ENDOLUMINAL REPLACEMENT OF THE ENTIRE AORTA FOR ACUTE TYPE A AORTIC DISSECTION IN A PATIENT WITH MARFAN SYNDROME

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On May 15, 1998, a 36-year-old patient with signs of Marfan syndrome was admitted on an emergency basis with cardiocirculatory collapse, which followed a sudden excruciating retrosternal pain radiating to the back. The left radial and the left femoral pulses were absent. Computed tomographic scanning, transesophageal bidimensional echocardiography, and angiography revealed type A aortic dissection extending into the noncoronary sinus with aortic valve insufficiency. There was no history of cardiovascular disease. Five hours after admission, the patient underwent operative repair. The particular technique used was developed on the basis of our 15-year experience (1982-1997) with total aortic replacement.¹

Surgical technique. A series of 4 total aortic grafts was prepared by assembling a composite valve graft (valve size: 23, 25, 27, and 33 mm) to an aortic arch graft (Sultz-Carbomedics Inc, Austin, Tex) bearing three 8-mm side branches; the first of these side branches had to be shaped as the innominate artery (Fig 1, B). Then an equally sized tube graft (Hemashield Meadox, Boston Scientific Corp, Oakland, NJ) was added to the arch graft to meet the length of the entire aorta. After anesthesia was induced, both carotid and subclavian arteries were exposed through small incisions in the neck and in the subclavian areas (Fig 1, A). The chest was opened by two surgical teams¹ so that the aortic root and the aortic arch were replaced while the thoracoabdominal aorta was being prepared. The aortic root and the ascending aorta were exposed through a 15-cm incision in the right second intercostal space (Fig 1, A), separating the second, third, and fourth costal cartilages from the sternum. The thoracoabdominal aorta was exposed extraperitoneally through a standard thoracoabdominal incision. A circular detachment of the diaphragm was done.

Stages of the operation. First, partial cardiopulmonary bypass with cooling was instituted by means of femoro-

femoral cannulation in the right groin. The left heart was vented through the right superior pulmonary vein.

Second, while body temperature was decreasing, the ascending aorta was crossclamped and opened longitudinally. Crystalloid cardioplegic solution was injected into the coronary ostia, and the aortic root was replaced with the composed valve graft at the proximal end of the long aortic graft. The coronary ostia were reattached to the graft by the inclusion technique.

Third, at the body temperature of 15°C, circulation was arrested, the patient was placed in the head-down position, the ascending aorta was unclamped, and the arch replacement was started. Simultaneously, the arch graft was pulled through the lumen of the ascending aorta, and the 8-mm side grafts were pulled through and then out of the lumina of the respective carotid and subclavian arteries (Fig 1, B). This maneuver allowed the arch graft to be set in place.

Fourth, the carotid grafts were anastomosed end to end to the carotid arteries. The subclavian grafts were instead, cut to size, and left free in the arterial lumen.

Fifth, once the second surgical team had stapled closed the first 7 intercostal arteries outside the aortic wall, the ostia of the lower intercostal and the first lumbar arteries (T8-L1) were anastomosed to the aortic graft in a single button (Fig 1, C).

Sixth, the incision of the ascending aorta was sutured. The lower thoracic aorta was also sutured to the point of the intercostal's reconnection. Then, the aorta was clamped beyond this point (Fig 1, C), allowing cold reperfusion to the upper body to start after 45 minutes of circulatory arrest. Upper body reperfusion was effectuated through the left subclavian graft (Fig 1, C).

Seventh, during reperfusion, the abdominal stage of the operation was completed by reconnecting the visceral and renal arteries to the graft with a single anastomosis. The distal end of the graft was then cut to size and was left sutureless in the aortic lumen just above the aortic bifurcation (Fig 1, D). We made certain that the femoral perfusion cannula was placed well inside the lumen of the abdominal aortic graft (Fig 1, D). Cardiopulmonary bypass and rewarming were resumed after the suture of the abdominal aorta was completed. By this technique, the dissected aorta was entirely grafted within the true lumen.

Rewarming time was 58 minutes. Before the chest was closed, atrial and ventricular pacing wires were placed. The costal cartilages were reconnected to the sternum. The patient was extubated after 10 hours. On the second postoperative day, transient signs of cerebrocortical irritation appeared, which were very likely caused by gaseous emboli. After 1

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Fig 1. **A**, After inducing anesthesia, both carotid and subclavian arteries are prepared. The ascending aorta and the aortic root are exposed through a small incision. **B**, The arch graft and its side branches are simultaneously pulled through the respective vessels. **C**, The arch graft is set in place. The carotid grafts are ready to be anastomosed to the respective carotid arteries. After reconnection of the lower intercostal and the first lumbar arteries to the aortic graft, upper reperfusion is started. **D**, The visceral and renal arteries are anastomosed in a single button to the side of the graft which is cut to size and left free in the lumen.

week, the patient was ambulating in his room and was discharged after 21 days. This patient is now leading a normal life almost 2 years after the operation.

Discussion. The treatment of aortic dissection by endoluminal grafting began with the introduction of rigid sutureless endoprostheses^{2,3} set in place by open surgical procedures. After the advent of the percutaneous stent-graft technique,^{4,5} we conceived of treating type A aortic dissection with a total endoluminal stent graft. The dissected aorta should be replaced in an endoluminal manner to avoid cutting through its wall and suturing. Suturing represents the main source of bleeding, causing morbidity and mortality in open surgical operations. Our studies on animal models encountered difficulties in deploying the endograft across the orifices of the aortic side branches. While waiting to find a solution to this problem, we performed the above operation in an effort to accomplish total aortic endoluminal grafting. Through a small incision, the aortic root was replaced in an endoluminal manner with a composite valve graft. The coronary ostia were reattached by the inclusion technique. Even though this method carries the risk of a late pseudoaneurysm at the site of the coronary anastomoses, no other choice was available. The Cabrol technique offered the same risk, and both the button and the standard bypass techniques did not fit the endoluminal solution.⁶ Regarding the end-to-end anastomoses between grafts and carotid arteries, the choice was made to guarantee a sufficient arterial perfusion pressure to the brain and to cut the dissection in case it had extended to the distal part of the carotid arteries (Fig. 2). Back-bleeding from the subclavian grafts was not a concern because, during the upper body reperfusion,

Fig 2. Angiography performed before discharging the patient. These images did not come from a cineangiogram but from seriography. The two films available for the upper and the lower part had to be spliced together. It is evident that the stiffness of the carotid and subclavian arteries is caused by graft replacement.

the ascending aorta was closed and the lower thoracic aorta was clamped. We had to be sure that the femoral arterial return cannula was well inside the abdominal aortic graft because, through it, cardiopulmonary bypass and rewarming had to be resumed. The perfusion through the subclavian graft had to be interrupted soon in order to reduce the ischemic time to the left arm and to avoid interfering with the perfusion of the left vertebral artery.

Future development of the endovascular technique should lead one to perform total aortic replacement as the ideal treatment for acute type A aortic dissection, so that the spectrum of high-risk surgical procedures could be avoided.

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