SHORT REPORT

Aortic-arch Reconstruction with Bolton Medical Branched Thoracic Stent Graft

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Introduction: Surgical repair of the aortic arch is technically demanding and requires complex circulatory management. Endovascular techniques can treat arch diseases but frequently need surgical de-branching of supra-aortic vessels.

Report: We describe the use of a new, custom-made, branched stent-graft system to treat a penetrating atherosclerotic ulcer of the aortic arch. This system consisted of a combination of three endoluminal prostheses introduced via peripheral arteries.

Discussion: The branched stent-graft system was effective and safe. Minimally invasive techniques for aortic-arch repair are attractive but technological progress and further improvements are still necessary in the endovascular treatment of complex arch anatomy.

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INTRODUCTION

Surgical repair of the aortic arch is technically demanding, requiring complex circulatory management. The risk of perioperative neurologic events as well as of other major complications and death is remarkable.[1] Endovascular techniques can be used to treat aortic-arch diseases but they frequently need surgical de-branching of supra-aortic vessels (SAVs).[1–3] In this paper, we describe the use of a new custom-made branched stent-graft system developed by Bolton Medical to treat a penetrating atherosclerotic ulcer (PAU) of the aortic arch.

REPORT

A 75-year-old man was referred to our hospital for a distal aortic-arch PAU. Medical history consisted of a chronic obstructive pulmonary disease, type II diabetes, mild renal insufficiency and several recent episodes of thoracic pain at rest. The preoperative angio-computed tomography (angio-CT) scan is shown in Fig. 1(a). Conventional surgery was refused by the patient. A minimally invasive procedure was planned according to the patient's risk profile, wishes and expectations. Informed consent was obtained. A silicon three-dimensional model, exactly corresponding to the patient's aorta, was manufactured by Bolton Medical and a branched endovascular stent-graft system was specifically designed and tested (Fig. 2). Previous to thoracic endovascular aortic repair (TEVAR), a retropharyngeal carotid—carotid bypass (CCB) was performed. Then, the patient underwent partial ascending aorta and total arch reconstruction with the branched stent-graft system, a combination of three endoluminal prostheses (Fig. 2(C)—(E)). Surgery was limited to bilateral cut-down of both common carotid (CCA) and left femoral artery (FA). Percutaneous access involved the right brachial and FA. Since the ascending aorta had a diameter of 44 mm, a proximal stent graft (46/42 × 80 mm) was deployed into the ascending aorta to provide a smaller proximal convenient neck to the main body (Fig. 2(C)). The main body, delivered into the arch through the FA, had a tunnel (15 mm in diameter × 30 mm in length) directly connected with a 30 × 30-mm fenestration (Fig. 2(C) and (D)). The pre-curved inner catheter of the delivery system allowed the device to self-align to the anatomy, with the big fenestration oriented towards the top of the arch. The fenestration was identified by a series of dot-shaped markers sutured around it, and by a dumbbell marker for longitudinal alignment. The procedure was completed by placement of a limb extension (15/17 × 100 mm) through direct puncture (Seldinger technique) of the bypassed right carotid artery, caudally with respect to the anastomosis. The side branch was deployed a few millimetres out of the proximal end of the main body tunnel and did not cover the innominate artery bifurcation (Fig. 2(E)). The left subclavian artery was covered by the main body graft and left subclavian artery (LSA)-left common carotid artery (LCCA) bypass has not been performed. The operative procedure was technically successful (Fig. 1(B)). The patient was extubated 4 h after the procedure, discharged from the intensive care unit (ICU) in the first postoperative day and did not experience any symptom of upper-extremity ischaemia. The postoperative course was uneventful and CT scan at discharge as well as after 1-year follow-up confirmed satisfactory results (Fig. 1(C)—(F)).

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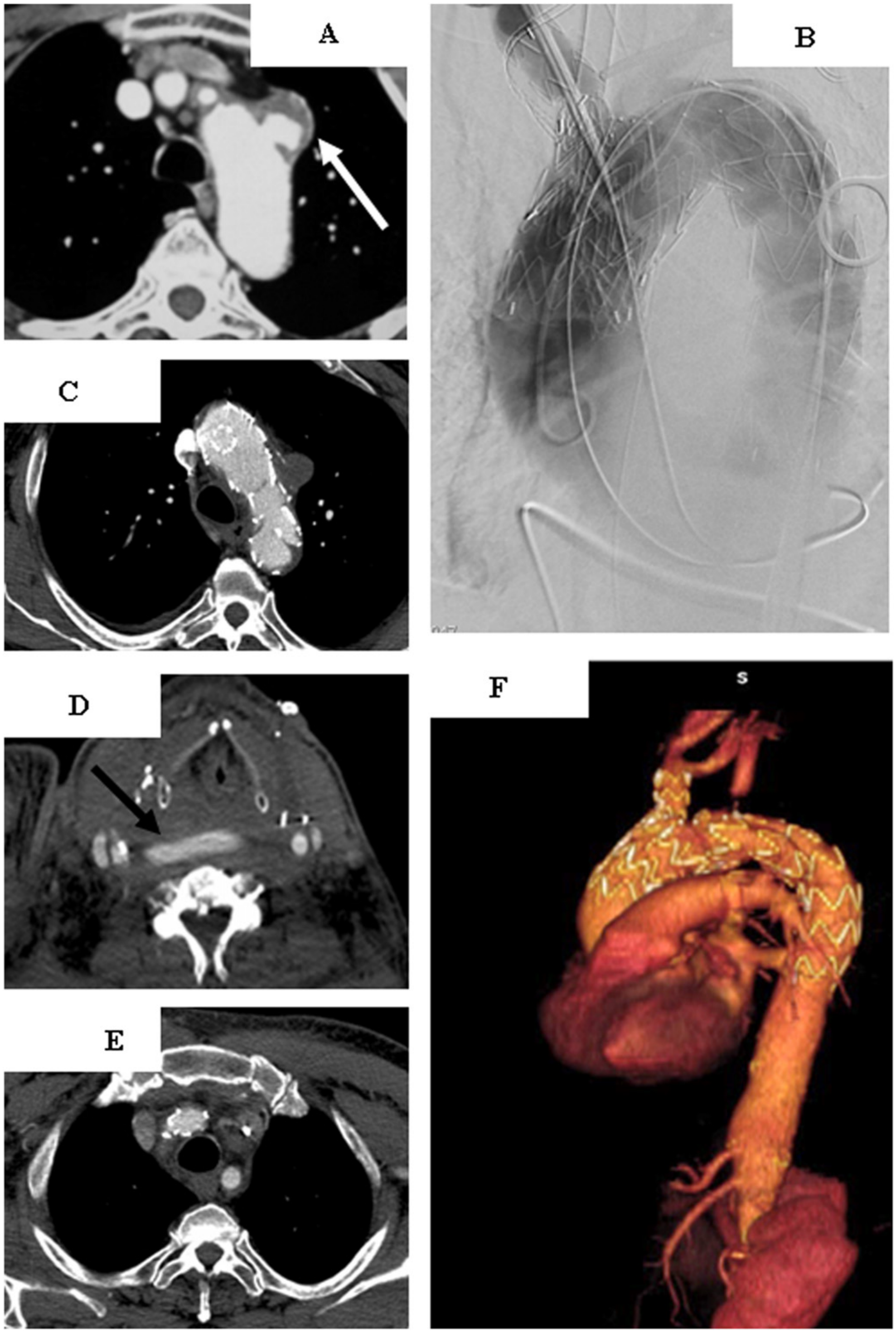

Figure 1. Case imaging. Preoperative angio-CT scan of the thoracic aorta showed a PAU immediately after the left subclavian artery (white arrow in A). Supra-aortic vessels originated from the arch, very close to each other (A). The angiographic control at the end of procedure showed a good result, absence of endoleaks and no prosthetic migration (B). CT-scan performed at discharge showed PAU thrombosis (C), patency of CCB (D), correct positioning of the branched stent-graft (C and E), thrombosis of the left common proximal carotid artery, patency of LSA due to retrograde perfusion in absence of significant endoleaks (E). CT-scan reconstruction of the thoracic aorta was performed after 1-year follow-up and confirmed a satisfactory result (F).

DISCUSSION

The repair of aortic-arch diseases remains a surgical challenge. Despite significant advances in perioperative care, reported mortality rates range from 7% to 17% and neurologic injury rates range from 4% to 12%.[1,2] Recent advances in thoracic stent grafts have enhanced the management of arch-related thoracic aorta disorders. Endovascular treatment of the aortic arch using branched stent grafts provides another attractive alternative. Initial experience was reported by Inoue et al. in

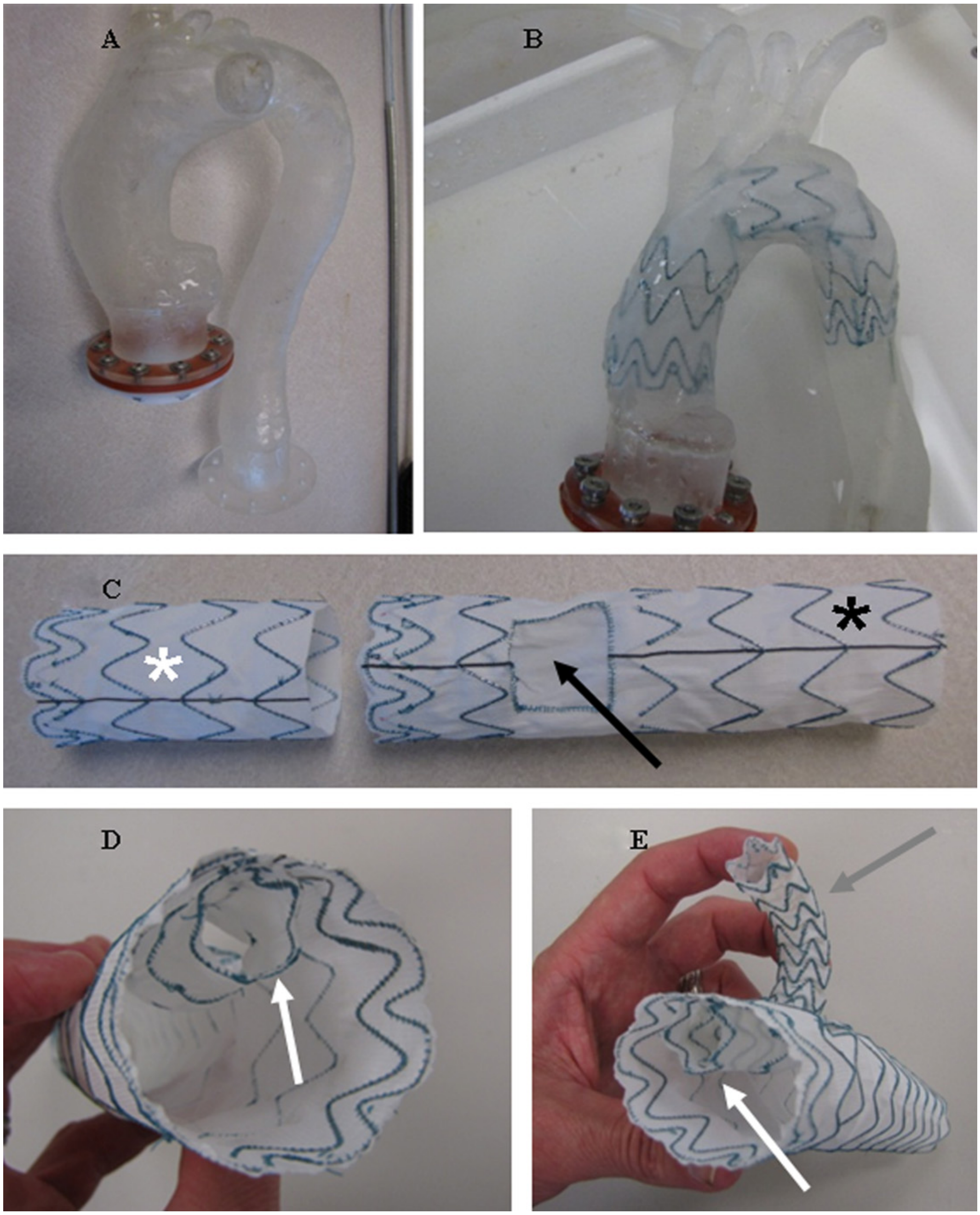

Figure 2. The new branched stent-graft system. A silicon 3-dimensional model, exactly corresponding to the patient's aorta, was manufactured by Bolton Medical (A). In-vitro deployment and orientation tests were performed (B). In C, the main body stent-graft (46/34 mm × 220 mm, proximal and distal Crown stent, NBS Plus delivery system) is indicated by a black asterisk and the proximal stent-graft for the ascending aorta by a white asterisk. A tunnel of 15 mm in diameter (white arrow in D and E) was added to the main body, directly connected with a 30 mm × 30 mm fenestration (black arrow in C, superior view point). A limb extension was inserted into the main body tunnel to preserve blood flow in the innominate artery (gray arrow in E).

1999[4] and later by Chuter and associates.[5] Recently, Lioupis and colleagues presented their experience with a new, modular, transfemoral, multibranched stent graft for treating aortic-arch aneurysms in six patients.[5] According to the patient's risk profile, wishes and expectations, we decided to treat the PAU with a new, custom-made, branched stent-graft system. The advantages of this procedure consisted in avoiding extracorporeal circulation, hypothermic circulatory arrest (HCA) with selective antegrade/retrograde cerebral perfusion, surgical manipulation of the arch and of the SAV at an intrathoracic level and sternotomy or partial upper sternotomy for SAV re-routing. As a significant limitation, all cerebral circulation depends on a single branched vessel. Clear indications and the exact role of these techniques have not been defined yet and long-term durability remains unknown. Minimally invasive techniques for aortic-arch repair are desirable but technological progress and further improvements are still necessary for the endovascular treatment of patients with complex arch anatomy. In our experience, the branched stent-graft system was effective and safe. More patients and longer follow-up are mandatory to confirm this preliminary result.

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None of the above-mentioned physicians has financial relationships with Bolton Medical, Inc., FL, USA, or any other personal interest in promoting the system previously described.

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