CASE SERIES

Extremity vascular injuries following skeletal fractures, a tertiary care centre experience from Sri Lanka

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Introduction

Vascular injuries (VI) can occur, due to direct or indirect mechanisms, following skeletal fractures of the extremities. Sharp fragments of the fractured bone can cause direct injury to vessels. Shear forces and stretching during injury as well as during manipulation can lead to indirect arterial injury (1) leading to tissue ischemia and subsequent tissue death that ultimately may result in amputation. To avoid such unfavourable outcomes, blood supply needs to be urgently restored. (2).

The incidence of VI following fractures of extremity bones is reported to be 0.1%-1.6% (1, 2, 3, 4, 5, 6). However the incidence varies depending on the population (civilians or military population) and geographic location (1) In Sri Lanka, only small scale studies have been done regarding VI associated with extremity fractures. Therefore this study was done to determine the incidence of VI in extremities caused by skeletal trauma as well as its contributory and associated factors.

Material and Methods

This study was conducted at the accident and emergency department of the National Hospital Sri Lanka, Colombo (NHSL) which is the Sri Lanka's largest tertiary care trauma centre.

NHSL is a level one trauma center. Multidisciplinary teams involving trauma surgeons, vascular surgeons, orthopaedic surgeons, intensivists and interventional radiologists are involved in 24/7 trauma care. A retrospective analysis of consecutive trauma admissions to the NHSL, having extremity fractures with concomitant VI was analysed. The study was done from October 2019 to February 2020. The patients included direct admissions as well as transfers from other hospitals. Data were collected from admission and operation registries of the hospital. Patients having forearm, hand and foot fractures were excluded from the study.The reason for excluding above mentioned fractures is that the VIs in the forearm, hand and foot region are referred to the plastic and reconstructive surgeons. Data on patient demographic factors, the fracture pattern and the soft tissue status; whether its open fracture or closed fracture, the presence of VI, type of vascular repair done and the method of skeletal fixation were recorded. Data was entered directly to a database with a specific serial number allocated to individual patients.

Results

During the study period of 5 months a total 1135 cases were identified as having upper and lower extremity fractures and dislocations after exclusion of forearm, hand and foot fractures. Mean age was 52.3 years (10 to 96).1124 (99.03%) had fractures and 11(0.97%) patients had knee joint dislocation (KJD). 150(13.3%) had upper limb (UL) (humerus) fractures alone and 973(86%) had lower limb bone (LL) fractures alone. 1 (0.08%) had both LL and UL bone fractures.

Of the patients who had fractures, 678 were males (60.3%) and 446 were females (39.7%). Among KJD patients, 7 were males (63.6%) and the rest i.e. 4 were females (36.3%).

Isolated fractures and combinations of multiple fractures were also recorded. Isolated tibia fractures were the commonest isolated fractures involving 30.6% of the total cases. Combination of femur and tibial fractures was the commonest combination fracture (0.2%) (Table 01).

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The site of fractures and the numbers are summarized in the table 01.

Out of these 1124 cases, 50(4.4%) were found to have a VI. In the cases with VI, the mean age was 35.82 years (16 to 81).

The site of fractures with VI and the numbers are summarized in the table 02.

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Table 1. The site of fractures and the numbers

Fracture site	No of patients	%
Femur	272	24.1%
Tibia	344	30.6%
Humerus	150	13.3%
Femur and Tibia	3	0.2%
Humerus and Femur	1	0.08%
Neck of femur	332	29.5%
Pelvic	22	1.9%
Total	1124	100%

Table 2. The site of fractures with VI

Site of fracture	No of patients	%
Femur	16	32%
Tibia	15	30%
Humerus	17	34%
Pelvic	2	4%
Total	50	100%

Table 3. The type of fracture according to soft tissue status

Location	Closed fractures	Open fractures	Total
Femur	4	12	16
Tibia	5	10	15
Pelvis	2	0	2
Humerus	6	11	17
Total	17(34%)	33(66%)	50(100%)

Majority of the VIs were following humerus fractures (34%) followed by femur fractures (32%) and tibial fractures (30%) (Table 02).

The type of fracture according to soft tissue status and the numbers are summarized in the table 03.

Out of 50 cases of concomitant extremity fracture with a VI, 40 patients underwent vascular repair. Reversed Saphenous Vein Graft (RSVG) repair in 24(48%), direct Repair in 13(26%). In 9 cases vessel ligation was done due to extensive soft tissue injury or nonviable muscles (5 mangled limbs and 4 non-viable limbs). All of these patients subsequently underwent primary amputation. Furthermore, in one patient with humerus fracture, vascular repair was not done due to extensive soft tissue injuries, haemodynamic instability and the presence of adequate distal perfusion due to adequate collateral blood flow (Table 04).

The type of vascular repair and the numbers are summarized in the table 04.

Total admissions with knee dislocation were 11 during this period. Out of that 8 cases (72%) had a VI. Direct repair was done in 1 patient (12.5%) and 7 patients (87.5%) underwent RSVG repair. All limbs on which the vascular repairs were done were salvaged in this series.

When considering soft tissue status, the majority were open fractures (n-33/66%). 17(34%) were closed fractures (Table 03).

Fracture/dislocation stability was achieved with external fixation in the majority (58.6%) before the vascular repair. Internal fixation was done in 15 (25.8%). 9 patients (15.5%) were stabilized using plaster cast (Table 05).

Table 4. The type of vascular repair

Fracture site	Vascular repair					Total
	Direct Repair	Ligation	Patch angioplasty	RSVG	None	
Femur	6	4	1	5	0	16
Humerus	4	1	2	9	1	17
Pelvic	0	1	0	1	0	2
Tibia	3	3	0	9	0	15
Total	13 (26.0%)	9 (18.0%)	3 (6.0%)	24 (48.0%)	1 (2.0%)	50

Table 5. The method of skeletal fixation

Skeletal fixation	Number	percentage
Plaster cast	9	15.5%
Internal fixation	15	25.8%
External fixation	34	58.6%

The method of skeletal fixation and the numbers are summarized in the table 05

Discussion

Globally the incidence of VI in extremity fractures is less than 1.0 %(0.1%-1.6%). (1, 2, 3, 4, 5, 6) However in the current study the incidence of VI is 4.4%. This is significantly higher than the incidence reported from the studies done in other countries ($p<0.00001$). Global incidence of VI in knee dislocation is around 16% (5, 7). Anatomical proximity of the popliteal artery to the tibio-femoral articulation leads to increased incidence of popliteal arterial injury in knee joint dislocation (2, 9). However these rates are significantly higher in our study population (72%) ($p < 0.000001$). Poor handling of the fracture in the pre-hospital care of the patient may be a contributing factor for this because in many parts of Sri Lanka still there is no established pre-hospital care available. Globally open fractures are associated with high risk for VI (2, 10, 11). In this study too, the majority of VIs were associated with open fractures (66%).

Two main aspects in management of these injuries are vascular repair and skeletal stabilization. Vascular repair options include endovascular and open surgical management. Open surgical management includes direct repair, interposition graft placement and bypass surgery (1). The main principles of open vascular repair following trauma is approximation of healthy vessel ends without tension in a healthy surrounding tissue field. When the arterial ends are lacerated or contused for a long distance, this should be trimmed. After trimming if the gap between the trimmed ends is more than 1cm, there will be tension between the ends. Therefore if the gap is more than 1 cm an interposition graft repair is done. If the gap is less than 1cm an end to end repair is done (direct end to end approximation. For side wall injuries (partial tear), the defect is closed with a venous patch (venous patch angioplasty).In our population of fractures associated with VI, the majority have undergone interposition graft repair with RSVG 24(48 %) followed by direct repair in 13(26%). One patient with distal humerus fracture associated with brachial artery injury has undergone non surgical management due to adequate collateral flow around elbow joint maintaining the distal perfusion. However in long term, due to extensive soft tissue injuries, the limb may not be functional. If the limb regains function, the circulation may not be adequate, resulting in claudication of the limb muscles.

In a fracture associated with VI, the fracture segments should be stabilized to prevent further VI and to protect the vascular repair. The options used in our population were plaster cast, external fixation and internal fixation. External fixation was used in majority (n-34 /58.6%) This can be explained by the fact that in our population majority were open contaminated fractures with VI.

Therefore in summary, vascular injury occurs in 4.4% of fractures of extremity which needs combined management of vascular and orthopaedic surgical teams. Incidence of concomitant VI in our population was higher than global values (4.4% vs <1%). VI rates associated with knee joint dislocation was also higher in our population (16% vs. 72%). Poor pre-hospital care can be a contributory factor and this indicates that we should establish a proper pre-hospital care for handling of the fractures.

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