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UPPER LIMB SALVAGE

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Abstract

Among the vascular injuries, the brachial artery injury is common one. This is a retrospective study of 90 patients admitted at Al-Sader teaching hospital in Najaf from the 1st of January 2007 to the 1st of January 2008. The most common mechanism of injury was bullet and shell injuries (57.8%) followed by stab (25.5%), and blunt injury (13.4%). The least was iatrogenic in (3.3%) of cases. The surgical technique used to repair the vessel was resection and end to end anastamosis in 47.8% of cases, in 27.8% of the patients venous graft was used. Arteriorhaphy was done in 8.8% of the cases. Associated venous injuries were dealt with by ligation of the veins. No attempt to do venous repair and no fasciotomy was needed. The outcome of the injury in this study was in general good. The morbidity of the patients due to nerve injury, wound infection and joint stiffness still a problem. Mortality was 7.7% was due to associated injuries and delayed presentation of the patients. This study aimed to analyze the cause of injury, surgical approach, outcome and complications of brachial artery injury.

Introduction

Vascular injuries (arterial and/or venous) used to be linked to armed conflicts and wars in the past. But with marked increasing violence in the cities, both blunt and penetrating injuries to blood vessels are on the raise[1].

Though the limb vascular injury is seldom fatal, the rate of amputation or retention of painful, useless extremity is quite high because of lack of facilities to treat these injuries and there are very few competent vascular surgeons available in rural areas to handle these emergencies. These, when available, are limited to few big cities and then also to few hospitals[1].

Prompt effective diagnosis, resuscitation and early revascularization are necessary for successful limb salvages. Attempt to revascularize, after the "first golden 8 hrs", though technically successful will have progressively higher rates of amputation, especially in the lower limbs[2].

The 1st recorded vascular reconstruction was reported by Lambert in 1762. He described Hallowell's closure in1759 of small opening in brachial artery[3], this was a historic step because prior to that time restoration of flow had always been sacrificed for the sake of haemostasis and vessel ligation was essentially the only vascular procedure practiced.

In 1899, Kummel performed the 1st end to end anastamosis of an artery in a human[3].

The 1st successful arterial allograft was reported by Koepfner in 1903. Rudimentary vascular repair technique were introduced for the 1st time during the Korean conflict, resulting in the lowering of the amputation rate (13%) and reduced mortality and morbidity for extremity vascular trauma[4]. Vascular repair techniques were improved further during Vietnam war,

combined with advances in resuscitation, anesthesia and perioperative care resulted in similar low amputation rate[3].

More than 90% of all major arterial injuries in Vietnam involved the upper and lower extremities with the brachial and superficial femoral arteries being the most commonly injured vessels. Surgical principles learned from these wars have advanced rapidly the care of patients with civilian vascular injuries lowering the amputation rate to 2%[4].

In 1924 the use of intra-arterial injection of contrast medium (sodium iodine) was introduced by Brooks, who published impressive arteriograms utilizing this technique[4]. In 1952 the introduction of prosthetic arterial substitute began, when Voorhees and Blakemore first used Vinyon-N[3].

Patients and Method

This is a retrospective study of 90 cases presented with brachial artery injury and admitted to Al-Sader teaching hospital at the period from 1st January 2007 to the 1st January 2008.

Collection of data is from referral sheets regarding the details of injuries, the initial resuscitation measures, intraoperative and postoperative management. Seventy-seven patients 85.5% were males and 13 were females 14.5%. Twenty nine percent of the cases directly reached our hospital while the remaining(71%) referred from other hospitals. Age distribution of the patients in our study ranges from 8 months to 70 years with an average of 27.7 years. The mechanism of injury was: Bullet or shell injury in 52 cases 57.7%. Stab in 23 cases 25.5%. Blunt injury in 12 cases 13.4%. latrogenic in 3 cases 3.4%.

Results

The patients are divided into two groups according to the location of the injury either above or below the profunda brachii artery. Injuries above the profunda brachii artery are found to be associated with more sever signs of vascular injury, Table I.

Brachial artery is found to be associated with many local and general injuries as shown in table II. These injuries are found to be related to the causative factor of the injury whether stab or bullet injury.

Median nerve is found to be the most liable nerve for injury in association with brachial artery injuries. Control of bleeding was performed by direct pressure in 63 patients (70%) while in the remaining 27 patients (30%) the control of bleeding was done by the application of tourniquet. Those patients were presented with more sever symptoms of pain, oedema, pulselessness, parasthesia, cyanosis &coldness. Sixty eight patients (75.5%) were managed surgically within the 6 hours after injury. While the remaining twenty two patients (24.5%) were delayed more than 6 hours, seven of them developed thrombosis, four developed claudication and one developed gangrene. The type of surgery is determined by the pathophysiology of the arterial injury and the length of the injured segment. Seventy three (81.1%) patients presented with completely severed artery, eleven patients (12.2%) with partially severed and six patients (6.6%) presented with non severed artery. Saphenous vein graft was used in 25 patients (27.7%). In eight patients (8.8%) the artery was ligated because of sever injury with tissue loss. In the remaining 43 patients (47.8%) resection & direct end to end anastamosis were achieved. Systemic heparin was used in most of the cases except in the cases of ligation and in multiple injured patients, in cases of end to end anastomosis and lateral suturing local flushing with heparinized saline was enough.

Twenty one patients had uneventful recovery, sixty two patients developed different post operative complications and seven of them died. Tables III & IV.

Table I: Presentation of patient with brachial artery injury

Site	No.	No pulse	Pain	Coldness	Pallor	Parasthesia	Hematoma	Edema	Paralysis
Above profunda Artery	19 21.2%	16 17.6%	6 6.6%	10 11.1%	14 15.5%	9 9.9%	6 6.6%	13 14.4%	13 14.4%
Below profunda Artery	71 78.8%	65 72.2%	15 16.6%	61 67.7%	58 64.4%	23 25.5%	7 7.7%	25 27.7%	15 16.6%
Total	90 100%	81 89.8%	21 23.1%	71 78.8%	72 79.7%	32 35.4%	13 14.3%	38 42.1%	28 31%

Table II: Associated injuries

General injuries			Local injuries		
Type	No.	%	Type	No.	%
Head & neck	3	3.3%	Venous	47	52.2%
Chest	25	27.7%	Nerve	25	27.7%
Abdomen	5	5.5%	Bone (humerus, upper radius&ulna)	21	23.3%
Bone (apart from humerus, upper radius& ulna)	6	6.6%			

Table III: Postoperative complication

Time	Complication	No. of patient	%
Early (<24 hr.)	Edema	23	25.5%
	Thrombosis	3	3.3%
	Bleeding	6	6.6%
Late (>24hr.)	Paralysis	25	27.7%
	Joint stiffness	29	32.2%
	Wound infection	35	38.8%
	Ischemia	5	5.5%
	Gangrene	3	3.3%
	Aneurysm	1	1.1%

Table IV: Mortality and cause of death.

Sq.	Type of injury	Age(yr)	Time: injury to death	Cause of death
1	Penetration (bullet)	35	12 days	Renal failure
2	Penetration (bullet)	42	1 day	Multiple chest and abdominal injuries
3	Blast	18	1 day	Head injury
4	Blast	27	3 days	Multiple head and abdominal injuries
5	Penetration (bullet)	24	18 hr	Chest injury
6	Penetration (stab)	13	5 h r	Shock state after sever bleeding from brachial and femoral artery injuries
7	Blast	45	3 days	Multiple upper and lower limbs injuries

Wound infection was the most common post-operative complication occurred in 35 cases (38.8%) followed by joint stiffness in 29 cases (32.2%) and paralysis in 25 cases (27.7%).

Early after surgery twenty three patients developed edema, three developed thrombosis and six patients developed re-bleeding and required re-exploration. Five patients developed gangrene and required amputation.

Discussion

Vascular injuries can be encountered in civilians especially in urban areas where violence is endemic. Brachial artery injury; is a common vascular injury at Al-Sader Teaching Hospital which is parallel to Fields study which is conducted in Department of surgery, Virginia Commonwealth University, USA[5,6].

In this study the age of the patient ranged from 8 months to 70 years with an average of 27.2 years, in Hunt's study the age ranged from 6 years to 92 years with an average of 52 years, this difference is because of the high average age in western countries and because the younger age groups are more liable to violence in our country[5,6].

Penetrating injuries either bullets, shells or stab wounds represent the majority of injuries and this is similar to Hunt's study which is conducted in trauma center, Carraway Methodist Medical Center, Bermingham, Ala, USA. in which 90% cases were due to penetrating injury[6].

The bullet injury is the commonest cause of injury followed by stab and blunt injuries in contrast to Schroeder study which is conducted in Rigs hospital, Copenhagen Denmark. Where vascular injury caused by fracture of the humerus in 57%, contusion in 33% and penetrating injury in 10%[7].

Two groups of brachial artery injuries were found to influence the symptoms and prognosis of the patients, those injuries above the profunda brachii artery 21.2% or below the profunda brachii artery,78.8%.. Injuries below the profuda artery are more common because of the long course of the artery and the anterior anatomic location. Injuries above the profunda, presented with more sever symptoms of ischemia, pulselessness pallor, parasthesia, pain &paralysis, because the profuda artery provides many collateral vessels around the elbow joint which are able to keep the limb alive[8,9].

Brachial artery injuries are found to be associated with many local & general injuries, the most common local injuries are venous injuries 52.2%. Which is different from Penkove[10] study which is

conducted in Vascular Surgery Clinic, Medical University, Stara Zagora, Bulgaria. In which the most common associated one was nerve injury[10,11]. In all cases of venous injuries no attempt is to repair the veins and all veins are ligated without significant morbidity.

Nerve injuries are associated in many occasions with brachial artery injuries which is similar to Penkove[11]. In our study 25 patients (27.7%) presented with local nerve injuries. Median nerve is the commonest nerve to be injured with brachial artery, (19) patients (21.1%) presented with Median nerve injury due to its anatomic proximity to the brachial artery[8,9].Four patients (4.4%) presented with Radial nerve injury and two (2.2%) patients with ulnar nerve injury. Totally cut nerves are dealt with by refreshment of the edges with end to end anastomosis using prolene suturing at the time of the operation and referred later on to the neurosurgical side.

Fracture Humerus or upper ulna & radius occurred in 21 patients (22.3%) mainly in association with bullet & blunt traumas in which the vascular injury may be caused by the fracture itself or by bone fragment this is different from Schroeder study which is conducted in Rigs hospital, Copenhagen Denmark in which more than half of the injuries are caused by the bone fractures[7].

Fixation of the bone is mandatory before the vascular repair to protect the vascular anastomosis[12].

In this study all cases of vascular repair are done before the fixation of the bone because no orthopedic surgeon was available & to avoid the delay in vascular repair ,so the limb is fixed post-operatively by back slap, and referred later for the orthopedic side for fixation. No data was available about the patients after referral for fixation.

Tourniquet was used in 27 patients (30%) to control the bleeding in patients referred from remote areas, those patients presented with more sever symptoms which is similar to Schroeder's figure[13]. These patients are presented with pulselessness (100%), parasthesia (100%), cyanosis (77.7), coldness (81.8%), edema (48.1%) & pain (70.3%), because of the venous congestion & impaired collateral blood flow which causes edema so limb ischemia may be the end. As the time between the injury and surgical intervention is so important because any delay in the vascular repair can affect the prognosis of the limb post repair.

Sixty eight patients (75.5%) were referred for surgery within the first six hours after the injury in which the repair was successful while the other twenty tow patients (24.5%) were delayed more than six hours because of the delayed referral, this is different from Penkov study in which only 10% were presented with prolonged ischemia in which the prognosis was bad[10]. Even in those patients surgery was carried out because there was no absolute contraindication for vascular repair as long as the limb was viable.

The indications for surgery were determined on clinical bases because of the unavailability of Angiography & Doppler studies in the emergency department and the urgency of these cases this is similar to Hunts figure[10] in which arteriography is used if there are multiple sites of injury.

The type of operative repair was determined by the mechanism and the pathophysiology of the vascular injury, either repair, end to end anastomosis or graft interposition. Twenty five patients (27.8%) needed graft interposition. In all cases of graft interposition saphenous vein is used as a conduit because of its good size and easy access.

This is different from Andereeve study which is conducted in Vascular Surgery Clinic, Medical University, Stara Zagora,

Bulgaria, in which 45% of cases used autogenous graft, this difference is due to that the majority of patients in Andereevs study were caused by blunt trauma[10].

Resection and end to end anastomosis is carried out in 43 cases (47.8%), most of these cases were caused by stab wound with clear cut ends, while in Andreeve study it is required in 55% of the cases as most injuries in Andreeve's study were caused by blunt or bullet injuries.

If end to end anastomosis is attempted to be done in pediatric age group, it is better to be performed by interrupted suturing to allow circumferential growth in the future[4,12-15] this technique is followed in our cases.

Ligation is performed in eight patients (8.8%), as a life saving measure to stop bleeding in severely injured patients and in patients with crushed limb & tissue loss this is different from Andreev[10] study in which the brachial artery was ligated in a single patient who was in shock.

But it is associated with higher morbidity and the risk of gangrene is higher especially if it is performed above the profunda artery 55% than if performed below the profunda 25%, because of the good collateral vessels given by the profunda brachii artery[3].

Postoperative morbidity in this series occurred in 62 patents (68.8%). The most common cause of this morbidity was the wound infection due to dirty wounds caused by bullet injuries. This is different from Andreeve study in which paralysis & joint stiffness were the most common causes of morbidity. The second common cause of morbidity is paralysis followed by joint stiffness.

Joint stiffness can be avoided by early establishment of physiotherapy after the union of fracture, if present and two weeks after surgery if bon fracture is not a problem patients who came for follow up are referred for physiotherapy after wound healing.

Seven patients in our series died, and the cause of death was not the brachial artery injury itself, but it was due to other associated injuries this is deferent from Schroeder study in which the mortality was zero[16].

Conclusions and Recommendations:

Brachial artery injury is a common vascular injury. Bullet and shell injuries are the commonest causes of brachial artery injury. Diagnosis of brachial artery can be done on clinical bases. Young males are more affected by brachial artery injury. Tourniquet should be avoided whenever possible. Systemic heparin is preferably used especially in delayed cases and those cases without multiple injuries. Venous injury either deep or superficial can be ligated safely without significant morbidity. Faciotomy is not necessary in most cases of brachial artery injury. Late post-operative complication is mostly due to wound infection followed by paralysis and joint stiffness. Good cover of prophylactic antibiotics should be given to avoid wound infection. Early post-operative physiotherapy should be started to avoid joint stiffness.

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