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Chronic Residual Aortic Dissection after Type A Aortic Dissection Repair: 7-year Results

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Abstract

BACKGROUND: Residual Type B aortic dissection (RTBAD) after Type A aortic dissection (TAAD) repair is a serious disease that requires reintervention. Thoracic endovascular aortic repair (TEVAR) for RTBAD after TAAD repair is an acceptable choice for this problem.

AIM: This study aimed to investigate the outcomes of extended coverage of the descending thoracic aorta by TEVAR for RTBAD after TAAD repair.

METHODS: This was a retrospective study. From November 2017 to August 2022, 12 patients were enrolled in this study. Patients underwent extended TEVAR for residual chronic Type B aortic dissection after TAAD repair. Data were collected from 12 patients in this period, and detailed patient characteristics were analyzed before, early after, and periodically after procedure. At the same time, we tried to develop an algorithm for this group of the patients.

RESULTS: TEVAR consisted of isolated TEVARs (n = 12). The mean time from TAAD repair to TEVAR was 27 ± 33 months (2–86 months). Technical success of TEVAR was 100%. The distal ends of the stent grafts were T 8 (eight cases), T 9 (four cases). The average length of hospital stay after TEVAR was 3.41 day (2–5 days). There were no surgical/hospital deaths or complications. The average postoperative follow-up period was 26.75 months (22–34) without death or reintervention.

CONCLUSION: The short-term outcomes of extended TEVAR for residual chronic Type B aortic dissection after TAAD repair were acceptable without major adverse aortic events. By careful systematic evaluation of the patients, coverage of the descending thoracic aorta may prevent aortic events, but middle-and long-term results should be clarified.

Introduction

It is known that ascending aorta or hemiarch repair (HR) after Type A aortic dissection (TAAD) offers several advantages over total aortic arch repair: It shortens myocardial ischemia time, cardiopulmonary bypass (CPB) time, and operation time, and it decreases intraoperative blood loss and the transfusion requirement [1]. Both ascending aorta repair (AAR) and HR are associated with the presence of a residual patent false lumen in the descending aorta. Residual Type B aortic dissection (RTBAD) is a challenging clinical issue associated with risk of catastrophic complication such as rupture and/or end-organ malperfusion. A patent false lumen frequently enlarges and is a well-known risk factor for aortic growth, reinterventions, and mortality [2]. The residual dissection can lead to a new intimal tear that acts as communicating channel between the true and false lumen, and eventually leading to the redistribution of high pressure in favor of the false lumen [3].

The aim of the study was to report our clinical outcomes of extended coverage of distal thoracic aorta by thoracic endovascular aortic repair (TEVAR) for RTBAD. This study aims to form an “TEVAR algorithm” for this subset of patients.

Materials and Methods

This is a retrospective study from the same surgery team. From November 2017 to August 2022, 12 patients underwent extended TEVAR for residual chronic Type B aortic dissection after TAAD repair. The patient’s characteristics including initial procedures for TAAD and status of residual aortic dissection after initial repair are shown in Table 1. Eight patients had previously underwent an AAR + HR and four patients modified Bentall procedure + HR.

All patients were followed up with a post-operative computed tomography (CT) scan after discharge from the first procedure at 6 and 12 months and then annually. The diameter of the aorta was measured, and the false lumen was examined. The

Table 1: Demographic variables of the patient (preintervention)

Patient	12
Age, Y	64,83 (max. 78, min. 55)
Male	7
Hypertension	12
Diabetic	8
Chronic obstructive lung disease	2
Peripheral arterial disease	5
Chronic renal failure	0
Chest, back, or abdominal pain	5
Preoperative stroke	0
Reoperation	0
CT findings	0
Descending Thoracic	12
Abdominal extension	10
Iliac or beyond iliac extension	5
Residual intimal flap	12
Initial procedure	
AAR+Hemiarch replacement	8
Bentall procedure+Hemiarch replacement	4

AAR: Ascending aorta replacement.

false lumen was diagnosed as patent or thrombosed if blood flow was detectable or undetectable, respectively, in false lumen during the late phase of CT with contrast infusion. If patients were assessed by CT more than twice after discharge hospital, the most recent image was used to determine aortic growth rates.

Our decision indications for extended TEVAR were as follows: Rapid growth (aortic diameter more than 55 mm, aortic expansion of 10 mm or more in 1 year), persistent symptomatic malperfusion (manifested as abdominal angina or intermittent claudication), and residual tear in DTA. Patients without criteria listed above were excluded. Following carefully evaluation of the patients, we decided to perform or not TEVAR. We received informed consent from the patients and their family for procedure. Postoperative complications included perioperative incidence of SCI, stroke, renal failure newly requiring dialysis, reintervention, and mortality.

First intervention for TAAD-operative technique

Shortly, initial surgery for TAAD was performed in our center in the standard fashion. After systemic heparinization, CPB was established by direct cannulations of the right axillary artery. Retrograde cold blood cardioplegia was infused every 15 min. Circulatory arrest (CA) was instituted when the vesical temperature was 25°C. We preferred moderate hypothermia with anterograde cerebral perfusion (ACP) for cerebral protection during CA. In all cases, bilateral invasive blood pressure monitoring was performed through radial arteries. Intraoperative cerebral monitoring was provided by near-infrared spectroscopy.

When the entry was located in the ascending aorta, we performed the replacement of the ascending aorta with the hemiarch aorta. All distal anastomosis was performed in the opened fashion during moderate hypothermic CA with CPB and selective ACP (to include repair of the lesser curvature of the arch).

Partial arch replacement was performed in two cases of primary entry tear between the innominate artery (IA) and left subclavian artery. In these cases, the IA was debranched in the proximal part of ascending aortic repair.

Aortic root replacement with a valved-conduit prosthesis was performed according to the modified Bentall procedure in patients with dilatation of the aortic root or an aortic root damaged by the entry tear.

Second intervention-TEVAR

Our decisions parameters for reinterventions-TEVAR were malperfusion syndrome, pain, aortic aneurysmal evolution (diameter of the thoracic aorta of 55 mm or greater, or impending rupture of the aorta or rapid aortic growth 10 mm/year). Patients with a thrombosed false lumen (no contrast in the false lumen), small false lumen, and descending aorta-true lumen <45 mm were excluded from the intervention. Validation of these interventions and the choice of surgical procedure for all cases were decided in multidisciplinary approach. Following stepwise evaluation described above, we decided for each patient whether we should go toward TEVAR or not. Intervention was done under local anesthesia through a groin incision with open femoral arteriotomy. A guidewire and pigtail catheter were introduced into the true lumen, in retrograde manner, up to the ascending aorta under fluoroscopic guidance and evaluate the proximal (zone 3 or 4) and distal landing zones. The delivery system was introduced through the femoral arteriotomy and advanced using a stiff guide wire. In case of short proximal landing zone (<20 m), one of the following strategies was applied to create an extra proximal landing zone: intentional coverage of the left subclavian artery, if the right vertebral artery was patent and dominant, or physician-modified fenestrated device. The decision to extend the proximal landing zone was based on the location of the main new entry tear (on distal anastomosis of the ascending aortic repair or in the descending thoracic aorta). The distal extension of the stent graft was based on the distal extension of the dissected aortic aneurysm.

Statistical analysis

Statistical analysis was performed using the Microsoft Office, Excel Software (Microsoft Office). All numerical data were expressed in mean ± standard error, while categorical variables were expressed in percentage.

Results

Of the 48 consecutive patients operated for TAAD involving the ascending aorta and arcus aorta (including lesser curvature of the arcus aorta), 42 had dissection extending at least beyond the aortic arch. From these 42 patients, 18 had RTBAD. Three of the patients left the study and medical treatment was decided for other 3 patients. In the end, 12 patients underwent TEVAR procedure (Figure 1). Of the patients that underwent TEVAR procedure, the mean patient age was 64.83 year (55–78), and 7 patients were men (58.33%). Hypertension was diagnosed in all patients (100%). The characteristics and pre-operative data are displayed in Table 1. Their previous operations were Ascending Aorta Replacement + partial arch resection (seven patients) and modified Bentall procedure + partial arch resection (five patients). Partial arch resections were done with extensive resection of the lesser curvature of the arcus aorta. Indications for TEVAR was aneurysmal progression in 12 cases, malperfusion in 5 (chest, back, or abdominal pain) patients and how we said above the patent false lumen in all patients. The procedural data including postprocedural variables are shown in Table 2. The endografts were successfully deployed in all patients (Valiant-Medtronic Vascular, CA, USA), 10 patients in zone 3 and 2 patients in zone 2. Completion angiography-aortography showed restoration of blood flow in the true lumen and enhanced flow to the abdominal arteries. All patients were discharged alive from the hospital, with no early death and no paraplegia and paraparesis or stroke or renal failure occurred after TEVAR. No end leak of any subtype was detected in the early post-procedural period. The average hospital stay was 3.41 day (2–5 day). Clinical and radiological follow-up was complete in all patients. The mean time

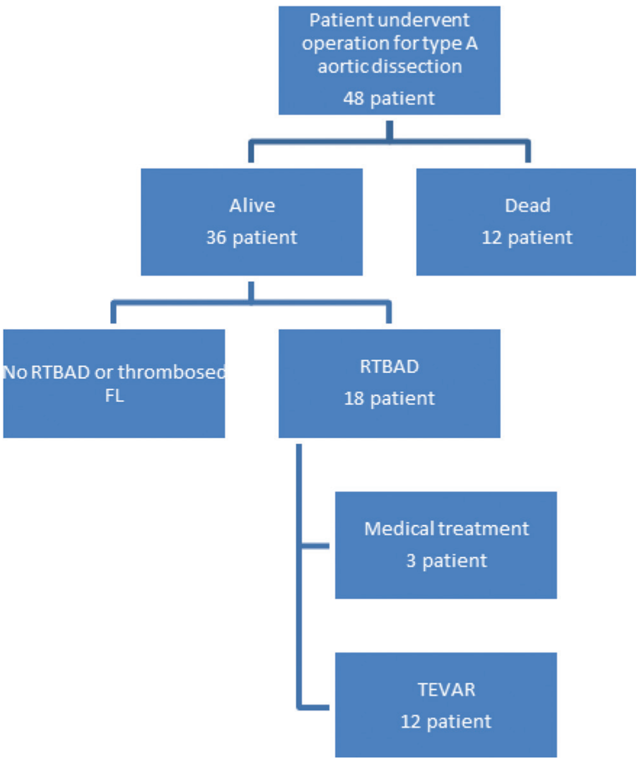

Figure 1: Treatment strategy for residual Type B aortic dissection, TEVAR: Thoracic Endovascular aortic repair, FL: False lumen

from TAAD repair to TEVAR was 2.25 year (1–4 year). Post-procedural contrast-enhanced CT was performed in all patients. Follow-up CTA at 6 and 12 months after TEVAR showed a decrease in the size of the thrombosed false lumen in all of the patients, and complete exclusion of tear in the DTA was achieved in all patients by extended TEVAR, and positive aortic remodeling occurred in the stented segment of the aorta in 100% of the patients and residual flow in the false lumen was not recognized in all of the patients without enlargement of the descending aorta.

Table 2: Procedural and postprocedural data

Patients	12
Time between TAAD repair and TEVAR (Year)	2.25 (1–4)
TEVAR	12
The distal landing zone	
T8	8
T9	4
Complications	
SCI	0
Stroke	0
Renal failure	0
Reintervention	0
Mortality	0
Hospital stay (day)	3.41 (2–5)
Follow-up duration (month)	26.75 (22–34)

TAAD: Type A aortic dissection, TEVAR: Thoracic endovascular aortic repair, SCI: Spinal cord ischemia.

Discussion

TAAD is a catastrophic disease, with high mortality if surgical intervention is not performed early [2]. Even in the presence of early identification and timely surgery, operative mortality remains high [3]. There are two main aims of emergency surgery for acute TAAD. The first aim is to save the patient's life by the treatment or prevention of serious complications of this pathology, such as cardiac tamponade, coronary dissection, and acute aortic valve regurgitation. The second aim is to resect the primary entry tear and decrease the blood flow of the false lumen. Because of known deleterious effects of CPB, with repair of the ascending aorta and-or HR offers several advantages over total aortic arch repair: It shortens myocardial ischemia time, CPB time, and operation time, and it decreases intraoperative blood loss and transfusion requirement [1]. Knowing that entries often exist in the ascending aorta and proximal aortic arch, we usually resect most of the lesser curvature. Along with this, the number of patients who require additional procedure for the residual aortic dissection has also been increasing. Uchida *et al*. reported that after AAR with primary entry resection, expected thrombosis and healing of false lumen in the aortic arch. However, it remained present in some patient after AAR despite resection of the entry tear. In their series, 42% of patients who had undergone AAR had patent false lumen in their aortic arch after surgery. The cause of this phenomenon was blood leakage to the false lumen at the distal anastomosis in some patients [4]. This could be explained with aortic remodeling, which is defined as positive if there was a significant decrease in the diameter of the aortic lumen or if there was an increase in the diameter of the true lumen; stable if the diameters of the aortic lumen and true lumen did not change significantly; and negative if there was a significant increase in the diameter of the aortic lumen or a significant decrease in the diameter of the true lumen, as previously defined by IaFrancesco *et al*. [5]. Another definition of the aortic remodeling is a process of stabilization of the overall aortic dimensions by slow obliteration of the FL, and maintenance of true lumen patency. However, in the majority of the cases, this obliteration is incomplete and variable, which leads to aneurysmal dilatation of the aorta in 13.4–62.5% of these patients after the index repair [6].

In our own series of 48 patients (36 patients survived), undergoing AAR + HR or Modified Bentall procedure and HR, residual chronic Type B dissection was detected to the 18 patients. Reintervention with TEVAR was required in 15 patients, but performed only in 12 patients (indications were explained above). Neither death nor any paraplegia or stroke occurred after reintervention with TEVAR.

TEVAR is widely used for Type B aortic dissection (TBAD) due to the availability of advanced endovascular technique and acceptable outcomes. At present, the treatment strategy of TEVAR is to enhance aortic remodeling as it excludes proximal tear, reduces blood pressure, and induces thrombogenesis in the false lumen [7]. The persistence of a non-resected intimal tear and a patent false lumen has been identified as risk factors for delayed aneurysmal expansion, reoperation, and worse long-term survival [8]. Although the surgical treatment for TAAD is performed following the “tear-oriented strategy,” the distal tear tends to remain untreated as a residual aortic dissection [9]. Zierer *et al*. identified aortic diameter, elevated systolic blood pressure, and presence of a patent false lumen as risk factors for aortic enlargement after TAAD repair and pointed out the risk of leaving the tear untreated [10]. Zhang *et al*. reported that 129 patients out of 962 (13.4%) suffered from distal aortic segment enlargement after aortic dissection repair and that 66.7% of the patients suffered from distal aortic segment enlargement within 3 years after the aortic dissection repair [11]. Esposito *et al*. reported one death among 65 patients undergoing TEVAR after surgery for Type A acute aortic dissections [12]. In the report of Kimura *et al*., 7 patients (2.5%, 7 of 280) underwent distal TEVAR to manage a patent false lumen after surgery for acute Type A dissection, no 30-day or in-hospital death, stroke and spinal cord ischemia occurred) [1].

The present study did not include patients who already had symptoms before TEVAR. Moreover, this study was performed in the chronic phase. It is considered that TEVAR performed after the development of collateral circulation to the spinal cord is less likely to cause SCI than when performed in the acute phase which is associated with rapid organ malperfusion and hemodynamic change. Identically, we can find the same result at the Iida *et al*. report [9]. Pan *et al*. reported very low incidence of the spinal cord injury, because of the two reasons: (1) Most of the TEVAR procedures were performed more than 12 months after FET procedure. Two-stage interventions on the thoracoabdominal aorta have been suggested to reduce the risk of the SCI, and (2) a lower distal landing zone has been associated with an increased risk of paraplegia [13]. Leontyev *et al*. reported that distal landing zone lower than T 10 was a risk factor for spinal cord injury [14].

Beneficial effects of TEVAR for this group of the patients were declared many times in the different papers. However, it is also known that this procedure has many complications. With this investigation, we aimed to find a successful and safe approach for this group of the patients, that can be easily applied by the surgery team, and to share our results. As a summary, following the pathway step-by-step described in Figure 1, we propose a safe decision-making method for selecting the suitable candidate for TEVAR. Retrospective study design and lack of long-term follow-up, the small sample size, and the absence of a control group for comparison are major limitations of the study, and we still need the multicenter investigation to improve surgical strategies.

Conclusion

We investigated the outcomes of extended TEVAR for residual aortic dissection after TAAD repair and found acceptable outcomes including good aortic remodeling and the absence of any complications in early period linked with TEVAR. However, a longer follow-up is considered necessary. Aggressive coverage of the DTA by extended TEVAR may prevent aortic events in the future and might play an important role in achieving preemptive treatment for the downstream aorta.

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