# Type A aortic dissection with arch entry tear: Surgical experience in 104 patients over a 12-year period

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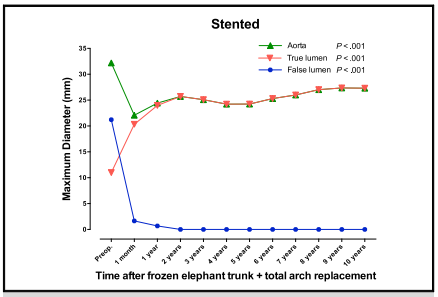
## ABSTRACT

**Objective:** To evaluate the efficacy of the frozen elephant trunk (FET) and total arch replacement (TAR) technique (FET + TAR) in the management of type A aortic dissection (TAAD) with arch entry tear.

**Methods:** Clinical outcomes were analyzed for 104 TAAD patients with arch entry tear undergoing FET + TAR at 4.7 ± 3.5 days from symptom onset and compared with 728 TAAD patients with entry tears in elsewhere. The mean patient age was 49.3 ± 9.3 years, compared with 45.6 ± 10.8 years in other TAAD patients ($P < .001$). There were 84 men (80.8%). Hypertension was seen in 84.6% (88/104).

**Results:** Operative mortality was 8.6% (9/104). Spinal cord injury occurred in 3 cases (2.9%), stroke in 2 (1.9%), renal failure in 4 (3.8%) and limb ischemia in 2 (1.9%). Follow-up was 100% (95/95) at mean 5.6 ± 2.6 years (range 1.3-11.6). Late death occurred in 2 cases (1.9%). Survival and freedom from late adverse events were 89.2% (95% confidence interval [CI], 81.3%-93.9%) and 85.0% (95% CI, 76.3%-90.8%) at 8 years, respectively. Both the stented and unstented distal aortic segments showed significant trends of false lumen shrinkage and true lumen expansion over time ($P < .001$). Of the 65 CT scans at mean 4.6 ± 2.9 years postoperatively, the false lumen was completely obliterated in 63. Risk factors for arch entry tear were hypertension (odds ratio [OR], 2.091; 95% CI, 1.186-3.687; $P = .011$) and age (OR, 1.025; 95% CI, 1.002-1.048; $P = .032$).

**Conclusions:** TAAD with arch entry tear was treated safely and durably by FET + TAR. Although patients with arch entry tear were somewhat older than other patients, operative mortality was not substantially higher despite their older age and arch location of entry tear. These results argue favorably for the use of the FET + TAR technique in the management of TAAD patients with arch entry tears. (J Thorac Cardiovasc Surg 2016;■:1-12)




Following FET + TAR, the stented aortic segment showed significant temporal trends toward false lumen shrinkage and true lumen expansion.

### Central Message

Acute aortic dissection with arch entry tear represents a higher level of complexity than patients with ascending aortic location of tear. This study finds very favorable results via total aortic arch replacement with frozen elephant trunk. This extensive surgical approach is recommended in such a setting.

### Perspective

Aortic dissections with arch entry tear account for 12.5% of type A aortic dissections. Arch tears are most frequently located in the greater curvature. Patients in this series were somewhat older than those with an entry tear located elsewhere. The arch tear location makes the clinical situation more challenging. The rate of aortic valve resuspension was higher and rate of root replacement lower than patients with other type A dissections. Our satisfactory early and late outcomes argue favorably for the use of the frozen elephant trunk and total arch replacement technique in the management of patients with arch dissections.

ACD

Aortic dissections originating from an entry tear located in the transverse arch represent a special entity that is not addressed by the most widely accepted Stanford and DeBakey classification schemes.[1,2] Although relatively uncommon, these dissections occur with significant frequency, comprising 9%-31% of all aortic dissections.[3,4] The

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**Abbreviations and Acronyms**

CI = confidence interval
CPB = cardiopulmonary bypass
CT = computed tomography
FET = frozen elephant trunk
OR = odds ratio
TAAD = type A aortic dissection
TAR = total arch replacement

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optimal management of aortic dissections with arch entry tear, or "arch dissections," has generated much controversy.[5] Most authors recommend surgical repair for aortic dissections with arch entry tear; however, the appropriate extent of resection is a matter of debate, and various surgical techniques have been reported, including isolated ascending aortic replacement (with a composite graft if needed), hemiarch replacement, total arch replacement (TAR), possible elephant trunk techniques, and even extra-anatomic bypass.[6-22]

The frozen elephant trunk (FET) technique is being increasingly used to repair aortic dissections involving the aortic arch and proximal descending aorta, and has improved clinical outcomes considerably.[23,24] The general consensus is that the FET approach will achieve complete arch repair and reduce the need for subsequent reoperations,[23] and there is some evidence to support this. Nonetheless, the optimal indications for this approach remain a matter of debate,[24] as do the potentially increased risks of stroke and mortality. In addition, there are only limited data regarding the long-term outcomes of the FET technique,[23,25,26] especially when performed in patients with arch entry tears.[27,28]

Over the past decade, we have performed FET and TAR using a 4-branched graft (ie, the Sun procedure[29]) in 104 consecutive patients with type A aortic dissection (TAAD) originating from an entry tear in the transverse aortic arch. The present study aimed to evaluate the efficacy of the Sun procedure in the management of arch dissections by analyzing early and late outcomes in this group of patients.

## METHODS

The Ethics Committees of Fu Wai Hospital and Cardiovascular Institute and Beijing Anzhen Hospital, Capital Medical University approved this retrospective study.

### Patients

Between April 2003 and November 2012, our group performed the Sun procedure in a total of 832 patients with TAAD. The mean patient age was 46.1 ± 10.7 years (range, 17-78 years), and the cohort was 79.8% male (n = 664). Based on the location of the primary entry tear, patients were divided into the "arch group," with an entry tear located in the transverse arch in 104 cases (12.5%), and the "non-arch group" (n = 728), with an entry tear located elsewhere, including the ascending aorta in 366 cases (44.0%), descending aorta in 211 cases (25.4%), multiple in 90 cases (10.8%) and unidentified in 61 cases (7.3%) (Figure 1). In the arch group, the entry tear originated in the transverse arch, extending primarily proximally into the ascending aorta and often distally into the descending aorta. Patients with TAAD arising from an entry tear in the descending aorta with retrograde extension proximally into the arch and ascending aorta were excluded from the arch group.

The 104 patients with arch entry tear included 84 men (80.8%) and had a mean age of 49.3 ± 9.3 years (range, 20-65 years), significantly older than the patients in the non-arch group (mean, 45.6 ± 10.8 years; $P < .001$). Sixteen patients (15.4%) were aged 60 years or older. Hypertension was more predominant in the arch group than in the non-arch group (84.6% [88 of 104] vs 68.0% [496 of 728]; $P < .001$), whereas Marfan syndrome was identified in only 1 patient (0.9%) of the arch group compared with 86 patients (11.8%) in the non-arch group ($P < .001$). Bicuspid aortic valve and isolated left vertebral artery were present in 4 cases each (2.9%), and polycystic kidney disease was seen in 1 case (0.9%). Preoperative malperfusion syndrome occurred in 10.6% of patients (11 of 104) in the arch group, compared with 10.7% (78 of 728) in the non-arch group ($P = .966$).

Based on an interval between symptom onset and surgery of ≤14 days, all TAADs with arch entry tear in this study were acute, repaired at a mean of 4.7 ± 3.5 days from symptom onset (median, 3.8 days; range, 5 hours to 14 days). In comparison, the TAADs in the non-arch group were repaired at a mean of 95.6 days from symptom onset (median, 14 days; range, 2 hours to 10 years; $P < .001$) (Table 1). The selection criteria for the Sun procedure in patients with TAAD have been described previously.[29]

### Surgical Techniques

The surgical technique, known as the Sun procedure,[29] has been described in detail previously.[30,31] Specifically, right axillary artery cannulation is used for cardiopulmonary bypass (CPB) and unilateral selective antegrade cerebral perfusion under moderate hypothermic circulatory arrest at 25°C. The flow rate of antegrade cerebral perfusion is 5-10 mL/kg/min, and a mean perfusion pressure of 40-60 mm Hg is maintained during CPB. A pressure of ≥20 mm Hg in the left radial artery is considered sufficient for cerebral perfusion. The procedure involves deployment of an open stent graft (Cronus; MicroPort Medical, Shanghai, China) into the descending aorta, followed by TAR with a 4-branched vascular graft (Maquet Cardiovascular, Wayne, NJ). To minimize the duration of cerebral, myocardial, and spinal cord ischemia, distal reperfusion is initiated once the distal anastomosis is completed, and the left carotid artery is reconstructed first (after which rewarming is started and the brain is perfused bilaterally), followed by the ascending aorta (to resume myocardial perfusion), then the left subclavian artery, and finally, the innominate artery.

### Patient Follow-up

All operative survivors were followed up regularly through phone calls, e-mails, or letters. An annual computed tomography (CT) scan was recommended to detect thrombosis and obliteration of the false lumen; evaluate the size of the true lumen, false lumen, and stented and unstented distal aortic segments; and identify endoleak and other complications. By March 2015, 65 patients had undergone follow-up CT scans (68.4%).