Cross-sectional Study

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Vascular trauma injury evaluation in Khorramabad, Iran: a cross-sectional study

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Background: Vascular trauma injuries are associated significantly with disabilities and mortality where prompt diagnosis and management are of great importance.
Objectives: In this study, the authors aim to evaluate the pattern of vascular trauma injuries.
Methods: This descriptive retrospective study was performed on patients with vascular injuries due to trauma referred to (Shohada Ashayer Hospital and Shahid Chamran Hospital, Khorramabad). Patients' files were evaluated for the following data: diagnostics, types of treatment and outcome, type of trauma, cause of trauma, anatomy of the injured site, duration of surgery, type of lesion, delayed complication, and requirement of revision surgery. The data obtained were descriptively evaluated using SPSSv22.
Results: Of 233 patients studied, 95.3% were males. The mean age of the patients was 29.15 ± 11.8 years. 82.8% of patients presented with penetrating trauma whereas 32.2% of patients had stab wound trauma. The most common sign at the time of referral was a loss of sensation in 54.9% of patients. Direct diagnosis based on clinical presentation was made in 79% of patients. The upper extremity was the most common site of vascular injury in 77.3% of patients with the involvement of radial and ulnar arteries, in 63.1%. 66.9% of patients underwent primary vascular repair, 92 received revision surgery, and 69 required blood transfusion.
Conclusion: Epidemiological studies of vascular injury can help clinicians and local healthcare centres to understand the pattern of vascular trauma based on the geographical location and train trauma surgeons and medical staff to provide effective and timely management.

Keywords: blood transfusion, mortality, surgeon, surgery, trauma, vascular injury

Introduction

Trauma is the third leading cause of mortality and morbidity[1]. In the United States, among children and adults aged younger than 45 years, 790 000 deaths are reported each year due to trauma[2,3]. The increased trend in vascular trauma injury has raised concerns, for it requires immediate management and diagnosis, particularly in cases where major vessels are involved[4,5]. Injuries with direct clinical presentation can be diagnosed and managed instantly[6], whereas those with indirect signs add diagnostic challenges since the outcomes of undiagnosed vascular injury can cause disability and even death[7].

HIGHLIGHTS

- -Trauma is the third leading cause of mortality and morbidity.
- -Vascular trauma injuries are associated significantly with disabilities and mortality.
- -Epidemiological studies of vascular injury can help clinicians and local healthcare centres.
- vascular trauma based on the geographical location and train trauma surgeons and medical staff.

Recent research and data have shed light on the persisting relevance and severity of vascular trauma injuries, prompting the need for continued investigation and improvement in management strategies[8]. Recent studies and incidences have provided fresh insights into the landscape of vascular trauma injuries[9]. A retrospective study conducted in a North-European level 1-trauma centre spanning from 2009 to 2018 focused on adults admitted with non-iatrogenic vascular trauma. This study underscored the enduring challenges and complexities associated with vascular trauma.

Advanced diagnostic modalities, resuscitation methods, vascular techniques, and prosthetics have improved the outcomes of vascular injuries in these patients[9]. The location of the injury, mechanism of the injury, age, geography, and hemodynamic parameters are important factors in determining the clinical outcomes[10–13]. Different studies have identified different patterns of these injuries. A study reporting civilian vascular trauma injury reported that thoracic and abdomen vascular injuries are significantly associated with mortality. Gunshot wounds were the

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most common cause of the injury and penetrating trauma was the most frequent[14,15]

This study aims to evaluate vascular trauma injuries among patients referred to two main trauma centres.

Methods

In this study, our primary objective was to evaluate the pattern of vascular trauma injuries referred to two major trauma centres.

Study design

This retrospective descriptive study was conducted to analyze the data of patients with vascular injuries, confirmed through clinical examination or other diagnostic methods, resulting from trauma. The study period encompassed cases referred to (Shohada Ashayer Hospital and Shahid Chamran Hospital, Khorramabad). Patients in whom vascular injuries were ruled out were excluded from the study.

Data collection and variables

Records of patients admitted with vascular injuries during the period were evaluated. Information required for this study including age and sex of patients, duration of surgery, complications of vascular injury, mechanism of vascular injury, type of damaged vessel, location of vascular injury, clinical signs, comorbidities, vital signs on arrival, method Diagnostic tests, types of treatment, treatment results, the time interval from the time of injury to the start of treatment, the average length of hospital stay, receiving blood products (packed cells and freshly frozen plasma) need for fasciotomy, number of surgeries performed in the same hospital, number Re-admission due to delayed complications, cost of hospitalization, a physician treating vascular injury, duration of surgery, type of anaesthesia, description of the type of lesion.

Statistical analysis

Data collected from the patient records were subjected to statistical analysis using SPSSv22. Descriptive statistics, including mean, standard deviation, and frequency, were employed to summarize the data. Tables and graphs were used to present the results. Comparative analysis was carried out using χ^2 and *t*-test. A p value less than 0.05 was considered statistically significant.

Ethical approval

The study was approved by the ethical committee of Lorestan University (Shohada Ashayer Hospital and Shahid Chamran Hospital, Khorramabad). This study adheres to the STROCSS (Strengthening the Reporting of Cohort Studies in Surgery) criteria[16], for comprehensive and transparent reporting of surgical cohort studies. Ethical guidelines set forth by the Declaration of Helsinki were strictly followed throughout the study to ensure the ethical treatment of participants and the handling of their medical data.

Results

A total of 233 patients were included in the study from both centres. The mean age of the patients was 29.15 ± 11.8 years (range: 02–78 years). The patients aged 30 years and less were 66.1% and those above 30 years were 33.1%. Overall, 222 males (95.3%) and 11 (4.7%) were female.

One hundred ninety-three patients (82.8%) presented with penetrating trauma and 40 patients (17.2%) had blunt trauma (Fig. 1). Among penetrating trauma cases, a knife stab was reported in 32.2%, trauma due to glass injury in 31.8%, and 5.2% had a gunshot wound. Among blunt trauma patients, 12.4% had car accidents, 2.1% had fallen, 1.7% had pedestrian accidents and 0.8% had sports injuries.

At the time of referral, 84.5% of patients had stable hemodynamics whereas 15.5% of patients presented with unstable hemodynamics. Patients (67%) had active bleeding, which was the most common clinical symptom in the patients. Other clinical presentations included numbness (54.9%), loss of pulse (49.8%), reduced or asymmetric pulse (25.3%), distal limb ischaemia (23.6%), bone fracture (13.7%), haematoma (9.9%), haemorrhagic shock (6%), progressive haematoma (2.6%) and bruit sound (1.7%).

Vascular injuries in 184 patients (79%) were diagnosed with clinical examination only and without using other diagnostic methods. In 24 patients (10.3%) the diagnosis was made using computed tomography (CT) angiography, in 22 patients (9.4%) with sonography, and in 3 cases (1.3%) the diagnosis was made using angiography. Of 233 patients, 226 patients (97%) presented with arterial injury 89 patients (38.2%) had a venous injury and 86 (36.9%) patients were diagnosed with simultaneous arterial and venous injury.

The frequency distribution of the anatomical location of the trauma in the study population is reported. Injury to the upper limb was seen in 180 cases (77.3%), lower limb in 36 cases (15.5%), thorax in 7 cases (3%,) abdomen and pelvis in 6 cases (2.5%), and neck in 4 cases (1.7%).

Based on the location of vascular damage, radial and ulnar artery injuries were in 147 cases (63.1%) followed by brachial 32 cases (13.7%), femoral in 17 cases (17.3%), popliteal in 14 cases (6%), tibioproneal 13 cases (5.6%), digital 5 cases (2.1%), carotid 5 cases (2.1%), subclavian 4 cases (1.7%), axillary 4 cases (1.7%), abdominal aorta 2 cases (0.9%), thoracic aorta 2 cases (0.9%), renal 1 case (0.4%), coeliac and mesenteric 1 case (0.4%) and gastroepiploic 1 case (0.4%).

Out of 5 cases (2.1%) of carotid artery damage, due to active bleeding, 4 cases were repaired urgently, and recovery was achieved without leaving complications like a stroke. Of the 2 cases of abdominal aortic injury (0.9%), one was due to blunt trauma caused by a car accident, and one was penetrating trauma due to penetration of an iron rod from the anterior abdomen, both cases underwent vascular graft repair surgery where one case showed no improvement and one case developed severe postoperative bleeding and died. Of the 2 cases of thoracic aortic artery injury (0.9%), one case died in the emergency room and one was discharged after basic treatment due to stable hemodynamics and lack of malperfuiosn. Three cases of renal, gastroepiploic, and coeliac artery injuries were diagnosed by a general surgeon during an emergency laparotomy and were repaired with an arterial ligature.

In venous injury, 86 cases (36.9%) were associated with arterial injury including radial and ulnar veins (36.5%) as the most common venous injury (36.5%), followed by jugular, iliac, renal, basilic, cephalic and saphenous. All these cases were treated with ligation.

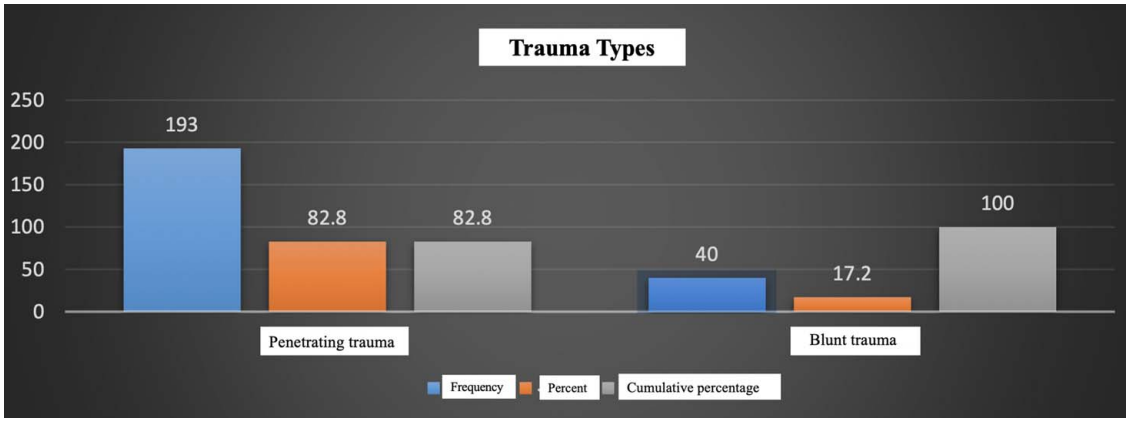

Figure 1. Frequency distribution of different types of trauma in the studied patients.

The frequency of concomitant injuries with vascular injury was seen in 214 patients (91.8%). These included nerve injury in 147 patients (63.1%), tendon rupture in 132 patients (56.7%), soft tissue and muscle defects in 78 patients (37.3%), a bone fracture in 52 patients (22.3%), chest injury in 16 patients (6.9%), abdomen and pelvis 9 patients (3.9%), skull and brain injury 4 patients (1.7%) and face injury 1 patient (0.4%).

According to Table 1, of 233 patients, 61 patients (26.2%) underwent arterial repair in less than 6 h after the accident, and in 172 patients (73.8%) the repair was performed after 6 hours. One hundred repairs were performed by vascular surgeons, 74 surgeries were performed by a general surgeon, 55 of those by a plastic surgeon, and 4 surgeries were performed by an orthopaedic surgeon. 93.1% of surgeries were performed under general anaesthesia with a mean duration of 175 ± 6 min (50-625 min).

In 156 patients (66.9%) arterial damage was repaired by primary vascular repair method (including primary and lateral anchorage), in 60 patients (25.8%) by venous graft method (graft interposition or bypass graft), and in 11 patients (4.7%) were treated by arterial ligation. In 6 cases (2.6%) of minor arterial injury no surgical intervention was performed.

According to Table 2, in the case of various types of arterial injury after exploration 135 cases (57.9%) of the arteries were completely severed, 83 cases (35.6%) partially damaged, in 70 cases (30%) arterial thrombosis was seen, 14 cases (6%) had intimal femoral artery injury, 4 cases (1.7%) were presented with vascular spasms, 4 cases (1.7%) showed crush injury and 3 cases (1.3%) of deep vein thrombosis was seen.

The most common complications due to vascular injury following trauma were compartment syndrome (12%), necrosis (9.9%), rhabdomyolysis (7.7%), infection (7.3%), acute kidney injury (6%), thrombosis (4.7%), ischaemia (3.4%), haematoma (3%) and surgical site bleeding (2.1). 171 patients did not report any complications (73.4%). 141 patients (60.5%) underwent surgery once and 92 patients underwent surgery more than once (Table 3).

In terms of other surgeries performed, 38 patients (16.3%) underwent debridement of necrotic tissue and skin graft, 18 patients (7.7%) received internal fixators, 12 patients (5.2%) received thoracostomy, 6 patients (2.6%) underwent organ transplant, 6 patients (2.6%) received laparotomy, and 1 patient (0.4%) underwent laparoscopy and thoracotomy, respectively.

Of the total number of patients studied, 69 required blood transfusion, of which 69 (24.9%) and 28 (11.2%) received fresh frozen plasma. About 10% of patients received more than 4 pack cells.

In terms of length of hospital stay, about 55 patients (23.6%) were hospitalized for more than a week of which 32 were presented with blunt trauma (23 vehicle accidents, 5 pedestrian accidents, 3 falls from a height, and 1 collision) and 23 patients with penetrating trauma (8 shotguns, 5 stab wounds, 5 gunshot, and 3 glass wounds), all of which, in addition to arterial injuries, had other injuries like fractures, neuromuscular injury. The types of arteries involved were as follows: femoral 15 cases, popliteal 12 cases, brachial 9 cases, tibioperoneal 8 cases, radial 8 cases, ulnar 5 cases, carotid, and axillary 2 cases each and renal, subclavian, and mesenteric 1 case each. Out of 55 patients, 30 patients had some degree of disability, 20 patients fully recovered, 3 patients were amputated and 2 died.

After repairing the damaged artery, about 19 patients (8.2%) due to the need for additional surgeries to repair nerves, tendons,

Table 1

Frequency distribution of frequency distribution the time interval between injury and the start of treatment.

The interval between the onset of vascular damage and the start of surgery	Frequency	Percent	Cumulative percentage
6 h >	61	26.2	26.2
6–12 h	28	12	38.2
12 h <	144	61.8	100

Table 2

Frequency distribution of different types of arterial damage.

Description of vascular lesion	Frequency	Percent
Partially damaged	135	57.9
Partial cutting	83	35.6
Arterial thrombosis	70	30
Intimal femoral artery injury	14	6
Vascular spasms	4	1.7
Crush injury	4	1.7
Deep vein thrombosis (DVT)	3	1.3
Arteriovenous fistula	1	0.4

Table 3

Frequency distribution of complications due to vascular injuries following trauma in the studied patients.

Complications after treatment	Frequency	Percent
Compartment syndrome	28	12
Necrosis	23	9.9
Rhabdomyolysis	18	7.7
Infection	17	7.3
Acute kidney injury	14	6
Thrombosis	11	4.7
Ischaemia	9	3.4
Haematoma	7	3
Operational bleeding	5	2.1
Arteriovenous fistula	4	1.7
Pseudoaneurysm	4	1.7
Amputation	3	1.3
Osteomyelitis	2	0.9
Acute respiratory distress	1	0.4
Pneumonie	1	0.4
Septicaemia	1	0.4
No side effects	171	73.4

and fractures and unavailability of orthopaedic surgeons or plastic surgeons, unacceptance by the surgeons available, or lack of sufficient facilities were referred to other centres.

Forty-seven patients (2.21%) were readmitted due to complications associated with vascular injuries, including functional disability (inability to use the injured limb in daily work) as well as infection due to surgery and vascular complications after surgery such as venous arterial fistula and thrombosis (Table 4).

Discussion

This study was performed to evaluate vascular injuries among blunt and trauma patients. Our study reported that among upper extremity vascular injuries radial and ulnar artery injuries followed by brachial injury had the highest incidence whereas, among lower extremity injuries, femoral and popliteal artery injuries had the highest incidence, respectively.

In comparison to the study by Rozycki *et al.*[17]. who also examined vascular injuries in trauma patients, our findings align in terms of the high incidence of upper extremity injuries. However, their study reported a different pattern with tibial artery involvement being more common in lower extremity injuries. This variance may be attributed to regional or patient demographic differences. They reported that among blunt trauma patients' lower extremity injury is more common with tibial artery involvement and brachial artery involvement in lower extremity injury. 95% of the trauma patients in the study had associated fractures or dislocations. Ligation was the most common treatment performed for vascular damage.

Table 4

Frequency distribution of treatment outcomes of patients with vascular injury.

Treatment results	Frequency	Percent	Cumulative percentage
Treated	121	52	52
Functional disability	105	45	97
Amputation	3	1.3	98.3
Mortality 24 h ago	3	1.3	99.6
Mortality after 24 h	2	0.4	100

Regarding the distribution of trauma types, we observed that 95% of the trauma patients in our study had associated fractures or dislocations. Furthermore, ligation was the most common treatment performed for vascular damage. This aligns with the findings of Perkins *et al.*[18]. who evaluated vascular trauma injuries in British trauma centres, and reported that there were 53% of cases of penetrating trauma caused vascular injuries. The severity of blunt trauma vascular injuries was seen to be higher and had greater mortality, ICU stays, duration of hospitalization, limb amputation, and need for blood transfusion. Of all trauma injuries, vascular injuries accounted for 4%. Stab wounds were the most common type of wound and arterial injuries were the commonest. The study also reported that central vessels were more commonly severed than those at the extremities. Contrast CT scans were performed mostly for diagnosis and open surgeries and radiological interventions were commonly performed as therapeutic procedures.

Comparing our study to the work of Gupta *et al.*[19]. who conducted a 5-year epidemiological study in Australia, we noted some contrasts in the prevalence of vascular injuries. In our study, upper limb injuries were most common, with radial and ulnar vessels being commonly affected. Clinical evaluation followed by CT angiography was the primary diagnostic method. Conversely, in their study, lower limb and neck stab injuries were more common, with thoracic and abdominal vascular injuries having the highest mortality. The differences may stem from variations in trauma epidemiology between our respective regions.

Kauvar *et al.*[20]. reported that among lower limb vascular injuries in their region, injury to the superficial femoral artery had greatest incidence which was also the leading cause of mortality. Penetrating trauma wounds were most common in the study caused by gunshots. Following the arteries of upper extremity, femoral artery injury had greatest incidence in our study. A report from The American Association for the Surgery of Trauma presented that blunt trauma accounted for greater vascular injuries compared to penetrating trauma and motor vehicle accident was the most frequent cause of trauma. Computed tomography angiography was used to identify vascular injury followed by operative exploration. A vertebral artery had the greatest incidence of vascular injury in the study and ~50% of the patients received non-operative management. The most common complication reported was the need for reintervention and operation due to vascular injury. 39.5% of patients underwent revision surgery in our study and most of the patients in our surgery received primary repair of the injury[21].

Our study is a retrospective discretional study that allows clinicians and healthcare authorities to understand the pattern of vascular trauma in the region. However, our study lacks a comparative analysis that can identify these patients' risk factors for bad prognosis, morbidity, and mortality. The retrospective design may introduce selection bias, as the study relies on data collected from medical records, which may not capture all relevant variables or outcomes. This design also makes it challenging to establish causality and temporality in certain associations. Additionally, the study was conducted in a specific geographic region, which may limit the generalizability of the findings to broader populations. Furthermore, the data presented in this study were obtained from two major trauma centres, which might introduce an element of referral bias, as patients with more severe

or complex cases may have been disproportionately represented. Therefore, we recommend further studies in this area targeting comparative analysis.

Significant clinical implications

In our study, the reported complications have several significant clinical implications. Compartment syndrome, with a prevalence of 12%, can lead to compromised blood flow in the affected limb, potentially resulting in tissue necrosis and functional impairment. Necrosis, observed in 9.9% of cases, signifies the risk of tissue death, potentially necessitating additional surgical interventions for tissue debridement and grafting. Rhabdomyolysis, seen in 7.7% of patients, may lead to kidney injury due to the release of myoglobin, emphasizing the importance of monitoring renal function in these cases. Infections, with an incidence of 7.3%, underline the need for stringent wound care to prevent septic complications. Thrombosis, affecting 4.7% of patients, can result in recurrent ischaemic events, making anticoagulation therapy and vigilant follow-up crucial. The presence of these complications underscores the complexity of vascular trauma cases, highlighting the importance of a multidisciplinary approach, early diagnosis, and comprehensive management strategies to mitigate adverse clinical outcomes and ensure optimal patient recovery.

Conclusion

This study illuminates the diverse landscape of vascular trauma injuries, demonstrating their origin, anatomical distribution, associated complications, and mortality rates. It becomes evident that these patterns are profoundly influenced by geographic factors, injury mechanisms, regional healthcare systems, and the level of expertise available. To mitigate mortality and morbidity, it is paramount to establish standardized international and national guidelines and protocols for the timely and efficacious diagnosis and management of vascular injuries. This research underscores the urgent need for tailored, location-specific strategies to enhance the care of vascular trauma patients and reduce the overall burden of these injuries.

Ethical approval and consent to participate

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent for publication

Not applicable.

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Author contribution

M.S. and M.J.M.: conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript. M.B.: designed the data collection instruments, collected data, carried out the initial analyses, and reviewed and revised the manuscript. A.M. and M.G.: coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content.

Conflicts of interest disclosure

The authors deny any conflict of interest in any terms or by any means during the study.

Research registration unique identifying number (UIN)

Research Registry Unique: researchregistry7424.

The study was approved by the ethical committee of Lorestan University of Medical Sciences (IR.LUMS.REC.1399.072).

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Guarantor

Masoud Sharifian.

Data availability statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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