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Surgical Treatment of Thoraco-Abdominal and Low Thoracic Aneurysms of the Aorta. One Single Center Experience over Ten Years

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Abstract. This work presents the results of surgery in thoraco-abdominal aortic aneurysms (TAA) and thoracic descending aortic aneurysms (TDA) in one single center between January 1rst, 1996 and December 31, 2005. It concerns open surgery in 42 and endovascular procedures in ten patients.
Forty two patients (11 TDA and 31 TAA (4 type I, 12 type II , 6 type III and 9 type IV)) define the open surgery series. Twenty six patients were operated on elective basis and 16 patients in emergency condition. Surgical correction was made under partial cardio-pulmonary bypass (PCPB) in 70% of cases via femoral vessels ; most significant intercostal arteries were reimplanted and cerebro-spinal fluid (CSF) drainage used in half of the cases. Operative mortality was zero in the elective group (0/26) and attained 19% in the emergent group (3/16). Mortality was linked to cerebrovascular accidents (CVA) in two cases and post-pump left lung hemorrhagic infarction in one case. The paraplegia accounts 2/26 in the elective group and one in the emergent group (1/16). That is 7.1% in both groups. At the end of five years, survival is 66% in elective group and 74% in the emergency group.
Ten patients (5 TDA and 5 TAA (2 type I, 3 type III)) were treated endovascularly. Operative mortality and postoperative paraplegia were nil.

Introduction

Spontaneous evolution of thoraco-abdominal aortic aneurysms (TAA) is deemed very gloomy (1, 2). Once diagnosis has been made, the survival would be 50% at 4 months and 24% at 2 years, according to Crawford's data, about non operated patients (3). The aim of this study is to analyse the results over a ten year period of surgical management of the TDA and TAA in one single center, and under the supervision of the same senior surgeon (EC).

Methods

Patients

From January 1996 to December 31, 2005, 52 consecutive patients with TAA or TDA have been admitted to the department. Degenerative atherosclerotic aneurysms, chronic aortic dissections with aneurysmal dilatation, pseudo-aneurysms and aneurysms resulting from Marfan's disease were included in the study. Nevertheless, acute aortic dissection and post-traumatic ruptures of the isthmic aorta were excluded.

Forty two patients were treated by open surgery (6 TDA, 4 TAA I, 12 TAA II, 6 TAA III, 9 TAA IV), while ten patients were treated by endovascular approach (5 TDA, 2 TAA I, 3 TAA III). The data were collected from a prospective vascular surgery registry.

Methods

Patients were classified according to Crawford's classification (3). Preoperative renal dysfunction is defined by serum creatinine > 15 mg/l. Preoperative coronary insufficiency concerns patients taking specific medication or who have a history of myocardial infarction, coronary angioplasty or coronary surgery. Postoperative renal failure is defined by necessity of a temporary or permanent hemodialysis. Transitory elevation of creatinemia is not considered as renal failure. Postoperative paraplegia or paraparesia, is defined as a definite paralysis of the lower limbs. Postoperative hemorrhage is defined by the necessity of surgical second look for verification of the hemostasis. Postoperative respiratory insufficiency is attested if the patient has remained more than 2 days under mechanical respiration.

Surgical methods

Open surgery

All patients have been submitted to a peroperative left lung exclusion via selective intubation of the right bronchus and benefited from an intensive monitoring including pulmonary artery, vena cava superior and right radial artery catheterism. In 70% of cases, distal aortic perfusion was obtained via partial extra-corporeal

femoro-femoral circulation (PCBP). In some cases of TAA IV, CBP was not used.

Systematic drainage of cerebro-spinal fluid (CSF) is routinely done. Reimplantation of most important intercostal arteries below the T5-T6 level was done every time it was possible. Surgical exposure is done via retroperitoneal approach during the first part of the study, but now, we use the transperitoneal approach with right viscero-rotation. The diaphragm was severed circumferentially in all TAA I and III, and if necessary, in TAA II and IV. Since 2003, we have opted for the peripheral partial radial section of the diaphragm and applied the technique of sequential clamping. Visceral arteries, when implicated, have been reimplanted with the Carrel patch technique, with the exception of some renal arteries who necessitated a separated bypass. Systemic hypothermia (30°C) was performed every time the PCBP was used.

The follow-up was done at the out-patient clinic at 1 month, 6 months and yearly thereafter.

Endovascular approach

A thoracoabdominal CT-scan and IA angiogram were done to evaluate the feasibility of endovascular repair. Particularly, the diameter of the neck is determined, as its position with regard to the left subclavian artery, the evaluation of the aortic angulation and the possible existence of atheromatous lesions, proximal or distal. Anatomic criteria of feasibility are concordant to those described in literature (4). The procedure takes place under general anaesthesia. One femoral artery is exposed, the left subclavian artery is catheterised to facilitate the angiography, necessary for the procedure. A small dose of heparin (2,500 to 5,000 units) is given. The implantation of the prosthesis is done with the collaboration of a vascular radiologist. The five stentgrafts implanted between 1999 and 2003 were Talent prostheses (Medtronic Vaascular, Sunrise, Florida, USA) ; the five most recent endoprostheses were Zenith prostheses (Cook, Inc. Bloomington. Ind., USA).

Results

Between January 1rst, 1996 and December 31, 2005, 42 patients benefited open surgical repair ; 26 were done on an elective basis and 16 in emergency. Ten patients were treated by the endovascular approach, all ten under elective condition.

Open Surgery

Elective and emergent patients have been compared with regard to the mean age (63 and 70 years), coronary insufficiency (21 and 31%), arterial hypertension (81 and 63%), diabetes (0 and 13%), chronic obstructive pulmonary disease (26 and 44%). Sex ratio is 23% female patients in the elective group and 56% in the emergent group. None of these differences reaches a statistical significance (Table I). It is note-worthly that four patients who undergone cardiac transplantation in the past : two of them were operated on electively for their TAA and two others were operated on in emergency.

Table I

Patient characteristics

	Elective (n = 26)		Urgent (n = 16)	
	N	%	N	%
The range of ages	24-81		40-83	
Mean age	63		70	
Female Sex	6	23	9	56
Coronary Insufficiency (CI)	6	23	5	31
Hypertension (HTA)	21	81	10	63
Diabetes	0	0	2	13
COPD	7	26	7	44

Table II

Aneurysm characteristics

Aneurysm characteristics	Elective (n = 26)		Urgent (n = 16)	
Range of the diameter (mm)	50-100		50-116	
Mean diameter (mm)	68		76	
Degenerative	22	85%	10	62%
Chronic aortic dissection	4	15%	6	38%

Table III

Aneurysmal extension

Aneurysms	Elective (n = 26)	Urgent (n = 16)
TDA	9	2
TAA I	3	1
TAA II	6	6
TAA III	2	4
TAA IV	6	3

We have compared the two groups with regard to aneurysm characteristics : mean diameter is more important in emergency cases (76 mm vs 68 mm). Majority of aneurysms are of the degenerative type in both groups (85 vs 60%) and chronic aortic dissections account only for 15 and 38% in both groups (Table II).

The aneurysmal extension is defined in table III. It is important to note a past history of aortic surgery. This is detailed in Table IV.

Moreover, one TAA I (160 mm diameter) had been admitted in emergency in a context of aorto-oesophageal fistula (5).

Mortality and postoperative morbidity are detailed in Table V. There is no mortality in the electively operated

Table IV

Previous aortic surgery

Past History	Elective (n = 26)	Urgent (n = 16)
Previous aortic surgery	10	3
Previous AAA surgery	7	3
Previous TAA surgery	2	0
Previous surg. of ascending aorta	1	0
Previous heart transplantation	2	2
Traffic accident	3	0

Table V

Mortality and postoperative morbidity

Operative outcome	Elective (n = 26)		Urgent (n = 16)	
	N	%	N	%
30 days mortality	0	0	3	19
Haemorrhage	1	4	2	13
Renal complications	1	4	5	31
Pulmonary complications	8	31	7	44
Paraparesia	1	4	0	0
Paraplegia	2	8	1	6
CVA	1	4	3	19
Digestive ischemia	0	0	1	6
Cholecystitis	1	4	1	6
Lower limb ischemia	1	4	1	6
Compartmental syndrome	0	0	1	6

Table VI

Paraplegia prevention

Medullar protection	Elective (n = 26)		Urgent (n = 16)	
	N	%	N	%
CSF drainage	13	50	3	19
Intercostal arteries reimplantation	12	46	7	44
PCBP	18	70	16	100

group. In the emergency group, there are three deaths (19%) : they concern two patients with a TAA II and one patient with TAA III. Both patients TAA II deceased because of a cerebrovascular accident (CVA) secondary to an important hemispheric cerebral infarction in one case, and infarction of the cerebral trunk in the other. The only TAA III patient, who deceased, presented an aneurysm of 110 mm diameter ; operated in emergency under partial cardiopulmonary bypass with exclusion of the left lung, presented postoperatively an intractable hemorrahge in the left lung (attributed to a excessive retraction and compression of the lung during surgery).

CSF drainage has been done more often in the elective group than in the emergency group (50% vs 19%). PCBP was used systematically in emergency (100% in emergency cases vs 70% elective cases) (Table VI).

Intercostal artery reimplantation was equivalent in both groups(46 and 44%). Postoperative renal failure is observed in one case of the elective group and in five cases of the emergency group. The patient of the elective group (with TAA IV) required transitory hemodialysis and then reversed to normal. Three of the five kidney failures after emergency operation (1 TAA II, 1 TAA III, 1 TAA IV) necessitated definitive dialysis. The two other patients regained a normal kidney function. Paraplegia did appear in two patients of the elective group (1 TAA IV and 1 TAA III) and in one patient of the emergency group (TAA III). The two elective patients had benefited from CSF drainage and intercostal artery reimplantation. The patient operated on in emergency (TAA III) who suffered paraplegia benefited reimplantation of intercostal arteries but did not benefit of the drainage of the CSF.

Four cerebrovascular accidents (CVA) did appear, one for the elective group and 3 for the emergency group. The elective patient had a history of carotid thromboendarterectomy ; two of the three CVA in the emergency group were fatal.

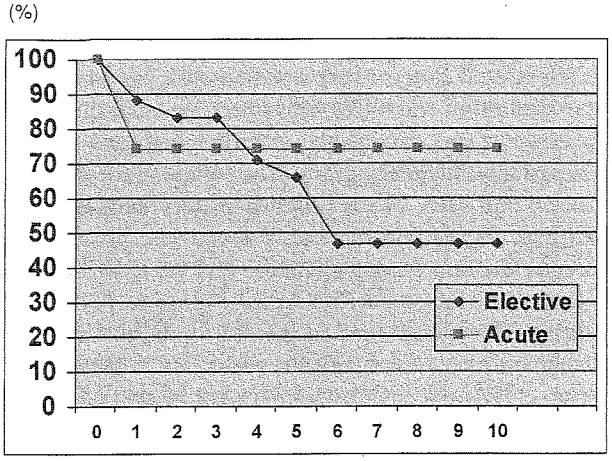
Partial cardiopulmonary bypass was used in 70% cases in the elective group. The only patient with TDA and not having undergone partial femoro-femoral extra-corporeal circulation, developed a sub-acute ischemia of the lower limbs. In the group of three patients with TAA III not having benefited from an extra-corporeal femoro-femoral circulation, there was one postoperative paraplegia. Despite reimplantation of intercostal arteries, three patients have presented a postoperative paraplegia.

Survival

In the elective group, two patients were lost to follow up between first and second year. By using actuarial methods, survival at one year is 88%, at five years 66%, and at ten years 47%. In the emergent group, the survival at five years is 74% and survival at ten years is still 70% (Fig. 1).

Endoaneurysmal stentgrafting

Endovascular surgery was introduced in our institution in 1999, and since then, ten patients have been electively submitted to this form of treatment : 5 TDA, 2 TAA I and 3 TAA III. Sex ratio was 9 men for 1 woman, mean age was 60 years. Half of the patients had a history of prior aortic surgery. Aneurysms were of the degenerative type in eight cases and 2 were the sequelae of aortic dissection. Mean diameter was 54 mm for the TDA, 65 mm for the TAA I and 62 mm for the TAA III. There was no significant complication postoperatively, except a



Patients at risk											
Elective	26	19	17	16	14	12	7	6	5	1	1
Acute	16	11	8	5	5	5	4	4	2	2	1

Fig. 1
Actuarial survival curve for open surgery

persisting type I endoleak evidenced at the time of procedure and immediately treated by the placement of another coaxial endoprosthesis.

Discussion

Results of this unicentric study are obviously limited by the small number of cases, and overall by the selection bias for choosing between open surgery or endovascular surgery.

However, this series represents the homogenous experience of one surgical team using a uniform surgical selection and technique. Data collected show an operative mortality of 0% in the elective group, and 19% in the emergent group with the paraplegia incidence of 8 and 6%, similar with those reported in other series (1, 2, 10-12).

Operative details about the use of a partial cardiopulmonary bypass, CSF drainage or reimplantation of intercostal artery are classically described in literature (6-9).

Of three paraplegic patients, only one (TAA III), operated on in emergency, had not benefited from CSF drainage. He was however submitted to a PCBP and significant intercostal arteries were reimplanted. The two other patients, TAA III and IV, had been operated on electively and had benefited from CSF drainage with no reimplantation of the intercostals arteries. The patient with TAA IV and postoperative paraplegia had not benefited from extra-corporeal by-pass and suffered hemodynamic instability at the time of unclamping.

Actuarial survival curve, if compared with survival of non operated aneurysms in Crawford's study, demonstrates the usefulness of surgery in term of survival but at the expense of a possible invalidating neurological morbidity.

Incidence of pulmonary complications is decreasing since January 2003 when we switched to radial section of the diaphragm, because we felt that the circumferential section of the diaphragm was partly responsible for high rate pulmonary complications (13). The incidence of pulmonary complications before 2003 was 32% in the elective group and 71% for the emergent group. Since January 2003, the incidence of pulmonary complications dropped to 25% in the elective group and 22% in the emergent group.

Postoperative renal failure is clearly more important in patients operated on in emergency (33%). There was no preoperative renal dysfunction in three patients who developed postoperatively a permanent end-stage renal insufficiency. None of the cases of postoperative renal insufficiency was linked with the revascularization of renal arteries. It has been reported that postoperative

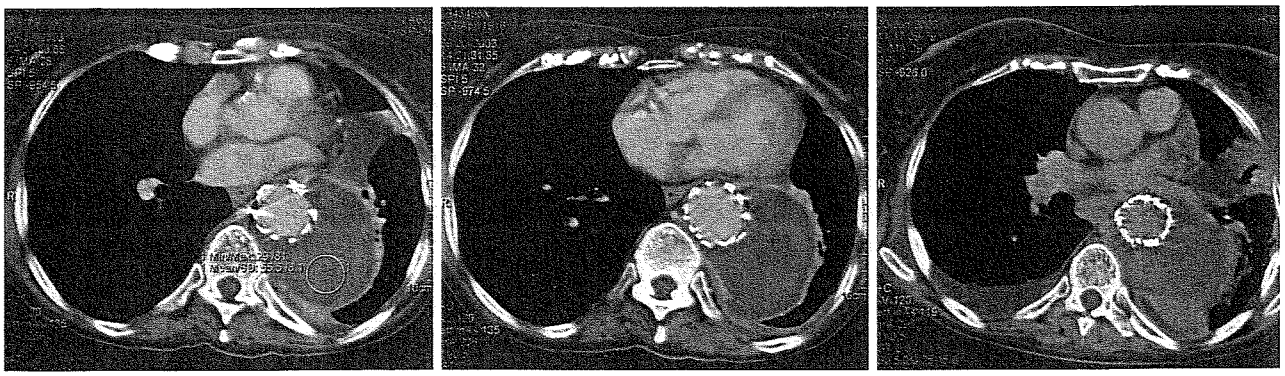


Fig. 2a
Peroperative CT scan of endovascular exclusion of a TAA type I

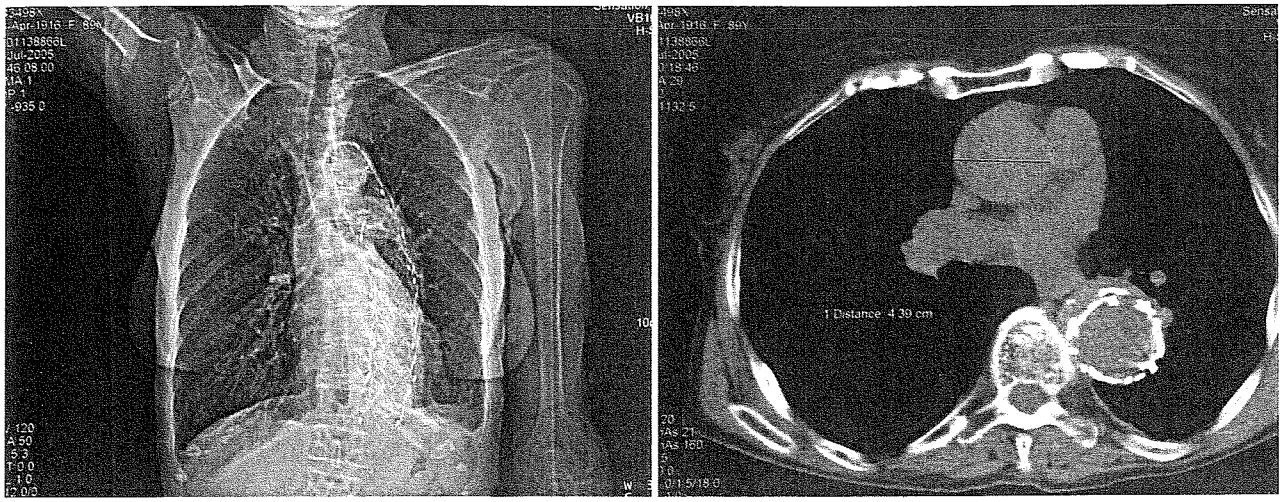


Fig. 2b
Follow-up CT Scans, 2 years post-stenting, shows complete exclusion and shrinkage of this TAA

morbidity was less in the group where visceral arteries had been reimplanted (14).

We have not compared our small group of endovascular repair with the reported series of thoracic stent-grafting in literature(11, 15), neither with the results of open surgery in this series because the selection bias assigning the less complex TAA and TDA for endovascular treatment. However, in this series, the results are excellent, especially with respect to the absence of paraplegia. This is important to notice since inevitably, with the endovascular technique, intercostal arteries are not reperfused (16).

Conclusion

Operative mortality is nil in elective cases, and at an acceptable level in emergency cases. These excellent results of open surgery confirm the adequacy of this type of surgery as soon as the aneurysm has reached a critical size (50 to 60 mm). The crucial point in this disease is the prevention of postoperative neurological morbidity. The use of an extra-corporeal bypass, CSF drainage and intercostal artery reimplantation seem to be essential in diminishing the incidence of this complication. However, it is remarkable to notice that neurological complications are virtually absent in endovascular cases where, by necessity, intercostal arteries are not reperfused. This brings us to reconsider the usefulness of intercostal artery reimplantation and emphasize the crucial importance of hemodynamic stability during and in the hours following the procedure. Finally, a long term study is needed to assess definitely the durability of the results obtained with endovascular repair of TAA and TDA.

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