Treating Complicated Acute Type B Aortic Dissection With Proximal Stent Grafts and Distal Bare Stents

Bare aortic stents can expand the true lumen immediately and result in early favorable aortic remodeling.

BY JER-SHEN CHEN, MD

Thoracic endovascular aortic repair (TEVAR) has been widely used to treat aortic dissection in recent years. Although TEVAR covers the entry tear in the descending aorta, there are still some concerns, including stent graft–induced new entry (SINE) tears[1] and persistent distal false lumen expansion.[2] The bare aortic stent is a part of the Zenith Dissection Endovascular System (Cook Medical). After proximal stent grafting, bare aortic stents are deployed distal to the stent graft to support the dissected distal aorta. The STABLE trial, a prospective, nonrandomized multicenter study, reported favorable clinical and anatomic results.[3] A recent systematic review article that analyzed four studies on proximal stent grafting and distal bare stenting also clearly demonstrated

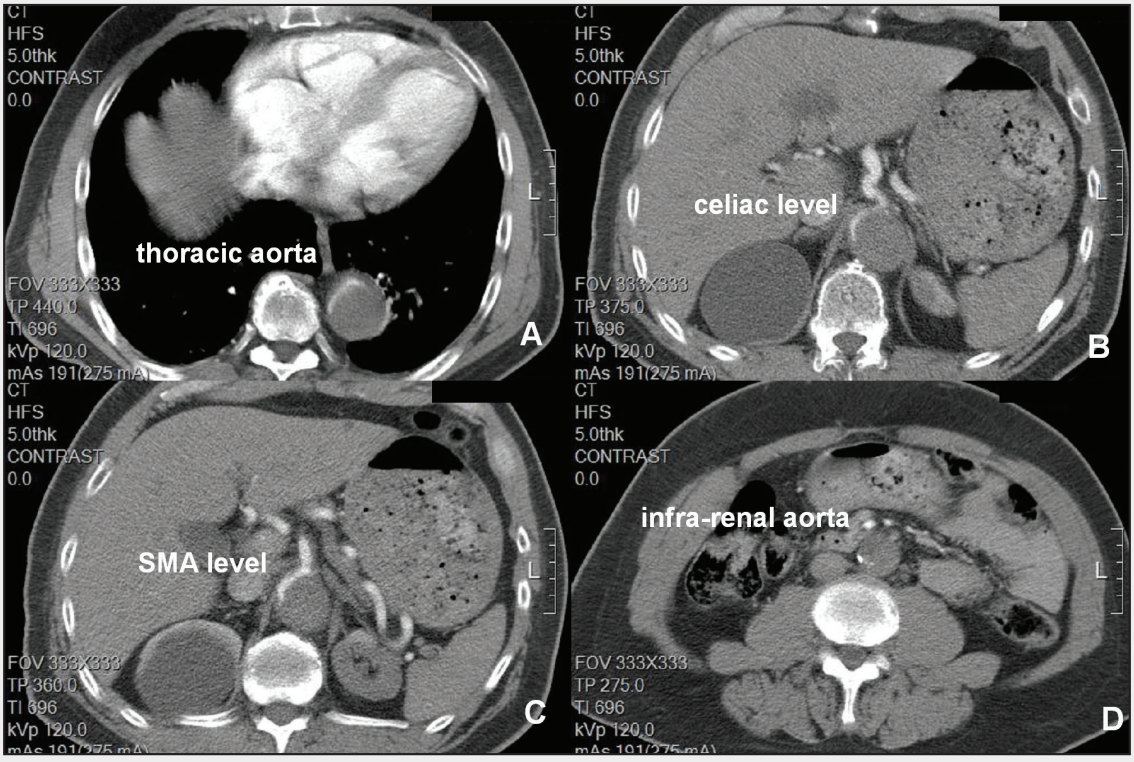

Figure 1. The true lumen was severely compressed by the false lumen, starting from the level of the mid-thoracic aorta (A). The celiac artery and superior mesenteric artery (SMA) were compromised (B, C). In the infrarenal aorta, virtually no blood flow was seen in the true lumen, which resulted in bilateral critical limb ischemia (D).

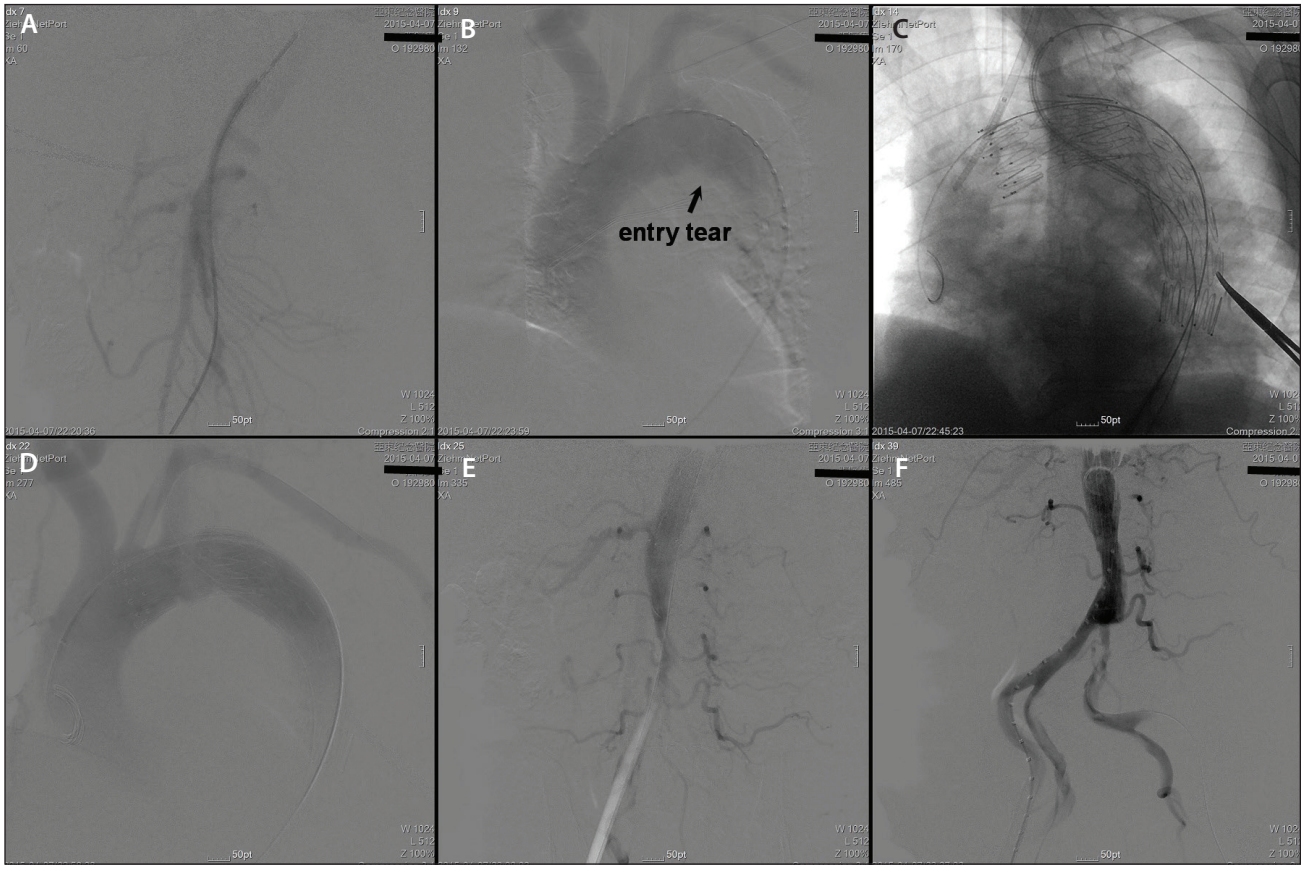

Figure 2. A thin true lumen was demonstrated in the abdominal aorta (A). The single entry tear was located just distal to the left subclavian artery (B) so that a zone 1 landing was required. In order to maintain the arch vessels' patency in the shortest time, a chimney graft was inserted from the left common carotid artery (11- X 50-mm Viabahn), and a periscope graft (13- X 100-mm Viabahn) was inserted from the left brachial artery between Cook TX2 aortic stent grafts (C). Aortography showed good seal of the entry tear without compromise of the arch vessels (D). However, after proximal stent grafting, the infrarenal aorta did not expand (E). Two Cook bare aortic stents (diameter: 36 mm, length: 180 mm) were placed down to aortic bifurcation, and the true lumen was opened by the stents (F). Thrombi in the left common iliac artery were removed.

improved true lumen perfusion and diameter.[4] Moreover, in patients with extremely malperfused branch vessels, the bare aortic stents have the advantage of immediate true lumen expansion, which can alleviate the malperfusion actively, rather than just waiting for true lumen expansion.

A CASE STUDY

A 67-year-old man was sent to the emergency room due to sudden onset of severe back pain and cold sweating, followed by bilateral lower leg numbness. On examination, his heart rate was 60 beats/min, and his blood pressure was 209/119 mm Hg. Bilateral lower leg sensations were severely impaired. No pulsation over both feet could be detected by a handheld Doppler ultrasound probe. A CT scan revealed an acute Stanford type B aortic dissection with severe compromise in the visceral arteries and bilateral lower legs (Figure 1). The patient was sent to the operating room immediately.

Bilateral groin, left elbow, and left neck cutdowns were performed. Initial aortography demonstrated a severely compressed true lumen of abdominal aorta (Figure 2A). The patient had a single entry tear, which was just distal to the left subclavian artery (LSA) (Figure 2B). Therefore, a zone 1 landing was required. In order to restore the patient's perfusion in the shortest amount of time, we decided to maintain the patency of the left common carotid artery (LCCA) and LSA by a chimney and periscope method. The first Cook TX2 stent graft (diameter: 28–32 mm, length: 162 mm) was inserted via the right femoral artery and deployed just distal to the LSA. A left brachial wire was inserted into the aortic stent graft, and a 13- X 100-mm Viabahn stent graft (Gore & Associates) was inserted into the LSA as a periscope graft. A second 11-X 50-mm Viabahn was inserted via the LCCA as a chimney graft. Then, the second Cook TX2 stent graft (diameter: 36 mm, length: 77 mm)

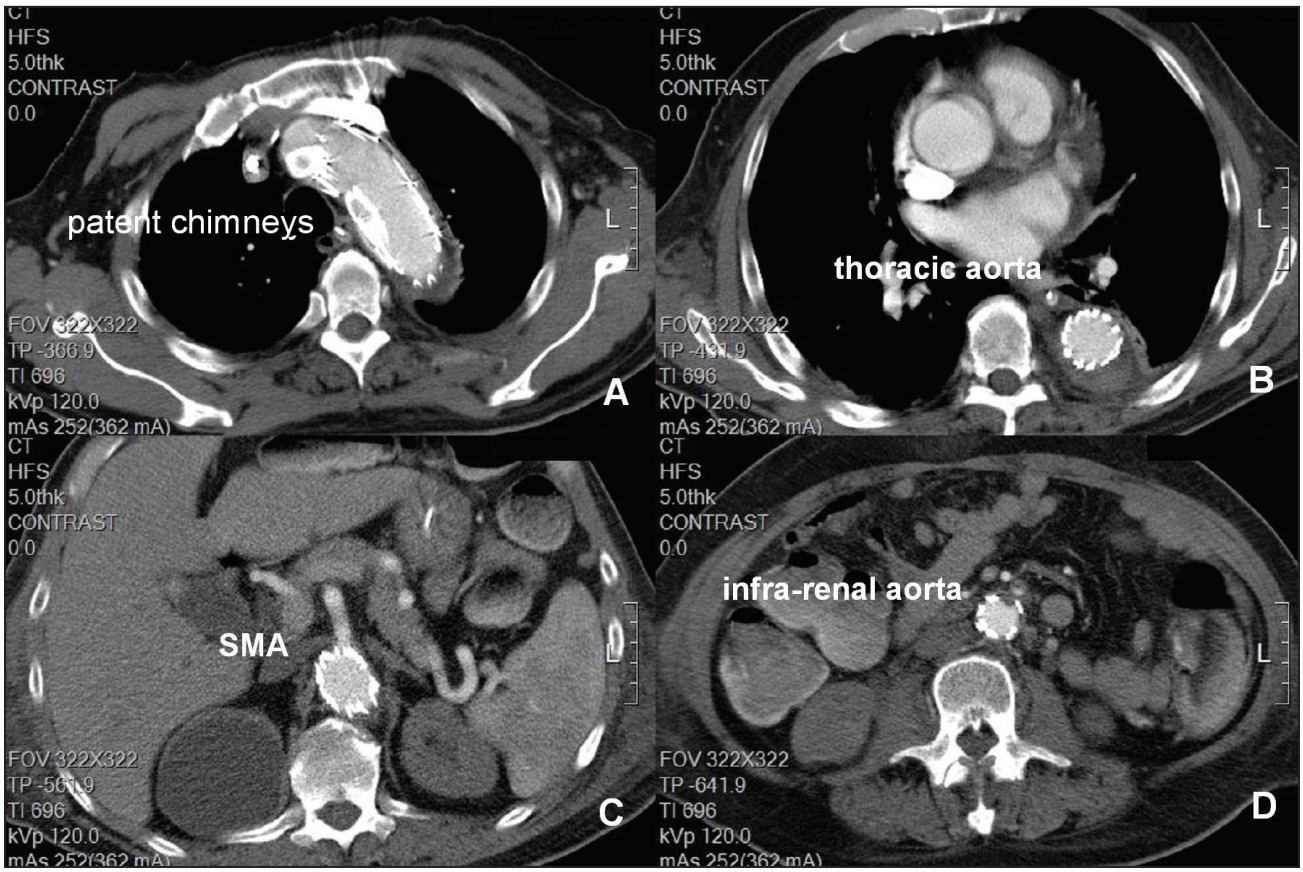

Figure 3. A follow-up CT was performed 1 month later. The chimney and periscope grafts were patent (A). The true lumen fully expanded all the way down (B–D).

was inserted into zone 1 (Figure 2C). After deployment of all devices, the entry tear was well sealed, and the LCCA and LSA were patent (Figure 2D). Unfortunately, the infrarenal aorta still did not expand (Figure 2E). Bilateral femoral artery pulsation still could not be felt via the cutdown wounds. Therefore, two Cook dissection bare aortic stents (diameter: 36 mm, length: 180 mm) were deployed down to the aortic bifurcation, and the true lumen was successfully expanded by the stents (Figure 2F). Right femoral pulsation recovered, and left femoral pulsation also recovered after removal of the thrombi in the left common iliac artery.

After the operation, the patient's peak creatine phosphokinase was 56,440 IU/L. He received hemodialysis for 2 months for rhabdomyolysis and acute renal failure. Ileus resolved quickly without complications. A follow-up CT 1 month later showed patent chimney and periscope grafts (Figure 3A) and fully expanded aortic true lumen all the way down (Figure 3B–D).

OUR DATA

From February 2014 to November 2014, nine consecutive patients (eight men and one woman; mean age of 58.6 ± 9.2 years) with complicated acute type B dissection

TABLE 1. OUTCOMES OF PROXIMAL STENT GRAFT AND DISTAL BARE STENTING FOR COMPLICATED ACUTE TYPE B DISSECTION

Technique success, n (%)	9 (100%)
Resolution of dissection-related complications, n (%)	
Ileus and bowel ischemia (n = 5)	5/5 (100%)
Hepatic dysfunction (n = 1)	1/1 (100%)
Refractory pain (n = 2)	2/2 (100%)
Lower limb ischemia (n = 1)	1/1 (100%)
Extubation in operation room, n (%)	6 (66.7%)
Intensive care unit stay (days), mean ± SD	1.3 ± 1.6
Hospital stay (days), mean ± SD	5.8 ± 2.2
Complications, n (%)	
Upper gastrointestinal bleeding	2 (22.2%)
Jaundice	1 (11.1%)
Renal failure requiring hemodialysis	1 (11.1%)
Paraplegia	1 (11.1%)
Operative mortality/30-day mortality	0 (0%)

underwent proximal stent grafting and distal stenting with the Cook Zenith Dissection Endovascular System. The technical success rate was 100%. All preoperative dissection-related complications, which were also surgical indications, resolved quickly after the operation. Six patients (66.7%) were extubated in the operating room. The mean intensive care unit stay was 1.3 ± 1.6 days (range, 0-4 days). The mean hospital stay was 5.8 ± 2.2 days (range, 3-9 days) (Table 1).

Follow-up CT was arranged accordingly, generally around 3 to 6 months after the operation. To assess aortic remodeling, we measured the true lumen, false lumen, and total aortic diameter at five levels: immediately after the orifice of the LSA, T9 vertebra, T11 vertebra, celiac artery, and superior mesenteric artery (SMA). The T9 level was measured in addition to the T11 level because it was immediately below the end of the proximal stent graft. The decreases in the false lumen diameter ranged from 53.9% to 86.8% at different levels, which were statistically significant at all levels except for the SMA level (Table 2). The increases in the true lumen diameter ranged from 130% to 226%, which were also statistically significant at all levels except for the SMA level (Table 3). In terms of the total aortic diameter, although the false lumen regressed and the true lumen expanded, the total aortic diameters were unchanged at the T9, T11, celiac, and SMA levels. Only the diameter of the thoracic aorta beyond the LSA level decreased significantly from 44.1 ± 7.2 mm to 31.8 ± 5.1 mm (P = .002).

TABLE 2. AORTIC REMODELING IN THE FALSE LUMEN

	False lumen			
Diameter	**Pre-OP (mm), mean ± SD**	**Post-OP (mm), mean ± SD**	**Regression[b] (%)**	***P***
Beyond LSA	25.0 ± 5.1	3.3 ± 6.2	86.8%	< .001[a]
T9	24.5 ± 8.0	8.3 ± 8.6	66.8%	.001[a]
T11	22.8 ± 9.5	8.8 ± 7.0	61.4%	.005[a]
Celiac	17.0 ± 4.7	7.1 ± 6.6	58.2%	.004[a]
SMA	10.2 ± 8.3	4.7 ± 6.8	53.9%	.16

Abbreviations: OP, operation; LSA, left subclavian artery; SMA, superior mesenteric artery.
[a]Statistically significant, $P < .05$
[b]Regression percentage was defined as [1-(Post-OP/Pre-OP diameter)]*100%

TABLE 3. AORTIC REMODELING IN THE TRUE LUMEN

	True lumen			
Diameter	**Pre-OP (mm), mean ± SD**	**Post-OP (mm), mean ± SD**	**Expansion[b] (%)**	***P***
Beyond LSA	19.1 ± 6.0	28.4 ± 3.3	149%	.002[a]
T9	10.9 ± 3.3	24.6 ± 3.5	226%	< .001[a]
T11	12.8 ± 4.4	24.1 ± 3.7	188%	< .001[a]
Celiac	11.2 ± 3.0	21.4 ± 3.9	191%	< .001[a]
SMA	15.1 ± 4.8	19.6 ± 4.3	130%	.05

Abbreviations: OP, operation; LSA, left subclavian artery; SMA, superior mesenteric artery.
[a]Statistically significant, $P < .05$
[b]Expansion percentage was defined as (Post-OP/Pre-OP diameter)*100%

DISCUSSION

Complicated aortic dissections occur in 25% of patients with acute type B dissection.[5] In the interdisciplinary expert consensus on the management of type B dissection, TEVAR was considered to carry lower mortality than open surgery.[6] Today, TEVAR is used widely in the treatment of patients with complicated acute type B dissection. However, persistent distal false lumen expansion[7] remains one of the unsolved problems of TEVAR for acute type B dissection.

Bare aortic stents have at least two theoretical advantages in the management of complicated type B dissection. First, they can expand the true lumen immediately, which will increase the blood flow in the true lumen and provide a prompt improvement of malperfusion. Second, bare aortic stents can support the distal aorta with evenly distributed radial force, and this may provide better remodeling in the long run. In our series, all cases of malperfusion improved quickly after proximal stent grafting and distal stenting. The prompt improvement of malperfusion resulted in short durations of intensive care unit stay and hospital stay after the operation. In the case presented earlier, without the bare aortic stents, we would have had to perform axillofemoral and femorofemoral bypasses, which would have increased the patient's limb ischemic time and resulted in more severe rhabdomyolysis.

For acute type B dissection, medical therapy is still the first-line treatment. Our patients had a mean duration of 81.3 ± 61.1 hours between symptom onset and operation. This meant that medical therapy of more than 3 days was carried out to stabilize the patients but

failed. For these truly "complicated" patients, we wanted to minimize the surgical trauma. Therefore, we did not perform any extra-anatomic bypass for the five patients whose safe landing zone was at zone 1 or zone 2. Chimney and periscope methods were used in two patients, while in three patients, the LSA was just covered and embolized. The technique of proximal stent grafting and distal stenting was largely the same with the TEVAR procedure. To insert bare aortic stents, the operator just had to locate the position of the aortic bifurcation. The technique success rate was 100% in our series, which was comparable with the results of TEVAR.[2]

Two patients in our series suffered from upper gastrointestinal bleeding, which was partly caused by celiac artery malperfusion. The bleeding was controlled by intravenous proton pump inhibitors and did not affect the patients' recovery. One patient had progressive jaundice, due to a comorbid condition of a gallbladder stone. ERCP with lithotripsy solved the problem smoothly. The most devastating complication was paraplegia that occurred in one patient, who also had bilateral common iliac artery compromise. When the patient presented to the emergency department, he had severe bilateral lower limb numbness. We could not differentiate whether the numbness was a result of limb ischemia or spinal cord ischemia. The patient's lower limb perfusion recovered immediately after the operation. However, the paraplegia persisted without much improvement. We suspected that the spinal cord ischemia was a complication of the acute dissection per se and was not the consequence of thoracic aorta coverage by stent grafts.

On the follow-up CT, smooth alignments between the proximal stent grafts, distal bare stents, and thoracic aorta were observed in all patients. We believe that a smooth alignment will preclude SINE in the future, although this needs longer follow-up results to prove. Moreover, the aorta had very favorable remodeling. Statistically significant true lumen expansion and false lumen regression were observed at different levels including the thoracic aorta beyond the LSA, T9 vertebra, T11 vertebra, and celiac artery. At the SMA level, false lumen regression of 53.9% (P = .16) and true lumen expansion of 130% (P = .05) were quite obvious, although not statistically significant. We believe that if we collected data from more patients, the changes at the SMA level would also become statistically significant.

In conclusion, proximal stent grafting and distal bare stenting for complicated acute type B dissection are very effective at resolving dissection-related complications. The operation was not more complex compared with standard TEVAR. This approach may facilitate favorable aortic remodeling, which appears early after the operation. ■

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