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INTRODUCTION

Mortality rates and medical resource utilization are greater in patients with vascular injuries compared to those without such injuries (1). Later on, pseudoaneurysms (PAs), arteriovenous fistulas, or arterial thrombosis/stenosis with distal ischemia may be reported due to vascular injuries not initially detected during presentation and assessment (2,3). Severe, lifelong functional impairment or even limb amputation can result from complications of undetected vascular injury.

Blunt injuries, which can cause internal membrane damage by dissection, thrombosis, or pseudoaneurysm, occur through a tension or shear force mechanism in the arterial wall (4).

Successful surgical treatment in patients with late major vascular complications of missed minor vascular injuries

Abstract

Aim: Vascular injuries can result from various causes, including trauma, surgery, or medical procedures, and can present immediate life-threatening risks. While some injuries are readily apparent and require urgent intervention, others may not display obvious signs of vascular compromise during the initial evaluation, potentially leading to delayed major complications. Analyse errors in the primary treatment of vascular injuries and delayed presentation of overlooked vascular injuries as surrogate indicators of the need for improved vascular surgical training for future surgeons.

Material and Methods: At the İnönü University Cardiovascular Surgery Clinic between June 2011 and June 2019, all instances of unidentified vascular injuries that present post-trauma in the form of pseudoaneurysm, arteriovenous fistula, and post-traumatic arterial occlusion were reported within the hospitals during the study duration.

Results: This study included 28 patients undergoing multiple vascular repair interventions at our institution, including 14 penetrating, 10 blunt and 4 iatrogenic. Vessels of the lower limbs were involved in 18 cases (64.2%), vessels of the upper limbs in 7 cases (25%) and vessels of the neck in 2 cases (7.14%). All patients underwent surgical procedures without any fatalities or loss of limb function. There were no fatalities or unanticipated amputations.

Conclusion: Vascular injuries may lead to noteworthy delayed complications occurring months or even years subsequent to the initial injury, including false aneurysms, dissections, occlusions, and fistulas, which may cause considerable disability, albeit, fortunately, they are typically not fatal. Patients with suspected injury, even in the absence of clear clinical signs of vascular injury, should be carefully monitored and a detailed examination is recommended to assess individuals with potential vascular injury.

Keywords: Vascular system injuries, vascular surgical procedures, delayed diagnosis, surgical outcomes

In contrast, urgent intervention is often required for partial or complete arterial transection, which can be identified by clear signs of penetrating trauma such as external bleeding, expanding haematoma, absence of pulse, pallor, paresthesia, pain, paralysis or a palpable tremor/audible humming (5). Injuries with no obvious vascular compromise may go unrecognised at initial assessment and may result in recurrent bleeding in the early post-injury period, or may present later as a pseudoaneurysm, traumatic arteriovenous fistula (AVF), thromboembolism or arterial occlusion (3). If a minor penetrating trauma partially injures an artery, blood flows out through the rent in the artery. The surrounding muscles and fascia prevent the blood from escaping externally due to the small external wound. Consequently, a

hematoma forms which is communicating with an internal injury. When an arterial defect becomes organized, it can result in a pseudoaneurysm. In cases where both the adjacent artery and vein are partially injured, an arteriovenous fistula is formed (6). This observation has led to a review of the complications encountered due to missed or untreated arterial injuries.

MATERIAL AND METHODS

This study was carried out at Inonu University Cardiovascular Surgery Clinic from June 2011 to June 2019. All cases of unrecognized vascular injuries presenting with posttraumatic pseudoaneurysm, arteriovenous fistula and posttraumatic arterial occlusion reported in these hospitals during the study period were included. Patients with acute vascular injury and patients with iatrogenic and pseudoaneurysms at the site of vascular anastomoses were excluded. Vascular injuries that were not initially diagnosed but were reported after surgery were considered missed vascular injuries because of subsequent complications occurring at different time intervals. Technical abbreviations are explained when first used. Patient characteristics such as age, gender, time elapsed between injury and presentation, trauma mode (penetrating, blunt, or iatrogenic), and site of injury were analysed.

History, clinical examination and Doppler examination of the affected area were used for diagnosis. All patients underwent conventional arteriography or CT angiography before surgery. A longitudinal incision was made proximal and distal to the site of injury in cases of traumatic AVF and pseudoaneurysm. Affected vessels were controlled before examining traumatic AVF and pseudoaneurysm. Three minutes before clamping, 5000 units unfractionated heparin were given. After exploration and opening of the artery-vein communication in cases of traumatic AVF, the extent of vascular injury was assessed.

The appropriate repair technique was determined by the extent and type of injury. Post-operatively, patency of the repair was assessed by palpation of distal pulses, capillary refill and using an intra-operative handheld Doppler probe. Muscle/soft tissue coverage of the repaired vessels and wound cleansing with normal saline were performed in all patients. Drains were left in place for 24-48 hours in all cases. Postoperatively, patients were closely monitored (for presence of distal pulses, capillary refill and temperature) and assessed for signs of secondary bleeding or wound infection. At the time of discharge, they were instructed to return to the vascular outpatient clinic for follow-up in two weeks. At the follow-up visit, the vascularity of the limb was assessed both clinically and by Doppler examination. Motor

deficits and wound complications were documented, and patients were instructed to return for follow-up, initially at one month and then every three months. Data were presented as frequencies and percentages and subsequently analysed using the Statistical Package for Social Sciences (SPSS) version 20.

This study Approved by Scientific Research and Publication Ethics Committee (Decision no: 2023/5054).

RESULTS

In this study, a total of 28 patients in our hospital underwent multiple vascular repair procedures due to missed vascular injuries 14 of them were penetrating, 10 of them blunt and 4 of them iatrogenic injuries. Of these, 7 patients (25%) had traumatic arteriovenous fistula, 3 patients (10.7%) had post-traumatic thrombosis and occlusion, and 1 patients (3.57%) had pseudoaneurysm and recurrent hemorrhage. Penetrating injuries such as gunshot, stab and vascular occlusive injuries were the most frequent cause of injury identified in 14 patients (50%). 10 patients (35.71%) suffered from blunt trauma and 4 patients (14.29%) from iatrogenic injury. The time between injury and hospital presentation ranged from 1 to 11 weeks (with a mean of 3.93 weeks). Lower limb vessels were involved in 18 cases (64.2%), upper limb vessels in 7 cases (25%), and neck vessels in 2 cases (7.14%). The most frequently involved vessel was the popliteal artery, which was reported in 7 cases (25%) (Table 1). The treatment of the injured arteries was segmental resection in 27 patients followed by an insertion of a graft (14 patients: saphenous vein graft, in 1 patient: polytetrafluoroethylene). The remaining patients had ligation (1 patient) or a primary repair (lateral suture or patch plasty - 11 patients). The venous side of arteriovenous fistula was generally closed with a primary suture. There was no operative mortality and significant perioperative morbidity.

Table 1. Region of vascular injury (n=28)

Anatomical site of injured vessel	Number of cases (n)	Percentage (%)
Superficial femoral artery	4	14.29
Popliteal artery	7	25.00
Common carotid artery	2	7.14
Common femoral artery	6	21.43
Axillary artery	2	7.14
Brachial artery	2	7.14
External iliac artery	1	3.57
Subclavian artery	1	3.57
Radial artery	2	7.14
Peroneal artery	1	3.57

Table 2. Causes, presentations and management of missed vascular injuries (n=28)

Cause of injury	Presentation	Operative management
Penetrating (n:14)	Pseudoaneurysm (17)	Excision and interposition vein graft (5)
		Excision and primary repair (11)
		Ligation (1)
Blunt (n:10)	AV fistulae (7)	Excision and repair with reverse vein graft (6)
		With PTFE graft (1)
Iatrogenic (n: 4)	Thrombosis (3)	All with Excision and repair with interposition vein graft
	Pseudoaneurysm with bleeding (1)	

DISCUSSION

Vascular injuries may be missed during physical examination and other diagnostic procedures, but prognosis varies with the type and extent of injury. Typically, most unnoticed arterial injuries are either promptly treated or stabilized, without compromising the distal circulation and perfusion (7,8). Assessing patients with suspected vascular injuries requires careful evaluation of their medical history and physical examination. A careful inquiry should encompass the nature of the injury, the extent of bleeding, and any associated symptoms indicating a compromised circulatory or nervous system. A meticulous physical examination is often the key to an accurate diagnosis. Patients experiencing distal ischemia, decreased or absent pulses, bruits, arterial bleeding, or an enlarging or throbbing hematoma are likely to have vascular injuries in the majority of cases. Stable and moderate haematoma, injuries to anatomically related nerves, or hypotension with complex causes are less highly indicative signs (9).

Despite palpable distal pulses and the lack of obvious signs of vascular injury, relying solely on physical examination can be misleading in the case of arterial injury (10). It is necessary to conduct a Doppler Pressure Index (DPI) measurement, Duplex scan or angiography to accurately evaluate such circumstances. A measured Ankle Brachial Pressure Index (ABPI) of less than 1.0 indicates significant vascular injury (11). When a case presents with low DPI, the affected limb should undergo Computerized Tomographic (CT) angiography or conventional catheter angiography (12,13). In all cases presented in this study, angiography was performed to ascertain the diagnosis and plan the management. CT angiography, which is less invasive and more accessible has been proven to be a potent and effective alternative to standard angiography in evaluating vascular injuries (14). Arteriography is essential for penetrating injuries near significant arteries in cases of peripheral vascular trauma, which require immediate surgical attention. All cases of missed arterial injuries in this study were managed with different open surgical techniques. Post-traumatic AVF are increasingly being treated by catheter-based endovascular techniques. Endovascular embolization has been employed to close arteriovenous fistulas in vessels and may assist in controlling bleeding, if open repair is required.

Furthermore, delayed diagnosis and treatment can lead to amputation or even fatality. Presently, the management of vascular trauma has noticeably advanced. The primary aims of treating vascular injuries are instant control of haemorrhage with vascular grafts and swift restoration of blood flow (15). To achieve successful treatment and management of vascular trauma, it is vital to address the pathophysiology of vascular injury. The aim of surgical care is to guarantee adequate blood flow, and the time spent without blood flow should be considered. Damage to nerves and muscles can result in disability and amputation, which is irreversible. While open surgical repair has traditionally been the preferred treatment for overlooked vascular injuries, the utilization of endovascular techniques for specific indications is gaining more recognition.

CONCLUSION

Trauma is often caused by fragments. This can lead to complications such as missed arterial injury. Many patients do not exhibit any definitive indications of vascular injury. Arteriography is highly recommended to assess the condition of patients with possible vascular injury, and patients with injuries close to major blood vessels need to be closely monitored. Surgeons must take precautionary measures to prevent missing any possible vascular injuries. Vascular injuries resulting from wounds can lead to significant delayed complications, even several months or years post-injury. Have a high level of suspicion and adhere strictly to the diagnostic approach for vascular trauma.

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