Total arch replacement with an open stent graft for acute type A aortic dissection: fate of the false lumen

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Abstract

Objective: To describe the fate of the false lumen remaining in the descending thoracic aorta after extensive primary repair of the thoracic aorta by the modified elephant trunk technique with a stent graft for acute type A aortic dissection, particularly the changes of the false lumen on enhanced CT scanning. Methods: The subjects were 65 consecutive patients who received arch replacement with an open stent graft for type A acute aortic dissection. CT scanning was performed at 1, 3, 12, 36, and 60 months postoperatively to detect thrombus formation, absorption of thrombus, and obliteration of the false lumen after its exclusion by the stent graft. The aorta was measured at four levels, which were the distal border of the stent graft, the middle and distal parts of the descending thoracic aorta, and the origin of the superior mesenteric artery. Results: Obliteration was recognized in all patients at the distal border of the stent graft and absorption of thrombus was seen in 90% at the middle of the descending thoracic aorta within 1 year after surgery. However, the false lumen remained patent at the superior mesenteric artery (SMA) level in 50% of the patients. Conclusions: In patients with acute type A aortic dissection, it is possible to perform extensive primary repair of the thoracic aorta with relative safety by stent grafting, and this method may reduce the necessity for further operations to manage a residual false lumen.

1. Introduction

Conventional graft replacement for acute type A aortic dissection is often limited to the region from the ascending aorta to the aortic arch [1], so a false lumen sometimes remains in the descending thoracic aorta after surgery that can significantly influence the early and late prognosis [2]. We have performed extensive primary repair of the thoracic aorta by the modified elephant trunk technique using a stent graft (so-called open stent graft placement) [3,4] for acute type A aortic dissection with the aim of obliterating the residual false lumen in the descending thoracic aorta. The present report describes the fate of the false lumen as shown by enhanced CT scanning.

2. Methods

2.1. Subjects

We performed emergency total arch replacement by transaortic stent grafting ('open stent grafting') for 65 patients in 120 consecutive patients with type A acute aortic dissection within 48 h of the onset of dissection between December 1997 and January 2008. All operations were done by two surgeons (Ishihara and Uchida). The patients consisted of 28 men and 37 women aged from 32 to 85 years, with a mean age of 66.6 years (Table 1). The indication for open stent grafting to repair type A aortic dissection was a false lumen extending from the ascending aorta to the abdominal aorta with the primary tear anywhere in that region. The size and length of the stent graft was determined by intraoperative measurement using a ball-shaped sizer inserted into the true lumen of the descending aorta through a transverse incision under transesophageal ultrasound guidance. The distal border of the stent graft was positioned at the level of the main pulmonary trunk. The primary tear was distal to the left subclavian artery (DeBakey subtype III-D) in 17 patients, so their primary tears were covered by the graft.

2.2. Operative technique of open stent grafting

When it was confirmed that the rectal temperature had fallen to 28 °C, total circulatory arrest was achieved. The clamp was removed and the aortic arch was incised longitudinally until immediately before the origin of the left subclavian artery. At the end of this incision, the aortic
arch was dissected transversely. Three balloon catheters were inserted into the brachiocephalic artery, the left common carotid artery, and left subclavian artery for perfusion at a rate of 400, 200, and 200 ml/min, respectively, to maintain the blood supply to the brain. A ball-shaped sizer was inserted into the true lumen of the descending thoracic aorta from the transverse incision in the aortic arch, and the exact diameter of the true lumen was measured. A synthetic graft 7—15 cm long, which had been attached to a self-expanding Z-shaped stent (William Cook Europe A/S) with the tip 5 cm on the distal side, was selected with a diameter 1—3 mm larger than the measured diameter of the true lumen. Then the stent graft was placed in a 30F introducer, and was inserted into the descending aorta according to the method of Kato and colleagues [5]. The graft was fixed in the true lumen of the descending aorta by expansion of the Z-shaped stent and by aortic blood pressure. The graft was pulled as far as the transverse dissection line in the distal aortic arch and was trimmed to match this line. The left subclavian artery was dissected transversely at its proximal end, and the proximal stump was closed with 4—0 polypropylene sutures. The adventitia of the aortic stump was covered with a felt strip 2 cm wide, and the stump was reinforced with continuous 4—0 polypropylene sutures. A synthetic graft with four branches was anastomosed end to end to the stump of the distal aortic arch with continuous 3—0 polypropylene sutures. The mean duration of extracorporeal circulation with selective cerebral perfusion, total extracorporeal circulation time, and operating time were 70 ± 18, 163 ± 43, and 354 ± 89 min, respectively (Table 1).

### Table 1

<table>
<thead>
<tr>
<th>Patient data</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients characteristics</td>
<td></td>
</tr>
<tr>
<td>Patients number</td>
<td>65</td>
</tr>
<tr>
<td>Men:women</td>
<td>28:37</td>
</tr>
<tr>
<td>Age (years) (mean)</td>
<td>32—85 (66.6)</td>
</tr>
<tr>
<td>Operative data</td>
<td></td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>354 ± 89</td>
</tr>
<tr>
<td>Cardiopulmonary bypass time</td>
<td>163 ± 43</td>
</tr>
<tr>
<td>Selective cerebral perfusion time</td>
<td>70 ± 18</td>
</tr>
<tr>
<td>Diameter of stent graft (mm) (mean)</td>
<td>22—32.5 (28.3)</td>
</tr>
<tr>
<td>Diameter of stent graft (mm) (mean)</td>
<td>7—15 (9.7)</td>
</tr>
</tbody>
</table>

2.3. Follow-up CT study

Three patients died within 30 days of the operation. The other 62 patients were all followed up until May 2008. Computed tomography (Fig. 1) was performed at 1, 3, 12, 36, and 60 months postoperatively to detect thrombus and absorption of the false lumen that had been excluded by the stent graft. The status of the false lumen was classified as showing patency, thrombus formation, absorption of thrombus, or obliteration. Patency was defined as contrast enhancement of the false lumen. Thrombosis meant that the false lumen showed no contrast enhancement and thrombus was detected at the site. When the thrombus showed a decrease, this was defined as absorption. When the thrombus became less than 2 mm thick, this was defined as obliteration (Fig. 2). Measurement was done at four levels, which were the distal border of the stent graft,
the middle of the descending thoracic aorta (mid portion),
the distal part of the descending thoracic aorta (distal
portion), and the origin of the superior mesenteric artery
(SMA) (Fig. 3).

3. Results

The mean diameter of the stent graft was 28.3 mm (range:
22—32.5 mm) and the mean length was 9.7 cm (range: 7—
15 cm). Three patients died within 30 days of the operation
due to the low output syndrome with coronary dissection
(n = 1) and deep infection (n = 2). However, paraplegia or
intestinal ischemia did not occur in any of the patients. Late
results were obtained for the other 62 patients after a follow-
up period of 67 months (range: 3—124 months). Three
patients died in the late phase due to cerebrovascular
accident, chronic renal failure and bladder cancer in our
hospital. The 5-year survival rate was 92.8%. Aortic events
occurred in two patients in the chronic period, including one
patient with redissection of the annular aorta and one
needing an additional operation on the descending thoracic
aorta. The latter required additional surgical treatment of
the descending thoracic aorta after 16 months because its
diameter increased to 5.6 cm. This patient had a type of
DeBakey subtype III-D aortic dissection with the primary tear
in the mid-descending thoracic aorta that should have been
excluded by stent grafting. The rate of events affecting the
thoracic aorta over 5 years was 95.8%.

3.1. Fate of the false lumen

The changes of the false lumen are summarized in
Figs. 4—7.

3.1.1. At the stent graft border

Thrombus formation in the false lumen was recognized in
all patients, except for one who required additional graft
replacement of the descending thoracic aorta 16 months
later. The other 61 patients had complete thrombus of
the false lumen after 1 month. In 39 patients, obliteration of
the false lumen was recognized after 3 months, and obliteration
was recognized in all of the patients by year 3 after the
operation (Fig. 4).

3.1.2. At the mid portion

The false lumen remained patent in 13 patients at 1 month
after surgery. One patient needed re-operation as mentioned
above, and the other 12 patients had a small tear of an
intercostal artery according to operative transesophageal
ultrasound. The remaining 49 patients had complete
thrombus of the false lumen on CT after 1 month and the
thrombus become absorbed (as at the stent graft level) after
3 months (Fig. 5).
3.1.3. At the distal portion

The distal portion showed a different pattern from the middle portion, and about 40% (25/62) of the patients had a patent false lumen 1 month after surgery. Follow-up CT showed various changes, such as persistent patency or eventual thrombus formation. On the other hand, some patients showed progressive absorption of thrombus during the chronic period as occurred at the middle portion (Fig. 6).

3.1.4. At the SMA level

At the SMA level, 30/62 patients (48%) showed thrombosis of the false lumen 1 month after surgery, and the thrombus was absorbed over and disappeared. If the false lumen was patent at 1 month, however, it remained patent throughout the period, and there was no change. The fate of the false lumen was thus dependent on the presence of abdominal re-entry (Fig. 7).

The false lumen was patent after 3 months at the distal portion in 12/31 patients with patency at the SMA level. In three patients, thrombus formed subsequently, but no tendency for absorption was recognized. The other patients showed persistence of a patent lumen. On CT, retrograde blood flow into an intercostal artery from the abdominal re-entry was recognized in these patients.

4. Discussion

In recent years, the results of surgery for acute type A dissection have improved. Considering the long-term prognosis, total arch replacement is often performed for long thoraco-abdominal aortic dissection in younger patients, and good results have been reported [6–8]. However, a false lumen sometimes remains in the distal part of the descending thoracic aorta after the operation and we have experienced
several cases of severe complications. Akutsu et al. [9] reported that patency of the false lumen is a strong independent prognostic factor for dissection-related death and dissection-related events. Therefore, there have been recent reports about total replacement of the aortic arch at the first operation in patients with acute type A aortic dissection, even if the primary intimal tear is located in the ascending aorta. In addition, the use of stent grafts has made obliteration of the false lumen in the descending thoracic aorta more likely. However, the long-term prognosis after stent graft surgery is unknown. Therefore, we followed the fate of the false lumen by performing enhanced CT at internals in our 62 patients.

The residual false lumen in the distal part of the descending thoracic aorta almost disappeared during the chronic period after stent graft insertion. There may be two reasons for this outcome. The first is that anastomotic leakage was prevented by using a stent graft, but even the elephant trunk method without a stent graft should prevent this. However, it is possible that stent compression prevented anastomotic leakage more effectively. The second reason is that bronchial or intercostal arteries were dissected, and we confirmed the second tear by intraoperative transesophageal ultrasound, with a stent graft inserted to the pulmonary artery level completely closing any tears as far as the mid-descending thoracic aorta.

Use of a stent graft for acute dissection has problems such as the risk of intimal damage or selection of the correct size [10,11], and we want to emphasize that direct sizing through an incision in the aortic arch is very important. We insert a ball-shaped valve sizer into the true lumen of the descending aorta from a transverse incision in the arch under transesophageal ultrasound guidance to determine the graft size and we always have stent grafts of various sizes prepared in advance. It is important to minimize intimal damage by inserting a graft of the correct size under circulatory arrest and, we have not found any new intimal tears caused by the stent graft after surgery in our series. We only have experience of stent grafting for Marfan syndrome in one patient and the long-term prognosis is unknown, so the use of a stent graft in such patients needs careful consideration.

The risk of paraplegia due to sacrificing the spinal arteries must be considered when a long synthetic vascular graft is inserted into the descending thoracic aorta. According to a recent report, however, this usually occurs when a stent graft is used for a true aneurysm and obstruction or embolism of intercostal arteries by debris also has a role [12]. Therefore, the importance of perfusion of the left subclavian artery has been pointed out. On the other hand, intercostal arteries are often patent after acute dissection and it seems very likely that blood flow will occur via re-entry as shown by our CT data even if the intercostal arteries are dissected. In patients with many pairs of intercostal arteries involved by the dissection, prevention of delayed paraplegia can be achieved by maintaining blood pressure rather high to encourage early thrombosis of the false lumen by stent graft compression.

5. Conclusions

In patients with acute type A aortic dissection, it is possible to perform extensive primary repair of the thoracic aorta with relative safety by using a stent graft, and this method may reduce the necessity for further surgery to manage a residual false lumen.


