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Upper Limb Vascular Injury

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Abstract

Background: Upper extremity vascular injuries had high incidence in current surgical practice due to increased incidence of terrorist action.
Aim of study: Is to highlight the Medical City experience as major referral center and to assess morbidity and mortality of injured patient, also analyzes the causes of injuries, presentations, surgical approaches, outcome and complications of vascular trauma of the upper limbs, in spite of limited hospital resources.
Methods: From October 2014 to November 2015 (56) cases were collected from Ghazi Al-Harreri Martyr Hospital, Thoracic and Vascular Department, Medical City, Baghdad. All patients underwent full physical examination, resuscitation and evaluation were performed according to Advanced Trauma Life Support (ATLS) guidelines.

Result:

Fifty six patients with upper limb vascular injury were prospectively followed, of them 51 males (91%) and 5 females about (9%) with age range from (7-46) with a mean age of 22 years. The mechanism of trauma was mostly penetrating (bullet, shells and stabbing injury) in 50 patients (89%), blunt trauma was in 6 patients (11%).
Conclusion:
Upper extremity vascular injuries carry better prognosis and lower complication. Early referral of injuried patients affects the outcome of these patients especially when associated with other injuries.

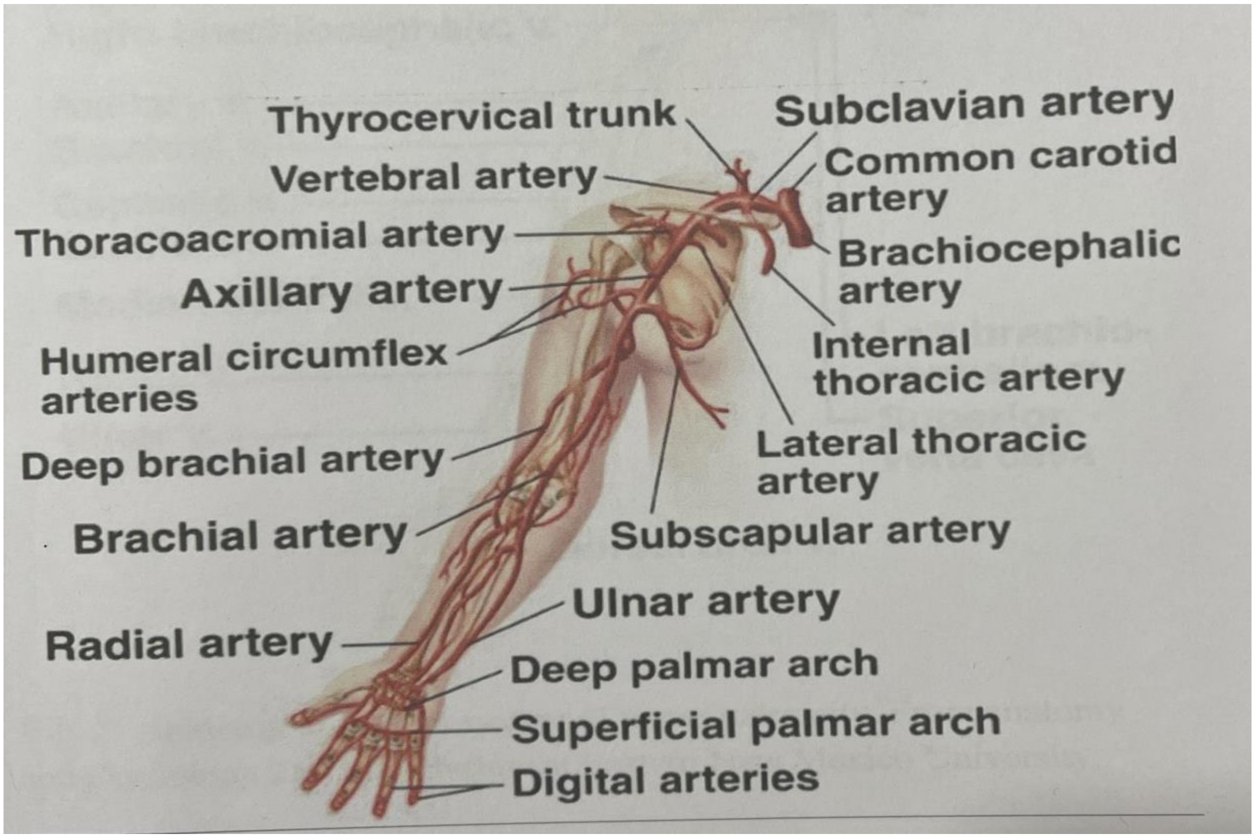
Key wards: Trauma, vascular injury , upper limbs, Iraq.

1. Introduction
1-A
Historical review

Trauma is a great public health problem in developing and developed countries and usually involves young people.
Among types of trauma, vascular injuries of the extremities need special consideration because they can be both life and limb threatening "
The evolution of extremity vascular injury treatment is intimately related to experience obtained during military conflict.
From routine ligation and amputation in the World Wars through the rapid evacuation and successful in-theater use of autogenous reconstruction during Korea and Vietnam conflicts, these struggles have provided models for improvement in revascularization and limb salvage (2, 3)
Past wartime experience and recent civilian reports indicate upper extremity (UE) vascular injury occurs less often and with less limb loss than lower extremity (LE) injury.
Given advances in critical care, damage control techniques and military armor technology improve the management of vascular injury (4).
Patients with injured extremities often require a multidisciplinary approach with involvement of trauma, orthopedic, and plastic surgeons to address vascular injuries, fractures, soft tissue injuries, and compartment syndromes.
Published reports from the wars in Afghanistan and Iraq demonstrate that the rate of vascular injury is as high as 9% to 12% of battle-related injuries, making the recorded frequency approximately five times that reported in previous wars (5.
Undoubtedly, the effectiveness of tourniquets and modern body armor and the strategic forward placement of surgical capabilities also allow the treatment of vascular injuries that would have been fatal in past wars ©).

1-B Anatomy of arterial system of upper extremity
Upper limb supplied mainly by:
• Subclavian artery and its branches.
• Axillary artery and its branches

• Brachial artery, radial and ulnar arteries as shown in figure 1.I'm



Figure(1): Anatomy of arterial system of upper extremity.
From anatomy and physiology 210 with Barlow at Eastern New Mexico University.

1-C Anatomy of venous system of the upper limb
Upper limb drain blood into main venous blood vessels as shown in figure 2.

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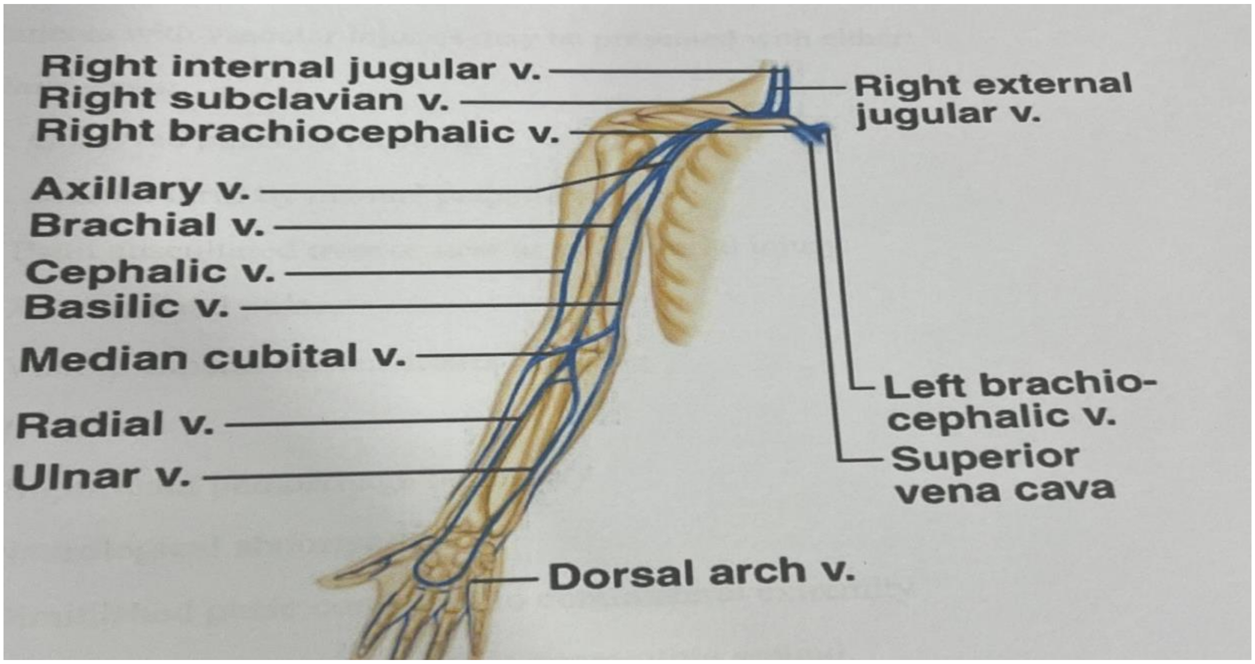

Figure(2): Anatomy of venous system of upper extremity.
From anatomy and physiology 210 with Barlow at Eastern New Mexico University.

1-D Clinical presentation

Patients with vascular injuries may be presented with either:

Hard signs:

1. Observed pulsatile bleeding.
2. Arterial thrill by manual palpation.
3. Bruit auscultated over or near area of arterial injury.
4. Absent distal pulse.
5. Visible expanding hematoma ».

Soft signs:

1. Significant hemorrhage by history
2. Neurological abnormality.
3. Diminished pulse compared to contralateral extremity
4. In proximity to bony injury or penetrating wound.
5. Decreased capillary refill.

Cold pale extremity with diminished pulse is not necessarily ischemic due to arterial injury. (e.g. shock , hypothermia) compared to contra lateral extremity. Of the signs and symptoms of ischemia, neurologic deficit signifies the greatest threat to irreversible injury.

The "6 hours" window for limb salvage is not valid for all cases on and it depends on collateral circulation, site, and nature, extent of injury, patient age, and hemodynamic status and associated injuries (8) Upper limb vascular injury

1-E Clinical assessment This includes:

1- Mechanism of injury, whether blunt or penetrating.

2- Location of injury, proximal, distal, or at deltopectoral groove. Upper extremity vascular injury rarely causes ischemia because good collateral around shoulder, elbow and presence of complete palmer arch.

3. Duration of injury, the "6-hour" window.

4. Associated soft tissue injuries: depend on mechanism and level of arterial injury.

5. Fractures are seen in only 15% to 40% of limbs with an arterial injury.

Common combined injuries include clavicle, first rib fractures and subclavian artery injuries. Dislocated shoulder, proximal humeral fractures and axillary artery injuries. Supracondylar fractures and elbow dislocations and brachial artery injuries.

6. Venous injuries concomitant with extremity arterial trauma ranges between 15% and 35% in most studies. Long-term limb edema in particular appears to be unrelated to whether a venous injury was repaired or not, also venous repair or ligation does not predict amputation (10)

7. Upper extremity vascular trauma is associated with a much higher incidence of nerve injury, around 40% to 50% and also it does not predict amputation (11)

8. Significant soft tissue disruption often accompanies extremity vascular trauma. As with nerve injuries, the incidence appears to be higher in the upper extremity, reported as 40% to 70%, than in the lower extremity, for which rates are typically reported to be 30%. The presence of a significant soft tissue deficit does appear to correlate with amputation in lower extremity arterial trauma (10)

1-F Diagnosis And Workup a. General

The efficient diagnosis and rapid localization of such injuries are of great importance in the evaluation of a trauma patient. In cases in which a patient presents with "hard signs" of vascular (primarily arterial) injury, the existence and location of the injury are generally obvious, and the next step in management is clearly operative exploration and repair.

The diagnosis of injuries in patients presenting with only "soft signs" is more challenging, and such patients typically require specific diagnostic modalities in addition to the secondary trauma survey (.

b. Duplex and Doppler ultrasonography

It is noninvasive, does not require intravenous administration of contrast material, and can be performed at the bedside or even intraoperatively for both penetrating and blunt extremity injuries. When it is used by a trained vascular technician, it can accurately identify the presence of intimal flaps, pseudo aneurysms, punctures, transection, arteriovenous fistula, compression, or active bleeding.

In a series of 198 patients with extremity or neck trauma, it demonstrated a sensitivity and specificity of 95% and 99%, with an accuracy of 98%.

For evaluation of proximity wounds in extremity trauma, the reported sensitivity and specificity are 100%, with a 100% negative predictive value (12).

Those patients with possible occult injuries who are not studied with arteriography need close observation, and the most useful method may be duplex ultrasonography for both initial evaluation and follow-up (13).

C. Angiographic Study By necessity, arteriography delays the surgical treatment of a traumatized patient. In patients with threatened uncontrolled exsanguinations, immediate operative control of hemorrhage is indicated and angiography is not performed. If the site of injury is not obvious (multiple fractures, multiple sites of penetrating injury, shotgun wounds), arteriography may be necessary to guide the surgeon to the proper injured area (14).

Completely severed arteries and complete occlusions arising from injuries in continuity show a sudden arrest of the column of contrast material.

Partially severed arteries may demonstrate the escape of contrast material from the arterial lumen. In some patients, the resultant hematoma may actually protrude into the lumen and appear as a filling defect (2)

Nonsevered arteries may be noted as an asymmetrical narrowing, a filling defect, or a point at which there is a sudden change in the diameter of the arteries. Arteriovenous fistulas, visualization of the adjacent venous system as well as the sac of the false aneurysm or fistulous track confirms the diagnosis (3) Angiographic study usually include:

1. Conventional catheter-based angiography:

Once considered the "gold standard" for the preoperative diagnosis and localization of extremity vascular Injury in patient of the large number of fragments, such as those with shotgun injury, conventional angiography may offer better diagnostic capability than CT-angiography.

Conventional angiography is preferred if potential for endovascular intervention is high and also can distinguish intimal disruption from vasospasm (14).

2. CT angiography (CTA) : Ct angiography considered the initial diagnostic and localization modality of choice in patients presenting with soft signs of extremity arterial injury, especially in those whose Doppler index is less than 1.0(2) Multidetector CT scanners and modern imaging software allow rapid and noninvasive high- quality vascular imaging, and CT angiography has been demonstrated to have equivalent sensitivity and specificity to catheter angiography for both truncal and extremity vascular injuries (15) It is limitation in metallic foreign body and in paediatric.

3. MR angiography (MRA):

Limitations are : 1-FB

2-Not dynamic 3-Time consuming.

Advantages are :1-soft tissue changes 2- bone changes.

1-G Treatment Principles

• Focus on control of external hemorrhage and assessment of distal perfusion.
• Identify arterial segments involved.
• Assess severity of distal ischemia.
•Evaluate neurologic status of extremity.
• Assess for compartment syndrome.
• Assess for the associated injuries.
• Damage control is employed for unstable patients via temporary control of hemorrhage and establishment of distal perfusion, with subsequent resuscitation and delayed final reconstruction.

Distal perfusion is maintained by means of a temporary intra-arterial shunt (up to 24 hours Commercially-available carotid shunt, suction catheter, sterile intravenous tubing which can be used in 3 settings:

Damage control setting, Transfer to another facility for higher level of care, Repair of combined vascular/orthopedic injuries when skeletal alignment must be accomplished first. In general the management of vascular injuries can be divided in two major categories (1).

A- Nonoperative Management

The presence of an arterial injury in a traumatized extremity does not mandate surgical therapy in all cases. These Injuries included small, non-flow-limiting intimal defects and flaps, small pseudo aneurysms, and arteriovenous fistulae. None of these injuries produced distal ischemia, nor was there is free extravasation. The results of many studies confirm the lack of necessity for routine arteriography and suggest that nonoperative management of selected arterial injuries is reasonable, but a high index of suspicion for the possible development of pseudo aneurysm or ischemic complication is necessary during a period of close clinical follow-up (17.

B) Operative management

This includes:

1-Endovascular Therapy

The use of endovascular techniques had became integrated into vascular surgical practice during the past 2 decades. From 2000 to 2003, there was a nearly fourfold increase in the percentage of arterial injuries treated by endovascular means. This same period showed a greater than 30-fold increase in the use of stent-grafts to treat arterial trauma (18)

Endovascular therapy is currently applied more frequently in blunt than in penetrating trauma and in lower extremity than in upper extremity injuries. It appears to have similar or improved outcomes compared with open repair of extremity arterial injuries despite being applied in patients with a significant burden of associated injuries and medical co-morbidities (19)

Being less invasive than open surgery, endovascular treatment of extremity arterial injuries seems most appropriate when the morbidity difference between the open and endovascular procedures is greatest.

This is most often the case in the setting of injuries to junctional vessels (such as the subclavian and iliac). In such cases, the use of endovascular balloon occlusion for proximal vascular control may obviate the need for opening a body cavity (hybrid approach).

If the traumatic vascular lesion can be safely traversed with a guide wire, a definitive endovascular treatment can be performed (20)

Stent-grafts have been successfully deployed to treat arterial injuries manifesting with hemorrhage and occlusion (21)

Catheter- directed embolization with coils and glue has been used to treat smaller vessels and seems particularly successful when it is used for the treatment of small pseudo aneurysms and arterio-venous fistula (22, 23)

2- Open Surgical Management Operations should be performed on a table amenable to fluoroscopic imaging of the injured extremity. This can facilitate orthopedic treatment of associated bone injuries and on-table angiography if needed.

The patient should be prepared and draped widely to facilitate exposure, typically circumferentially in the case of extremity injuries. If the need for a vein graft is anticipated, the proposed harvest site should be included in the prepared operative field.

Conventional practice is to obtain saphenous vein grafts from uninjured extremities to preserve collateral venous drainage. It may be appropriate to harvest conduit from an injured extremity if there is no venous injury present.

To ensure adequate exposure for control and repair, incisions are typically made longitudinally, directly over the target vessel proximal and distal to the injury. Once vascular control is achieved, the incisions can be extended as needed to expose the zone of vascular injury. In some cases of extremity injury, control may need to be obtained proximal to the extremity itself.

Upper extremity control may require infraclavicular or supraclavicular incisions to expose the subclavian vessels. Many trauma patients may be unable to tolerate systemic anticoagulation because of ongoing hemorrhage or associated injuries. In these patients, local anticoagulation with heparinized saline injection directly into the injured vessel proximal and distal to the injury may be used to prevent local thrombosis 24, 25).

Wide debridement of contaminated and nonviable tissue within the zone of vascular injury should be performed. During debridement, an assessment of the availability of healthy tissue to cover the vascular repair should be made, if this is not possible, then extra-anatomical bypass should be considered (26)

Three options exist for repair. In some cases, a short injured segment can be resected circumferentially and enough of the vessel freed proximally and distally to perform a spatulated end-to- end anastomosis of the injured vessel. In other cases, a single arteriotomy can be débrided and a vein patch angioplasty performed.

In many cases, however, neither of these "simple" options is feasible, and a vein interposition graft of appropriate length must be performed.

All open traumatic wounds are considered contaminated, and the preferred conduit for repair of vascular injuries is autologous vein harvested from an uninjured extremity.

Infections involving prosthetic grafts resulting in high rates of graft failure and amputation. These issues are exacerbated when there is inadequate soft tissue coverage of the graft (27, 28)

It is generally accepted that the poor long-term patency seen with prosthetic grafts used for chronic occlusive disease will be manifested in trauma patients as well. The prosthetic arterial grafts most at risk for thrombosis were those placed in smaller vessels.

Despite the perception of a high failure rate, the use of prosthetic conduits remains controversial, and no long-term patency data are available in cases in which such grafts are placed to repair.

A short-segment prosthetic graft may be considered to repair uncontaminated (typically blunt) arterial injuries to large vessels, such as the subclavian and axillary arteries where size match with the autologus vein may be a problem 26,28).

1-H Specific arterial injuries of upper extremity

a) Subclavian artery

Subclavian artery injuries often have a different presentation and complicating factors. Among modern combat casualties, the incidence of upper extremity vascular injury is 1.7% and 23% of these involve the subclavian artery (29.

The majority of civilian injuries are due to penetrating trauma (55%-75% and are most common in shotgun wounds (18%), followed by gunshots (10%) and stab wounds (9%)(30)

Autopsy data suggest that pre-hospital
mortality is 75% for penetrating subclavian injury(31).

Blunt subclavian injuries are rare and are due to either shear forces or clavicle fracture with nearly universal presence of nerve injury or fracture. Concomitant vein injury is present in one third of patients and should be repaired when possible.

These more proximal injuries may present with palpable distal pulses (even with complete occlusion or transaction) in 60% to 70% because of collateralization at the shoulder or axilla (32)

Limb function is often severely impaired, but this is primarily due to the high incidence (40%-100%) of associated brachial plexus injury.

Endovascular interventions for subclavian repair found a 97% technical success rate and an 84% patency rate (33).

A median sternotomy with cervical extension can be used for right subclavian artery injuries, while an infraclavicular or not so commonly used "trap door" incision for left subclavian artery injuries.

Venous repair should be performed over ligation whenever possible.

Arterial injuries when feasible are treated with debridement and repair.

Conventional arterial reconstruction can be performed by the use of autogenous vein or prosthetic grafting.

Subclavian artery exposure is shown in fig.3.

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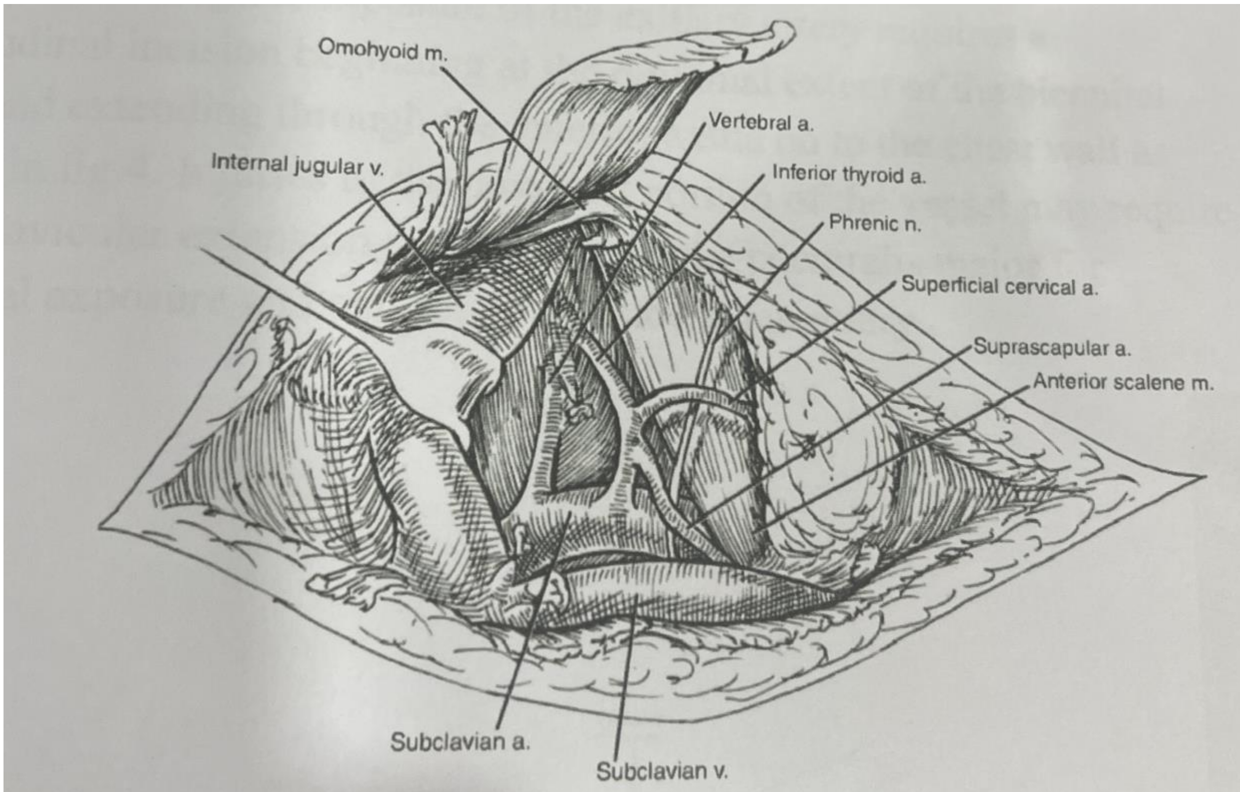
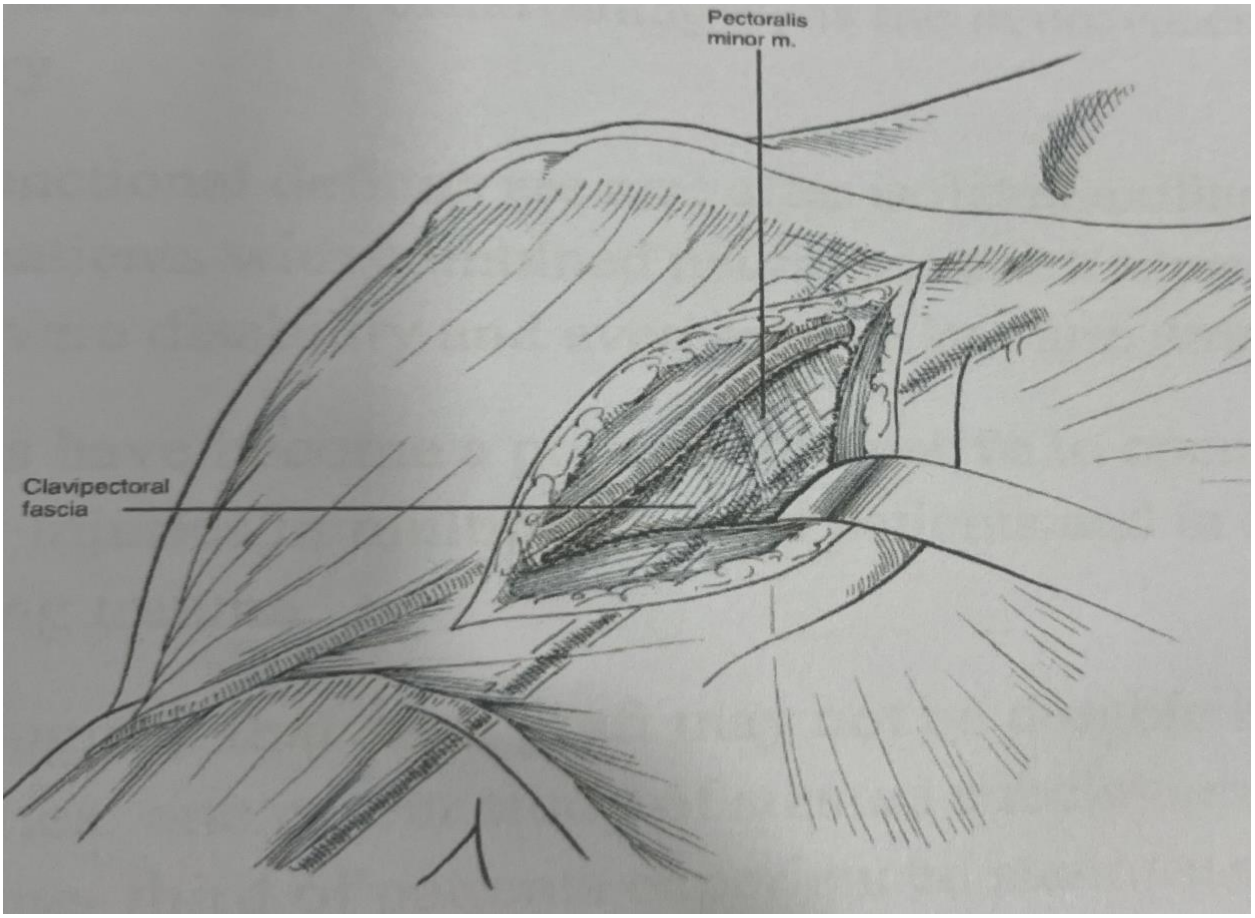


Retraction of the carotid sheath and scalene fat pad exposes the subclavian vessels and anterior scalene muscle.

Figure:(3)Subclavian Artery Exposure. From Anatomic Exposure In Vascular Surgery. Gary G. Wind - R.James Valentine.

b)Axillary Artery

The standard surgical exposure of the axillary artery requires a longitudinal incision beginning at the proximal extent of the bicepital fossa and extending through the anterior axilla on to the chest wall as shown in fig. 4. Injuries to the proximal portion of the vessel may require infra-clavicular extension and division of the pectoralis major for proximal exposure and control of the subclavian artery.



Figure(4):Axillary artery exposure. From anatomic exposure in vascular surgery. GARY G. Wind - R.James Valentine.

Because the proximal portion of the vessel is relatively fixed and cannot be significantly mobilized longitudinally, injuries to the axillary artery are most commonly primarily repaired or treated with an interposition graft (24, 34)

Owing to the proximal location of the axillary artery near the thoracic outlet, certain injuries in hemodynamically stable patients may be amenable to stent-graft treatment if the lesion can be safely traversed with a wire.

The endovascular procedure can be performed antegrade by the femoral approach or retrograde by the ipsilateral brachial approach (35, 36)

The axillary artery is an ideal donor artery in extra-anatomic bypasses to the opposite arm or to the lower extremities. It is a direct extension of major aortic arch branches and is usually free of flow-limiting arterial stenosis (37)

The superficial location of the axillary artery and its proximity to the brachial plexus also carry disadvantages, as the neurovascular bundle is prone to injury.

Long term functional deficits are rare after isolated axillary artery injuries, but patients with combined neurovascular trauma may experience severe disability and even require late arm amputation (38).

Covered stents have become a popular alternative to open repair of axillary artery injuries in multiple injured patients and in selected patients with penetrating trauma.

Limited data suggest that stent graft may not be durable in large upper extremity arteries: one recent study of stented subclavian artery injuries reported that one- third of patients experienced stenosis or occlusion of the stent graft after a mean of four years (39.

C) Brachial Artery

The exposure of the brachial artery is through a longitudinal incision along the course of the artery in the bicipital fossa (fig 5). Care is taken to avoid injuring the median nerve, which is located in the brachial sheath with the artery. If brachial artery distal to the elbow must be exposed, a «azy S" skin incision should be used to span the antecubital fossa. The brachial artery's course is generally straight and the vessel can be extensively mobilized. Brachial injuries can be repaired with an end-to-end anastomosis in about 50% of cases; most of the remaining injuries are treated with an interposition graft(40)

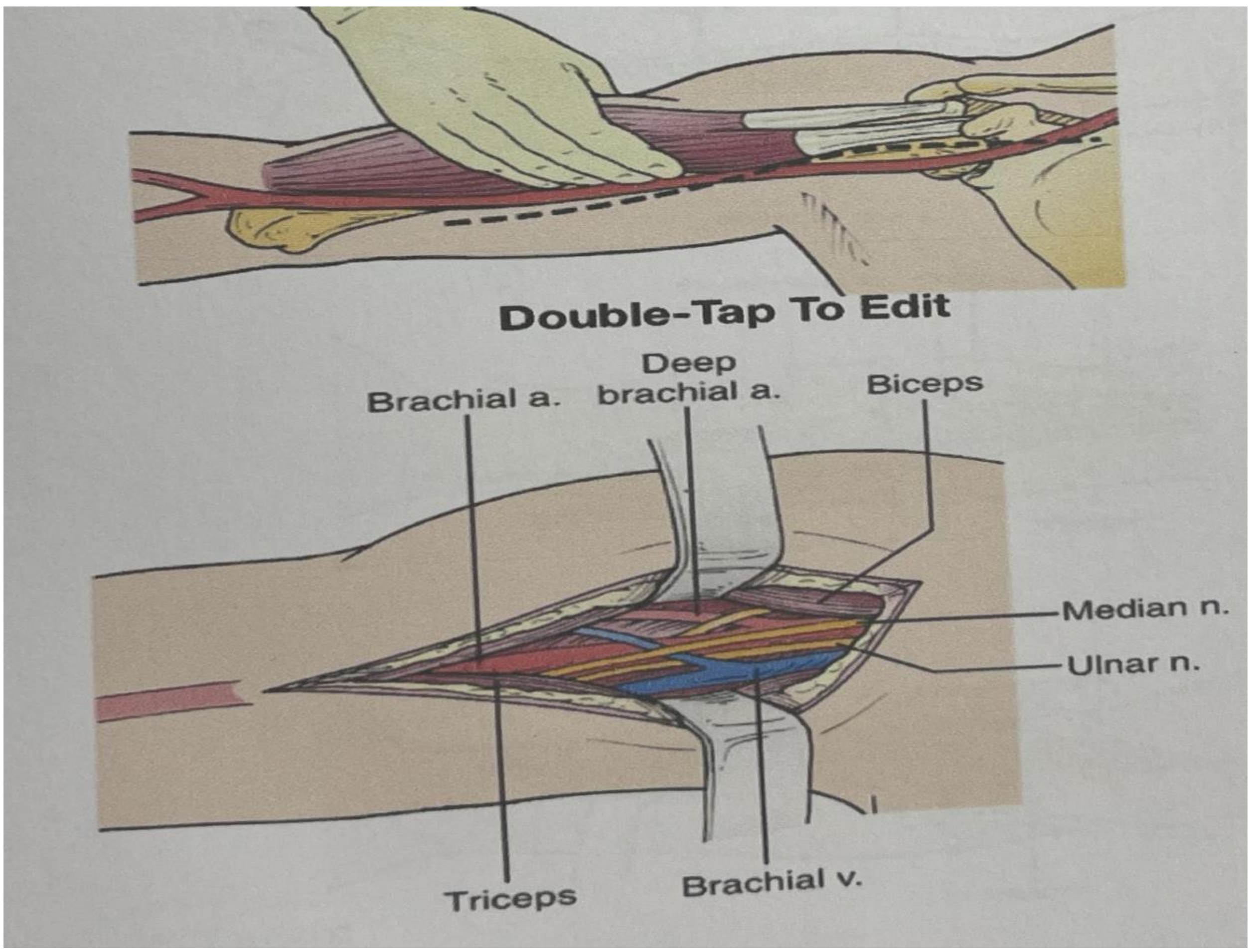


Figure. (5): Brachial artery exposure. From Rutherfords vascular surgery 2014.

D) Radial and Ulnar Arteries

The radial and ulnar arteries are exposed with longitudinal incisions made directly overlying their courses in the forearm (fig.6). Both are located most superficially at the wrist and deeper more proximally. If only one of the forearm arteries is injured and an Allen test reveals a patent palmar arch, the injury can be safely ligated. If the palmar arch is not patent in the absence of the contribution of the injured artery, the artery should be repaired. In instances in which both the radial and ulnar arteries are injured, preference should be given to repair of the ulnar artery as it is most commonly the dominant contributor to the perfusion of the hand.

Like the brachial, the forearm arteries are most commonly amenable to mobilization and end-to-end repair (4).

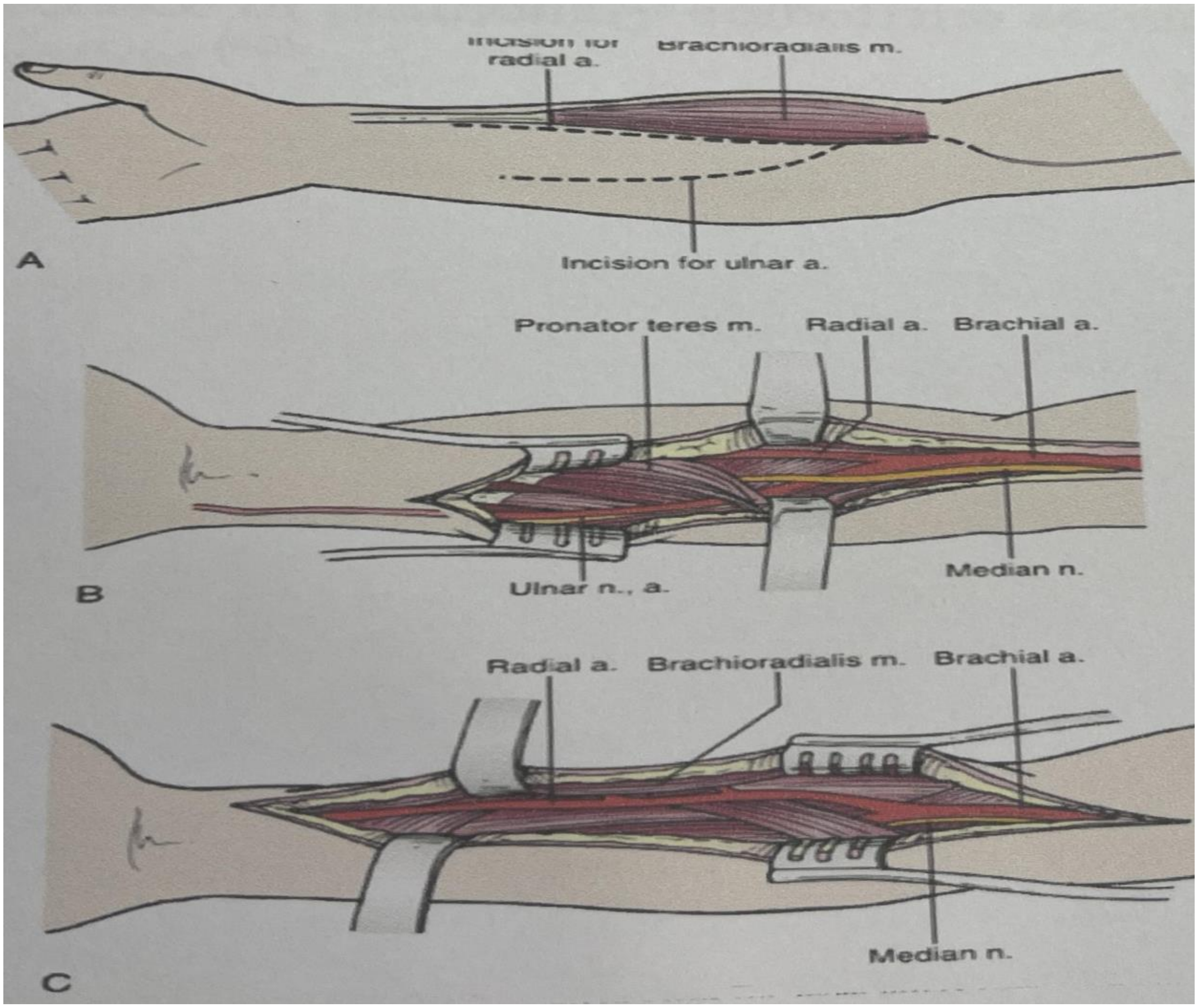


Figure. (6) Radial and Ulnar artery exposure from Rutherfords vascular surgery 2014.

e) Venous Repair versus Ligation

The decision to repair or to ligate a major extremity vein injury should be made in the context of the patient's overall physiologic condition. If it is safe to take the time required to repair an injury, it is reasonable to attempt to do so. End- to-end anastomosis, lateral suture venorchaphy, patch venoplasty, and interposition grafting are all viable options for repair, depending on the anatomy of the injury. Ligation should be performed if the patient's condition will not tolerate the additional operative time. The majority of venous repairs will be occluded in the first
48-96 hours. However 85% of these repairs are patent after 12 weeks (4).

The incidence of deep venous thrombosis (DVT) more after ligation than in repair. But the incidence of pulmonary embolisim seems to be similar in both repair and ligation (42).

2. Patient and methods

From October 2014 to November 2015 (56) patients were collected from Ghazi Al-Harreri Martyr Hospital Thoracic and Vascular Department ,Medical City, Baghdad.

These patients were prospectively entered into a clinical database. Basic demographic data collected included patient age, sex, and residency.

Specific patterns of injury were documented, noting the mechanism of vascular injury, site and type of vessel injured, and the presence of any associated injuries. Vascular repairs were analyzed by the type of repair performed, and the use of autogenous or synthetic grafting.

All patients underwent full physical examination and resuscitation Initial resuscitation and evaluation were performed according to Advanced
Trauma Life Support (ATLS) guidelines.

The diagnosis of upper extremity vascular injury and indications for surgery were based on the findings of clinical presentation and Dopller study. Casualties with evidence of pulsatile arterial bleeding, persistent hemodynamic instability or severe ischemia were taken immediately to the operating theatre.

The remainder underwent additional imaging procedures (duplex sonography, conventional angiography or Tangiography) to identify the exact location and extent of arterial damage.

All confirmed arterial injuries were surgically treated as soon as possible, using standard arterial exposure and repair procedures. The patients with co-existing injuries including fractures, soft tissue damage of an extremity, nerve, and other organs were also assessed by related departments, and then referred to the theater for control of bleeding and revascularization.

All patients with associated orthopedic injuries, reduction of joint dislocation or bone fracture and immobilization by internal or external fixation should be done first unless there is critical limb ischemia or lengthy orthopedic procedure expected then revascularization done first.Associated venous injuries were repaired if feasible, with simple lateral repair or end-to-end anastomosis, or they were ligated. Primary epineurial suture was performed in selected cases of associated clean nerve transaction in hemodynamically stable patient.

In grossly contaminated wounds with extensive tissue destruction, nerve endings were identified and marked with non-absorbable sutures for delayed repair. Postoperatively the trauma victims were closely monitored for signs of compartment syndrome or revasculrization failure, if this occurred then embolectomy with or without revision should be done.

All patients operated upon under general anesthesia after proper resuscitation .All of them received intravenous preoperative, prophylactic antibiotics, which were continued postoperatively for five to seven days unless prolonged use was indicated by the presence of contamination or infection.

Patients with more severe soft tissue and muscle injuries were treated with extensive debridment of all grossly nonviable tissues, removal of foreign bodies and copious irrigation with isotonic saline. Suitable covers for the defect were given by Plastic surgeons with split skin grafting (SSG) or with the application of flap techniques.

Repaired vessels especially at the anastomotic suture lines and at graft localization were compulsory covered with muscles and soft tissue to prevent desiccation and disruption.

Clinical signs of compartment syndrome were considered indications for open fasciotomy; no prophylactic fasciotomies were carried out Few upper limbs fasciotomies were also performed. Successful repair was assessed by the return of distal pulses at the end of the operation (clinically or with the use of hand held Doppler).

All patients also received intravenous heparin according to body weight for a period of 5-7 days postoperatively and were discharged home on oral aspirin 100mg tab/day for a period of twelve weeks. Regular follow up was not possible in all patients.

3. Results

From October 2014 to November 2015 (56) patients with upper limb vascular injury were prospectively followed, of them 51 males (91% and 5 females about (9%) with age range from (7-46) with a mean age of 22 years. The mechanism of trauma was mostly penetrating (bullet, shells and stabbing injury) in 50 patients (89%), blunt trauma was in 6 patients about (11%) and this shown in figure (7).

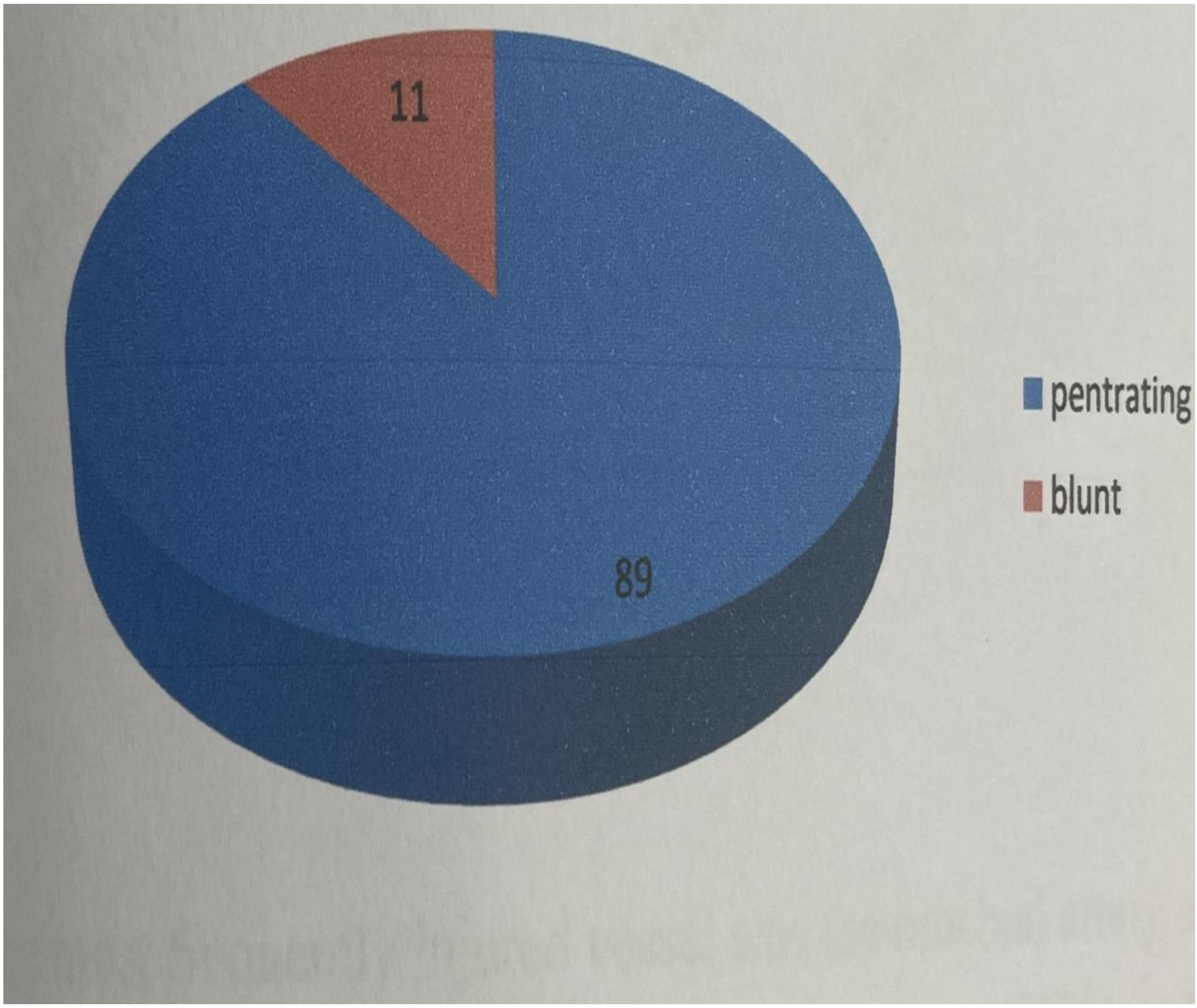


Figure..(7)Types of injury(mechanism)

Successful outcome in vascular trauma depends on early diagnosis and referral to specialist's center. The time interval between the onset of injury and arrival to our center was 8 h in average. In our series, most of the patients(37) presented within what is considered as the "Golden period" (6-8 hrs), the others within 8-12 hours.

Twenty five (44%) presented with negative distal pulses, 16 patients (28%) presented with active bleeding, while 11 patients (19%), three patients (5%) had delayed presentations with pseudo aneurysms and only one patient presented with post-traumatic A-V fistula this shown in figure 8 below.

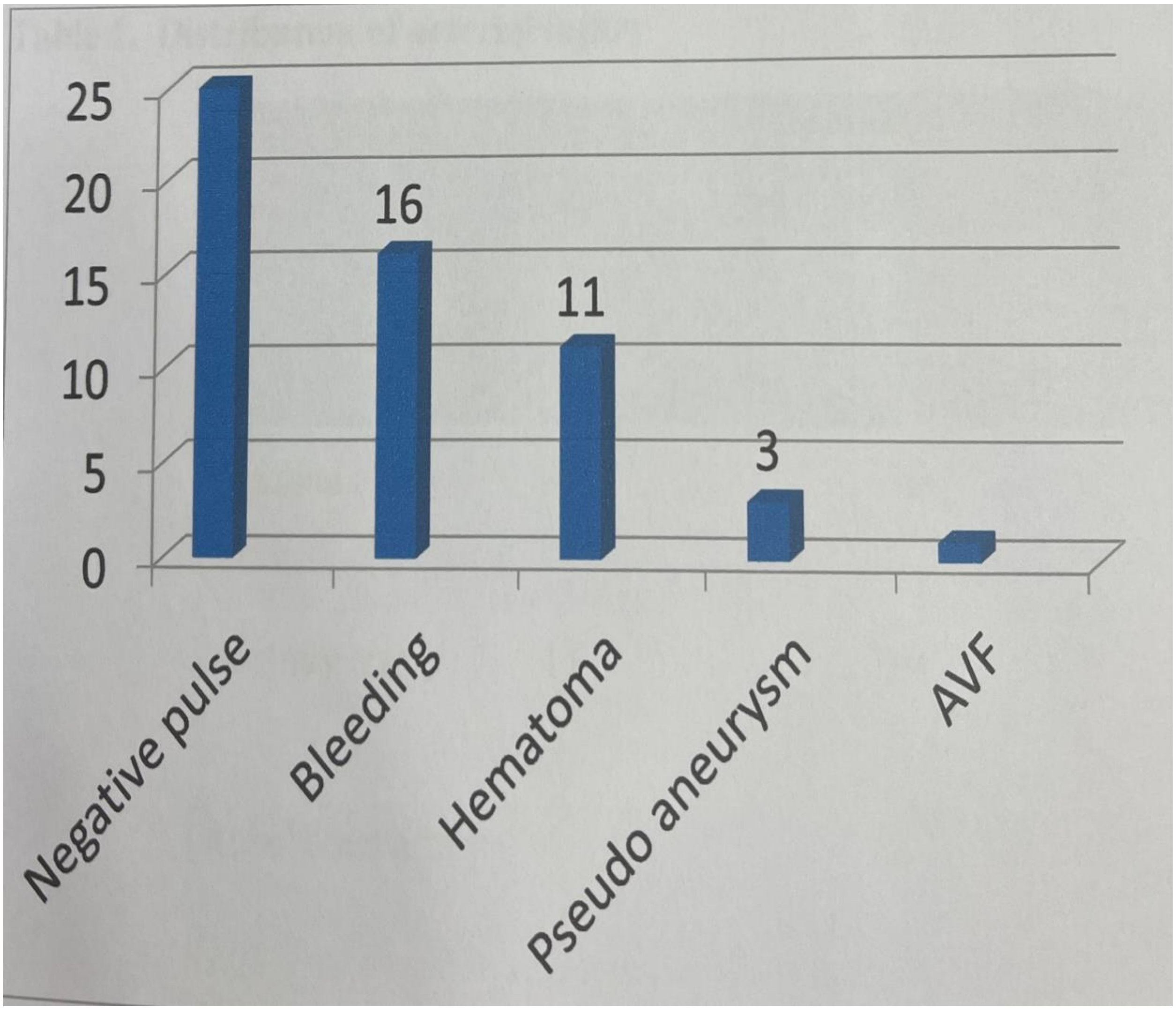


Figure.(.8)distribution of the presentation.

The most frequently injured vessel was the brachial artery seen in 38 patients (68%) , followed by axillary 11 patients (20%), and subclavian artery4 patients (7%), 3 patients' radial and ulnar injuries (5%) this is shown in table no. 1.

Table(1). Distribution of arterial injury

Types of arterial injury	Number	%
Brachial artery	38	58
Axillary artery	11	20
Subclavian artery	4	7
Radial & Ulnar	3	5

Orthopedic injuries were in the form of a fracture in 7 patients (12%) only. Arterial repair was the primary decision over orthopedic fixation in all the threatened limbs in 8 patients.

There are 9 patients with nerve injuries (16%) , proximal and distal nerve ending were marked with non-absorbable sutures.

A balloon embolectomy catheter was used routinely for all patients for both removal of clots and relieve of spasm. Although synthetic grafts were not used for repair, an end-to-end anastomosis after the resection of contused segment was the most frequently used single technique of arterial repair in 37 patients (66%).

Other techniques used included (11) patients (20%) with vein interposition graft (basilic and saphenous) , venous patch angioplasty in patients (7%) , lateral arteriorraphy in two patients (3%), only two patient end with arterial ligation. patients with pseudo aneurysms underwent excision of the pseudo aneurysm and repair of the vessel this shown in figure no.9.

Upper limb vascular injury

Concomitant venous injury occurred in 13 patients (23%), of them venorrhaphy and end to end anastomosis was done in 4 patients while in the other 9 patients ligation was done.

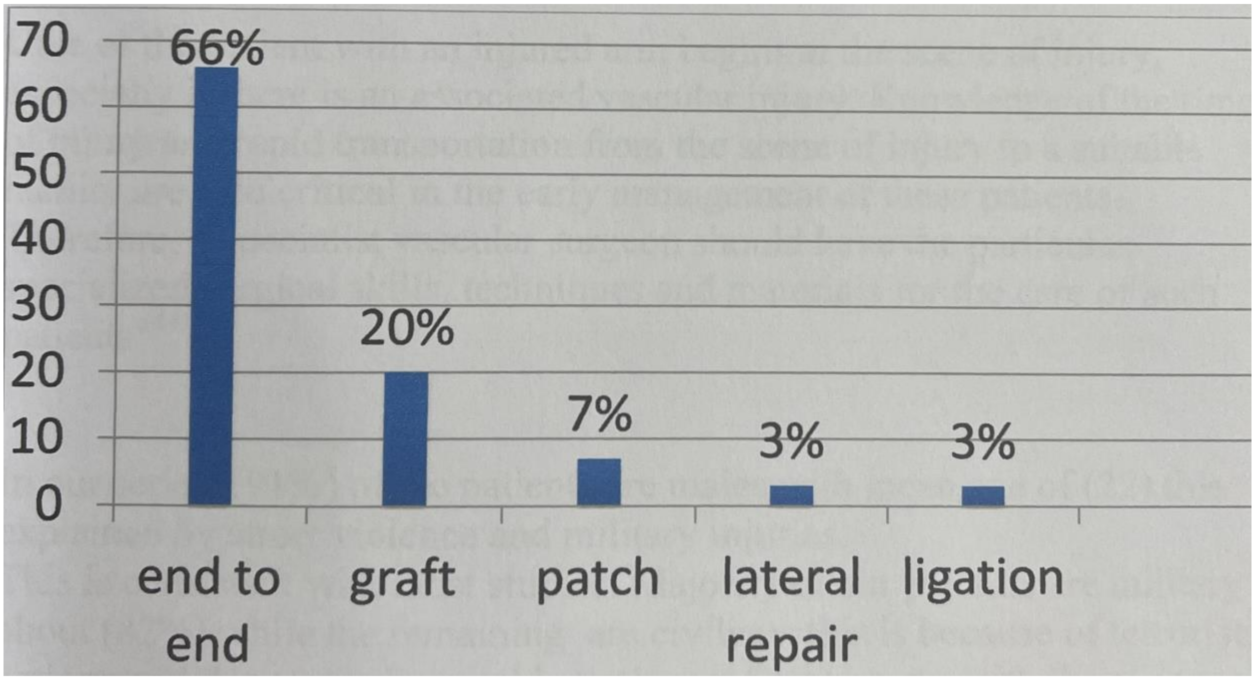


Figure. (9) types of repair

Five patients (9%) required revision procedures such as embolectomy, revision of the graft and anastomosis. Five patients (9%) developed infection, most of whom had severe upper limb soft tissue injury.

The infected wounds were treated with the appropriate antibiotics according to the culture and sensitivity as well as with frequent wound debridement and dressings. One patient underwent delayed amputation above the elbow due to blast injury and sever soft tissue loss in which saphenous vein interposition graft was used. A limb salvage rate of 98% was therefore achieved in 55 patients.

4 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 (43)

Care of the patient with an injured arm begins at the scene of injury, especially if there is an associated vascular injury. Knowledge of the time of injury and rapid transportation from the scene of injury to a suitable facility are also critical in the early management of these patients.

Therefore, a specialist vascular surgeon should have the particular specialized surgical skills, techniques and materials for the care of such patients (44)
In our series, (91%) of the patients are males with mean age of (22) this explained by street violence and military injuries.
This is consistent with most studies. Majority of our patients are military about (82%) while the remaining are civilians this is because of terrorists actions and due to our hospital is tertiary referral centre with the absence
fspecialized military hospital and this is close to result from Clouse et
and Fox et al (4)
in contrast Shalabi majority are civilians.
Most vascular injuries were related to penetrating traumas about 89% mainly due to bullet and shells injuries which is consistent with reports from other countries (46, 47) , and inconsistent with Rasoli et al, stabbings are the most frequent causes of penetrating injuries, in contrast to Shalabi et al (48) RTA blunt injuries are more frequent, this may be due to the fact that the road traffic is intense during Uma and Hajj period and when visiting the Mosque of prophet Mohammed, leading Medina to have one of the highest rates of RTA in Saudi Arabia.
We have no iatrogenic vascular injuries this is inconsistence with the European experience, up to 40% of vascular injuries are iatrogenic, as a result of endovascular and other surgical interventions (49.
The long-term outcome of upper limb injury is not dependent on vascular injury alone, which can be successfully managed, but also on the duration of limb ischemia before revascularization and concomitant injuries to bone, nerve, and soft tissue (50).
Most of our patients were treated with in first 8 h, in average because of early referral and due to proximity of these accidents to our centre and this is good prognostic factor and this is inconsistent with M.dragas et al
Upper limb vascular injury
(54) study about 66% treated after 12h, which adversely affected the results of surgical treatment.
In our study, we found that nerve injury is more common than fracture bones about (16%) a result that is close to reports from Shalabi R.et al* However, it is lower than some other reports(51)
Regarding preoperative management, clinical examination and Doppler study were enough for assessment without the need for conventional angiography as in our series and other studies (49, 51)
Arteriography had no role in our study because of lack of this facility during emergency situation and majority of the patients presented at night time were these investigations are not available. However angiography was used only in delayed presentation (traumatic arterio-venous fistula and false aneurysm formation).
Autogenous venous graft was used when end to end anastimosis was not possible.No prosthesis was used to avoid subsequent possible infection. In our series, end-to-end anastomosis was primary method for repair in about 66%, which was the most frequent technique and it is consistent with studies of Rasouli et a (2) and Murad et al, in Egypt)

However, it is in contrast with reports by Shalabi R.et al,Saudia arabia (48), M.Dragas et al (S4) and Clouse et al, Balad base hospital Iraq (S where grafting the most comon technique of repair while in our study only 20% autogenous graft were used as shown in table 2.
Upper limb vascular injury

Table(2).Repair Comparison

Types of study	Graft%	ETEA%
Our series	20	66
Shalabi et al	53	29
Clouse et al	62	15
M.Dragas et al	64	36

Brachial artery injury were the most frequent injuries (58%) and this consistent with other studies Clouse et al (56)
and Shalabi et al(48).
All brachial artery injuries in our series are repaired, no ligation was done which is similar to other many studies.
All ulnar and radial arterial injuries in our series have been ligated or repaired by end-to-end anastomosis in relatively the same frequency.
Although the results of vascular repair in our patients were similar to the results of some other study (S'' in which successful rate (98%).

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Regarding presentation of vascular injury, in our study frequently negative distal pulses more than other sign of presentation which differ from other study from Turkey done by Kasim Ergunes et al shown in

Table No.(3)

S&S	Kasim Ergunes et	Our study
Negative pulse	89%	44%
Bleeding	59%	28%
Hematoma	17%	19%
AVF	0	5%
Pseudoaneurysm	0	2%

38

Venous injury occurred in 13 patients (23%), of them venorrhaphy and end to end anastomosis was done in 4 patients while in the other 9 patients ligation was done. In this series, if repair of associated venous lesions required anything more than lateral suture or end-to-end anastomosis, ligation was our practice as long as compartment syndrome and obvious signs of venous hypertension were absent.

We found no additional morbidity among 9 people undergoing venous ligation, which is consistent with other reports (48, 52,

Infection occurred in (9%) of the patient who was controlled by heavy antibiotic cover and frequent debridement and dressing. These complications less frequent if compared with other studies (54,55).

An amputation was done in about 2% of our patients (only one patient), due to severe infection and severe soft tissue loss after 6 days of trauma which is lower than in other balad base report(55).

5. Conclusions and recommendations

Upper extremity vascular injuries carry better prognosis than lower ones.

Early referral of injuried patients affects the outcome of these patients especially when associated with other injuries.

Venous graft interposition and end to end anastamosis both has good result in trauma.

Ligation of venous injury does not carry high morbidity in contrast to lower limb venous injuries.

Majority of the patients are military because data collected during military conflict, therefore re establishment of specialized military centers are of great importance to deal with these cases.

Trained vascular surgeons should be available in all majors' hospitals to avoid unnecessary referral.

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