A Combined Branched Stent Grafting Technique to Reconstruct Total Aortic Arch in the Treatment of Stanford A Aortic Dissection

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Traditional total arch replacement technology and artificial blood vessels are designed for patients with Stanford A aortic dissection who have 3 branches (brachiocephalic trunk, left common carotid artery, and left subclavian artery) arising from the arch of the aorta. However, if there is anatomical variation of the aortic arch branches, the operation will be very difficult. The number of primary branches of the aortic arch can be reduced to 1 or 2 or increased to 4 to 6. Also, anastomoses of the graft to the left subclavian artery and descending aorta are usually very difficult because of the deep surgical field. Moreover, once bleeding occurs after the anastomoses, hemostasis in the deep field is difficult. Therefore, we applied a “combined branched” stent grafting technique for total arch reconstruction to reduce such problems.

In traditional total arch replacement for Stanford A aortic dissection, anastomoses of the graft to the left subclavian artery and descending aorta are often very difficult. Once bleeding occurs after the anastomoses, hemostasis in the deep field is difficult. Moreover, manipulations of the arch and anastomoses are more difficult when there is anatomical variation of aortic arch branches. The number of primary branches of the aortic arch can be reduced to 1 or 2 or increased to 4 to 6 [1, 2]. To reduce such problems, we applied a “combined branched” stent grafting technique to reconstruct total aortic arch in the treatment of Stanford A aortic dissection. With open placement of our single-branched stent graft and branched stent grafts into the open descending aorta and arch vessels, we avoided the distal anastomosis at the ascending aorta. Using this technique, total arch replacement may become easier, safer, and more widely used for Stanford A aortic dissection.

Operative Technique

The ascending aorta and arch were approached through a median sternotomy. Cardiopulmonary bypass was established by 2 venous cannulas through the right atrium and femoral arterial cannulation. Myocardial protection was achieved by multiple administrations of histidine-tryptophan-ketoglutarate solution. During core cooling, the innominate and left common carotid arteries were dissociated and exposed as much as possible. The ascending aorta was clamped at the base of the innominate artery (Fig 2A). Proximal manipulations such as aortic valve repair and sinus of Valsalva reconstruction were performed. The transected proximal stump of the ascending aorta was reconstructed with a polyester tube graft (Fig 2B). When core cooling to a 16°C rectal temperature was achieved, selective antegrade cerebral perfusion through the right subclavian artery was established, and perfusion to the lower body was discontinued. Through the transverse incision, the main graft of the single-branched stent graft was inserted into the true lumen of the arch and descending aorta, and the sidearm graft was positioned in the left subclavian artery (Fig 2C). Once both sections of the main graft and sidearm graft were properly positioned, the restraining strings were...
withdrawn. After having measured the diameter and distance of the other 2 arch vessels, 2 branched stent grafts (10% to 20% bigger than the diameters of the arch vessels) were inserted into the true lumen of the other arch vessels (Fig 2D). Two holes with diameters of 12 to 18 mm were then made at the corresponding position of the main body of the single-branched stent graft. The 2 branched stent grafts were anastomosed to the 2 holes in an end-to-side fashion with 4-0 polypropylene suture (Fig 2E). In this way, a combined branched stent graft was made. Finally, the distal end of the polyester tube graft was anastomosed to the proximal end of the combined branched stent graft in an end-to-end fashion (Fig 2F). The air was carefully flushed from the combined branched stent graft when blood flow from the femoral and right
subclavian arteries was restored. Antegrade systemic perfusion from the branch was then started, and the patient was rewarmed.

**Comment**

From August 2010 to September 2012, the combined branched stent graft placement technique was used in 10 consecutive patients in our department (6 men and 4 women; mean age, 46.4 ± 10.01 years; range, 32-61 years). All patients were classified as having Stanford A aortic dissection. Placement of the single-branched stent graft and 2 branched stent grafts into the true lumen of the proximal descending aorta, arch, and 3 arch vessels was technically successful in all 10 patients. The mean cardiopulmonary bypass time was 173.90 ± 9.31 minutes, aortic cross-clamp time was 89.80 ± 7.04 minutes, and selective cerebral perfusion and lower body arrest time was 43.90 ± 6.35 minutes. No patient required a reopening of the chest to correct excessive postprocedural bleeding. Postoperative hoarseness did not occur. There were no late deaths or need for reoperation. All patients were given prospective follow-up by means of aortic computed tomographic angiography before discharge and 3 months after the operation. The first postoperative aortic computed tomographic angiogram (Fig 3) showed that all stent grafts were fully open and not kinked and that there was no space or blood flow surrounding the single-branched stent grafts and 2 branched stent grafts. All patients resumed normal lives.

With open placement of our single-branched stent graft and small stent grafts, and with the anastomosis of the 2 small stent grafts to a single-branched stent graft in an end-to-side fashion, we avoided anastomoses of the arch vessels and distal anastomosis at the descending aorta. We performed the distal aortic anastomosis at the proximal arch at the base of the innominate artery, which provided a better surgical view, and the anastomosis and hemostasis were much easier to perform than with traditional total arch replacement. Placement of the single-branched stent graft in the descending aorta and the left subclavian artery was easily completed in 1 to 2 minutes. During this procedure, the distal arch and proximal descending aorta did not require dissection, incision, and suturing. In this study, the mean cardiopulmonary bypass time, aortic cross-clamp time, and selective cerebral perfusion and lower body arrest time were lower than in the study of Sakamoto and colleagues [3] who finished the total aortic arch replacement using the 4-branched prosthetic graft (204 ± 53 minutes, 136 ± 43 minutes, and 83 ± 14 minutes, respectively).

The diameters of the aortic arch and arch vessels and the distances between 2 neighboring arch vessels are different in each patient. The proper size of each stent graft is key to quick clot formation and shrinkage of the false lumen and also for preventing new intimal trauma owing to the continuous compression of the oversized stent graft on the dissected and fragile intimal wall [4]. In the procedure, the diameters of the single-branched stent graft and small stents graft should be 10% to 20% bigger than the diameters of the aortic arch and arch vessels. Moreover, the location of the holes made in the single-branched stent graft anastomosed to the corresponding small stent grafts should be suitable; this could avoid stent migration, distortion, and endoleak.

In conclusion, open combined branched stent graft placement is a feasible technique. With this technique, total arch replacement may become easier, safer, and more widely used for Stanford A aortic dissection. However, rigorous long-term evaluation and further extensive clinical trials are necessary.

**References**