Axillary Artery Injuries
Surgical experience review in a single vascular trauma center

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ABSTRACT

Background: Injuries to blood vessels are among the most dramatic challenges facing trauma surgeons because repair is often urgent, the surgeon has to decide between management options (open or endovascular), and gaining control and reconstructing a major arterial injury can be technically demanding .
Objective:,To analyze the cause of injury, surgical approach, outcome and complications of axillary artery injuries.
Methods A descriptive cross-sectional study on fifty patients at Ibn-Alnafees hospital in Baghdad from January 2005 to December 2010

Results Males were more commonly affected than female with ratio of 6.1:1. Most injuries were caused by bullet and shell (84%), followed by stab wounds (10%) and blunt trauma (6%). Patients were divided into three groups according to the involved part of the axillary artery: the first part, the second part and the third part. The second part represents most of the cases (48%), the third part account for (30%), while the least is the first part (22%). Resection and end to end anastomosis was done in 80% of the cases, lateral repair in 8%, graft interposition in 8 % and ligation in 4%.

Conclusion: The outcome of the injury in this study was in general good. The morbidity of the patients due to nerve injury and wound infection still problem. Mortality due to associated injury and delayed presentation was 4% which is acceptable as compared with other studies.

Keywords: axillary artery injuries , penetrating vascular trauma , open vascular repair .

INTRODUCTION

Injuries to blood vessels are among the most dramatic challenges facing trauma surgeons because repair is often urgent, the surgeon has to decide between management options (open or endovascular), gaining control and reconstructing a major arterial injury can be technically demanding. Yet major vascular trauma remains crucial element of trauma surgery, and every surgeon must be prepared to deal with them either definitively or using bail-out vascular damage control tactics.

HISTORICAL BACKGROUND

In 1546, **Ambroise Pare** performed the first arterial ligation during leg amputation in the midst of a combat and said **"**without having seen this attempt by any other person, nor heard or read but God advised me to tie the artery of the amputee". He also introduced the first arterial forceps, the "bec de corbin**".**[(1)] **Jean-Louis Petit** (1731) was the first surgeon to study haemostasis. The first recorded vascular reconstruction was reported by **Lambert** in 1762..**Eugene Koeberle**, a surgeon in Strasburg, invented a simple haemostatic clamp and applied it in surgery in 1868. It was the first operation actually ushering in our present technique of clamping and tying, which was carried out and popularized by **J. Pean** with a clamp he invented in 1869. In 1899, **Kummell** performed the first end-to-end anastomosis of an artery in a human. [(2)] In 1906, **Carrel** wrote the following instructions which are still valid a century later: "The vessels must be handled very gently and the endothelium must be protected…No dangerous metallic forceps are used. Great care is exercised to obtain accurate and smooth approximation of the endothelium of the vessel without invagination. Sutures should be made with very fine needles while the wall is somewhat stretched. Stenosis or occlusion only occurs as a result of faulty technique". [(4)]**Goyanes** of Madrid in 1929, after excision of a popliteal aneurysm, used an adjacent segment of popliteal vein to successfully bridge the defect (the first in situ vein graft). **Sven Ivar Seldinger**, a radiologist at the Karolinska Hospital in Stockholm, applied in 1952 a technique for peripheral arteriography; the procedure is now coined with his name and is used at present for all endovascular procedures.

METHOD

A descriptive cross-sectional hospital based study had been done including 50 cases and the study population collected from operating room records at Ibn-Alnafees hospital in Baghdad from January 2005 to December 2010. All the patients of vascular injuries of every age and sex group, military or civilian were included in the present study. Males were more commonly affected than female with ratio of 6.1:1

Those patients were admitted in the surgical department; Relevant history was obtained, data were collected directly from the patients or from their relatives as well as additional information were obtained from their referral sheets. These patients' demographics such as age and sex and involved vessels, pattern of presentations as well as other data which included etiological factors, treatment offered and outcome of such treatment were analyzed by simple statistics.

Inclusion criteria included the following:

1) All patients admitted to the vascular surgery department with a history of upper limb trauma with suspected vascular injury.

2) Patients with either "soft signs" or "hard signs" of vascular injury.

Exclusion criteria are:

All patients with traumatic amputations who had severely crushed limbs in whom there was no prospect of return of function with heavily contaminated wounds.

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 physical signs concerned to be associated with possible significant vascular injury were shock, active bleeding, hematoma (pulsating or expanding), and extensive tissue loss, absent pulses of the lower limbs or neurological deficit. Any active bleeding was controlled by tight bandaging and the wound were examined to determine the location and the mechanism of the injury . The diagnosis was made by reassessment of the primary referral diagnosis; physical examination, radiological investigations such as X-ray, laboratory investigations including blood, and biochemical tests.. Angiography was not always available and instead Doppler study was used and proved to be a useful aid in establishing the diagnosis.

After that the patients had been transferred to the ward and stayed postoperatively for few days and then discharged home. They were followed up but unfortunately the follow up details for those patients were not documented in the tables.

RESULTS

In our study 43 patients (86%) were male and 7 patients (14%) were female. Age distribution of the patients in our study ranges from 9 years to 55 years with an average of 32 years.

The largest proportion fall between 20-40 years of age and is equal to 88% of the study population.

The mechanism of injury was as illustrated in the pie chart with penetrating injuries made up to 94% of victims , of which 84% were missile injuries and no iatrogenic injury found .

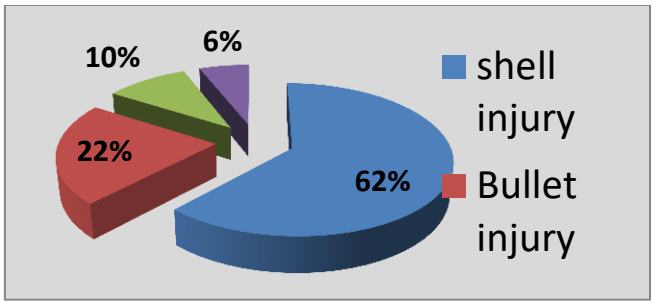

Figure 1 : The mechanism of injury

Evaluation and classification of injury was done according to the anatomic location: 11 cases (22%) were located in the first part of the axillary artery, 24 cases (48%) were located in the second part of the axillary artery, and 15 cases (30%) were located in the third part of the axillary artery.

Injuries of the first part were found to be associated with more severe signs of shock and circulatory collapse , these accounted for 22% of the total with 48% and 30% to the second and third parts respectively .

--**Table 1** Presentation of patient with axillary artery injury

part	no	Absent pulse	pain	parasthesia	hematoma	paralysis
First	11	8	7	4	6	2
Second	24	19	15	14	12	5
Third	15	12	9	3	9	0
Total	50	39 78%	31 62%	21 42%	27 54%	7 14%

Brachial plexus injury is found to be in close association with axillary artery injury , mostly associated with second part arterial injuries . Control of bleeding was performed by direct pressure in 11 cases (22%) , while in 35 cases (70%) , the bleeding stopped by large hematoma formation , and in the remaining 4 cases (8%) , the bleeding could not be controlled before surgery .

Thirty eight patients were managed surgically within the first 6 hours , while the remaining 12 patients were delayed more than 6 hours , none of them developed gangrene

The type of surgery was determined by the pathophysiology of the arterial injury and length and part of the injured segment . 21 patients (42%) were presented with completely severed artery while 26 (52%) were presented with partially severed artery. The remaining 3 (6%) were presented with non-severed artery .

Resection and direct end to end anastomosis was done in 40 patients(80%),lateral repair was done in 4 patients(8%),graft interposition was done in 4 cases(8%)(synthetic graft was used in one patient and saphenous vein was used in the remaining) and ligation was done in 2 cases(4%)because of severe bleeding with massive tissue loss.

Systemic heparin was used in some cases except in the cases of ligation and multiply injured patients. In cases of resection and direct end to end anastomosis and lateral

repair, local flushing with heparinized saline was enough.

Nineteen (38%) patients had complete recovery, 29(58%) patients developed different postoperative complications and 2(4%) patients died.

Wound infection was the most common postoperative complication occurred in 38% of the patients followed by edema (18%) and rebleeding that required re-exploration in 12% of the patients. No one developed gangrene. One patient died due to associated head injury and the other died due to massive bleeding and irreversible shock

DISCUSSION

In this study the age of the patients ranged from 9 years to 55 years with an average of 32 years. Young males were the highest risk group, due to their propensity to engage in high-risk activities. In our study 43 patients (86%) were male and 7 patients (14%) were female. The male to female ratio was 6.1:1.

Penetrating injuries either bullets or shells represent the majority of injuries (84%). The shell injury is the commonest cause (62%) followed by bullet injury (22%), stab wound (10%) and blunt trauma (6%).

The three parts of the axillary artery have their own signs, symptoms and prognosis when they are injured. So the second part represents most of the cases (48%), the third part account for 30%, while the least is the first part 22%. Injuries of the second part are more common because of the anatomical location that make it less protected than the first or the third part.

Brachial plexus injuries were associated with axillary artery injury in many occasions because throughout its course, the artery is closely related to the cords of the brachial plexus and its branches and is enclosed with them in the axillary sheath. In this study brachial plexus injury occurred in 26%. The second part of the axillary artery was more commonly associated with brachial plexus injury 7 patients, followed by the first part 4 patients and the third part 2 patients. 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 department.

The time between the injury and the surgical intervention is so important because any delay in the vascular repair can affect the prognosis of the limb. Thirty eight patients (76%) were referred for surgery within the first six hours after the injury in whom the repair was successful while the other twelve patients (24%) were delayed more than six hours because of delayed referral. Even in delayed patients surgery was carried out because there was no absolute contraindication for vascular repair as long as the limb was viable. None of them developed gangrene.

The indications for surgery were determined on clinical bases because of the unavailability of angiography and Doppler studies in the emergency department and the urgency of these cases.

The type of operative repair was determined by the mechanism and pathophysiology of injury, either lateral repair, end to end anastomosis or ligation. Resection and end to end anastomosis was carried out in forty patients (80%). Most of these cases were caused by shell injuries. If end to end anastomosis is attempted in pediatric age group, it is better to be performed by interrupted suture to allow circumferential growth in the future. This technique was applied in our cases. Ligation was performed in 2 patients (4%),

as a life saving measure to stop bleeding in severely injured patients and in patients with crushed limb and extensive tissue loss. It is associated with higher morbidity although less risk of gangrene compared to other important limb vessels. This is mainly due to extensive collaterals. Small punctures were dealt with by lateral repair in 4 patients (8%).

The most common cause of morbidity was wound infection followed by edema and paralysis.

This study was compared with the study performed by Elias and Thomas who performed a retrospective study of 32 patients with axillary artery injury. [(24)] There was an overall mortalty of 6% entirely accounted for by associated injuries while in our study the overall mortalty was 4%. Preoperative angiography was used in 12 of these patients while in our study angiography was not used because it was not available in the emergency department. 12 patients (37.5%) underwent lateral arterioraphy or end to end anastomosis and 19 (59%) patients had an interposition graft. While in our study resection and end to end anastomosis was done in 40 (80%), ligation was performed in 2 patients (4%) and Small punctures were dealt with by lateral repair in 4 patients (8%). Eleven patients (34%) had brachial plexus injury while in our study 13 (26%) patients had brachial plexus injury.

This study was compared with the study performed in emergency and trauma department of medical faculty of Istanbul, Istanbul University where 38 patients were treated for axillary artery injuries between January 1989 and July 2002. [(25)] End to end anastomosis was done in 10 patients (26.3%) while in our study end to end anastomosis was done in 40 patients (80%). lateral repair was done in 6 patients (15.7%) while in our study lateral repair was done in 4 patients (8%). Graft interposition was done in 16 patients (42%) while in our study graft interposition was done in 4 patients (8%). Ligation was done in 6 patients (15.7%) compared with only 2 patients (4%) in our study. 14 patients (36%) presented with brachial plexus injury while in our study only 13 patients (26%) had brachial plexus injury. wound infection developed in 8 patients (21%) compared with 19 patients (38%) in our study. 2 patients (5.2%) died of concomitant injuries while in our study 2 patients (4%) died.

CONCLUSION

Most injuries are caused by high-velocity weapons , with most victims being men . Like all injuries, the presentation of axillary artery injury depends on the biomechanics and the amount of energy transfer that occurs at the moment of injury. The natural history of axillary artery injury depends on the injury's location and how much of the arterial wall is injured. Further, presentation of ischemia, in large part, depends on the availability of collateral circulation. Most of the cases can be diagnosed clinically.

The most useful way to organize axillary artery injuries is to classify them simply as first, second and third parts. Injuries of the second part are more common , because of the anatomical location that makes it less protected than the first or the third part.The successful management of axillary artery injury hinges on the adaptation of standard vascular surgical techniques to nonstandard situations. The use of temporary intraluminal shunts and balloon catheter tamponade demonstrates how standard technical adjuncts have been adapted to provide new solutions in difficult situations.

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