Penetraging Vascualr Trauma on the Rise in Civilian Practice

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Trauma is one of the leading cause of death throughout the world[1]. Many of the patients have multiple injuries, but wounds of major vascular structures are the sole cause or major contributing cause in many of the deaths and even those patients who survive may experience disability as a result of vascular injury that lead to amputation of limbs or impaired function[2]. Unrecognized or untreated vascular injuries lead to painfully obvious gangrene or contracture. Penetrating trauma is much more common than blunt trauma.. For the last decade there has been an increase in the number of cases with penetrating vascular injuries in our country. This is understandable because of the increased violence due to lawlessness, sectarian violence, free availability of sophisticated firearms and several social, economic and ethnic reasons. An analysis of management of 40 patients with penetrating vascular injuries who presented in the casualty department of Mayo Hospital is made. Evaluation of results obtained is done and comparison with other studies made. Most of the patients reaching the hospital with suspected arterial injuries are young males. In our study of 40 patients 36(90%) patients were male and 4(10%) patients were female. Most common cause of penetrating vascular trauma were gunshot wounds, i.e. 70% of the total cases. Stab wounds were responsible for 22.5% of cases. Extremity injuries predominate over truncal injuries. In our setting the approach of direct exploration in the case of overt clinical sign is the best. Different factors for the failure of vascular repair have been note and discussed. Successful management is largely dependent on meticulous surgical technique.
Key words: Penetrating vascular trauma

Recorded history reveals that the management of vascular trauma for many centuries consisted mainly of efforts to stop haemorrhage[3]. In evaluating the development of successful management of civilian vascular trauma, it is easy to identify that the majority of successful results have occurred during the past 35 years, a limited percentage of recorded history. There are interesting historical notes about the advances of the past several centuries that contributed to the rapid development of the recent successful management of civilian vascular trauma.

Civilian vascular trauma is a malady that affects primarily urban members. The high rate of violent crime, seen in the urban areas accounts for the enormous preponderance of penetrating injuries over blunt injuries; blunt trauma accounts for only 7% of reported civilian vascular injuries[4].

Considering the rising incidence of penetrating vascular trauma, it has become very important for the surgeons to be familiar with all the practical proceedings required to deal with these emergencies.

Proper initial diagnosis of arterial injury should minimize the possibility of missing a vascular injury. This is important when one considers the possible late sequaelae and increased difficulty of operative repair. Strokes, organ loss, limb loss, peripheral nerve injury, venous thrombosis, and cardiac failure may be avoided by proper early identification and treatment of arterial injuries. Therefore, it behooves the surgeon to suspect, diagnose, and properly treat the injury early.

Hence, we undertook this study with the aims and objects as follows:

1. Early recognition of vascular trauma.
2. Identification of factors which can modify the final outcome.

Material and methods

A total of 40 patients with penetrating vascular trauma those presented in emergency department of Mayo Hospital, Lahore were included in this study. As soon as the patient was received, he/she was examined by the Medical Officer in-charge and a quick survey of the injured was made. Resuscitation was started immediately, initial attention to the airway and control of bleeding was the first priority. Senior Registrar was informed promptly. Cases were mostly diagnosed clinically. Rapid and accurate diagnosis requires a thorough understanding of clinical manifestations that reliably indicate the presence of vascular injury. Most significant extremity trauma manifests "Hard Sigtns" or clear unequivocal physical finding as shown in Table 1.

Table 1: Hard Signs

- Absent or diminished distal pulses.
- Active haemorrhage.
- Large, expanding or pulsatile haematoma.
- Bruit or thrill
- Distal ischaemia (pain, pallor, paralysis, paraesthesia, coolness)

Presence of these hard signs, mandate immediate surgery in the setting of limb trauma without further time consuming evaluation. In the presence of "soft sign" as shown in Table 2. Patients were monitored with masterly inactivity till the investigations confirmed the diagnosis. On the other hand when the condition of patient

deteriorated surgical exploration was immediately performed.

Table 2: Soft Signs

- Small stable haematoma
- Injury to anatomically related nerve.
- Unexplained hypotension.
- History of haemorrhage no longer present.
- Proximity of injury to major vessel.

Angiography was performed in patients who presented to us with pseudoaneurysm and arteriovenous fistulae to delineate the anatomy of the region.

A single shot of heparin was given at the start of vascular repair unless associated injuries contraindiate its use. Post operatively heparin was not used. Locally heparin was used in every case of vascular repair. Fogarty catheter was used to remove any distal or proximal clot. Third generation cephalosporin were given as a routine in every case as prophylaxis.

The most important principle of proximal and distal control of the injured vessels was followed, injured vessel was exposed the extent of the injury was assessed.

Associated injuries were noted and these were dealt with according to their merit. In various treatment options which were employed to repair vascular injury were ligation of vessel, lateral repair, end to end anastomosis and reverse vein graft. Proper debridement of injured vessel as well as of the surrounding tissue was performed. A wound toilet with normal saline was done in all cases. Drainage was employed. Whenever necessary skin was closed selectively. Fasciotomy in the limbs was performed when indicated.

In the post operative period patients were given antibiotics with gram-positive and gram negative cover. Patients were observed for early detection of most common complications that develop in relation to vascular injury like thrombosis and infection. Patient were followed up to three months.

All the details regarding the patients biodata, nature and site of injury risk factors, operative technique used and the status of the surgeon dealing with vascular trauma and post operative events were recorded in a proforma prepared for this purpose.

Materials

Polypropylene (prolene) monofilament synthetic material was used for repair of injured vessels. The size of the suture was dependent upon the size of the vessel being repaired. Silk was used for simple ligation of the vessels. Autogenous vein graft was used where required. No synthetic graft was used.

Results

Forty patients with penetrating vascular trauma were managed and included in this study. Of these 36 (90%) patients were male and 4(10%) were females as Age of the patients ranged from 16 years to 60 years with a mean of 28 years. Most of the patients were in 3rd and 4th decade of their life. Most of the patients presented soon after injury. Average interval being 04 hours. However this varied from 30 minutes to 24 hours.

Table 3 Etiology of Penetrating Vascular Trauma

Mode of Injury	n=	%age
Low velocity firearm	19	47.5
High velocity trauma	09	22.55
`Stabs	09	22.55
Miscellaneous	03	7.5

Of the penetrating injuries gunshot were more common than stab injuries. Almost 70% of the penetrating vascular trauma was caused by gunshot injuries, of this 47.5% was caused by slow velocity firearm and 22.5% by high velocity missiles. Stabbing accounted for only 22.5% of the penetrating vascular trauma. This is shown in Table 3. This study showed that extremity vascular trauma accounted for 52.5% of cases, lower extremity slightly commonly (30%) involved than upper extremity (22.5%). Truncal vessels injuries were involved in 37.5% of the cases of penetrating vascular trauma. In 10% of the cases, neck vessels were damaged. This regional distribution is shown in the Table 4.

Fasciotomy was performed in 3(25%) patients of penetrating lower extremity trauma. The two patients who required popliteal arterial repair needed fasciotomy.

Only one patient bled post operatively which was managed by re-exploration. One patient whose popliteal artery was repaired later required amputation. This patient had also fracture of the femur. In 40 patients two deaths happened, one table death of the patient with penetrating trauma to the heart and one due to ARDS probably due to polytrauma. Only one wound got infected but did not influence the repair.

One patient presented with arteriovenous fistula and two patients with pseudoaneurysm of femoral artery. The patients with arteriovenous fistula in the neck was referred from Tehsil Headquarter Burewala. This patient had stab injury over right side of neck which resulted in arteriovenous fistula. The two patients with pseudoaneurysm of the femoral artery were referred from the District Headquarter Hospitals. Angiography was done in these patients to delineate the anatomy of the region. These cases were successfully managed in our unit.

Table 4 Regional Distribution

Region	n=	%age
Upper limb	09	22.5
Lower limb	12	30
Abdomen	09	22.5
Thoracis	06	15
Neck	04	10

Discussion

Even today vascular trauma remained a formidable challenge with considerable deaths from exsanguination.

Most of the patients reaching the hospital with suspected arterial injuries are young males. In our study of 40 patients 36(90%) patients were male and 4(10%) patients were female with an average age of 28 years. This is in comparison with a study by Kenneth L. Maltax et al; in a retrospective study of 5760 vascular injuries in 4459 patients in which 84% were male in an average age of 30.

Our study showed that the most common cause of penetrating vascular trauma were gunshot wounds, i.e. 70% of the total cases, among them 47.5% were caused by low-velocity firearm. Stab wounds were responsible for 22.5% of the cases. These results are in consistent with the study done by Savage and Walker in 1995[5] which showed that the most common cause of vascular injuries was gunshot wounds. Most of our patients reported in the emergency room after the injury with a mean interval of about 4 hours, range varied from 30 minutes to 24 hours which is more than in foreign studies[6,7].

Although most large military and civilian series of patients reported in the past showed a tremendous predominance of extremity injuries over truncal injuries[8], the largest, most recent civilian series show a predominance of truncal injuries (66%)[9]. Our study showed that in 37.5% of cases, truncal injuries were involved. Significantly lower incidence of major truncal injuries can be explained on the lethal nature of these injuries, as in our setup these victims are less likely to reach at a proper facility for definitive treatment.

Suitability of different type of repair depends greatly on the mechanism of injury. In my study, in case of lower extremity trauma, 41.66% required graft, 32.3% underwent lateral repair,16.66% had ligation and only 8.33% required end-to-end anastomosis. In a study conducted by Feliciana DV et al showed a review of 220 patients with 225 arterial injuries of the lower extremity requiring repair, 39% had an interposition graft, 28% underwent segmental resection with end-to-end anastomosis, 17% had ligation and 7% underwent primary repair[10].

In our setting where the patients coming in the emergency are mostly belonging to low socioeconomic class, also the hospital resources are meagre, the approach of direct exploration in the case of overt clinical sign is best. This is the strategy we have adopted with no mortality and morbidity because rate of negative exploration was almost zero.

Present role of arteriography is penetrating vascular injuries is in exceptional circumstances where either the existence or location of a vascular injury is still not clear in spite of presence of hard signs. These conditions include injuries in which there are multiple possible sites of vascular disruption[11,12] and thoracic outlet injuries in which the surgical approach may vary with the exact site of vascular involvement[13,14].. Still another indication of arteriography is any vascular injury that presents with an established complication (False aneurysm, arteriovenous fistula) because there is no longer any urgency in treatment and operation planning requires a knowledge of injury morphology and location.

In our study we used the arteriography in patients who presented to us with pseudoaneurysm and arterovenous fistula to delineate the anatomy of lesion.

Many of the patients, with vascular trauma have associated injuries and certain priorities must be set up if a successful conclusion is to be gained. Initial attention to the airway and control of bleeding must be the first priority. Once haemorrhage has been controlled, and patient resuscitated, an organized decision must be reached about the best management of the vascular injury. In the presence of continuing haemorrhage, surgery should not await resuscitation but is an integral part of resuscitation. The factors that influence the decision about the repair of injured vessels include the underlying condition of the patients, the severity of associated injuries and the complexity of the proposed arterial repair. We observed that the type of arterial repair is largely determined by the severity of injury. Seven patients out of 19 of extremity trauma in this study had vein graft and only 3 patients underwent resection and end-to-end anastomosis, and 4 patients required lateral repair. All repairs except one were successful. In one patient with popliteal artery graft, thrombosis occurred. This patient had fracture of femur in addition to vascular injury. The analysis of the factors leading to failure of the repair was made. We saw that in penetrating injuries resulting from gunshot wound, adequate debridement is mandatory to assure a satisfactory repair. It has been suggested that inadequate debridement of the artery and the surrounding tissue and associated fracture of the femur may be a limiting factor in continued patency. But there were no persuasive evidence that this contributed to the failure in the study. There was no consistent correlation between the presence of infection and ultimate failure of repair. We found continuous suture to be good for use in all types of repair except smaller vessel where we used interrupted sutures.

In all we found that the factors for the failure of vascular repair are:

i. Tension at the anastomotic site.
ii. Stenosis of the anastomotic site.
iii. Failure to secure intimal coaptation.
iv. Inadequate debridement of the vessel wall and tissue.

Analysis of the results has emphasized several important points. The successful management of vascular injuries depends upon:

1. Reduction in delay between time of injury and ultimate restoration of arterial flow.
2. Prioritization of various injuries and initiation of prompt treatment. Airway and control of bleeding should be the first priority.

3. Proper resuscitation of the patient with blood and balanced crystalloid solution unless continuing haemorrhage requires immediate surgical intervention.
4. The most important principle of the surgical repair of the injured vessels is to get proximal and distal control before exploring the site of injury.
5. Blind clamping often causes severe damage to adjacent neurovaslcular structures.
6. Manual pressure over the bleeding vessel is safer and will not compound distal ischaemic damage by limiting collateral flow. Tourniquet on extremity should be avoided.
7. Vascular repair should never be performed under tension and should not result in stenosis particularly in smaller calibre distal vessels.
8. When the extremity is threatened by vascular compression, prompt fasciotomy is necessary.
9. Adequate exposure and debridement before attempting definitive repair. High velocity missile cause greater damage to the vessel wall so proper debridement in this setting is very important.
10. Every effort must be made to ensure intimal coaptation and restoration of normal vessel diameter.
11. A search for and removal of intravascular thrombi prior to closure of the vessel will reduce the possibility of early thrombosis.
12. Preoperative antibiotics are essential in our surgical circumstances and cephalosprin preferably third generation is a better choice. Antibiotics should be continued postoperatively for at least five days because haematoma is a good culture media for bacteria.
13. Following repair every effort should be made to maintain an effective circulating blood volume and hematocrit levels.
14. Pulse distal to the site of arterial repair should be evaluated at hourly interval by digital palpation or Doppler ultrasonic flow technique.
15. If the diagnosis of postoperative thrombosis is made, immediate surgical correction is the only approach.
16. The extremity should not be elevated; it should be kept in neutral position, since elevation causes decreased blood flow, and in an already jeopardized limb, the flow should not be decreased at all.

Conclusion

The reduction in the time lag between the presentation of the injury and the repair is critical for the ultimate outcome of repair. Those presenting within six hours of injury have better chances of repair as compared to those who presented late.

The second important factor is the early recognition of the injury and prompt resuscitation, not forgetting that operation is also important part of resuscitation.

Successful management of vascular injuries demand the precise application of surgical technique. This means an adequate experience of vascular trauma, early recognition, tension free anastomosis, intimal coaption and restoration of normal vascular diameter and length and the recognition of need for early fasciotomy in extremity trauma. This whole comprises what is called the successful management of vascular injuries.

We suggest more studies of this nature in order to create awareness of the magnitude of civilian vascular trauma morbidity, especially limb loss, and associated mortality. We strongly recommend establishment of trauma centers manned by surgeons competent in dealing with the vascular injuries.

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