The Single-centre Experience of the Supra-arch Chimney Technique in Endovascular Repair of Type B Aortic Dissections

Y. Zhu, W. Guo *, X. Liu, X. Jia, J. Xiong, L. Wang

Department of Vascular and Endovascular Surgery, 301 General Hospital of PLA, 28#, Fuxing Road, Beijing 100853, China

WHAT THIS PAPER ADDS

The chimney technique in the aortic arch is thought to be a bailout option based on the currently commercial available devices in emergent cases. Nevertheless, there are scarce data available to prove its safety and efficacy as a routine assistive technique in the thoracic endovascular aortic repair (TEVARs) involving the aortic arch. In this study, we summarise the initial experience from our centre of the chimney technique in TEVARs of type B aortic dissections. This may be beneficial to the accurate assessment of this technique applicability.

Objectives: We summarised the data performed at our centre to evaluate the feasibility of the chimney technique in type B aortic dissections (ADs) with supra-aortic vessel involvement.

Methods: From September 2006 to December 2011, 34 thoracic endovascular aortic repairs (TEVARs) for ADs were performed combined with reconstruction of the arch branches with chimney stents (innominate artery, IA, $n = 3$; left common carotid artery, LCCA, $n = 8$; left subclavian artery, LSA, $n = 23$). Indications for these chimney stents included an inadequate proximal landing zone (<1.5 cm); high surgical-risk patients who are not suitable for open repair or hybrid procedures; and emergent endovascular repair of ADs. The series consisted of 13 acute, 12 sub-acute and 9 chronic cases. The right common carotid—left common carotid—left subclavian artery bypasses were performed in the IA chimney cases to reserve an adequate cerebral perfusion from the LCCA and left vertebral artery, while the left common carotid—left subclavian artery bypasses were performed in the cases having dominant left vertebral arteries. All the TEVARs, chimney stents and bypasses were performed as a single stage. Follow-ups were performed at 3, 6 and 12 months, and yearly thereafter.

Results: Endografts were deployed in Zone 0 ($n = 3$, 9%), Zone 1 ($n = 8$, 24%) and Zone 2 ($n = 23$, 67%). Twenty-five (74%) balloon-expandable and 9 (26%) self-expanding stents were used, of which seven (21%) were covered and 27 (79%) were bare stents. The technical success rate was 82% (28/34). Immediate type I endoleaks were observed in five patients (5/34, 15%), all of which underwent bare chimney-stent repairs. Three self-expanding chimney stents were compressed by endografts and another balloon expandable stent was deployed inside the first one. Five patients underwent surgical bypasses (RCCA—LCCA—LSA, $n = 3$; LCCA—LSA, $n = 2$). Perioperative morbidity included one ST-elevation myocardial infarction. No perioperative death or stroke was observed. The mean follow-up was 16.3 months (range, 3—60 months). Primary patency was maintained in all the chimney stents as well as the surgical bypasses. No stent fracture or recurrent chimney-related endoleak was observed during the follow-up period.

Conclusions: In repairs for type B ADs, the chimney technique provides a minimally invasive way of preserving flow to the arch branches combined with a favourable mid-term outcome. The bare stents seemed to be related to a higher probability of the immediate type I endoleaks. A balloon-expandable stent should be regarded as the first choice due to its greater radial strength.

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The thoracic endovascular aortic repairs (TEVARs) for the type B aortic dissections (ADs) involving the aortic arch need some modified techniques such as those using the fenestrated stent grafts, scallop stent grafts, branched stent grafts and chimney stents to achieve the arch branch preservation. Limited by the evolution of the devices and the complex procedural techniques, the fenestrated or scallop stent grafts and the branched stent grafts for aortic arch repairs are still under investigation and custom-made devices based on individual anatomic characteristics are required.[1–4] The chimney technique was originally applied to permit continued branch perfusion of the visceral arteries in the

* Corresponding author. Fax: +86 10 68176994.
E-mail address: yanxinting@126.com (W. Guo).

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endovascular repair of abdominal aortic aneurysms (EVAR)[5] and in recent years, increasingly used in aortic arch repairs.[6–14] The chimney technique in the aortic arch is thought to be a bailout option based on the current commercial available devices in emergent cases. Nevertheless, there are scarce data available to prove its safety and efficacy as a routine assistive technique in the TEVARs involving the aortic arch in AD cases. In this study, we summarise our initial experience to evaluate the feasibility of the chimney technique in type B ADs involving the aortic arch.

METHODS

From September 2006 to December 2011, 338 TEVARs were performed in our centre, of which 34 type B AD cases (Table 1) involving the aortic arch underwent the aortic repairs combined with arch-branch reconstruction with chimney stents (innominate artery, IA, $n = 3$; left common carotid artery, LCCA, $n = 8$; left subclavian artery, LSA, $n = 23$). The mean age of this group was 65.7 ± 2.9 years. Twenty-six of the 34 patients were male. Indications for these chimney stents included the proximal landing zone of the thoracic endograft being shorter than 1.5 cm; the high surgical-risk patients who are not suitable for open repairs or hybrid procedures; and the emergent endovascular repair of aortic arch ADs. The 34 ADs consisted of 13 acute, 12 sub-acute and 9 chronic cases, which were treated due to visceral arteries' involvement (mesenteric arteries = 9, renal arteries = 11 and lower-limb arteries = 5) according to preoperative images in acute and sub-acute dissections or false lumen aneurysms in chronic cases. Thoracic-aorta endografts included Talent (Medtronic, Minneapolis, MN, USA; $n = 10$), Zenith (Cook, Bloomington, IN, USA; $n = 14$), Hercules-T (Microport Medical, Shanghai, China; $n = 8$) and Ankura (Lifetech Scientific, Shenzhen, China; $n = 2$). The choices of endograft size were aiming at an adequate sealing of the entry site and were generally oversized by 10%. Chimney stents included Fluency (Bard Tempe, AZ, USA; $n = 7$), Express (Boston Scientific, Natick, MA, USA; $n = 23$), Scuba (Invatec s.r.l., Roncadelle, Italy; $n = 2$) and S.M.A.R.T Control (Cordis, Bridgewater, NJ, USA; $n = 2$). Generally, in the case that a short distance is needed in which the stent parallels the endograft, the balloon-expandable bare stent is chosen due to its greater radial strength. Otherwise, the covered stent is a reasonable choice. A 1-cm overlap between the endograft and the stent was adequate in most cases. Preoperative computed tomography angiographies (CTAs) were performed for diagnosing the ADs and measuring their dimensions. General anaesthesia and systemic heparin were used in all cases.

Table 1. Clinical demographics of 34 patients in this series.

	IA ($n = 3$)	LCCA ($n = 8$)	LSA ($n = 23$)	Total/ mean
Age				65.7 ± 2.9
Gender (M/F)	3/0	6/2	17/6	26/8
Smoking	3	5	13	21
Clinical course of ADs				
Acute	0	3	10	13
Sub-acute	2	1	9	12
Chronic	1	4	4	9
Comorbidities				
Hypertension	2	5	12	19
CHD		1	2	3
COPD		1		1
Diabetes			3	3
Renal insufficiency	1		1	2
Previous history of aortic surgery or trauma		1	3	4

IA, Innominate artery; *LCCA*, Left common carotid artery; *LSA*, Left subclavian artery; *AD*, Aortic dissection; *CHD*, Coronary heart disease; *COPD*, Chronic obstructive pulmonary disease.

The thoracic endograft was delivered via open common femoral artery access. LSA and IA chimney stents were placed via percutaneous left or right brachial artery accesses, respectively. LCCA chimney stents were placed via open ($n = 2$) or percutaneous ($n = 6$) LCCA accesses. To preserve the direct perfusion into the left cerebral hemisphere, the right common carotid—left common carotid—left subclavian artery (RCCA—LCCA—LSA) bypasses were needed in all the IA chimney cases. The LCCA—LSA bypass was needed when an LCCA chimney case has a dominant left vertebral artery. All the bypasses were performed before the deployments of the endograft and the stent as a single stage. For the LSA chimney technique, after the wire accesses were obtained via the thoracic aorta and arch vessel, angiography was performed to confirm the deployment position. A long sheath (6F—9F) was introduced into the LSA, through which a super-stiff guide wire was put into the ascending thoracic aorta, and then the distal end of the long sheath tracked the guide wire into the aorta and was placed at the branch ostium. In this way, the ostium would not be totally sealed during the endograft deployment, and the unremitting blood flow into the LSA was kept. When the deployment of the endograft was finished, a super-stiff guide wire was put into the ascending aorta along the outer curvature of the aortic arch through the long sheath in the LSA. Then the chimney stent was delivered through the guide wire and rapidly deployed paralleling the endograft. The manoeuvres in the IA and LCCA chimney technique were analogous to that in the LSA. The percutaneous ultrasound-guided LCCA accesses were recommended to avoid the iatrogenic vascular injury and the risk of LCCA dissection. In the IA, due to the severe reduction of cerebral blood flow after endograft deployment, the chimney stent had to be deployed prior to the endograft. Completion angiography was performed to evaluate the positions of both the endograft and chimney stent and the immediate endoleak. Then angioplasties of the endograft and the chimney stent were performed when necessary. Coil (Tornado® Embolization Coils, Cook, Bloomington, IN, USA) embolisations of the proximal LSA were selectively used aiming to prevent the type II endoleak as a single stage (Fig. 1). Technical success was defined as achieving an accurate deployment of the endograft without type I endoleak, meanwhile a successful target-vessel revascularisation without stent compression after the angioplasties of the