CLINICAL RESEARCH

Endovascular treatment of descending aortic dissection (type B): short- and medium-term results

Traitement endovasculaire des dissections de l’aorte descendante (type B) : résultats à court et moyen terme

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Summary

Background. — Optimal treatment of type B dissections is open to debate. The use of endoprostheses is an option that requires evaluation.

Aim. — To report our experience with endoprostheses in type B aortic dissections.

Methods. — We report our short- and medium-term results with covered prostheses for the treatment of acute (n=7) and chronic (n=28) type B aortic dissections. The criteria used to indicate treatment were the same as those usually used for surgery: acute complications or dilated aneurysm. Cover of the main intimal tear was obtained in all cases with an improvement in symptoms in patients with acute dissections.

Results. — Early mortality was 14.3% (five patients), linked in three cases to the occurrence of a retrograde dissection of the ascending aorta. No neurological complications were observed. Four patients required an additional endovascular and/or surgical procedure. On early control scans, complete thrombosis of the false lumen at the thoracic level was observed in 40% of cases, partial thrombosis in 42.8% and an absence of thrombosis in 11.4%. After a mean follow-up of 20.8 months, one patient died of a pneumopathy. No secondary aneurysm expansion was noted at the thoracic stage whereas three patients presented with dilation of the abdominal aorta.

Conclusion. — The results of treatment of type B dissections with covered endoprostheses are encouraging. However, the morbimortality associated with treatment and the uncertainty of long-term results do not allow the use of this therapeutic option outside the criteria usually recognized to indicate surgery.

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Résumé

Justification. — Le traitement optimal des dissections de type B dissections est discuté. L'utilisation des endoprothèses est une technique d'apparition relativement récente qui doit être validée.
Introduction

Type B dissections involve only the descending aorta. In acute cases, the reference treatment for these dissections is medical and is associated with prolonged follow-up: most clinicians will not consider surgical treatment unless there is a complication (visceral malperfusion, refractory pain, etc.) [1-4]. In chronic type B dissections, however, surgical treatment is considered when there is an expanding dilated aneurysm. The surgical approach used in this aortic pathology is associated with a high morbimortality [5]. Implantation of endoprostheses has been proposed as an alternative therapy for patients at high surgical risk. However, endovascular treatment of type B dissections is not without complications [6], although few data are currently available in the literature. We report our short- and medium-term experience of endovascular treatment of type B dissections, highlighting the limitations and complications of this new technique.

Patients and methods

This retrospective study investigated our experience with endovascular treatment of acute (n = 7; 20.0%) and chronic (n = 28; 80%) type B dissections over a 6-year period. The study population comprised 26 males (74.2%) and nine females (25.8%), with a mean age of 63.4 ± 8.6 years (41-83 years). The study population comprised 26 males (74.2%) and nine females (25.8%), with a mean age of 63.4 ± 8.6 years (41-83 years).

By definition, any dissection treated 14 days or later after the appearance of symptoms was considered to be chronic. In acute cases, these consisted of either the persistence of pain refractory to analgesics (n=1), or the existence of a rupture revealed by the presence of a hemothorax (n = 1), or visceral malperfusion (n = 5). In these cases, the clinical diagnosis of malperfusion (ischemia of a lower limb (n = 2), abdominal pain (n = 3), oligo-anuria (n = 2)) was confirmed using an angioscanner. It should be noted that patient had a gastro-intestinal claudication and that several patients presented with several complications. As far as chronic dissections are concerned, the indication for endovascular treatment was determined by the diameter of the aneurysm (> 60mm) and/or it evolutive character. In all cases, the medical findings were discussed jointly by a vascular radiologist and a cardiovascular surgeon pre-surgery, to decide on procedures and follow-up.

Procedures

All procedures except for one were carried out in a surgical unit equipped with a mobile C-arm and a radiotransparent operating table with carbon fibers.

Implantation of the endoprosthesis was carried out under general (n = 31; 88.5%), local (n = 3; 8.5%), or loco-regional (n = 1; 2.8%) anesthesia. In all cases except one, a surgical approach via the common femoral artery (or the external iliac artery if there was insufficient diameter) was used to introduce the prosthesis.

The prosthesis was released in the true channel for all patients except one (deliberately placed in the false channel). Antibiotic prophylaxis (second generation cephalosporin) and one dose of non-fractionated heparin (100UI/kg) were administered before implantation in all cases.

The endovascular sequence of events consisted of the systematic introduction of a standard metallic guidewire, followed by a pigtail catheter allowing the introduction of a rigid guidewire, which permitted positioning of the catheter carrying the endoprosthesis. A pigtail catheter was also introduced percutaneously via the left humeral artery to locate the left subclavian artery and enable aortography to be carried out. In all cases, the objective of the endoprosthesis was to cover the main thoracic intimal tear to
decrease the pressure in the false channel and facilitate its thrombosis. Anatomically, the only criterion necessary was the existence of a non-dilated proximal neck of the aorta, at least 1.5 cm long; this was measured from the left primitive carotid artery. When the tear was close to the left subclavian artery, the latter was covered after a preoperative angioscan had ensured the functional character of the polygon of Willis. The artery of Adamkiewicz was not investigated.

Only autodisplaceable stents were used: Talent® (Medtronic Inc, Sunrise, FL, USA) in 15 patients (42.8%), TAG® (Gore Tex Inc, Sunnyvale, CA, USA) in 14 (40%), Excluder® (Gore Tex Inc, Sunnyvale, CA, USA) in five (14.4%) and Zenith® (Cook Inc, Bloomington, IN, USA) in one patient (2.8%). The choice of endoprosthesis depended on their availability, the anatomy of the patient and of the lesion. A discrete oversizing of 10% compared to the diameter of the aorta, measured preoperatively on CT-scan images, was used in all cases. Eight patients received more than one endoprostheses (maximum of four) and a total of 46 endoprostheses were implanted. The diameters of the implanted endoprostheses varied from 30 to 42 mm (mean 33.5 mm). After implantation, patients were observed in intensive care for a minimum period of 2 hours and then went onto the general hospital ward where they stayed for at least another 24 hours.

Follow-up

All patients (except for two who died early) underwent CT-scan with injection of contrast medium before leaving hospital, on the first or second day post-surgery. Patients were seen again in the clinic 1 week after leaving hospital to check on healing of the femoral access. Scannographic follow-up was then scheduled for the following times post-surgery: 6, 12, 18 and 24 months. Mean follow-up was 20.8 months; median follow-up was 12 months (1-80 months).

Results

Short-term results (at 30 days)

The dissection tear was successfully covered in all endovascular procedures (100%). No surgical conversion was carried out. For acute dissections, improvement of symptoms was obtained in all cases.

For all our patients, complete thrombosis of the false channel at the thoracic level was obtained in 14 patients (40.0%), partial thrombosis in 15 (42.8%) and an absence of thrombosis in only four patients (11.4%). Two patients who died early did not undergo a control scan. The details as a function of the type of dissection are shown in table 1.

No cerebral or medullar neurological accidents were observed. The left subclavian artery was deliberately occluded in 10 patients (28.6%), without immediate ischemic complications (one case of claudication of an upper limb occurred later).

Early mortality was 14.3% (five patients). Three of these patients suffered a ruptured retrograde dissection of the ascending aorta. One patient had a ruptured aorta 5 hours after placement of the endoprosthesis and died on day 2 due to multiorgan failure, despite complete replacement of the ascending aorta as an emergency procedure. The second had a ruptured aorta on day 10 and died before surgery could be performed. The third underwent surgery for type I retrograde dissection on day 4 with replacement of the ascending aorta. Two days later he suffered a major hemorrhage (rupture of the anastomotic suture on the endoprosthesis stent) and died soon after in intensive care.

One patient died suddenly on day 22 post-implantation, while he was in intensive care for multiorgan failure. This patient presented with an acute dissection associated with mesenteric ischemia. Although no autopsy was performed, the most likely cause of death was rupture of the descending thoracic aorta. The final patient died of pneumonia, several days after leaving hospital.

Four patients required an associated endovascular and/or surgical procedure: carotid-subclavian by-pass (1), carotid-carotid by-pass (1), endoprosthesis of the infra-renal abdominal aorta (1), stent of the superior mesenteric artery and of a renal artery (1).

The incidence of early mortality was 27.8% (table 2).

Medium-term results

At the mean follow-up time of 20.8 months, 29 patients were alive, without any lost to follow-up. One patient (3.3%) died during the follow-up period from septic shock on top of probable inhalation pneumopathy during the second month post-surgery (patient treated with immunosuppressants).

No patient presented with an aneurysm expansion of the thoracic aorta, whereas an aneurysm expansion of the abdominal aorta was found in three patients (15.8%). Five patients required a supplementary endovascular and/or surgical procedure during the follow-up period (table 3).

Finally, no stent rupture and no migration of the endoprosthesis were observed in our series.

Discussion

Our study reports the short- and medium-term results of endovascular treatment of acute and chronic type B dissections. We observed a high early mortality (14.3% at day 30), although it was lower than that reported recently by Böcker in a comparable study (19% of 29 implanted patients) [6]. Dake also reported a series of 19 endovascular treatments for complicated acute type B dissections with an early
In our series, three of the five deaths were linked to retrograde dissection of the ascending aorta and a fourth to a probable rupture. These complications are certainly linked to the creation of a new tear either at the time of the procedure or more probably due to direct contact between the endoprosthesis and the fragile aorta. These new intimal tears lead to the formation of a new dissection or an aneurysm in 10-20% of treated patients. In our center, we have tried to decrease the risk by using more flexible prostheses, by limiting oversizing, and by abolishing implementation of the prosthesis by inflating a balloon. Nevertheless, the last case of retrograde dissection occurred despite these precautions.

Other complications were rare and were not associated with an increase in the mortality rate in our series. These consist of peripheral vascular problems, accessible to surgical or endovascular treatment. The minimal invasive character of the procedure allows us to limit the incidence of potentially fatal post-operative complications observed after conventional surgery. Another advantage of endovascular treatment appears to be the extremely low incidence of medullary ischemic complications despite the long length of cover, sometimes over the entire descending thoracic aorta. In our series, no spinal cord injury were observed. In the retrospective register for the Talent endoprosthesis, Fattori et al. reported four cases of such a complication among 180 patients (2%), of which half consisted of regressive paraparesis [8]. The only risk factor found was a length of cover greater than 20 cm. Other studies have reported a similar rate of spinal cord injury. Several explanations can be put forward to explain the low incidence of paraplegia post endovascular treatment: absence of aortic clamping, effective and adequate collaterality, decreased blood loss and correlated hypotension, deployment at a distance from the Adamkiewicz artery and over a short portion of the aorta corresponding to the intimal tear.

Anatomically, a minimum distance of 1.5 to 2 cm is classically accepted as the optimum proximal neck to avoid type I endoleaks. To obtain sufficient proximal anchorage, it was necessary to cover the left subclavian artery in 10 patients (28.6%). As recommended by several authors, the permeability of the polygon of Willis was confirmed whenever possible by pre-implantation scans [9]. A case of claudication of a left upper limb was observed more than 2 years after endovascular management, requiring subclavian-carotid transposition. Two patients benefited per-implantation from surgical revascularization of the supra-aortic trunk. In these two cases, post-operative course was uncomplicated. Our results are similar to those reported by Palma from a large series of 70 type B aortic dissections treated by the endovascular route: 14 patients (20%) had the left subclavian covered by the stent, one had a subclavian-carotid bypass 8 months post-implantation [10]. However, in the series of Fattori, covering the subclavian artery was a risk factor for a cerebral vascular accident [8].

An incidence of reinvention or death of up to 40% was found during long-term follow-up of patients who underwent type B aortic dissection by conventional open surgery. This was due to aortic pathology in the 7 years following the initial intervention [11]. Obtaining thrombosis of the false lumen and stabilization of the true lumen are the two essential therapeutic objectives in order to prevent the development of a dilated aortic aneurysm. When this objective is achieved, it is possible to obtain complete retraction of the false channel (figure 1). In our series, complete thrombosis of the false lumen at the thoracic level was obtained in 14 patients (40.0%), partial thrombosis in 15 (42.8%) and the absence of thrombosis in four patients only (11.4%). It should be noted that for two patients who died early, a control scan was not performed. In a recent comparable study carried out on 29 type B dissections by the endovascular method, the observed rate of total or partial thrombosis of the false lumen was 44% [6]. Dialetto reported a series of type B dissections comparing

### Table 2. Associated morbidity.

<table>
<thead>
<tr>
<th>Type</th>
<th>(n)</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular lesion</td>
<td>Iliac dissection (1)</td>
<td>Open surgical repair</td>
</tr>
<tr>
<td></td>
<td>Iliac rupture (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower limb ischemia (1)</td>
<td></td>
</tr>
<tr>
<td>Aseptic fever</td>
<td>4</td>
<td>Corticotherapy for 6 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in one patient</td>
</tr>
<tr>
<td>Renal subcapsular hemotoma</td>
<td>1</td>
<td>Surveillance</td>
</tr>
<tr>
<td>Septic shock on top of renal necrosis (linked to the dissection)</td>
<td>1</td>
<td>Medical treatment</td>
</tr>
<tr>
<td>Endoleak - type I</td>
<td>From the left subclavian artery (1)</td>
<td>Percutaneous occlusion</td>
</tr>
</tbody>
</table>

### Table 3. Additional procedures during follow-up.

<table>
<thead>
<tr>
<th>Type</th>
<th>Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal aortic fenestration + renal arterial stent for persistent hypertension</td>
<td>3 months</td>
</tr>
<tr>
<td>Treatment of endoleak type I by endoprosthesis</td>
<td>6 months</td>
</tr>
<tr>
<td>Completion of occlusion of left subclavian artery</td>
<td>7 months</td>
</tr>
<tr>
<td>Subclavian-carotid transposition for claudication of upper limb</td>
<td>27 months</td>
</tr>
<tr>
<td>Surgery for abdominal aorta aneurysm</td>
<td>52 months</td>
</tr>
</tbody>
</table>
28 patients treated medically and 28 treated by the endovascular method. Thrombosis of the false lumen was observed in 10.7% (3/28) of patients treated medically versus 72% (18/25) of surviving patients treated by the endovascular method [12].

It is important to note the efficacy of endovascular treatment for acute complications, particularly ischemic, associated with acute dissections. Only one of seven patients who presented with an acute complication died (14%). In a recent study by Sakakura et al. reporting an incidence of acute complications of 7% in a retrospective study of 200 type B dissections, these complications were associated with a mortality of 50% [13]. In the international register of acute dissections, 17% of 472 patients hospitalized for acute type B dissections underwent surgery for acute complications with a mortality rate of 29% [14]. In the case of ischemic complications related to a dynamic occlusion, some authors propose carrying out fenestration. In our decisional algorithm, this therapeutic approach remains second choice, if it is not possible to treat the intimal tear with an endoprosthesis [15].

Concerning chronic dissections, treatment is usually indicated when the diameter of the aorta exceeds 60 to 65 mm. It is difficult to compare the results of endovascular treatment with surgical treatment for two reasons. First, there have been few surgical studies and those that have been performed have mixed different types of aneurysms in terms of their etiology and size [16]. Secondly, irrespective of the size of the aneurysm endovascular therapy only treats the thoracic component, but there are occasionally repercussions at the infra-diaphragmatic level. In the large surgical surveys, the risk of surgery and the risk of paraplegia vary between 2 and 10% and 8 and 16%, respectively, as a function of the extent of surgery. The incidence of paraplegia can be decreased by carrying out systematic drainage by LCR during the operation.

Treatment failure can be due to the presence of an endoleak. There are four types of endoleak: 1) Type I: leak at the ends of the prosthesis due to a fault with attachment; 2) Type II: retrograde leak originating from a collateral branch; 3) Type III: tear in the cover of the prosthesis or defect in the overlap between two prostheses; 4) Type IV: porosity of the prosthesis cover.

Type III and type IV leaks are rare, and type II endoleaks are more frequent at the abdominal level. In our series, one patient presented a type I leak from the left subclavian artery. This was treated by embolization. In the case of dissections, the notion of endoleaks has not been determined. Indeed, if we defined any persistence of opacification of the false channel as an endoleak, then this was noted in 53% of the patients in our series. However, in most cases this opacification is related to intimal tears situated in the non-treated aorta and below the endoprosthesis. This is why it appeared more logical to us to evaluate our results in terms of thrombosis of the false channel and evolution of the diameter of the aneurysm.

Post-implantation fever is an unfortunate phenomenon and was observed in four of our patients, all of whom were treated for chronic dissection. Fever can be prolonged, sometimes for several weeks, and exceptionally several months. Attributed to inflammatory phenomena and degradation of the thrombus in the false lumen, it does not usually require the use of antibiotics because of its non-infectious etiology. Treatment with antipyretics (paracetamol) for several days, occasionally combined with non-steroidal anti-inflammatory drugs, is usually sufficient [17]. Rarely, this fever may be prolonged requiring (one case in our study) protracted treatment with oral corticosteroids. Taking all this into account, infection of the prosthesis should always be considered if fever occurs after implantation of a foreign body and the necessary examinations should be carried out on a case by case basis, taking clinical factors into account.

Conclusion

Endovascular treatment of type B aortic dissections has a place in the therapeutic arsenal of the cardiovascular surgeon. Our short- and medium-term results with this technique lead us to propose this therapeutic approach as an alternative to conventional open surgery taking into account the
high risk associated with the latter technique. However, complications do occur with endovascular treatment and the absence of long-term data do not enable us to recommend the systematic implantation of a vascular endoprosthesis for an asymptomatic and/or uncomplicated type B aortic dissection.

References