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European Journal of Cardio-thoracic Surgery 12 (1997) 195–201

EUROPEAN JOURNAL OF CARDIO-THORACIC SURGERY

Aortobronchial and aortoesophageal fistulae as risk factors in surgery of descending thoracic aortic aneurysms[1]

L.K. von Segesser [a,*], T. Tkebuchava [a], U. Niederhäuser [a], A. Künzli [a], M. Lachat [a], M. Genoni [a], P. Vogt [a], R. Jenni [b], M.I. Turina [a]

[a] *Clinic for Cardiovascular Surgery, University Hospital, CHUV, Rue du Bugnon 46, CH-1005 Lausanne, Switzerland*
[b] *Clinic for Cardiovascular Surgery and Cardiology, University Hospital, Zürich, Switzerland*

Received 8 October 1996; received in revised form 7 April 1997; accepted 14 April 1997

Abstract

Objective: Assess outcome of patients with descending thoracic aortic aneurysms complicated by aortobronchial and aortoesophageal fistulae in comparison to patients undergoing repair of aortic aneurysms without fistulae. **Methods**: In a consecutive series of 145 patients (age 60 ± 12 years) with repair of descending thoracic and thoracoabdominal aortic aneurysms, 11 patients (8%: age 63 ± 9; NS) primarily presented for hematemesis and/or hemoptysis. In 8/11 patients (73%) an aortobronchial fistula was identified, and 3/11 patients (27%) suffered from an aortoesophageal fistula. Five of 11 patients (45%) had undergone previous aortic surgery in the same region. **Results**: Extent of aortic segments (range: 1–8) replaced was 3.1 ± 1.4 for all versus 2.6 ± 0.9 for fistulae (NS). Aortic cross clamp time was 38 ± 22 min for all versus 45 ± 15 min for fistulae (NS). Mortality at 30 days was 18/145 (12%) for all versus 16/134 (12%) without fistulae versus 2/11 (18%) with fistulae (NS). Paraparesis and or paraplegia was observed in 11/145 (8%) for all versus 10/134 (7%) without fistulae versus 1/11 (9%) for cases with fistulae (NS). Nine additional patients died after hospital discharge, seven without fistulae and two with fistulae (days 80, and 120) bringing the 1-year mortality up to 23/134 (17%) without fistulae versus 4/11 (36%) with fistulae (NS). Further analysis shows that the 1-year mortality accounts for 1/8 patients (13%) with aorto-bronchial fistulae versus to 3/3 patients (100%) with aorto-esophageal fistulae (esophageal versus bronchial fistula: $P = 0.018$; esophageal versus no fistula: $P = 0.006$). **Conclusions**: Outcome of patients suffering from descending thoracic aortic aneurysms complicated by aorto-bronchial fistulae can be similar to that without fistulae, whereas for cases complicated by aorto-esophageal fistulae the prognosis seems to remain poor even after successful hospital discharge. © 1997 Elsevier Science B.V.

Keywords: Thoracic aortic aneurysm; Rupture; Aortic fistula; Bronchial fistula; Esophageal fistula; Homografts

1. Introduction

Aortobronchial and aortoesophageal fistulae complicating ruptured descending thoracic and thoraco-abdominal aortic aneurysms are serious complications making already difficult surgical procedures even more challenging. The problems encountered during surgery under such circumstances include the choice of appropriate graft material, proper debridement, maintenance of spinal chord perfusion, handling of the fistulae, repair of the bronchi, repair of the esophagus and others.

Although there are some reports in the literature about successful surgical repair of descending thoracic aortic aneurysms complicated by aortoesophgageal [1–3,5,9,14,20] or aortobronchial fistulae [6–8,10,11], there is little information about the outcome of patients undergoing repair of descending thoracic aortic aneu-

* Corresponding author. Tel.: +41 21 3142280; fax: +41 21 3142278.

[1] Presented at the 10th Annual Meeting of the European Association for Cardio-thoracic Surgery, Prague, Czech Republic, 6–9 October 1996.

PII S1010-7940(97)00142-5

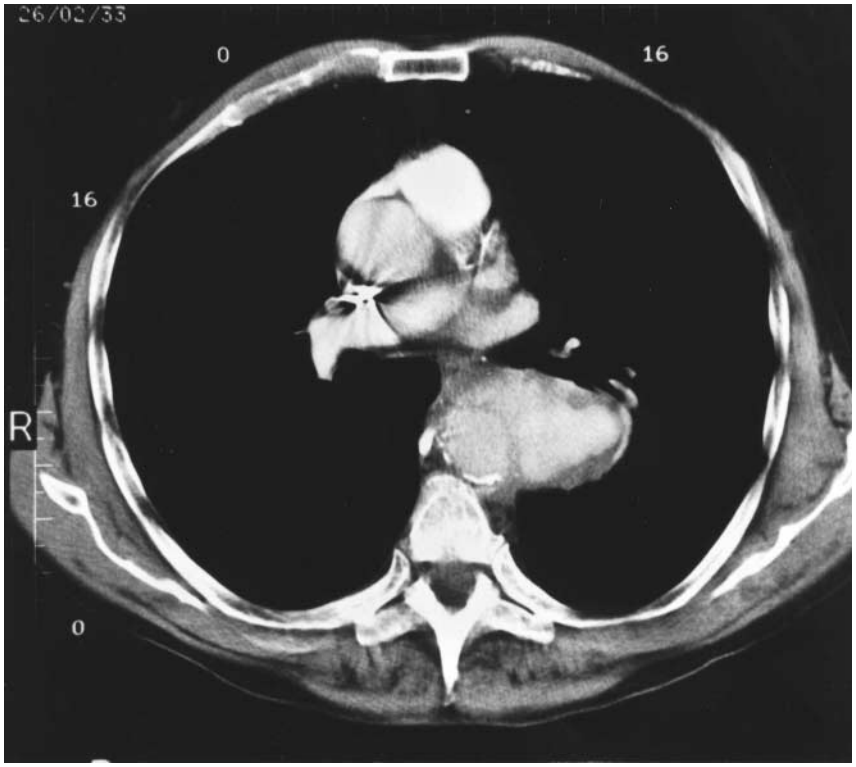


Fig. 1. Computerized axial tomography at the level of the pulmonary artery bifurcation after intravenous injection of contrast media: partially thrombosed aneurysm of the descending thoracic aorta invading the left lung of a 45-year-old patient with hemoptisis who had undergone surgical correction of a coarctation more than 28 years ago.

rysms with such complications as compared to repair in a larger series without. In addition one may assume, that the cases with successful repair reported in the literature do not represent the true proportion of positive results and that a significant number of unreported failures remains hidden.

The present study was designed in order to provide some answers to the issues raised by analyzing a consecutive series of patients undergoing repair of the descending thoracic or thoracoabdominal aorta with or without fistulae.

2. Patients and methods

In a consecutive series of 145 patients (age 60 ± 12 years) undergoing surgical repair of descending thoracic and thoracoabdominal aortic aneurysms, 11/145 patients (8%: age 63 ± 9; NS) presented for hematemesis and/or hemoptysis. In 8/11 patients (72%) an aorto-bronchial fistula was identified, and 3/11 patients (28%) suffered from an aorto-esophageal fistula. Five of 11 patients (45%) had undergone previous aortic surgery in the same or an adjacent region of the descending thoracic aorta.

2.1. Diagnostic work-up

Echocardiography was the standard diagnostic tool for screening patients with descending thoracic and thoracoabdominal aortic aneurysms in the emergency setting. In hemodynamically stable patients, proximal and distal extension of the aortic disease was established by computerized axial tomography. In contrast to magnetic resonance imaging, computerized axial tomography allows also for identification of thrombosed aortic areas, and, for ruptured aneurysms, evaluation of the parenchymatous penetration as demonstrated in Fig. 1 for a patient with aorto-bronchial fistula. Magnetic resonance imaging and classic angiography were used to assess the origin and state of perfusion in peripheral and visceral arteries. However, patients with unstable hemodynamics due to hemoptysis and hematemesis or mediastinal hemorrhage were operated with minimal diagnostic work-up, i.e. echocardiography only.

2.2. Surgery

A lateral thoracotomy for descending thoracic aortic aneurysms and a thoraco-phreno-laparotomy for thoraco-abdominal aortic aneurysms were standard. In

hemodynamically stable patients these incisions were made prior to cannulation for partial cardiopulmonary bypass and double lumen intubation for single lung ventilation was used. In hemodynamically unstable patients, the common femoral or the external iliac arteries were cannulated first and partial cardio-pulmonary bypass was initiated before the chest was opened. This approach allowed for use of cardiotomy suction and retransfusion of large blood volumes as soon as significant bleeding occurred. Aortic control was first achieved distally to the aneurysmal lesion and only thereafter its proximal neck was addressed (often aortic arch between left carotid and subclavian artery). In patients with critical hemodynamics or otherwise difficult technical situations, occlusive balloons were used for endovascular control. An open technique was used occasionally to establish the distal anastomosis. Hypothermic circulatory arrest was not used.

Staged aortic cross-clamping, orthotopic aortic repair with sealed grafts from proximal to distal and graft inclusion were routine [15–17]. Extent of aortic repair was expressed as number of aortic segments from the aortic arch to its bifurcation (one segment proximal to the subclavian artery, three thoracic segments, three abdominal segments, and the aortic bifurcation equals eight segments all together) as previously reported [17]. In cases with inadequate autologous tissue for graft inclusion, a glutaraldehyde preserved pericardial xenograft (Xenomedica, Division of Baxter-Edwards, Horw, Switzerland) was used [18].

Homografts were used for aortic repair in the presence of fistulas whenever available and suitable [4,12,13]. Fig. 2 shows the peroperative view of an aorta which had been repaired more than 28 years earlier for coarctation by the means of a Dacron patch (forceps). During the procedure, the clot that can be seen at the proximal end of the patch was extracted and is shown in Fig. 3. It is easy to recognize the cast of the aorto-bronchial fistula and to understand why this patient was suffering from hemoptysis. A homograft (see Fig. 2) was used under these circumstances for repair of the descending thoracic aorta. This and the other aorto-bronchial fistulae were closed with bioabsorbable monofilamentous sutures and sealed with fibrin glue mixed with antibiotics [19]. Broad spectrum antibiotic treatment followed. The same technique was used for repair of aorto-esophageal fistulae. In the latter cases, the graft was again separated from the fistulae by autologous aortic tissue or a pericardial xenograft (transfer of omentum was not used) and a drainage gastrotomy was placed initially and later converted for feeding.

2.3. Perfusion

Prior to cannulation of the common femoral or external iliac vessels, low dose systemic heparinization was initiated using heparin 100 IU kg^{-1} bodyweight (Liquemin: Roche, Basel, Switzerland). For the venous cannulation, guidewire supported cannulas were frequently necessary to bring the orifices into the inferior vena cava in order to achieve adequate drainage. During partial perfusion (initially 50% of cardiac output determined by thermodilution or estimate in emergencies) with tip-to-tip heparin coated perfusion equipment (Duraflo II, Baxter, Irvine, CA, USA) including a flexible venous reservoir and a low prime oxygenator (Spiral Gold, Baxter: clear priming including 1000 IU of heparin per liter of priming volume), the activated coagulation time (ACT) was kept above 180 s [16] (ACT $>$ 300 s if significant volume had to be stocked in the cardiotomy reservoir). To reduce metabolic demand, the blood temperature was set at 30°C. Deep hypothermia and circulatory arrest were not used. After aortic repair, rewarming, and weaning from cardiopulmonary bypass, circulating heparin was neutralized with protamine equivalent to the heparin loading dose and additional protamine was titrated according to the ACT.

A red cell spinning device (Autotrans, Dideco, Mirandola, Italy) was used before and after systemic heparinization as well as for concentration of the oxygenator sump blood at the end of perfusion.

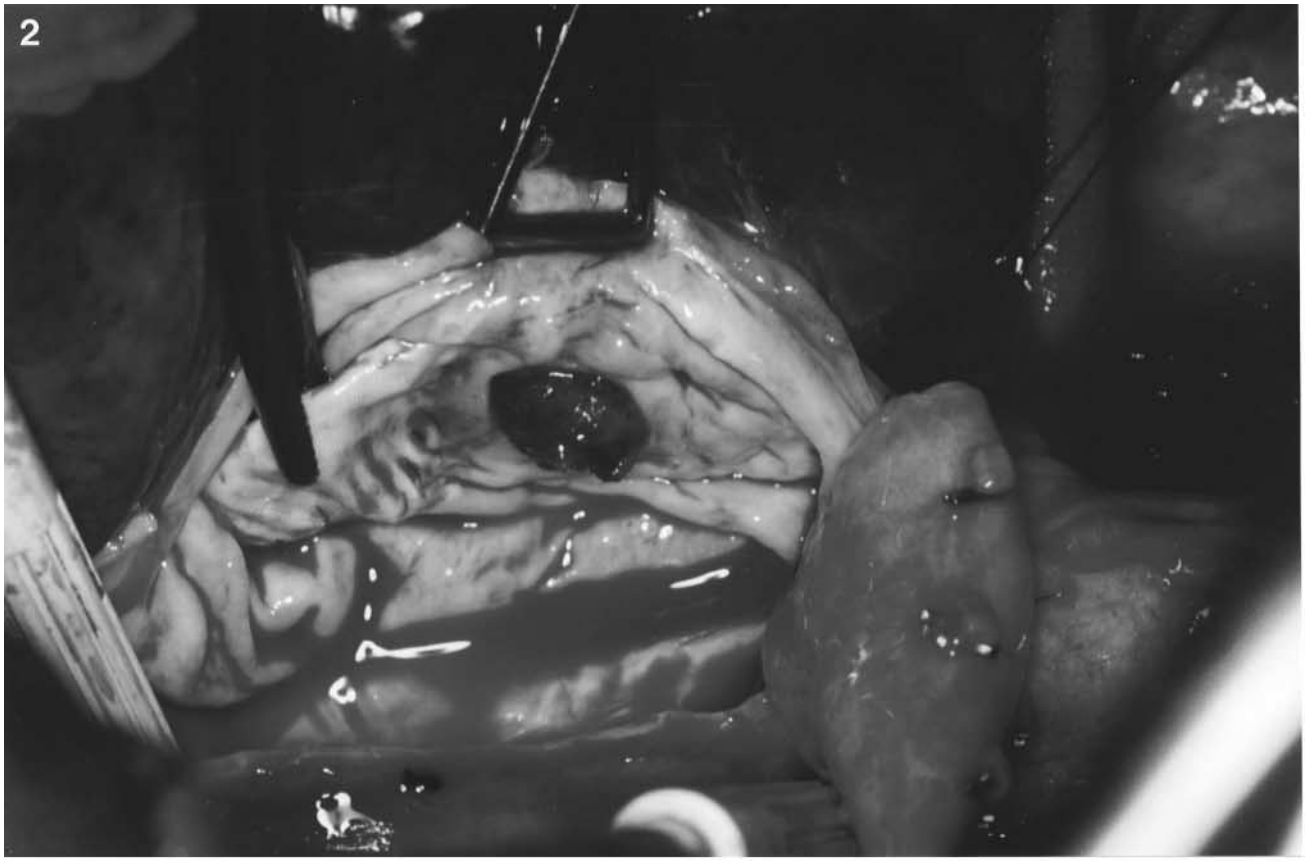
2.4. Data analyses

Continuous variables are presented as the mean $\pm$ standard deviation. Comparison of continuous variables was made using Student's *t*-test for paired or unpaired variables where appropriate. Univariate analysis of descriptive data was performed using Fisher's exact test. Statistical significance was confirmed by a probability value less than 0.05.

3. Results

Mean number of aortic segments (1–8: one proximal to subclavian artery, three thoracic, three abdominal, and aortic bifurcation) repaired during the surgical procedures was 3.1 ± 1.4 for the patients of the entire series versus 2.6 ± 0.9 for cases with fistulae (NS). Mean aortic cross clamp time was 38 ± 22 min for the patients of the entire series versus 45 ± 15 min for cases with fistulae (NS). Mean perfusion time was 60 ± 31 min for the patients of the entire series versus 99 ± 29 min for cases with fistulae ($P < 0.005$).

The mortality and the main morbidity of the procedures performed are shown in Fig. 4: mortality at 30 days was 18/145 patients (12%) for the patients of the entire series versus 2/11 patients (18%) for cases with fistulae. Paraparesis and/or paraplegia was observed in 11/145 (8%) for the entire series as compared to 1/11



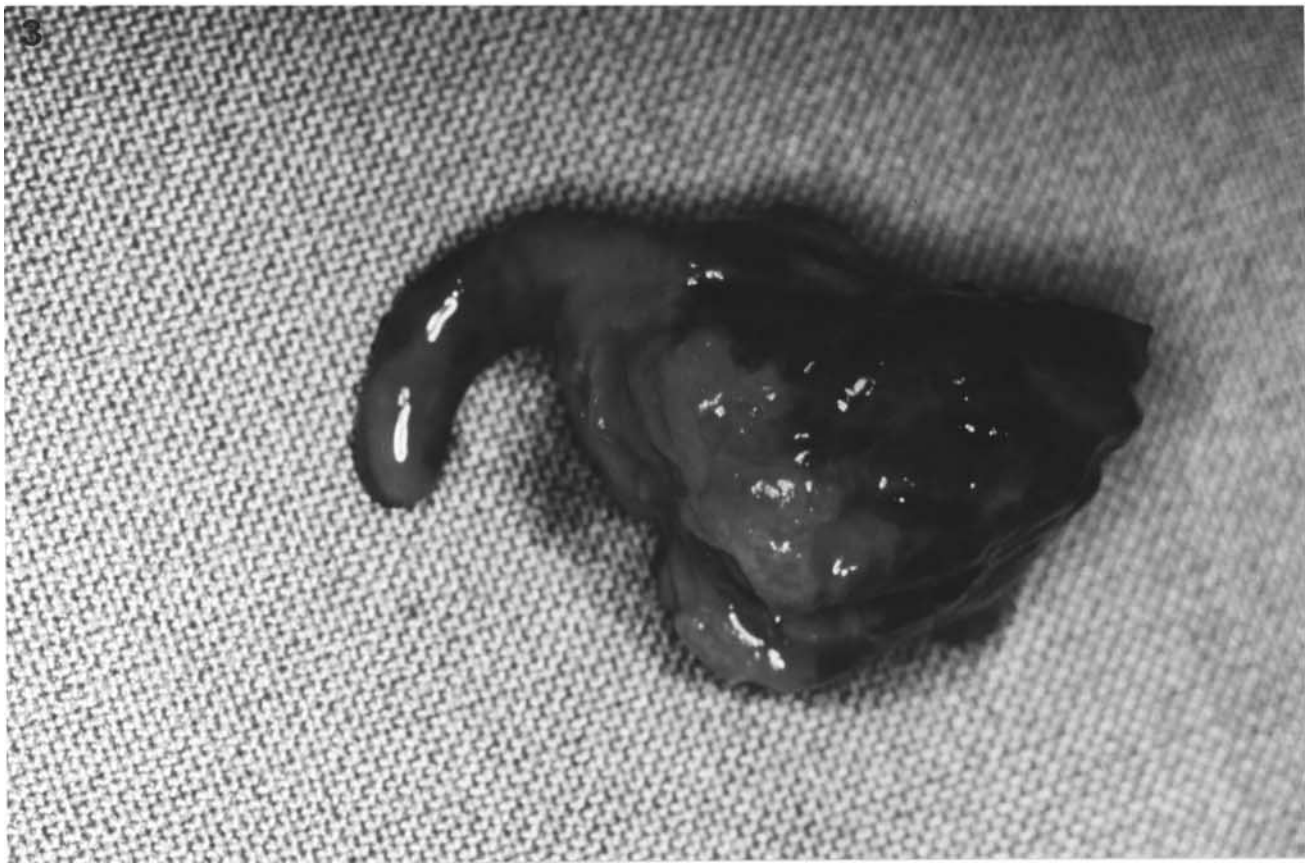


Fig. 2. Opened descending thoracic aortic aneurysm of the patient studied in Fig. 1 exposing a prosthetic patch used for repair of a coarctation (left: forceps), a thrombus temporarily occluding the aorto-bronchial fistula (center), and the homograft prepared for orthotopic repair (right). Fig. 3. Thrombus extracted from the aortobronchial fistula of the patient described in Figs. 1 and 2 casting the aortobronchial communication.

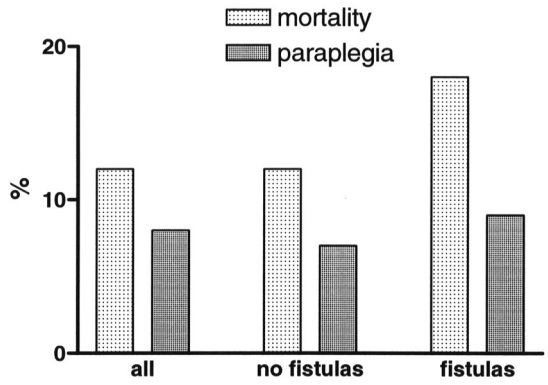


Fig. 4. Morbidity (parapareses and paraplegias) and mortality (at 30 days) of all patients who underwent repair of the descending thoracic or thoracoabdominal aorta versus patients without fistulas versus patients with fistulas. Although the patients with fistulas have a higher mortality, and, to a lesser extent a higher rate of parapareses or paraplegias, the differences observed do not reach statistical significance.

(9%) for cases with fistulae. Nine additional patients died after hospital discharge, seven without fistulae and two with fistulae bringing the one year mortality up to 27/145 patients (18%). Mortality at 1 year was 23/134 patients without fistula (17%) as compared to 4/11 patients (36%) with fistulae. The mortality after hospital discharge in patients with fistulae occurred at days 80 (hematemesis) and 120 (pneumonia), respectively. Further analysis (see also Fig. 5) shows that the 1-year mortality accounts for 1/8 patients (13%) with aortobronchial fistulae as compared to 3/3 patients (100%) with aortoesophageal fistulae ($P = 0.02$). The difference in mortality of patients suffering from aortoesophageal fistula versus patients suffering from aortobronchial fistulae was significant ($P = 0.018$). Comparison of death rate in patients with aortoesophageal fistulae versus no fistulae was even more significant ($P = 0.006$).

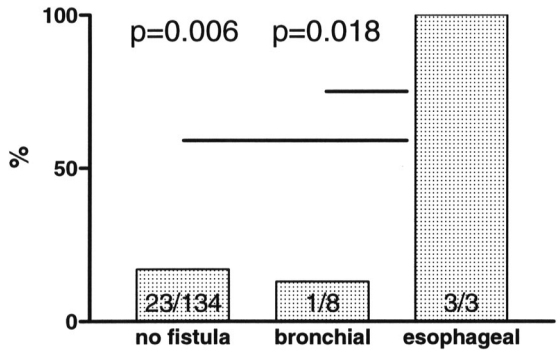


Fig. 5. Comparison of the 1-year mortality for patients without fistulas (17%) versus patients with bronchial fistulas (13%) versus patients with esophageal fistulas (100%) suggests despite the small numbers analyzed that the presence of an aortoesophageal fistula remains a highly lethal condition. In contrast the presence of aortobronchial fistulas does not severely compromise the outcome after surgical repair.

4. Comments

Repair of descending thoracic aortic aneurysms complicated by aortobronchial fistulae appears to have a reasonably good outcome, whereas for cases complicated by aorto-esophageal fistulae the prognosis seems to remain poor even after successful hospital discharge. For the series presented here, the 30 day mortality was in fact very similar for patients without and with fistulae. In contrast, the one year mortality for patients with fistulae was about the double of that in patients without fistulae. The most interesting finding is however the fact, that the main mortality is concentrated in the patients with aortoesophageal fistulae and that half of the patients who died late had already left the hospital in good general condition.

As mentioned previously, there are not many larger series available in the literature for comparison. Still, there are some reports providing further evidence for our findings. Successful repair of aortobronchial fistulae is documented since several decades [10]. Pippert et al. [8] reported on three cases with aortobronchial fistulae late after surgery for coarctation and stated, that a survival rate $> 80\%$ can be expected if the diagnosis is made early. The patient shown in Figs. 1–3 of this report is a typical example for this type of complication. There are also reports describing the occurrence of aortobronchial fistulae after previous aortic surgery for aneurysms [7]. One may speculate, that after previous surgery, the periaortic adhesions prevent the rupture of an aortic aneurysm into the pleural space and that the blood therefore invades the pulmonary parenchyma and finally reaches the bronchial tree. Under such circumstances, it can be necessary to intubate one bronchial mainstem for isolated ventilation of one lung in order to reach the operating theater for repair of the aneurysm. Recommendations for the surgical strategy with regard to potential contamination of the surgical field include use of homografts which are known for their improved resistance to infection [12,13], use of fibrin glue mixed with antibiotics [19], omentopexy [7], resection en bloc of the aortobronchial fistula with the lower pulmonary lobe [11], and others.

Although an aortoesophageal fistula was already described in 1818, the first survival after surgical repair was reported not earlier than in 1983 and still very few survivors (about five) were documented by 1992 [2]. This despite the fact, that recommendations for the presurgical management of aortoesophageal fistulae were given in 1985 by McFaddin who used the Sengstaken Blackmore tube under these circumstances [5], technique which also proved to be useful in our institution. Obviously the risk of contamination of the surgical field is higher in the presence of an esophageal leak as compared to a bronchial leak. As a result some of the surgical strategies proposed are more or less inva-

sive and include total resection of the esophagus with interposition of a gastric tube [14], local drainage of the esophageal leak with a T-tube, local repair of the esophagus and transfer of omentum, sealing using fibrin glue with antibiotics, proximal and distal drainage of the esophagus, and others. Likewise the proposals for repair of aortic aneurysms in the presence of an esophageal fistula have a broad spectrum and include extraanatomic solutions carrying the risk of aortic stump blow out as well as orthotopic repairs using homografts which are known for late degeneration. Poor late outcome despite initial success brings up the question if aortoesophageal fistulae occur mainly in patients with reduced general condition as it is known for some groups of patients with esophageal cancer. One may speculate, that compression of the esophagus by the aortic aneurysm is chronic and may in some of these patients result in a reduced nutritional status prior to the occurrence of the aortoesophageal fistula, which in turn would explain the poor late outcome observed despite favorable initial recovery.

There can be no doubt about the fact that the surgical strategy for handling of such rare complications of descending thoracic and thoracoabdominal aortic aneurysms has to be adapted to each individual case and its specific pathology.

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Appendix A. Conference discussion

Mr Westaby (*Oxford, England*): Why don't we start by just asking you, if a patient comes along with an aneurysm and coughing up copious amounts of blood, what sort of precautions do you take on the way to the operating room?

Dr von Segesser: Well, in the patients with aorto-esophageal fistulas, there is one who had been successfully brought to the operating theater with a Sengstaken-Blakemore probe, and in the patients with bronchial fistulas, double-lumen intubation would be the treatment of choice to have at least one lung that can be ventilated.

Dr Westaby: Do you see any reason at all to do either a bronchoscopy or an esophagoscopy in these patients, or do you just get straight on rapidly with the thoracotomy?

Dr von Segesser (*Zurich, Switzerland*): Once that an aneurysm is documented and we know that the blood is coming not from the stomach or from another place, I don't think we need anything else to go for surgery.

Dr Okita (*Osaka, Japan*): We had five patients with aorto-esophageal fistula and all patients had extra-anatomical bypass and they all have died from mediastinitis. So I would ask you how many homografts did you use for the three patients?

Dr von Segesser: In the three patients, two had homografts.

Dr Okita: But the two have died, right?

Dr von Segesser: All have died, but two were discharged from the hospital, yes.

Dr Okita: So do you think the homograft can relieve the infection, for example, of mediastinitis after direct repair?

Dr von Segesser: There have been numerous procedures suggested to handle esophageal fistulas, not always with regard to the aorta, and there are not many reports about successful management of aorto-esophageal fistulas, but I think the two patients who left the hospital and died late could have made the object of a report on successful treatment.

Dr Okita: Did you put an omental flap over that?

Dr von Segesser: No.

Mr Westaby: You mentioned that you can't get large enough homografts, but if you have a homograft department, it is easy to sew two homografts together and make a big one. I think that is preferable to using Dacron.

Dr von Segesser: Yes.

Dr Rizzoli (*Padua, Italy*): Have you ever tried to use, as we have done in one case that we recently published, glutaraldehyde-fixed pericardium? Glutaraldehyde is used as a sterilizing medium in many fields in medicine and so maybe it could be an option in these infected cases.

Dr von Segesser: Glutaraldehyde-fixed pericardium was used routinely for graft inclusion but not for primary graft repair; in addition only.

Dr von Der Emde (*Erlangen, Germany*): What was the cause of death after the closure of the fistula?

15 years ago a 10-year old boy was admitted in cardiogenic shock with an aortic oesophagus fistula in the presence of an aneurysm. The opening in the oesophagus was closed, the aorta repaired with a dacron tube graft.

Then 2 years later the patient came back again in cardiogenic shock with haematemesis. Aortic oesophagus fistula again was suspected, the patient was taken in the OR immediately, the aorta was exposed through a medium sternotomy, a 20 mm dacron graft was connected to the ascending aorta and was taken through the diaphragm and anastomosed to the right of the abdominal aorta just above the renal artery.

Then the patient was turned to the right and a posterolateral thoracotomy was performed. Proximal to the aneurysm the aorta was crossclamped just below the left subclavian artery. The graft was excised and the proximal and distal aortic stump oversewn, antibiotics locally applied and the chest closed.

Now the patient is weighing about 100 kg, he had a normal postoperative cause and living a normal life with normal blood pressure at all extremities.

Dr von Segesser: I would like to congratulate you for your success, however, we know that for patients with infected abdominal aortic aneurysms, that stump blowout after ligation of this aorta is one of the problems that you can have. So it is a solution but maybe not 100% successful in any patient.

Dr Haverich (*Hannover, Germany*): First, congratulations. I think this is a small but very important series of observations. The most cumbersome of course is the fact that all three patients with esophageal fistual died, and this is the reason for two questions. Number one, did you take intraoperative swabs for bacterial growth and was there a difference between those who had bronchial fistula as opposed to those who had esophageal fistual?

And the other question, did you refuse any patient from operation, patient coming in the emergency room in such a bad situation with this type of fistula that you did not operate on?

Dr von Segesser: Question two first. We did not refuse patients. If a patient could be brought to the operating room, he was operated on. With regard to the swabs, the swabs were taken but I cannot recall the data.

Dr Kamar (*Cairo, Egypt*): How many patients died before reaching the theater? It is an emergency operation.

Dr von Segesser: I can recall one or two patients that died before, but all patients that do not go beyond a CT or something like that, I would not even be aware of, so I cannot give reliable figures for your question. But the patients which were presented to us with this diagnosis, they were operated on.