S Afr J Surg. 2025;63:23-27. Online first
https://doi.org/10.36303/SAJS.00167

S Afr J Surg
ISSN 038-2361

TRAUMA SURGERY

Epidemiology of vascular injury in trauma-ICU patients over a decade – the KZN experience

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Background: Vascular injuries are among the causes of preventable death and disabilities. Vascular injuries are observed in both the civilian and combat setting. The vessel injured and mechanism of injury are important considerations prior to the management.
Methods: This was a combined retrospective and prospective study from January 2013 until December 2022 and included patients with vascular trauma requiring trauma-ICU admission. Frequencies and percentages were calculated to summarise categorical data. Median, quartiles and range were calculated to summarise numerical data. Ethical clearance was granted by the University of KwaZulu-Natal BREC (BREC 0004353/2022) and the Department of Health.
Results: A total of 2 805 trauma patients were treated by the author's institution over a period of 10 years. From this number, there were 153 (5.5%) patients with vascular injuries who met the criteria to be enrolled in the study. The most commonly injured vessel was the CCA, with a total of 26 (13.5%) and the most common associated injury was bone fractures with a total number of 66 (53.2%). Penetrating trauma accounted for 99 (64.7%) of the cases, which is significantly higher than the blunt trauma component of 54 (35.2%) cases. Of the penetrating injuries 51 (33%) were due to stab wounds, 46 (30%) were due to gunshots, one (0.6%) was due to a bush knife and one (0.6%) due to a bicycle spoke accident.
Conclusion: This study makes an important contribution to the literature because it focuses on the epidemiology of vascular injury only in a subset of patients that are in ICU, whereas most studies focus on all patients. In order to prevent these injuries and associated injuries, the Department of Health with other government departments needs to develop practical and effective preventive measures.
Keywords: polytrauma, vascular injury, epidemiology, KwaZulu-Natal, penetrating trauma, blunt trauma

Introduction

Vascular injuries are among the causes of preventable death and disabilities, and the leading cause of death and disability in both the civilian and military settings.[1,2]

Vascular trauma accounts for approximately 1% of injuries to the extremity.[3] It can arise from blunt injuries, penetrating and combined injuries. These injuries can be seen in different scenarios, such as military or in a civilian setting, where it can either be interpersonal violence or iatrogenic injuries. A previous local study described a rate of 5.9% of blunt vascular injury in polytrauma patients.[4] Although the penetrating injuries remain high compared to the blunt injuries, most hospitals are now seeing an increasing number of vascular injuries as a result of blunt trauma, which presents secondary to motor vehicle collisions (MVC), mining accidents, and industrial incidents in South Africa.[5]

Since blunt vascular injury is usually associated with other non-vascular injuries, it tends to carry a higher rate of mortality compared to penetrating vascular injury. The amputation rate is also higher in blunt extremity vascular injury compared to penetrating vascular injury, especially when associated with comminuted fractures.[6]

Vascular injuries are challenging especially in the setting of a polytrauma patient since they require urgent intervention to avert loss of life or limbs. The fact that serious vascular trauma may also present with only subtle, or even no signs at all, adds more challenge. A variation is observed in terms of the time of presentation, clinical presentation, and type of injury. The presentation may be immediately after the injury up to months or even years after the initial injury. The clinical presentation is due to bleeding, vascular insufficiency, embolisation, pseudoaneurysm and arteriovenous fistula (AVF).[7,8]

The civilian vascular trauma is seen frequently with young males. It can also be seen at any age because of MVC, gunshot wounds (GSW), stab, bomb blast and iatrogenic injuries. In low-income countries, the proliferation in the number of high-speed vehicles, with poor road infrastructure and inattentive motorists, has resulted in a rise in traumatic vascular injuries from MVC. Peripheral vascular injury makes up 6% of the major trauma and 40–60% of the vascular trauma treated in trauma centres.[6,8]

In higher-income countries there has been good progress in terms of trauma system development, injury prevention, road safety interventions, and emergency medical services. While this has resulted in significant improvements in terms of the mortality from this injury, death immediately after the trauma remains as high as 60%. Injuries account for 5.3% of all deaths, and this remains the leading cause of death in people aged 15 to 29 years.[9]

The incidence of civilian vascular trauma has reported to be between 1.6% and 8% of adults admitted for major trauma. Vascular trauma is a major cause of morbidity and mortality. Mortality is determined by the location of the injured vessel as transection of the thoracic aorta and severe abdominal vascular injuries are associated with the highest mortality. The management of these patients places a significant burden on health resources.[9,10]

Modernisation has brought high-speed vehicles, modern weapons, highly combustible substances and other factors that impart high energy to the victims causing complex injuries. Head and major vascular injuries are the leading causes of morbidity and death. As much as several advances in the surgical field have occurred for management of complex trauma patients, there has not been much in terms of the initiative to create awareness and prevention of these devastating injuries.[10]

This study aimed to evaluate the epidemiology, demographics, mechanism of injury, investigations and distribution of arterial and venous injuries of patients admitted in trauma ICU at the study institution. Management and outcome are not included here.

Methods and materials

A retrospective cross-sectional study was performed including patients with vascular trauma requiring ICU admission between January 2013 and December 2021. Additional data was collected prospectively between January 2022 and December 2022. All patients who were admitted in trauma ICU with vascular injury with or without any associated injury were included in the cohort. Patients who died with the suspicion of vascular injury, prior to the confirmation of the injury were excluded. The injury was confirmed either by imaging or via exploration. The pre-designed data proforma with the following variables was used – age, sex, mechanism of injury, imaging modality, injured vessel and associated injuries. Data were then cleaned manually for consistency and for any missing values. The data were analysed using Stata version 17 (Statacorp, College Station TX). Frequencies and percentages were calculated to summarise categorical data. Median, quartiles and ranges were calculated to summarise numerical data.

Ethical clearance was granted by the University of KwaZulu-Natal BREC (BREC 0004353/2022) and the Department of Health. All data were de-identified in the data collection sheet.

Results

During the 10-year period a total of 2 805 patients were treated at the trauma ICU. A total of 153 (5.5%) patients who had vascular trauma, with or without associated other injuries, met the eligibility criteria and were enrolled in the study.

Demographic characteristics

Among the total of 153 vascular trauma patients, 140 (91.5%) were males while the remaining 13 (8.5%) were females. The ratio of males to females was 11:1. The median age was 29 years with the range being 5–67 years. Table I details the demographics of the vascular trauma cohort.

Table I: Demographic characteristics

Sex	**Frequency**	**Percentage**	**M:F ratio**	
Male	140	91.5%	11:1	
Female	13	8.5%		
Total		153		
Age				
Minimum	1st Quartile	Median	3rd Quartile	Maximum
5	24	29	37	67

Mechanism of injury and diagnosis

Penetrating trauma accounted for 99 (64.7%) of the cases, which is significantly higher than the blunt trauma component (n = 54, 35.3%). Of the penetrating injuries 51 (33%) were due to stabs wounds, 46 (30%), secondary to gunshots, one (0.6%) due to a bush knife and one (0.6%) an accidental bicycle spoke injury. Among the blunt trauma cases 53 (34.6%) were due to road traffic collisions, while one (0.6%) was due to self-inflicted hanging. For the purpose of diagnosis, a duplex ultrasound was performed in 2 (1.3%) cases, computerised tomographic angiography (CTA) was performed in 125 (81.7%) cases and catheter-directed angiography (CDA) was required in 38 (24.8%) cases. All of the patients who had CDA, were initially investigated with CTA. In 26 (17.0%) cases the diagnosis was made on clinical grounds (physical examination) alone, without the use of the imaging. Table II illustrates the demographic distribution of the injuries and initial imaging performed.

Table II: Mechanism of injury and diagnosis

Penetrating				**Blunt**		
GSW	Stab	Accident	Bush knife assault	MVC (RTC)	PVC (RTC)	Hanging
46(30%)	51 (33%)	1 (0.6%)	1 (0.6%)	30 (21.6%)	23 (15%)	1 (0.6%)
Total	99 (64.7%)			54 (35.7%)		
Diagnosis						
Physical examination only		Duplex ultrasound		CTA		CDA
26 (17%)		2 (1.3%)		125 (81.7%)		38 (24.8%)

RTC – Road traffic collisions, GSW – Gunshot wounds, MVC – Motor vehicle collisions, PVC – Pedestrian vehicle collisions

Table III: Vascular injury distribution

Arterial injuries		Venous injuries	
Injured artery	**Frequency**	**Injured vein**	**Frequency**
Common carotid artery	26 (13.5%)	Internal jugular vein	13 (6.7%)
Aorta	25 (13%)	Inferior vena cava	5 (2.6%)
Superficial femoral artery	15 (7.8%)	Subclavian vein	3 (1.6%)
Brachial artery	14 (7.6%)	External iliac vein	3 (1.6%)
Popliteal artery	11 (5.7%)	Axillary vein	3 (1.6%)
Axillary artery	9 (4.7%)	External jugular vein	2 (1%)
Subclavian artery	8 (4.1%)	Common iliac vein	2 (1%)
External iliac artery	7 (3.6%)	Common femoral vein	2 (1%)
Vertebral artery	6 (3.2%)	Internal iliac vein	1 (0.5%)
Internal carotid artery	5 (2.6%)	Forearm vein	1 (0.5%)
Forearm arteries	4 (2.7%)	Pelvic venous plexus	1 (0.5%)
Profunda femoris artery	4 (2%)	Femoral vein	1 (0.5%)
External carotid artery	3 (1.6%)	Profunda vein	1 (0.5%)
Common iliac artery	3 (1.6%)	Popliteal vein	1 (0.5%)
Common femoral artery	3 (1.6%)		
Innominate artery	2 (1%)		
Internal mammary artery	2 (1%)		
Thyrocervical trunk	2 (1%)		
Crural arteries	2 (1%)		
Internal iliac artery	2 (1%)		
Visceral arteries	1 (0.5%)		
Total	154 (79.8%)	**Total**	39 (20.2%)
Total		193 (100%)	

Vascular injury distribution

In our cohort of 153 patients, there were a total of 193 vascular injuries. The majority of injuries (n = 154, 79.8%) were arterial with venous injuries constituting 20.2% (n = 39).

The most common arterial injuries were common carotid artery (CCA) injuries with a total of 26 (13.5%) followed by aortic injuries with a total of 25 (13.0%). The most common venous injuries were to the internal jugular vein (IJV), with a total of 13 (6.7%) followed by inferior vena cava (IVC) in 2.6% (n = 5) of cases. The distribution of vascular injuries is detailed in Table III.

Associated injuries

Out of 153 patients with vascular injuries, 124 (81.0%) had associated injuries, while 29 (18.9%) had no associated injuries. The most common associated injuries were bone fractures, with a total number of 66 (53.2%). The second most common associated injury was the presence of a haemothorax, which was observed in 29 (23.4%) of the patients followed by traumatic brain injuries which were found in 17 (13.7%) patients. The rest of the identified polytrauma injuries are shown in Table IV.

It is important to include the injury severity in the assessment of trauma patients. The commonly used scoring systems are the injury severity score (ISS) and new injury severity score (NISS). Both scores were similar irrespective of the mechanism of injury (Table V).

Table IV: Associated injuries

No associated injuries	Associated injuries	
29 (18.9%)	124 (81%)	
	Nature of injury	**Frequency**
	Bone fracture	66 (53.2%)
	Haemothorax	29 (23.4%)
	Traumatic brain injury	17 (13.7%)
	Pneumothorax	13 (10.5%)
	Liver injury	13 (10.5%)
	Laryngeal injury	11 (8.9%)
	Lung contusion	9 (7.2%)
	Small bowel injury	9 (7.2%)
	Splenic injury	9 (7.2%)
	Limb compartment syndrome	9 (7.2%)
	Peripheral nerve injuries	7 (5.6%)
	Oesophageal injury	6 (4.8%)
	Renal injury	4 (3.2%)
	Spinal injury	4 (3.2%)
	Diaphragmatic injury	3 (2.4%)
	Urogenital injury	2 (1.6%)
	Tendon injury	2 (1.6%)
	Eye injury	1 (0.8%)
	Tracheal injury	1 (0.8%)
	Stomach injury	1 (0.8)
	Pancreatic injury	1 (0.8%)

Table V: Trauma scores – injury severity score (ISS), new injury severity score (NISS), interquartile range (IQR)

ISS		NISS	
Median	IQR	Median	IQR
25	16–33	26	18–34
Penetrating injury		**Penetrating injury**	
Median	IQR	Median	IQR
20	16–26	25	18–32
Blunt injury		**Blunt injury**	
Median	IQR	Median	IQR
29	18–43	34	23–45

Discussion

Over the past few years there has been an increasing number of vascular injuries in the civilian setting. The mechanisms of these injuries vary from population to population. In higher income countries the mechanism of vascular injury is most commonly road traffic collisions, with penetrating injury usually due to iatrogenic injuries.[11]According to the American Association for the Surgery of Trauma (AAST), blunt causes are more frequent than penetrating except during military conflicts.[12] In South Africa, a lower-middle-income country, the mechanism of injuries, however, differs to those of higher-income countries. In our cohort, 99 (64.7%) were penetrating, while 53 (34.6%) were due to road traffic collisions. For those with penetrating injuries, 51 (33%) were secondary to stab wounds and 46 (30%) were due to GSW. Stab wounds and GSW had almost equal distribution and the fact that there is such a high number of injuries related to GSW is alarming. The female-to-male ratio and the median age of our patients were in keeping with the global trends, as trauma is mainly observed in young males.[13,14] The findings demonstrated that most of the patients sustaining vascular injury are males (91.5%) of the young adult age group, with a median age of 29 years. In our cohort there were only 2 (1.3%) paediatric patients with ages 5 and 8 years. The findings are in keeping with the observation in other studies.[12]

Polytrauma patients require a very dynamic approach with early identification of all the affected systems. Polytrauma patients with associated vascular injury tend to have higher ISSs. In our cohort the median for ISS was 20. In the local study the median ISS on patients who sustained blunt vascular trauma was 34.[4]

The mechanism of the trauma is crucial in determining the severity and the outcome of the injury as blunt injury tends to be associated with an increased injury severity and worse outcomes compared to penetrating injury.[15] In general, patients with vascular trauma have multiple injuries, such as complex fractures and amputations, with increased post-surgical complications and incapacity.[13] Thoracic aortic rupture is a leading cause of immediate death secondary to deceleration injury. Only a small fraction of patients with partial or completely contained rupture of the aorta survive to hospital. These patients have sustained significantly high forces leading to significant associated injuries as well.[3,15,16] Vascular injury of the limbs associated with fracture especially of the pelvis is associated with severe consequences for the patient such as limb loss.[17-19]

Early diagnosis of vascular injury is crucial to save a life, to preserve a limb or to prevent morbidity.[5,20] The diagnosis of vascular injury varies from clinical examination, non-invasive assessment to invasive assessment.[20] In our cohort the most commonly used investigations were CTAs which was performed for 81.7% of the patients and CDAs which were done in 24.8% of cases. The CDA was mainly for those patients who also required endovascular intervention since the advantage of this image modality includes the ability to intervene in the same setting. Some patients, such as those with haemodynamic instability, active bleeding and threatened limbs do not require imaging prior to vascular exploration, and in our cohort 17% of the patients did not receive imaging prior to the intervention.

Depending on the injured anatomical area, several associated injuries can be observed. These injuries can be broadly categorised into head or neck (traumatic brain injuries and facial fractures); thorax (intrathoracic and visceral injuries); abdomen (intra-abdominal, visceral, pelvic and spine injuries) and extremity (fracture and peripheral nerve injuries). Associated injuries in neck, thorax, and abdomen tend to have higher rates of mortality than the associated extremity injuries.[15] In our cohort, the majority of the patients (81.0%) had associated injuries. The top three associated injuries were fractures which were observed in 55.2%, this was followed by a haemothorax which was observed in 23.4% of cases and traumatic brain injury which was observed in 13.7%.

The vascular injuries can be classified according to the anatomical area involved such as peripheral vascular injury (upper limb and low limb) or central vascular injuries (neck, thorax and abdomen). The other classification is either arterial, venous or combined injury. Arterial injury is more frequently seen compared to venous injury. Peripheral vascular injuries are observed more frequently than the central vascular injury.[1,15] However, a local study revealed 93.5% of arterial injuries and 21.5% of venous injuries occurred in the cervico-mediastinal region.[21] In the present study, 79.8% arterial injuries and 20.2% venous injuries were observed. In the present cohort most of the injuries were central, mainly involving the neck and thorax, with CCA and thoracic aortic injuries being the most common injuries at 13.5% and 13.0%, respectively.

In terms of the limitations, the majority of the data were retrospective, with the risk of missing information, however this is partly mitigated by the electronic patient record.

Conclusion

Although in the present study the incidence of 5.5% for vascular injury was low, the major vessels in the form of CCA and thoracic aorta were more frequently injured than the injuries of peripheral vessels. The mechanism of injury varies depending on the injured vessel; however, in our setting penetrating injuries are observed more frequently. These vascular injuries are likely to be associated with other injuries. This study makes an important contribution to the literature because it focuses on the epidemiology of vascular injury only in a subset of patients who are in ICU, whereas most studies focus on all patients. The victims are predominantly young patients, who are still expected to contribute to the labour force and the economy of the country. To deal with this form of injury the Department of Health in collaboration with other government departments needs to develop well-informed preventative measures to avoid these injuries.

Conflict of interest

The authors declare no conflict of interest.

Funding source

No funding was required.

Ethical approval

Prior to commencement of the study ethical approval was obtained from the University of KwaZulu-Natal Biomedical Research Ethics Committee: BREC/00004353/2022.

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REFERENCES

1. Mirdamadi N, Bakhtiari M, Baratloo A, Fattahi MR, Farshidmehr P. An epidemiologic overview of traumatic vascular injures in emergency department: a retrospective cross-sectional study. Arch Acad Emerg Med. 2022;10(1):e59. https://doi.org/10.22037/aaem.v10i1.1663.
2. Patel JA, White JM, White PW, Rich NM, Rasmussen TE. A contemporary, 7-year analysis of vascular injury from the war in Afghanistan. J Vasc Surg. 2018;68(6):1872-9. https://doi.org/10.1016/j.jvs.2018.04.038.
3. Huber GH, Manna B. Vascular extremity trauma. [Updated 2023 Apr 19]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK536925/.
4. Muckart DJ, Pillay B, Hardcastle TC, Skinner DL. Vascular injuries following blunt polytrauma. Eur J Trauma Emerg Surg. 2014;40:315-22. https://doi.org/10.1007/s00068-014-0382-y.
5. Rasmussen TE, Tai NR. Rich's vascular trauma e-book. Elsevier Health Sciences; 2021.
6. Gebregiorgis D, Nega B, Seyoum N. A perspective of extremity vascular trauma epidemiology and its management in a resource limited set up. Clin Surg Res Commun. 2021;5(3):27-34. https://doi.org/10.31491/CSRC.2021.09.080.
7. Dhillan R, Bhalla A, Kumar Jha S, Singh H, Arora A. Vascular injuries due to penetrating missile trauma in anti-terrorism ops. J Trauma Inj. 2019;32(2):93-100. https://doi.org/10.20408/jti.2018.032.
8. Nwafor IA, Eze JC, Akanni BA. The civilian vascular trauma in a lowincome country - the determinant factors of morbidity and mortality. Niger J Med. 2020;29(2):224-8. https://doi.org/10.4103/NJM.NJM_23_20.
9. Johannesdottir B, Geisner T, Gubberud E, Gudbjartsson T. Civilian vascular trauma, treatment and outcome at a level 1-trauma centre. Scand J Trauma Resusc Emerg Med. 2022;30(1):1-11. https://doi.org/10.1186/s13049-022-01059-5.
10. WHO Organization. World health statistics 2010: WHO; 2010.
11. Jawas A, Hammad F, Eid HO, Abu-Zidan FM. Vascular injuries following road traffic collisions in a high-income developing country: a prospective cohort study. World J Emerg Surg. 2010;5:1-5. https://doi.org/10.1186/1749-7922-5-13.
12. Kobayashi L, Coimbra R, Goes Jr AM, et al. American Association for the Surgery of Trauma-World Society of Emergency Surgery guidelines on diagnosis and management of peripheral vascular injuries. J Trauma Acute Care Surg. 2020 1;89(6):1183-96. https://doi.org/10.1097/TA.0000000000002967.
13. Soares LT, Bastos CC, Koury Junior A, Pereira AJF. Vascular injuries in the state of Pará, Brazil, 2011-2013 and their relation with demographic and clinical variables. J Vasc Bras. 2015;14:123-32. https://doi.org/10.1590/1677-5449.0042.
14. Ahmed AN, Husasin R, Aslam M, Rasool I. An experience with vascular trauma. Ann King Edw Med Univ. 2004;10(1):33-4 https://doi.org/10.21649/akemu.v10i1.1146.
15. Atia SM, Regal SAEH, Ahmed ME. Incidence of vascular injuries in poly-traumatised patients. Egypt. J Hosp Med. 2021;82(4):719-29. https://doi.org/10.21608/ejhm.2021.152991.
16. Perkins Z, De'Ath H, Aylwin C, et al. Epidemiology and outcome of vascular trauma at a British major trauma centre. Eur J Vasc Endovsc Surg. 2012;44(2):203-9. https://doi.org/10.1016/j.ejvs.2012.05.013.
17. Warren KR, Balogh ZJ. Major vascular trauma. Eur J Trauma Emerg Surg. 2019;45:941-2. https://doi.org/10.1007/s00068-019-01267-2.
18. Trlica J, Kucěrová Š, Kočová E, et al. Deceleration thoracic aortic ruptures in trauma centre level I areas: a 6-year retrospective study. Eur J Trauma Emerg Surg. 2019;45(6):943-9. https://doi.org/10.1007/s00068-018-01063-4.
19. Gilbert F, Schneemann C, Scholz CJ, et al. Clinical implications of fracture-associated vascular damage in extremity and pelvic trauma. BMC Musculoskeletal Disorders. 2018;19(1):1-9. https://doi.org/10.1186/s12891-018-2333-y.
20. Ntola VC, Hardcastle TC. Diagnostic approaches to vascular injury in polytrauma: a literature review. Diagnostics. 2023;13(6):1019. https://doi.org/10.3390/diagnostics13061019.
21. Islam J, Laing GL, Bruce JL, Oosthuizen G. Outcomes for cervicomediastinal vascular trauma managed by a vascular sub-specialist led vascular trauma service: vascular surgery. S Afr J Surg. 2016;54(2):15-20.