OWN CLINICAL OBSERVATIONS OF TREATMENT OUTCOME IN ACUTE TYPE B AORTIC DISSECTION

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The aim of the study was to analyse early results of treatment of acute type B aortic dissection. Material and methods. 59 patients, treated between 1998 and 2011, were divided into four groups. Group I comprised ten patients in whom hybrid procedures were performed: extra-anatomical by-pass graft from the brachio-cephalic trunk to the left carotid artery in six patients, transposition of the left carotid artery to the right one in two patients, and reversed Y prosthesis from the brachio-cephalic trunk to both carotids in the remaining 2 patients, to facilitate stent-grafting. Group II comprised 13 patients in whom endovascular procedures were performed (stent-grafting). Group III comprised 21 patients in whom conventional surgery was done. Group IV comprised 15 patients who were treated conservatively.

Results. In group I, a very good clinical outcome, without complications, was achieved in six patients (60% of cases). The total mortality rate was 40%. One patient died on the operation table, following stent-grafting, due to the rupture of the aortic arch. Two patients died as a result of brain damage (cerebral aneurysm rupture in one, and ischemic stroke in the other). In one patient, an aorto-oesophageal fistula developed. In group II, one patient died during endovascular procedure. Another patient suffered from type 1 endoleak, requiring repeated endovascular surgery. In group III, 15 patients died. Moreover, four patients required acorrective cardiac surgery (Bentall procedure) which in three patients resulted in death. Thus, the total mortality rate in this group was as high as 85%. In group IV, the mortality rate was 13%.

Conclusions. We noticed a clear superiority of endovascular procedures over conventional surgeries for acute type B aortic dissection. Hybrid procedures for acute, complicated type B aortic dissection evidently reduce mortality and postoperative morbidity. Uncomplicated acute type B aortic dissections should be treated conservatively at intensivecare units.

Key words: acute aortic dissection, hybrid procedures, stentgraft

Type B aortic dissection, despite enormous advancement of medicine, is a major medical problem. Its main causes are atherosclerosis and a hypertensive crisis. It is also frequently caused by connective tissue diseases, Marfan syndrome, Ehlers-Danlos syndrome, cystic medial necrosis of the aorta, coarctation of the aorta (mainly in pregnant women) and Loeys-Dietz syndrome. There are also iatrogenic and traumatic aortic dissections. It is estimated that acute aortic dissections affect 3–4 persons per 100,000 yearly (1). In Poland, this serious disease affects about 1,200 persons each year. In 70% of patients, aortic dissection occurs in the wall of the ascending aorta. It is type A dissection which requires emergency cardiac surgery. Type B aortic dissections constitute 30% of cases of this pathology and best results
are achieved by conservative treatment which consists in the reduction of blood pressure and heart rate (2). The mortality rate in conservatively treated patients is about 10%. If dissection complications occur, such as acute ischaemia of organs or limbs, the mortality rate exceeds 30% (3). In such cases, surgery is necessary. Aortic dissection results from a tear in the inner layer of the aortic wall (entry) which extends distally and sometimes also retrograde, taking on a spiral shape. Tear in the tunica media of the aorta results in its separation and formation of pseudolumen. Extending downward, the dissection most frequently spreads along the left lateral part of the aorta, and in 25% cases the left renal artery branches off from the false channel (4). From the aorta branching, the process continues bilaterally, and usually involves the left iliac and femoral artery, resulting in the symptoms of acute limb ischaemia. As the dissection progresses, fragments of endarterium in the aortic wall come off, creating spontaneous openings (re-entries). This way, the false channel merges with the true channel. The progressing dissection of the aorta often results in the closure of lumen of the arteries branching off from the aorta (5). As the openings in the distal section are smaller than in the portal of entry of the dissection, the pressure in the false channel is higher and causes its widening, and at the same time narrowing of the diameter of the true channel (6).

Based on anatomic characteristics of the aortic dissection syndrome, in 1965, DeBakey proposed a classification of dissections depending on their location and extension of the process. In type I, dissection originates in the ascending aorta and involves the aortic arch and the thoracic and abdominal aorta. In type II, the dissection originates in the ascending aorta, and is confined to the brachio-cephalic trunk. In type III, the dissection originates in the descending aorta, it involves the thoracic descending aorta in the so-called type IIIa, and extends downwards distally, involving the abdominal aorta, in the so-called type IIIb (7).

Another classification, named the Stanford classification, divides dissections into type A dissections which involve the ascending aorta (DeBakey types I and II), and type B dissections which involve the descending aorta, irrespective of their extension (DeBakey types IIIa and IIIb). Thus, it classifies aortic dissections as proximal and distal (8).

Clinical classification divides dissections into acute ones (up to 2 weeks from symptom occurrence) and chronic ones (over 2 weeks from symptom occurrence) (9).

The aim of the study was to evaluate early (occurring within 30 days) results of treatment of acute aortic dissection in the thoracic and abdominal region (Stanford type B), either conservative or surgical (classic, endovascular and hybrid procedures), in the Department of Vascular, General and Transplantological Surgery of the Medical University in Wroclaw and the Department of Surgery of the 4th Military Clinical Hospital in Wroclaw, during 14 years (1998–2011).

MATERIAL AND METHODS

In the Department of Vascular, General and Transplantological Surgery of the Medical University in Wroclaw and the Department of Surgery of the 4th Military Clinical Hospital in Wroclaw, between 1998 and 2011, 59 patients with type B acute aortic dissection were treated surgically. Patients were divided into four groups, depending on the treatment modality.

Group I comprised 10 patients who, between 2005 and 2011, underwent hybrid procedures consisting in surgical transposition of the great vessels of the aortic arch, their separation from the arch, and then covering the above mentioned arteries with endovascular prosthesis — a stentgraft. In six patients, an extra-anatomical by-pass grafting, with the use of a braided prosthesis, from the brachio-cephalic trunk to the left common carotid artery or the carotid-carotid by-passing was necessary (fig. 1). In two patients, transposition of the left common carotid artery to the right common carotid artery was performed. The left common carotid artery, below the site where the by-pass was sewn in or after transposition, was ligated proximally to prevent leakage. In two patients it was necessary to place a reversed Y prosthesis in the brachio-cephalic trunk and the left common carotid artery, sewn in through the common supplying branch to the ascending aorta (fig. 2). The arms of the prosthesis were sewn in individually to the brachio-cephalic trunk and the left common carotid artery, end-to-end. Proximal segments of the above men-
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Fig. 1. Hybrid procedure for acute type B aortic dissection using by-pass from the brachio-cephalic trunk to the left common carotid artery (open procedure – stage I, fig. 1B) and deployment of a stentgraft in the distal segment of the aortic arch and the descending aorta (endovascular procedure – stage II, fig. 1C)

Fig. 2. Hybrid procedure for acute type B aortic dissection transformed into type A, using extra-anatomical by-pass grafts from the ascending aorta to the brachio-cephalic trunk and the left common carotid artery (stage I – open surgical procedure, fig. 2B) and implantation of a stentgraft in the dissected aortic arch and the descending aorta (stage II – endovascular procedure, fig. 2C)

mentioned great arteries were ligated. The procedures were performed via sternotomy. The ascending aorta was clamped contiguously after wide opening of the pericardial sac. The remaining surgeries were performed from a supraclavicular approach, without sternotomy. After the first “open” stage, the endovascular part of the surgery began. Through incisions in both groins, the common femoral arteries were uncovered. Upon administration of 1 mL of Heparin (5000 units), the stentgrafting set was introduced into the aortic arch and the
descending aorta through the common femoral artery. On many occasions, surgical uncovering of the femoral arteries facilitated the introduction of the endovascular set to the true channel of the aortic dissection, which obviously shortened the duration of the procedure, as opposed to the percutaneous approach to femoral arteries. Upon deployment of the stentgraft (Zenith TX or Talent/Valiant) in the aortic arch and the descending aorta (fig. 3), endovascular fenestration of endarterium within the abdominal aorta was done, to supply blood flow to the arteries branching off from the false channel of the dissected abdominal aorta. In the event of difficulties in providing blood flow to renal and celiac arteries, if needed, the balloon-mounted metal stents (Express Vascular and Genesis) were placed, which allowed proper blood flow in the main arteries of the abdominal aorta. The surgery ended with angioplasty of the dissected common femoral arteries.

Group II comprised 13 patients with type B aortic dissection in whom, between 2005 and 2011, endovascular implantation of a stent-graft (Zenith TX or Talent/Valiant), covering the left subclavian artery, was performed. In 70% of cases, the stentgraft crown (free flow) was located proximally, and in 30% — distally. In one patient, during the procedure that followed stentgraft implantation, a sudden death due to type A aortic dissection occurred. Only in two patients (15%) symptoms of chronic ischaemia of the left upper limb occurred, requiring reconstructive surgery: one surgery consisted in the transposition of the subclavian artery to the left common carotid artery; in the other case, by-passing with the deployment of a prosthesis between the left carotid artery and the left subclavian artery was necessary. No acute ischaemia of the left upper limb was observed. In five patients, symptoms of the steal syndrome, differing in intensification, were found, confirmed with transcranial Doppler (TCD).

Group III comprised 21 patients who underwent classic surgery between 1998 and 2006. In seven patients, due to acute ischaemia of the lower limb, retrograde fenestration of tunica intima was made, via the common femoral artery. An immediate good result in the form of improved blood-supply was achieved in four patients. Three patients died as a result of progressing multiorgan failure and no improvement in blood-supply to the limb. In 12 patients, fenestration of the abdominal aorta was done, or an aorto-biiliac orbifemoral Y vascular prosthesis was sewn in; 10 patients in whom this modality was used died in the immediate perioperative period. The remaining patients received intensive conservative therapy which brought good clinical results. In two patients, fenestration and implantation of a vascular prosthesis from the subclavian artery to the descending aorta over the diaphragm was performed through left toracotomy. The indications for the procedure were as follows: rupture of the dissection to the chest and haemorrhagic shock. Both procedures ended in death on the operation table. Four patients in this group required corrective cardiac surgery (Bentall procedure) which ended in the death of three patients.

Group IV comprised 15 patients with acute aortic dissection who received intensive conservative treatment consisting in the reduction of blood pressure to 90–100 mm Hg, and the reduction of heart rate to 50–60/min. Good clinical results were achieved in 11 patients, which constituted 73%.

In four patients (27%), due to periodic increase in blood pressure, retrograde intensification of dissection in the aortic arch and the retrograde ascending aorta occurred (transformation of type B to type A). Patients underwent cardiac surgery.
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Patients who died during the diagnostic workup (seven patients) and patients diagnosed with acute type A aortic dissection involving the ascending aorta were not taken into consideration. These patients were transferred to the Department of Cardiosurgery as emergency cases (48 patients).

RESULTS

In group I (hybrid procedures), in six patients very good clinical results were achieved and no complications were observed (60% of cases). One patient (10%) died on the operating table, following stent grafting in the aortic arch. Rupture of tunica intima of the aorta above the stentgraft, and then acute cardiac ischaemia with pericardial tamponade were the causes. In two patients (20%), symptoms of brain damage occurred. In one patient, cerebral aneurysm rupture occurred, followed by subarachnoid bleeding and brain edema. The patient died on postoperative day 10. In the other patient, ischaemic stroke occurred, followed by left-sided hemiparesis, which ended in death on postoperative day 12. In one case, 21 days after the surgery, an acute aorto-oesophageal fistula developed which resulted in the patient’s death (10%). The total mortality rate in this group of patients was 40%. In one patient, symptoms of acute kidney failure occurred which required dialysis, and which receded after two weeks (10%). Three patients required reoperation due to bleeding from vascular anastomoses in the neck or in the groins (30%).

In group II (implantation of a stentgraft), in one patient follow-up examination revealed type I leak (endoleak) necessitating endovascular reintervention and the stentgraft deployment. This complication was observed in 7.5% of cases. Surgical management of symptomatic ischaemia of the left upper limb was required in two patients (15%). One patient died on the operation table following stent grafting, due to acute type A aortic dissection (7.5%).

In group III (classic surgeries), in 15 patients surgical procedures ended in death, which constituted 72%. Further four persons required cardiac surgery after which three patients died. The total mortality rate in this group of patients was 85%.

In group IV (conservative treatment), a good clinical result was achieved in 11 patients (73%) – acute aortic dissection transformed into chronic one. Despite intensive conservative treatment, four patients (27%) required cardiac surgery due to the transformation of aortic dissection from type B to type A. Two patients from this group died during surgery (13%).

In our study, only about 25% of patients were treated conservatively. Other patients presented with acute symptoms of acute dissection of the thoraco-abdominal aorta and required emergency surgical intervention (fig. 4).

DISCUSSION

The classic symptom of acute aortic dissection is sudden chest pain. If the dissection involves the ascending aorta, retrosternal pain occurs. If it involves the descending aorta, pain is located in the back, in the interscapular region. In 70% of patients, the pain is sudden and very intense, and in 20% it migrates downwards. Abdominal pain occurs in about 40% of patients (10). Loss of consciousness is more frequent in type A, while paresis is by 2–8% more frequent in type B (11). Severe hypertension, difficult to manage, occurs in over 70% of patients. Acute ischaemia of the lower limbs occurs in about 15% of patients. The symptoms of acute intestinal ischaemia and acute kidney failure can occur in about 20% of patients (12).

The basis for diagnosis and the diagnostic “gold standard” for this disease entity is the computed tomography angiography (13, 14, 15).

![Fig. 4. Results of treatment of acute type B aortic dissection](image-url)
Impaired blood flow to organs occurs in 10–75% of patients, its mortality rate reaching 60–80% (16, 17). Surgical fenestration reduces early mortality to about 20–40% (18). However, this treatment modality does not undo the dissection or prevent further degradation of the aortic wall (19).

In the recent years, a dynamic development of new surgical techniques has been observed. Endovascular techniques, consisting in the implantation of stentgrafts, endovascular fenestration of tunica intima at various levels and stenting of the main arterial trunks, meet with increasing interest (20, 21).

The primary aim of endovascular surgery is to close proximal and distal portals of entry (entries and re-entries) of the dissection, and to restore proper blood flow in the true channel (22).

Most portals of entry of the dissections are found in the region where the left subclavian artery branches off. The nearest segment of normal aorta lies above that site. Placing a stentgraft in the region of the aortic arch in about 30% of patients requires covering the left carotid artery and the subclavian artery. In rare cases, a vascular prosthesis should be placed in the aortic arch, covering also the brachio-cephalic trunk. Such management requires surgical preparation in the form of extra-anatomical by-pass grafts which allow covering the aortic arch with a stentgraft. They are the so-called hybrid procedures (23).

Complications of type B aortic dissections, in the form of impaired blood-supply to individual vascular regions and ruptures of the aortic wall, require individual approach. Classic surgeries performed in the acute phase of the disease are associated with a significant mortality rate reaching 70–80% (24, 25, 26). That is why endovascular procedures are becoming more and more popular, and are now recommended as standard proceeding in complicated type B aortic dissections. Often, endovascular fenestration is performed, with insertion of stents into arteries that branch off from the thoraco-abdominal aorta. Stentgrafts are deployed to close the proximal portal of entry of the dissection and cause thrombosis in the false channel. It has been shown that in about 90% of patients with acute type B dissection, thrombosis in the false channel forms along the stentgraft (27, 28). The proximal segment of the dissected thoraco-abdominal aorta remains patent in about 60% patients. Blood inflow from the distal segments of the aorta to the false channel may entail rupture of the aorta or formation of a pseudoaneurysm. The risk of aortic rupture following the leak from the true channel to the false channel increases more frequently at the level of the thoracic aorta than the abdominal aorta. That is why some authors recommend covering the whole descending thoracic aorta with a stentgraft (29).

One of the life-threatening complications is retrograde aortic dissection following stentgrafting, that is the transformation of type B dissection into type A dissection. This complication occurs in about 3–10% of cases (30). In our study, we found it in two patients, which constituted 8%. Another complication of endovascular procedures are endoleaks (30). However, they are definitely rarer in aortic dissection than in true aneurysm of the thoracic and abdominal aorta. Type I leaks connected with these procedures occur in about 6% of cases and require remodelling of an endoprosthesis with an intraaortic balloon or deployment of the proximal segment-extension of the stentgraft. In our study, this complication occurred in one patient (4%). Type II leaks are very rare and are caused by retrograde flow from the subclavian artery (31).

Combination of various types of classic and endovascular surgeries for the treatment of acute type B aortic dissection raises increasing interest. Decompression of arteries that branch off from the aortic arch, combined with sequential or simultaneous endovascular implantation of an aortic endoprosthesis, is a modern and recommendable modality. Good clinical results were achieved in almost 60% patients. Perioperative mortality was about 40%. Compared with the results of classic surgeries where the mortality rate is 80–90%, the results can be deemed good. Employing a hybrid procedure allowed a twofold reduction of the mortality and postoperative morbidity rates. The procedures can be performed without extracorporeal circulation (32).

Technological progress of fenestrated or branched stentgrafts introduced to the aortic arch is subject to intensive experimental and clinical studies. Endovascular prostheses which are more readily adjusted (modelled) to the aortic arch are being developed (32).
Nowadays, the use of aortic endoprostheses is a "gold standard" of treatment for acute type B aortic dissection. However, this modality should be treated as one of many options, and the decision to employ it should be made by a team comprising specialists in interventional radiology, vascular surgeons, cardiac surgeons and anaesthesiologists. The INSTEAD study, comparing conservative treatment with endovascular treatment in patients with uncomplicated type B aortic dissection, did not show superiority of endovascular modality over conservative treatment (33, 34).

CONCLUSIONS

1. Unquestionable superiority of endovascular procedures over classic surgeries for type B aortic dissections has been observed.
2. Hybrid procedures in the treatment of acute, complicated type B aortic dissections significantly reduce the mortality and postoperative morbidity rates.
3. Uncomplicated acute type B aortic dissections should be treated conservatively at intensive care units.

REFERENCES


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