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Case Report
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Firearm Injury to the Carotid Axis; Surgical Repair with Autologous Graft: Case Report

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Abstract

Introduction: Between 6% to 20% of penetrating neck traumas produce injuries to the carotid arteries. 4% to 17% of these traumas are caused by firearms. Mortality due to damage to the carotid arteries is high, between 15% and 25%, mainly due to massive hemorrhage.

Clinical Case: A 15-year-old female patient, with no clinical history of relevance to the case, who began to suffer from a gunshot wound to the cervical and face, with unknown trauma kinematics, was admitted to the shock area with hemodynamic instability; she had a circular wound in the right mandibular region, a neck with a right cervical hematoma and a trachea deviation to the left. Initial management included intubation to maintain a patent airway and a central venous catheter. Laboratory tests were reported normal.

Results: The General Surgery service performed cervical surgical exploration with the following findings; lesion in the right external carotid artery with complete section and extensive loss of vascular wall, bleeding collateral vessels; the ends of the injured carotid artery were immediately clamped to prevent hemorrhage; the end-to-end anastomosis could not be performed due to the great length of the vessel loss; it was decided to perform a graft, taking a portion of the internal saphenous vein of the left thigh. The proximal end anastomosis was performed with simple sutures after of heparinized solution and the distal anastomosis with continuous sutures. The patency was confirmed, without leaks, the muscle fascia was closed, and drainage and skin-muscle closure. During the transoperative period, three red blood cell concentrates and a thawed plasma were transfused, norepinephrine and vasopressin were started to maintain stable blood pressure; transoperative bleeding of 800 ml, arterial blood gas analysis showed metabolic acidemia with hyperlactatemia, and the patient was subsequently admitted to intensive care.

Conclusion: The present work aims to provide evidence from the experience of our unit regarding the diagnosis and management of this very complex and rare injury treated in a center where there is neither a cardiovascular surgeon nor all the resources.

Keywords: Firearm injury; Carotid axis; Surgical repair; Autologous graft

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Introduction

Between 6% to 20% of penetrating neck traumas produce injuries to the carotid arteries and 4% to 17% of these traumas are caused by firearms. Mortality due to damage to the carotid arteries is high, between 15% and 25%, mainly due to massive hemorrhage.

Depending on the anatomical level of the injury, the neck can be divided into three zones. Zone 2 contains the highest density of vital structures and where the carotid arteries are located. For its management, clinical examination and maintaining blood perfusion are essential, which is why vascular reconstruction is preferable to ligation [1,2].

When the arterial wall is very damaged, which prevents its repair, an alternative is autologous graft. The saphenous vein, due to its easy anatomical access, its strong wall resistant to systemic arterial pressure, with luminal endothelial cells with elastic properties similar to those of arteries, is the ideal graft for angiological and cardiac surgeries [1]. The objective is to describe the surgical

management for penetrating trauma of the external carotid artery under the principles of damage control surgery.

Clinical Case

A 15-year-old female patient, with no clinical history of relevance to the case, who began to suffer from a gunshot wound to the cervical and face, with unknown trauma kinematics, was admitted to the shock area with hemodynamic instability; she had a circular wound in the right mandibular region, a neck with a right cervical hematoma and a trachea deviation to the left. Initial management included intubation to maintain a patent airway and a central venous catheter. Laboratory tests were reported normal.

The General Surgery service performed cervical surgical exploration with the following findings: Lesion in the right external carotid artery with complete section and extensive loss of vascular wall, bleeding collateral vessels; the ends of the injured carotid artery were immediately clamped to prevent hemorrhage; the end-to-end anastomosis could not be performed due to the great length of the vessel loss; it was decided to perform a graft, taking a portion of the internal saphenous vein of the left thigh. The proximal end anastomosis was performed with simple sutures after instillation of heparinized solution and the distal anastomosis with continuous sutures. The patency was confirmed, without leaks, the muscle fascia was closed, and drainage and skin-muscle closure were placed (Figure 1). During the transoperative period, three red blood cell concentrates and a thawed plasma were transfused, norepinephrine and vasopressin were started to maintain stable blood pressure; transoperative bleeding of 800 ml, arterial blood gas analysis showed metabolic acidemia with hyperlactatemia, and the patient was subsequently admitted to intensive care.

The patient responded adequately to surgical treatment, remaining hemodynamically stable. Vasopressor and ventilatory support were withdrawn seven days after surgery; the patient was conscious, well-oriented and cooperative with no neurological deficit. Surprisingly, the patient presented transvaginal bleeding and ultrasound revealed a gestational sac of 12 SDG with no data on viability, so a curettage was performed by the gynecology and obstetrics service. She was kept under surveillance on the Pediatrics floor, where the drain and sutures were removed. Laboratory studies revealed a right mandibular fracture that was treated conservatively by the Maxillofacial Surgery service. She was subsequently discharged with pharmacological management for pain and outpatient follow-up. This patient was managed with open surgery due to her hemodynamic instability and although the risk of neurological damage is high, when it is addressed quickly and efficiently the risk is reduced and her evolution is satisfactory.

Discussion

Open surgery has been the most widely used treatment, recommended as the first treatment strategy in patients with carotid injury who present hemodynamic instability. This type of injury is considered to be at higher risk of exsanguination or neurological damage due to the flow it provides to the circle of Willis [3]. The human Internal Saphenous Vein is the most universally used autologous graft in Vascular and Cardiac Surgery; it is easily accessible and widely available; it is stronger and more resistant to systemic blood pressure than any other vein. It has qualities that make it unique as an arterial substitute: the presence of endothelial cells on its luminal surface and elastic properties similar to the artery [4]. We have few surgeons with surgical experience in this specific type of injury as it is an infrequent anatomical territory, constituting a challenge for trauma and emergency surgery. Currently, there is a shortage of data, both internationally and nationally, on epidemiology, evidence on interventions, and their results [5].

Raherinantenaina et al. [6], report on the management of an acquired left carotid-jugular fistula in a 29-year-old man, caused by a gunshot wound to the left cheek of one month's duration with the diagnosis of a carotid pseudoaneurysm discovered on Doppler ultrasound. The clinical presentation was marked by cervical thrill in favor of an arteriovenous fistula confirmed by computed tomography angiography. Surgical exploration by cervicotomy revealed a communication between the common carotid artery and the internal jugular vein which were repaired using a saphenous vein patch and a lateral suture, respectively, without complications. The five-month follow-up found an asymptomatic patient with good patency of the repaired vessels.

The diagnosis and treatment of penetrating injuries to the cervical carotid arteries remain controversial. Most patients with stab or gunshot wounds to the common or internal carotid artery in cervical zone II (sternal notch at the angle of the mandible) present with symptoms of external or intraoral bleeding, a rapidly expanding hematoma, evidence of a carotid-jugular arteriovenous fistula at an obvious site, or loss of the carotid pulse with a neurologic deficit. Immediate airway control and arterial repair are indicated in these patients.

Other patients present with stab or gunshot wounds with proximity only to the carotid sheath, a stable hematoma, an unknown level of a carotid-jugular arteriovenous fistula, or loss of the carotid pulse without a neurologic deficit. Diagnostic options in this latter group include duplex ultrasound, color duplex imaging, and standard arteriography, whereas the role of CT or MRI angiography in the evaluation of patients with penetrating cervical wounds is unclear at this time. Certain arterial injuries discovered on diagnostic testing are currently treated with observation, endovascular stenting (for intimal or wall irregularities), and arteriographic embolization (for small pseudoaneurysms or high carotid-jugular fistulas).

Surgical repairs for Zone II injuries are performed through an oblique cervical incision and include all options used with peripheral vascular injuries. Patients with penetrating cervical injuries, preoperative neurologic deficits, and immediate transport to the trauma center should receive repair rather than ligation of the injured carotid artery. When the patient is truly comatose with a Glasgow Coma Scale score <8, an unsatisfactory neurologic outcome is likely with arterial repair or ligation. Extracranial internal carotid artery injuries in cervical zone III (above the angle of the mandible) may require innovative approaches to control hemorrhage and then maintain flow to the ipsilateral cerebral cortex [7].

Rabinovich et al. [8] report a 24-year-old man admitted after sustaining a single gunshot wound to the neck with an expanding hematoma on the left side. CT angiography showed bilateral pseudoaneurysms of the internal carotid artery, with interruption of flow on the left side and a carotid-jugular fistula on the right side. At operation, transection of the left internal carotid artery required ligation of the artery. No injuries were found in the trachea or larynx, but the pharynx was lacerated and was repaired. The patient was transferred to the angiography suite, where a stent graft was placed in the right internal carotid artery. This served to close the pseudoaneurysm and arteriovenous fistula while preserving

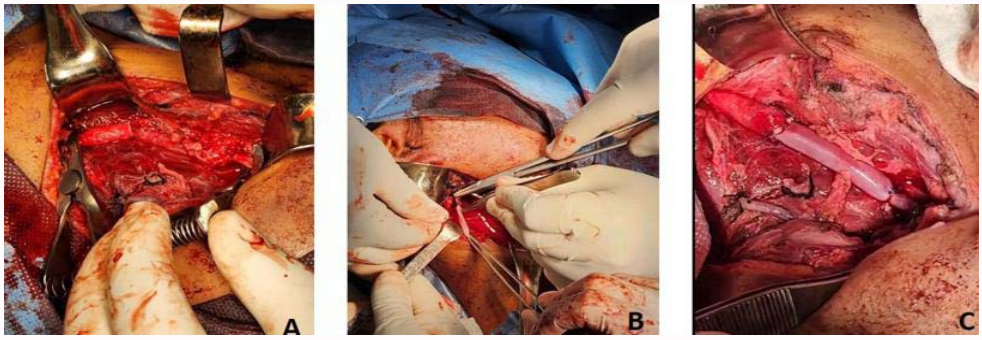

Figure 1: Representative image of the graft. **A.** Dissection of the injured carotid artery with ligation at the ends of the vessel. **B.** Anastomosis of the saphenous vein with the ends of the carotid artery. **C.** Patency of the graft.

distal flow. The patient recovered with intact brain function and mild tongue paresis related to the hypoglossal nerve injury. He was discharged home after 7 days.

Annolfi et al. [9], report a case of a penetrating wound in zone II of the neck and injury to the internal carotid artery. The optimal evaluation and treatment of vascular injuries remain controversial. A review of retrospective studies published in the literature has shown that physical examination alone can be as accurate as arteriography in detecting significant cervical vascular injuries requiring surgical repair. Not surprisingly, the results of carotid artery repair in neurologically stable patients have been excellent, compared with the results of revascularization in patients with equivocal or less severe neurological deficits.

Conclusion

The present work aims to provide evidence from the experience of our unit regarding the diagnosis and management of this very complex and rare injury treated in a center where there is neither a cardiovascular surgeon nor all the resources. The use of the internal saphenous vein as an autologous replacement for the injured external carotid artery gave satisfactory result, since it allowed maintaining blood perfusion and hemostasis, without neurological damage, which is the main complication of this type of surgery.

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