RESEARCH ARTICLE

Outcome of patients presenting 6 to 12 hours after isolated vascular trauma in a tertiary care hospital of Pakistan

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Abstract

Objective: To assess the outcome of vascular injuries in patients presenting 6-12 hours after isolated vascular trauma.

Method: The analytical cross-sectional study was conducted at East Surgical Ward of Mayo Hospital, Lahore, Pakistan, from July 1, 2020, to June 30, 2022 and comprised consecutive patients of either gender aged >13 years with isolated vascular trauma presenting 6-12 hours after vascular injury. Operative procedures included ligation, end-to-end repair and reverse venous graft of the injured vessels. Outcomes, including cause of amputation and mortality, were noted. Data was analysed using SPSS 26.

Results: Of the 82 patients, 61(74.03%) were males and 21(25.06%) were females. The overall mean age was 33±5.41 years. Femoral artery was damaged more 54(65.85%) compared to brachial artery 28(34.14%) in all modes of injuries. Ligation of vessel was done in 35(42.68%) cases. Mortality was the outcome in 15(18.29%) patients, amputation in 29(35.36%) and discharge after successful vascular repair 38(46.34%).

Conclusion: Ligation of the femoral or brachial artery was found to be a safe and lifesaving procedure in patients presenting 6-12 hours after isolated vascular trauma to the emergency department in a tertiary care setting.

Key Words: Vascular system injuries, Amputation, Surgical, Brachial artery, Femoral artery.

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Introduction

Trauma is considered one of the most common health problems in the world. It has been estimated that about 5.8 million people die each year around the world due to trauma[1]. This constitutes about 10% of the world's total deaths each year, and includes both blunt trauma and penetrating trauma cases. Vascular trauma is responsible for about 1-2% of total deaths due to trauma. Vascular trauma to the limbs is considered the third leading cause of potentially survivable injuries[2].

In developing countries, injuries and trauma are increasing rapidly and becoming one of the leading causes of mortality and morbidity, especially related to the limbs[3]. Vascular injuries to the limbs are caused by blunt trauma, like motor vehicle accidents, or due to penetrating trauma, like gunshot wounds (GSWs). In countries where firearms are easily accessible, the number of vascular injuries are even higher, and some countries reported that vascular injuries due to GSWs constitute about 20% of trauma deaths and subsequently highest utilisation of hospital resources[4].

Trauma related to the limbs is considered very challenging, and time is one of the key factors while dealing with vascular injuries[5]. If not timely managed, vascular injuries lead to amputation of the limb which causes lifelong morbidity for patients. The most commonly involved arteries in trauma are the brachial and femoral arteries[6]. Timely diagnosis and management, and early revascularisation not only decrease the chances of mortality, but can also save the patients from amputation[7].

The time duration between trauma and the start of treatment proves to be an important factor in determining mortality and morbidity of the patient[8]. The critical ischaemia time of human skeletal muscle is 2.25 hours on a temperature of 26-38 degree centigrade, which is much shorter than previously reported in literature[9]. However, literature also suggests successful repair results of >97% if done within 6 hours of the trauma. However, this success rate of repair decreases to 40-50 % if done 6 hours after the trauma[10].

The current study was planned to assess the outcome of vascular injuries managed by general surgeons in a tertiary care hospital 6-12 hours after trauma.

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Patients and Methods

The prospective, cohort study was done at at the East Surgical Ward of Mayo Hospital, Lahore, Pakistan, from July 1, 2020, to June 30, 2022. After approval from the ethics review board of the King Edward Medical University (KEMU), Lahore, the sample was raised using consecutive sampling technique from among those who presented to the Accident and Emergency Department (A&ED) with brachial or femoral artery injury due to any mode of injury.

Those included were patients of either gender aged >13 years who presented with clinical signs and symptoms of isolated brachial and femoral artery injury after 6-12 hours of injury without any other major injury on head, neck, chest and abdomen with Mangled Extremity Severity Score (MESS) score of ≤7[11]. The sign and symptoms included hard and soft signs. According to the Western Trauma Association (WTA)[6], hard signs include absent pulses, bruit or palpable thrill, active haemorrhage, expanding haematoma and distal ischaemia. The soft signs included haematoma, history of haemorrhage at the scene of injury, unexplained hypotension and peripheral nerve deficit. The presence of one hard sign or two soft signs of vascular injury was set as the criteria of exploration of vessel[6].

Patients who presented within 6 to 12 hours after vascular injury, those with MESS score >7, and patients with any other major solid or hollow viscus injury due to any cause on head, neck, chest or abdomen[12] were excluded. In case of any suspicion of injury to other organs, computed tomography (CT) scan of the relevant area was advised and inclusion/exclusion was decided depending on the presence or absence of organ injury. Written informed consent was taken from all the enrolled patients for vessel exploration under general anaesthesia (GA) along with counselling for amputation of limb after operation in case of infection, and graft failure leading to signs and symptoms of septicaemia. Amputation included above-knee amputation and above-elbow amputation using the technique described by Herr Hm et al[13].

All the included patients were evaluated in the emergency room as per the Advance Trauma and Life Support (ATLS) protocol[14]. They were resuscitated and a single shot of broad-spectrum antibiotics and anti-tetanus vaccine was given. Physical examination was used to assess the preoperative status of the affected limb, especially when the hard signs were present. In patients with soft signs or suspected vascular injury, help was taken by various investigative and imaging modalities, like the ankle brachial index (ABI), arterial pressure index (API) and Doppler ultrasonography. Prognostic scores, like MESS, Injury Severity Score (ISS), severity of limb ischaemia and magnitude of associated injuries were assessed preoperatively.

Exploration of wound was done under general anaesthesia after taking proximal control of the vessel, and then the nature of the injury was noted for the type of repair or ligation needed. The decision of end-to-end repair, reverse venous graft and ligation of the vessel was taken keeping in view the haemodynamic status of the patient on presentation and during exploration, including pulse, blood pressure, respiratory rate, duration of presentation after trauma >9 hours, and blood products in hand. All the operative procedures were done by a specialist general surgeon with experience of >2 years in dealing with vascular injuries in the emergency department. In cases with >5cm of arterial segment loss, reverse venous graft from the great saphenous vein of the opposite limb was taken in line with the technique described in literature[15]. The technique used for vascular repair was described by Kuralay E. et al[10]. Any venous injury encountered during operation was ligated, and adjunctive procedure, like fasciotomy of limbs, was done where needed depending upon the presence or absence of limb compartment syndrome. In case of long-bone fractures, reduction and stabilisation was done during the exploration to avoid damage of the repaired vessel by bony fragments. Any nerve injury encountered was ligated for latter management by a plastic surgeon. The outcome of vascular procedures was described as amputation of limb after repair, mortality of patient, and discharge of patient with viable limb. In patients with mortality and amputation of limb, the causes of amputation and mortality were assessed.

Data was analysed using SPSS 26. Qualitative variables were expressed as frequencies and percentages, while quantitative variables were presented as mean ± standard deviation or median with interquartile range. Categorical data was analysed using chi-square test and student's t-test. Fisher's exact test was used when applicable. $P<0.05$ was considered statistically significant.

Results

Of the 112 patients screened, 82(73.2%) were included. Of them, 61(74.03%) were males and 21(25.06%) were females. The overall mean age was 33±5.41 years (range: 14-54 years), with 34(41.4%) aged 31-40 years and 18(21.9%) aged 13-20 years. The median age was 34.8 years (IQR = 14 – 54). The mean age of males was significantly higher than that of females ($p<0.05$).

Table: Modes of injury to brachial and femoral arteries.

	Brachial artery	Femoral artery	Total
Road traffic accidents	8 (9.7%)	22 (26.8%)	30 (36.5%)
Gunshot wounds	15 (18.2%)	27 (32.9%)	42 (51.2%)
Stab wounds	5 (6.1%)	5 (6.1 %)	10 (12.1%)
Total	28 (34.1%)	54 (65.8 %)	.

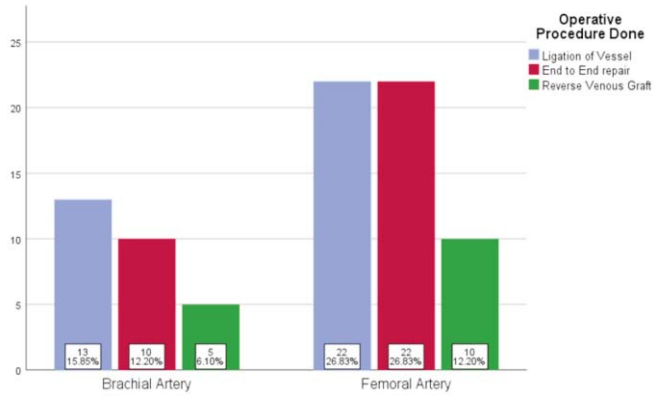

Figure-1: Different surgical procedures done on brachial and femoral arteries..

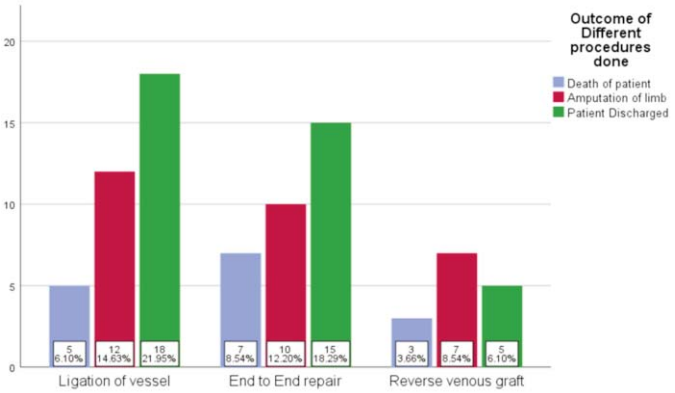

Figure-2: Outcome of the vascular procedures

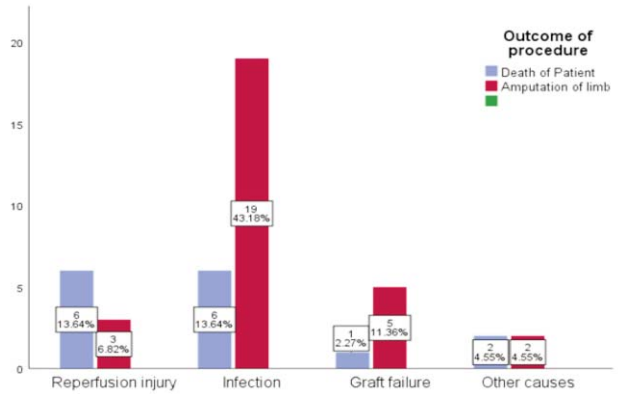

Figure-3: Causes of death of patients and amputation of limbs.

Femoral artery was damaged more 54(65.85%) compared to brachial artery 28(34.14%) in all modes of injuries (Table 1), and most of the vascular injuries were caused by GSWs 42(51.2%) (Table 2).

Ligation of vessel was done in 35(42.68%) cases (Figure 1). Mortality was the outcome in 15(18.29%) patients, amputation in 29(35.36%) and discharge after successful vascular repair 38(46.34%) (Figure 2). Among the 35(42.68%) ligation cases, 18 patients were discharged. Infection of the wound and reperfusion injury were the most common causes of mortality, while infection alone was the leading cause of amputation (Figure 3).

Discussion

During and after World War II, there was a shift from ligating the injured vessel to primary repair, which resulted in significant decrease in amputation rates from 50% to 2%[16]. But with the advent of reliable scoring systems of vascular trauma, like MESS and ISS, and advanced management options, vascular repair is reserved only for selected cases. This is also endorsed by a common principle of 'life over limb'[17]. In armed conflicts, vascular injuries contribute to 80-90% of total cases, while this percentage is quite low, about 20-30%, in civilian trauma injuries[18].

Males were affected more than females in the current study, and the overall mean age was 33±5.41 years, which were in line with earlier studies[19,20].

The most common cause of vascular injuries in the current study was road traffic accidents (RTAs)30(36.5%). Worldwide, RTAs constitute about 21% of total trauma patients, and femoral artery is affected more than brachial artery[21]. The current study also showed that femoral artery was affected more compared to brachial artery. This is because lower limb injuries are more common in RTAs compared to the upper limbs. The presence of one hard sign is enough to diagnose the vascular injury, while the presence of one soft sign carries the risk of vascular injury to about 10%, and the presence of 2 soft signs carries the chance of vascular injury to about 25%[22].

Time and mode of injury play an important role in the management of vascular injuries. In many studies, the critical limit of time that affected the outcome of the revascularisation (also called golden time) was considered to be <6 hours after the trauma till revascularisation[23]. However, many studies published good results of revascularisation even 6 hours post-trauma[24]. The current study observed outcome of revascularisation of injured vessels 6-12 hours after

trauma. In 35 patients, ligation of the vessel was done, and 18 of them were discharged home safely. The phenomenon of limb viability after ligation of the major vessel of the limb is due to the existence of good collaterals in the limb[25]. Many studies have proposed that in critical situations and specific conditions, ligation of limb is better than further causing the bleeding during revascularisation attempts, and prolonging the ischaemia time and infection rates[26].

The mortality rate in the current study was 15(18.29%). Among them, 6 patients expired due to reperfusion injury, and 6 due to infection of limb which later led to septicaemia and acute kidney injury. One patient expired due to graft failure, and 2 expired due to sudden cardiac arrest on the second postoperative day.

Ligation of the injured vessel was the most common procedure adopted for saving life of the patient 35(42.68%) in the current study, and the outcome of ligation of the injured vessel was more satisfactory compared to other definitive procedures. A few decades back, it was considered that the repair of artery should always be attempted, and ligation of the vessels should be considered only the second option. However, with the advent of modern trauma scoring systems and ATLS, in cases of severe trauma, ligation of vessel is the preferred option to buy time for resuscitation and to do a definitive procedure later when the patient is haemodynamically stable[27].

In different studies worldwide, complication rate in emergency revascularisation has been found to be 10-18% but these figures were reported by studies in which revascularisation was done <6 hours after trauma[28]. In the current study, complications were found in 44(53.65%) patients, and 15(34%) of them died during or after the operation, while 29(65.9%) underwent amputation on index operation or after graft failure. In a study, ischaemia time and the order of revascularisation were not related to the rate of amputation and, the main predictor of amputation was MESS score >7[29]. This was due to time tolerance owing to ischaemia severity[4]. Another study showed that many factors played an important role in deciding amputation in patients with vascular trauma, like blunt trauma, major soft tissue injury, compartment syndrome, and age >55 years[30].

In the current study, infection of the wound and the reperfusion injury were the most common causes of mortality. Infection alone was the leading cause of amputation in patients who underwent vascular repair. Among 29(65.9%) patients who underwent amputations after facing complications, 19(65%) amputations were due to infection process occurred post-operatively, while 6(20.6%) patients died due to septicaemia post-operatively. Similarly, reperfusion injury after vascular repair caused complications in 9(20.4%) patients, and 6(66.6%) of them died post-operatively due to acute kidney injury, while 3(33.3%) underwent amputation due to reperfusion injury leading to muscle necrosis and ultimately acute kidney injury. In a study, repair of vascular injury 8 hours after injury led to mortality of 27% patients due to reperfusion injury, while this mortality percentage was reported to be 38% by Qin et al. when vascular injuries were repaired 9 hours after injury[31,32]. The infection rate was found to be 6%in one study, while it was 18 % in another study[33,34].

The infection rate was found to be higher in patients with major soft tissue injury after vascular repair, but the infection could be controlled through irrigation with copious amount of water and using prophylactic broad-spectrum antibiotics, and later converting to specific antibiotics according to culture and sensitivity reports.

There are certain limitations to the current study. First, the study was conducted at a single centre, and, as such, the results are dependent on the operation theatre (OT) environment of a single hospital. Second, the sample size was relatively small.

Conclusion

Ligation of the femoral or brachial artery could be considered a safe and lifesaving procedure in patients who presented late to the emergency department after trauma to brachial or femoral vessels. Many factors played an important role in deciding the best treatment option for the patients. Recruitment of vascular surgeons to deal with vascular trauma in emergency department would be a very significant step towards decreasing the morbidity and mortality of such patients.

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References

1. Bäckman PB, Riddez L, Adamsson L, Wahlgren CM. Epidemiology of firearm injuries in a Scandinavian trauma center. Eur J Trauma Emerg Surg 2020;46:641-7. doi: 10.1007/s00068-018-1045-1
2. Boufi M, Ejargue M, Gaye M, Boyer L, Alimi Y, Loundou AD. Systematic review and meta-analysis of endovascular versus open repair for common femoral artery atherosclerosis treatment. J Vasc Surg 2021;73:1445-5. doi: 10.1016/j.jvs.2020.10.026
3. Cai J, Jiang Y, Zhang M, Zhao H, Li H, Li K, et al. Protective effects of mitochondrion-targeted peptide SS-31 against hind limb ischemia-reperfusion injury. J Physiol Biochem 2018;74:335-43. doi: 10.1007/s13105-018-0617-1

4. Fingerhut A, Leppäniemi AK, Androulakis GA, Archodovassilis F, Bouillon B, Cavina E, et al. The European experience with vascular injuries. Surg Clin North Am 2002;82:175-88. doi: 10.1016/s0039-6109(03)00147-6
5. Doody O, Given MF, Lyon SM. Extremities--indications and techniques for treatment of extremity vascular injuries. Injury 2008;39:1295-303. doi: 10.1016/j.injury.2008.02.043
6. Feliciano DV, Moore FA, Moore EE, West MA, Davis JW, Cocanour CS, et al. Evaluation and management of peripheral vascular injury. Part 1. Western Trauma Association/critical decisions in trauma. J Trauma 2011;70:1551-6. doi: 10.1097/TA.0b013e31821b5bdd.
7. Haney LJ, Pugh MJV, Copeland LA, Wang CP, MacCarthy DJ, Amuan ME, et al. Persistent Pain, Physical Dysfunction, and Decreased Quality of Life After Combat Extremity Vascular Trauma. Ann Vasc Surg 2021;71:167-80. doi: 10.1016/j.avsg.2020.08.104
8. García A, Millán M, Burbano D, Ordoñez CA, Parra MW, González Hadad A, et al. Damage control in abdominal vascular trauma. Colomb Med (Cali) 2021;52:e4064808. doi: 10.25100/cm.v52i2.4808
9. Andrew Koman L. Management of upper extremity arterial penetrating vascular trauma. Injury 2021;52:3573-9. doi: 10.1016/j.injury.2021.10.001
10. Kuralay E, Demirkiliç U, Ozal E, Oz BS, Cingöz F, Gunay C, et al. A quantitative approach to lower extremity vein repair. J Vasc Surg 2002;36:1213-8. doi: 10.1067/mva.2002.128934
11. Hohenberger GM, Konstantiniuk P, Cambiaso-Daniel J, Matzi V, Schwarz AM, Lumenta DB, et al. The Mangled Extremity Severity Score Fails to be a Good Predictor for Secondary Limb Amputation After Trauma with Vascular Injury in Central Europe. World J Surg 2020;44:773-9. doi: 10.1007/s00268-019-05263-w
12. Özel M, Altintaş M, Tatliparmak AC, Yilmaz S, Ak R. The role of Mangled Extremity Severity Score in amputation triage in a transport health facility with catastrophic earthquake admissions. Injury 2023;54:111003. doi: 10.1016/j.injury.2023.111003
13. Herr HM, Clites TR, Srinivasan S, Talbot SG, Dumanian GA, Cederna PS, et al. Reinventing Extremity Amputation in the Era of Functional Limb Restoration. Ann Surg 2021;273:269-7. doi: 10.1097/SLA.0000000000003895
14. Sreekrishnan TP, Gireesh Kumar KP, Dhanasekaran BS, Kader BA, Keerthana CU, Mohan N, et al. Adherence to ATLS protocols for primary survey. Amrita Journal of Medicine (AJM) 2019;15:19-23.
15. Hanna INA. Novel technique of vein harvesting for reversed saphenous vein bypass graft. J Med Sci Res 2020;3:286-8. DOI: 10.4103/JMISR.JMISR_86_20.
16. Liu JL, Li JY, Jiang P, Jia W, Tian X, Cheng ZY, et al. Literature review of peripheral vascular trauma: Is the era of intervention coming? Chin J Traumatol 2020;23:5-9. doi: 10.1016/j.cjtee.2019.11.003
17. Kayssi A, Metias M, Langer JC, Roche-Nagle G, Zani A, Forbes TL, et al. The spectrum and management of noniatrogenic vascular trauma in the pediatric population. J Pediatr Surg 2018;53:771-4. doi: 10.1016/j.jpedsurg.2017.04.015
18. Khan S, Elghazaly H, Mian A, Khan M. A meta-analysis on anticoagulation after vascular trauma. Eur J Trauma Emerg Surg 2020;46:1291-9. doi: 10.1007/s00068-020-01321-4
19. Perkins ZB, Yet B, Glasgow S, Marsh DWR, Tai NRM, Rasmussen TE. Long-term, patient-centered outcomes of lower-extremity vascular trauma. J Trauma Acute Care Surg 2018;85(Suppl 1):s104-11. doi: 10.1097/TA.0000000000001956
20. Ramdass MJ, Muddeen A, Harnarayan P, Spence R, Milne D. Risk factors associated with amputation in civilian popliteal artery trauma. Injury 2018;49:1188-92. doi: 10.1016/j.injury.2018.04.028
21. Sharrock AE, Tai N, Perkins Z, White JM, Remick KN, Rickard RF, et al. Management and outcome of 597 wartime penetrating lower extremity arterial injuries from an international military cohort. J Vasc Surg 2019;70:224-32. doi: 10.1016/j.jvs.2018.11.024
22. Smith S, Allen L, Khwaja K, Joos E, Ball CG, Engels PT, et al. Management of vascular trauma across Canada: A cohort study with implications for practice. Injury 2022;53:1662-6. doi: 10.1016/j.injury.2021.12.052
23. Wu L, Xiong X, Wu X, Ye Y, Jian Z, Zhi Z, et al. Targeting Oxidative Stress and Inflammation to Prevent Ischemia-Reperfusion Injury. Front Mol Neurosci 2020;13:28. doi: 10.3389/fnmol.2020.00028
24. Sorber R, Pedroso FE, Murphy JM, Stewart D. Dual-layer everted saphenous vein patch for pediatric femoral artery repair following ECMO decannulation. J Pediatr Surg 2020;55:1409-13. doi: 10.1016/j.jpedsurg.2020.02.055
25. López-Narváez L, Salazar-Trujillo A, Cáceres-Sepúlveda JF, Rincón-Guio C, Charry-Cuellar JD. Peripheral vascular trauma. Literature review. Cir Gen 2019;41:184-90.
26. Mi L, Zhang Y, Xu Y, Zheng X, Zhang X, Wang Z, et al. HMGB1/RAGE pro-inflammatory axis promotes vascular endothelial cell apoptosis in limb ischemia/reperfusion injury. Biomed Pharmacother 2019;116:109005. doi: 10.1016/j.biopha.2019.109005
27. Larsen DW. Traumatic vascular injuries and their management. Neuroimaging Clin N Am 2002;12:249-6. doi: 10.1016/s1052-5149(02)00006-0
28. Eguchi S, Ono S, Soyama A, Fukui-Araki S, Isagawa-Takayama Y, Hidaka M, et al. One-step reconstruction of IVC and right hepatic vein using reversed auto IVC and left renal vein graft. Int J Surg Case Rep 2019;57:57-9. doi: 10.1016/j.ijscr.2019.03.004
29. Prieto JM, Van Gent JM, Calvo RY, Checchi KD, Wessels LE, Sise MJ, et al. Pediatric extremity vascular trauma: It matters where it is treated. J Trauma Acute Care Surg 2020;88:469-76. doi: 10.1097/TA.0000000000002595
30. Teixeira PGR, DuBose J. Surgical Management of Vascular Trauma. Surg Clin North Am 2017;97:1133-55. doi: 10.1016/j.suc.2017.05.001
31. Percival TJ, Rasmussen TE. Reperfusion strategies in the management of extremity vascular injury with ischaemia. Br J Surg 2012;99(Suppl 1):s66-74. doi: 10.1002/bjs.7790
32. Qin S, Zang J, Wang Y, Jiao S, Qin X, Pan Q. Traumatic Sequelae of Lower Limb. In: Qin S, Zang J, Jiao S, Pan Q, eds. Lower Limb Deformities: Deformity Correction and Function Reconstruction, 1st ed. Gateway East, Singapore: Springer Nature Singapore Pte Ltd, 2020; pp 433-70. doi: 10.1007/978-981-13-9604-5.
33. Karimian M, Okhli A, Noormohammadi-Dehbalaee A, Gholami A, Abdi A, Salimi E, et al. Prevalence of Vascular Trauma and Related Factors in Iran: ASystematic Review. Int J Med Toxicol Forensic Med 2021;11:31441. doi: 10.32598/ijmtfm.v11i2.31441.
34. McDonald SJ, Sharkey JM, Sun M, Kaukas LM, Shultz SR, Turner RJ, et al. Beyond the Brain: Peripheral Interactions after Traumatic Brain Injury. J Neurotrauma 2020;37:770-81. doi: 10.1089/neu.2019.6885

AUTHORS' CONTRIBUTIONS:

ASA & SIA: Concept, design, drafting, revision, final approval and agreement to be accountable for all aspects of the work.

SAN: Design, drafting, revision, final approval and agreement to be accountable for all aspects of the work.

AL: Data acquisition, interpretation, drafting, revision, final approval and agreement to be accountable for all aspects of the work.

AMJ: Data interpretation, drafting, revision, final approval and agreement to be accountable for all aspects of the work.

AS: Data analysis, interpretation, drafting, revision, final approval and agreement to be accountable for all aspects of the work.