Patients with acute aortic dissections involving the arch and descending aorta can effectively be treated using the frozen elephant trunk technique. We describe here the novel technique of temporary banding of the descending aorta onto the stent of the hybrid graft in 3 patients who developed unmanageable bleeding from the distal suture line due to retrograde false lumen perfusion and disintegration of the adventitia. Retrograde false lumen perfusion was stopped and therefore bleeding controlled in all patients. Temporal aortic banding represents a novel, feasible, and effective bailout technique for otherwise unmanageable bleeding with fatal outcome in hybrid arch surgery.

The frozen elephant trunk (FET) technique is a safe and effective treatment option for the patients with acute aortic dissections involving the arch and descending aorta [1–3]. This elegant 1-stage procedure ensures favorable short-term and long-term outcomes [4–7]. However, the phenomenon of intraoperative severe bleeding from the distal anastomosis due to the persistent false lumen perfusion may develop into a fatal complication of this procedure. We report here on 3 patients who developed such bleeding during the FET procedure due to persistent retrograde false lumen perfusion, which was successfully controlled using a previously non-described bailout technique of temporary banding of the descending aorta onto the stented portion of the FET graft.

Technique

From February to October 2015, 28 patients with Stanford type A aortic dissection were treated surgically, 12 of them using the FET technique due to the involvement of arch and descending aorta. Three of these patients developed the seemingly uncontrollable bleeding from the distal anastomosis due to the persistent retrograde false lumen perfusion and disintegration of the adventitia of the dissected aorta. All 3 patients were men and were 44, 48, and 63 years of age. The etiology of aortic dissection was aneurysm in 1 case but unknown for the others. All patients were in need of moderate to high doses of inotropes preoperatively, whereas only 1 of the patients was unstable due to cardiac tamponade. One patient demonstrated completely normal preoperative neurology, whereas the 2 other patients suffered from peripheral sensory deficits (legs) and left-sided paraparesis. Postoperatively, the neurological status completely recovered in all patients with no residuals.

Total aortic arch replacement using the Thoraflex Hybrid (Vascutec, Inchinnan, Scotland) prosthesis in combination with antegrade selective cerebral perfusion (ASCP) was performed. Only 1 patient underwent a Bentall operation as a concomitant procedure. On cardiopulmonary bypass, a core body temperature of 25.5°C was aimed for. Crystalloid cardioplegia (Bretschneider’s HTK, Köhler Chemie, Bensheim, Germany) was used for myocardial protection. During circulatory arrest, the cold ASCP was performed at 18°C. The median duration for cardiopulmonary bypass was 246 (range, 205 to 348) min, for aortic cross-clamping was 224 (range, 174 to 271.5) min, for circulatory arrest was 63 (55.5 to 71.5) min, and for ASCP was 76 (range, 71 to 76.5) min.

After implantation of the stented portion of the hybrid graft into the true lumen of the descending aorta, the sewing collar was used to perform the anastomosis just distally to the origin of the left subclavian artery. Three of these patients developed the seemingly uncontrollable bleeding from the distal anastomosis due to the persistent retrograde false lumen perfusion and disintegration of the adventitia of the dissected aorta. All 3 patients were men and were 44, 48, and 63 years of age. The etiology of aortic dissection was aneurysm in 1 case but unknown for the others. All patients were in need of moderate to high doses of inotropes preoperatively, whereas only 1 of the patients was unstable due to cardiac tamponade. One patient demonstrated completely normal preoperative neurology, whereas the 2 other patients suffered from peripheral sensory deficits (legs) and left-sided paraparesis. Postoperatively, the neurological status completely recovered in all patients with no residuals.

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After implantation of the stented portion of the hybrid graft into the true lumen of the descending aorta, the sewing collar was used to perform the anastomosis just distally to the origin of the left subclavian artery. The use of glue or Teflon felt to reunite the dissected layers of the descending aorta was avoided according to departmental policy. The fourth side branch was cannulated for distal perfusion while the arch vessels were reattached to the corresponding branches of the graft. The anastomoses of the arch vessels were lined by bridging stents in 2 cases (Viabahn stent, W. L. Gore & Associates, Newark, DE).

During reperfusion, unmanageable bleeding developed from the distal anastomosis due to persistent retrograde false lumen perfusion in all 3 cases. It proved impossible to control the bleeding by surgical means combined with extensive substitution of blood and...
coagulation factors, as the apparent reason was disintegration of the sewn aortic adventitia (Fig 1A).

To manage the bleeding, the left pleural cavity was opened and the proximal part of descending aorta was circumferentially mobilized. Temporary banding of descending aorta with a textile band secured with a tourniquet in 2 cases and prolonged manual compression for approximately 1 h in 1 case were performed (Fig 1B). This maneuver is practically invisible for the surgeon who has to perform a blind manipulation. Leaving the transesophageal echocardiography probe in place proved to be very helpful to avoid the danger of esophageal lesions. In the 2 patients with tourniquet banding, the upper left pleural cavity was subsequently packed with towels for hemostatic compression and preliminary closure of the sternum for 2 days (Fig 2A). After proof of thrombotic

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**Fig 1.** (A) Mechanism of the uncontrollable bleeding from the distal anastomosis due to the persistent retrograde false lumen perfusion. (B) Technique of temporal banding of descending aorta over the stented graft with a textile band and a tourniquet.

**Fig 2.** (A) Representative chest x-ray during the preliminary sternal closure with an in situ clamp holding the tourniquet. (B) Postoperative computed tomography scan with complete thrombotic sealing of false lumen.
sealing of the false lumen by computed tomography angiography scan, the banding was released on the third postoperative day. Retrograde false lumen perfusion had stopped and bleeding control was thus achieved in all patients. Figure 2B shows the postoperative computed tomography angiography in 1 of the patients.

All patients survived the procedure with no 30-day mortality. The intensive care unit stay was 10, 12, and 17 days for each patient. All of the patients are currently alive after 11, 18, and 19 months of follow-up, respectively.

Comment

Persistent retrograde false lumen perfusion can lead to severe intraoperative bleeding along suture lines in patients treated for acute aortic dissection. This may even occur when FET devices are used, as the stent is rarely strong enough to completely obliterate the false lumen by remodeling the dissection membrane completely against the outer perimeter of the dissected aorta. Temporal aortic banding represents a novel and effective bailout technique to successfully manage this otherwise potentially fatal complication during the FET technique. As the described phenomenon of persistent retrograde false lumen perfusion is relatively rare, we would not advise performing the surgically challenging and potentially dangerous maneuver of aortic banding permanently in every case. Although no direct complications of the banding maneuver were observed in this small cohort of patients, we still consider it to be a bailout strategy for this severe complication.

References