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VASCULAR INJURIES ASSOCIATED WITH FRACTURES AND DISLOCATIONS - PRESENTATION, MANAGEMENT AND OUTCOME ANALYSIS

Orthopaedics

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ABSTRACT

INTRODUCTION: Fractures with arterial injury requiring vascular repair are high grade and severe injuries with soft tissue being compromised. Uniform approach and experience in the management of these fractures is relatively uncommon. External fixation followed by definitive fixation has been on the rising trend. The main aim of this study is the analyze the mode of injury, time and patterns of presentation, and the outcome of fractures associated with vascular injuries. We followed up 84 fracture patients with vascular injury who were admitted in a span of one year. In our study, we had a limb salvage rate of 71.5%, 25% primary amputation rate and 3.5% secondary amputation rate.

CONCLUSION: Orthopedic intervention prior to vascular repair provided similar longterm outcome compared with patients treated in the reverse sequence. Definitive fixation following initial external fixation should be done as soon as possible for early mobilization.

KEYWORDS

Vascular injuries, fractures, dislocations, external fixation, arterial injuries

INTRODUCTION:

Trauma frequently involves the bones of the extremities. Fractures with arterial injury requiring vascular repair are high grade and severe injuries with soft tissue being compromised and neurological status impaired in most of them. Most vascular injuries occur in areas in which the vessel is in close approximation to the bone and is held in a more or less fixed position by muscles or other bones[1]. Most of these injuries occur in young males who met with motorcycle road traffic injuries[2]. Higher mortality and morbidity is associated especially due to rapid and voluminous blood loss into pelvic or femoral soft tissue compartments[3]. Depending on level of soft tissue and skeletal damage, rates of amputation vary from 4% to 61%[4]. Uniform approach and experience in the management of these fractures is relatively uncommon[5][6][7][8]. With advancement in arterial repair and regaining the vascularity, methods of fracture management and associated complications are the major issues to be noted[9]. External fixation has been increasingly preferred in the last few years[10]. The delay in time between the injury and surgery may produce a limb that is beyond recovery as ischemia with necrosis of tissue and thrombosis of small arteries sets in[11]. In this study, we have retrospectively evaluated our experience with a subset of patients admitted in the Institute of Orthopaedics and Traumatology, Chennai between Sep-2017 to Sep-2018 who had a combination of vascular injury and limb fractures.

MATERIAL AND METHODS:

The main aim of this study is the analyze the mode of injury, time and patterns of presentation, and the outcome of fractures associated with vascular injuries. We followed up 84 fracture patients with vascular injury who were admitted in a span of one year in our institute which is a tertiary care center, most of them being referred from surrounding hospitals. All patients with vascular injury associated with long bone fractures irrespective of the age group were included in the study. Patients with associated head injury, chest wall injury and abdominal injuries were excluded. Upon arrival, after stabilisation of all vital parameters, a focused extremity examination was performed. Extremity pulses was determined by palpation. If pulses were absent, hand-held Doppler by a vascular surgeon was used to assess arterial Doppler signals. All patients were subject to radiographs, Doppler examination and CT arteriography (if situation demands with no impending critical ischemia). Vascular injuries were managed by end-to-end anastomosis, thrombectomy, simple ligation or interposition graft procedures (Figures1,2,3) after tourniquet application. Ligation was reserved for those cases where either anterior or posterior tibial and radial or ulnar artery injuries where arterial supply by anastomosis is possible. However, we preferred arterial repair whenever possible for all patients. Arterial repair was done prior to orthopaedic stabilization in some cases and the remaining had fractures reduced by external fixator first. Orthopaedic injuries were managed by closed and open reductions with external fixation and definitive fixation later on. The records from these 84 cases were prospectively reviewed. Data including mechanism of injury, location and severity of vascular and orthopaedic injuries, time of intervention, methods of vascular and orthopaedic repair, and amputation rates were collected.

Figure 1: Brachial artery repair

Figure 2: Femoral artery repair

Figure 3: Axillary artery repair

RESULTS:

The mean age of presentation was 24 years, most common age group being 21-30 years. There were 5 paediatric patients. Age of one patient with a psychiatric disorder could not be ascertained correctly. There were 78 men and 6 women among the 84 patients owing to the fact that the usage of two wheelers, rash driving and alcoholism are common among men. Most common mode of injury was road traffic injury and two wheeler accident was more common among them followed by machinery cut injury. Among the offending vehicles, heavy vehicles resulted in amputations most commonly. Mode of injury in one patient could not be elicited. The average time between the incident and surgical intervention is 9.6 hours ranging from 4 hours to 36 hours. Left side injuries constituted about 41 and right side about 39. Bilateral injuries were found in 4 patients. Upper limbs were involved in 26 patients amidst which 12 were right sided and 14 were left sided. Lower limbs were involved in 58 patients amidst which 30 were right sided and 28 were left sided. Among these 4 were bilateral cases and 1 had right sided popliteal vein DVT. 6 patients had compartment syndrome, 3 in right and 3 in left all confined to legs. Both radial and ulnar arteries were involved in 4 patients of which 3 were left sided and 1 right sided. Both anterior tibial and posterior tibial arteries were involved in 11 patients of which 6 were right sided and 5 were left sided. Popliteal artery was most commonly involved in lower limb and brachial artery in upper limb. 3 nerve injuries including median, radial and common peroneal nerve were identified and was managed intraoperatively by plastic surgery team. Segmental fractures were found in 12 cases which indicate high energy injury. Dislocations with vascular injury were noticed in 11 patients, 5 cases in upper limb, all

affecting elbow and 6 cases in lower limb with knee being more common to talus subluxation. On admission, all patients are heparinized preoperatively if not contraindicated and general anaesthesia was given intraoperatively for all patients. All dislocations and unstable fractures amounting to 20 cases were orthopaedically stabilized first and then vascular intervention is done if required (Table 1). For all stable fractures, vascular repair done first and then fracture fixed by external fixation. Fasciotomy was done in 50% cases with vascular injury and those with compartment syndromes. Definitive fixation was done in 18 patients where nailing was done in 6 patients and plating in 12 patients. All cases with open injuries to knee and elbow suffered from joint stiffness due to prolonged application of external fixator. Among other cases, 18 patients with definitive fixation had good range of movements but 2 patients had edematous limb and 2 patients required bone grafting in later stage for union. Other patients where only external fixation was done, 7 patients had malunion, 3 had non-union while the rest developed union and has started to weight bear with decreased range of movements. Primary amputation was done for 24 patients and one patient had bilateral amputation done above knee and at forefoot level. Most common cause for primary amputation was done due non salvageable limb with severe soft tissue damage, contamination of the extremity and late referrals. No amputation was done for single vessel injury in forearm or leg while a 75% amputation rate was done in forearm for double vessel injury the most common cause being a traumatic amputation with severe contamination by machine. 63% amputation is documented in double vessel injury in the leg the most common cause being a non-salvageable crush injury by a heavy vehicle. Secondary amputation was done in 3 patients of which 2 were graft failures and one developed sepsis and calf muscle necrosis of the affected limb. Salvage rate for cases presenting more than 6 hours is about 75% for upper limbs and 50% for lower limbs. Salvage rate for cases presenting less than 6 hours is about 50% for upper limbs and 45% for lower limbs due to non-salvageable crush injury and contamination of extremities. Death was documented in 3 cases where one died due to hypovolemic shock, one due to sepsis and the other during follow-up due to medical comorbidity. The mean hospital stay was about 2 months.

DISCUSSION:

Vascular injury in fracture dislocation maybe due to direct high velocity trauma or impinging fracture fragments. Short pre-evaluation period and time interval between onset and surgery is necessary in preventing necrosis. Ischemia depends on the duration, level of arterial injury, soft tissue extent and effective collateral circulation. Mirdad[12] in his study reveals an average age presentation of 29.6 years and a male to female ratio of 13:1 owing to people engaged with active and probably dangerous activities in the most productive stages of life. He also indicates that Road traffic accident was the most important mode of injury which was found in our case too. Reduction in amputation and prevention of microciruratory thrombosis is seen with early application of systemic anticoagulation therapy(heparin 100 U/kg i.v qid) [13]. All our cases with suspected vascular injuries are heparinized on initial presentation with a dose of 5000 IU i.v stat (100 U kg/i.v qid) after which the mode of management is planned. Starr et al[14] in his study explains no difference in the order of fixation for vascular and orthopaedic management. However in our cases, vascular intervention was done first as most of them were late presentations but in some unstable fracture dislocations orthopaedic intervention was done prior to vascular repair. Iannacone[15] and Cakir[4] preferred external fixation in the initial stages to definitive fixation due to time constraints, less operative time, decreased tissue destruction, decreased infection,ease of daily dressing and irrigation of compound wounds due to soft tissue injury. DiChristina[16] in his study mentions not more than 90^0flexion in all compound femoral shaft fractures. Similar findings of decreased range of movements found in our study in external fixators spanning the joint due to prolonged immobilization for wound healing. External fixator cases where no joint was spanned had almost full range of movements. Topal et al[17] suggests prophylactic fasciotomy in patients whose duration had exceeded >6 hours especially in two bone fractures below knee. In our study, we had fasciotomies done for patients who presented with signs of compartment syndrome, late presentations, prolonged surgeries and to avoid compartment hypertension. Feliciano[18] suggests repair of associated venous injury to avoid edematous compression over the arterial repair site. We had one patient presenting with popliteal vein DVT where thrombectomy was done and no gross edema found postoperatively. Skin cover for compound cases was done as early as possible to avoid possible damage to vascular repair site[4]. Neurorrhaphy was done for nerve injury and recovery was achieved by additional physiotherapy. We had secondary amputation done in three patients due to graft failure and sepsis. In our study, we had a limb salvage rate of 71.5%, 25% primary amputation rate and 3.5% secondary amputation rate. Decrease range of movements were found in 35% cases. 21% patients had definitive fixation done secondarily of which 2% patients required bone grafting for union. 46% patients were managed by external fixator alone of which 8% developed malunion and 4% developed non-union. 4% death rate in 84 patients was noted.

CONCLUSION:

A good clinical examination and vascularity assessment by hand held doppler alone is vital for limb salvage due to immediate intervention. Ruling out the contraindications, preoperative heparin and general anaesthesia are vital for better results. Initial vascular intervention is preferred over orthopaedic management except for unstable fracture dislocations. Except for decreased postoperative range of motion, external fixator serves a ideal initial method of management for compound fractures with severe soft tissue injury. Definitive fixation should be done as soon as possible for early mobilization. Fasciotomy and adequate skin cover for compound wounds as early as possible are of utmost importance to avoid arterial graft failures.

Table 1: Arterial Injuries And Method Of Repair

	Numbers involved	Ligation	Thrombectomy/ Embolectomy	End to end anastomosis	Interposition graft	Heparin and Skeletal stabilization	Amputation
Axillary artery	1				1		
Brachial artery	20	-	1	1	8	4	6
Radial artery	1			1			
Ulnar artery	-						
Radial and Ulnar arteries	4				1		3
External Iliac artery	1						1
Femoral artery	3			1	1		1
Popliteal artery	23				14	1	7
Anterior tibial artery	6	1				5	
Posterior tibial artery	6			1		5	
Anterior and Posterior tibial arteries	11				2	2	7
Dorsalis pedis artery	1						1
Popliteal vein DVT	1		1				

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