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Case Report

Off-pump total thoracoabdominal aortic aneurysm repair: a case report

Chao Ma[1,2,4*], Huan Luo[3*], Feng Li[5], Carsten Tschöpe[2,4], Xian'en Fa[1], Bing Liu[1]

[1]Department of Cardiovascular Surgery, The Second Affiliated Hospital of Zhengzhou University, Zhengzhou, People's Republic of China; Departments of [2]Cardiology, [3]Ophthalmology, Campus Virchow, Charité-Universitätsmedizin Berlin, Germany; [4]German Centre for Cardiovascular Research (DZHK), Partner Site Berlin, Berlin, Germany; [5]Department of Thoracic Surgery, Campus Mitte, Charité-Universitätsmedizin Berlin, Germany. [*]Equal contributors.

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Abstract: A high level of difficulty is associated with the surgical procedure of total thoracoabdominal aortic aneurysm repair (tTAAAR), widespread clinical use has not been attained due to high demands of the procedure on the skill level of vascular surgeons, high incidence of complications and high mortality rates are often encountered in tTAAAR with deep hypothermic circulatory arrest (DHCA). In October 2014, a case of off-pump tTAAAR combined with left renal artery stent placement was performed at the Second Affiliated Hospital of Zhengzhou University, with short operative time, rapid postoperative recovery, no postoperative complications, 36 months follow-up of patients alive.

Keywords: Thoracoabdominal aortic aneurysms, total thoracoabdominal aortic aneurysm repair, off-pump, normothermia

Introduction

Thoracoabdominal aortic aneurysms (TAAA), especially Crawford type II aneurysms, often affect blood supply to organs such as the spinal cord, kidneys, and intestines. Surgical treatment usually involves long operative time and requires massive intraoperative transfusion, and aortic reconstruction and restoration of blood supply to the internal organs must be completed in the shortest time possible. Therefore, a high level of difficulty is associated with the surgical procedure. Since the first use of total thoracoabdominal aortic aneurysm repair (tTAAAR) in the treatment of Crawford type II TAAAs, widespread clinical use has not been attained due to high demands of the procedure on the skill level of vascular surgeons. Also, high incidence of complications and high mortality rates are often encountered in tTAAAR with deep hypothermic circulatory arrest (DHCA). Given the issues above, Prof. Lizhong Sun and his research team attempted an off-pump tTAAAR procedure and achieved breakthrough results. The excellent clinical efficacy attained by the procedure has been recognized by both domestic and foreign researchers [1]. In October 2014, a case of off-pump tTAAAR combined with left renal artery stent placement was performed at the Second Affiliated Hospital of Zhengzhou University, and details have been presented in the following sections.

Case presentation

A 49-year-old male (body weight: 53 kg, height: 167 cm) was admitted to the emergency department with the chief complaint of acute lower back and abdominal pain for seven days accompanied by a disturbance of consciousness for two days. The patient had a history of hyperthermia (1 year), smoking (24 years, 20 cigarettes/day), and drinking (24 years, 50 g/day). After admission, symptomatic treatments including analgesics and antihypertensives were actively administered. A dual-source computed tomography coronary angiography (DSCTA) examination performed on the thoracoabdominal aorta revealed widening and division of the aorta into a true lumen and a false lumen. The

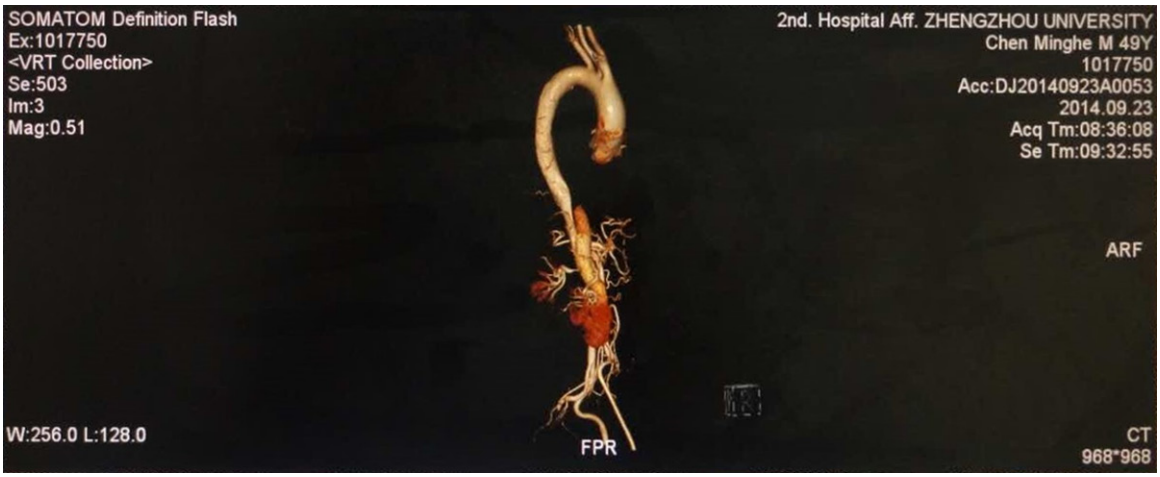

Figure 1. Preoperative 3D CT image of the patient who received tTAAAR. An intimal tear was found at the origin from the abdominal aorta to the right common iliac artery, the right common iliac artery was visibly narrow, and no signals were observed in the right internal iliac artery.

Table 1. Intraoperative clinical data of patient who received tTAAAR

Parameter	Intraoperative data
Duration of descending aorta clamping (min)	15
Duration of spinal cord ischemia (min)	30
Duration of celiac trunk ischemia (min)	45
Duration of left renal artery clamping (min)	60
Operative time (h)	11.8
Intraoperative RBC transfusion (U)	12
Intraoperative plasma transfusion (L)	1.2
Intraoperative platelet transfusion	One therapeutic dose

Table 2. ICU clinical data of patient who received tTAAAR

Parameter	ICU data
Ventilation time (h)	35.5
Anesthesia recovery (h)	14
Gastrointestinal decompression (h)	106.5
Routine RBC transfusion (U)	12
Routine plasma transfusion (L)	2
Cryoprecipitate transfusion (U)	10
ICU stay (h)	132.5

true lumen was narrower than the false lumen, and all artery flows originated from the true lumen. Low-density shadows were observed around the right common iliac artery and descending aorta, and the appearance of an intimal tear was found at the origin from the abdominal aorta to the right common iliac artery. The right common iliac artery was visibly narrow, and no signals were observed in the right internal iliac artery (Refer to **Figure 1**). Color Doppler ultrasound of the kidneys and renal arteries revealed a thickening of the left renal arterial wall at the proximal end, approximately 7 mm from the opening of the renal artery, which resulted in local stenosis, with the diameter of the narrowest segment being approximately 1.9 mm. Laboratory test results were as follows: WBC: 10.09×10^9/L, D-dimer level: 3.7 mg/L, creatinine: 61 μmol/L. Physical examination results were as follows: Cardiopulmonary auscultation: negative, hepatojugular reflux: negative, weak pulse in the right dorsalis pedis artery, blood pressures in the extremities: left upper extremity 187/105 mmHg, right upper extremity 192/108 mmHg, left lower extremity 219/103 mmHg, and right lower extremity 142/94 mmHg. No abnormalities were observed in all other results. Following discussion among all physicians of the division, the diagnosis was confirmed, and a decision to perform TAAAR combined with left renal artery stent placement was made. The surgery was successful, and relevant intraoperative and ICU data are shown in **Tables 1** and **2**. Postoperatively, the patient was administered symptomatic and supportive treatments, which included anti-infectives, anticoagulants, and antihypertensives. The patient

Figure 2. Postoperative 3D CT image of the patient who received tTAAAR. Aortic unobstructed, no abnormalities.

made a satisfactory recovery and regained normal muscle strength in all extremities. No abnormalities were found during the postoperative checkup (Refer to **Figure 2**).

Discussion

At present, open surgery remains the gold standard for the treatment of tTAAAs, especially Crawford type II aneurysms [2, 3]. However, open surgery places higher demands on the skill level of vascular surgeons, surgical procedures are highly complex, and early postoperative mortality rates are generally high. Therefore surgical treatment of Crawford type II TAAAs has always been a considerable challenge for clinicians. Various surgical methods have been attempted by domestic and foreign researchers; however, the clinical efficacy of surgery has remained unsatisfactory. In one study, domestic researchers performed off-pump tTAAAR with shunting at the aortic bifurcation and reported a mortality rate of 7.7% [4]. Other researchers adopted deep hypothermic circulatory arrest (DHCA) with tTAAAR, which resulted in an early postoperative mortality rate of close to 8%, whereas the incidence rate of postoperative complications such as hypoxemia was as high as 25.40% [5]. Kouchoukos et al. [6] also reported a high early postoperative mortality rate of 15.6% when tTAAAR using DHCA was performed for the treatment of Crawford type II TAAAs. Possible reasons for unsatisfactory clinical efficacy are as follows: (1) Prolonged periods of extracorporeal circulation coupled with severe damage to red blood cells may lead to the occurrence of the systemic inflammatory response syndrome [7], (2) Under conditions of deep hypothermia, red blood cell damage, and hypostasis activates the fibrinolytic system, resulting in the release of inflammatory mediators such as interleukins and thromboxane, thus leading to the aggravation of the inflammatory response and coagulopathy, and (3) Intraoperative transfusion of blood products aggravates disorders of the interior milieu and coagulation. To resolve the problems above, Sun et al. [1] attempted an off-pump tTAAAR method, and achieved good clinical efficacy. In a further study by Zhang et al. [8], it was found that the postoperative mortality rate and incidence rate of postoperative complications such as hypoxemia in patients who received off-pump tTAAAR were both significantly lower than that of patients who received tTAAAR with DHCA.

In this case, we performed an off-pump tTAAAR procedure in a patient. After combined anesthesia, the patient was placed in a right lateral position, then routine disinfection and draping were performed. A thoracoabdominal incision was made from the left posterolateral chest to the side of the left rectus abdominis muscle. Entry into the thorax was made at the fifth intercostal space, excision of the costal arch was performed, and the aorta was located via a retroperitoneal approach. Firstly, a trifurcate graft was used to establish a bypass from the descending aorta to the iliac arteries, then end-to-end anastomosis was performed for intercostal artery reconstruction to restore blood supply to the spinal cord; lastly, visceral vessel reconstruction was performed, left renal artery stent placement was made, and the proximal end of the common iliac artery was sealed. Based on experience, we are well aware that revascularization for the restoration of blood supply to vital organs in the shortest time possible remains the most critical step of the procedure; in particular, intercostal artery reconstruction is a vital measure for spinal cord protection. According to the literature [9], at a temperature of 37°C, the safe duration of spinal cord ischemia is 25-50 min. In this case, the duration of spinal cord ischemia was 30 min., which indicates that intercostal artery reconstruction and restoration of blood supply can be completed within the safe duration of spinal cord ischemia. Postoperatively, the patient regained normal muscle strength in all extremities, and daily activities were not significantly affected, which further demonstrate the excellent clinical efficacy achieved with off-pump tTAAAR. During surgery, care should be taken to prevent anastomotic fistula formation, the graft should be placed at an appropriate position to prevent abnormal angulation and subsequent hemodynamic changes, and the duration of interruption of blood supply to vital organs should be shortened as much as possible to minimize the incidence of associated postoperative complications.

Off-pump tTAAAR has certain limitations as well. We believe that the off-pump procedure is not suitable for patients with the following conditions: (1) Excessively large proximal descending aortic aneurysms, which make occlusion infeasible, (2) Distinct distal iliac lesions found via a retroperitoneal approach, such that a bypass from the descending aorta cannot be established, and (3) Concomitant serious valvular heart disease or coronary heart disease.

In conclusion, off-pump tTAAAR is a procedure that is worth learning and popularizing among clinicians. However, as this procedure is complicated, has stringent requirements for surgery time, has certain limitations, and places high demands on vascular surgeons, further research, and investigation by clinicians on surgical methods for patients with Crawford type II TAAAs remain necessary.

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Disclosure of conflict of interest

None.

Address correspondence to: Drs. Xian'en Fa and Bing Liu, Department of Cardiovascular Surgery, The Second Affiliated Hospital of Zhengzhou University, No. 2 Jingba Road, Zhengzhou 450014, People's Republic of China. Tel: 86-371-63935973; E-mail: dr_xianenfa@163.com (XEF); Tel: 86-18703692010; E-mail: 40306177@qq.com (BL)

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