

Civilian Traumatic Vascular Injuries of the Upper Extremity: Report of the Iranian National Trauma Project

Mohammad R. Rasouli, MD, Majid Moini, MD, and Ali Khaji, MD

Purpose: The determination of the pattern of traumatic vascular injuries of the upper extremity in Iran was the aim of this study.

Methods: Data of the Iranian national trauma project were used to identify patients with upper extremity vascular injuries. This project was conducted in 8 major cities from 2000–2004.

Results: A total of 113 cases with 130 vascular injuries were found, including 2 axillary, 18 brachial, and 69 radial and ulnar arteries. In 91 cases (81%), penetrating trauma was responsible. Associated nerve and/or upper extremity fractures were seen in 20% and 18% of cases, respectively. End-to-end anastomosis, interposition of saphenous graft, and ligation were used for the management of 44%, 28%, and 17%, respectively, of brachial artery injuries. Ulnar and radial artery injuries had been either ligated (n = 36; 52%) or sutured (n = 33; 48%). Median, ulnar, and radial nerve injuries, except for one, had all been sutured primarily. No patients needed fasciotomy. Amputation and mortality resulting from associated injuries occurred in 3 (2.6%) and 5 (4.4%) patients, respectively.

Conclusion: This study revealed that stabbings are the most frequent causes of these injuries in Iran, in spite of the management of patients in level 3 trauma centers; the rate of amputation is acceptable. However, this study does not provide limb functions of the patients. (*Ann Thorac Cardiovasc Surg* 2009; 15: 389–393)

Key words: trauma, vascular injury, upper extremity, Iran

Introduction

Trauma is a great public health problem in developing and developed countries alike and usually involves young people. Among kinds of trauma, vascular injuries of the extremities need special consideration because they can

be threatening to limb and life.¹⁾

Although the rate of successful management of these injuries has been increased as a result of appropriate pre-hospital care, early referral of patients to equipped trauma centers, and on-time surgical interventions, these injuries remain a challenging problem, especially in developing countries.^{2,3)} In Iran, besides an inappropriate prehospital care system, too many patients are being referred too late to vascular surgery centers. This is related to the limited number of level one and level two trauma centers that are equipped with vascular surgery divisions. Thus some of these patients are being given preliminary ligation of the injured vessels by general surgeons in other centers.⁴⁾

Further, vascular injuries are more common following penetration compared to blunt trauma. Because the rate

From Department of Vascular Surgery and Sina Trauma and Surgery Research Center, Sina Hospital, Tehran University of Medical Sciences, Tehran, Iran

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Address reprint requests to Majid Moini, MD: Department of Vascular Surgery and Sina Trauma and Surgery Research Center, Sina Hospital, Tehran University of Medical Sciences, Hassanabad Square, Tehran, 1136933511, Iran.
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of penetrating trauma varies significantly across regions, the incidence of vascular injuries is also variable. Thus it is necessary to determine the pattern of vascular injuries separately for each region.⁵⁾

To our knowledge, there are but few studies regarding traumatic vascular injuries of the upper extremity in Iran,⁴⁾ and the pattern of traumatic vascular injuries is not well defined. In this study, we intended to evaluate traumatic vascular lesions of the upper extremity in Iran by using the data registry system of the Iranian National Trauma Project (INTP).

Materials and Methods

During a 4-year period (2000 to 2004), a cross-sectional study was performed as a part of the INTP in eight major cities. This study was set up in accordance with the American College of Surgeons National Trauma Registry System (TRACS) and the National Trauma Data Bank (NTDB), using a valid questionnaire.^{6,7)} A group of physicians were trained to process data collection in several sections. Throughout the study, they visited traumatic patients during their first 24-hour admissions to emergency rooms and wards, where the questionnaires were completed.

Patients with traumatic vascular injuries of the upper extremity were found from among a total of 17,753 patients who had been referred to trauma centers of the eight cities and hospitalized for more than 24 hours. The required data were obtained, which included demographics, duration of transportation to the hospital, mechanism of trauma, details of injured vessels and nerves, associated injuries (coded according to ICD-10), preoperative investigations, surgical intervention, duration of hospital stay, and outcomes (amputation or death) were obtained. Associated nerve injuries had been determined by preoperative examinations and explorations in the operating room. The arterial injuries were diagnosed by physical examination, Doppler ultrasound, and, if necessary, arteriography. In short postoperative days, patients with pure arterial injury had received low molecular weight heparin for anticoagulant therapy, but in cases with pure venous injuries or combined arterial and venous injuries, heparin infusion with control of partial thromboplastin time (PTT) had been prescribed.

The collected data were analyzed using SPSS (Statistical Package for the Social Sciences, version 13.0, SPSS Inc., Chicago, IL, USA) software, and *p* value <0.05 was considered statistically significant.

Table 1. The mechanism of trauma and the injured vessels and nerves are shown in detail

	Number	(%)
Mechanism of trauma		
Penetrating		
Stabbings	87	77
Gunshot	2	1.8
Shotgun	1	0.9
Blunt		
Falls	2	1.8
Accidents	12	10.6
Blunt objects	7	6.2
Undetermined	2	1.8
Injured vessels*		
Axillary artery	2	1.5
Brachial artery	18	14
Ulnar artery (at forearm)	18	14
Radial artery (at forearm)	17	13
Ulnar artery (at wrist)	21	16
Radial artery (at forearm)	13	10
Superficial palmar arch	1	0.75
Blood vessels of thumb and other fingers	7	5.25
Axillary and/or brachial vein	2	1.5
Nonspecific or multiple vessel injuries	31	24
Nerve injuries**		
Axillary nerve	1	4
Median nerve	9	33
Ulnar nerve	9	33
Radial nerve	3	11
Nonspecified nerves	5	19

* , nine and four patients had 2 and 3 injured vessels, respectively; **, at forearm and wrist.

Results

During the period, 113 patients (101 men) with traumatic vascular injuries of the upper extremities presented to the emergency rooms of the hospitals used in the study. The mean age of the patients was 27.13 ± 13.87 (mean \pm standard deviation [SD]); the years ranged from 3 to 82. The mean duration of transportation was 3.29 ± 9.32 hr (mean \pm SD) and ranged from 10 min to 96 hr. Thirteen patients (11.5%) presented to the centers after 6 hr. However, there was no significant association between time of transportation and amputation (*p* >0.05, independent samples t-test).

Vascular injuries in 68 cases (60%) were accidental, and deliberate injuries were seen in 13 patients (12%). In 21% of the patients (*n* = 24), the vascular injury had resulted from occupational trauma. Workers (*n* = 23; 20%) were the most affected groups. Blunt and penetrating traumas were responsible for vascular injuries in 22 (19%) and 91 (81%) cases, respectively (Table 1). Thirteen patients (11.5%) had been presented with hemorrhagic shock (systolic

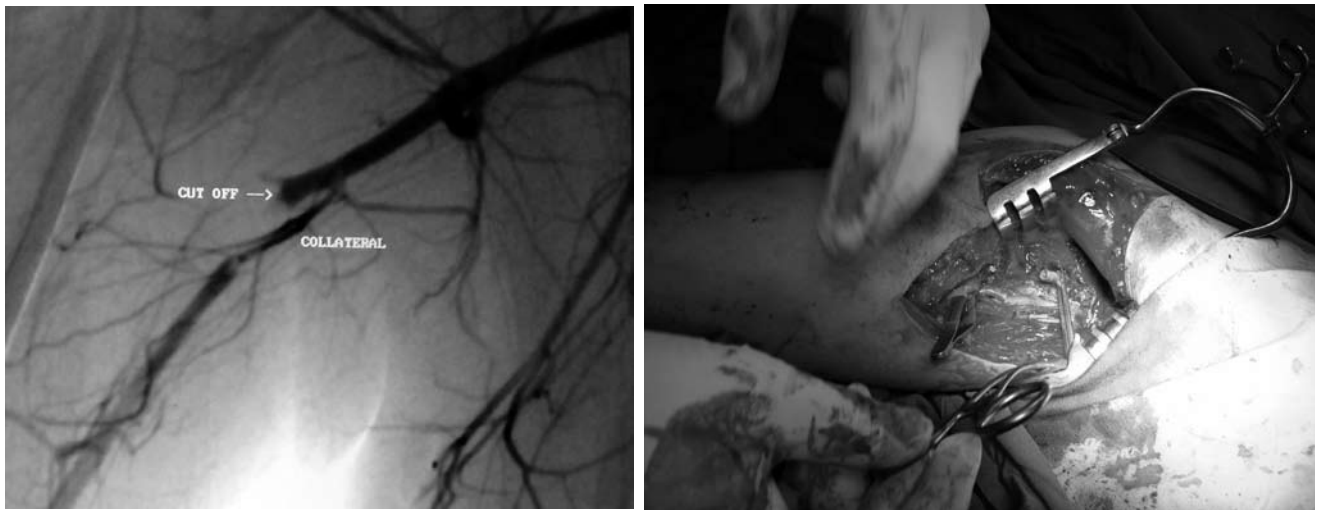


Fig. 1. Angiographic and operating fields of a patient with axillary artery injury are shown.

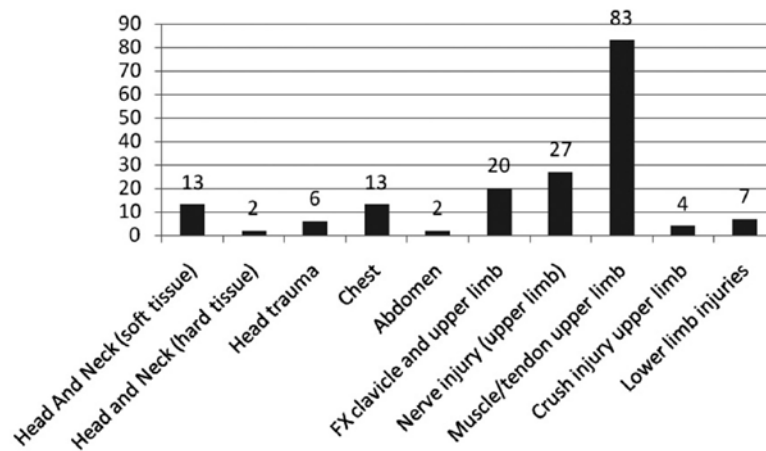


Fig. 2. Associated injuries.

blood pressure < 90 mm Hg).

Arteriography was performed in 8 cases as preoperative assessment in which clinical evaluation showed no definite vascular injury. The axillary (Fig. 1) and brachial arteries had been injured in 2 and 18 cases, respectively. Table 1 shows the details of injured vessels. Nerve injuries were seen in 27 cases (24%). The injured nerves were median (n = 9), ulnar (n = 9), radial (n = 3), and axillary (n = 1). One case had a nonspecified nerve injury. Upper extremity fractures were seen in 18% (n = 20) of cases. (Table 1, Fig. 2).

Axillary artery injuries were treated with ligation (n = 1) and end-to-end anastomosis (n = 1). Brachial artery lesions were managed by removing the injured parts and by end-to-end anastomosis (n = 8; 44%), interposition of saphenous graft (n = 5; 28%), bypassed with saphenous graft (n = 2;

11%), and ligation of the brachial artery (n = 3; 17%). Ulnar and radial artery injuries had been either ligated (n = 36; 52%) or removed and anastomosis performed (n = 33; 48%). Vascular injuries of the palmar arch and fingers had been managed by ligation. All venous injuries (n = 30) were ligated. All median, ulnar, and radial nerve injuries, except one ulnar nerve, had been repaired primarily. An intraluminal shunt was used in no patients, and none needed fasciotomy. All simultaneous tendon ruptures were repaired. Of 3 patients (2.6%) who underwent amputation, the mechanism of trauma was blunt in 2 (p = 0.013, Chi-square test). The amputation levels were finger, wrist, and above the elbow. Five patients died because of the severity of associated injuries. The mean hospital stay was 4 ± 3.61 days.

Discussion

Upper extremity vascular injuries carry better prognosis than lower ones, especially if the injury is distal to the profunda brachii artery. It is related to rich collateral supplements of the upper limb.⁴⁾

In our series, most vascular injuries were related to penetrating traumas, which is consistent with our previous report⁴⁾ and also to reports from other countries.^{2,8-14)} However, in some countries such as South Africa,¹⁰⁾ gunshot injuries are more frequent than in Iran. Moreover, our study showed that blunt traumas carry worse prognoses than penetrating injuries similar to previous reports,^{5,15)} and they are more likely to result in amputations. This is because most blunt trauma results from falls and motor vehicle accidents; higher energy injuries are more likely to result from vascular injuries. Also, vascular trauma is associated with certain skeletal injuries.

In our series, 89% of patients were males. This is similar to previous reports, which showed vascular injuries more frequently in males than in females.^{8,13)} The mean age of our patients was 27, which is inconsistent with previous reports that suggested these injuries usually affect young people.^{4,13)}

Regarding preoperative investigations, arteriography had been performed in only 8 cases. It shows that most of the arterial injuries of the upper extremity can be diagnosed by physical examination and Doppler ultrasound. However, arteriography has been advocated for the diagnosis of vascular injury in patients with penetrating proximal trauma to the extremities.¹⁶⁾ In our study, arteriography was used for diagnoses on 2 patients with axillary artery injuries. However, it has been shown in previous studies that accurate physical examinations¹⁷⁾ and Doppler ultrasound¹⁸⁾ have high sensitivity in the diagnosis of vascular injuries of the extremities. Furthermore, Shanmugam et al.¹⁹⁾ report 100% success in limb salvage without angiography in their center, which provides good evidence for the management of upper limb arterial injuries without arteriography.

Satisfactory exposure of the injured vessel with prompt proximal and distal control has long been recognized as essential in the treatment of vascular injuries. Repair can be achieved by lateral sutures in selected situations, provided there is no compromise to the vessel lumen. More often the vessel requires excision of the traumatized segment and end-to-end anastomosis without suture line tension. If end-to-end anastomosis is impossible, an interposition graft is indicated using an autogenous vein, if at all possible, to avoid subsequent infection of a prosthesis.²⁰⁾ In our series, end-to-end anastomosis of brachial artery was

possible in 44%, which was the most frequent technique that is similar to previous reports.^{2,4)} However, it is in contrast with reports by Wali⁸⁾ and Zellweger et al.¹³⁾ In our series, 17% of brachial artery injuries had been managed by ligation of the brachial artery, which is similar to the report from Saudi Arabia.⁸⁾ All ulnar and radial arterial injuries in our series have been ligated or repaired by end-to-end anastomosis the relatively the same frequency.

Although the results of vascular repair in our patients were similar to the results of some other studies,²¹⁻²³⁾ we should not overlook reports that the long-term outcome of upper limb injury is not dependent on vascular injury, which can be successfully managed, but on the duration of limb ischemia before revascularization and concomitant injuries to bone, nerve, and soft tissue.^{21,24)}

In this study, 24% of the patients had associated nerve injuries, a result that is close to our previous report.⁴⁾ However, it is lower than some other reports.²⁵⁻²⁷⁾ In this study, all the injured nerves had been sutured primarily. According to our previous report, primary suture of nerve injuries in upper extremity traumatic lesions is associated with good results.²⁸⁾ In this study all median, ulnar, and radial nerves except one had been sutured primarily.

Although fasciotomy is indicated in the presence of an obviously tense compartment on presentation, its relative indications are less well defined. Some authors recommend the performance of a fasciotomy when limb ischemia time is more than 6 hr.²⁹⁾ In our series, although 11.5% of the patients presented after 6 hr, no fasciotomy was reported that is similar to our previous report.⁴⁾ However, in the mentioned study all subjects had prolonged ischemia (> 24 hr). Prophylactic fasciotomy is not routine in the management of traumatic vascular injuries in our hospitals.^{4,30)} However, it will do when an overt or suspicious compartment syndrome is present.^{2,30)} This approach is even used in prolonged lower limb ischemia, as we previously reported.³⁰⁾

Amputation was done in 3% of our patients, lower than in other reports.^{11,15)} However, we have some patients in our study who have suffered only from venous injuries, and the rate of gunshot and blunt traumas were also low.

The limitations of our study are those related to retrospective studies. Moreover, this study provides no long-term outcomes of these patients, especially of those with nerve injuries.

In conclusion, this study revealed that stabbings are the most frequent causes of these injuries in Iran, in spite of the management of patients in level 3 trauma centers; the rate of amputation is acceptable. However, this study does not provide limb functions of the patients.

References

1. Hammond DC, Gould JS, Hanel DP. Management of acute and chronic vascular injuries to the arm and forearm. Indications and technique. *Hand Clin* 1992; **8**: 453–63.
2. Ergunes K, Yilik L, Ozsoyler I, Kestelli M, Ozbek C, et al. Traumatic brachial artery injuries. *Tex Heart Inst J* 2006; **33**: 31–4.
3. Huynh TT, Pham M, Griffin LW, Villa MA, Przybyla JA, et al. Management of distal femoral and popliteal arteries injuries: an update. *Am J Surg* 2006; **192**: 773–8.
4. Moini M, Hamedani K, Rasouli MR, Nouri M. Outcome of delayed brachial artery repair in patients with traumatic brachial artery injury: prospective study. *Int J Surg* 2008; **6**: 20–2.
5. Dueck AD, Kuceyw D. The management of vascular injuries in extremity trauma. *Curr Orthoped* 2003; **17**: 287–91.
6. World Health Organization. International statistical classification of diseases and health related problems (The ICD-10). 2nd ed. Geneva: World Health Organization; 1994.
7. The American College of Surgeons National Trauma Registry System. Available from: http://www.facs.org/trauma/national_tracs/tracmenu.html
8. Wali MA. Upper limb vascular trauma in the Asir region of Saudi Arabia. *Ann Thorac Cardiovasc Surg* 2002; **8**: 298–301.
9. Myers SI, Harward TR, Maher DP, Melissinos EG, Lowry PA. Complex upper extremity vascular trauma in an urban population. *J Vasc Surg* 1990; **12**: 305–9.
10. Degiannis E, Levy RD, Sofianos C, Florizoone MG, Saadia R. Arterial gunshot injuries of the extremities: a South African experience. *J Trauma* 1995; **39**: 570–5.
11. Razmadze A. Vascular injuries of the limbs: a fifteen-year Georgian experience. *Eur J Vasc Endovasc Surg* 1999; **18**: 235–9.
12. Borman KR, Snyder WH 3rd, Weigelt JA. Civilian arterial trauma of the upper extremity. An 11 year experience in 267 patients. *Am J Surg* 1984; **148**: 796–9.
13. Zellweger R, Hess F, Nicol A, Omoshoro-Jones J, Kahn D, et al. An analysis of 124 surgically managed brachial artery injuries. *Am J Surg* 2004; **188**: 240–5.
14. Andreev A, Kavrov T, Karakolev J, Penkov P. Management of acute arterial trauma of the upper extremity. *Eur J Vasc Surg* 1992; **6**: 593–8.
15. Fitridge RA, Raptis S, Miller JH, Faris I. Upper extremity arterial injuries: experience at the Royal Adelaide Hospital, 1969 to 1991. *J Vasc Surg* 1994; **20**: 941–6.
16. O’Gorman RB, Feliciano DV, Bitondo CG, Mattox KL, Burch JM, et al. Emergency center arteriography in the evaluation of suspected peripheral vascular injuries. *Arch Surg* 1984; **119**: 568–73.
17. Frykberg ER, Dennis JW, Bishop K, Laneve L, Alexander RH. The reliability of physical examination in the evaluation of penetrating extremity trauma for vascular injury: results at one year. *J Trauma* 1991; **31**: 502–11.
18. Bynoe RP, Miles WS, Bell RM, Greenwold DR, Sessions G, et al. Noninvasive diagnosis of vascular trauma by duplex ultrasonography. *J Vasc Surg* 1991; **14**: 346–52.
19. Shanmugam V, Velu RB, Subramaniyan SR, Hussain SA, Sekar N. Management of upper limb arterial injury without angiography—Chennai experience. *Injury* 2004; **35**: 61–4.
20. Reynolds RR, McDowell HA, Diethelm AG. The surgical treatment of arterial injuries in the civilian population. *Ann Surg* 1979; **189**: 700–9.
21. Shaw AD, Milne AA, Christie J, Jenkins AM, Murie JA, et al. Vascular trauma of the upper limb and associated nerve injuries. *Injury* 1995; **26**: 515–8.
22. Degiannis E, Levy RD, Sliwa K, Potokar T, Saadia R. Penetrating injuries of the brachial artery. *Injury* 1995; **26**: 249–52.
23. Orcutt MB, Levine BA, Gaskill HV, Sirinek KR. Civilian vascular trauma of the upper extremity. *J Trauma* 1986; **26**: 63–7.
24. Sturm JT, Bodily KC, Rothenberger DA, Perry JF Jr. Arterial injuries of the extremities following blunt trauma. *J Trauma* 1980; **20**: 933–6.
25. Nichols JS, Lillehei KO. Nerve injury associated with acute vascular trauma. *Surg Clin North Am* 1988; **68**: 837–52.
26. Visser PA, Hermreck AS, Pierce GE, Thomas JH, Hardin CA. Prognosis of nerve injuries incurred during acute trauma to peripheral arteries. *Am J Surg* 1980; **140**: 596–9.
27. Sitzmann JV, Ernst CB. Management of arm arterial injuries. *Surgery* 1984; **96**: 895–901.
28. Taha A, Taha J. Results of suture of the radial, median, and ulnar nerves after missile injury below the axilla. *J Trauma* 1998; **45**: 335–9.
29. Field CK, Senkowsky J, Hollier LH, Kvamme P, Saroyan RM, et al. Fasciotomy in vascular trauma: is it too much, too often? *Am Surg* 1994; **60**: 409–11.
30. Moini M, Takyar MA, Rasouli MR. Revascularisation later than 24h after popliteal artery trauma: is it worthwhile? *Injury* 2007; **38**: 1098–101.