Safe and Less Invasive Surgery for Acute Type A Aortic Dissection: "Zone 0 arch repair" Strategy

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INTRODUCTION

Surgical treatment strategy in acute type A aortic dissection, particularly in patients with DeBakey type I or type III (Retrograde), has been controversial in terms of superiority and inferiority in postoperative early and late outcomes. Currently, aortic resection based on a "tear-oriented" strategy is recommended in acute Type A aortic dissection. Hemiarch or ascending aortic replacement (HAR) is used for patients with a primary tear in the ascending aorta or along the inner curvature of the aortic arch. Total arch replacement (TAR) with or without an elephant trunk is selected when the primary tear is located in the aortic arch or descending aorta. Recent reports have shown that postoperative early mortalities or complications are comparable between TARs and HARs.[1)] However, TARs are more invasive and have a higher risk of postoperative organ injury or respiratory disorder compared to HARs.[2)] On the other hand, the late distal reintervention rates after HARs have been reported to be significantly higher than those of TARs. A report from the University of Pennsylvania comparing the postoperative outcomes of HAR between 177 patients with DeBakey type I and 357 patients with DeBakey type II showed that the distal reintervention rate after HAR in patients with DeBakey type I was significantly higher than patients with DeBakey type II, and that 28 of 32 postoperative reinterventions underwent open repair.[3)] This suggests that the remaining patent false lumen after HAR for DeBakey type I may be involved in postoperative events in the downstream aorta. If the primary tear is resected, blood flow into the false lumen (FL) may continue and cause an expansion of the FL due to residual tears in the aortic arch and proximal descending aorta or newly developed tears in the suture line of the distal anastomosis.[4)] Therefore, when considering a more ideal surgical strategy, it is important that (1) the aortic arch resection is avoided, (2) the FL thrombosis in the distal arch and descending aorta is facilitated, and (3) reintervention to the downstream aorta can be performed with an endovascular approach.

In 2014, a prospective randomized study in patients with acute type B aortic dissection showed that stent graft implantation into the true lumen (TL) to close the entry tear significantly reduced the FL diameter.[5)] This suggests that even if multiple tears exist, FL thrombosis and elimination (i.e., aortic remodeling) can be achieved (due to the entry closure) using endovascular techniques. The study rationalized the efficacy of aortic remodeling by deploying a stent graft from zone 0 to the descending aorta. Based on this, in 2014, we developed a surgical strategy called "Zone 0 arch repair" using a frozen elephant trunk (FET) technique as an alternative to the "tear-oriented" strategy. The FET technique was developed by Kato et al.[6)] in Japan and is now being performed globally. Since October 2014, we have used the "Zone 0 arch repair" strategy, consisting of (1) FET deployment from zone 0 aorta to the descending aorta, (2) ascending aortic replacement, and (3) arch vessel reconstructions.[7)]

SURGICAL PROCEDURES

Under general anesthesia, an anastomosis was performed (using a vascular graft) to the left axillary artery for systemic perfusion. A median sternotomy was carried out and hypothermic total cardiopulmonary bypass (CPB) was initiated by venous cannulation via the superior and inferior vena cava. After the ascending aorta was clamped, cardiac arrest was induced with a cold blood cardioplegic solution injected in an antegrade and retrograde manner. The ascending aorta was transected, and the proximal aorta was trimmed 1 cm distal to the sinotubular junction. Subsequently, the thrombus in the FL was carefully removed, and then the dissecting aortic walls were reapproximated by applying BioGlue® and clamping with Bolst pliers. This was followed by fixation of the proximal aorta using a continuous stitch of 5-0 polypropylene sutures reinforced with bovine pericardial strips (approximately 8 mm in width) inside and outside of the aortic wall (Fig 1, 2).

Circulatory arrest (CA) was initiated when the rectal temperature was below 25˚C. The left subclavian artery was ligated at the origin and left axillary arterial perfusion was resumed. Selective cerebral perfusion (SCP) was then performed to the left carotid and brachiocephalic arteries, and the proximal ends of both arteries were closed (Fig. 3). The distal aorta was trimmed 2 cm proximal to the origin of the brachiocephalic artery. The FROZENIX prosthesis was inserted from the distal aortic end (zone 0) into the descending aorta, and the distal end of the stent was positioned at the level just above the aortic valve using transesophageal echocardiographic guide. The stent part length has been principally set at 150mm since December 2019. In our practice, to determine device length, we take the proximal end of the implant and position it at the origin of the brachiocephalic artery branch. Then for the device diameter, we take 90-100% of the descending aortic diameter at the level of the main pulmonary arteries according to preoperative enhanced CT scans. The proximal graft portion of the FROZENIX was trimmed and anastomosed together with the distal aortic wall to a 4-branched arch graft (J Graft vascular prosthesis) using a continuous stitch of 4-0 monofilament suture reinforced with pericardial strips. Distal perfusion was resumed from the perfusion side branch of the 4-branched graft. During systemic rewarming, proximal anastomosis was performed with 4-0 polypropylene suture (Fig. 4).

The first branch of the arch prosthesis is used for de-airing during myocardial reperfusion (Fig. 5). The third and second branches of the arch prosthesis were anastomosed to the left common carotid and brachiocephalic arteries, respectively, with 5-0 sutures reinforced with pericardial strips. Finally, the perfusion side branch was anastomosed to the prosthesis for axillary artery perfusion drawn to the anterior mediastinum via the left thoracic cavity prior to protamine infusion after CPB was stopped (Fig. 6).

Fig. 1

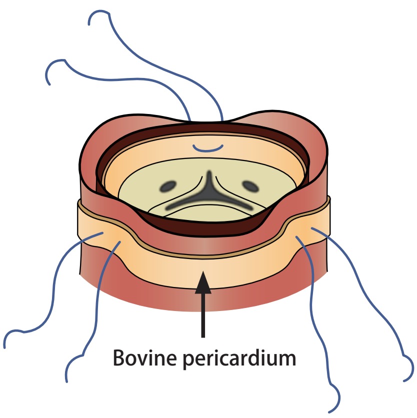
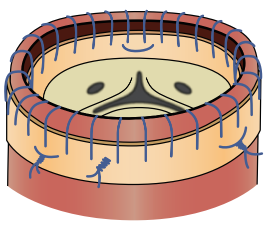


Fig. 2



CONCLUSIONS

This strategy, consisting of (1) FROZENIX deployment from the ascending (zone 0) aorta into the descending aorta, (2) ascending aortic replacement, and (3) arch vessel reconstructions, is straightforward, safe, and less invasive, which may lead to reasonable early postoperative results. An advantage for late postoperative results is that aortic events (late TL stenosis or FL dilation) in the downstream aorta can be fixed by endovascular techniques without open aortic repairs. Furthermore, if any problem occurs in the proximal anastomotic site, cardioplegic arrest can be induced by clamping the vascular prosthesis between the first and second branches of the arch graft, which allows a sufficient working space during the repair procedure. In our experience of 108 patients (Oct 2014 – April 2018) that underwent surgery based on the "zone 0 arch repair" strategy for type A acute aortic dissection, the 30-day mortality rate was 2.8% (3/108) and the hospital mortality rate was 6.5% (7/108). The postoperative CT 3 weeks after surgery revealed complete FL thrombosis of the aortic arch level for all cases. The cumulative incidence of aortic reintervention was 5.8%, 9.1%, and 9.1% at 1, 2, and 3 years, respectively.[7]

Fig. 3

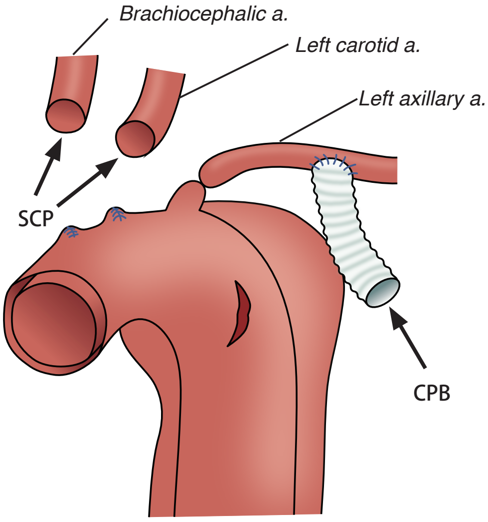


Fig. 4

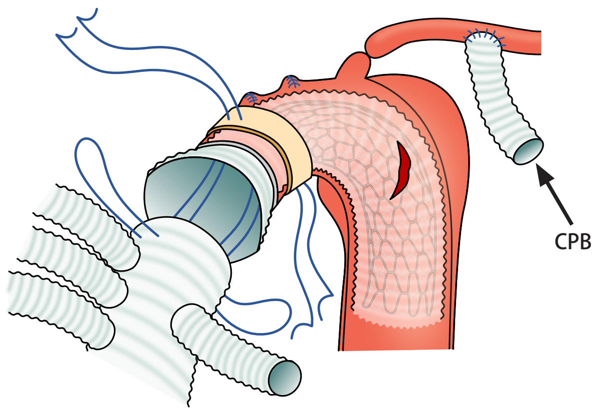


Fig. 5

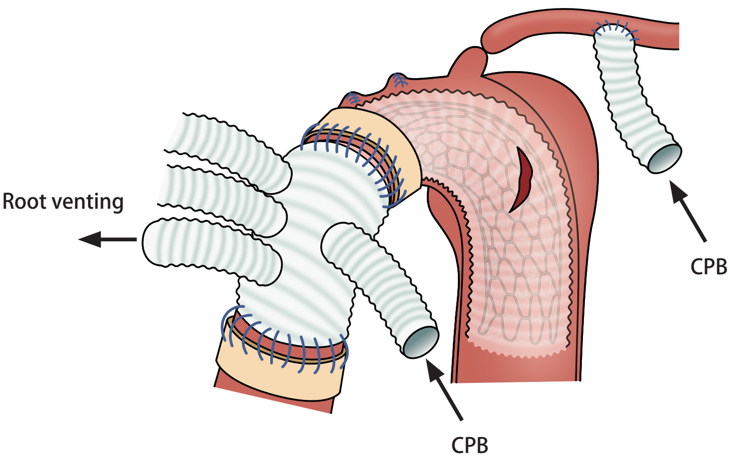
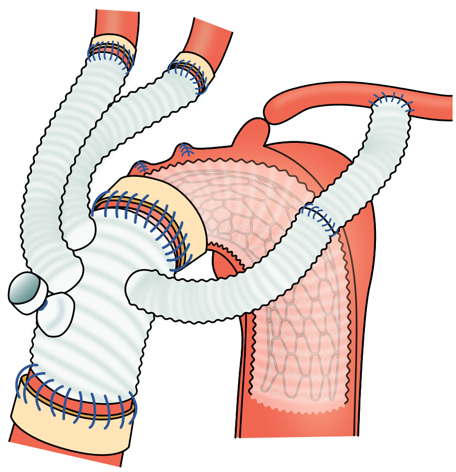


Fig. 6



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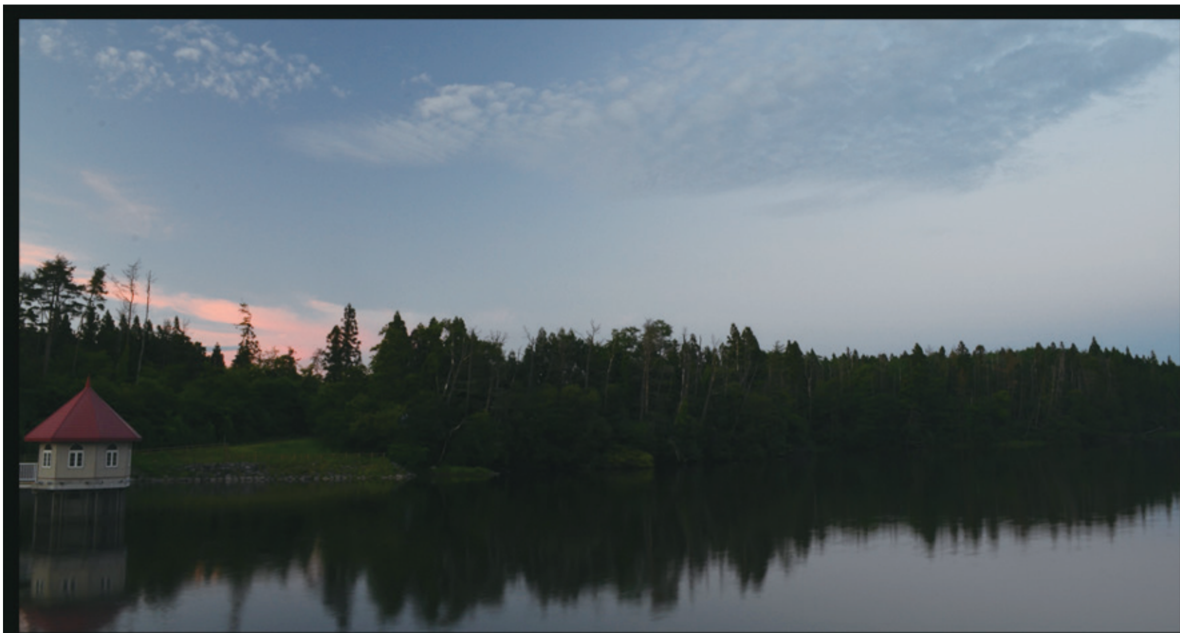

A lake in Akita *Photo: Hiroshi Yamamoto*

PROFILE

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