

Iatrogenic Vascular Injuries: A Review

Hashem B. Abood¹, Loai T. Aleithan², Lamees A. Binmohammed³, Abdulrahman S. Alghamdi⁴, Shareefah M. Alenazi⁵, Ahoud M. Alruwaili⁶, Aseel E. Dulaimi⁷, Nouf M. Aldhamdi⁸, Bandar A. Alomar⁹, Ahlam M. Alfaraj¹⁰, Amal Y. Alyousif¹¹, Khalid F. Altowairqi¹².

¹Consultant general surgery, king Fahad Hospital, Albaha, KSA. ²GP, Dhahran aljanoub general hospital, Dhahran, KSA. ³King Khaled University, KSA. ⁴MBBS, MD, General Physician -Service Resident, Dammam Medical Complex, KSA. ⁵General physician, King Fahad specialty hospital, Tabuk, KSA. ⁶General physician, king Abdulaziz hospital, al jouf, Sakaka, KSA. ⁷MD, MBBS, Ibn Sina National College for Medical Studies, Jeddah, KSA. ⁸General physician, Pediatric Surgery Service Resident, King Saud Medical City, Riyadh, KSA. ⁹Intern, Aalma'arefa university, Riyadh, KSA. ¹⁰Arabian Gulf University, Bahrain, Manama. ¹¹General physician, Qatif General Hospital, Qatif, KSA. ¹²General Physician, King Abdulaziz specialist Hospital, Taif, KSA.

ABSTRACT


Vascular injuries provide a significant challenge to emergency room staff because they call for quick action to avert loss of life or limb. Sometimes only modest or latent indications or symptoms of significant vascular damage are present. The patient may show signs of vascular insufficiency, embolization, pseudoaneurysm, arteriovenous fistula, etc., weeks or months after the initial damage. Although gunshot wounds, stabbings, and blast injuries account for the majority of vascular injuries, patients who have displaced long bone fractures, crush injuries, prolonged immobilization in a fixed position due to tight casts or bandages, and various invasive procedures should be evaluated for the possibility of vascular injury. Further investigations are required to help identify risk variables that might put a patient at more risk of suffering harm than benefiting from an intervention.

Keyword: Iatrogenic, Vascular injury, vascular surgery, Endovascular treatment.

Introduction

Iatrogenic vascular injuries (IVI) are uncommon but critical to identify because they are brought on by medical personnel whose overall purpose is not to cause damage. The percentage of iatrogenic injuries appears to rise in non-military contexts when vascular injuries occur [1]. Healthcare associate's injuries and adverse events (AE) are injurious, sustain redundant suffering for the patients and form a further cost to the patients, the healthcare administration, and the community [2]. Complications caused by failing to follow approved procedures or AE brought on by inadequate care are preventable and ought to be

Avoided. Examining the causes and effects of AE following medical intervention may help create prevention methods, and understanding medico-legal and insurance claims (IC) is crucial for risk management and secure clinical practice [2]. IVI, which can result in serious morbidity or even death, damages the vascular system and are particularly common after open or endovascular vascular surgery. A clinical lesson can be drawn from insurance claims for medical malpractice and malpractice insurance regarding complications following surgery [3, 4]. A growing number of patients are being exposed to these

Access this article online	
Quick Response Code:	Website: www.smh-j.com
	DOI: 10.54293/smhj.v2i2.42

Address for correspondence: Hashem Bark Awadh Abood, Consultant general surgery, king Fahad Hospital, Albaha, KSA.

E-mail: ha-abood@moh.gov.sa

Received: 2 September 2022 **Received in revised form:** 15 October 2022

Accepted: 21 October 2022

This is an open access article by SMHJ is licensed under Creative Commons Attribution 4.0 International License.

<https://creativecommons.org/licenses/by/4.0>

Please cite this article as: Bark Awadh Abood H, Tawfeek Aleithan L, Abdullah Binmohammed L, Saeed H Alghamdi A, Mesabl Alenazi S, Mrji Mhasef Alruwaili A, Eihab A Dulaimi AEAD, Mohammed A Aldhamdi N, Abdulrahman Alomar B, Mohammed S. Alfaraj A, Yasir Alyousif A, Fahad R Altowairqi K. The Iatrogenic Vascular Injuries: A Review: Iatrogenic Vascular Injuries. SMHJ [Internet]. 2022;2(2):76-80. Available from: <https://www.smh-j.com/smhj/article/view/42>

Iatrogenic Vascular Injuries: A Review

Procedures and, as a result, to the risk of problems as a result of the numerous intrusive methods for diagnosis, treatment, or monitoring that have been developed as a result of medical advancements. Healthcare professionals must carefully weigh the possible benefits of any intervention against any potential risks. This implies that the costs and dangers of intervention are constantly calculated. As a result, health care professionals must be aware of the dangers and hazards when planning diagnostic tests and treatments [5]. The aim of this review is to describe and emphasize the published literature on iatrogenic vascular lesions. The review also investigates the main components including the history, epidemiology, pathophysiology, manifestations, outcomes diagnosis, and management.

History

Vascular injury and the need to control bleeding have been important considerations in human survival throughout history [6]. The earliest documented accounts of this practice date to the 1600s BC, when the Egyptians utilized mixes of mineral oil or plant material, such as lead sulfate, antimony, or copper sulfate, to stop bleeding, according to the Ebers papyrus, which was found by Ebers near Luxor in 1873 [7]. On the other hand, the Chinese documented using tight bandages and metalized substances to control bleeding around 1000 BC [8]. Wars have played a crucial role in the growth of knowledge, experience, and advancement in the treatment of vascular trauma. In order to give himself more time to apply the ligature, a military physician named Morel put a rod into the bandage in 1674. As a result, controversial tourniquet came out for the first time [9]. The first vascular procedure described by the Englishman Hallowell was carried out in 1759. He stitched an eight-shaped suture over a pin inserted through the artery's walls to hold the edges of the humeral artery together as he treated the damage. In this approach, significant advancements in knowledge, homeostatic procedures, and vascular repair have been made from minor but consistent discoveries and from the results of warlike acts [10].

Epidemiology

Iatrogenic injuries in medicine were not widely understood until the latter half of the 20th century. Despite advances in knowledge of worldwide general trauma epidemiology, traumatic vascular damage is still poorly understood. This is less well defined, especially in the civilian sphere. Lack of regional or global datasets, ill-defined populations at risk, and a study emphasis on particular injury subtypes rather

than a broad viewpoint are the main causes of this pause. Vascular damage may have occurred in as much as 12% of recent military operations in Iraq and Afghanistan. In comparison to earlier South East Asian campaigns, this represents a fivefold increase [11]. Although it varies greatly by region, the occurrence of vascular trauma in civilians is substantially lower. The prevalence of vascular trauma is still largely unclear despite the fact that torso injuries are more frequent than in military settings in the majority of countries due to the lack of extensive registry data. Vascular trauma experts face population-specific difficulties due to vascular injuries in patients' juvenile and geriatric cohorts [11]. Worldwide, earlier studies estimated yearly incidence in civilians ranges from 0.9 to 2.3 per 100,000 [12].

Pathophysiology

The initial effect of vascular trauma is bleeding, which can either be visible or controlled. 8 When blood flow to the extremities or organs is suddenly cut off, ischemia results. As a result of the decrease in oxygen supply to the tissues, anaerobic metabolism is created, resulting in the formation of lactic acid and inflammatory mediators [13]. Activated cellular and humoral inflammatory pathways may result in cell death if the tissue is not provided with enough oxygen once more [14, 15]. Depending on the tissue, hypoxemia can cause different types of injuries over time. For example, muscular tissue can experience hypoxic pain for up to three hours before recovering its function, whereas nerve tissue can sustain gradual, irreversible damage in much less time [16]. An unexpected and massive release of inflammatory mediators, lactic acid, potassium, and other intracellular debris occurs as a result of reperfusion when ischemia is reversed. This can result in severe myocardial depression and generalized vasodilation, which in turn can lead to systemic inflammatory response syndrome (SIRS) and death [14, 15]. Iatrogenic injuries can happen during procedures including angiography, placing a central catheter, and laparoscopic surgery. Depending on the nation and the socioeconomic status of the population, the trauma mechanism can vary greatly. IAI is described as damage to an artery sustained during a procedure or percutaneous intervention. Up to 33% of the present vascular trauma in civilian patients is caused by it. Interventional and surgical methods are advanced and often used. As IAI occurs more frequently, numerous catheter-based treatments have been developed [17, 18]. Community vascular and general surgeons are responsible for the great majority of iatrogenic arterial

injuries in hospitals serving the local area. A vascular surgical approach is required for the treatment or complication prevention of about 50% of IAIs [19].

Signs and symptoms

During many types of interventions, an IVI can happen at any time and without warning and usually needs prompt management. A vascular surgeon should be aware of a wide range of symptoms that the injuries may present with, including open or closed bleeding, thrombosis, or an intimal flap dissection with poor circulation and ischemic symptoms from the injured organ or limb. A fake aneurysm (pseudoaneurysm) may develop in circumstances of arterial injury with self-stopping bleeding as a result of counterpressure in the surrounding tissues. An IVI can have moderate early symptoms with a chance of delayed diagnosis [5, 20]. Ischemia or bleeding are two symptoms of IVI. The diagnosis is frequently obvious when there is visible bleeding; however, the diagnosis might not be as straightforward when there is internal bleeding. Although access site issues, primarily groin hemorrhage, are frequent and repeating adverse events (AE) (Studies II and IV), they seem challenging to identify if there is no overt bleeding or visible edema in the groin. One rationale could be the danger of normalizing deviation, i.e., that access site issues are common and there is no cause for concern. Retroperitoneal hemorrhage, internal bleeding in a cavity, is difficult to identify because there are no obvious external symptoms except for pain and hypovolemia, which causes a drop in blood pressure [5, 21].

Outcomes

In vascular surgery, the results of IVI and AE can lead to serious morbidity, including paresis, limb amputation, and death. The reported mortality rates ranged from 1.9 to 7.1% [22-24]. Iatrogenic vascular lesions cause more deaths than non-IVIs do. IVI has a greater probability of fatal outcomes in an older population with more co-morbidities [22, 23]. IVI that affects larger, more central (such as abdominal) arteries is more frequently deadly and typically requires more involved treatments, like by-passes and interposition grafts, but with fewer successful outcomes (graft occlusions and reoperations due to bleeding) [25]. The majority of fatal IVIs are caused by vascular injuries from intraabdominal surgery, percutaneous endovascular or cardiovascular interventions, and vascular injuries; however, death within 30 days is more frequently related to the conditions and diseases that the patients had rather than the IVI itself. Iatrogenic carotid artery injuries

frequently result in death, according to registry data. However, additional case record analysis showed that patients with IVI of the carotid artery frequently died from the condition they had before the damage, not the injury itself [5].

Diagnosis

The gold standard for evaluating vascular damage is angiography; however, its utility is constrained by the method's invasiveness. Given that this method is non-invasive, colour-Doppler is advantageous for imaging the vessels in the extremities, as shown by numerous studies [26]. There are some drawbacks to color-doppler; the main one is being dependent on the investigator's expertise. The rapid advancements in Doppler technology are anticipated to result in better tools for vascular tree visualization [27]. The use of magnetic resonance (MR) angiography is becoming more widespread in the investigation of elective patients, although trauma cases have not yet been extensively studied [27]. The value of routine angiography and the treatment of any treatable diseases discovered are the current topics of discussion in the management of vascular injuries. It is uncommon to perform a routine surgical investigation of penetrating wounds close to major blood vessels but without obvious vascular damage. Angiography is frequently used to identify or rule out vascular damage and is thought of as conventional medical practice. The premise behind this is that even minor artery damage eventually leads to blockage [28, 29].

Management

Prevention

Vascular trauma can be classified into several kinds, primarily based on how the injury was caused. The most typical types of vascular injury are those caused by blunt and penetrating trauma. Vasospasm, contusion, intimal flaps, intimal disruption or hematoma, external compression, laceration, transection, and localized wall defects with pseudoaneurysm or bleeding are a few examples of vascular injury types [30].

Treatment

Iatrogenic damage is a regrettable side effect of medical treatment. Procedure problems are not entirely preventable, although they can be reduced with the right education, experience, and visual assistance (such as real-time ultrasonography). Patient outcomes can be improved by prompt identification of iatrogenic damage and proper triage for additional treatment. For individuals with IVI, minimally invasive endovascular therapy may be an alternative [31].

Endovascular treatment

The concepts of reconstruction established for elective vascular surgery are used to treat vascular injuries. Due to continuing bleeding, circulatory instability, and challenging exposure, surgical procedures in emergency situations can be highly complicated. The potential of lessening the operating burden, ischemia time, and bleeding makes the idea of minimally invasive repair appealing. It is desirable to immediately stop a bleeding vessel via catheter-directed balloon occlusion. Regardless of the controversy surrounding whether or not angiograms are necessary for penetrating injuries to the extremities, there are many more situations in which angiography is obviously required. Clearly, angiography is necessary before endovascular therapy [27, 31]. Endovascular and minimally invasive procedures are increasingly used in the transitional stage of vascular surgery. This has effects on how vascular injuries are treated as well. The constraints are that endovascular techniques are not frequently employed, and there might not be an institutional or regional organization for emergency operations, even though it is likely that many instances are appropriate for endovascular repair [27].

Primary anastomosis

This is carried out when there is no or little segmental loss. The segmental loss sets the primary anastomosis in danger, and if the anastomosis is under tension, there is a hazard of thrombosis or blowout [32].

Reverse Saphenous Vein Graft

If the segmental loss is greater than 2 cms. The limb on the other side should be used to harvest the saphenous vein. When repairing arteries, the vein should be utilized upside down. There should be no kinks in the graft or stress on the suture line [32].

Lateral repair

If only a lateral tear is present, sutures are primarily placed at the site of the vessel tear.

Conclusion

IVI registration is growing, and delayed diagnosis and treatment can have a detrimental impact on the prognosis. Given the nature of the iatrogenic injury, a large portion of the examined research consisted of case reports or retrospective studies, which limited its use. More studies are required to help identify risk variables that might put a patient at more risk of suffering harm than benefiting from an intervention. A better definition of outcomes for patients with IVI treated with minimally invasive endovascular procedures as opposed to conservative care, or surgical intervention requires additional research.

Conflict of Interest

None

Funding

None

References

1. Georgeades C, Rothstein AE, Plunk MR, Arendonk KV. Iatrogenic vascular trauma and complications of vascular access in children. *Semin Pediatr Surg.* 2021;30(6):151122. doi:10.1016/j.sempedsurg.2021.151122
2. Rudström H, Bergqvist D, Ahlberg J, Björck M. Insurance claims after vascular surgery in Sweden. *Eur J Vasc Endovasc Surg.* 2011;42(4):498-505. doi:10.1016/j.ejvs.2011.04.026
3. Vincent, C., Davy, C., Esmail, A., Neale, G., Elstein, M., Cozens, J. F., & Walshe, K. Learning from litigation: The role of claims analysis in patient safety. *Journal of evaluation in clinical practice.* 2006;12(6):665-674.
4. Rudström H, Bergqvist D, Ogren M, Björck M. Iatrogenic vascular injuries in Sweden. A nationwide study 1987-2005. *Eur J Vasc Endovasc Surg.* 2008;35(2):131-138. doi:10.1016/j.ejvs.2007.09.010
5. Rudström H, Bergqvist D, Björck M. Iatrogenic vascular injuries with lethal outcome. *World J Surg.* 2013;37(8):1981-1987. doi:10.1007/s00268-013-2061-2
6. Nazem M, Beigi AA, Sadeghi AM, Masoudpour H. Non iatrogenic paediatric vascular trauma of the extremities and neck. *Afr J Paediatr Surg.* 2009;6(1):35-39. doi:10.4103/0189-6725.48574
7. Barr J. Vascular medicine and surgery in ancient Egypt. *J Vasc Surg.* 2014;60(1):260-263. doi:10.1016/j.jvs.2014.04.056
8. Shaw V. Chōng meridian an ancient Chinese description of the vascular system. *Acupunct Med.* 2014;32(3):279-285. doi:10.1136/acupmed-2013-010496
9. Mabry RL. Tourniquet use on the battlefield. *Mil Med.* 2006;171(5):352-356. doi:10.7205/milmed.171.5.352
10. Asensio JA, Petrone P, Pérez-Alonso A, et al. Contemporary wars and their contributions to vascular injury management. *Eur J Trauma Emerg Surg.* 2015;41(2):129-142. doi:10.1007/s00068-014-0430-7
11. Herrera MA, Millán M, Del Valle AM, et al. Damage control of peripheral vascular trauma - Don't be afraid of axillary or popliteal fosses. *Colomb Med (Cali).* 2021;52(2):e4074735. doi:10.25100/cm.v52i2.4735

Iatrogenic Vascular Injuries: A Review

12. Baghi I, Herfatkar MR, Shokrgozar L, Poor-Rasuli Z, Aghajani F. Assessment of Vascular Injuries and Reconstruction. *Trauma Mon.* 2015;20(4):e30469. doi:10.5812/traumamon.30469
13. Tonnessen BH. Iatrogenic injury from vascular access and endovascular procedures. *Perspect Vasc Surg Endovasc Ther.* 2011;23(2):128-135. doi:10.1177/1531003511409057
14. Hafez HM, Woolgar J, Robbs JV. Lower extremity arterial injury: results of 550 cases and review of risk factors associated with limb loss. *J Vasc Surg.* 2001;33(6):1212-1219. doi:10.1067/mva.2001.113982
15. Britt LD, Weireter LJ, Cole FJ. Newer diagnostic modalities for vascular injuries: the way we were, the way we are. *Surg Clin North Am.* 2001;81(6):1263-xii. doi:10.1016/s0039-6109(01)80007-4
16. Liu JL, Li JY, Jiang P, et al. Literature review of peripheral vascular trauma: Is the era of intervention coming. *Chin J Traumatol.* 2020;23(1):5-9. doi:10.1016/j.cjtee.2019.11.003
17. Rich, N. M., Hobson II, R. W., & Fedde, C. W. Vascular trauma secondary to diagnostic and therapeutic procedures. *The American Journal of Surgery.* 1974;128(6):715-721.
18. Youkey JR, Clagett GP, Rich NM, et al. Vascular trauma secondary to diagnostic and therapeutic procedures: 1974 through 1982. A comparative review. *Am J Surg.* 1983;146(6):788-791. doi:10.1016/0002-9610(83)90342-2.
19. Mills JL, Wiedeman JE, Robison JG, Hallett JW Jr. Minimizing mortality and morbidity from iatrogenic arterial injuries: the need for early recognition and prompt repair. *J Vasc Surg.* 1986;4(1):22-27. doi:10.1067/mva.1986.avs0040022
20. Nguyen T, Kalish J, Woodson J. Management of civilian and military vascular trauma: lessons learned. *Semin Vasc Surg.* 2010;23(4):235-242. doi:10.1053/j.semvascsurg.2010.11.004
21. 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(2):203-209. doi:10.1016/j.ejvs.2012.05.013
22. Bains SK, Vlachou PA, Rayt HS, Dennis M, Markose G, Naylor AR. An observational cohort study of the management and outcomes of vascular trauma. *Surgeon.* 2009;7(6):332-335. doi:10.1016/s1479-666x(09)80105-4
23. Giswold ME, Landry GJ, Taylor LM, Moneta GL. Iatrogenic arterial injury is an increasingly important cause of arterial trauma. *Am J Surg.* 2004;187(5):590-593. doi:10.1016/j.amjsurg.2004.01.013
24. Usman R, Jamil M, Anwer MF. Evaluation, Surgical Management and Outcome of Traumatic Extremity Vascular Injuries: A 5-year Level-1 Trauma Centres Experience. *Ann Vasc Dis.* 2018;11(3):312-317. doi:10.3400/avd.oa.18-00068.
25. Lazarides MK, Tsoupanos SS, Georgopoulos SE, et al. Incidence and patterns of iatrogenic arterial injuries. A decade's experience. *J Cardiovasc Surg (Torino).* 1998;39(3):281-285..
26. Fry WR, Dort JA, Smith RS, Sayers DV, Morabito DJ. Duplex scanning replaces arteriography and operative exploration in the diagnosis of potential cervical vascular injury. *Am J Surg.* 1994;168(6):693-696. doi:10.1016/s0002-9610(05)80147-3
27. Risberg B, Lönn L. Management of vascular injuries using endovascular techniques. *Eur J Surg.* 2000;166(3):196-201. doi:10.1080/110241500750009267
28. Biffi WL, Zhao FZ, Morse B, et al. A multicenter trial of current trends in the diagnosis and management of high-grade pancreatic injuries. *J Trauma Acute Care Surg.* 2021;90(5):776-786. doi:10.1097/TA.0000000000003080
29. Seamon MJ, Smoger D, Torres DM, et al. A prospective validation of a current practice: the detection of extremity vascular injury with CT angiography. *J Trauma.* 2009;67(2):238-244. doi:10.1097/TA.0b013e3181a51bf9
30. Evans C, Chaplin T, Zelt D. Management of Major Vascular Injuries: Neck, Extremities, and Other Things that Bleed. *Emerg Med Clin North Am.* 2018;36(1):181-202. doi:10.1016/j.emc.2017.08.013
31. Smith TA, Gage D, Quencer KB. Narrative review of vascular iatrogenic trauma and endovascular treatment. *Ann Transl Med.* 2021;9(14):1199. doi:10.21037/atm-20-4332
32. Wani ML, Ahangar AG, Ganie FA, Wani SN, Wani NU. Vascular injuries: trends in management. *Trauma Mon.* 2012;17(2):266-269. doi:10.5812/traumamon.6238