

 **Case Report** 

# Is TEVAR with Full Petticoat Technique Effective for Complicated Acute Type B Dissection Cases?

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Treatment by thoracic endovascular aortic repair (TEVAR) for type B dissection has improved outcomes. We tried the procedure named “Full Petticoat technique” in which the proximal entry tear was excluded with a covered stent and extended bare metal stents were placed to the aortic bifurcation for three complicated type B dissection cases with dynamic obstruction of the common iliac artery. Follow-up computed tomography revealed favorable aortic remodeling in which the true lumen was expanded. The short-term result of this procedure has shown acceptable aortic remodeling. The significance of this procedure is still unknown in the long term; hence long-term follow-up is necessary to completely understand the usefulness of this technique.

**Keywords:** aortic dissection, endovascular repair, stent graft

## Introduction

In current practice, patients with uncomplicated acute type B aortic dissection have been treated with medical hypotensive therapy. However, complicated cases involving rupture, rapid dilatation, malperfusion, or continuous pain warrant either surgical or interventional treatment. In progressive treatment for complicated cases, thoracic endovascular aortic repair (TEVAR) has improved outcomes in comparison with open surgical treatment.<sup>1)</sup> The first successful case using both a covered stent graft and

extended bare stents for the treatment of the thoracic-abdominal aorta for complicated type B dissection with renal artery and external limb malperfusion was published in 2005.<sup>2)</sup> The concept of this treatment is to promote progressive aortic remodeling with expansion of the true lumen and thrombosis of the false lumen. This procedure, named the PETTICOAT (Provisional Extension to Induce Complete Attachment) procedure, has demonstrated favorable outcomes.<sup>3)</sup> How far to extend the bare stent coverage, however, has not been made clear, or standardized. Based on the concept of this technique, we tried the procedure named “Full Petticoat technique” in which the proximal entry tear was excluded with a covered stent, and extension bare stents were placed to the terminal aortic bifurcation to expand the collapsed true lumen in three patients with complicated type B dissection.


## Case Report

Three patients were admitted to our institution with a sudden onset of chest and back pain. They were males, with a mean age of 69 years (range, 64–72 years). Enhanced computed tomography (CT) showed an acute type B dissection with a proximal entry tear in the distal arch. Further CT scans revealed shrinkage of the true lumen, with expansion of the false lumen, and dynamic obstruction of the common iliac (CI) artery in all three patients.<sup>4)</sup> All patients underwent the Full Petticoat technique by the ZenithTX2 TAA Endovascular Graft (Cook Inc., Bloomington, IN, USA) and the TX-D Dissection Endovascular System (Cook Inc., Bloomington, IN, USA). The proximal covered stent size was calculated from the diameter of the healthy thoracic aorta and was deployed in Zone 2 to exclude the entry tear. In all patients, the extension bare stent was deployed proximally to a point just above the celiac artery (CA). The behavior of the true lumen and false lumen was observed by digital subtraction angiography (DSA). Once the collapsed true lumen was confirmed, additional bare stents were deployed, extending to the aortic bifurcation. **Table 1** summarizes the preoperative malperfusion site, vessel arising, and proximal covered stent size for all patients.

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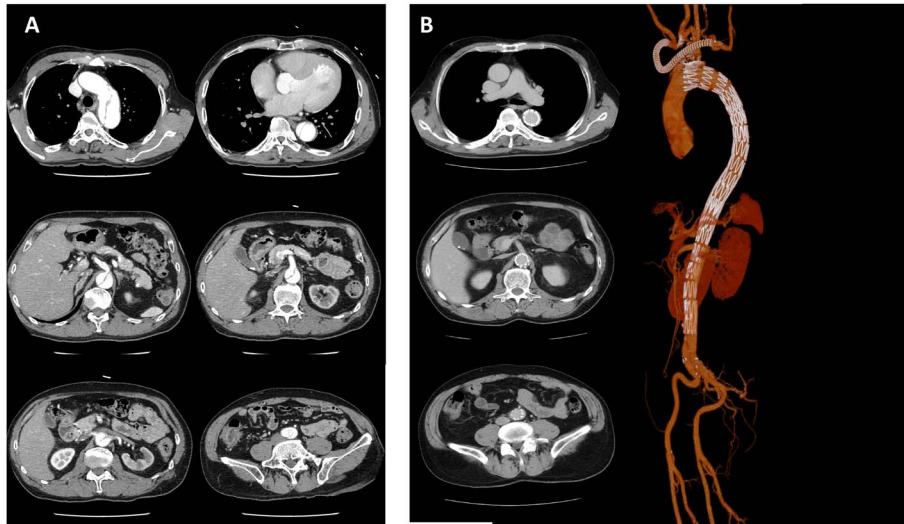
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**Table 1** Characteristics of 3 cases of type B dissection

Case	Age	Sex	Malperfusion	Branch from TL	Proximal graft
1	62	Male	Rt. CIA	CA, SMA, Rt. RA	34-24-159 mm
2	72	Male	Lt. CIA	SMA, Rt. RA	34-34-157 mm
3	72	Male	Bil. CIA	SMA, Rt. RA, Lt. RA	34-34-157 mm

Rt: right; Lt: left; Bil: bilateral; CIA: common iliac artery; CA: celiac artery; SMA: superior mesenteric artery; RA: renal artery; TL: true lumen



**Fig. 1** Computed tomography (CT) scan for case 1. **(A)** Preoperative CT shows the dissected aorta and narrowing of the true lumen. The maximal diameter was 42mm on the distal arch. The left renal artery arose from the false lumen. **(B)** Postoperative CT 1 year later demonstrated a favorable remodeling, with significant expansion of the true lumen.

### Case 1

A 62-year-old man with a history of coronary artery disease, hypertension, and renal dysfunction was admitted to our institute with symptoms of aortic dissection. He was managed conservatively with antihypertensive therapy as an acute uncomplicated type B dissection in the intensive care unit (ICU). Follow-up CT confirmed no change to his aorta; with stable controlled blood pressure, he was followed at the outpatient clinic.

Two months later, he visited our outpatient clinic with right limb pain. His emergent CT revealed a narrowing of the true lumen and an obstruction of his right CI artery (**Fig. 1**). The entry tear just distal to the left subclavian artery (SCA) was excluded by deploying a covered stent in Zone 2, after left SCA revascularization was performed with a SCA–SCA bypass. Extension bare stents were then placed to the aortic bifurcation. Postoperative CT showed that the true lumen was significantly expanded from the distal arch to the abdominal aorta and the obstructed iliac artery flow was resolved completely.

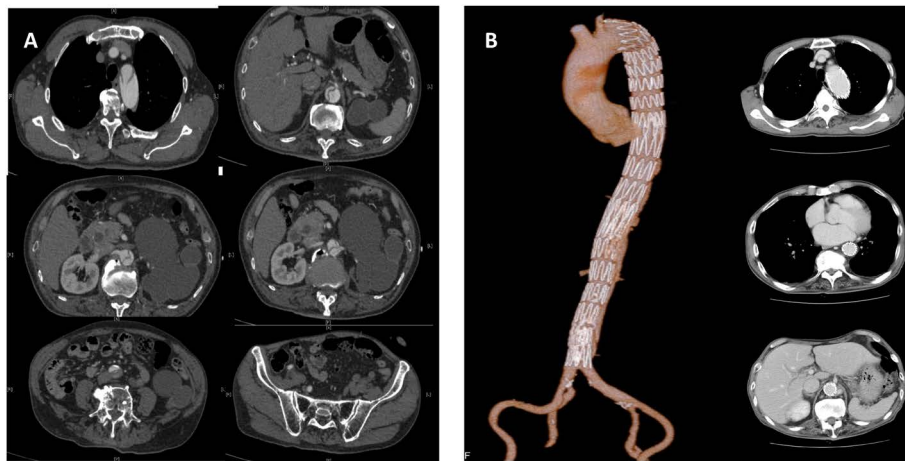
The postoperative course was uneventful and the patient was discharged on day 7. Follow-up CT after 1 year confirmed favorable aortic remodeling (**Fig. 1**).

### Case 2

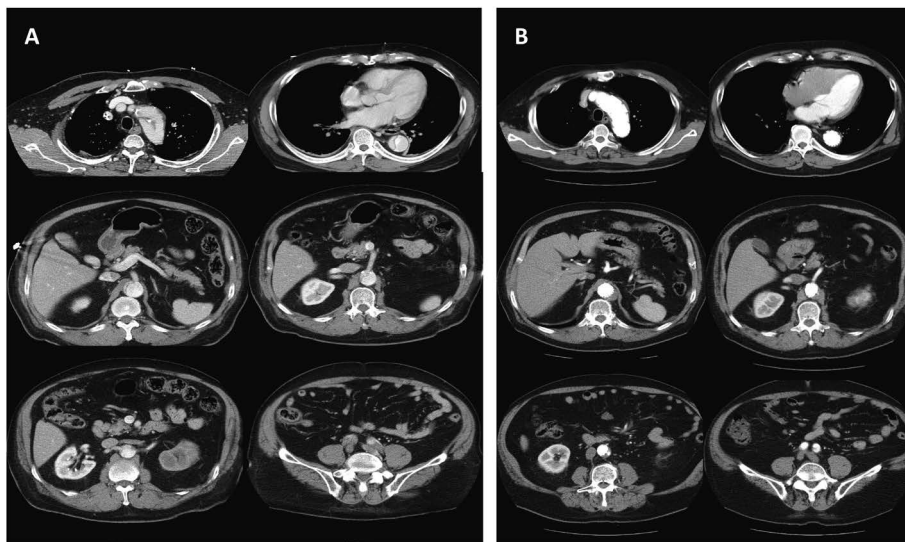
A 72-year-old man with a history of hypertension was admitted to our institute for back pain and left limb sensory disturbance. Left limb perfusion was compromised with cyanosis and loss of sensation because it was older than 8 hours from the onset. Enhanced CT showed an acute type B dissection with a proximal entry tear on the distal arch and a dynamic obstruction of the left CI artery (**Fig. 2**).

Emergent TEVAR was indicated, and a covered stent to exclude the proximal tear was deployed in Zone 2 without left SCA revascularization; left limb color and preoperative symptoms were improved immediately after the operation, but the creatine kinase (CK) value increased to 8,308 U/L. This patient was observed carefully in the ICU. The CK value was improved by increasing the volume of infusion and diuretic therapy without renal dysfunction.

The postoperative course was uneventful, without disturbance of the left arm and left limb, and the patient was discharged on foot. Postoperative CT showed that the true lumen was significantly expanded from the distal arch to the abdominal aorta and the dynamic obstruction of left iliac artery was improved. However, small amount residual blood flow was detected in the false lumen from the CA to the terminal aorta. On CT 1 year later, this find-



**Fig. 2** Computed tomography (CT) scan for case 2. (A) Preoperative CT shows the proximal entry tear on the distal arch and narrowing of the true lumen. The maximal diameter was 40 mm on the distal arch. The left renal artery and celiac artery were arising from the true and false lumen. The left iliac artery was not shown by contrast CT. (B) The true lumen maintained a significant expansion 1 year later. The false lumen and the small flow in the false lumen were not increased.



**Fig. 3** Computed tomography (CT) scan for case 3. (A) Preoperative CT shows the proximal entry tear on the distal arch and narrowing of the true lumen. The maximal diameter was 40 mm on the distal arch. Bilateral iliac arteries were not shown by contrast CT. (B) The true lumen maintained a significant expansion 1 year later. The small flow in the false lumen from the abdominal aorta to the left iliac artery was maintained but not increased.

ing had not changed (Fig. 2).

### Case 3

A 72-year-old man with a history of hypertension was admitted to our institute with sudden onset chest and back pain. Bilateral femoral arteries were not palpable. Enhanced CT showed an acute type B dissection with a proximal entry tear on the distal arch and occlusion of bi-

lateral CI arteries due to an expanded false lumen (Fig. 3).

After left SCA revascularization, the covered stent was deployed in Zone 2 and extension bare stents were placed up to the aortic bifurcation.

A post-procedural CT showed a significantly expanded true lumen and a thrombosed false lumen. The postoperative course was uneventful and the patient was discharged on foot. Follow-up CT 1 year later showed that favorable

aortic remodeling had been maintained and small residual blood flow in the false lumen had not changed (Fig. 3).

## Discussion

In uncomplicated acute type B dissection, medical treatment with aggressive antihypertensive has been recommended.<sup>5)</sup> However, the onset of complications, such as malperfusion, rupture, rapidly expanding aortic diameter, and continuous pain, presents an ongoing risk warranting emergency treatments. Options for treatment should be considered, including open surgery with aortic replacement, TEVAR with extra-anatomical bypass, or endovascular fenestration. In surgical treatment for thoracic aortic aneurysm, it has been reported that TEVAR is associated with a lower risk of short- and long-term results than open surgery.<sup>6)</sup>

Recently, several reports have demonstrated the benefits of simple TEVAR to exclude the proximal entry tear with a covered stent in acute type B dissection.<sup>7)</sup> The purpose of simple TEVAR is to provide favorable aortic remodeling by promoting expansion of the true lumen and concomitant regression of the false lumen.

However, this is not always possible. When expansion of the true lumen is limited to the thoracic segment, there is a possibility of remaining flow in the false lumen via a distal re-entry tear in the thoracic and abdominal aorta. As a result, the potential of true lumen collapse and false lumen flow carries the possibility of late aortic-related complications and/or re-intervention.<sup>5)</sup>

Deployment of a stent graft, including a covered or bare stent, on the fragile intimal flap might also be a cause of stent graft-induced new entry (SINE), arising from a stent graft's excessive radial force of its distal self-expandable stent,<sup>8)</sup> thus requiring some re-intervention.

On the other hand, Feng et al. demonstrated that the extension bare stent to the distal aorta was effective in preventing stent graft-induced distal re-dissection in SINE.<sup>8)</sup> In a study of aortic volume change in type B dissection with the Petticoat technique, the extension bare stent coverage to the distal abdominal aorta provides significant expansion of the true lumen and regression of the false lumen compared with proximal entry closure alone.<sup>9)</sup>

Moreover, Hofferberth et al. reported that late aortic re-intervention after the Petticoat technique was not only significantly lower than proximal entry closure alone but also exhibited a significant improvement in abdominal aortic remodeling.<sup>3)</sup>

Therefore, in treating our patients presenting with onset of ischemic changes in limbs due to acute type B dissection, we selected TEVAR with the Full Petticoat technique.

Indeed, after a proximal covered stent was deployed above the CA, DSA showed shrinkage of the remaining

true lumen and persistent flow via a secondary tear in the abdominal aorta. The true lumen was expanded significantly and the false lumen was decreased, with thrombosis promoted, aided by an extension bare stent through the terminal aorta immediately without additional branched intervention. Although very small persistent flow was seen in the abdominal false lumen by CT before discharge, the maintenance of favorable remodeling was confirmed by follow-up CT 1 year later.

The VIRTUE Registry suggested that a majority of aortic remodeling was complete within 6 months of TEVAR.<sup>10)</sup> Our technique also experienced favorable aortic remodeling in patients who underwent TEVAR with the Full Petticoat technique at 6 months after onset.

If expansion of the false lumen is confirmed in the chronic phase, secondary intervention through the stent struts to the target vessels can be an option, obviating open surgery. Although the Full Petticoat technique validated the efficacy for dynamic obstruction due to acute type B dissection in the short term, long-term results are still unknown.

This procedure should be considered as an available option to perform emergency treatment for acute complicated type B dissection.

## Conclusion

The Full Petticoat technique has demonstrated acceptable short-term results for dynamic obstruction due to acute type B dissection. The significance of this procedure is still unknown in the long term; therefore, long-term follow-up is required to completely understand the procedure.

## Disclosure Statement

There is no conflict of interest regarding this article.

## Author Contributions

Study conception: TN

Data collection: TN

Critical review and revision: all authors

Final approval of the article: all authors

Accountability for all aspects of the work: all authors

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