Institutional report - Vascular thoracic

Intraoperative iatrogenic type A aortic dissection and perioperative outcome

Tatiana Fleck*, Marek Ehrlich, Martin Czerny, Ernst Wolner, Martin Grabenwoger, Michael Grimm

*Department of Cardiothoracic Surgery, Medical University of Vienna, Leitstelle 20A, Währinger Gürtel 18-20, 1090 Vienna, Austria

Department of Cardiothoracic and Vascular Surgery, Lainz Hospital, 1220 Vienna, Austria

Received 12 June 2005; received in revised form 30 September 2005; accepted 10 October 2005

Abstract

We assessed the risks and causative mechanisms of intraoperative iatrogenic aortic dissection type A. During a 3-year period (2002–2004) with 3000 open heart cases, 7 patients sustained an intraoperative aortic dissection type A, resulting in an incidence of 0.23%. The original procedures were mitral valve replacement in 3 patients, aorto coronary bypass surgery in 2 patients, ascending aortic replacement with aortic valve replacement and single lung transplantation with ECMO support in 1 patient each. Dissection occurred during aortic cannulation or decannulation in 3 patients, during insertion of the antegrade cardioplegia line in 1 patient, during manipulation of the aortic cannula in 1 patient and through direct cannulation of the axillary artery in 1 patient, and during femoral artery cannulation in 1 patient. Replacement of the ascending aorta with resection of the entry side was successfully performed in all 7 patients (median OT time 387 min, ECC 192 min, ACC 101 min, CA 25 min). Patients with iatrogenic aortic dissection have an increased mortality rate and risk factors for bad outcome are as follows: a mean aortic pressure of less than 50 mmHg during the change of arterial cannulation site, advanced age and the time of diagnosis of the dissection.

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Keywords: Aortic dissection; Outcomes; Surgery complications; Aortic surgery

1. Introduction

Intraoperative iatrogenic ascending aortic dissection is a feared and potential lethal complication of open heart surgery. Cannulating the ascending aorta for cardiopulmonary bypass and for the delivery of antegrade cardioplegia often disrupts the three layered aorta through manipulation and flow.

Since the first reports in 1976 and 1983 the incidence has not changed [2,3]. The International registry of aortic dissection (IRAD) provided us with recent data about the incidence of iatrogenic aortic dissection [1]. From 723 patients in the IRAD database, 5% (n = 34) had iatrogenic aortic dissection, 69% of the ascending aortic dissections were caused by cardiac surgical procedures [1]. The aim of this retrospective study was to review our experience with this complication and to analyse the early outcome of those patients.

2. Methods

2.1. Study population

Retrospective review of patient records revealed 7 intraoperative iatrogenic aortic type A dissections during 2002–2004. As 3000 cardiac surgery procedures were done during that time period at our institution, the incidence of intraoperative iatrogenic aortic type A dissection can be estimated with 0.23%.

There were 4 female and 3 male patients with a mean age of 69.2 ± 7.6 years.

Causes for dissection were variable and as follows:

- In 3 patients dissection was caused by cannulation or decannulation of the aorta,
- In 1 patient during manipulation of the arterial cannula,
- In 1 patient during forceful direct cannulation of a small axillary artery,
- In 1 patient during insertion of the antegrade cardioplegia cannula, and
- In 1 patient retrograde during cannulation of the femoral artery.

Primary operations were aorto coronary bypass surgery (ACBG) in 2 patients, single lung transplantation with extra corporal membrane oxygenation (ECMO) in 1 patient, mitral valve replacement in 3 patients, and ascending aortic replacement and aortic valve replacement in the remainder.

Redo surgery was performed in 1 patient. Severe atherosclerosis was known in 2 patients.
2.2. Surgical technique

2.2.1. Aortic cannulation
Our standard cannulation technique used in nearly all open heart procedures consists of the following: after digital palpation of the ascending aorta to reveal any atherosclerotic plaques, two 4-0 purse-string sutures were placed in a diamond shape. Thereafter the visceral pericardium was freed of any fatty tissue and an incision was made with a no. 11 blade. Then a 22 or 24 French aortic cannula (Medtronic DLP, Minneapolis 55432, USA) was gently inserted. Attention was paid that the mean aortic pressure did not exceed 70 mmHg at the time of cannulation.

2.2.2. Insertion of antegrade cardioplegia line
Cannulation for antegrade cardioplegia was done after freeing the visceral pericardium at the chosen cannulation site from fatty tissue. Thereafter a single 4-0 purse-string suture was placed in a circular shape and a cardioplegia needle (Calmed 9 French, Cosra Mesa 92626 California, USA) was inserted.

2.2.3. Direct subclavian artery cannulation
In one patient with a small and elastic subclavian artery, direct cannulation with a 22 French Medtronic cannula was performed. After this a 5-0 prolene purse-string suture was placed at the subclavian artery and a guidewire inserted. Thereafter subsequent dilatation with an 18 and 20 French sheath is done and the artery incised at the bottom of the circular suture. Then a 20 or 22 French cannula (Medtronic DLP) is inserted over the guidewire and the tourniquet tightened.

2.2.4. Femoral artery cannulation
In the patient with retrograde dissection the right femoral artery was cannulated directly with a 20 or 22 French cannula (Medtronic DLP femoral) after oblique transsection and occlusion with femoral clamps. The cannula was fixated with a ligature.

2.2.5. Statistical methods
Statistical procedures were done by using SPSS 10.0 (SPSS Inc, Chicago, Illinois, USA). Data are expressed as means ± S.D.

3. Results

3.1. Intraoperative results
In four patients dissection happened at the beginning of cardiopulmonary bypass (57%), whereas in the remainder the dissection was diagnosed at the end of operation by routine transoesophageal echocardiography evaluation (43%). In the 4 patients with dissection onset at the beginning of CPB, a bluish discoloration of the ascending aorta was seen, as well as the reported high impedance of the arterial flow which was noted by the perfusionist. TEE confirmed the diagnosis and revealed an intima tear in the ascending aorta in all patients.

From the 4 patients where dissection was diagnosed at the beginning of CPB, 2 needed cardiopulmonary resuscitation during change of cannulation site and in 2 patients the MAP was below 50 mmHg during cannulation site change.

Time relapse from the onset of dissection until reestablishment of normal circulation lasted from 15 to 30 min, depending on the depth of the femoral vessels, which were used as an alternative cannulation site in all 7 patients. During re-cannulation pharmacologic support by the anesthesiologists as well as mechanical CPR in 2 patients was needed to maintain an adequate circulation.

Treatment of iatrogenic aortic dissection type A consisted of the original procedure, additionally, replacement of the ascending aorta with resection of the entry side was successfully performed in all 7 patients. The median operating times were 387 min, Extra corporal circulation time (ECC) 192 min, Aortic cross clamp time (ACC) 101 min. Deep hypothermic circulatory arrest without cerebral perfusion was used in 3 patients and moderate hypothermic circulatory arrest with antegrade cerebral perfusion in the remaining 4 patients (median duration 25 min).

Myocardial protection was achieved by antegrade as well as retrograde cold blood cardioplegia every 10 to 20 min. Interestingly, the aortic diameter was not described as dilated in the operating records of all 7 patients. However, in 2 patients atherosclerosis and calcification of the ascending aorta was noted. The intima tear was localized at the cannulation site in all 7 patients.

The following emerged as risk factors for bad outcome:
- Change of cannulation site during CPR \( n=2 \) (28%).
- MAP < 50 mmHg during change of cannulation site \( n=3 \) (43%).
- Time of diagnosis of dissection at the end of operation \( n=3 \) (43%).

3.2. Early outcome
Postoperative mortality was 43% \( (n=3/7) \) for the patients with iatrogenic dissection. Causes of death were decompensated heart failure in 2 patients. Both patients underwent a re-operation when dissection occurred. One patient succumbed to multi-organ failure on postoperative day 21 and the patient who underwent lung transplantation could not be weaned from the respirator and died on postoperative day 78 due to respiratory insufficiency. The remaining patients are well during a median follow up of 20 months.

Median intensive care unit (ICU) stay in the iatrogenic dissection group was 9.2 days and hospital stay for the 3 survivors was on average 58.2 days.

4. Discussion
In the contemporary literature, the incidence of iatrogenic aortic dissection type A is described to be between 0.12 and 0.16% \( [3,5–7] \). Unfortunately these numbers take into account not only intraoperative aortic dissections, but also dissections which occur hours and days after cardiac surgery.

The following factors seem to be associated with iatrogenic aortic dissection, namely dilated ascending aorta, known atherosclerosis, previous CABG surgery, older age and blood pressure at the time of dissection \( [8] \).
In our series, we focused only on dissections which occurred during cardiac surgery procedures. The diagnosis of aortic dissection was made on appearance of a bluish discoloration of the aorta, in conjunction with high impedance at the beginning of cardiopulmonary bypass or cannulation.

A factor, not mentioned previously but we assume to be important, is a high impedance at the beginning of cardiopulmonary bypass, which should always raise the suspicion of aortic dissection and requires immediate evaluation of the position of the aortic cannula.

Trans-oesophageal echocardiography (TEE), which is routinely performed in every patient at our department was used for confirmation of aortic dissection. Emphasis was placed to identify the dissection and to ensure perfusion to and of the supra aortic branches as this defines the outcome [5]. To enable perfusion as soon as possible a standard protocol still has to be determined. In our series, we usually established perfusion through the femoral artery, as it is easy and fast to expose with enough work space. Another advantage over the subclavian artery in this emergency situation is the fact that (at least in our department) the subclavian artery is not routinely draped and is always hidden by the sternal retractor. Furthermore, there is not enough space for the surgeons to expose the subclavian artery during ongoing surgery. In the case of the femoral artery, a second surgeon can easily prepare the femoral vessels whereas the other team members can work on the open chest.

The rationale to replace the ascending aorta was based on the fact that the dissection was not localized to a small part of the aorta (verified by TEE), so that we felt more safe, to replace the ascending aorta, as it is done in every acute aortic dissection type A in order to avoid any extension of the dissection when reapproximating the injured intima by direct repair. This is supported by the majority of papers published on this topic [5,9–11]. Furthermore, as the time to perform a replacement is not significantly longer as a local repair [10].

In a recent report of the IRAD registry, they reported an increased risk of cardiac complications in patients with spontaneous aortic dissection when compared against patients with iatrogenic aortic dissection. This is in accordance with our results and might be based on the fact that patients with spontaneous aortic dissection usually are not evaluated in respect to cardiac function, and especially coronary status through the urgency of their disease. In contrast, the patients with iatrogenic aortic dissection are operated for another reason and therefore are fully evaluated regarding ventricular function and coronary status.

In our series, the mortality of iatrogenic aortic dissection type A is high, and exceeded the mortality of spontaneous dissection twice.

Whereas the patients with iatrogenic aortic dissection had a 43% mortality rate, this was less frequent in spontaneous dissections during the same time period with 19.2%. This might be due to the fact that patients with iatrogenic aortic dissection tended to be older (on average 10 years) than those with spontaneous aortic dissection.

As advanced age is a well-known risk factor, this might be responsible for the increased mortality in the IAD group [12,13]. Another reason might be that the surgical team is not prepared for such an accident which needs improvising and that the perfusion circuit is inadequate, the cannulation often switched in high emergency and sometimes in an inappropriate site, resulting in malperfusion. This is supported by our results where, a mean MAP of less than 50 mmHg during cannulation site change emerged as a risk factor for bad outcome.

As in the majority of cases, aortic dissection occurred at the beginning of the procedure, extra corporal circulation times, as well as cross clamping times and circulatory arrest times were not prolonged compared to spontaneous dissections.

ICU and hospital stay were markedly prolonged in the surviving patients compared to patients with spontaneous aortic dissection, which can be assumed to be a result of the complexity of the procedure and not of the dissection itself.

We are aware of the following limitations of our study: Data were collected retrospectively and therefore are subject to incomplete or missing data.

Long-term outcome and follow-up was not addressed in this study, which might have an impact on the mortality rates.

5. Conclusion

The mortality rate of iatrogenic aortic dissections is increased.

As crucial for the outcome emerged an adequate perfusion pressure during the change of cannulation site and the diagnosis of dissection at the beginning of cardiopulmonary bypass.

References


Appendix A. ICVTS on-line discussion

Author: Mehmet Ates (Siyami Ersek Thoracic and Cardiovascular Surgery Center, Istanbul, Turkey)

eComment: We encountered type A dissection during the decannulation period. We noticed excessive bleeding around the aortic cannula side and then suddenly the ascending aorta tore in two patients. The radial artery pressure went down. We tried to control bleeding with the finger. While preparing the femoral artery for cannulation, we put the aortic cannula into the right atrium to maintain proper arterial perfusion as a time gaining procedure. After cannulation of the femoral artery, we removed the aortic cannula from the atrial appendage and inserted a two stage venous cannula instead. CPB restarted and the patient cooled to 18 °C. TEE revealed that the dissection and rupture was limited to the ascending aorta. The aorta was repaired successfully with grafts in both cases. As in our cases, we were successful by cannulating the right atrium with the arterial cannula as a time saving procedure while the femoral artery was preparing.

In conclusion, potential hazards can be minimized during cannulation of the aorta by these simple measures:

- Careful evaluation of the preoperative chest film for ascending aorta calcification;
- Gentle palpation of the aorta prior to cannulation;
- The avoidance of repeated exclusion clamping;
- The use of atraumatic clamps;
- Visualization of the lumen prior to insertion of the cannula;
- Direct cannulation without excision clamping in instances of advanced atherosclerosis;
- The use of an alternate peripheral route.