Original Article

Comparison of chimney technique and single-branched stent graft in a cohort of patients with type B aortic dissections: a retrospective cohort study

Yue Xing[#], Zhengrong Zhu[#], Lan Zou, Jiayu Wu, Guojian Xu, Yiding Xu, Zhijian He, Jianqiang Cao, Canhua Luo

Department of Vascular Surgery, The First People's Hospital of Foshan, Foshan, China

Contributions: (I) Conception and design: Y Xing, Z Zhu, C Luo; (II) Administrative support: Y Xu, Z Zhu; (III) Provision of study materials or patients: Y Xu, Z Zhu, C Luo; (IV) Collection and assembly of data: Y Xing, Z Zhu, L Zou, J Wu, G Xu, Y Xu; (V) Data analysis and interpretation: Z He, J Cao; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Canhua Luo, MD. Department of Vascular Surgery, The First People's Hospital of Foshan, No. 81, North Lingnan Avenue, Chancheng District, Foshan 528000, China. Email: 63216466@qq.com.

Background: Single-branched stent grafts and the chimney technique are widely used in the treatment of type B aortic dissection (TBAD). The main objective of this study was to compare the outcomes of single-branched stent grafts and the chimney technique in the treatment of TBAD.

Methods: From January 2019 to December 2021, the retrospective cohort study contained a cohort of 91 patients with TBAD undergoing thoracic endovascular aortic repair (TEVAR) using single-branched stent grafts and the chimney technique. Group A included 55 patients treated with single-branched covered stents, and Group B included 36 patients treated with the chimney technique. We compared the effects of the procedures on peri-/post-operative outcomes between the two groups. The primary endpoint is clinical death, and the secondary endpoints include the patency of branch stents, the incidence of cerebral infarction, false lumen thrombosis, and the proportion of paraplegia.

Results: For the baseline data, the two groups of patients show no differences in terms of age, gender, and associated symptoms. All procedures were successfully performed in both groups. The median follow-up period was 17.6 months (range, 10–34 months). During TEVAR, 5 (9.1%) type I endoleaks occurred in group A, and 11 (30.6%) occurred in group B ($P<0.05$). During follow-up, there were 2 cases (3.6%) of paraplegia and 1 case (1.8%) of cerebral infarction in Group A, while Group B had 1 case (2.8%) of paraplegia. Three patients in group B reported retrograde type A aortic dissection (RTAD), and 1 of them died (2.8%); however, there were no RTAD cases in group A. Complete thrombosis of the false lumen in the thoracic aorta was observed in 45.5% (25/55) of patients in group A and in 41.7% (15/36) in group B ($P=0.72$). No significant difference in the thrombosis-volume ratio in the whole false lumen was found during follow-up between group A (81.0%±2.9%) and group B (81.8%±2.6%; $P=0.23$).

Conclusions: Branched stent grafts can be used in cases with insufficient proximal landing zones and reduce the occurrence of type 1 endoleak compared to the chimney technique. This may help to prevent RTAD. Further research, including more cases and longer follow-up periods, is needed to substantiate these results.

Keywords: Chimney technique; single-branched stent graft; type B aortic dissection (TBAD); retrograde type A aortic dissection (RTAD); type 1 endoleak

Submitted Nov 21, 2023. Accepted for publication Apr 12, 2024. Published online Jun 17, 2024.
doi: 10.21037/cdt-23-449
View this article at: https://dx.doi.org/10.21037/cdt-23-449

Introduction

Background

In the treatment of type B aortic dissection (TBAD), thoracic endovascular aortic repair (TEVAR) has been utilized for two decades (1). Compared to traditional surgery, TEVAR is associated with lower mortality and complication rates (2), making it the preferred first-line treatment method for TBAD. However, TEVAR has often been limited to patients with a healthy aorta proximal landing zone of at least 15 mm. Therefore, an inadequate landing length remains the primary contraindication for TEVAR (3,4).

Rationale and knowledge gap

In recent years, various methods have been adopted to extend proximal landing zones, including a covered left subclavian artery (LSA), chimney endovascular aneurysm repair, fenestrated endovascular aneurysm repair, and hybrid techniques. Despite these efforts, notable shortcomings still exist. Branched stents offer the ability to extend the proximal landing zones and fulfill hemodynamic requirements. The Castor™, a single-branched aortic stent-graft system, was introduced by Shanghai MicroPort Endovascular MedTech (Group) Co., Ltd. (Endovastec™) in July 2017. This system overcomes the limitations of traditional stents and provides a new approach to treating TBAD in cases with inadequate landing zones while simultaneously reconstructing the LSA. However, only a limited number of reports have compared branched stents and the chimney technique in the treatment of TBAD (5,6).

Highlight box

Key findings

- This study found that the Castor™ stent graft can be utilized in some patients with type B aortic dissection (TBAD) who have shorter proximal landing zones, leading to fewer endoleaks compared to chimney grafts.

What is known and what is new?

- Single-branched stent grafts and the chimney technique are widely used in the treatment of TBAD.
- Only a limited number of reports have compared branched stents and the chimney technique in the treatment of TBAD.

What is the implication, and what should change now?

- Branched stent grafts can be used in cases with insufficient proximal landing zones and reduce the occurrence of type 1 endoleak compared to the chimney technique. This may help to prevent retrograde type A aortic dissection.

Objective

In this study, we present a summary of the TEVAR and LSA reconstruction process and evaluate the perioperative and follow-up results involving LSA reconstruction in patients with TBAD. We present this article in accordance with the STROCSS reporting checklist (available at https://cdt.amegroups.com/article/view/10.21037/cdt-23-449/rc).

Methods

In this study, we conducted a retrospective analysis of a cohort of patients with TBAD who were admitted and treated in the Vascular Surgery Department of The First People's Hospital of Foshan, Guangdong Province, China, from January 2019 to December 2021. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by institutional ethics board of The First People's Hospital of Foshan (No. 2023-72), and informed consent was taken from all the patients. A total of 91 patients with TBAD were recruited, diagnosed via computed tomography angiography (CTA), and treated using TEVAR. Patients with stable vital signs, resolved chest pain, and no signs of major organ ischemia underwent TEVAR 2 weeks after their presentation at our hospital; otherwise, TEVAR was conducted immediately. The patients in Group A were treated with branched stents, and in Group B were treated with the chimney technique. Inclusion criteria: (I) CTA of the aorta was performed upon admission, and TBAD was definitively diagnosed; (II) patients with entry tears within 2 cm from the LSA origin and required LSA reconstruction; (III) the patient's heart ejection fraction (EF) is ≥50%. The patients had no issues with the lungs such as chronic obstructive pulmonary disease (COPD) or pneumonia, and were deemed able to tolerate TEVAR.

Exclusion criteria: chronic diseases such as malignant tumors, tuberculosis, chronic cardiac insufficiency, and cerebral infarction complications.

Group A

After administering general anesthesia, a 5-F sheath and a 7-F sheath (Terumo Corporation, Tokyo, Japan) were percutaneously inserted into the femoral artery and the left brachial artery, respectively. The 5-F angiographic catheter

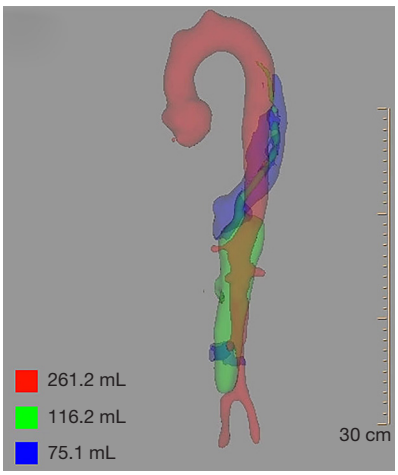

Figure 1 False lumen thrombus volume calculation model. The true lumen is represented in red, the false lumen without the thrombus is shown in green, and the thrombus is depicted in blue.

Figure 2 Schematic diagram of Castor stent.

was then guided into the abdominal aorta, starting from the descending aorta and progressing to the ascending aorta for angiography. If the stent's diameter exceeded 20% of the distal vessel diameter, a slightly smaller restrictive stent was initially placed at the intended stent's end to prevent excessive cutting of the vessel by the proximal stent. Subsequently, the traction conduit was established, and the Castor^{TM} stent graft (MicroPort Endovascular MedTech, Shanghai, China) was advanced to the aortic arch. For the patient with aberrant subclavian artery, there are differences in the stent release process, specifically, the approach is from the right brachial artery when establishing the guidewire track. The covered-branch stent was aligned with the LSA, with the proximal end positioned at the distal border of left common carotid artery origin, and the distal end overlapping 4–5 cm with the restrictive stent. Finally, the stent position was confirmed using angiography, while also checking for the presence of an endoleak.

Group B

After administering general anesthesia, the femoral artery and the left brachial artery were punctured retrogradely using the Seldinger technique. First, angiography was conducted from the brachial artery to the ascending aorta using the catheter. Then, the guide wire catheter, passing through the true lumen to the ascending aorta, was inserted from the sheath of the femoral artery. The Lunderquist ultra-hard guide wire was advanced to the root of the ascending aorta and looped at the tail end. The main stent was introduced through the sheath of the femoral artery, while the "chimney" stent (Viabahn, Gore Inc., Arizona, USA) was introduced through the sheath of the brachial artery. An angiogram was performed again, and the membrane-covered edge of the main stent was adjusted to be flush with the distal end of the left common carotid artery opening before releasing the main stent. Another angiogram was performed to check for endoleak and to verify if the main stent adequately covered the LSA opening. The proximal end of the "chimney" stent extended beyond the membrane-covered edge of the main stent. After releasing the chimney stent, the Pigtail catheter was advanced to the ascending aorta, and another angiogram was performed to check for endoleak, assess the branch vessels of the arch, and confirm the stent's patency. If the stent's diameter exceeds 20% of the distal vessel diameter, a restrictive covered stent should be implanted in the thoracic aorta.

Clinical endpoints and follow-up

The primary endpoint is clinical death, and the secondary endpoints include the patency of branch stents, the incidence of cerebral infarction, false lumen thrombosis, and the proportion of paraplegia (7). Creatinine level was measured one week before and three months after the surgery. CTA of the aorta was performed twelve months post-procedure, and the volume of the false lumen thrombus in the aortic dissection was calculated using IntelliSpace Portal 9 (Philips, Amsterdam, Netherlands) to evaluate aortic remodeling (AR) (*Figures 1*,*2*). AR refers

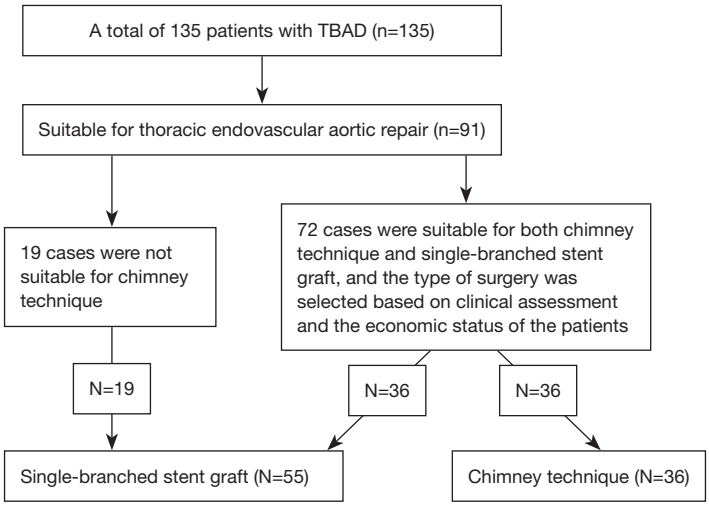

Figure 3 The flow diagram of the study. TBAD, type B aortic dissection.

to the changes in the true and false lumens after stent implantation. Additionally, adverse clinical and device-related events including cerebral infarction, paraplegia, occlusion of branch stents, endoleak, etc. were assessed. In this study, a type I endoleak is leakage from the proximal (Ia) or distal (Ib) attachment site.

Statistical analysis

Data was analyzed using SPSS® version 22 (IBM® Corp., Armonk, NY, USA). The normality of the data was evaluated with Kolmogorov-Smirnov test. Normally distributed data is presented as mean ± standard deviation, and was compared using a *t*-test. For the data that were not normally distributed, data were expressed as median with interquartile range (IQR), and was compared using Mann-Whitney test. The categorical data was compared using Chi-square test, and a P value <0.05 was considered statistically significant.

Results

Patient information

The flow diagram of the study was shown in *Figure 3*. In this study, a total of 135 patients were recruited. Among these 135 patients, 91 patients were suitable for TEVAR and were included in this study. In the included patients, 19 patients were not suitable for chimney technique, and were treated with branched stents. The resting 72 patients were either received chimney technique or chimney technique based on the clinical assessment and the economic status of the patients. Finally, 55 patients were recruited in Group A and 36 patients were recruited in Group B (*Figure 3*).

As shown in *Table 1*, Group A consisted of 55 successfully followed-up patients, comprising 49 males and 6 females, with a mean age of 53.8±13.3 years. Group B included 36 successfully followed-up patients, with 29 males and 7 females, and a mean age of 56.1±12.0 years. There were no significant differences in sex and age between the two groups. Additionally, there were no significant differences in past medical history, including hypertension (Group A: 61.8% *vs.* Group B: 44.4%, P=0.10), diabetes (Group A: 1.8% *vs.* Group B: 5.6%, P=0.32), heart disease (Group A: 3.6% *vs.* Group B: 8.3%, P=0.33), chronic renal insufficiency (Group A: 5.5% *vs.* Group B: 5.6%, P=0.98), cerebral infarction (Group A: 7.3% *vs.* Group B: 5.6%, P=0.74), Tobacco/alcohol abuse (Group A: 14.5% *vs.* Group B: 13.9%, P=0.93), and aberrant subclavian artery (Group A: 3.6% *vs.* Group B: 0, P=0.24), between the groups.

Perioperative outcomes

In Group B, 30 patients were implanted with Endurant covered stents (Medtronic, Inc., Minneapolis, USA), and 6 patients were implanted with Excluder covered stents (Gore Inc., Arizona, USA). As shown in *Table 2*, the distance from the entry tear to the LSA as measured by re-constructed three-dimensional computerized tomography was 15.5 (IQR, 10.0–20.7) mm in Group A and 9.2 (IQR, 6.6–28.5) mm

Table 1 Patient characteristics

Variables	Group A (N=55)	Group B (N=36)	P value
Male	49 (89.1)	29 (80.6)	0.25[$]
Female	6 (10.9)	7 (19.4)	–
Age (years)	53.8±13.3	56.1±12.0	0.40[#]
Hypertension	34 (61.8)	16 (44.4)	0.10[$]
Diabetes	1 (1.8)	2 (5.6)	0.32[$]
Heart disease	2 (3.6)	3 (8.3)	0.33[$]
Renal insufficiency	3 (5.5)	2 (5.6)	0.98[$]
Cerebral infarction	4 (7.3)	2 (5.6)	0.74[$]
Tobacco/alcohol abuse	8 (14.5)	5 (13.9)	0.93[$]
Aberrant subclavian artery	2 (3.6)	0	0.24[$]

Data are expressed as mean ± standard deviation or n (%). [#], unpaired *t*-test; [$], Chi-square test. Group A: patients treated with single-branched covered stents; Group B: patients treated with the chimney technique.

Table 2 Results in perioperative period

Variables	Group A (N=55)	Group B (N=36)	P value
Operation time (min)	124.3±54.1	107.9±60.7	0.18[#]
Contrast volume (mL)	115.4±23.5	109.0±15.9	0.15[#]
Oversize (%)	8.9±4.1	10.3±5.6	0.17[#]
Distance between LSA and first tear (mm)	15.5 (10.0–20.7)	9.2 (6.6–28.5)	0.10*
Size of first tear (mm)	6.8 (5.5–8.1)	5.9 (5.7–6.5)	0.02*
Restrictive stent	35 (63.6)	20 (55.6)	0.53[$]
Endoleak in operation	5 (9.1)	11 (30.6)	0.008[$]
Endoleak in follow-up	2 (3.6)	6 (16.7)	0.03[$]
Postoperative fever	28 (50.9)	14 (38.9)	0.26[$]

Data are expressed as mean ± standard deviation, median (interquartile range) or n (%). *, Mann-Whitney test; [#], unpaired *t*-test; [$], Chi-square test. Group A: patients treated with single-branched covered stents; Group B: patients treated with the chimney technique. LSA, left subclavian artery.

in Group B, which did not show statistically significant differences. However, the size of the first tear in Group A was larger than that in Group B (P=0.02), and the average operation time was 124.3±54.1 minutes, slightly longer than the 107.9±60.7 minutes in Group B. Nevertheless, the difference in operation time between Groups A and B was not statistically significant (P=0.18). In addition, there was no significant difference in contrast volume (Group A: 115.4±23.5 mL *vs.* Group B: 109.0±15.9 mL; P=0.15) and strictive stent (Group A: 63.6% *vs.* Group B: 55.6%, P=0.53) between the two groups. During the intraoperative assessment, 5 cases (9.1%) in Group A and 11 cases (30.6%) in Group B experienced type I endoleaks; during postoperative follow-up processes, 2 cases (3.6%) in Group A and 6 cases (16.7%) in Group B had type I endoleaks. All these were residual endoleaks from the intraoperative period. There were significantly fewer endoleaks in Group A during intraoperative (P=0.008) and postoperative assessment (P=0.03). The most common perioperative event was post-implantation syndrome: characterized by fever, with a maximum temperature of 38.5 ℃. Overall, 28 patients (50.9%) in Group A and 14 patients (38.9%)

Table 3 Results of follow-up

Variables	Group A (N=55)	Group B (N=36)	P value
Follow-up (months)	16.5±3.7	17.7±4.3	0.19[#]
Paraplegia	2 (3.6)	1 (2.8)	0.84[$]
Cerebral infarction	1 (1.8)	0	0.42[$]
Creatinine elevation (mmol/L)	10.2 (1.4–20.2)	7.2 (0.9–11.4)	0.14*
Death	0	1 (2.8)	0.20[$]
Stent occlusion of LSA	0	6 (16.7)	0.001[$]
Retrograde type A aortic dissection	0	3 (8.3)	0.02[$]
False lumen thrombosis			
Complete thrombosis	25 (45.5)	15 (41.7)	0.72[$]
Partial thrombosis	30 (54.5)	21 (58.3)	0.65[$]
Thrombotic volume (%)	81.0±2.9	81.8±2.6	0.23[#]

Data are expressed as mean ± standard deviation, median (interquartile range) or n (%). *, Mann-Whitney test; [#], unpaired *t*-test; [$], Chi-square test. Group A: patients treated with single-branched covered stents; Group B: patients treated with the chimney technique. LSA, left subclavian artery.

in Group B experienced fever; no stent graft infection was observed.

Follow-up results

As shown in *Table 3*, a total of 91 patients were successfully followed up, with a mean follow-up time of 18.6 months (range, 10–34 months). All subclavian artery branches in Group A remained normal without stent occlusion, while 6 cases (16.7%) in Group B were discovered to have stent occlusion (P=0.001). During post-surgical hospitalization, 3 cases of paraplegia were observed: 2 in Group A (3.6%) and 1 in Group B (2.8%, P=0.84). Paraplegia presented as a significant decline in muscle strength of one or both lower limbs to grade 0–2. These patients received hormone therapy, and their symptoms gradually improved. Regarding renal function, creatinine levels increased by a median value of 10.2 (IQR, 1.4–20.2) mmol/L in Group A and 7.2 (IQR, 0.9–11.4) mmol/L in Group B, with no significant difference observed (P=0.14).

There were 3 cases (8.3%) of RTAD in Group B. In one patient, ascending aortic dissection occurred immediately after stent placement, leading to a switch from the endovascular approach to open surgery and undergoing a total aortic replacement. Ultimately, multiple organ dysfunction occurred, and the patient died 11 days after surgery. The other patient was monitored for 2 months, and when the RTAD was discovered, repeat stent surgery was performed.

During the follow-up period, the true lumen of the thoracic aorta was completely expanded, and the false lumen was completely closed in 25 patients (45.5%) in Group A and 15 patients in Group B (41.7%; P=0.72); partial thrombosis was observed in 30 patients (54.5%) from Group A and 21 patients (58.3%) from group B (P=0.65). After analysis, the average thrombosis volume was 81.0%±2.9% in Group A and 81.8%±2.6% in Group B, with no significant difference between the two groups (P=0.23).

Discussion

Key findings

Insufficient proximal anchoring area in TBAD was not only the main challenge of TEVAR but also a significant factor contributing to type Ia endoleak. The incidence of endoleak during TEVAR surgery is approximately 5–30% (8). In our study, we found that single-branched stent technology in some patients with insufficient proximal landing zones can effectively reduce the occurrence of type I endoleaks comparing to chimney technique.

Strengths and limitations

This study presented a summary of the TEVAR and LSA reconstruction process and evaluated the perioperative

and follow-up results involving LSA reconstruction in patients with TBAD. Our study has several limitations. Firstly, the data were collected retrospectively, making the potential for diagnostic errors unavoidable. Secondly, the patients in our research consisted of those referred to tertiary hospitals, which may not fully represent patients admitted to hospitals of varying degrees. Thirdly, not all patients in the control group used the same brand of stent. Therefore, ascertainment bias in diagnosis may obscure the interpretation of the data. Fourthly, the sample size of both sub-cohorts (especially group B) limits the scope for comparisons and conclusions. Fifthly, this was not an RCT. The choices of technique were likely based on clinical parameters that rendered one technique more suitable than the other.

Comparison with similar researches

Currently, various techniques are employed to increase the proximal landing zone size, such as hybrid procedures, "chimney" stents, stent fenestration and slotting, *in situ* fenestration, and branched stent grafts. Cervical open debranching techniques such as the carotid-subclavian bypass have recently been compared with LSA chimneys showing less endoleaks and better technical and clinical success rates compared to chimneys (9). Hybrid procedures involve creating an artificial blood supply bypass graft involving the cervico-carotid artery and subclavian artery before stent insertion. However, this surgery is more traumatic, invasive, and higher-risk, and it may be more prone to postoperative stent infection. Based on the experience of our institution, for large dissection ruptures located in the greater curvature of the aorta, the tear is often adjacent to the posterior edge of the LSA opening, and when LSA lesions are perpendicular to the arch, the incidence of type I endoleaks is high. Chimney stenting is used to reduce this risk by increasing the proximal landing zone (10); but the risk of endoleak remains relatively high. Parallel grafts such as the chimney procedures in the aortic arch have a higher rate of endoleaks than usually reported due to the fact that gutter endoleaks often are not seen as type I endoleaks (11). According to the literature, the average endoleak rate is approximately 20% (12), slightly lower than the 30.6% (11/36) found in this study. Some centers have reported using *in vitro* or *in situ* stent fenestration to increase the proximal landing zone. However, in certain areas, artificially changing stent structures is illegal, and the average incidence of endoleaks is approximately 0–21.4% (12). Furthermore, this technology has a steep learning curve.

As the available methods did not suit every case, branched stents were introduced. Castor™ single-branched stents from MicroPort Endovascular MedTech, Shanghai, can extend the stent into zone 2 of the aortic arch. In our study, we included patients with an average landing zone of 15.5 mm. The incidence of endoleaks during surgery in Group A was approximately 9.1%, reducing to 3.6% during follow-up. The presence of endoleaks in the branched stents group was significantly lower. Therefore, the Castor™ stent is suitable for cases with insufficient proximal landing zones and some cases with tears near the LSA. Based on the literature, the one-year patency rate for open surgery in treating the LSA is typically around 97.8% (13). The patency rate for our branch stent procedures reaches 100%, while chimney stenting achieves only 83.3%. Open surgery for LSA blood flow reconstruction can be considered the gold standard for maintaining antegrade LSA flow in cases of interrupted flow during repair of thoracic aortic aneurysms or open surgery for aortic arch repair. It demonstrates good patency rates in mid-term and long-term follow-ups.

Regarding complications, the incidence of adverse events in the branched stents group was 12.7% (7/55), including 3 cases of paraplegia (5.5%), 1 case of cerebral infarction (1.8%), and 3 cases of type I endoleak (5.5%). However, the incidence of adverse events in the chimney stent group was 44.4% (16/36), with 6 cases of type Ⅰ endoleak, 1 case of postoperative paraplegia, 6 cases of chimney stent occlusion, and 3 cases of RTAD. In this study, the incidence of type I endoleak in the chimney technique group was significantly higher than that in the branched stent group (30.6% *vs.* 9.1%, P=0.009), and the cause of endoleak is related to the limitations of the chimney technology itself. During TEVAR, multiple chimney stents were released in parallel or crossed at the aortic arch, which inevitably led to gaps between the stents, resulting in proximal leakage (14). The chimney stent, which is also free from the proximal aorta, is subjected to long-term impact from the pulsating blood flow of the aorta. Moreover, the use of two different stent materials with vastly different sizes inevitably results in compression, leading to potential fracture, stenosis, or occlusion of the chimney stent in the medium to long term. A review report shows that the incidence of type Ia endoleak is 9.4%, the incidence of proximal reverse avulsion type A dissection is 1.8%, the incidence of stroke is 2.6%, and the reintervention rate is 10.6% (15). The average

follow-up time of the chimney technique group in this study was 17.3 months, and the incidence of type I endoleak decreased to 16.7% (6/36), while the chimney support occlusion rate reached 16.7% (6/36). The branched stents technique for reconstructing the branches above the arch is more complex with normal anatomical structures, resulting in a lower incidence of perioperative complications and endoleak. A recently published study investigating the impact of the selection of the proximal landing zone on long-term outcomes suggested that landing in zone 3 creates significantly better outcomes then compared to zone 2 using different LSA debranching techniques, no matter if the landing zone was healthy or not (16). This study found that placing stents in Zone 2 may lead to a higher rate of secondary interventions, as cases requiring stent placement in Zone 2 are generally more complex than those in Zone 3. Therefore, the likelihood of secondary interventions is higher for Zone 2 cases. This conclusion is not in conflict with our own study, which concluded that branched stents have fewer complications compared to chimney stents.

Explanations of findings

RTAD is a serious complication after TEVAR for TBAD, with an incidence ranging from 1.33% to 13.8% and a mortality rate of 4.2% to 37.1%. Surgical treatment of RTAD is extremely challenging, and postoperative mortality rates range from 4.2% to 11.3% (17-20). In this study, the overall incidence of RTAD was 3.3%, occurring exclusively in the chimney technique group. RTAD typically presents as severe chest and back pain following TEVAR. There is no standard surgical treatment, but commonly performed procedures include complete or semi-arch replacement of the ascending aorta (21). The occurrence of RTAD is mostly associated with surgical experience, interventional procedures (18), the development of stent-damaged aortic walls, and dissection-associated vascular disease. During aortic dissection, the walls become edematous, and the intima fragile. The arterial wall can be easily damaged by direct guidewire or catheter injury during TEVAR, or due to the uneven shear stress generated during stenting. Additionally, intraoperative balloon dilatation may also lead to injury of the aortic wall and subsequent RTAD (22).

Stent size selection is also a crucial factor in preventing retrograde dissection. Canaud *et al.* (23) discovered that when the stent is oversized by more than 9%, for every 1% increase in size, the risk of RTAD increases by 14%. Liu *et al.* (24) found that stents oversized by less than 5% did not increase the risk of stent displacement and endoleaks, and they provided sufficient landing forces with good vascular conformity. Therefore, stents oversized up to 5% can be used for endovascular repair without adverse outcomes, but stents oversized by more than 9% increase the risk of RTAD. Furthermore, the probability of RTAD after TEVAR is significantly higher in patients with autoimmune diseases, such as Marfan syndrome or Takayasu's arteritis (25). A proximal landing zone diameter >40 mm is also associated with an increased risk of RTAD (26). A meta-analysis (17) found that stent placement in the aortic arch (zones 0–2) was a risk factor for RTAD, with a relatively high incidence in zone 0, and emphasized the importance of placing stents in a healthy area of the aortic wall. In our study, no patients experienced RTAD in the Castor™ stent group, possibly because the stent was extended to zone 2, where the aortic wall should be healthier than in zone 3. This suggests that the Castor™ branched stents may reduce the incidence of RTAD. AR is a crucial factor in the treatment of aortic dissection after stent implantation. AR, especially false lumen thrombosis, is a complex process. Its outcomes depend on various parameters such as the number of patent arteries in the dissected area (27) and oral anticoagulation (28). In comparison to acute TBAD, chronic TBAD is less correlated with aortic reconstruction rates. Patients with acute TBAD tend to experience more favorable AR after TEVAR compared to those with chronic TBAD. The majority of patients in this study underwent surgery during the subacute phase, so timing was not a major influencing factor. Research indicates that aortic segment remodeling with stent coverage is significantly better than that of uncovered distal thoracic and abdominal aorta. Greater coverage of the entry tear is advantageous for AR, but it also comes with an increased risk of paraplegia (29). Postoperatively, all patients were administered oral aspirin for antiplatelet therapy. A study suggests that anticoagulation and antiplatelet therapy may be disadvantageous for false lumen thrombosis, but antiplatelet therapy can prevent occlusion of LSA stent (30). In our study, no significant difference regarding AR was observed between these two groups.

Implications and actions needed

However, certain limitations still exist in this study, such as the small sample size and the relatively short follow-up duration. Further investigation is necessary to ascertain whether the Castor™ stent can effectively reduce the incidence of RTAD.

Conclusions

In conclusion, the Castor™ stent graft can be utilized in some patients with TBAD who have shorter proximal landing zones, leading to fewer endoleaks compared to chimney grafts.

Acknowledgments

Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROCSS reporting checklist. Available at https://cdt.amegroups.com/article/view/10.21037/cdt-23-449/rc

Data Sharing Statement: Available at https://cdt.amegroups.com/article/view/10.21037/cdt-23-449/dss

Peer Review File: Available at https://cdt.amegroups.com/article/view/10.21037/cdt-23-449/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://cdt.amegroups.com/article/view/10.21037/cdt-23-449/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by institutional ethics board of The First People's Hospital of Foshan (No. 2023-72), and informed consent was taken from all the patients.

References

1. Dake MD, Kato N, Mitchell RS, et al. Endovascular stent-graft placement for the treatment of acute aortic dissection. N Engl J Med 1999;340:1546-52.
2. Fattori R, Tsai TT, Myrmel T, et al. Complicated acute type B dissection: is surgery still the best option?: a report from the International Registry of Acute Aortic Dissection. JACC Cardiovasc Interv 2008;1:395-402.
3. Kudo T, Kuratani T, Sawa Y, et al. Effectiveness of Proximal Landing Zone 1 and 2 Thoracic Endovascular Aortic Repair for Type B Aortic Dissection by Comparing Outcomes With Thoracic Arch Aneurysm. J Endovasc Ther 2023. [Epub ahead of print]. doi: 10.1177/15266028231174407.
4. Mesar T, Alie-Cusson FS, Rathore A, et al. A more proximal landing zone is preferred for thoracic endovascular repair of acute type B aortic dissections. J Vasc Surg 2022;75:38-46.
5. Zhang H, Huang H, Zhang Y, et al. Comparison of Chimney Technique and Single-Branched Stent Graft for Treating Patients with Type B Aortic Dissections that Involved the Left Subclavian Artery. Cardiovasc Intervent Radiol 2019;42:648-56.
6. Chang H, Jin D, Wang Y, et al. Chimney Technique and Single-Branched Stent Graft for the Left Subclavian Artery Preservation During Zone 2 Thoracic Endovascular Aortic Repair for Type B Acute Aortic Syndromes. J Endovasc Ther 2023;30:849-58.
7. Pocock SJ, Rossello X, Owen R, et al. Primary and Secondary Outcome Reporting in Randomized Trials. Journal of the American College of Cardiology 2021;78:827-39.
8. Liu Z, Zhang Y, Liu C, et al. Treatment of serious complications following endovascular aortic repair for type B thoracic aortic dissection. J Int Med Res 2017;45:1574-84.
9. Dueppers P, Meuli L, Reutersberg B, et al. Early and Mid-Term Outcomes of Open versus Endovascular Left Subclavian Artery Debranching for Thoracic Aortic Diseases. Ann Thorac Cardiovasc Surg 2022;28:193-203.
10. Malkawi AH, Hinchliffe RJ, Yates M, et al. Morphology of aortic arch pathology: implications for endovascular repair. J Endovasc Ther 2010;17:474-9.
11. Dueppers P, Reutersberg B, Rancic Z, et al. Long-term results of total endovascular repair of arch-involving aortic pathologies using parallel grafts for supra-aortic debranching. J Vasc Surg 2022;75:813-823.e1.

12. Scurto L, Peluso N, Pascucci F, et al. Type 1A Endoleak after TEVAR in the Aortic Arch: A Review of the Literature. J Pers Med 2022;12:1279.
13. Mandigers TJ, de Beaufort HWL, Smeenk HG, et al. Long-term patency of surgical left subclavian artery revascularization. J Vasc Surg 2022;75:1977-1984.e1.
14. Carino D, Castellà M, Quintana E. Closing the gap between type A and type B aortic dissections. Curr Opin Cardiol 2019;34:621-6.
15. Ahmad W, Mylonas S, Majd P, et al. A current systematic evaluation and meta-analysis of chimney graft technology in aortic arch diseases. J Vasc Surg 2017;66:1602-1610.e2.
16. Dueppers P, Meuli L, Stoklasa K, et al. Long-Term Outcomes in Thoracic Endovascular Aortic Repair for Complicated Type B Aortic Dissection or Intramural Hematoma Depending on Proximal Landing Zone. J Clin Med 2023;12:5380.
17. Chen Y, Zhang S, Liu L, et al. Retrograde Type A Aortic Dissection After Thoracic Endovascular Aortic Repair: A Systematic Review and Meta-Analysis. J Am Heart Assoc 2017;6:e004649.
18. Eggebrecht H, Thompson M, Rousseau H, et al. Retrograde ascending aortic dissection during or after thoracic aortic stent graft placement: insight from the European registry on endovascular aortic repair complications. Circulation 2009;120:S276-81.
19. An Z, Song Z, Tang H, et al. Retrograde Type A Dissection after Thoracic Endovascular Aortic Repair: Surgical Strategy and Literature Review. Heart Lung Circ 2018;27:629-34.
20. An Z, Tan MW, Song ZG, et al. Retrograde Type A Dissection after Ascending Aorta Involved Endovascular Repair and Its Surgical Repair with Stented Elephant Trunk. Ann Vasc Surg 2019;58:198-204.e1.
21. Li B, Pan XD, Ma WG, et al. Stented elephant trunk technique for retrograde type A aortic dissection after endovascular stent graft repair. Ann Thorac Surg 2014;97:596-602.
22. Zhang S, Chen Y, Lu Q. Retrograde type A aortic dissection complicating endovascular therapy of type B aortic dissection and descending thoracic aneurysm disease. Curr Opin Cardiol 2018;33:581-6.
23. Canaud L, Ozdemir BA, Patterson BO, et al. Retrograde aortic dissection after thoracic endovascular aortic repair. Ann Surg 2014;260:389-95.
24. Liu L, Zhang S, Lu Q, et al. Impact of Oversizing on the Risk of Retrograde Dissection After TEVAR for Acute and Chronic Type B Dissection. J Endovasc Ther 2016;23:620-5.
25. Ma T, Dong ZH, Fu WG, et al. Incidence and risk factors for retrograde type A dissection and stent graft-induced new entry after thoracic endovascular aortic repair. J Vasc Surg 2018;67:1026-1033.e2.
26. Tjaden BL Jr, Sandhu H, Miller C, et al. Outcomes from the Gore Global Registry for Endovascular Aortic Treatment in patients undergoing thoracic endovascular aortic repair for type B dissection. J Vasc Surg 2018;68:1314-23.
27. Logghe G, Trachet B, Segers P, et al. Outflow Through Aortic Side Branches Drives False Lumen Patency in Type B Aortic Dissection. Front Cardiovasc Med 2021;8:710603.
28. Jesse K, Meuli L, Kopp R, et al. ORal anticoagulation risks late aortic intervention in Conservatively managed type B Aortic dissection (ORCA study). Eur J Cardiothorac Surg 2022;62:ezac495.
29. Qing KX, Yiu WK, Cheng SW. A morphologic study of chronic type B aortic dissections and aneurysms after thoracic endovascular stent grafting. J Vasc Surg 2012;55:1268-75; discussion 1275-6.
30. Chang H, Rockman CB, Cayne NS, et al. Anticoagulation and antiplatelet medications do not affect aortic remodeling after thoracic endovascular aortic repair for type B aortic dissection. J Vasc Surg 2021;74:1833-1842.e1.

Cite this article as: Xing Y, Zhu Z, Zou L, Wu J, Xu G, Xu Y, He Z, Cao J, Luo C. Comparison of chimney technique and single-branched stent graft in a cohort of patients with type B aortic dissections: a retrospective cohort study. Cardiovasc Diagn Ther 2024;14(3):367-376. doi: 10.21037/cdt-23-449