermediate-term and long-term benefits of TEVAR on the remodeling of the aorta [8,9].

The 5-year results of INSTEAD-XL showed, with elective TEVAR for type B aortic dissection, an association with favorable and better aortic remodeling and long-term survival despite early hazards, although best medical management alone was associated with failure to prevent progressive expansion or late complications triggering steady crossover to TEVAR at 5 years [8].ADSORB was the first and the only prospective randomized and clinical study of acute uTBAD. The endpoint analysis showed that the results of the TEVAR plus best medical treatment group were significantly more effective than those of the best medical treatment group only. There was significantly more remodeling in the first year among the patients in the TEVAR plus medical treatment group than in the best medical treatment-only group, and there was no dissection-related mortality in both groups [9].

The results of our study showed favorable outcomes of pre-emptive TEVAR with BMT in terms of the aortic remodeling. This was evidenced by a significant reduction in the false lumen diameter (from 18.767 to 7.850 mm; P=0.00), a significant increase in the true lumen diameter (from 20.1 to 33.9 mm; P=0.00), stabilization of the maximum aortic diameter (from 41.14 to 33.90 mm; P=0.130), and significantly higher ability to induce complete false lumen thrombosis (61 vs. 33% in the TEVAR+BMT group; P=0.007) compared with the BMT-only group.

Conclusion

Primary TEVAR with the best medical treatment proved to be a relatively effective and safe strategy for the treatment of uATBAD with favorable effects on aortic remodeling and resulted in a significant

increase in the true lumen diameter and decrease in the false lumen diameter compared with the best medical treatment alone.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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