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Case Report

Subclavian-Brachial Bypass for Chronic Limb Threatening Ischemia Associated with an Old Motorcycle Accident

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Chronic limb-threatening ischemia is rarely associated with previous traumatic injury. We present a case of a 28-year-old male with progressive digit ulcers, a weak pulse, cyanosis, and a cold limb. Eight months prior, he had a motorcycle accident resulting in a right clavicle fracture and brachial plexus injury. Computed tomography angiography revealed occlusion of the right subclavian artery near a surgically implanted reduction plate. The patient underwent an open subclavian-brachial bypass with a reversed saphenous vein graft. His postoperative recovery was uneventful. After 3 months, he had a euthermic right hand with a palpable pulse and his ulcers had completely healed. This case reinforces the need for patients with a neurological deficit in the upper extremity caused by blunt trauma to undergo thorough vascular examination to identify potential arterial injury and compromised perfusion.

Key Words: Fracture, Subclavian artery, Chronic limb-threatening ischemia, Vascular injuries, Vascular grafting

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INTRODUCTION

Trauma is the leading cause of mortality for individuals aged <45 years, with up to 14 million yearly traumatisms worldwide [1]. Perkins et al. [2] reported a 4.4% incidence rate of vascular injury among 5,823 admissions to a major trauma center in the United Kingdom. Deguara et al. [3] reported that the most common cause of upper limb ischemia was thromboembolism (35%), followed by traumatic vascular injury (31%). In Mexico, vascular trauma accounts for 9% of trauma mortality; however, the actual incidence rate is thought to be significantly higher [4]. Blunt vascular trauma to the upper extremity (UE) with consequent development of chronic limb-threatening ischemia (CLTI) is rarely reported. Nevertheless, UE blunt trauma is significantly associated with high blood transfusions rates, longer hospital stays, critical care admission, concomitant orthopedic, nervous and vascular injury, and high death rates in comparison to patients with penetrating trauma [2,5]. Shaw et al. [6] found that 80% of patients with blunt trauma to the subclavian or axillary arteries also had serious brachial plexus lesions, and that the brachial artery was the most frequently affected vessel, followed by the axillary, antebrachial, and subclavian arteries. We report a case of successful subclavian–brachial bypass in a patient who presented with CLTI 8 months after undergoing clavicle fracture repair following a motorcycle accident. The report was approved by the Institutional Review Board of the Instituto Nacional de Cien-

cias Médicas y Nutricion Salvador Zubiránand (IRB no. SCI-4073-22-22-1), and written informed consent was obtained from the patient.

CASE

A previously healthy 28-year-old male suffered a traumatic high-velocity motorcycle accident that resulted in a clavicle fracture due to direct impact on his right shoulder. Subsequently, he underwent open reduction of the fracture via plate installation and osteosynthesis in another trauma center. The orthopedic surgery achieved stability and reduction of the clavicular fracture.

Eight months after the injury, the patient was referred to our institution with new-onset progressive digital ulcers on the second and third ipsilateral fingertips. On physical examination, the right upper limb was mildly cyanotic and cold to touch from the fingers to the shoulder and had delayed capillary filling. The brachial, radial, and ulnar pulses were palpable; however, arterial Doppler signals were weak. The patient had no motor or sensory function (M0 and S0) distal to the shoulder in the right UE immediately after the accident. His blood pressure was 80/50 mmHg in the right arm and 120/90 mmHg in the left arm. UE computed tomography angiography (CTA) revealed a 75-mm subclavian artery occlusion with reconstitution of the axillary artery by collateral vessels of the scapular circulation. The distal axillary and brachial arteries were patent (Fig. 1). A nerve conduction study reported complete right brachial plexopathy (C5-T1) with active denervation.

The patient underwent open surgical revascularization via a subclavian-brachial bypass with a reversed great saphenous vein (GSV) graft. Preoperative ultrasound imaging identified a suitable GSV in the right thigh which was subsequently harvested while the patient was in the supine position with the right arm in abduction (Fig. 2). Using a right supraclavicular approach, we identified and achieved vascular control of the subclavian artery proximal to the occlusion and avoided damage to the surrounding structures; no chronic hematoma was found in the dissection of the supraclavicular space. An end-to-side anastomosis was performed on the first portion of the subclavian artery using the parachute technique (Fig. 3A). We dissected the infraclavicular space avoiding manipulation of the nerves and muscular structures. The graft was tunneled distally through the axillary space and underneath the clavicle through a subclavian incision. The inner arm was dissected to achieve vascular control of the proximal brachial artery by completing a distal end-to-side parachute vascular anastomosis to the brachial artery (Fig. 3B). All vascular anastomoses were done using vascular 6-0 Prolene sutures. Finally, bypass patency was confirmed with triphasic waveforms using Doppler ultrasonography (DUS) and hemostasis was accomplished. The postoperative period was uneventful, and the patient was discharged 4 days later. Follow-up CTA after 3 months revealed a patent graft with good distal perfusion (Fig. 4). The patient had a warm right hand with palpable brachial, radial, and ulnar pulses, no digital ulcers, and a right arm blood pressure of 110/80 mmHg. However, motor paralysis persisted and paresthesia of the right hand developed. The patient is in a rehabilitation program with a

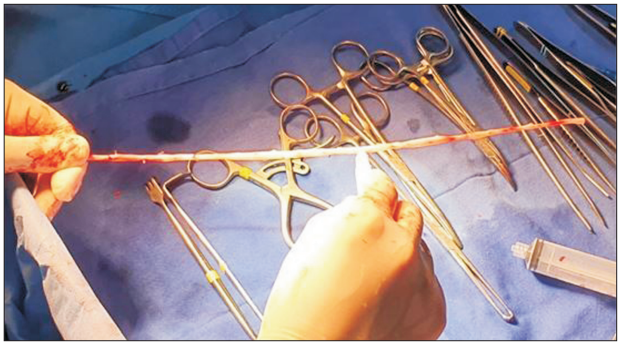

Fig. 2. The great saphenous vein obtained from the right inner thigh. The graft was an adequate length and was compressible without sclerosis.

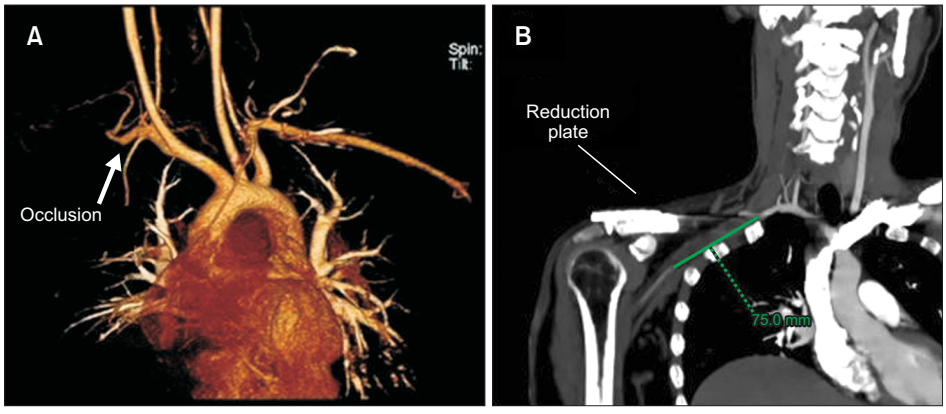

Fig. 1. (A) Computed tomography angiography three-dimensional coronal view demonstrated complete occlusion (arrow) of the subclavian artery at the first section. (B) The right subclavian artery was completely occluded for 75 mm near the reduction plate with reconstitution of the axillary artery from collateral circulation.

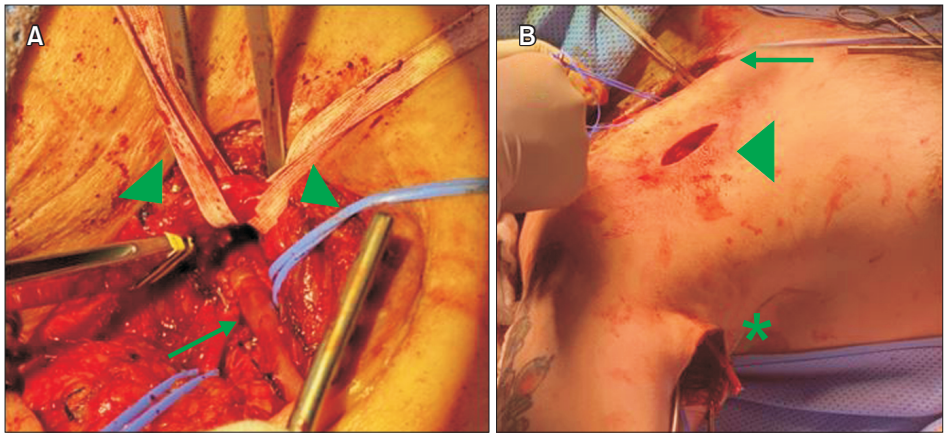

Fig. 3. (A) Operative pictures of the proximal subclavian anastomosis via a supraclavicular approach. The arrow points to the reversed great saphenous vein (GSV) graft and the arrow heads show the anterior scalene muscle. (B) Three incisions were made; a supraclavicular incision for the proximal anastomosis (arrow), an infraclavicular incision to tunnel the graft (arrowhead), and an axillary incision for the distal anastomosis with the GSV graft in place (asterisk).

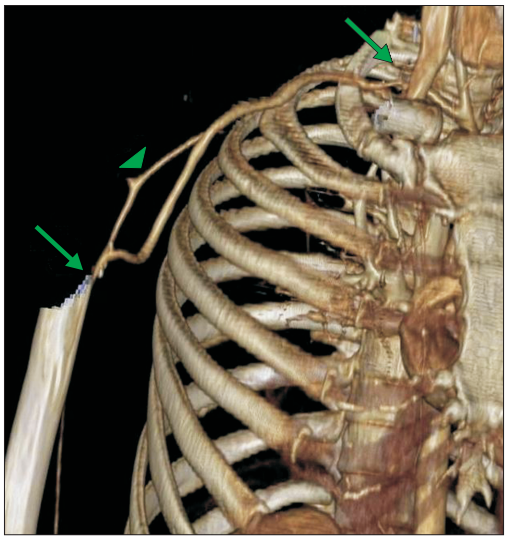

Fig. 4. Follow-up computed tomography angiography at 3 months revealed a patent subclavian-brachial vein bypass with successful proximal and distal anastomoses (arrows) and the axillary artery (arrowhead).

multidisciplinary team.

DISCUSSION

UE trauma with arterial injury remains a challenge for therapeutic pathology. The actual global incidence of injuries of this kind is difficult to determine as most of these lesions do not require surgical treatment; however, acute limb ischemia is an urgent indication for surgical management [7]. Endovascular treatment is commonly considered for the initial treatment of patients with non-occlusive lesions with suitable short segment anatomy to avoid the morbidity and mortality of open arterial repair [8]. In this case, we decided to perform open elective surgery because of the long occluded arterial segment, the location of the disease below the clavicle, possible vascular trauma, and CLTI of the affected limb. We believe the patient developed progressive CLTI due to fibrosis of the subclavian space after the blunt trauma and orthopedic surgery. This case is important as it highlights how trauma with nerve involvement can mask developing limb ischemia.

It is critical to individualize the therapeutic approach for each patient based on the mechanism of trauma, clinical signs of ischemia, and imaging description of arterial injury to provide the optimal treatment for arterial repair and limb-salvage surgery. Due to anatomical proximity to other structures and high-energy injury mechanisms, patients with trauma to the shoulder and UE experience multiple injuries. Our findings concur with those of other studies which found that concomitant axillary or subclavian injuries are almost always present in the presence of blunt brachial plexus injury. Furthermore, patients with vascular injury and blunt trauma, compartment syndrome, early graft failure, or associated skeletal and brachial plexus damage were found to be at a significantly higher risk of limb loss and poor functional limb outcome [9-11]. All patients with blunt UE trauma and accompanying risk factors must undergo vascular exploration to identify potential arterial injury. Persistent nerve damage and loss of function experienced by patients with blunt trauma and vascular injury may be due to the formation of perineural hematomas that can cause aseptic nerve injury, inflammation, and compartment syndrome [12,13].

Furthermore, in acute settings the diagnosis of an

ischemic arm may be missed in unconscious or confused patients with polytrauma or brachial plexus involvement injuries. Up to one-third of patients may not have signs or symptoms of arterial damage; however, vascular exploration must be carried out to identify any potential soft and hard signs of vascular trauma [14]. Noninvasive diagnostic modalities include DUS and CTA [15]. CTA can detect not only vascular injuries, but also combined trauma in adjacent structures. Invasive arteriography is usually reserved for interventional treatment. Generally, the management of brachial plexopathy usually begins with observation and rehabilitation for 3-6 months; however, early surgical management is justified for penetrating injuries where direct trauma damage is confirmed. The surgical management of patients needs to be approached in a multidisciplinary manner in conjunction with rehabilitation services, physical therapy, neurology, neurophysiology, and reconstructive surgery to achieve enhanced functional outcomes. Surgical techniques for peripheral nerve damage are focused on nerve decompression, reconstruction, and transfer or muscle and tendon transfer. Brachial plexus surgery outcomes depend on the nature and severity of the injury, timing of surgery, and the surgeon's experience with brachial plexus injuries. Approximately 60% to 70% of appropriately selected patients have improved functional outcomes after surgical treatment of brachial plexus injuries [16-20].

In conclusion, chronic ischemia associated with vascular trauma to the UE is uncommon. Even with expert management, these types of injuries are associated with high rates of amputation, disability, adverse cardiovascular outcomes, and mortality. This case illustrates why patients with blunt UE trauma with nerve involvement must undergo thorough vascular examination to identify potential arterial obstruction or injury.

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CONFLICTS OF INTEREST

The authors have nothing to disclose.

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REFERENCES

1) López Narváez L, Salazar Trujillo A, Cáceres Sepúlveda JF, Rincón Guio C, Charry Cuellar J. Peripheral vascular trauma. Literature review. Cir Gen 2019;41:184-190.
2) Perkins ZB, De'Ath HD, Aylwin C, Brohi K, Walsh M, Tai NR. Epidemiology and outcome of vascular trauma at a British Major Trauma Centre. Eur J Vasc Endovasc Surg 2012;44:203-209.
3) Deguara J, Ali T, Modarai B, Burnand KG. Upper limb ischemia: 20 years experience from a single center. Vascular 2005;13:84-91.
4) Rodríguez-López E, Fabián-Mijangos W, Casares-Bran T, Lecuona-Huet N, Olivares-Cruz S, Carbajal-Robles V, et al. [Civil vascular trauma: Three years of management in Mexico City General Hospital]. Rev Mex Angiol 2017;45:154-162. Spanish.
5) Tan TW, Joglar FL, Hamburg NM, Eberhardt RT, Shaw PM, Rybin D, et al. Limb outcome and mortality in lower and upper extremity arterial injury: a comparison using the National

Trauma Data Bank. Vasc Endovascular Surg 2011;45:592-597.
6) Shaw AD, Milne AA, Christie J, Jenkins AM, Murie JA, Ruckley CV. Vascular trauma of the upper limb and associated nerve injuries. Injury 1995;26:515-518.
7) Sluys KP, Shults J, Richmond TS. Health related quality of life and return to work after minor extremity injuries: a longitudinal study comparing upper versus lower extremity injuries. Injury 2016;47:824-831.
8) Chama-Naranjo A, Becerra-Bello J, Huerta-Huerta H, Olivares-Cruz S. Surgical management of peripheral vascular injuries. Rev Mex Angiol 2020;48:137-143.
9) Papaconstantinou HT, Fry DM, Giglia J, Hurst J, Edwards JD. Endovascular repair of a blunt traumatic axillary artery injury presenting with limb-threatening ischemia. J Trauma 2004;57:180-183.
10) Dragas M, Davidovic L, Kostic D, Markovic M, Pejkic S, Ille T, et al. Upper extremity arterial injuries: factors influencing treatment outcome. Injury 2009;40:815-819.
11) Joshi V, Harding GE, Bottoni DA, Lovell MB, Forbes TL. Determination of functional outcome following upper extremity arterial trauma. Vasc Endovascular Surg 2007;41:111-114.
12) Rasulic L, Cinara I, Samardzic M, Savic A, Zivkovic B, Vitosevic F, et al. Nerve injuries of the upper extremity associated with vascular trauma-surgical treatment and outcome. Neurosurg Rev 2017;40:241-249.
13) Steinfeldt T, Wiesmann T, Nimphius W, Cornelius V, Eismann D, Kratz T, et al. Perineural hematoma may result in nerve inflammation and myelin damage. Reg Anesth Pain Med 2014;39:513-519.
14) Kiefer R, Kieseier BC, Stoll G, Hartung HP. The role of macrophages in immune-mediated damage to the peripheral nervous system. Prog Neurobiol 2001;64:109-127.
15) Huang AE, Noland SS, Spinner RJ, Bishop AT, Shin AY. Outcomes of reconstructive surgery in traumatic brachial plexus injury with concomitant vascular injury. World Neurosurg 2020;135:e350-e357.
16) Duran C, Bismuth J. Advanced imaging in limb salvage. Methodist Debakey Cardiovasc J 2012;8:28-32.
17) Terzis JK, Kostopoulos VK. The surgical treatment of brachial plexus injuries in adults. Plast Reconstr Surg 2007;119:73e-92e.
18) Elkwood AI, Schneider LF, Yu D, Abdollahi H. A global approach to upper extremity paralysis: the role of surgery in limb reanimation. In: Elkwood A, Kaufman M, Schneider L, editors. Rehabilitative surgery: a comprehensive text for an emerging field. Cham: Springer; 2017. p. 189-216.
19) Haninec P, Sámal F, Tomás R, Houstava L, Dubovwý P. Direct repair (nerve grafting), neurotization, and end-to-side neurorrhaphy in the treatment of brachial plexus injury. J Neurosurg 2007;106:391-399.
20) Dahlin LB. The role of timing in nerve reconstruction. Int Rev Neurobiol 2013;109:151-164.