

## Management of Retrograde Dissection Complicating Thoracic Endovascular Aortic Repair

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### ABSTRACT

**Background:** Retrograde type A aortic dissection is a challenging surgical emergency associated with high morbidity and mortality.

**Objective:** The aim of this study was to describe our experience with retrograde type A aortic dissection (RAAD) following thoracic endovascular aortic repair (TEVAR) and its surgical management strategy.

**Patients and Methods:** Our study was conducted between January 2011 and January 2021 at Cairo University Hospitals, and included 100 patients undergoing (TEVAR) to highlight the management of retrograde dissection complicating the procedure. The mean age was  $55 \pm 9$  years and 76% of patients were males. All retrograde dissection patients underwent emergency surgical repair.

**Results:** The in-hospital mortality was 10% of patients who had RAAD and occurred in one patient who suffered from fatal hematemesis postoperatively. The mean cross clamp time was  $93 \pm 17$  minutes and circulatory arrest time was  $25 \pm 6$  minutes. One patient also suffered from acute renal failure requiring hemodialysis during the postoperative hospital stay.

**Conclusions:** Retrograde type A aortic dissection is an uncommon but potentially catastrophic complication of TEVAR. Surgical replacement of ascending aorta and a segment of aortic arch involving the entry tear offers an efficient strategy for the management of retrograde type A aortic dissection post TEVAR.

**Keywords:** Aortic dissection, Retrograde dissection, TEVAR.

### INTRODUCTION

Open surgical repair of descending thoracic aortic disease was the standard management technique for years offering acceptable results despite the associated morbidity and mortality<sup>(1)</sup>. Thoracic endovascular aortic repair (TEVAR) has evolved to become a widely utilized modality in the treatment of thoracic aortic pathologies. An uncommon but potentially catastrophic complication of this technique is the occurrence of retrograde type A aortic dissection (RAAD)<sup>(2)</sup>. There are many factors that may promote the occurrence of RAAD including intra-aortic manipulation by the stent graft and the different wires and catheters. RAAD may occur early after TEVAR or may present in a delayed manner<sup>(3)</sup>. TEVAR offers many advantages compared to the surgical option in the management of descending thoracic aortic disease, avoiding extensive thoracotomies as well as cardiopulmonary bypass<sup>(4)</sup>.

The aim of this study was to describe our experience with RAAD following TEVAR and its surgical management strategy.

### PATIENTS AND METHODS

The study was conducted during the period between January 2011 and January 2021 on 100 consecutive patients who underwent TEVAR to repair descending aortic pathologies.

### Ethical approval:

An approval of the study was obtained from Cairo University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

32 patients were presenting with complicated acute type B dissection, 37 with chronic type B dissection and 31 with descending aortic aneurysm.

Exclusion criteria were pathologies not suitable for TEVAR reconstruction.

A detailed assessment of all patients was done including the routine preoperative work up, transthoracic echocardiography (TTE), multi-slice computed tomography (MSCT) scan or magnetic resonance angiography (MRA) in cases of elevated serum creatinine, to assess the extent of dissection of the aorta, to identify the location of intimal tears and to assess the maximal diameters of each segment of the aorta.

10 patients (10%) developed retrograde type A dissection at different time interval after TEVAR (ranging from 2 weeks to 3 months) and presented with acute severe chest pain. 3 patients developed acute haemopericardium with tamponade mandating emergency surgical repair.



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**Surgical technique:** for the repair of retrograde aortic dissections following TEVAR.

The cornerstone in the treatment of RAAD is to completely excise the stent induced entry tear typically located in the lesser curve of aortic arch with proximal and distal aortic reconstruction. Total circulatory arrest and cerebral perfusion were used for open distal anastomosis. Neuroprotection strategies were utilized during circulatory arrest.

All patients were operated upon via standard median sternotomy. Cardiopulmonary bypass (CPB) was established by arterial cannulation of the axillary artery (n = 6), the femoral artery (n = 3), or the distal ascending aorta true lumen (n= 1) and a dual-stage atriocaval cannula in the right atrium was used for venous cannulation.

**Proximal root reconstruction:**

The technique of aortic reconstruction depends on the degree of extension of aortic dissection in the sinuses of Valsalva. Usually, RAAD stops at the level of the sinotubular junction with mild affection of sinuses. In such cases, the aorta was resected till the level of the sinotubular junction followed by a classic supracommisural anastomosis of the aortic dacron tube graft. Meticulous dissection of the aortic root was performed to preserve the integrity of the intima and the adventitia with removal of all thrombi in the dissected aortic layers. The commissures were resuspended with 3/0 pledgeted prolene sutures, to avoid the possibility of late prolapse. The aortic graft was then sewn to the reconstructed sinus segment using continuous 3/0 prolene augmented with a pericardial strip.

**Distal arch reconstruction: (open anastomosis under hypothermic circulatory arrest)**

The surgical anastomosis in retrograde aortic dissection involving the aortic arch segment requires meticulous reconstruction and is challenging due to the presence of the endovascular stent with metallic elements usually protruding in the distal arch, some of which may even perforate through the aortic wall.

We performed a hemi-arch anastomosis under total circulatory arrest distally with a circumferential anastomosis to the deployed aortic stent graft being mandatory. The key to performing a hemostatic and successful surgical repair is to completely excise the primary entry tear. If the endovascular stent was deployed in a relatively proximal segment of the aortic arch (which commonly occurred in patients with a bovine arch with the stent covering the left subclavian artery), the tear was commonly found closely related to the proximal metallic element of the stent usually on the lesser curve of aortic arch.

We performed an extended hemi-arch aortic

anastomosis, completely excising the entry tear with a long bevel extending into the stent graft along the lesser curve. We completely excised any protruding metal springs using wire cutters. This allowed the proximal end of stent graft to be incorporated into the anastomosis. Achieving a circumferential arch anastomosis should include the thoracic aortic stent graft, to achieve a hemostatic repair and prevent future endoleak. The key to a perfectly sealed distal anastomosis is sewing the graft fabric to native aorta and the synthetic dacron tube graft all together. Interrupted 4/0 prolene pledgeted mattress sutures were used to reinforce the suture line.

Cerebral protection was achieved by unilateral antegrade cerebral perfusion through axillary artery (n = 6) or retrograde cerebral perfusion (n = 4) combined with moderate hypothermia (26°C). Our myocardial protection strategy involved the use of intermittent antegrade cold blood cardioplegia (n=6) or Custodiol solution (n= 4).

**Statistical analysis**

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Qualitative data were represented as frequencies and relative percentages. Quantitative data were expressed as mean ± SD (Standard deviation).

**RESULTS**

The demographic and preoperative data of all TEVAR patients in our study are shown in table 1.

**Table 1: Patients' demographics and peoperative clinical data**

	Number of patients (n=100)
<b>Age (years)</b>	55 ± 9
<b>Gender</b>	
Male	76 (76 %)
Female	24 (24%)
<b>Indication for TEVAR</b>	
Complicated dissection (B)	32 (32 %)
Chronic dissection (B)	37 (37%)
Descending aneurysm	31 (31%)
<b>Risk factors</b>	
Hypertension	83 (83%)

10 patients suffered from RAAD after TEVAR in our study. The time interval between TEVAR and the occurrence of RAAD ranged between 2 weeks and 3 months. 3 patients developed pericardial effusion as a complication of acute type A aortic dissection. Figure 1 shows a CT reconstruction of one of our cases showing a

previously deployed stent with subsequent occurrence of type A aortic dissection.



**Figure (1):** CT aortography showing Stanford type A aortic dissection with a previously deployed endovascular stent distally

Operative data for the management of RAAD in this study is summarized in table 2 including arterial axis for extracorporeal circulation, total bypass, cross clamp and circulatory arrest times as well as utilized cerebral perfusion techniques. All operative interventions were performed as emergency surgical procedures.

**Table (2): Operative data for the management of RAAD in the studied patients**

	Number (%) OR Mean ± SD
<b>Timing of operation</b>	
Emergency	10 (100%)
<b>Arterial Inflow</b>	
Axillary artery	
Femoral artery	6 (60%)
Distal Ascending aorta	3 (30%)
(central cannulation)	1 (10%)
<b>CPB duration (minutes)</b>	144± 21
<b>Cross clamp duration (minutes)</b>	93± 17
<b>Total circulatory arrest time (minutes)</b>	25± 6
<b>Cerebral perfusion</b>	
Antegrade (ACP)	6 (60%)
Retrograde (RCP)	4 (40%)

The proximal end of the deployed stent during operative intervention treating RAAD in one of our patients is visible in figure 2.



**Figure (2):** Intraoperative view showing the proximal end of previously deployed stent during open repair of RAAD

Postoperative data including mechanical ventilation, ICU and hospital stay durations are shown in table 3. One mortality occurred in our study due to fatal hematemesis occurring on the 2<sup>nd</sup> day postoperatively. Also, one of our patients (10%) suffered from acute renal failure requiring dialysis during his hospital stay.

**Table (3): Postoperative data after repair of RAAD in the studied patients**

	Mean ± SD Number (%)
Mechanical ventilation duration (hours)	36± 9
ICU stay duraion (hours)	84± 13
Hospital stay duration (days)	13± 5
Acute renal failure requiring dialysis	1 (10%)
Mortality	1 (10%)

**DISCUSSION**

There is no doubt about the advantages of TEVAR in the treatment of descending thoracic aortic pathologies. Yet with the widespread use of endovascular techniques many complications have been reported,

including the potential risk for retrograde aortic dissection<sup>(5)</sup>.

Many risk factors have been identified for the development of RAAD. The metal springs in the proximal end of endovascular stents have been frequently related to the entry tear identified intraoperatively. The common location for this tear is on the lesser curvature of the aortic arch which may be related to the high radial forces expressed on the aortic wall at this location (6).

Luehr and colleagues also linked the occurrence of RAAD to the original indication for TEVAR being type B aortic dissection as well as ascending aortic diameter exceeding 40 mm<sup>(7)</sup>. The natural history of Stanford type B dissection may involve false lumen expansion as well as extension of the dissection process<sup>(8)</sup>. Stent oversizing more than 20% may play a role in increasing the incidence of RAAD. Ballooning is contraindicated in aortic dissection patients but its use in aneurysm cases following stent deployment may improve endoleak but may favor the subsequent occurrence of retrograde dissection<sup>(9)</sup>.

Acute Stanford type A aortic dissection mandates emergency surgical intervention. This is no different in the setting of retrograde dissection following TEVAR<sup>(10)</sup>. The main objective of the surgical procedure in our study was to replace the dissected ascending aorta with high risk of rupture as well as the segment of aortic arch showing the entry tear usually located in the lesser curve. A hemiarch procedure is usually sufficient but careful removal of some of the proximal metal springs of the endovascular stent is required. This allows the involvement of the stent fabric as well as native aortic wall in the distal aortic reconstruction.

Mortality occurred in one patient in our study (10%) similar to the study by **An and Colleagues** showing a mortality of 11%<sup>(6)</sup>.

**Luehr and Colleagues** recommended performing CT aortography 1 week after TEVAR, allowing the early detection of complications such as early retrograde dissection as well as helping in assessment of the success of the endovascular intervention<sup>(7)</sup>.

## CONCLUSION

Retrograde type A aortic dissection remains an uncommon but potentially catastrophic complication of TEVAR. Surgical replacement of ascending aorta and a

segment of aortic arch involving the entry tear offers an efficient strategy for the management of this disease. Our study has some limitations, namely the small number of patients and the lack of long term follow up data.

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