The Role of Extra-Anatomic Bypass in the Surgical Treatment of Acute Abdominal Aortic Occlusion

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Background: Aortic occlusion is a rare catastrophic pathology with high rates of mortality and morbidity. In this study, we aimed to share our experience in the management of aortic occlusion and to assess the outcomes of extra-anatomic bypass procedures. Methods: Eighteen patients who had undergone extra-anatomic bypass interventions in the cardiovascular surgery department of our tertiary care center between July 2009 and May 2013 were retrospectively evaluated. All patients were preoperatively assessed with angiograms (conventional, computed tomography, or magnetic resonance angiography) and Doppler ultrasonography. Operations consisted of bilateral femoral thromboembolectomy, axillo-bifemoral extra-anatomic bypass and femoropopliteal bypass and were performed on an emergency basis. Results: In all patients during early postoperative period successful revascularization outcomes were obtained; however, one of these operated patients died on the 10th postoperative due to multiorgan failure. The patients were followed up for a mean duration of 21.2±9.4 months (range, 6 to 36 months). Amputation was not warranted for any patient during postoperative follow-up. Conclusion: To conclude, acute aortic occlusion is a rare but devastating event and is linked with substantial morbidity and mortality in spite of the recent advances in critical care and vascular surgery. Our results have shown that these hazardous outcomes may be minimized and better rates of graft patency may be achieved with extra-anatomic bypass techniques tailored according to the patient.

Key words: 1. Abdominal aorta 2. Aortic occlusion 3. Vascular surgery 4. Therapeutics 5. Extra-anatomic bypass

INTRODUCTION

Acute aortic occlusion (AAO) is a rare but catastrophic pathology that has high rates of mortality and morbidity. The causes of aortic occlusion include thrombosis and emboli accompanied by atherosclerosis, malperfusion due to acute aortic dissection and embolization of intracardiac tumors [1,2].

Even though indications, techniques and results of various treatment options have been presented and discussed in the recent literature [3,4], there is no consensus on many aspects of AAO. The objective of the present study was to explore the efficacy and mid-term results of extraanatomical bypass procedures used in the treatment of total aortic occlusion.
### METHODS

This retrospective study was carried out using the medical records of eighteen patients with acute abdominal aortic occlusion treated between July 2009 and May 2013. All patients were male with an average age of 71.2 ± 8.82 years (range, 56 to 83 years) and extranatomical bypass procedures were performed. Hypertension (n=9), diabetes mellitus (n=8), chronic obstructive pulmonary disease (n=8), peripheral arterial disease (n=8), congestive heart failure (n=2), cerebrovascular occlusion (n=2), and chronic renal failure (n=2) were systemic diseases detected. Twelve patients had been diagnosed for...
Table 2. Diagnostic and therapeutic methods applied to our patients

| Age (yr) | Sex | Diagnostic methods | Surgical procedures |
|---------|-----|---------------------|---------------------|
| 56      | M   | Doppler USG, CTA    | Axillofemoral bypass with 8 mm PTFE graft |
| 83      | M   | Doppler USG, CT, conventional angiography | Thromboembolectomy; axillofemoral bypass with 8 mm PTFE graft; femoropopliteal bypass |
| 76      | M   | Doppler USG, CTA    | Axillofemoral bypass with 8 mm PTFE graft |
| 65      | M   | Doppler USG, CT, conventional angiography | Axillofemoral bypass with 9 mm PTFE graft |
| 68      | M   | Doppler USG, CTA    | Axillofemoral bypass with 8 mm PTFE graft |
| 77      | M   | Doppler USG, CT, conventional angiography | Axillofemoral bypass with 8 mm PTFE graft |
| 80      | M   | Doppler USG, CT, conventional angiography | Thromboembolectomy; axillofemoral bypass with 8 mm PTFE graft |
| 63      | M   | Doppler USG, CT, conventional angiography | Axillofemoral bypass with 8 mm PTFE graft |
| 73      | M   | Doppler USG, CT, conventional angiography | Thromboembolectomy; axillofemoral bypass with 8 mm PTFE graft; femoropopliteal bypass |
| 58      | M   | Doppler USG, CTA    | Axillofemoral bypass with 8 mm PTFE graft |
| 81      | M   | Doppler USG, CT, conventional angiography | Thromboembolectomy; axillofemoral bypass with 8 mm PTFE graft; femoropopliteal bypass |
| 78      | M   | Doppler USG, CTA    | Axillofemoral bypass with 8 mm PTFE graft |
| 63      | M   | Doppler USG, CT, conventional angiography | Axillofemoral bypass with 8 mm PTFE graft |
| 70      | M   | Doppler USG, CTA    | Thromboembolectomy; axillofemoral bypass with 8 mm PTFE graft |
| 75      | F   | Doppler USG, CT, conventional angiography | Axillofemoral bypass with 9 mm PTFE graft |
| 82      | F   | Doppler USG, CT, conventional angiography | Thromboembolectomy; axillofemoral bypass with 8 mm PTFE graft |
| 62      | M   | Doppler USG, CT, conventional angiography | Axillofemoral bypass with 8 mm PTFE graft |
| 72      | M   | Doppler USG, CT, conventional angiography | Axillofemoral bypass with 8 mm PTFE graft |

M, male; F, female; USG, ultrasonography; CTA, computed tomography angiography; PTFE, polytetrafluoroethylene; CT, computed tomography.

coronary artery disease, eight of whom had received stenting and four of them underwent coronary artery bypass grafting. One of the two cases with a history of aortic aneurysm was endovascular aneurysm repair had been performed for the other patient with intrarenal abdominal aortic aneurysm. Previous history of abdominal surgery had been reported in 5 patients (Table 1).

The common complaints included pain, pallour, and cyanosis in lower extremities. In addition, eight patients suffered from intermittent claudication and paresthesia and one patient had foot drop. In one patient, diffuse abdominal pain and acute abdomen was the presenting symptom (Table 1).

Physical examination revealed pale and cold bilateral lower extremities in addition to the absence of femoral and distal pulses on bilateral lower extremities. In six patients, discoloration was observed starting from lower extremities extending to the umbilicus. Paresthesia was noted in four patients, while paraplegia was diagnosed in one patient (Table 1). Six patients underwent urgent bilateral femoral thromboembolectomy subsequent to doppler ultrasonography. Doppler ultrasonography was routinely performed to all patients, while conventional and computed tomography angiography were performed in 12 and 6 patients, respectively (Table 2, Fig. 1, and Fig. 2A, B). Juxtarenal aortic occlusion with total occlusion of left renal artery was observed in two patients, while emergent surgical intervention was performed in sixteen patients with infrarenal abdominal aortic occlusion.

1) Surgical technique

All patients were operated under general anesthesia. In the beginning, right infraclavicular incision was made. The pectoralis muscle was exposed and fibers were split superiorly and inferiorly. At this point, the pectoralis minor muscle insertion was divided to allow for more exposure. Right axillary arteries were exposed, and proximal and distal control is obtained. Longitudinal or oblique groin incisions were made for exposure of femoral region. The common, superficial, and deep (profunda) femoral arteries were dissected and controlled.
with vessel loops. Subcutaneous tunneling was performed prior to systemic heparinization. A graft tunneling device (e.g., Gore Tunneler) was used to create a midaxillary tunnel lateral to the nipple and above the abdominal fascia, extending from the axillary incision to the femoral incision. If required, a femoral-to-femoral tunnel was formed superior to the pubic bone for a bifemoral reconstruction. After intravenous heparinization (5,000 IU), a proximal axillary anastomosis and bilateral femoral distal anastomoses were made. An additional femoropopliteal bypass procedure was carried out in patients with peripheral arterial disease that underwent extraanatomic bypass. In all patients, ring polytetrafluoroethylene grafts and 5/0 polypropylene sutures were used (Table 2). Anatomical layers were closed in standard fashion subsequent to the control of bleeding.

**RESULTS**

Early postoperative results demonstrated that revascularization could be successfully accomplished in all patients. However, one patient died due to multiple organ failure on 12th day postoperatively. The mean duration of stay in intensive care unit was 6.7±2.9 days (range, 3 to 12 days), while the duration of hospitalization was 15.1±3.9 days (range, 9 to 22 days). Re-intervention or amputation were not indicated in the early postoperative period. Graft infection was not detected in any patients, whereas thrombectomy was required in one patient to overcome graft thrombosis. The mean duration of follow-up is 21.2±9.4 months (range, 6 to 36 months) and grafts are currently patent (Fig. 2B).

**DISCUSSION**

In the present study, we aimed to outline the clinical presentation as well as the surgical outcomes and prognosis of patients treated for AAO. Our results demonstrated that extraanatomic bypass provides satisfactory results in selected cases.

AAO is a rare catastrophe that does not affect aorta only, but also may have rapid deleterious effects on the organs perfused by aorta [2,3]. Therefore, increased clinical awareness on this entity is crucial for establishing the diagnosis accurately and planning the treatment accordingly.

Ischemic injury may exist in lower extremities, spinal cord, kidneys, and intestines with an early mortality rate ranging between 31% and 52% [5-8]. Basal perfusion compensated by
collateral arterial network may mask the typical ischemic clinical scene and constitute a diagnostic dilemma. Most frequent causes of AAO include thrombosis enhanced by atherosclerosis and hypercoagulable state, saddle emboli, luminal enlargement due to aortic dissection and aortic trauma [1,2]. In our series, the most common cause was thrombosis due to atherosclerosis.

AAO may present in a wide spectrum of symptoms from pallour in extremities to cyanosis and compartment syndrome. Paresthesia, loss of sensation, and motor deficits are typical findings of lower extremity. Absence of pulses is an indicator of severe ischemia which predominates the clinical picture approximately 6 hours after the onset of symptoms. Delay of the occurrence of severe ischemia symptoms may interfere with setting the correct diagnosis on time [3,4]. One of our patients presenting with paraplegia has been referred with a presumable diagnosis of spinal cord compression. Recovery of neurological symptoms after reestablishment of distal perfusion reminds that neurological deficit may be reversible in aortic occlusion. Since neurological deficits may mask the underlying vascular pathology, we suggest that major vascular occlusive disorders must be kept in mind in the differential diagnosis.

The main causes of mortality in AAO are cerebrovascular occlusion, ischemic injury to organs like heart and liver, hyperkalemia due to renal injury, respiratory failure, and fatal arrhythmias [1,3]. Danto et al. [9] reported a mortality due to hyperkalemia after being operated for bilateral internal iliac artery occlusion. Our patient who died on 12th postoperative day had been suffering from congestive heart failure and chronic renal failure.

Even though typical clinical findings mostly suffice for diagnosis, Doppler ultrasonography constitutes a practical, reliable and non-invasive option that has 93% specificity and 90% sensitivity [10]. In addition to routine Doppler ultrasonographic evaluation, we preferred confirmation with angiography.

Therapeutic modalities for acute abdominal aortic occlusion are embolectomy, aortobifemoral bypass, thrombolytic treatment, and axillo-bifemoral extraanatomic bypass procedures. In spite of publications that advocate thrombolytic treatment [11], we think that it may be more useful for AAO developing in the setting of a hypercoagulable state such as oral contraceptive use or factor V Leiden mutation. Treatment of AAO may vary according to the underlying etiology. If the etiology is linked with emboli, embolectomy for aorta and its distal branches may be required. We have performed embolectomy in three patients initially, but axillobifemoral bypass was required since blood flow could not be restored.

We made femoropopliteal bypass in addition to axillobifemoral bypass in vascular occlusion patients with atherosclerosis. Acute thrombosis was reported to occur concomitantly in chronic peripheral arterial disease [8,12]. The axillobifemoral bypass operation is an alternative to direct arterial reconstruction, such as aortobifemoral grafting. This procedure is performed in patients with aortic graft sepsis or a mycotic aneurysm and in patients with a totally occluded abdominal aorta with a high operative risk. It is less invasive than the total reconstruction of the aorta and surgical replacement of the infected aortobifemoral graft is not necessary in the ‘hostile’ abdomen.

Preoperative medical measures such as heparinization, hydration, and optimization of cardiac functions may be employed to enhance the success of surgery. Data achieved by invasive monitorization may demonstrate suboptimal left ventricular function and result in the modification of surgical approach. Due to the low rates of patency, we reserved axillobifemoral bypass for patients in poor general condition or patients with systemic comorbidities. In our series, occlusion of the graft was detected only in one patient and patency was supplied by thrombectomy.

In conclusion, AAO is a rare but devastating event and is linked with substantial morbidity and mortality in spite of the recent advances in critical care and vascular surgery. Our results have shown that these hazardous outcomes may be minimized and better rates of graft patency may be achieved with extra-anatomic bypass techniques tailored according to the patient.

**CONFLICT OF INTEREST**

No potential conflict of interest relevant to this article was reported.
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