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Favourable Outcomes of Endovascular Total Aortic Arch Repair Via Needle Based In Situ Fenestration at a Mean Follow-Up of 5.4 Months

Tao Shang [†], **Lu Tian** [†], **Dong-lin Li, Zi-heng Wu, Hong-kun Zhang** [*]

Vascular Surgery Department, The First Affiliated Hospital of Zhejiang University School of Medicine, Hang Zhou, China

WHAT THIS PAPER ADDS

Needle based in situ fenestration (ISF) had shown great potential in endovascular total aortic arch repair (ETAAR). However, the available evidence regarding the outcomes of ETAAR comes from mainly case reports, with only few prospectively analysed reports. The conclusions in this study were derived from a series of ten patients. It was found that ETAAR via needle based ISF can be successfully performed in aortic arch pathologies with a favourable early outcome. Establishing extracorporeal circulation before aortic endograft deployment, minimising the cerebral ischaemia period and creating ISF in the left common carotid artery first, were the key points.

Objectives: Endovascular repair of aortic arch pathologies remains challenging. Recently, needle based in situ fenestration (ISF) has shown great potential in endovascular total aortic arch repair (ETAAR). This study aimed to evaluate the feasibility, effectiveness, and safety of ETAAR via needle based ISF, and to present initial experience with this technique.

Design and methods: Patients who met the inclusion criteria were enrolled in this prospective study. The supra-arch branches were manually punctured in a retrograde manner using liver biopsy needles (18 gauge/30 cm) in the left common carotid artery (LCCA) and brachiocephalic trunk (BCT), and endo-puncture system or aspiration biopsy needles (21-gauge) in the left subclavian artery (LSA). All the branches were revascularised with bridge stents. Routine follow-up occurred at 1, 3, 6, and 12 months post surgery.

Results: Ten patients with arch pathologies underwent ETAAR. Revascularisation of three branches was successfully performed in eight patients, but attempts to create ISF in LSA were unsuccessful in two patients because of tortuosity and sharp angle. The time taken to establish ISF in LCCA and BCT was 100.4s and 489.6s, respectively. Bilateral regional cerebral oxygen saturation (RCOS) decreased after the arch endograft deployment (both, $p < .001$) and recovered to the pre-operative level once both carotid arteries were reconstructed (left, $p = .0856$; right, $p = .6$). The right RCOS was higher with the beneficial effect of extracorporeal circulation (after cTAGs deployment, $p < .001$; after LCCA revascularised, $p = .0148$) during the ischaemic period. In one case, the left iliac artery ruptured, but no ISF related or neurological complications occurred. An early follow-up (mean 5.44 months) CTA and ultrasound confirmed patency of all the branch grafts without any endoleak or migration

Conclusions: This study demonstrated that ETAAR via needle based ISF, making full use of off the shelf devices and techniques, can be successfully performed in aortic arch pathologies with a favourable early outcome.

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INTRODUCTION

The aortic arch is a challenging area because of its complex anatomical configuration and variation.[1] Open aortic arch repair with hypothermic circulatory arrest can be accomplished with excellent early and late results.[2] The supra-arch branches, namely, brachiocephalic trunk (BCT), left common carotid artery (LCCA), and left subclavian artery (LSA), can be reconstructed with bypasses.

Recent advances in thoracic endovascular aortic repair, such as the chimney technique, hybrid debranching, or physician modified fenestrated endografts, have extended the options for endoluminal therapy into the realm of the aortic arch.[3–6] However, each of these techniques has its own advantages and limitations.[7]

[†] T. Shang and L. Tian contributed equally to this article.

* Corresponding author. Vascular Surgery Department, The First Affiliated Hospital of Zhejiang University School of Medicine, 79# Qing Chun Road, Hang Zhou, 310003, China.

E-mail address: 1198050@zju.edu.cn (Hong-kun Zhang).

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In situ fenestration (ISF), which was first reported as successful in the LSA in 2004, has developed into an attractive option alongside the progress of endografts and penetration devices.[8] A few recent aortic arch ISF case reports have shown potential for generalisation of this technique into endovascular total aortic arch repair (ETAAR).[9] In this study, the needle based ISF procedure was modified and applied in the ETAAR of arch pathologies with an early follow-up.

METHODS

Patient selection

This prospective study was approved by the research ethics committee of the First Affiliated Hospital of Zhejiang University School of Medicine, China. Informed consent was obtained from each patient. The patients were counselled on all therapeutic strategies, including open surgery and endovascular repair. From June 2016 to July 2017, patients receiving ETAAR as their first line therapy were included, with critical inclusion criteria being retrograde type A aortic dissection (RAAD), type B aortic dissection (TBAD), and thoracic aortic aneurysm (TAA). The three supra-arch branches had to be involved or the proximal seal zone had to cover their origins (Fig. 1). The exclusion criteria were (1) patients with renal insufficiency and cardiopulmonary diseases who could not undergo general anaesthesia; (2) only the LCCA and/or LSA were involved and the proximal sealing zone was adequate to leave uncovered the origin of the BCT; (3) dominant left vertebral artery originated from the aortic arch; and (4) coronary or cardiac valves were involved by the dissection.

Needle based ISF procedure

All the procedures were performed under general anaesthesia in the hybrid operating room. Patients were placed in a supine position and were continuously monitored for regional cerebral oxygen saturation (RCOS) by the INVOS 5100c (Somanetics, Troy, MI, USA). The right common femoral vein (RCFV) and right axillary artery (RAA) were exposed surgically at the beginning to establish extracorporeal circulation (EC). For blood withdrawal, a 20F catheter was inserted from the RCFV to the right atrium, and oxygen saturated blood was returned to the RAA (12F catheter) through the EC bypass. The blood flow rate was set at 15–20 mL/kg/min and the partial pressure of oxygen (PO_2) was set at 200 mmHg (1 mmHg = 1.33 kPa) when the EC started to work. The circuit pressure was maintained at 100–

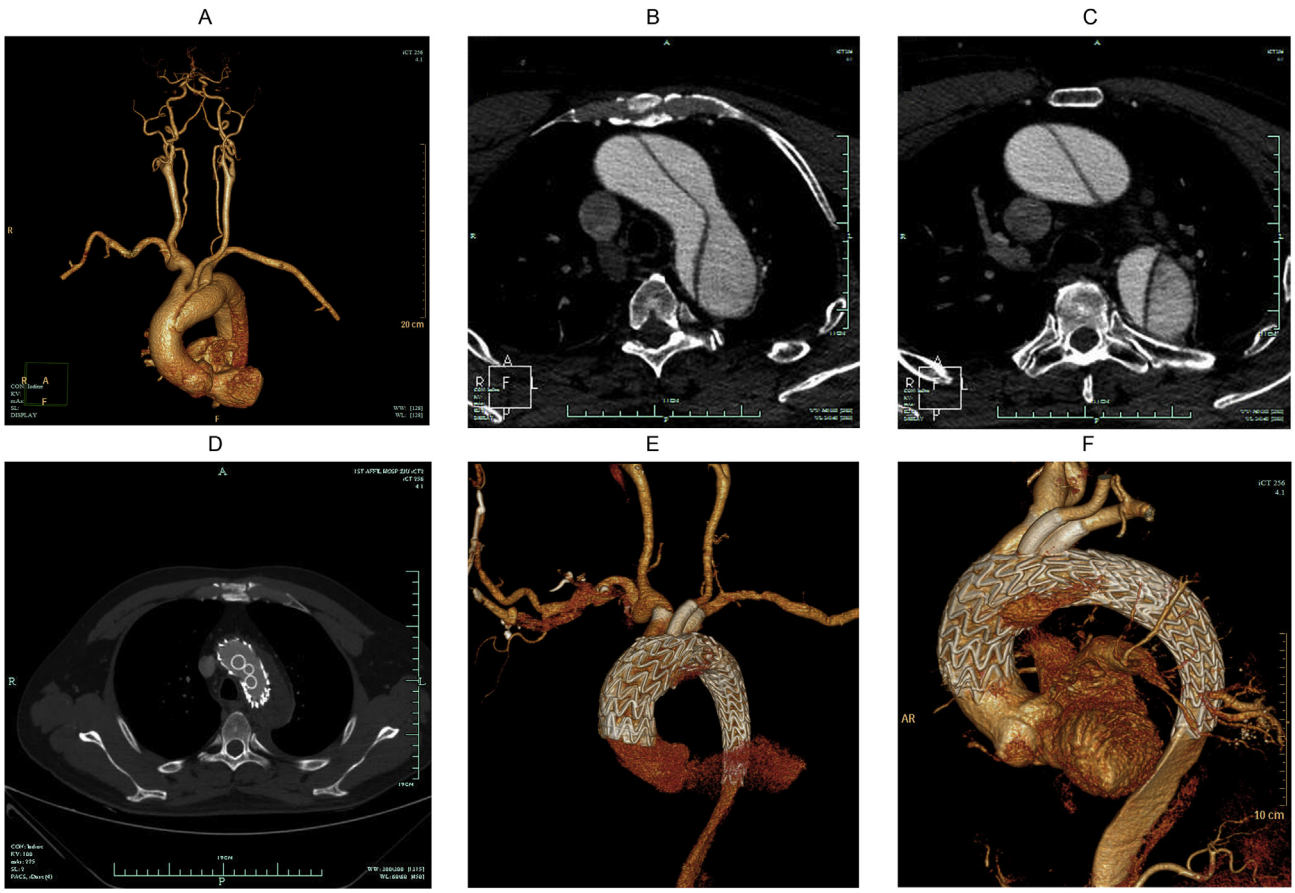

Figure 1. Pre-/post operation CTA images of a typical patient who underwent ETAAR via needle based ISF. (A) CTA shows a RAAD involving the aortic arch with the entry tear in the descending aorta. (B) and (C) Cross CTA shows the lesion involving Zone 0 to Zone 3. (D) and (E) 1 month post-operative CTA shows favourable seal of false lumen and patent supra-arch branch vessels. (F) 6 month post-operative CTA demonstrates stable and patent endografts with no endoleak. ETAAR = endovascular total aortic arch repair; ISF = in situ fenestration; CTA = computed tomography angiography; RAAD = retrograde type A aortic dissection.

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