Original Article

The Civilian Vascular Trauma in a Low-Income Country: The Determinant Factors of Morbidity and Mortality

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Abstract

Background: Civilian vascular injury is relatively common in the West African subregion, but it is highly underreported. **Aim/Objective:** The aim of the study was to evaluate the patients managed for civilian vascular surgeries and to determine the factors causing morbidity and mortality in low-income countries. **Materials and Methods:** This is a retrospective study spanning a period of 13 years (2007–2019) of civilian vascular injuries managed in a tertiary hospital in a low-income country. We obtained data from our hospital record department. Data obtained and analyzed were demography, etiology, vessels affected, pattern of presentation, stratification, and treatment. **Results:** Within the envisaged period, 58 patients were affected in civilian vascular trauma with a mean of 4.5 cases per year. The male-to-female ratio was 0.9:0.1. The age range of patients affected was from 0–10 to 71–80, with the age group of 21–30 years being the most affected. Male was more affected (87.9%). Motor vehicle crashes were the most common etiology agent (42.0%). The femoral artery was the most commonly injured vessel (31.3%). In the pattern of presentation, bleeding with shock was dominant (49.8%). Lateral tarsorrhaphy accounted for the major vascular treatment interventions (30.2%). **Conclusion:** The outcome was very variable and depended on warm ischemic time, type and/or mechanism of injury, collateral blood supply at the site of injury, and comorbidity.

Keywords: Amputation, civilian, injury, vascular, warm ischemic time

Introduction

Nigeria is the most populous black nation in Africa and indeed world over with an absolute value of 200 million people.[1] There are high levels of unemployment, high-poverty prevalence, moderate level of inequality, low level of certification of the working-age population, and therefore, weak capital developments and near-complete loss of tertiary graduates (brain drain syndrome).[2]

Vascular injury presents a great challenge to the emergency resident because these injuries require urgent intervention to prevent loss of life or limb. Sometimes, serious vascular injury presents with only subtle or occult signs or symptoms. The patient may present weeks or months after initial injury with symptoms of vascular insufficiency, embolization, pseudoaneurysm, and arteriovenous fistula. Although the majority of vascular injuries are caused by penetrating trauma from gunshot wounds (GSWs), stabbing, or blast injury, the possibility of vascular injury needs to be considered in patients presenting with displaced long bone fractures, crush injury, prolonged immobilization in a fixed position by tight casts or bandages, and various invasive procedures. Iatrogenic vascular injuries constitute about 10% of cases in most series; however, the incidence is an increasing trend because more endovascular procedures such as angioplasty and cardiac catheterization are being performed routinely.[3]

Civilian trauma is more frequently seen in young males. However, it can occur at any age due to road motor vehicle crashes, firearms, bomb blasts, and diagnostic procedures. Most of the time, civilian trauma causes less tissue damage.[4,5]

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This tends to affect the arteries and veins of the limbs as well as the cervicothoracic regions. Extremity and cervicothoracic vascular injuries occur both in isolation and in combination with other injuries, especially orthopedic injuries of the extremities.[6]

In our country, a developing one, the risk factors for civilian vascular injury include but not limited to travelling at high speed on poorly maintained Nigerian roads, living in areas where there is boundary or chieftaincy dispute, being with members of cult gang among secondary and university students, carrying cash and other valuables without police escort, and undergoing intravascular procedures such as central venous pressure line placement and cardiac catheterization.[4] Others include living in areas prone to arm banditry and kidnapping activities as well as Boko Haram terrorist activities.[7]

Peripheral vascular injuries constitute 4%–6% of major trauma and 40%–70% of all vascular injuries treated in civilian trauma centers.[8-10] This type of injury leads to an emergency situation because of acute blood loss and impending fatal outcomes if severe, and no intervention is instituted urgently. Diagnosis can be challenging. However, using hard and soft signs alongside requisite investigations where appropriate, diagnosis and appropriate treatment can be instituted. This is because hard signs have more than 90% positivity of arterial injury, while soft signs have about 35% positivity of arterial injury.[4,11]

In a low-income country like ours, there has been proliferation in the number of high speed and articulated fairly used vehicles, which with the attendant poor road infrastructure, and careless or reckless drivers, have resulted in an increase in traumatic vascular injuries from motor vehicle crashes.[4]

Materials and Methods

For a period of 13 years, January 2007 to December 2019, when our institution moved from its temporary site in Enugu urban to the permanent site at Ituku-Ozalla (suburban, along Enugu-Port Harcourt Express Way), 58 cases of common civilian vascular injuries of the neck and upper and lower extremities were managed. At the end of that period, the data of such patients were retrieved and analyzed.

Data analyzed were demography, named vessels, etiological agents, pattern of presentation, treatment, and outcome including the determinant factors of mortality and morbidity.

The results were analyzed using SPSS version 2.0 IBM Corp, released 2011, IBM SPSS Stastitics for Windows version 2.0, Armonk NY, IBM Corp (Chicago, IL, USA). Proportions were calculated using Chi-square and estimates were set as $P < 0.5$.

Results

Table 1 shows the distribution of age ranges of patients with civilian artery injuries. Age range of 21–30 (n = 21, 36.2%) was the highest, followed by 11–20 (n = 10, 17.2%). The least was 61–70 (n = 1, 1.7%).

Figure 1 shows the distribution of etiology of vascular injuries. Motor vehicle crashes (MVCs) have the highest (42%), while the least is others such as glass cuts and iatrogenic injuries (4%).

Table 2 shows the distribution of the affected vessels. Here, femoral artery (common, external, and internal) was the most affected (n = 20, 31.3%), while the least affected was the subclavian artery (n = 1, 1.5%). In the study group, there

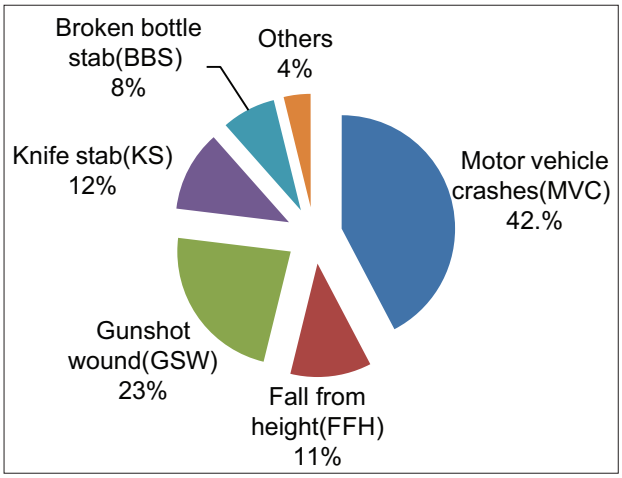

Figure 1: Etiology of vascular injury

Table 1: Age range of patients

Age ranges	*n* (%)
0-10	2 (3.4)
11-20	10 (17.2)
21-30	21 (36.2)
31-40	9 (15.5)
41-50	6 (10.3)
51-60	5 (8.6)
61-70	1 (1.7)
71-80	4 (6.9)
Total	58

Table 2: The distribution of the affected vessels

Affected vessel	*n* (%)
Femoral artery	20 (31.3)
Brachial artery	16 (25)
Basilic vein	1 (1.5)
Popliteal vein	2 (3.1)
Popliteal artery	5 (7.8)
External carotid artery	4 (6.3)
Radial artery	3 (4.7)
External jugular vein	2 (3.1)
Axillary artery	4 (6.3)
Dorsalis pedis artery	2 (3.1)
Posterior tibial artery	3 (4.7)
Subclavian artery	1 (1.5)
Subclavian vein	1 (1.5)
Total	64 (100)

were 58 patients with 64 affected vessels. Six patients had artery injuries in addition to the accompanying veins. They were subclavian, external jugular, popliteal, and basilic veins.

Figure 2 shows the laceration of the left popliteal artery from broken bottle stabs following physical assault. Here, the sciatic nerve was involved. After successful vascular repair, the patient required plastic surgery for soft-tissue reconstruction and about 6 weeks of both active and passive physiotherapies before he could bear weight on that limb.

Figure 3 shows the distribution of pattern of presentation. In this study, MVC was the most common etiology and in view of this, bleeding with varying degrees or types of hemorrhagic shock was the highest pattern of presentation (49.8%). This was followed by bleeding with 6Ps (pain, pulselessness, palour, paresthesia, paralysis, poikilothermia, or perishing cold). In one of these cases with 6Ps, a damage control was applied using a cut-to-size blood giving set to bridge a transected external femoral artery, enabling orthopedic surgeons to stabilize the fracture while achieving distal tissue supply and viability.

Table 3 shows the distribution of strata of vascular injuries alongside their treatment. Laceration requiring lateral tarsorrhaphy where there was no adequate collateral or outright suture ligation where collateral supply was judged adequate was highest (n = 19, 30.2%). In complete transection with tissue loss, endogenous great saphenous vein was used for interposition in a reversed manner. In one patient, polytetrafluoroethylene was used for the interposition.

Discussion

Vascular trauma involving extremities and cervicothoracic vessels are relatively common in war and civilian times. In peace times, the incidence of civilian vascular injury is significant. Civilian extremity vascular injury, as with the wartime experience, is most prevalent in cases of penetrating trauma;[12] however, in contrast to the military experience, penetrating trauma in the civilian setting is usually due to knife wounds or low-velocity handgun injuries.[13] Fortunately, high-velocity assault weapon injuries and explosive injuries are absent in our country, Nigeria. The emphasis of this paper is on civilian vascular injury in both cervicothoracic and extremity vessels.

Peripheral vascular injury is an injury to the axillobrachial arteries and branches in the upper extremity and femoropopliteal arteries and branches in the lower extremity.[13,14] Young age groups like in our study are more affected.[15-17] We recorded 36.2% in the age range of 21–30 years (n = 21, 36.2%), followed by the age range of 11–20 years (n = 10, 17.2%) [Table 1]. Males are more affected.[16] In our study, there were 51 males and 7 females, with a male-to-female ratio of 0.9:0.1 [Figure 4]. Penetrating trauma in other works[18] unlike ours is the most common cause with GSW and knife stabs accounting for 70% and 30%, respectively. In this study, motor vehicle crashes alone accounted for 42% [Figure 1]. This may be the location of the hospital along Enugu-Port Harcourt Expressway. Blunt peripheral vascular injury is 25% in other works.[18,19] As per the vessels involved, other works are in agreement with ours. The femoral artery is 50%–60% and the brachial artery is 30%.[20,21] In our review, femoral and brachial artery injuries accounted for 34.9% and 25.4%, respectively [Table 2].

The presentations of cervicothoracic and extremity vascular injury in our review were both in acute and chronic forms. Among the acute presenters, they were divided into either hard or soft signs. Eleven (42.3%) patients who presented at the accident center in hemorrhagic shock state, especially

Table 3: Stratification and treatment of vascular injury

Stratification	Treatment	*n* (%)
Intimal flaps±thrombus	Observation/anticoagulation	6 (9.5)
Laceration	Lateral tarsoraphy/suture ligation	19 (30.2)
Partial transaction	End-to-end anastomosis	12 (19.1)
Complete transaction	End-to-end anastomosis	5 (7.9)
Complete transaction with tissue loss	Vascular interposition (n=3) Amputation (n=4)	7 (11.1)
Pseudoaneurysm	Aneurysmorraphy	8 (12.7)
AVF	Patch tarsorrhaphy	6 (9.5)
Total		63 (100)

AVF: Arteriovenous fistula

Figure 2: Severely injured left popliteal artery(bandaged) to control haemostasis

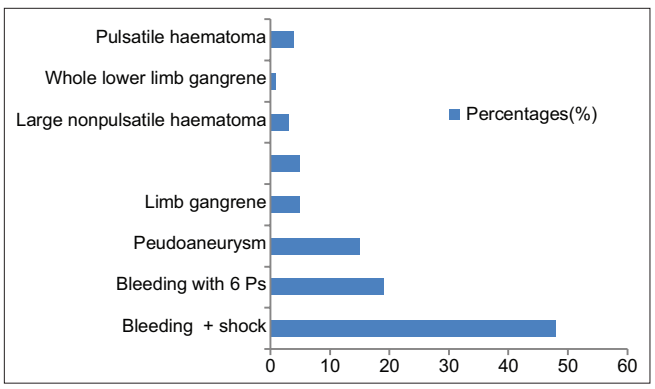

Figure 3: Pattern of presentation

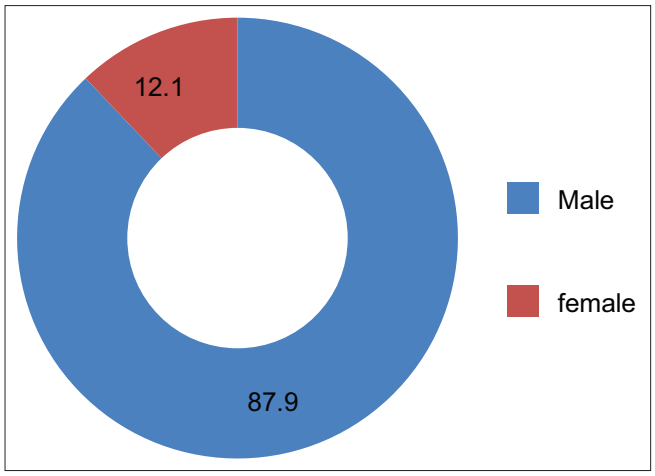

Figure 4: sex distribution: Male: female = 51:7 → 0.9:0.1. Males are more generally affected because of their proness to more activities including violence

in association with nonvascular injures, were resuscitated according to the acronym Airway, Breathing, Circulation, Disability, Exposure (ABCDE) ladder and Advanced Trauma Life Support-Protocol.[6,8,22,23] In the United States, high-speed motor vehicle accidents, often with fractures or dislocations, resulted in the next largest group of patients. In patients with large lacerations or open wounds, persisting or increasing hemorrhage with resuscitation is an early indication of vascular injury requiring operative exploration. Indeed, this is in agreement with our study where MVC was the most common etiology [Figure 1 and Table 3].

Stratification of vascular injury and treatment

Vascular injury, either cervicothoracic or peripheral vascular injuries, can be grouped into mild, moderate, and severe in terms of severity. Specifically, this study identified injury to the vessels, which then guided the types of intervention [Table 3]. Primary anastomosis: This was done when there was no or minimal segmental loss. Segmental loss puts the primary anastomosis at risk and there was a risk of thrombosis or blow out because the anastomosis was under tension. Reverse saphenous vein graft: when there was a segmental loss of >2 cm, the saphenous vein was harvested from the contralateral limb and used in reversed version, as valvotome was not available. Lateral repair (arteriorrhaphy or venorrhaphy) was adopted when there was a lateral tear only. Savage and Walker observed in their study of vascular injuries a number of 40 (60%) patients that had lacerations of the vessel wall and 10 (15%) had a loss of vessel wall segment.[24] Stratification and treatment of vascular injuries have been described by various authors.[25-30]

The determinant factors of mortality and morbidity

Morbidity and mortality emanating from vascular trauma are enormous. It has the highest resuscitation priority after airway and breathing in the acronym of ABCDE resuscitation ladder.[4] The most important and critical prognostic factors are the duration of warm ischemic time (WIT), level and type of vascular injury, collateral circulation around the level of the injury, tissue damage or crush injury, and patient factors such as comorbid medical conditions, for example, diabetes mellitus, obesity, and extremes of life.

Civilian vascular trauma is more frequently seen in young males. However, it can occur at any age due to motor vehicle crashes, firearms, bomb blasts, and diagnostic procedures including fall from heights and physical assaults. Most of the time, civilian vascular trauma causes less tissue damage relative to war trauma.[31] In developing countries, the mortality and morbidity arising from vascular injuries are relatively high on account of the following: poor medical emergency services such as national blood banks and altruistic blood donors,[32] long transportation time from the scene of injury to hospitals arising from poor road infrastructure, poorly trained paramedical personnel, nonavailability of interventional radiological techniques, and nonavailability of prosthetic vascular conduits as well as total absence of improved surgical techniques in primary and secondary health centers.

Others included overwhelming sepsis from wet gangrene from some patients' refusal to accept amputation when it was indicated. Prolonged application of tourniquet as well as delay in presentation to vascular surgeon (s) due to poor knowledge of WIT is another factor affecting morbidity and mortality. Patients who sustained serious thoracic and or abdominal vascular injuries never reached the tertiary hospital alive. Autopsy reports however estimated such injuries to be 0.3% of the study group. In low-income countries, some patients have comorbid diseases such as hypertension, diabetes mellitus, and human immune deficiency virus undiagnosed and untreated. Such patients had added complications of greater blood loss and subsequent replacement as well as delayed wound healing.

Of the 58 patients that presented to our center alive, the following outcome was noted, 60% had a successful repair, 20% had successful repair with residual nerve injury which needed plastic surgery intervention and subsequent physiotherapy, 15% had an unsalvageable limb that resulted in amputation, while 5% died from complications of hemorrhagic shock, septicemeia (wet gangrene) from refusal to accept amputation when it was absolutely necessary as well as complicated orthopedic injuries arising from undiagnosed and untreated comorbid diseases such as diabetes mellitus.

Conclusion

The civilian vascular injuries in our study affect the upper and lower extremities including the neck and thoracic and or abdominal vessels in varying degrees. The outcome was very variable and depended on WIT, types and/or mechanisms of injury, collateral blood supply at the site of injury, comorbidity, roles of the primary physician, and paramedics at the scene of injury. The low global development indices affected the outcome in low-income country like ours.

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Conflicts of interest

There are no conflicts of interest.

References

1. Michael TO, Odeyemi MA. Nigerians population policies: Issues, challenges and prospects. Ib J Soc Sci 2017;15:104-15.
2. Industrialization in Africa and Least Developed Countries. Report to the G20 Development Working Group by UNIDO. Available from: http://www.unido.org/fileadmin/user_media_upgrade/Worldwide/G20_new_UNIDO_report_industrialization_in_Africa_and_LDCs.pdf. [Last accessed on 2018 Jun 12].
3. Caps MT. The epidemiology of vascular trauma. Semin Vasc Surg 1998;11:227-31.
4. Nwafor IA, Eze JC, Ezemba N, Onyekwulu FA, Ngene CI. The pattern and outcome of civilian vascular in a teaching hospital over a 7-year period. World J Cardiovasc Dis 2016;06:44-53.
5. Feliciano DV, Federick A, Ernest E, Michael A, James W, Christine S, *et al*. Evaluation and Management of peripheral vascular injury, pattern 1. Western Trauma Association/Critical Decision in Trauma. J Trauma 2011;70:1551-6.
6. Xu V, Xu W, Wang A, Mang H, Wang Y, Lin S, *et al*. Diagnosis and treatment of traumatic vascular injury of limbs in military and emergency medicines. Medicine (Baltimore) 2019;98:e15406.
7. Ihenacho EN, Innocent EO. Boko haram insurgency in Nigeria: an impediment to national development. Spec J Polit Law 2017;2:38-49.
8. Ranna SH, Farani TM, Jamal J, Afzal M. Peripheral vascular injuries. Epidemiology and management. Prof Med J 2008;15:54-60.
9. Ojo E, Ibrahim A, Obiano S. Gunshot injuries in a North Eastern Nigeria tertiary hospital. Internet J Surg 2007;16:12.
10. Feliciano G, Roy SA, Wall MJ, Mattox KL. Prediction of amputation for popliteal artery injuries. J Surg 1995;170:568-71.
11. Feliciano DV. Evaluation and treatment of vascular injuries. In: Browner BD, Jupiter JB, Levine AM, Trafton PG, Kraffec C, editors. Steletal Trauma. Basic Science, Management and Reconstruction. Philadelphia, PA: Saunders Elsevier; 2009. p. 323-40.
12. Lateef WM, Gani AA, Nabi L, Singh SA, Majeed D, Akbar BM, *et al*. Vascular injuries caused by tear gas shells: Surgical challenge and outcome. Iran J Med Sci 2011;6:14-7.
13. Wan ML, Ahangar AG, Lone GN, Lone RA, Ashraff HZ, Dar AM, *et al*. Vascular Injuries after bear attacks: Incidence, surgical challenges and outcome. J Emerg Trauma Shock 2011;2:20-2.
14. Oller DW, Rutledge R, Clancy V. Vascular injuries in a rural state: A review of 278 patients a rural trauma registry. J Trauma 1992;32:740-6.
15. Thomas MO, Giwa TO, Adekoya C. Arterial injuries in civilian practice in Lagos, Nigeria. Nig J Clin Pract 2005;8:65-8.
16. Aduful H, Hodasi W. Peripheral vascular injuries and their management in Accra. Ghana Med J 2007;41:186-9.
17. Adeonye PO, Adebola SO, Adesiyin OA, Braimoh KY. Perpheral vascular procedures in Ilorin: Indications and outcome. Afr Health Sci 2011;11:433-7.
18. Deglannis E, Velhamos G, Krawaczykwoki D, Levy D, Souter I, Saad R. Penetrating injury in the subclavian artery. Br J Surg 1994;81:524-6.
19. Mattox KL, Feliciano DV, Bruch J, Beall AC Jr., Jordan GL Jr., de Bakey MO. Five thousand, seven hundred and sixty cardiovascular injuries in 4459 patients. Epidemiological evolution 1958 and 1987. Ann Surg 1989;209:698-707.
20. Cooper C, Rodrigruez A, Omert L. Blunt vascular trauma. Curr Prob Surg 1996;29:281-357.
21. Feliciano DV, Herskowitz K, O'Gorman RB, Cruse PA, Brandt ML, Burch JM, *et al*. Management of vascular injuries in the lower extremities. J Trauma 1988;28:319-28.
22. Nassoura ZE, Ivatury RR, Simon RJ, Jabbour N, Vinzons A, Stahl W. A reassessment of Doppler pressure indices in the detection of arterial lesions in proximity penetrating injuries of extremities: A prospective study. Am J Emerg Med 1996;14:151-6.
23. Shinco MA. Peripheral vascular injury. In: Feliciano DV, Mattox KI, Moore EE, editors. Trauma. 6th ed.. New York NY: McGraw-Hill; 2008. p. 941-71.
24. Savage HS, Walker E. Vascular trauma on the rise. J Vasc Nurs 1995;11:106-11.
25. Rich NM. Vascular trauma in vietinam. J Cardiovasc Surg Torino 1970;11:L568-77.
26. de DM, Simeone FA. Battle injuries of the arteries in World War II: An analysis of 2,471 cases. Ann Surg 1946;123:534-79.
27. Hughes CW. Acute vascular trauma in Korean War casualties; an analysis of 180 cases. Surg Gynecol Obstet 1954;99:91-100.
28. Hirshberg A, Wall MJ, Johnston RH Jr., Bruch JM, Mattox KL. Trans cervical gunshot injuries. Am J Surg 1994;167:309-12.
29. Fry WR, Fry EE, Fry WJ. Operative exposure of abdominal artery for trauma. Arch Surg 1991;126:289-91.
30. Hughes CW. The primary repair of wounds of major arteries; an analysis of experience in Korea in 1953. Ann Surg 1955;141:297-303.
31. Van CW. Vascular sutures technique. In: Moore EE, Elswanmann BE, editors. Clinical Decision in Trauama. 3rd ed.. St Louis: CVs Mosby; 1962. p. 648-52.
32. Nwafor IA, Arua OA, Eze JC, Ezemba N, Nwafor MN. Utilisation of blood and blood products during open heart surgery in a low-income country: Our local experience in 3 years. Cardiol Young 2018;28:1289-94.