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Case Reports

Circulatory Arrest for Traumatic Brachiocephalic Artery Pseudoaneurysm Repair

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Abstract

Blunt traumatic injuries to the brachiocephalic artery require surgical management. The operative technique used depends on the location of the injury, the patient's hemodynamic stability, and the surgeon's experience. Perfusion strategy can facilitate vascular control of the aortic arch and branch vessels. This report presents an urgent repair of a proximal posterior blunt traumatic brachiocephalic artery injury under circulatory arrest, with an excellent outcome.

Keywords: Blunt injuries; pseudoaneurysm; circulatory arrest, deep hypothemia induced

Introduction

Blunt traumatic rupture or pseudoaneurysm of the brachiocephalic artery is uncommonly reported in the literature. Autopsy reports confirm that the vast majority of patients experiencing blunt aortic and arch branch vessel trauma die before they reach the hospital.[1] In cases of brachiocephalic artery rupture in which patients survive to arrival at the hospital, surgical management is required because of the inherent instability of this lesion and its high associated mortality. More than 80% of reported cases involve the proximal brachiocephalic artery,[2] likely because of the relatively lower flexibility of the artery at its fixed point of origin.[3] Multiple surgical approaches have been reported for emergent brachiocephalic artery repair, which indicates that a standardized technique has not emerged as universally preferred.[1-9] Several features of the injury affect surgical decision-making. The ability to achieve proximal and distal control safely before disrupting the pseudoaneurysm is a major determinant of perfusion strategy. This report presents a case of a proximal blunt traumatic brachiocephalic artery pseudoaneurysm managed using femoral cannulation, circulatory arrest, and aortobrachiocephalic bypass grafting.

Case Report

The patient, a 32-year-old man, experienced blunt trauma to the anterior chest during a motor vehicle collision. In the trauma bay, he was hemodynamically stable. Bilateral chest tubes were placed for pneumothoraces. Computed tomography (CT) chest angiogram demonstrated a small pseudoaneurysm of the proximal brachiocephalic artery, with an adjacent hematoma indicative of a traumatic tear (Fig. 1). The posterior position of the pseudoaneurysm presented a particular challenge to its access (Fig. 2). Associated nondisplaced sternal fracture and fractures of the first 3 ribs were also identified. Preoperatively, systolic blood pressure was maintained at 90 to 100 mm Hg, and the patient was taken emergently to the operating room for surgical repair.

Technique

The case was initiated with femoral arterial and venous cannulation for cardiopulmonary bypass. Transesophageal echocardiography as well as radial and femoral arterial pressure lines were used for monitoring. The patient was cooled to 18 °C for circulatory arrest. The left ventricle was monitored during fibrillation, which occurred when the patient's temperature reached 27 °C; the ventricle did not become distended. Median sternotomy was performed when the patient's temperature reached 24 °C, the pericardium was opened, and a left ventricular vent

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Fig. 1 Computed tomographic image shows a traumatic posterior pseudoaneurysm of the proximal brachiocephalic artery with an adjacent hematoma (axial view).

Fig. 2 Computed tomographic image shows a 3-dimensional reconstruction of traumatic pseudoaneurysm at the proximal brachiocephalic artery (posterior view).

was inserted through the right superior pulmonary vein. When the patient was cooled to the target temperature of 18 °C, distal control of the brachiocephalic artery was achieved, and dissection around the pseudoaneurysm was performed. A proximal posterior tear of the brachiocephalic artery was identified at less than 1 cm from the aortic arch. The origin of the left common carotid artery was observed to be extraordinarily close to the brachiocephalic artery origin, suggesting a variant of a bovine arch. The superior vena cava was cannulated for retrograde cerebral perfusion, and circulatory arrest was initiated. The proximal brachiocephalic artery was transected, and the origin was closed with a Dacron patch. During the patch repair, antegrade cerebral perfusion was administered through a cannula inserted into the distal brachiocephalic artery. Circulatory arrest was ended after 27 minutes. A side-biting clamp was placed on the distal ascending aorta, and an aortobrachiocephalic bypass graft was performed using a 10-mm Dacron conduit (Fig. 3). Normal pulse and pressure were confirmed in the right radial arterial line. The patient was rewarmed and decannulated. The chest was packed for coagulopathy. Delayed chest closure was performed the following day with sternal plating. Total cardiopulmonary bypass time was 3 hours, 47 minutes. Cross-clamp time was 34 minutes.

Postoperative CT angiography of the chest showed a widely patent bypass graft and normal perfusion of all arch vessels (Fig. 4). The patient recovered favorably and was discharged home 4 days after chest closure with a normal neurologic exam.

Abbreviations and Acronyms

CT computed tomography

Discussion

Blunt traumatic injury to the brachiocephalic artery can be repaired primarily with suture, patch, or reimplantation of the origin, but the majority of published cases involve prosthetic graft reconstruction. Depending on the location and extent of injury, various graft techniques are indicated, including aortobrachiocephalic bypass grafting, interposition grafting, partial arch reconstruction, and ascending aortic bypasses directly to the right common carotid and right subclavian arteries.[4] A literature review published by Hirose and Gill[3] in 2004 found that 18 of 75 repairs implemented cardiopulmonary bypass, and 10 used carotid shunting during reconstruction. The overall mortality rate of surgical repair has been reported at 12%, although recently, a mortality rate as low as 1.5% has been reported (specific lesion characteristics and patient stability vary widely). A trend toward greater use of bypass grafting—in particular, aortobrachiocephalic bypass—coincides with the reduction in mortality in recent decades.[3,5]

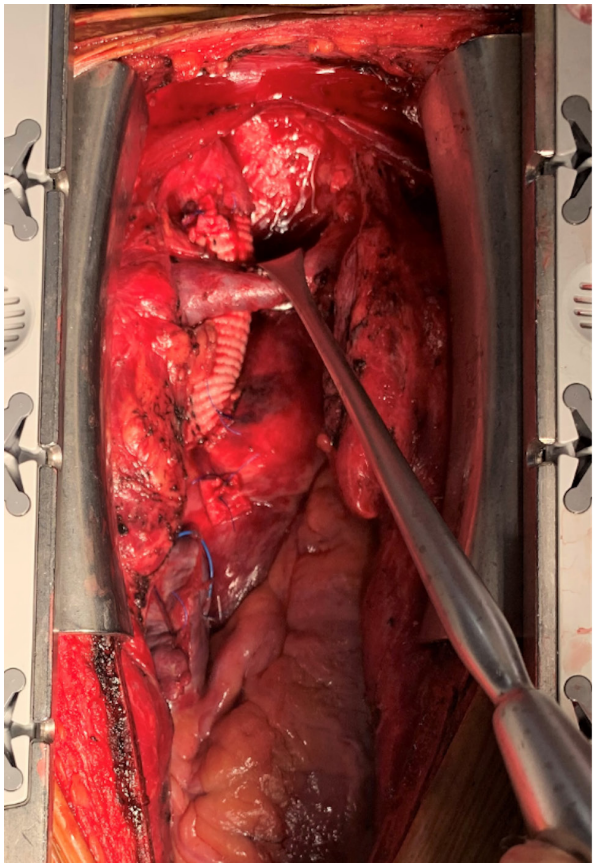

Fig. 3 Digital photograph of aortobrachiocephalic bypass using a 10-mm Dacron graft.

Fig. 4 Postoperative computed tomographic image of the patent aortobrachiocephalic bypass graft (coronal view).

In cases of multisystem polytrauma, reports of delayed brachiocephalic artery repair have been shown to be successful, although a delay would be advisable only out of necessity.[7] Endovascular repair has also been reported, although injuries at the brachiocephalic artery origin are technically limited and not standard.

Cardiopulmonary bypass can be avoided by using a side-biting clamp of the ascending aorta and aorto-brachiocephalic bypass grafting. Patients with blunt thoracic trauma are often younger than typical cardiac surgery patients and thus have significantly lower risk of a diseased or calcified aorta. These repairs have documented patency rates greater than 96% at 10 years and likely remain patent much longer.[8]

The benefit of cardiopulmonary bypass and (in this case) circulatory arrest is vascular control during dissection and reconstruction of the brachiocephalic artery. Again, the relative vascular health of the young trauma patient population provides additional safety. Patients with a low burden of atherosclerotic disease have low risks of femoral arterial cannulation complications, retrograde perfusion embolization, and cerebrovascular ischemia during antegrade cerebral perfusion. In the case of a proximal posterior injury, primary repair cannot be safely performed without a cardiopulmonary bypass strategy. The addition of circulatory arrest provided the safest circumstances for dissection and patch repair of an injured brachiocephalic artery that nearly involved the left carotid origin, as well. Placement of the arterial cannula at the femoral site provided the most flexible reconstruction options and cleared the cannula from the operative field.

The major limitations of circulatory arrest are the increased time and exacerbation of coagulopathy with systemic hypothermia in a trauma patient. Polytrauma patients often may not be amenable to these additional stressors. Yet, the literature suggests that patients with traumatic brachiocephalic artery pseudoaneurysms who survive to arrival at a hospital most often have self-selected for survival and are found to be hemodynamically stable on presentation. In some cases, diagnosis of the brachiocephalic artery lesions has been delayed more than a week, and the lesions were later successfully repaired.[7] This finding suggests that polytrauma patients can be stabilized with respect to other unstable injuries and then return to the operating room for definitive brachiocephalic artery repair.

In conclusion, femoral cannulation and hypothermic circulatory arrest are part of an important surgical strategy and offer a high degree of safety and control for complex proximal, blunt brachiocephalic artery injuries.

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