

“Open” repair of ruptured thoracoabdominal aortic aneurysm (experience of 51 cases)

Piero Paolo Zanetti¹, Marcin Krasoń², Ryszard Walas², Theodor Cebotaru³, Calin Popa³, Bogdan Vintila³, Flaviu Steiu³



¹Department of Cardiovascular and Thoracic Surgery, Center of Thoracic Aorta Surgery and Marfan Syndrome; Policlinic of Monza, Monza (MB), Italy

²Department of Cardiac, Endovascular Surgery and Transplantation, Medical University of Silesia in Katowice, School of Medicine with the Division of Dentistry in Zabrze, Silesian Center for Heart Diseases, Zabrze, Poland

³Ospitalul Monza, Center Cardiovascular, Bucuresti, Romania

Kardiologia i Torakochirurgia Polska 2015; 12 (2): 119-125

Abstract

Introduction: Surgical treatment of thoracoabdominal aortic aneurysms (TAAA) represents a difficult problem for the vascular surgeon and may become a formidable challenge in an emergency procedure. In patient with hemodynamic instability, protective measures as cerebral spinal fluid drainage and bio-pump against spinal cord, visceral and renal ischemia, may be ineffective or impracticable.

Material and methods: We report our experience of 51 emergency-operated patients with TAAA out of 660 treated between 1994 and 2014; 48 patients (94%) were hemodynamically unstable, 3 (6%) were hemodynamically stable. The TAAA patients were evaluated, according to Crawford classification, as: 18 type I, 13 type II, 15 type III, 5 type IV.

Results: Overall mortality was 23 cases out of 51 (43.1%); 8 deaths occurred during the surgical procedure and 14 in the postoperative period. Early deaths, subdivided by Crawford TAAA classification, were: type I 9/18 (50%), type II 9/13 (69.2%), type III 7/15 (46.6%), type IV 3/5 (60%).

Paraplegia-paraparesis developed in 6 cases out of 43 (16.2%), excluding 8 deaths during the operative procedure. Acute renal failure was observed in 8 out of 43 patients (18.6%). Dialysis was found to be a risk factor for hospital mortality ($p = 0.03$). Pulmonary insufficiency was diagnosed in 15 patients out of 43 (34.8%), and 5 patients (15.5%) needed tracheostomy, out of whom 3 died ($p = 0.04$). Postoperative bleeding was present in 8 cases out of 43 (18.6%). Inferior laryngeal nerve palsy was present in 6 cases out of 43 (13.5%). The follow-up period comprised 1-3-5-10 years postoperative follow-up. The actuarial survival rate of patients discharged from hospital was respectively 75%, 63%, 48%, 35%.

Conclusions: In the literature there are very few studies published on emergency treatment for TAAA. Having usually low numbers of patients in the groups wider experiences are still

Streszczenie

Wstęp: Chirurgiczne leczenie piersiowo-brzusznych tętniaków jest poważnym wyzwaniem w zabiegach ratunkowych. U niestabilnych krążeniowo chorych stosowanie drenażu płynu mózgowo-rdzeniowego i biopompy może być nieefektywne lub niewykonalne.

Materiał i metody: W pracy przedstawiono doświadczenia własne i wyniki leczenia 51 operowanych ratunkowo pacjentów z grupy 660 chorych z TAAA leczonych między 1994 a 2014 r. U 48 chorych (94%) obserwowano cechy niestabilności układu krążenia, 3 chorych (6%) pozostawało krążeniowo stabilnych. Chorych podzielono wg klasyfikacji TAAA Crawforda: typ I – 18 chorych, typ II – 13 chorych, typ III – 15 chorych, typ IV – 5 chorych.

Wyniki: W obserwowanej grupie zmarło 23 spośród 51 chorych (43,1%) – 8 chorych w czasie zabiegu, a 14 w okresie pooperacyjnym. Wczesne zgony podzielono wg klasyfikacji Crawforda: typ I – 9/18 (50%), typ II – 9/13 (69,2%), typ III – 7/15 (46,6%), typ IV – 3/5 (60%).

Porażenie kończyn dolnych lub ich niedowład wystąpiły u 6 spośród 43 chorych (13,9%), którzy przeżyli zabieg. Ostrą niewydolność nerek stwierdzono u 8 chorych (18,6%). Dializa stanowiła w grupie badanej istotny czynnik ryzyka zgonu szpitalnego ($p = 0,03$). Niewydolność oddechową zdiagnozowano u 15 pacjentów (34,8%), 5 chorych (11,6%) wymagało tracheostomii i w tej grupie zmarły 3 osoby ($p = 0,04$). Krwawienie pooperacyjne wystąpiło u 8 chorych (18,6%). Porażenie nerwu krtaniowego wsteczne obserwowano u 6 chorych (13,9%). Czas obserwacji pozabiegowej obejmował 1-, 3-, 5- i 10-letnie kontrole, a przeżycie chorych wynosiło odpowiednio 75%, 63%, 48% i 35%.

Wnioski: Dotąd opublikowano bardzo mało wyników badań dotyczących ratunkowego leczenia TAAA. Przy zwykle niewiel-

Address for correspondence: Marcin Krasoń, MD, PhD, Department of Cardiac, Endovascular Surgery and Transplantation, Silesian Center for Heart Diseases; 9 M. Skłodowskiej-Curie St., 41-800 Zabrze, Poland, phone: +48 32 373 36 04, fax: +48 32 278 43 34, e-mail: marcinkrason@op.pl

needed to give more light on the pathophysiology and surgical treatment of this type of TAAA, which are still being treated according to the individual surgeon’s experience.

Key words: thoracoabdominal aortic aneurysms, surgical treatment.

Introduction

Surgical treatment of thoracoabdominal aortic aneurysms (TAAA) represents a burdensome problem for the vascular surgeon and may become a formidable challenge in an emergency procedure. Mortality and morbidity rates rise exponentially in this patient group.

The few studies in the literature reporting on emergency TAAA surgical treatment present conflicting data, and the study samples are often very small.

The typology of emergency-operated patients in the literature often varies from one report to another, because cases with hemodynamic stability, due to covered ruptures, are mixed with those of hemodynamic instability for frank ruptures. As a result, mortality and morbidity rates reported in the literature are often optimistic, making the severity of the clinical pictures misleading.

The various protective procedures against spinal cord and renal ischemia are often ineffective or impracticable, in a situation of hemodynamic instability, thus reducing or eliminating its benefits consistently reported for elective surgical treatment [1-6].

This study evaluated mortality and morbidity outcomes in 51 patients operated on for TAAA rupture. Cases classified as “symptomatic” or “imminent rupture” were not taken into account because hemodynamic stability does not substantially distinguish these patients from those treated electively.

Material and methods

From 1 January 1994 to 31 December 2014 the same operator (PPZ) treated 711 TAAA, of which 51 were operated on in emergency and 660 in elective surgery.

The study group consisted of 38 men and 13 women (age range: 33 to 83 years; mean: 62 years). Preoperative risk factors are listed in Table I.

Of the 51 emergency-operated patients, 28 (54.9%) had true aneurysms, 23 (45.0%) dissecting aneurysms. Forty-

eight patients (94.1%), with frank rupture, required treatment within 2-6 h; 3 patients (5.88%), with covered rupture, were operated on within 24 hours.

Słowa kluczowe: tętniak piersiowo-brzusznny, leczenie chirurgiczne.

eight patients (94.1%), with frank rupture, required treatment within 2-6 h; 3 patients (5.88%), with covered rupture, were operated on within 24 hours.

The clinical indications for emergency surgery, in the presence of a frank rupture, for true or dissecting aneurysms, were seen in 48 out of 51 patients (94.1%), by arterial hypotension (AP ≤ 70 mmHg) and hemodynamic instability.

Other, various clinical signs included pain, renal, hepatic, intestinal ischemia, spinal cord paraparesis or paraplegia and ischemia of the lower limbs.

Hemodynamic stability (SAP > 90 mmHg) associated with worsening anemia was present in 3 patients.

Hemodynamic instability was related to dissecting lesions in 20 patients (39.2%), to true aneurysms in 24 patients (47%). Hemodynamic stability was related to a dissecting lesion in 1 patient (1.9%) and to true aneurysms in 2 (3.9%).

Clinical presentation comprised a left hemothorax in 25 patients (49%), right hemothorax in 2 patients (3.9%), and associated retroperitoneal hematoma and left pleural effusion in 22 cases (43.1%).

All 51 patients had undergone computed tomography scanning (CT) with contrast enhancement and were evaluated, according to the Crawford classification, as 18 type I (35.2%), 13 type II (25.4%), 15 type III (29.4%) and 5 type IV (9.8%).

Regarding surgical notes, after induction of anesthesia, patients were intubated using a Carlens tube to obtain left lung collapse.

Patients were positioned on the operating table to receive left thoraco-phreno-laparotomy.

In patients classified as TAAA type IV, the surgical access was limited to a short segment of the diaphragm and a small lateral thoracotomy in order to have control of the juxta-diaphragmatic segment of the aorta.

The thorax was opened between the 6th and the 9th ribs, without sacrificing the rib. The abdomen was opened using a transperitoneal access, and the diaphragm was cut circumferentially to avoid palsy of the phrenic nerve branches.

Two splenectomies (3.9%) were performed, due to iatrogenic injury, during dissection, whereas only 7 (1.05%) splenectomies were required in the 660 elective procedures.

Distal perfusion using a bio-pump was applied in 26 cases (50%), femoro-femoral CPB in 8 cases (15.6%), ‘clamp-and-go’ technique in 7 cases (13.7%) and CPB with deep hypothermia and circulatory arrest (DHCA) in 10 cases (19.6%).

Tab. I. Preoperative risk factors in 51 patients operated on in emergency

Risk factor	%	Number
Smoker or ex-smoker	68.6	35/51
Arterial hypertension	78.4	40/51
COPD	29.4	15/51
Chronic renal failure	19.6	10/51
Previous MI	15.6	8/51

COPD – chronic obstructive pulmonary disease, MI – myocardial infarction

Arterial return was performed as: left femoral artery and left atrium using the Bio-pump; left femoral artery and left femoral vein using CPB; and both femoral arterial and femoral vein, cannulation of the left atrium and, if necessary, also the pulmonary artery in order to achieve good venous drainage in DHCA.

Evaluating the 51 patients treated in emergency, the use of BIO-pump (50%) has been the more frequent procedure than clamp-and-go technique (7 cases – 13.7%).

In emergency spinal cord fluid drainage (SCFD) was performed in only 6 cases out of 51 (11.76%), whereas in 660 patients, treated electively, the percentage was 77.5%.

In the 20 cases (32.9%) with evident hemodynamic instability, the “open” distal anastomosis procedure, according to Cooley, was preferred. Alternatively in very dramatic cases, the big Foley catheter was distally placed in the aortic lumen, in order to avoid cross-clamping.

Surgical repair of TAAA using a “staged clamping” procedure was performed whenever possible. The first step of anastomosis was made proximally, at the level of the left subclavian artery in type I and type II TAAA and below the 6th rib in type III and type IV. The second step was the reimplantation of intercostal and lumbar arteries. The third step was the visceral and renal arteries’ anastomoses, using several techniques. The last step was the distal suture at the level of the aortic carrefour or below the renal arteries.

Proximal anastomosis with a precoagulated Dacron graft was fashioned with 3/0 nonabsorbable monofilament and continuous suture, strengthened with pledget stitches. We paid particular attention to the major problem of intercostal and lumbar arteries in the aortic segment between T3 and L4 [7]. Whereas no treatment was performed for the intercostal arteries already obstructed, 164 arteries were treated between T3 and L4 using a ligature or reimplanting.

Particularly, between T3 and T8, 88 arteries were tied and 6 reimplanted; between T9 and T12, 50 arteries were reimplanted, and 5 ligated; between T12 and L4, 3 were tied and 12 were reimplanted.

In an emergency situation we used a Fogarty catheter, in order to avoid “back flow” and to maintain a good blood pressure in spinal cord perfusion. We have never used this procedure for perfusion of intercostal artery ostia, neither in emergency nor in elective treatment of TAAA.

Reimplantation of visceral and renal arteries in emergency requires a procedure performed very rapidly and therefore without the use of a perfusion system with normothermic or cooled blood, or Ringer lactate solution.

This was our policy in the first period of our experience, but in the last years our method implies the rapid cannulation of celiac trunk and superior mesenteric artery with a Fogarty catheter (without perfusion), and the use of perfusion of the renal arteries with cold Ringer lactate solution.

This is our strategy, but it is not always possible to carry it out in an emergency, and case by case, we decided which method was the best, evaluating the situation of the vessel’s ostia, frequently diseased by stenosis or obstruction and consequently with technical impossibility of direct cannulation and then with the need for thrombo-endo-atherectomy or bypass.

Regarding the technical modality for visceral and renal vessels reattachment, several procedures were used.

In the presence of one short distance among ostia of the vessels and in order to obtain very rapid reimplantation (39 cases, 76.4%), “the single Carrell patch technique” was used.

A large aneurysm, with significant distance among ostia, particularly for the left renal artery (11 cases, 21.5%), required the reattachment of each vessel separately, and also to avoid a Carrell patch enlargement (it was seen in 11 cases, 21.5% in the group). Finally in Marfan patients, with the absolute need for removal of as much as possible of the diseased aortic wall, reimplantation of the vessels was performed using a branched graft (Coselli graft) with direct anastomoses of each branch to a single vessel’s ostia (4 cases, 7.8%).

Distal anastomosis at the level of the aortic bifurcation was performed in 45 cases (88.2%), in 5 cases (9.8%) at the level of the femoral arteries, using another bifurcated prosthesis and in 1 case (1.9%) by widening the diameter of the carrefour by opening the left common iliac artery.

Operative variables related to type of TAAA are listed in Table II; operative time, clamping time, and amount of blood loss were significantly increased for type II TAAA.

The risk factors were analyzed using univariate analysis with Fisher’s exact test; the survival curve was determined by the Kaplan-Meier method, and independent variables were evaluated using linear regression analysis.

Results

Overall mortality was 43.1% (22 cases /51): 8 deaths occurred during the operations and 14 in the post-operative period. The 8 operating room deaths were in 6 cases due to uncontrollable bleeding. One case of ischemic cerebral damage was due to acute retrograde dissection of the aortic

Tab. II. Operative variables divided by type of thoracoabdominal aortic aneurysms in 51 patients operated on in emergency

	Type I	Type II	Type III	Type IV
Operative time	225	280	230	200
Visceral ischemia time	38	40	35	32
Cross clamping time	40	70	60	40
Blood loss	3000	4000	2500	2000

arch and its branches and the second case was because of acute myocardial infarction during the operative period.

The 14 early deaths (within 30 days) were related in 2 cases to intestinal infarction owing to embolic events in the superior mesenteric artery by atheromatous material during intestinal reperfusion (both patients had undergone intestinal resection; the first died on the 2nd postoperative day whereas the other died on the 4th postoperative day).

Two myocardial infarctions occurred on days 15 and 21 of the postoperative period; 1 uncontrollable hemorrhage at 24 h due to dehiscence of proximal suture line; 1 iatrogenic perforation of the superior vena cava; 7 cases of multiorgan failure (MOF).

Late mortality regarded 1 death, due to acute rupture of a right iliac aneurysm at postoperative day 60. Analysis of deaths by type of lesion showed that 10 out of 28 (35%) patients died in the group of true aneurysms, 12 out of 23 (52.1%) in the group of dissecting aneurysms.

Early mortality (within 30 days) evaluated according to Crawford classification comprised: type I 9/18 (50%), type II 9/13 (69.2%); type III 7/15 (46.6); type IV 3/5 (60%) (Table III). Early mortality (within 30 days) after elective surgery occurred in 51 out of 661 cases (7.7%). Paraplegia and paraparesis (P/P) developed in 6 cases out of 43 (13.9%) excluding the 8 intraoperative deaths.

Table IV compares the number of P/P and the type of TAAA according to the Crawford classification.

Spinal cord damage was permanent in 5 out of 6 cases (83%); 5 out of 6 (83%) developed a bilateral lesion and 1 case (17%) developed a unilateral lesion. Spinal cord damage appeared in 3 cases after clamp-and-go technique, in 1 case after BIO-pump and 2 cases after femoro-femoral CPB.

Paraplegia and paraparesis, after elective surgery, occurred in 45 cases out of 661 (6.8%) in the experience of the first author.

Type II TAAA presented P/P in 3 cases out of 13 (23%); these data were found to be a risk factor for spinal cord damage ($p = 0.02$), the same as the drop of arterial pressure (< 50 - 60 mmHg) for periods longer than 30 minutes ($p = 0.01$).

This last finding was present in all cases of P/P in patients with severe hemodynamic instability or significant bleeding during the surgical procedure.

Our findings disagree with recent data reported in the literature [8], because, in our series, intercostal arteries’

ligature or reimplantation was not found to be always significant for development of P/P in emergency.

In this acute situation, in fact, the quality of the aortic wall is frequently poor, very fragile, and thus unfit for intercostal artery reattachment. In this setting the ligature of vessels is mandatory, but the stable mean arterial pressure above 80-90 mmHg seems to be a very protective factor in avoiding spinal cord damage.

In our experience, only 1 case developed P/P, after ligation of intercostal arteries between T9 and T12 in a dissecting lesion. In additional presence of a very low arterial pressure due to very difficult bleeding control that happened in this case it was very debatable whether a single cause of the P/P damage could be found.

Acute renal failure (ARF) was present in 8 out of 43 patients (18.6%); dialysis was not required in 3 patients (37.5%) who maintained diuresis with creatinine level > 3 mg/dl. In contrast, out of 5 patients who needed dialysis, 2 died.

Hence, despite the limitation of this study in terms of the small sample size, use of dialysis may be a predictive factor for hospital death ($p = 0.03$), as reported by Zeebregts and Schepens [9]. Other risk factors for onset of ARF were prolonged arterial hypotension ($p = 0.05$) and type II TAAA, particularly in the dissecting aneurysm group ($p = 0.04$).

A comparison between the percentage of ARF in 43 emergency-operated TAAA (18.6%) and that of electively treated TAAA (85/660, 12.8%) shows that the difference is not so significant and antithetical to data present in the literature.

Clamping time varied from 30 to 90 min (mean 50 min). This finding did not closely correlate either with the onset of ARF ($p = 0.09$) or with the onset of P/P ($p = 0.06$).

The main post-operative respiratory complications occurred in 15 cases out of 43 emergency (34.8%) and were comparable to those treated by elective surgery 180/660 (27.2%).

In 28 cases out of 43 extubation was performed within 48 h, in 15 cases within 5 days and in 5 tracheostomy was required.

In 21 patients out of 43 (48.8%), the complications comprised pneumonia, pleural effusion and disventilated areas for atelectasis.

Moreover 3 out of the 5 patients who received tracheostomy died, in consequence of respiratory complications leading to tracheostomy, which in our series may be considered a predictive risk factor for death ($p = 0.04$).

Tab. III. Mortality rate after emergent surgical treatment of 51 thoracoabdominal aortic aneurysms according to Crawford classification

Crawford type	Patients (n)	30 days	%
I	18	9	50
II	13	9	69.2
III	15	7	46.6
IV	5	3	60

Tab. IV. Percentage of P/P after emergent surgical treatment of 51 thoracoabdominal aortic aneurysms according to Crawford Classification

Crawford type	Patients (n)	%
I	2/13	15.3
II	3/13	23
III	1/15	6.6
IV	0/2	0

Tab. V. Type and percentage of complications in 51 patients operated on in emergency for thoracoabdominal aortic aneurysms

Complication type	Number (n)	%
Paraplegia/paraparesis	6/43	13.9
Renal failure	8/43	18.6
Respiratory insufficiency	15/43	34.8
MI	1/43	2.3
Stroke	2/43	4.6
Postoperative bleeding	8/43	18.6
Palsy of inferior laryngeal nerve	6/43	13.9%

MI – myocardial infarction

The small size of our group agrees with the experience of Coselli, where out of 39 TAAA in septuagenarians, the 4 who required tracheostomy died in the postoperative period.

Reintubation was required in 5 cases out of 43 (11.6%), without determining, in our experience, poor prognosis.

Postoperative bleeding was present in 8 cases out of 43 (18.6%), compared with 30 cases out of 660 (4.5%) in elective surgery. Particularly 1 case of type IV using clamp-and-go technique, 3 cases in type I using in one case bio-pump, in two cases femoro-femoral CPB, 1 case type III using bio-pump, and finally 3 cases type II, 1 with Bio-pump, 2 with DHCA.

Myocardial infarction (MI) was observed only in 1 case (2.3%), and cardiac arrhythmia developed in 18/43 cases (41.8%).

Palsy of the inferior laryngeal nerve occurred in 6 cases out of 43 (13.9%); 4 using bio-pump, 2 using DHCA. Table V lists the main postoperative complications after emergency treatment; Table VI lists the risk factors for postoperative death.

Length of stay (LOS) in the intensive care unit ranged from 1 to 71 days, and length of stay in hospital ranged from 12 to 85 days (mean, 16 days). After elective surgery, LOS in the intensive care unit ranged from 1 to 31 days, and LOS in hospital ranged from 12 to 80 days.

The 29 patients discharged from the hospital were followed up for 1-3-5-10 years. The actuarial survival rate at 1-3-5-10 years is 75%-63%-48%-35%.

The cause of death in 30% of cases in follow-up was attributable to surgery; in 70% of cases general complications such as cardiac, neurological, renal and neoplastic were the causes of death.

Discussion and conclusion

The literature offers scant data on emergency-treated TAAA.

Studies often analyze urgent and emergency cases together [6] or make a simplistic distinction between symptomatic and asymptomatic aneurysms [2].

In agreement with Gilling-Smith *et al.* [3], we believe that a distinction should be made between hemodynamically

Tab. VI. Postoperative risk factors for death in 51 patients operated in emergency for thoracoabdominal aortic aneurysms

	Number (n)	p
Tracheostomy	3/5	0.04
Dialysis	2/5	0.05
Postoperative bleeding	3/8	NS
Cardiac arrhythmia	2/16	NS
Type II TAAA	9/13	0.02

TAAA – thoracoabdominal aortic aneurysms

cally stable and hemodynamically unstable aneurysm patients.

This is the true feature that characterizes the emergent nature of treatment and the quality of results.

In our series, we found that hypovolemic shock and oligo-anuria at the time of hospital admission may be predictive factors for hospital mortality.

Mortality rates did not differ substantially between symptomatic TAAA, dissecting or TAAA with impending rupture or with a small covered rupture that were hemodynamically stable and cases of TAAA treated by elective surgery.

We agree with Coselli *et al.* and LeMaire *et al.* [4, 5] that the presence of an acute or chronic dissecting TAAA does not influence the rate of P/P in urgent cases, nor does cross-clamping time, as reported by Svensson *et al.* [2].

Prolonged hypotension (> 50 mmHg for 30 min) and lesion extension (type II) were found to be determinant factors for spinal cord damage.

In contrast, distal aortic perfusion (BIO-PUMP) and spinal cord fluid drainage should be used as protective measures only as the emergent situation may allow [10, 11].

The literature contains conflicting reports regarding the systematic use of intercostal arteries' reattachment between T9 and T12 to reduce the P/P rate. Coselli *et al.* and Safi *et al.* suggest, whenever possible, the intercostal arteries' reimplantation, both in elective and in emergency surgery, particularly in the presence of large vessels with poor or absent back-bleeding [4, 7, 8]. Svensson *et al.* [2] found that most reimplanted intercostal arteries were already occluded after several hours or within 1 to 2 days after the intervention. Gilling-Smith *et al.* [3] reported no difference in the onset of P/P between patients treated with or without intercostal artery reimplantation, regardless of the extent of the lesion (type I-II-III).

We believe that in emergency cases, especially in the presence of an acute dissecting lesion and highly fragile aortic wall, intercostal artery reimplantation may be difficult or even impossible to perform: therefore we advocate the use of a ligature. Instead, in the presence of chronic dissecting TAAA or true aneurysms, reimplantation of the intercostal arteries, especially between T9 and T12, is advisable also in emergent cases [7].

In surgical treatment of TAAA, ARF is present in 5% to 30% of cases, considering unfavorable factors such as older age, male sex, pre-existing renal failure and type II TAAA [12]. We agree with Mastroroberto and Chello [13] that over 50% of the forms of ARF are related to an episode of hypotension (AP > 50-60 mmHg) both in the pre- and intra-operative phase. In hemodynamic instability of emergency-operated patients acute hypotension plays a key role in the onset of ARF.

We agree with Safi *et al.* [12] on the need for distal perfusion to prevent or limit renal damage occurrence.

In our series, however, the percentage of ARF in emergency-operated-patients (18.6%) vs elective surgery (12.8%) was not significantly different.

This finding is difficult to explain and disagrees with the results published in the literature of rates of ARF between 20% and 30% in emergency-treated TAAA, especially in cases of type II aneurysm [10].

Respiratory complications were present in 34.8% of our series (15/43) and were a very important risk factor in 3 patients out of 5, who received tracheostomy and died.

In reference to the large series in the study conducted by Girardi and Coselli [14] we can confirm that in emergency-operated patients, respiratory complications leading to tracheostomy constitute a risk factor for postoperative death.

In contrast, Mastroroberto and Chello [13] reported that respiratory complications with the tracheostomy may be a cause of prolonged stay in the intensive care unit, or in hospital, but not a predictive factor for death.

Postoperative bleeding occurred in 8 cases out of 43 (18.6%), a significantly high rate but one which must be evaluated in the context of an extended surgical field, full heparinization of the patient, using femo-femoral CPB and with DHCA and consequently coagulation disorders, characteristic for important hemorrhage.

This complication is markedly reduced by using the Bio-pump and with modern techniques of blood recovery and reinfusion such as the “rapid infusion system”.

Postoperative cardiac complications, especially in emergency cases, are well known. In our series, only 1 patient died due to myocardial infarction during the postoperative period. In this case, however, coronary damage, especially in advanced age, can be considered as a predictive factor for death, given the impossibility to evaluate the state of the coronary vessels in an emergency situation, or the presence of latent coronary disease, in the context of arterial hypotension, which renders these lesions manifest.

Emergency surgery of TAAA is correlated with high mortality rates and frequently fatal postoperative complications (P/P, ARF, AMI, RF). Nonetheless, in severely compromised patients, the use of protective adjuncts, when possible (Bio-pump, spinal cord fluid drainage, intercostal arterial reimplantation, especially between T9 and T12) can reduce the otherwise high mortality and morbidity associated with emergency treatment.

The literature offers scarce data on this subject not only in terms of numbers but also in the correct evaluation

of patient classification [15]. Unfortunately, studies have mixed hemodynamically unstable cases with hemodynamically stable TAAA, thus rendering comparison between the 2 groups impossible [9, 16].

Most likely, treatment outcomes of hemodynamically stable cases of TAAA may be quite similar to those treated by elective surgery.

Finally we present a brief evaluation regarding the use of hybrid or total endoluminal treatment of ruptured TAAA in an emergency presentation.

In the literature the experience regards a small number of cases and the results are anecdotal [17-19].

In effect in a patient with hemodynamic instability, for frank rupture of TAAA, the proposal of whichever of these procedures is a cause of perplexity regarding the operative time consuming in both procedures, the wide availability in a surgical theatre of suitable material for every single patient, but, above all, the possibility to keep vital parameters sufficiently valid for all the long time of the surgical procedure.

The situation is different in the presence of symptomatic TAAA or with impending rupture, or with covered rupture, but with hemodynamic stability.

In these particular cases the hybrid or total endoluminal procedures may have a future, but in the presence of more solid and convincing experience and the use of devices more sure and suitable.

Disclosure

Authors report no conflict of interest.

References

1. von Segesser LK, Genoni M, Künzli A, Lachat M, Niederhäuser U, Vogt P, Schönbeck M, Turina M. Surgery for ruptured thoracic and thoracoabdominal aortic aneurysms. *Eur J Cardiothorac Surg* 1996; 10: 996-1001.
2. Svensson LG, Crawford ES, Hess KR, Coselli JS, Safi HJ. Experience with 1509 patients undergoing TAAA operations. *J Vasc Surg* 1993; 17: 357-368.
3. Gilling-Smith GL, Worswick L, Knight PF, Wolfe JH, Mansfield AO. Surgical repair of thoracoabdominal aortic aneurysm: 10 years' experience. *Br J Surg* 1995; 82: 624-629.
4. Coselli JS, LeMaire SA, Miller CC 3rd, Schmittling ZC, Köksoy C, Pagan J, Curling PE. Mortality and paraplegia after thoracoabdominal aortic aneurysm repair: a risk factor analysis. *Ann Thorac Surg* 2000; 69: 409-414.
5. LeMaire SA, Rice DC, Schmittling ZC, Coselli JS. Emergency surgery for thoracoabdominal aortic aneurysms with acute presentation. *J Vasc Surg* 2002; 35: 1171-1178.
6. Velazquez OC, Bavaria JE, Pochettino A, Carpenter JP. Emergency repair of thoracoabdominal aortic aneurysms with immediate presentation. *J Vasc Surg* 1999; 30: 996-1003.
7. Zanetti PP, Loddo P. Intercostal arteries treatment in TAAA repair. *G Ital Chir Vasc Surg* 2002; 9: 101-114.
8. Safi HJ, Miller CC 3rd, Carr C, Iliopoulos DC, Dorsay DA, Baldwin JC. Importance of intercostal artery reattachment during thoracoabdominal aortic aneurysm repair. *J Vasc Surg* 1998; 27: 58-68.
9. Zeebregts C, Schepens M. Surgical Repair of rupture thoracoabdominal aortic aneurysm in a renal allograft recipient. *Vasc Surg* 1999; 33: P113.
10. Loddo P, Degiudici A, Maxia A, Pibiri L, Pisu F, Ruiu G, Zanetti PP. Emergency surgery in thoracoabdominal aneurysms repair. Clinical outcome. *G Ital Chir Vasc* 2003; 10: 255-267.
11. Safi HJ, Hess KR, Randel M, Iliopoulos DC, Baldwin JC, Mootha RK, Shenaq SS, Sheinbaum R, Greene T. Cerebrospinal fluid drainage and distal aortic perfusion: reducing neurologic complications in repair of thoracoabdominal aortic aneurysm types I and II. *J Vasc Surg* 1996; 23: 223-229.

12. Safi HJ, Harlin SA, Miller CC, Iliopoulos DC, Joshi A, Mohasci TG, Zippel R, Letsou GV. Predictive factors for acute renal failure in thoracic and thoracoabdominal aortic aneurysm surgery. *J Vasc Surg* 1996; 24: 338-344.
13. Mastroberto P, Chello M. Emergency thoracoabdominal aortic aneurysm repair: clinical outcome. *J Thorac Cardiovascular Surg* 1999; 118: 477-481.
14. Girardi LM, Coselli JS. Repair of thoracoabdominal aortic aneurysms in octogenarians. *Ann Thorac Surg* 1998; 65: 491-495.
15. Rampoldi V, Arpesani A, Giorgetti PL, Rignano A, Trimarchi S, Conti D, Ruberti U. Ruptured aneurysms of the thoracoabdominal aorta: a case series. *Panminerva Med* 1995; 37: 123-128.
16. Bradbury AW, Bulstrode NW, Gilling-Smith G, Stansby G, Mansfield AO, Wolfe JH. Repair of ruptured thoracoabdominal aortic aneurysm is worthwhile in selected cases. *Eur J Vasc Endovasc Surg* 1999; 17: 160-165.
17. Zanetti PP. Thoracoabdominal aneurysm surgery. Update on "open" versus "hybrid" treatment and personal experience. *Kardiochir Torakochir Pol* 2008; 5: 254-256.
18. Richardson S, Popori RK, Pichel AC, Farquharson F, Serracino-Inglott F. A ruptured thoracoabdominal aortic aneurysm managed endovascularly using the telescoping chimney technique. *Ann Vasc Surg* 2011; 25: 384.e1-4.
19. Riesenman PJ, Reeves JG, Kasirajan K. Endovascular management of a ruptured thoracoabdominal aneurysm-damage control with superior mesenteric artery snorkel and thoracic stent-graft exclusion. *Ann Vasc Surg* 2011; 25: 555.e5-9.