Original Article

In situ fenestration (ISF) versus single-branched stent graft (SBSG) implantation in the management of acute Stanford type B aortic dissection involving the left subclavian artery

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Background: With the advances in medical technology and materials, thoracic endovascular aortic repair has become the mainstay of treatment for aortic dissection. In situ fenestration (ISF) and single-branch stent graft (SBSG) implantation are commonly used methods, with each having its own advantages and disadvantages. The study aimed to compare the perioperative outcomes and one-year follow-up results of patients who underwent ISF or SBSG in the treatment of acute Stanford type B aortic dissection involving the left subclavian artery (LSA).

Methods: From January 2018 to December 2022, consecutive patients with Stanford type B aortic dissection were retrospectively recruited and divided into ISF group and SBSG group according to the type of surgery. The patient's aortic physiology was evaluated by computed tomography angiography at 1, 3, 6, and 12 months after discharge.

Results: This study included 67 patients in the SBSG group and 21 patients in the ISF group. The baseline and preoperative indices were similar between the groups. The success rate of perioperative treatment was 100%, and no adverse consequences occurred in either group. No spinal cord ischemia, stroke, or paraplegia occurred in either group during the one-year follow-up. The rate of endoleak in the SBSG group was significantly lower (3%, all type I endoleaks) than that in the ISF group (9.5% type I and 14.3% type II endoleaks) (P=0.005). Type II endoleak mainly occurred in the LSA. In addition, complete thrombosis of the false lumen was achieved in 95.5% of the SBSG group versus 81.0% of the ISF group, but this was not a significant difference (P=0.091). The maximum diameter of the true lumen increased significantly in the ISF (P<0.001) and SBSG (P<0.001) groups. Meanwhile, the maximum diameter of the false lumen was significantly reduced in the ISF (P<0.001) and SBSG (P<0.001) groups, but the difference in the maximum diameter change of the true or false lumen between the two groups was not statistically significant (P>0.05).

Conclusions: SBSG was associated with a significantly lower incidence of endoleak than was ISF. However, there were no differences observed in complete thrombosis of the false lumen. Further studies with larger sample sizes are needed to definitively establish which treatment is superior in terms of complete thrombosis of the false lumen.

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Keywords: Stanford type B aortic dissection; single-branched stent graft (SBSG); in situ fenestration (ISF)

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Introduction

Aortic dissection is a life-threatening condition characterized by tearing in the intimal layer of the aortic wall causing blood to enter the medial layer and creating a dissection between the true and false lumens (1,2). The incidence of aortic dissection is approximately 3–10 per 100,000 individuals (3-6). With the advances in medical technology and materials, thoracic endovascular aortic repair has become the mainstay of treatment for aortic dissection (7) and involves stent graft placement within the thoracic aorta to seal the entry tear (8). Among the clinical subtypes of aortic dissection, as classified based on the pathology and location of the entry tear, Stanford type B dissection involving the left subclavian artery (LSA) is a fairly common type and is characterized by one or more entry tears in the thoracic aorta adjacent to the origin of the LSA (9). However, according to the requirements of thoracic endovascular aortic repair, to ensure normal blood flow through the LSA, the length of proximal landing zone of the stent graft should be enough, generally at least 15 mm away from the LSA origin (9). In treating this type of aortic dissection and maintaining blood flow through the LSA, in situ fenestration (ISF) (10-12) and single-branch stent graft (SBSG) implantation (13-15) are commonly used methods, with each possessing distinct advantages and disadvantages (16,17). The ISF technique has a high technical success rate, and the stent does not need to be customized in advance and can be adapted to different aortic arch shapes. However, fenestration involves damage to the main stent, and results in the membrane near the edge of fenestration area not being firmly attached. Moreover, the periodic blood pressure impact during cardiac contraction may cause fatigue of the fabric covering, thus affecting the stability of the fenestrated stent. The SBSG is more consistent with the anatomical structure of aortic arch and exerts less impact on the hemodynamics of the supra-arch vessels. In addition, the branched stent reinforces the structure of main stent and can effectively prevent stent migration. However, this stent needs to be customized according to the patient's aortic arch shape, which is time-consuming and is not suitable for emergency surgery. Moreover, the stent deployment is more difficult and the cost relatively high. Thus, there is a critical need for further research to establish robust evidence regarding the treatment outcomes of these methods, which can inform clinical decision-making and improve patient care. We present this article in accordance with the STROCSS reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-23-1705/rc).

Methods

Patients

This study enrolled consecutive patients with Stanford type B aortic dissection involving the LSA as classified by the Stanford criteria who underwent treatment at the Department of General Surgery from January 2018 to December 2022. A retrospective study deign was employed, with data being collected from the electronic medical record system of The First People's Hospital of Yunnan Province.

The inclusion criteria for patients were as follows: (I) patients diagnosed with Stanford type B aortic dissection based on medical history and computed tomography angiography (CTA) examination; (II) CTA examination revealed a distance less than 15 mm from the intimal tear to the origin of LSA and an inadequate proximal anchoring zone; (III) measurements of the diameters of aortic true lumen and false lumen diameter (18), the diameter of the descending aorta at the level of LSA, the diameter of the aorta at the level of the diaphragm, and the distance between LSA and left common carotid artery were used to determine eligibility for ISF or SBSG surgery; and (IV) symptom onset occurred within 14 days.

Meanwhile, the exclusion criteria were as follows: (I) accompanying thoracic aortic aneurysm, aortic intramural hematoma, or aortic transmural ulcer; (II) CTA showing involvement of the left common carotid artery or brachiocephalic artery indicating a lack of suitability for isolated LSA reconstruction; (III) completion of direct LSA coverage, chimney technique, or hybrid surgery; (IV) presence of severe liver or kidney dysfunction and anticoagulation contraindications before, during, or after surgery; and (V) multiple systemic diseases and an expected

survival time of less than 1 year.

The choice of the surgical method was decided upon with regard to anatomic requirements for each stent graft, extent of disease, comorbidities, age, and the corresponding surgical indication by a multidisciplinary vascular board on an institutional basis (19,20).

The selection principles for ISF are as follows: (I) the angle of the LSA with the aortic arch is >45°; (II) there is no severe distortion, stenosis, or occlusion present proximal to the LSA; (III) the direction of puncture membrane is controllable, ensuring no injury to the artery wall; and (IV) the patient is in a critical condition and emergent surgery is needed.

Meanwhile, the selection principles of SBSG implantation are as follows: (I) the proximal dissection flap is located between 15 mm distal to the left common carotid artery and 20 mm distal to the LSA, (II) the dissection tears retrogradely to the LSA, and (III) the length of the covered stent anchoring area is ≥15 mm.

This study was approved by the Ethics Committee of The First People's Hospital of Yunnan Province (No. KHLL2024-KY002) and was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Each patient signed an informed consent form.

Perioperative management

Preoperative management

Prior to surgery, patients underwent routine preoperative examinations, and diagnosis was confirmed by CTA.

Intraoperative management

ISF technique

After the patient was positioned in a supine position in the interventional suite, the groin areas on both sides and the elbow joint area of the left upper limb were disinfected and covered with sterile drapes. The left brachial artery was punctured/incised under general anesthesia, and a 6-F sheath was inserted. Thoracic aortic angiography was performed using a pigtail catheter inserted through the sheath to confirm the preoperative CTA measurements.

The right femoral artery was punctured, and a catheter and guide wire were inserted into the aorta, with the position of the guide wire confirmed within the true lumen via angiography. If the guide wire entered the false lumen, resuperselection was performed to ensure entry into the true lumen. A Lunderquist guide wire was inserted into the thoracic aorta to deploy the thoracic aortic stent graft (Ankura, Lifetech, Shenzhen, China), which was positioned proximally between the left common carotid artery and the LSA.

After successful release of the thoracic aortic stent graft, the Fustar adjustable sheath was inserted through the left brachial artery with the head of the long sheath positioned at the opening of the LSA of the large stent graft. The small balloon catheter and V18 guide wire with a sharpened tip were bound at the hard end and inserted through the long sheath. They were then positioned on the LSA opening of the stent graft after the angle of the Fustar adjustable sheath was adjusted through multiangle fluoroscopy.

After vertical and accurate penetration of the stent graft with the sharp needle, the membrane was punctured successfully, and the V18 guide wire was advanced. A 4-mm diameter balloon catheter was first used to dilate the fenestration hole and increase the diameter to 10 mm. Finally, the branched stent graft (FLUENCY, BD, Franklin Lakes, NJ, USA) was implanted, and the fenestration was expanded after implantation, depending on the type of stent graft and specific situation, to restore LSA blood flow. Different puncture kits or other methods can also be used to complete the fenestration depending on the chosen technique.

After angiographic confirmation of accurate positioning of the aortic stent graft and branched stent graft and the absence of type I endoleak and stent graft narrowing, the femoral and brachial sheaths and catheters were withdrawn, and the ProGlide closure device (Abbott Laboratories, Abbot Park, IL, USA) was used to suture the femoral artery puncture site. Elastic bandages were used to locally compress and bandage the site to stop bleeding. *Figures 1*,*2* show the relevant imaging of a case in which the ISF technique was used.

SBSG implantation technique

The preoperative preparation and procedure for the SBSG implantation technique were similar to those used for the ISF technique. Under general anesthesia, a 6-F short sheath was inserted into the right femoral artery. A guidewire and a golden marker catheter were then inserted into the ascending aorta to locate the intimal tear and the opening of the LSA. The left brachial artery was punctured or incised, and a 6-F guiding catheter and guidewire were inserted into the aorta via the brachial artery. The catheter was then withdrawn from the sheath in the right femoral artery, and the guidewire was left in place. A Lunderquist wire was then inserted into the ascending aorta through the golden marker catheter, and the catheter was subsequently removed.

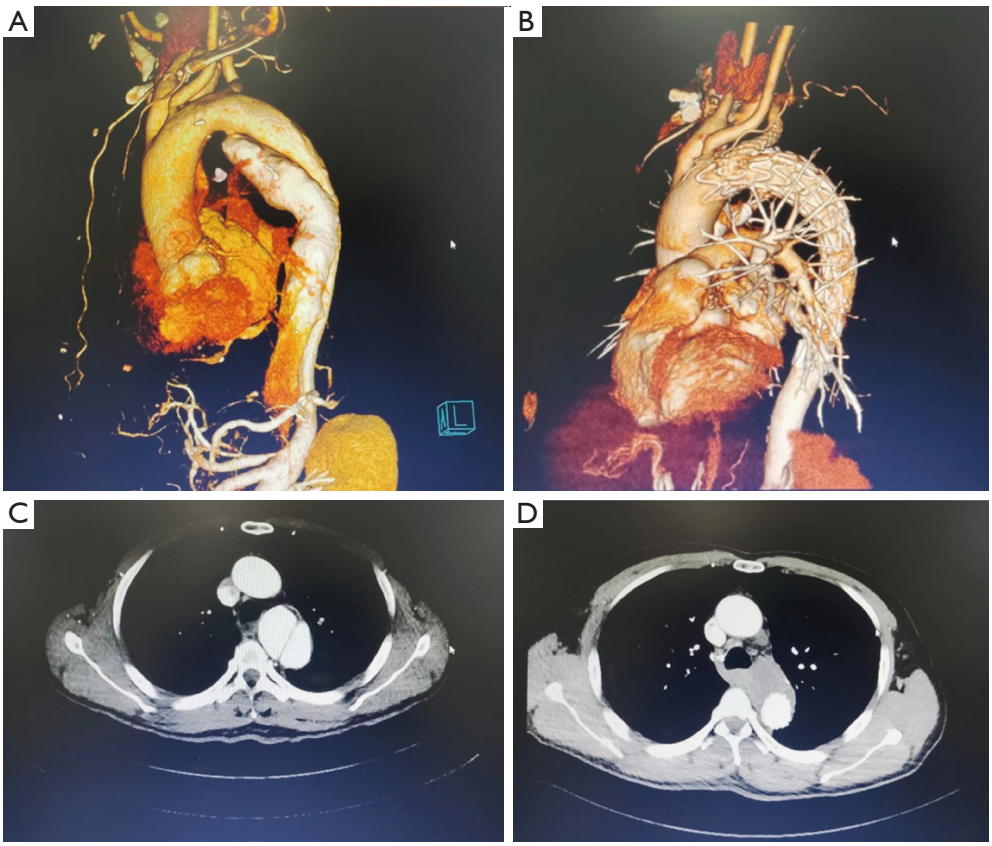

Figure 1 Imaging of a patient undergoing ISF. (A) The preoperative CTA indicated a definite diagnosis of aortic dissection in the patient, and the dissection flap was close to the LSA. (B) On follow-up CTA, the position of the stent graft was confirmed to be good, with no evidence of endoleak or stent graft stenosis. (C) Preoperative CTA transverse section scan confirmed the involvement of the LSA by AD. (D) On the follow-up CTA transverse section scan, significant expansion of the true lumen and thrombosis of the false lumen could be observed. ISF, in situ fenestration; CTA, computed tomography angiography; LSA, left subclavian artery; AD, aortic dissection.

Next, a branch wire of the Castor branched aortic stent graft delivery system (MicroPort Medical, Shanghai, China) was introduced through the femoral artery sheath. The wire was then pulled out through the brachial artery with the guide catheter, and the catheter was removed. The stent graft body was placed into the main artery along the Lunderquist wire through the femoral artery sheath while the assistant simultaneously pulled the branch wire via the guiding catheter. The delivery system's head end was led into the upper segment of the descending aorta by the two wires working together. Under fluoroscopy, the soft handle of the delivery system was gradually adjusted to the "8"-shaped mark toward the small curve side, and then the shape was adjusted to the "I" shape. The outer tube handle was fixed, and the tapered head of the delivery system was advanced to the same level as the LSA with the help of the assistant. The branch wire and the delivery system were monitored for entanglement during the process. If entanglement occurred, the delivery system would be retracted to the straight segment of the main artery, and the outer tube handle would be rotated to remove the entanglement.

The soft sheath wrapped around the stent graft was then retracted to the limit position, exposing the main and branch stents graft. The inner tube handle was pushed upward, and the assistant simultaneously pulled the branch wire to insert the branch stent graft into the LSA. The "O" mark on the leading edge of the branch stent graft positioning ring was positioned closely to the proximal end of the LSA opening, and the front and rear two "O" marks could then be overlapped or positioned closely to each other. The main stent graft position was adjusted slightly to

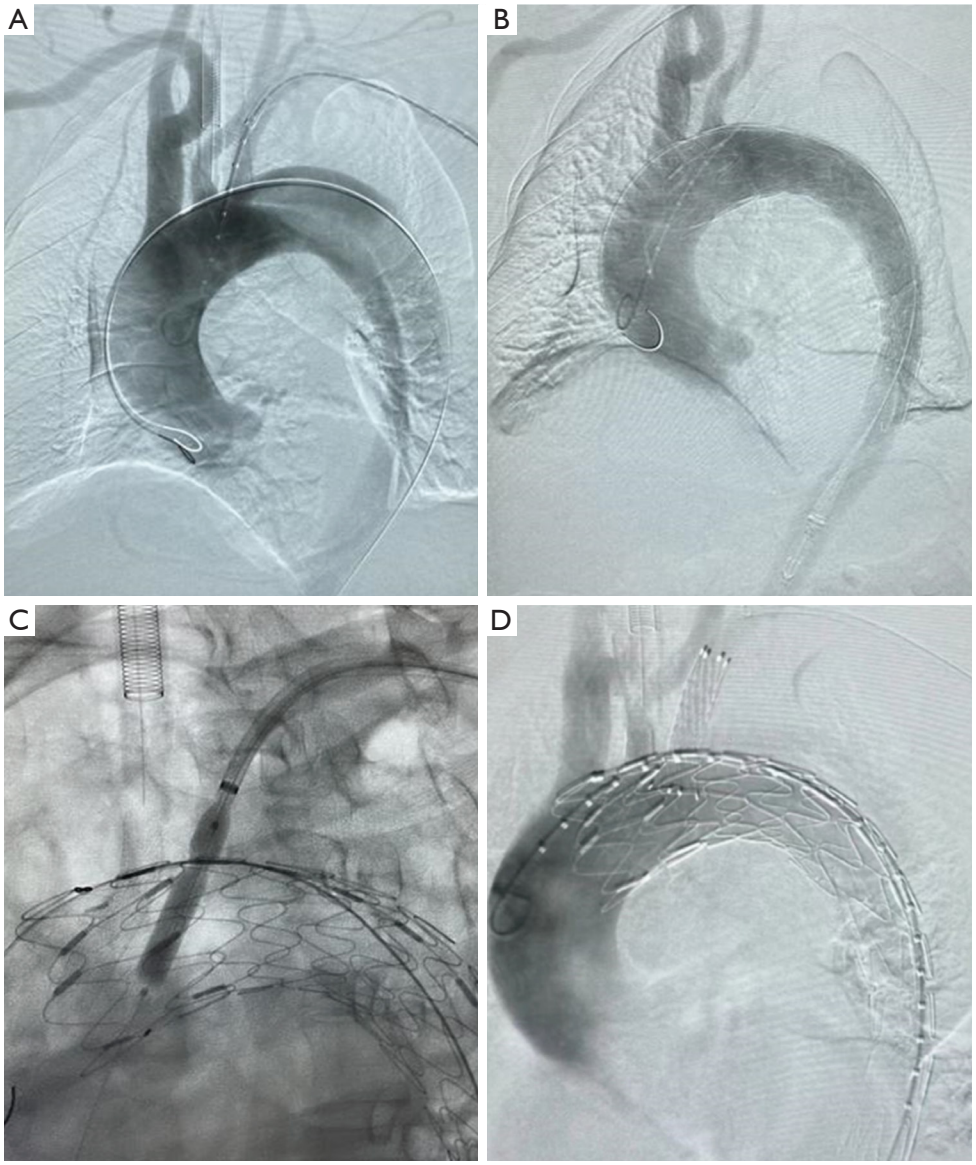

Figure 2 Imaging of a patient undergoing ISF. (A) Deployment of the main stent graft to the predetermined anchoring position. (B) Main stent graft released into position. (C) The membrane on the main stent graft was successfully punctured, and the fenestration was gradually dilated. (D) After expansion, the branch stent graft was deployed. ISF, in situ fenestration.

ensure that the branch stent graft was completely attached to the LSA vessel wall. Once complete, the assistant pulled the branch wire and fixed the delivery system, and the operator quickly released the main stent graft. After the main stent graft was released, the branch wire and the guide catheter were pulled, after which the branch stent graft was released. Imaging was then used to confirm the stent graft's position, the presence of leaks, and the presence of stenosis in the LSA branch stent graft. If endoleak or stenosis of the LSA stent graft occurred, spring coil embolization, balloon dilation, or stent graft insertion were applied to remedy the situation. The follow-up operation was the same as that of the ISF technique after the procedure. *Figure 3* shows the relevant imaging of a case in which the SBSG technique was used.

Postoperative management

Following the surgical procedure, all patients were

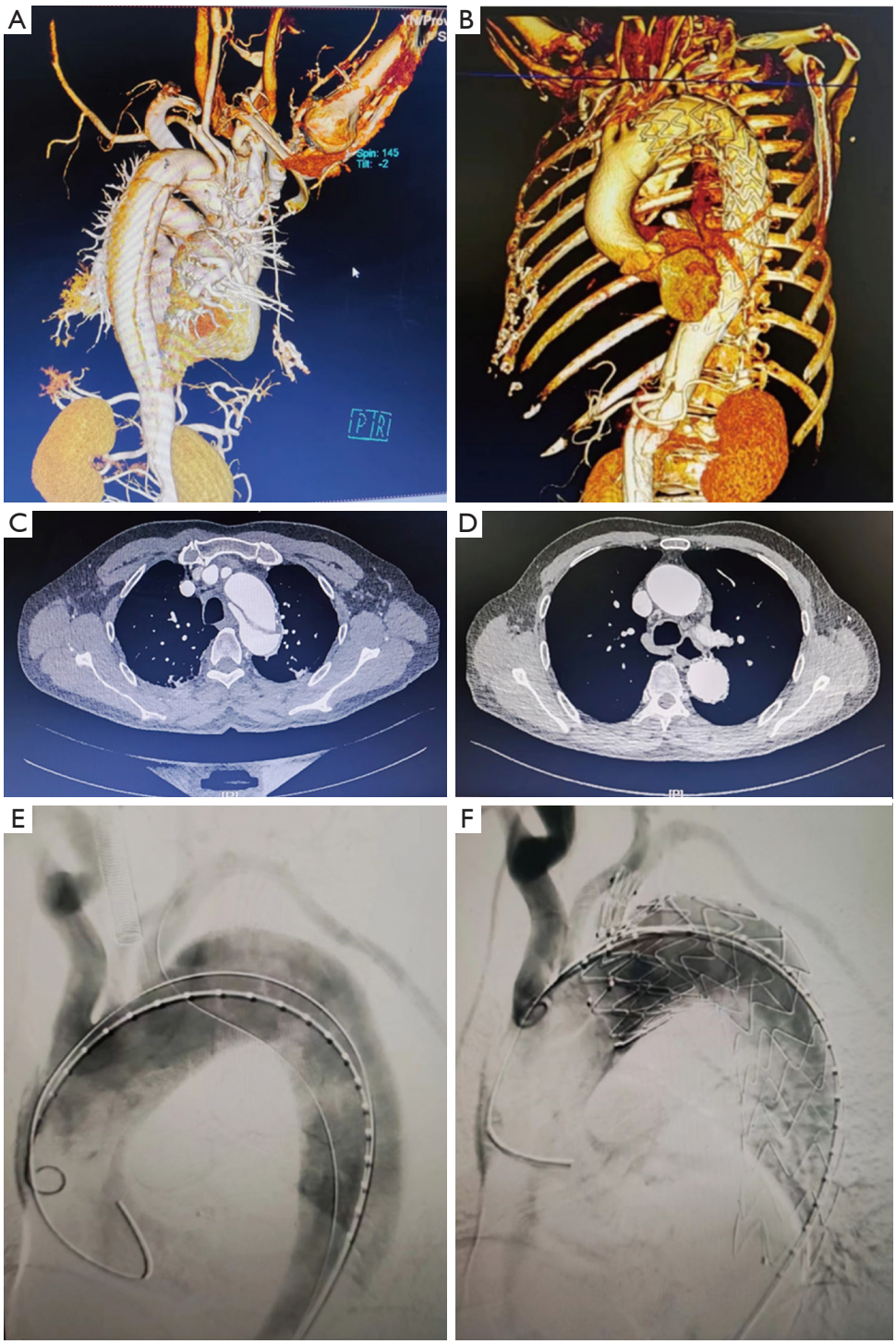

Figure 3 Imaging of a patient undergoing SBSG implantation. (A) Preoperative CTA indicated a definite diagnosis of aortic dissection in the patient, and the dissection flap was close to the LSA. (B) On follow-up CTA, the position of the stent graft was confirmed to be good, with no evidence of endoleak or stent graft stenosis. (C) A preoperative CTA transverse section scan confirmed the involvement of the LSA by AD. (D) On the follow-up CTA transverse section scan, significant expansion of the true lumen and thrombosis of the false lumen could be observed. (E) Deployment of the Castor to the predetermined anchoring position. (F) The Castor was released into the positions of the aorta and LSA. SBSG, single-branched stent graft; CTA, computed tomography angiography; LSA, left subclavian artery; AD, aortic dissection.

transferred to a specialized intensive care unit in our ward and instructed to maintain complete bed rest for 24 hours. Long-term electrocardiogram monitoring and oxygen therapy were provided, along with other symptomatic and supportive treatments. The puncture site or incision was regularly monitored for any abnormalities, which were promptly addressed if detected. Blood pressure was closely monitored and maintained at a range of 110–130 mmHg (systolic pressure)/70–90 mmHg (diastolic pressure) to prevent potential complications. Patients were closely monitored for sudden worsening of chest pain that could indicate potential retrograde dissection. Any perioperative complications such as death, stroke, spinal cord ischemia, or limb ischemia were recorded.

Prior to discharge, patients underwent a follow-up CTA of the chest and abdomen to assess for stent graft displacement, stenosis, endoleak, true lumen expansion, and false-lumen thrombosis. After the procedure, patients were prescribed 100 mg/day of enteric-coated aspirin and were advised to continue this regimen for one year.

Follow-up

All patients received regular follow-up via telephone, with appointments scheduled at 1, 3, 6, and 12 months after discharge. Patients' survival status was recorded, and they were asked about the recurrence of chest pain or any other complications. Follow-up CTAs of the chest and abdomen at 12 months should be performed to evaluate further progression of the dissection, true-lumen expansion, and false-lumen thrombosis, as well as any stent graft displacement, stenosis, endoleak, or rupture. The purpose of the follow-up was also to evaluate whether any stenosis or blockage within the stent graft was present.

Type I endoleak appears on CTA when the proximal or distal end of the stent does not closely adhere to the vessel wall, resulting in significant contrast agent leakage. This involves a large amount of leakage, with the contrast agent rapidly filling in a jet or cloud pattern, and the true- and false-lumen filling phases are almost synchronized, with the false lumen filling from the proximal to the distal end of the stent.

Type II endoleak is also known as reflux endoleak, and involves blood flow refluxes from collateral vessels such as the LSA and spinal artery. This type typically has a smaller amount of leakage, with the contrast agent slowly diffusing in a misty pattern, the false-lumen filling phase being significantly delayed compared to the true lumen, and the blood flow direction being variable.

Stent graft displacement is a displacement of the endograft by more than 5–10 mm from its original position on the CTA (21).

Statistical analysis

Statistical analysis was conducted using R software (The R Foundation for Statistical Computing). Continuous variables were expressed as the mean ± standard deviation and were compared using the *t*-test or paired *t*-test, while categorical variables were expressed as the frequency and percentage and were compared using the Chi-squared test or Fisher exact test. All the significance tests were two-sided, and P values less than 0.05 were considered to indicate statistical significance.

Results

A total of 88 patients were enrolled in this study and were divided into two groups based on the different treatment methods used: the SBSG group (n=67) and the ISF group (n=21). Both groups were followed-up for 12 months. The mean age of the patients was 50 years. The majority of patients were male and had hypertension, while a small proportion had type 2 diabetes mellitus. There were no significant differences between the two groups in terms of age, gender, or comorbidities (*Table 1*).

Between the two groups, there were no statistically significant differences observed in the preoperative diameters of the descending aorta at the opening of LSA or at the level of the diaphragm or in the distances between the LSA and the left common carotid artery or the LSA and the vertebral artery. Moreover, there were no significant differences in the maximal true-lumen diameter or maximal false-lumen diameter between the two groups. These findings suggest that the two groups were comparable in terms of relevant cardiovascular parameters (*Table 2*).

Table 3 presents a comparison of intraoperative and postoperative outcomes between the SBSG and ISF groups. The ISF group had a significantly longer operative time compared to the SBSG group. Neither group experienced postoperative bleeding, complicated postoperative infection, or incision hematoma. The length of hospital stay was similar between the two groups, with no statistically significant difference observed.

Table 4 presents a comparison of relevant conditions in the postoperative and follow-up period between the

Table 1 Comparison of basic information between the SBSG and ISF groups

Item	SBSG (n=67)	ISF (n=21)	P
Age (years)	54±12.02	50.71±12.78	0.284
Male	57 (85.1)	16 (76.2)	0.345
T2DM	3 (4.5)	1 (4.8)	>0.99*
Hypertension	53 (79.1)	17 (81.0)	>0.99*

Data are expressed as mean ± SD or n (%). *, Fisher exact test. SBSG, single-branched stent graft; ISF, in situ fenestration; T2DM, type 2 diabetes mellitus; SD, standard deviation.

Table 2 Comparison of preoperative CTA measurements between the SBSG and ISF groups

CTA parameter (mm)	SBSG (n=67)	ISF (n=21)	P
Diameter of the DAo at the opening of the LSA	26.17±4.30	25.76±4.58	0.708
Diameter of the DAo at the level of the diaphragm	29.02±3.90	30.61±4.24	0.126
Distance between the LSA and LCCA	15.16±3.01	14.08±3.07	0.157
Distance between the LSA and VA	36.52±9.98	38.75±6.61	0.342
Preoperative maximal true-lumen diameter of the DAo	20.26±8.79	17.01±6.85	0.125
Preoperative maximal false-lumen diameter of the DAo	19.84±7.90	20.96±6.72	0.560

Data are expressed as the mean ± SD. CTA, computed tomography angiography; SBSG, single-branched stent graft; ISF, in situ fenestration; DAo, descending aorta; LSA, left subclavian artery; LCCA, left common carotid artery; VA, vertebral artery; SD, standard deviation.

Table 3 Comparison of intraoperative and postoperative outcomes between the SBSG and ISF groups

Items	SBSG (n=67)	ISF (n=21)	P
Operative time (mins)	126.39±54.66	187.50±58.12	0.029
Postoperative bleeding	0 (0)	0 (0)	NA
Complicated postoperative infection	0 (0)	0 (0)	NA
Hematoma at the puncture site or incision	0 (0)	0 (0)	NA
Duration of hospital stay (days)	11.04±5.96	12.90±6.14	0.219

Data are expressed as mean ± SD or n (%). SBSG, single-branched stent graft; ISF, in situ fenestration; NA, not applicable; SD, standard deviation.

two groups. The maximum diameter of the true lumen was significantly increased in the ISF (P<0.001) and SBSG(P<0.001) groups, while the maximum diameter of false lumen was significantly reduced in the ISF (P<0.001) and SBSG(P<0.001) groups, but no significant differences were found between the two groups in terms of the maximal diameter changes of the true lumen or false lumen (*Figures 4*,*5*). Two patients in the ISF group experienced stent graft occlusion, but there was no statistical difference between the two groups in this regard. During the follow-up period, two patients in the SBSG group had type I endoleaks, while two patients in the ISF group had type I endoleaks and three had type II endoleaks. The type II endoleaks were mainly from the LSA. These two patients underwent a second surgery, reoperation was used to expand the proximal anchor region with a compliant balloon, fibrin adhesive was used for reinforcement, and a spring coil was used for reinforcement in one of the patients. There was no obvious endoleak after the second operation. The incidence of endoleaks was significantly lower in the SBSG group compared to the ISF group. At one-year postoperation, nearly all patients in the SBSG group achieved complete

Table 4 Comparison of postoperative and follow-up outcomes between the SBSG and ISF groups

Item	SBSG (n=67)	ISF (n=21)	P
Postoperative true-lumen diameter of the DAo (mm)	28.15±5.17	26.47±4.67	0.188
Change of the true-lumen diameter of the DAo (mm)	7.83±9.36[a]	9.46±6.49[a]	0.461
Postoperative false-lumen diameter of the DAo (mm)	12.73±10.43	11.59±7.61	0.645
Change of the false-lumen diameter of the DAo (mm)	–7.19±10.57[a]	–9.37±7.65[a]	0.385
Completed thrombosis of the false-lumen	64 (95.5)	17 (81.0)	0.091
Dead	0 (0)	1 (4.8)	0.239*
Endoleak			0.005*
Type I	2 (3.0)	2 (9.5)	
Type II	0 (0)	3 (14.3)	
Obstructed stent	0 (0)	2 (9.5)	0.055
Reoperative intervention	1 (1.5)	1 (4.8)	0.422*
Spinal cord ischemia	0 (0)	0 (0)	NA
Stroke	0 (0)	0 (0)	NA
Paraplegia	0 (0)	0 (0)	NA

Data are represented as the mean ± SD or n (%). Change = postoperative – preoperative. [a], paired *t*-test (postoperative *vs.* preoperative) P<0.001; *, Fisher exact test. SBSG, single-branched stent graft; ISF, in situ fenestration; DAo, descending aorta; NA, not applicable; SD, standard deviation.

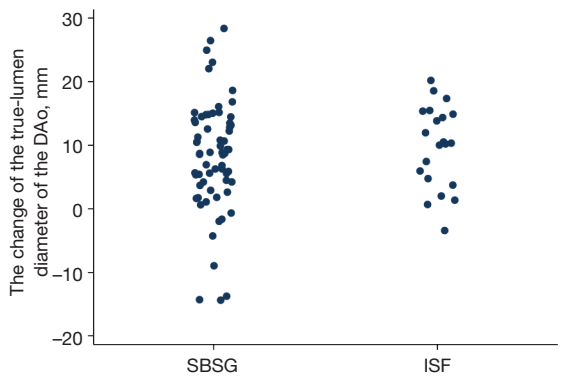

Figure 4 The change in maximal diameter of the true lumen of the DAo between the postoperative and preoperative assessments in the two groups (SBSG *vs.* ISF: P=0.461). Change = postoperative maximum – preoperative maximum. DAo, descending aorta; SBSG, single-branched stent graft; ISF, in situ fenestration.

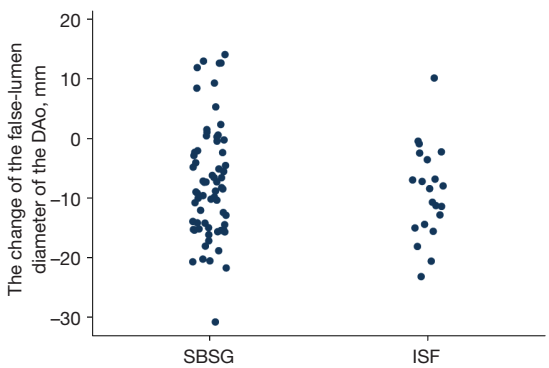

Figure 5 The change in maximal diameter of the false lumen of the DAo between postoperative and preoperative assessments in the two groups (SBSG *vs.* ISF: P=0.385). Change = postoperative maximum – preoperative maximum. DAo, descending aorta; SBSG, single-branched stent graft; ISF, in situ fenestration.

thrombosis of the false lumen, whereas approximately 81% of patients in the ISF group achieved the same outcome. However, there was no statistically significant difference observed between the two groups in this regard. One patient in the ISF group died during the follow-up period, but this did not result in a statistical difference with the SBSG group. Neither spinal ischemia, stroke, nor paraplegia occurred in either group.

Discussion

This study included 67 patients in the SBSG group

and 21 patients in the ISF group. The two groups were comparable in terms of gender, age, preoperative maximal true- and false-lumen diameters, and the diameters of the descending aorta at the opening of LSA and at the level of the diaphragm. Additionally, there were no statistically significant differences observed in the distances between the LSA and the left common carotid artery or the vertebral artery. During the follow-up period, both groups exhibited a significant increase in the maximal true-lumen diameter and a significant decrease in the maximal false-lumen diameter. Nearly all patients in the SBSG group achieved complete thrombosis of the false lumen, while 81% of patients in the ISF group achieved the same. However, the ISF group had a higher proportion of patients with endoleaks compared to the SBSG group.

The patients in our study were limited to those with acute Stanford type B aortic dissection involving the LSA, which could potentially limit the generalizability of our results in comparison to other studies (15,22). However, we chose to focus solely on patients with acute conditions because of their distinct prognosis compared to those with chronic conditions (23). Given the retrospective nature of this study, randomization was not feasible. Fortunately, our analysis of the basic demographic and comorbidity characteristics between the two groups revealed no statistically significant differences. Additionally, we assessed multiple preoperative indicators in both groups, including the diameters of the descending aorta at the opening of the LSA and at the level of the diaphragm, the distance from the LSA to the left common carotid artery, distance from the LSA to the vertebral artery, and the maximal diameters of the true and false lumen. These indicators are crucial for assessing the degree of lesion and treatment efficacy (9), and our results demonstrated no significant differences between the two groups for any of them. This indicates that the two groups were comparable pathologically, physiologically, and demographically.

SBSG implantation and ISF are established techniques for the treatment of patients with Stanford type B aortic dissection (9,24,25). In our study, there were no intraoperative deaths in either group. The minimally invasive nature of both procedures contributed to low rates of postoperative complications such as complicated postoperative infection, bleeding, and puncture site or incision redness, and to ensuring a short hospital stay of approximately 10 days. Consistent with previous reports (17,26), there were no statistically significant differences in these variables between the two treatment groups. Although both SBSG implantation and ISF are considered mature techniques, the duration of ISF surgery is longer than that of SBSG implantation (17). ISF surgery requires a high level of technical skill and experience, particularly for precise puncture and optimal window opening. In contrast, the SBSG implantation procedure is relatively straightforward, involving only the guidance of a branch stent graft into the LSA. The Castor integrated stent graft used in our study conforms closely to the physiological anatomical structure, and the branch stent graft provides stability to the main stent graft (24). Furthermore, one study demonstrated that SBSG treatment better preserves the branches of the aorta by accurately positioning the stent graft above the branch artery and preventing damage to the vessel (15). Although ISF has a greater adaptability, SBSG implantation offers advantages in surgical operation. In terms of fenestration, a vertical puncture angle causes the least damage to the covering stent graft and achieves the best window-opening effect (24). A longer and more tortuous LSA in ISF can make the puncture needle passage more challenging, affecting puncture position and intensity. Additionally, the visibility of the expanded polytetrafluorethylene (ePTFE) fiber under fluoroscopy is often poor, hindering determination of the fiber end's position, even with the assistance of other catheters (27). The technical ease and precision of SBSG implantation can be attributed to the Castor integrated stent graft, which makes it possible to avoid stent graft deformation and accurately position the branch stent graft above the branch artery. In conclusion, while ISF may be preferable in emergency situations where SBSG production time is insufficient, SBSG is generally a superior option due to its simplicity, accuracy, and ability to better protect the branches of the aorta (28).

Endoleak is a common complication of endovascular repair procedures and involves the continuous flow of blood from the excluded false lumen of the aortic dissection into adjacent collateral vessels (29,30). With the advancement of medical technology and materials, types III and IV endoleak have become less common, and types I and II are more frequently observed (9,29,30). Type I endoleak occurs when there is incomplete sealing between the endograft and the native vessel wall, resulting in blood flow entering the false lumen through the gap, while type II endoleak results from retrograde blood flow into the false lumen from a branch vessel, leading to persistent pressurization of the false lumen (31).The type II endoleaks are mainly related to LSA, but in a few cases, they arise from the intercostal or bronchial arteries. In our cases, all the type II endoleaks

originated from the LSA. One of the key factors influencing the development of both types of endoleaks is the degree of sealing between the endograft and the vessel wall, with exceptions seen in patients with certain pathological vascular changes. For reducing the incidence type II endoleaks in particular, SBSG can be customized to align with the physiological structure of the angle between the branch vessel and the aortic vessel (32). Our investigation found that the SBSG group exhibited a significantly lower incidence of endoleak compared to the ISF group, potentially due to the personalized customization of the SBSG closely matching the physiological structure of the aorta and its branches. Additionally, intraoperative manipulation is a risk factor for endoleak, and the higher complexity of the ISF procedure may serve as a potential risk factor for type I endoleak. However, in terms of reintervention, one case in each group underwent additional treatment due to the occurrence of type I endoleak, and there was no significant difference between the two groups in this regard. This finding is consistent with other similar research (12).

Complete thrombosis of the false lumen after thoracic endovascular aortic repair is a crucial prognostic indicator and is essential for aortic remodeling, while incomplete or nonthrombosis is a known risk factor for aortic rupture, as emphasized in previous studies (17,33-35). In our study, almost all patients in the SBSG group achieved complete thrombosis of the false lumen with one year after the procedure, whereas around 80% of patients in the ISF group achieved the same result, which is in line with previous studies (12,17,36). The process of thrombus formation in the false lumen is complex. After complete closure of the false lumen postoperatively, a decrease in blood flow velocity and pressure, along with the preservation of vascular wall integrity, results in the gradual formation of thrombus until it fills the false lumen. The degree of apposition between the stent graft and the vascular wall plays a crucial role in this process. In related studies, almost all patients in a one-piece stent graft group achieved complete thrombosis of the false lumen during follow-up (36,37). This outcome may be due to the integrated structure of the stent graft, which facilitates complete closure of the dissection and reduces blood flow velocity and pressure in the false lumen, thereby promoting thrombus formation.

After one-year of follow-up, one patient in the ISF group died due to severe pulmonary infection, while no adverse treatment outcomes such as spinal cord ischemia, stroke, or paraplegia were observed in either group, which is consistent with previous studies (12,17,38). Furthermore, we found that a minority of patients experienced a reduction in the true-lumen diameter or an increase in the false-lumen diameter one year after the operation. However, when analyzing the entire study sample, we noticed a consistent and statistically significant trend of increased true-lumen diameter and decreased false-lumen diameter one year postoperatively. Importantly, there were no significant differences between the two groups in terms of the maximal diameter changes of the true lumen or false lumen. This further underscores the favorable effect of both surgical procedures on the reconstruction of branch blood flow.

There are some limitations in our study that should be acknowledged. First, this study was not a randomized controlled trial, and although we found no significant differences between the two groups in some known confounding factors, potential biases might have been introduced due to the study design. Second, the sample size was relatively small, and larger studies are needed to confirm our findings, especially for outcomes for which no significant differences were observed. Third, the follow-up period was limited to one year, and longer-term follow-up may be necessary to establish the superiority or inferiority of the two treatment methods.

Conclusions

Both SBSG implantation and ISF are effective treatment options for patients with Stanford type B aortic dissection involving LSA. During the one-year follow-up, the SBSG group demonstrated a significantly lower incidence of endoleak compared to the ISF group. Although the rate of complete thrombosis of the false lumen was higher in the SBSG group, this did not constitute a statistically significant difference. Further studies with larger sample sizes are needed to definitively determine the advantages of complete thrombosis provided by these two treatments.

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Footnote

Reporting Checklist: The authors have completed the STROCSS reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-23-1705/rc

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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. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Ethics Committee of The First People's Hospital of Yunnan Province (No. KHLL2024-KY002). Written informed consent was obtained from the patients.

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