Frequency of Compartment Syndrome in Patients Presenting with Fractures of Tibia in A Tertiary Care Facility

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Abstract

Objective: To determine the frequency of compartment syndrome in patients presenting with fracture of tibia in a tertiary care facility.

Methods: In our descriptive cross- sectional studied conducted from January 2018 to June 2018 at the Department of Orthopaedics, Jinnah Postgraduate Medical Centre, Karachi, we included 136 patients in this study with age range between 18 to 45 years of either gender presenting with closetibial shaft fracture within 24 hours of injury. Brief history regarding the duration of fracture and comorbid like HTN was obtained. Patients with diabetes mellitus, chronic bleeding and renal disorders and I.V drug abusers were excluded from the study. Presence of any one or more of the following within 24 hours of injury were labelled as compartment syndrome: severe pain: VAS score 7 or more, limb paralysis: unable to move limb, paraesthesia: mild or no sensation on pin prick, pallor, as compared to contralateral limb and pulselessness: absence of pulse on Doppler.

Results: Mean age of the patients was 35.01 ± 9.34 years.More patients (n=72, 52.9%) were found older than 35 years of age while 64 (47.1%) patients with ?35 years of age. There were 99 (72.8%) males and 37 (27.2%) females. Mean weight, height and BMI of the patients were 60.11 ± 5.12 kg, 1.53 ± 0.06m and 27.23 ± 5.02kg/m^2 respectively. Average duration of fracture was 21.85 ± 1.63 hours. Majority (n=114, 83.8%) of the patients presented with >20 hours. Compartment syndrome was found in 9 (6.6%) patients out of 136 cases. A significant association of compartment syndrome was found with age (p-value 0.025), and BMI (p-value 0.043) of the patients. Out of nine patients with compartment syndrome, eight patients were older than 35 years. In contrast, BMI in eight patients diagnosed with compartment syndrome were less than 30. However, no significant findings were noted in relation to duration of fracture (p-value 0.201), smoking status (p-value 0.097) and HTN (p-value 0.108).

Conclusion: Compartment syndrome is a surgical emergency, which needs timely diagnosis and immediate decompression to avoid complications including limb loss.

Keywords: Compartment syndromes, tibia, tibial fractures, patients.

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Introduction

Orthopaedic surgeons often encounters acute compartment syndrome (ACS) in their clinical practice. It occurs following a rise in the pressure inside a limb muscle compartment to such a level that the circulation of the tissues in that compartment is diminished[1]. It is a surgical emergency and if the diagnosis is delayed and treatment not ensued within due time, it can lead to compression of vital structures like muscles, nerves, and vessels in a close facial compartment which is attributed to high morbidity and mortality[1,2].

Fractures are the most common cause of acute compartment syndrome in about two third of the cases[3] and the most common fracture associated with acute compartment syndrome in adults is fracture of the tibial shaft (near about 36%)[3]. The reported prevalence of acute compartment syndrome in literature for tibial diaphyseal fractures varies from

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2.7% to 15%,due to various diagnostic tools in different set ups[3,4,5].

Compartment syndrome is more common in diaphyseal tibia fractures than in proximal or distal tibia fractures[3]. In about one third of the cases, ACS of the lower leg results from blunt injury to the soft tissues[3]. ACS of the lower leg as a result of tibial shaft fractures is more common in younger patients and male patients are ten times more prone to develop ACS[2,3]. It is because of the fact that young patients have more muscular component, less space for tissue expansion after traumatic insult and tight facial attachments[6]. Other predisposing factors include high velocity injury and older patients on anticoagulation therapy[3,6]. Both open and closed fractures have equal chances of developing acute compartment syndrome[2,4,7,8]. All the four compartments of the leg can be affected in ACS[9], however anterior and lateral compartments are affected frequently because these are the tightest compartments[6,10].

The mechanism in the evolution of ACS includes either a raise in the volume of the compartment or reduced capacity of the compartment[6]. These two processes can occur concurrently or independantly[2,6]. External compression like tight dressings, bandages or casts reduce the size of a compartment[6,11]. In the cases of tibial diaphyseal and other fractures, increased compartment volume is the possible pathophysiology of developing an acute compartment syndrome[10]. Tissue swelling and haematoma formation due to fractures increase the contents of the compartment and there by raise the intra-compartmental pressure leading to reduced tissue perfusion to the muscles, nerves and arteries and subsequent ischemia and tissue necrosis[10].

The symptoms and signs of the compartment syndrome of the leg are pain, paresthesia, paralysis/paresis, pulselessness, and pallor[2,8]. Pain out of proportion to the injury and pain on passive stretching of the foot is known as the classic symptom of ACS of the leg and may be the only symptom present[12,13]. Paraesthesia in the affected extremity indicates hypoxia to nerve tissue within a compartment[2,13]. Increased compartment tightness may be the only objective finding in developing compartment syndrome. Diagnosis of ACS is largely on clinical grounds and it is mandatory to assess the patient repeatedly at different times as ACS is a dynamic process with incremental damage[2,14]. Time to diagnosis is the most important prognostic indicator for these patients. In addition to these clinical findings, there are other methods of varying invasiveness for diagnosis of ACS including compartment pressure measurements, inflammatory biomarkers and imaging techniques[1]. These methods are particularly useful in patients who are non-cooperative with physical examination and unable to provide clear history like children, patients with head injury, the critically ill patients, and patients with prolonged unconsciousness[13]. Non-invasive techniques for determining ICP include near-Infrared spectroscopy (NIRS) which measures the intra-compartmental tissue oxygen levels, ultrasonography like pulsed phase-locked loop(PPLL) and laser Doppler flowmetry which measures microvascular perfusion in the tissues[8,14,15]. Inflammatory markers like white blood cell (WBC) count, creatine kinase (CK) and myoglobin can also be useful in the workup of ACS but cannot specifically indicate compartment syndrome[8,14,15]. The invasive methods include needle manometry, the wick catheter method, the white sides method, and the solid-state transducer intra-compartmental catheter (STC) device[16,17]. In conclusion, whichever technique is used to determine the intra-compartmental pressure (ICP), compartment syndrome should be diagnosed with clinical features in mind to avoid detrimental outcome.

The rationale of the study is that data on compartment syndrome in tibial fracture is scarce and no local data is available. Secondly, the international study is done retrospectively. Therefore, the present study is designed to generate local data, so that appropriate measures could be adopted to diagnose ACS instantly and prompt measures could be taken to salvage the limb.

Subjects and Methods

This is a descriptive cross-sectional study conducted at the department of orthopaedic surgery, Jinnah Postgraduate Medical Centre, Karachi from January 2018 to June 2018. 136 patients with age range between 18 to 45 years of either sex were included in the study with close tibial diaphyseal fractures presenting within 24 hours of injury, with confidence level of 95%, and absolute precision of 4%. Frequency of compartment syndrome was found to be 6%. Technique for sample collection was non-probability consecutive sampling. Patients with chronic renal failure, bleeding disorders, malignancies, and diabetes mellitus (assessed by documented evidence of medical record), and intra-venous drug abusers were excluded from the study.

Patients were considered for study on meeting the inclusion criteria and informed consent was taken from all eligible patients presenting to Orthopaedic emergency department, Jinnah Postgraduate Medical Centre, Karachi. Demographics like patient's age, height, weight, BMI, duration of fracture, smoking status, history of hypertension (protective effect)[3,18], and mechanism of injury were recorded. The patients were examined by the resident for ACS and confirmed by a consultant having more than 2 years post fellowship experience. ACS was labelled as presence of three or more of the following features in patients with Tibial diaphyseal fracture presenting within 24 hours of injury (probability of ACS with three findings 93%)[14,19]. Severe pain: VAS score 7 or more, Paralysis: unable to move limb, Paresthesia: mild or no sensation on pin prick, Pallor: as compared to contrallateral limb, Pulselessness: absence of pulse clinically and in colour Doppler of the affected extremity.

Four compartment fasciotomy was performed once the clinical diagnosis was made. Postoperatively the wounds were managed with split thickness skin grafting between days 3 to 5 depending on wound condition.

Table 1. Comparison of compartment syndrome with age of the patients (n=136)

Age (in years)	Compartment syndrome Yes	No	Total	p-value
35	1 (11.1)	63 (49.6)	64 (47.1)	0.025
>35	8 (88.9)	64 (50.4)	72 (52.9)	
Total	9 (100)	127 (100)	136 (100)	

Table 2. Comparison of compartment syndrome with BMI of the patients (n=136)

BMI (in kg/m^2)	Compartment syndrome Yes	No	Total	p-value
30	8 (88.9)	69 (54.3)	77 (56.6)	0.043
>30	1 (11.1)	58 (45.7)	59 (43.4)	
Total	9 (100)	127 (100)	136 (100)	

Table 3. Comparison of compartment syndrome with duration of fracture (n=136)

Duration of fracture (in hours)	Compartment syndrome Yes	No	Total	p-value
20	3 (33.3)	21 (16.5)	24 (17.6)	0.201
>20	6 (66.7)	106 (83.5)	112 (82.4)	
Total	9 (100)	127 (100)	136 (100)	

Table 4. Compartment syndrome- mechanism of injury (n=136)

Mechanism	Compartment syndrome Yes	No	Total	p-value
MVA	7 (77.8)	59 (46.5)	66 (48.5)	0.069
Falls	2 (22.2)	68 (53.5)	70 (51.5)	
Total	9 (100)	127 (100)	136 (100)	

Data analysis was done on Statistical package for social sciences (SPSS) version 21 for windows. Qualitative variables like gender, smoking status (taking 5 or more cigarettes/day for the last 2 or more years), HTN (documented history of HTN and on treatment), and age of the patient, duration of fracture, height, weight and BMI was presented as mean ± standard deviation. Effect modifiers like age, gender, duration of fracture, BMI, mechanism of injury, Smoking status and HTN was dealt through stratification to see the effect on outcome. Post stratification chi square test/fisher exact test was applied and significance level was set at 0.05.

Results

Average age of the patients ranged between 35.01 ± 9.34 years. Majority of the patients 72 (52.9%) were >35 years of age while 64 (47.1%) patients were ≤35 years of age (Table 1). There were 99 (72.8%) males and 37 (27.2%) females. Mean weight, height and BMI of the patients were 60.11 ± 5.12 kg, 1.53 ± 0.06m and 27.23 ± 5.02kg/m^2 respectively. There were 77(56.6%) patients with BMI <30kg/m^2, whereas 59 (43.4%) patients have BMI >30kg/m^2 (Table 2). Mean duration of fracture was 21.85 ± 1.63 hours. Majority (83.8%) of the patients presented with fracture duration more than 20 hours (Table 3). In 66 (48.5%) patients, the mechanism of injury was motor vehicle accident (high velocity trauma) and in 70 (51.5%) patients, there was a history of fall. Frequency of smoking and HTN was found to be 42 (30.9%) and 56 (41.2%) respectively. Compartment syndrome was found in 9 (6.6%) patients. (Fig 1)

A significant association of compartment syndrome was found withage (p-value 0.025) {eight patients with age group more than 35 years}, BMI of the patients (p-value 0.043) {eight patients had BMI of <30}, gender (p-value 0.669) {six male and three female patients}, duration (p-value 0.201) of fracture, {six patients with duration more than 20 hours}, and mechanism of injury (p-value 0.069) {motor vehicle accident in seven patients}. Smoking status (p-value 0.097) and association of HTN (p-value 0.108) were found to be insignificant.

Discussion

The incidence of compartment syndrome of the leg with tibial shaft fractures in our study is 6.6%. Majority of the patients presented after 20 hours of injury, and the compartment syndrome was more common in these patients. The study revealed predominance of male patients, and the presenting age was more than 35 years in 72 (52.9%) patients. Eight out of nine patients with compartment syndrome had BMI of less than 30. Compartment syndrome was more common in patients with high velocity trauma (77.8%) due to motor vehicle injuries.

Out of all the causes of acute compartment syndrome tibial diaphyseal fractures is the most common cause in about one third of the cases[1,2,3,10]. In an analysis of 164 patients with acute extremity compartment syndrome, fracture of the tibial shaft was the most common cause found in 59 (36%) cases[3]. Soft-tissue injuries of the extremities without fractures were the second common cause of ACS in 38 (23%) patients. Other causes of ACS were fractures of the distal radius, crush injuries, fractures of the shaft of radius and ulna, femoral diaphyseal fractures, and proximal tibia fractures[3]. Meskey et al showed in results that compartment syndrome is more prevalent in proximal tibia and fibula fractures in comparison to diaphyseal or distal fractures[20]. Although it was a larger group study, the mechanism of injury in these patients was gunshot injuries[20]. In the study of Park S21 et al, the rate of compartment syndrome was highest in diaphysis fractures (8.1%) than proximal (1.6%) or distal (1.4%) tibial fractures.

In comparison to older patients, younger patients are three times more prone to develop acute compartment syndrome[3]. McQueen in his study showed the mean age of 32 years in patients with compartment syndrome[3]. In a retrospective cohort study on 414 patients the mean age of the patients

who developed compartment syndrome in tibial fractures was 27.5 +/- 11.7 years[21]. Although our results show preponderance of compartment syndrome in older patients, however the mean age of the patients was just over 35 years. Our results are supported by a prospective study done by Goyal S et al which showed the mean age of the patients with compartment syndrome was 40.3 years[19].

We found in our study the main mode of injury was high velocity trauma due to motor vehicle accidents in seven out of nine patients with compartment syndrome. In a large retrospective study of 938 fractures in 650 patients[20], only the patients with ballistic and gunshot injuries were included. 26 (2.8%) patients developed compartment syndrome and out of these, fractures of the tibia fibula were most commonly associated with compartment syndrome. Branco BC et al in their study showed gunshot injuries as the most common mode of injury in patients of compartment syndrome followed by sharp injuries and motor vehicle accidents[22].

ACS is more common in males than female patients with tibial diaphyseal fractures[3,4,22]. In a retrospective cohort study of 1407 patients, majority were male patients diagnosed with acute compartment syndrome supporting our data[23].

Although hypertension has protective effect on the development of ACS[3], in our study no association was found in this regard. Our results showed that ACS is more common in patients with BMI less than 30, however literature is sparse in this regard and reason is not well known.

Four compartment fasciotomy was performed in all patients once the diagnosis was confirmed on clinical examination in our study. Split thickness skin grafting was performed in all patients from day 3 to 5 after fasciotomy depending on the wound condition. Patients recovered well without significant morbidities.

The surgical technique varies with the surgeon's preference and skills and the condition of the patient[24]. Whatever method is used, the aim is to achieve release of all four compartments of the leg. The surgical incisions should be left open instead of primary closure, and dressed with aseptic measures in order to avoid recurrence of acute compartment syndrome[25].

≤ Functional outcomes are better when surgical release of the affected compartment is done early with developing acute extremity compartment syndrome, although assessment of the exact time of onset is often difficult. Studies suggest that if the fasciotomy is delayed for more than 12 hours, chances of infection and other complications are increased[26]. Many patients have sufficient damage by the time of fasciotomy release.

Limitations of our study were that we did not include all the fractures including proximal and distal tibia fractures so that we can determine and compare the incidence of compartment syndrome in all tibia fractures.

Conclusion

Compartment syndrome is a surgical emergency which needs timely diagnosis and immediate decompression to avoid complications including limb loss.

Conflict of Interest

Authors have no conflict of interest and no grant/funding from any organisation.

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