

Upper Limb Vascular Trauma in the Asir Region of Saudi Arabia

Mahmoud A. Wali, FRCSI, FICS, FACA

Upper limb vascular trauma is associated with major morbidity and mortality, but little is known about its incidence or nature in the Asir region of southern Saudi Arabia. During the five and a half-year period from May 1996 to December 2001, 27 patients were admitted to Asir Central Hospital (ACH), Abha, Saudi Arabia with upper limb vascular injury. The patients were 21 males and 6 females with a mean age of 27 ± 12.6 years. Although penetrating trauma was more frequent than blunt trauma (59%), road traffic accident (RTA) was the most common single mechanism of trauma (33%). The brachial artery was the most frequently affected artery and interposition vein grafting was the most commonly employed type of vascular repair. Fifty-two percent of the patients had associated orthopedic injury and 60% had associated nerve injury. One patient underwent delayed above-elbow amputation and two patients died from other associated injuries. Vascular repair was successful in 24 out of the 26 patients in whom it was attempted (92%). However, the functional outcome of the limbs depended on the presence of associated nerve injury. (*Ann Thorac Cardiovasc Surg* 2002; 8: 298–301)

Key words: Asir region, upper limb, vascular injury, orthopedic injury, nerve injury

Introduction

Trauma has become a public health problem in many parts of the world, and vascular trauma is an important component of this problem. Acute arterial injuries of the upper extremity, account for half of civilian arterial injuries in the United States. The great majority of these injuries are due to penetrating trauma, with stab and gunshot wounds being the most common cause.¹⁾ However, the mechanism of injury seems to differ between different parts of the world.^{2,3)} While successful treatment of major arterial injuries may be life-saving as well as allowing limb salvage and restoration of function,⁴⁾ return of function is often related to the presence of concomitant injury to peripheral nerves.⁵⁾

Upper limb vascular trauma can therefore be associ-

ated with major morbidity and mortality, but little is known about its incidence or nature in the Asir region of Saudi Arabia. A retrospective study of 27 patients requiring operative intervention for upper limb vascular trauma under one vascular surgeon over a five and a half-year period was undertaken. In this report we are presenting the different mechanisms of trauma, arteries involved, associated orthopedic or nerve injuries and types of vascular repairs employed. To the best of our knowledge, this is the first report on upper limb vascular trauma from this region of Saudi Arabia.

Patients and Methods

During the five and a half-year period between May 1996 and December 2001, 27 patients presented with upper extremity vascular injury. All patients underwent full physical examination and resuscitation according to the principles of the Advanced Trauma and Life Support (ATLS®) guidelines of trauma management. The patients were either first assessed by the vascular surgeon or were referred from the orthopedic surgeon after finding absent distal pulses in a patient with fracture or fracture/dislocation of the upper limb.

From Department of Surgery, College of Medicine and Medical Sciences, King Khalid University, Abha, Saudi Arabia

Received February 6, 2002; accepted for publication July 4, 2002. Address reprint requests to Mahmoud A. Wali, FRCSI, FICS, FACA: Department of Surgery, College of Medicine and Medical Sciences, King Khalid University, P.O. Box 641, Abha, Saudi Arabia. mahmoudwali@yahoo.com

Depending on the mode of presentation, patients were either taken immediately to the operating room for vascular or orthopedic/vascular management or were assessed by preoperative angiography. In all patients with associated orthopedic injury, reduction of joint dislocation or bone fracture and immobilization by internal or external fixation always preceded vascular repair. Endoluminal shunts were not used in any of the patients. In all patients, management of vascular injuries was done in the operating room under general anesthesia using standard vascular techniques. Depending on the condition of the limb after revascularization, open full forearm fasciotomy was used liberally to either relieve existing compression or to avoid one from occurring in the postoperative period. Few arm fasciotomies were also performed. Fasciotomy wounds were usually covered later by a delayed primary, split-thickness skin graft done by the plastic surgeon. An intraoperative angiogram was not done in any patient. Successful repair was assessed by the return of distal pulses at the end of the operation.

Although associated nerve injuries were not usually repaired at the time of vascular repair, major associated venous injuries were repaired in two patients. Patients with suspected nerve injuries were assessed late postoperatively by electric stimulation studies. Six weeks after discharge from the hospital, patients were routinely examined in the outpatient department (OPD) where segmental pressures were measured and functional status of the limb assessed. Thereafter, they were followed up at longer periods of time. The mean follow-up period for the whole group was 34.5 ± 24.9 months (range 1-68 months). All patients received intravenous preoperative, prophylactic antibiotics, which were continued postoperatively for 24 hours unless prolonged use was dictated by the presence of contamination or infection, or else advised by the attending orthopedic surgeon. All patients also received intravenous heparin for a period of 5-7 days postoperatively and were discharged home on oral aspirin 100 mg tablet/day for a period of six weeks. In one patient who sustained an almost guillotine-like injury to his left mid-hand by a falling fork lift, primary anastomosis of four metacarpal arteries was successfully performed after shortening of his metacarpal bones by the orthopedic surgeon.

Statistical analysis of the results was performed using SPSS®, statistical package for Windows version 7.5.

Results

The patients consisted of 21 males (78%) and 6 females

(22%) with a mean age of 27 ± 12.6 years (range 2-65 years). The left upper limb was the more frequently affected side as it was involved in 16 patients (59%) and the right side in 11 patients (41%). The mechanism of trauma was penetrating in 16 patients (59%) and blunt in the remaining 11 patients (41%). However, road traffic accident (RTA) was the single commonest cause of upper limb vascular injury in this group of patients, as it occurred in 9 patients (33%). RTA was also the commonest type of blunt trauma (9 out of 11), as stab injury was the commonest form of penetrating trauma (6 out of 16). Other forms of trauma in a descending order of frequency were cut wrist in 4 patients (15%), industrial or machinery like electric saw or hand drilling machine in 3 patients (11%), gunshot in 3 patients (11%) and a fall to the ground in 2 patients (7%). Thirteen patients (48%) presented with ischemia, 11 patients with bleeding (41%) and 3 patients with a pseudoaneurysm (11%).

The brachial artery was the most frequently affected artery as it was injured in 11 patients (41%), followed by the ulnar artery alone in 5 patients (19%), both the ulnar and radial arteries in 5 patients (19%) and the radial artery alone in 2 patients (7%). The axillary artery was involved in 2 patients (7%), and the subclavian and digital arteries in one patient each (4%). The vascular injury was more often associated with orthopedic injuries as both occurred in 14 patients (52%). Orthopedic injuries were in the form of fracture in 9 patients (33%), fracture/dislocation in 3 patients (11%) and dislocation alone in 2 patients (7%). Concomitant vein or nerve injury also occurred in 18 patients (67%). Associated nerve injury occurred in 16 patients (60%), vein injury in 10 patients (37%) and both occurred in 8 patients (30%).

In 19 patients (70%) the diagnosis of arterial injury was based on clinical and continuous wave Doppler (CWD) examination. Preoperative angiography was used in 7 patients (26%) and duplex scan was used in only one patient (4%). Thirty-five arteries were repaired in 26 patients of this group. While synthetic grafts were not used for any arterial repair, interposition vein graft was used in 13 patients (48%) as the most frequently used single technique of arterial repair. Other techniques used were ligation in 5 patients (19%); thromboembolectomy, patch angioplasty and primary anastomosis in two patients each (7%). Lateral repair and bypass grafting were used in one patient each (4%). Repair of major venous injuries was performed in 2 patients (7%). Therapeutic or prophylactic fasciotomy was performed in 13 patients (48%).

One patient (4%) underwent delayed, right, above-el-

bow amputation, two weeks after successful repair of his brachial artery injury. Two patients (7%) died from other associated injuries, mainly head trauma. In one patient, who died on the table, transection of the right subclavian artery was identified but was not repaired. In the second patient, the repair graft of his left brachial artery occluded shortly before he died, two days postoperatively. A limb salvage rate of 89% was therefore achieved in 24 patients. However, by excluding the patient who died on the table, vascular repair was successful in 24 out of the 26 patients (92%) in whom it was attempted.

Discussion

Among other findings, this study showed that the main victims of upper limb vascular injury in this region are young males, with female patients forming 22% of the total. However, in the study by Kruse-Andersen et al., all their patients were males with no female victims.⁶⁾ While, penetrating trauma was the predominant mechanism of injury in our patients occurring in 59% of them, it fared as high as 70-93% in reports from the U.S.A.^{3,5,7)} and as low as 14-43% in reports from Ireland, Canada, U.K. and Thailand.^{2,8-10)} RTA was the commonest single mechanism of trauma (33%) in this study, exclusively in male patients. This is similar to what was reported from Sweden,⁶⁾ and to some extent Thailand,¹⁰⁾ but totally different from that from the U.S.A., where gunshot injury was the primary cause.¹¹⁾ This may be due to the fact that the Asir region is known to have one of the highest rates of RTAs in Saudi Arabia.¹²⁾ Also, women are not allowed to drive in Saudi Arabia and the driver is the usual victim of RTA upper limb vascular trauma. Furthermore, most of the vascular injuries in the female patients of this study were due to household trauma. Therefore, the mechanism of trauma significantly depended on the sex of the patient as shown by both Pearson's ($P \leq 0.006$) and Spearman's ($P \leq 0.006$) correlation tests. Penetrating trauma was the main cause in female patients (83%), while blunt trauma predominated in male patients (52%). There was also a significant difference in the side of injury between the two sexes (Pearson's, $P \leq 0.015$; Spearman's, $P \leq 0.015$). The right upper limb was the most frequently affected side in female patients (83%) but much less so in male patients (33%). Similarly, while only one (17%) female patient had associated orthopedic injury, 57% of the male patients had some form of orthopedic injury. In general, associated orthopedic injury occurred in 52% of our patients, which lies in the middle of previously reported rates

of 12.5-69%.^{6,7)} Associated venous injury occurred in 41% of this group, which is almost double the 28% rate reported by previous investigators.^{6,10)} Apart from the much lower rate of 19% reported by Brown et al.,⁷⁾ associated nerve injury occurred in 63% of our patients, which agrees with most of previously reported rates at 46-86%.^{6,8-11,13,14)} As expected, the mechanism of trauma significantly affected the mode of presentation of the patients, by either ischemia or bleeding (Pearson's, $P = 0.000$; Spearman's, $P = 0.000$). Ischemia was more frequently associated with blunt trauma and bleeding with penetrating trauma. Blunt trauma in itself significantly determined the presence of associated orthopedic injury (Pearson's, $P = 0.000$; Spearman's, $P = 0.000$). Consequently, patients with associated orthopedic injury, presented more frequently with ischemia rather than bleeding (Pearson's, $P \leq 0.003$; Spearman's, $P \leq 0.001$).

Although preoperative angiography may be helpful, it should not delay arterial revascularization.¹⁵⁾ As previously suggested by Hunt and Kingsley⁵⁾ and Hammond et al.,¹⁾ the history of the injury and careful physical examination will identify most injuries. Whenever needed and the circumstances allowed, preoperative angiography was used in this series at a rate of 26% especially in patients with associated orthopedic injury. This is similar to the 20% rate reported by Andreev et al.,¹⁶⁾ but almost half of that reported by Sriussadaporn.¹⁰⁾ Duplex scan was used in only one child to ascertain the diagnosis of a pseudoaneurysm. In all the patients with associated orthopedic injury, the orthopedic surgeon performed reduction and fixation of fractures and/or dislocations prior to the vascular repair. We believe, as previously suggested by other authors, that a well-stabilized skeleton is essential before definitive soft tissue repair can be performed.^{15,17)} However, this is contrary to the view of Hunt et al., who suggested that arterial revascularization should be followed by skeletal stabilization and nerve and tendon repair.⁵⁾

The brachial artery was the most frequently affected artery in our patients at a rate of 41%, which is in agreement with most previous reports of between 37-66%.^{7,9,10,18)} However, in the report by Sitzmann and Ernst it constituted only 15% and the radial and ulnar arteries were the most frequently affected ones.¹³⁾ The most frequent type of vascular repair was interposition vein graft, using the thigh long saphenous vein, at a rate of 41%. This is close to the 40% and 45% rates reported respectively by van der Sluis et al.¹⁶⁾ and Andreev et al.⁸⁾ However, it is almost double those of 17% and 26% reported

by Sitzmann and Ernst¹³ and Borman et al.¹⁹ and almost half the 82% rate reported by Sriussadaporn.¹⁰ Ligation of the injured artery was used in 19% of our patients exclusively for radial or ulnar artery injury, which is close to the 16.5% reported by Sitzmann and Ernst.¹³ Resection of the damaged segment and primary anastomosis was performed in only 7% of our cases, which is close to the 10.7% reported by Sriussadaporn.¹⁰ Intraluminal shunts were not used in any of our patients without adverse effect, although Andreev et al. found it necessary in 8% of their patients.¹⁶ Injury to the brachial artery was associated with the highest rate of fasciotomy procedures (Pearson's, $P \leq 0.018$; Spearman's, $P \leq 0.023$), probably because it was the most frequently affected artery in this series. Although our reported fasciotomy rate of 48% is much higher than that reported by most authors at 7-10%,^{10,16} we recommend its liberal use especially in cases of established ischemia, as previously pointed out by Fletcher and Little.¹⁵

The only amputation performed in this series (4%) compares well with the 6% rate reported by Brown et al.,⁷ but much less than the 28% reported by Kruse-Andersen et al.⁶ Our mortality rate of 7% also compares well with the previously reported rates of 3-12%.^{6,18} While vascular repair was successful in 92% of the patients in whom vascular repair was attempted, the functional outcome depended on the associated nerve injuries as previously pointed out by different authors.^{2,7,10,11,19}

Conclusion

Decisive management of peripheral vascular trauma will maximize patient survival and limb salvage. Diagnosis rests upon an acute clinical awareness, supplemented by the appropriate use of noninvasive techniques and contrast radiography. Priorities must be established in the management of associated injuries, and delay must be avoided when ischemic changes are present. Early surgical consultation is essential.²⁰

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. Creagh TA, Broe PJ, Grace PA, Bouchier-Hayes DJ. Blunt trauma-induced upper extremity vascular inju-

- ries. *J R Coll Surg Edinb* 1991; **36**: 158-60.
3. Shaw BA, Kasser JR, Emans JB, Rand FF. Management of vascular injuries in displaced supracondylar humerus fractures without arteriography. *J Orthop Trauma* 1990; **4**: 25-9.
4. Lu Y, Huang Y, Zhao L, et al. Management of major arterial injuries of the limbs in 166 cases. *Iowa Orthop J* 1993; **13**: 183-95.
5. Hunt CA, Kingsley JR. Vascular injuries of the upper extremity. *South Med J* 2000; **93**: 466-8.
6. Kruse-Andersen S, Lorentzen JE, Rohr N. Arterial injuries of the upper extremities. *Acta Chir Scand* 1983; **149**: 473-7.
7. Brown KR, Jean-Claude J, Seabrook GR, Towne JB, Cambria RA. Determinates of functional disability after complex upper extremity trauma. *Ann Vasc Surg* 2001; **15**: 43-8.
8. van der Sluis CK, Kucey DS, Brenneman FD, Hunter GA, Maggisano R, ten Duis HJ. Long-term outcomes after upper limb arterial injuries. *Can J Surg* 1997; **40**: 265-70.
9. Shaw AD, Milne AA, Christie J, Jenkins AM, Murie JA, Ruckley CV. Vascular trauma of the upper limb and associated nerve injuries. *Injury* 1995; **26**: 515-8.
10. Sriussadaporn S. Vascular injuries of the upper arm. *J Med Assoc Thai* 1997; **80**: 160-8.
11. Hardin WD Jr, O'Connell RC, Adinolfi MF, Kerstein MD. Traumatic arterial injuries of the upper extremity: determinants of disability. *Am J Surg* 1985; **150**: 266-70.
12. Igbinovia A, Malik GM, Grillo IA, et al. Deep venous thrombosis in Asir region of Saudi Arabia. *Angiology* 1995; **46**: 1107-13.
13. Sitzmann JV, Ernst CB. Management of arm arterial injuries. *Surgery* 1984; **96**: 895-901.
14. 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.
15. Fletcher JP, Little JM. Vascular trauma. *Aust N Z J Surg* 1981; **51**: 333-6.
16. 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.
17. Faibisoff B, Daniel RK. Management of severe forearm injuries. *Surg Clin North Am* 1981; **61**: 287-301.
18. 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.
19. 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.
20. Soderstrom CA, Wasserman DH. Vascular injuries. *Emerg Med Clin North Am* 1984; **2**: 853-68.