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Frequency of Acute Compartment Syndrome in Closed Fractures of the Limbs

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1. Abstract

Acute compartment syndrome is a surgical emergency requiring in time management otherwise complications which may lead sever discomfort or to loss of limb can occur. In a study it has been found that acute compartment syndrome is present in 87 (7.73 %) of all tibial diaphyseal fractures with no significant difference in incidence of acute compartment syndrome in type of fractures. Result of this study can be used to find the magnitude of this emergency condition in patient with fracture and the pre planning for such condition.

1.1. Objective: To find out the frequency of acute compartment syndrome in patient with closed limb bone fracture.

1.2. Material and Methods: This is a Descriptive Case Series that has been done in the Department of Orthopedics and Trauma, Medical Teaching Institute Lady Reading Hospital Peshawar KP Pakistan from Aug, 2020 to Feb, 2021 on 194 patients. After detecting the patient with closed limb bone fracture, any symptoms related to compartment syndrome were observed and patient were labeled as yes/no for presence of acute compartment syndrome.

1.3. Results: In this study, 194 patients with closed fracture were included. Male to female ratio was 1.71:1. Acute compartment syndrome have been observed in 19(9.79%) cases.

1.4. Conclusion: Acute compartment syndrome is high in patients with closed fracture. Large and multi center studies are recommended to evaluate further.

2. Introduction

In modern era, where there is fast travelling system than even before, the fracture of bone become more prevalent. The worldwide annual femoral shaft fracture incidence from road traffic collisions was between and 2.9 million [1]. And about 16.7% of the RTA has upper extremity fractures [2]. A study in Pakistan showed that 93.4% of the tibial shaft fracture were male and only 6.6% were females [3].

Fracture of the bone may be open in which fracturing bone is visible to the exterior or close fracture in which the skin is intact and bone fracture is visible on radiograph. Close fracture is most commonly associated with internal injury like nerves or other internal tissue [4]. Thus, can cause a condition known as compartment syndrome. 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 [5].

In a study it has been found that acute compartment syndrome is present in 87 (7.73 %) of all tibial diaphyseal fractures with no significant difference in incidence of acute compartment syndrome in type of fractures [6]. In a closed tibial shaft fracture the acute compartment syndrome was found in 6.6% patients in 24 hours of fractures with a significant association of age (p-value 0.025), and BMI (p-value 0.043) of the patients [7].

Acute compartment syndrome is a surgical emergency requiring in time management otherwise complications which may lead sever discomfort or to loss of limb can occur. And if the diagnosis is delayed due some reason or treatment is not ensued within due time, it can lead to compression of other vital structures like muscles, nerves, and vessels in a close facial compartment which is attributed to high morbidity and mortality [5, 8]. There is less literature

available on the subject in Pakistan.

The rationale of this study is to find out the frequency of compartment syndrome in patients with closed fractures of the long bones of limbs as the very limited available local data is not enough to fulfill the statistical and research purpose. Result of this study can be used to predict the frequency of this emergency condition in patient with fracture and the pre planning for such condition. Also the condition like close monitoring or change in the management level of the close fracture can be consider after the result of this study. Furthermore, the result will be shared with other local clinicians for record and knowledge.

3. Material and Methods

This is a Descriptive Case Series that has been done in the Department of Orthopedics and Trauma, Medical Teaching Institute Lady Reading Hospital Peshawar KP Pakistan from Aug, 2020 to Feb, 2021 on 194 patients with non probability sampling. After detecting the patient with closed limb bone fracture, any symptoms related to compartment syndrome were observed and patient were labeled as yes/no for presence of acute compartment syndrome.

Frequency of acute compartment syndrome in closed fractured is 6.6%7 and with 3.5% absolute precision and with 95% confident interval with using WHO formula, sample size was 194 closed fractured patients.

All those patients who were presenting to orthopedic department for management of closed fracture within 24 hours, Closed diaphysial fractures (spiral, oblique, transverse) of upper limb or lower limb long bones like, humerous, radius, ulna, femur, tibia, fibula of the patient with age range 15 to 60 years of either sex that has given written informed consent were included in the effected limb will be taken to confirm the diagnosis and patient were managed as per hospital protocol. Data like, age, gender, weight (were measure when patient has wear light clothes only with no added clothes like sweater etc. and bare feet, if patient cannot stand then net weight of the patient's bed with and without the patient were taken manually available weight machines.) and height (height was measure by inches tap from the heel of the patient to the end of head) was taken. BMI (weight/height²) was calculated. The bone fracture was noted. If patient has previous history of diabetes or hypertension it was noted. And patient was followed for 24 hours from the injury. Any symptoms related to compartment syndrome as mention in the operational definition was observed and patient was labeled as yes/no for presence of acute compartment syndrome. All the data were collected by the researcher himself then it was noted in the proforma.

3.1. Data Analysis

SPSS version 22 were used for data analyses. Descriptive statistics for presenting mean and standard deviation were used for the

quantitative variable like age of the patient, weight, height and BMI. Frequency with percentage were calculated for qualitative variable like gender, specific bone fractures, cause of fracture, diabetes (known medical documented history of diabetes and use medication for it), hypertension (known medical documented history of hypertension and use medication for it), type of reduction done (open or close) and presence or absence of acute compartment syndrome. Effect modifier factors like age, BMI, diabetes, hypertension, specific bone fracture, type of reduction (open/close) and cause of fracture were stratified against the presence of acute compartment syndrome. Post stratification chi square test was applied and p value ≤ 0.05 was taken significant. All the results were presented with help of table and diagrams.

4. Results

In this study, 194 patients who are presenting to orthopedic department for management of closed fracture, in which 123(63.40%) were male and 71(36.60%) were female patients. Male to female ratio was 1.71:1 (Figure 1).

Patient's age was divided in four categories, out of which most common age group was 21–35 years. Forty five (23.2%) patients were in the age range of less than or equal to 20 years, 102 (52.6%) were of age range 21-35 years, 31(16%) presented at age 36-50 years while 16(8.2%) belongs to more than 50 years of age. The study included age ranged from 15 up to 60 years. Average age was 29.52years +11.38SD (Table 1). Acute compartment syndrome have been observed in 19(9.79%)while the remaining 175(90.21%) have not acute compartment syndrome (Figure 2). Cause of bone fracture has been observed and found that road traffic accident was the leading cause followed by other while fall/trauma was observed in 31(15.98%) of patients (Figure 3).

Age wise distribution of acute compartment syndrome shows that acute compartment syndrome was high in older age group but it was insignificant with p-value=0.233. Six (19.4%) acute compartment syndrome was found in patients have 36-50 years of age followed by 12.5% recurrence in age group of more than 50 years of age (Table 2).

Stratification of diabetes mellitus, hypertension and smoking over acute compartment syndrome shows that it was acute compartment syndrome was high but insignificant using chi square test (Table 3).

Stratification of over cause of bone fracture shows significant role over acute compartment syndrome while site of Gender, fracture, reduction and ASA class shows insignificance in our study (Table 4).

Specific bone fracture and BMI wise distribution shows that acute compartment syndrome has no such role over it. Mean of BMI was observed 26.4kg/m²+3.8SD (Table 5).

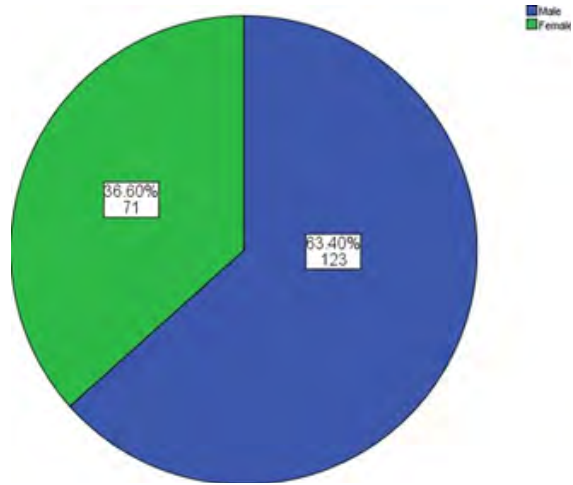


Figure 1: Gender distribution

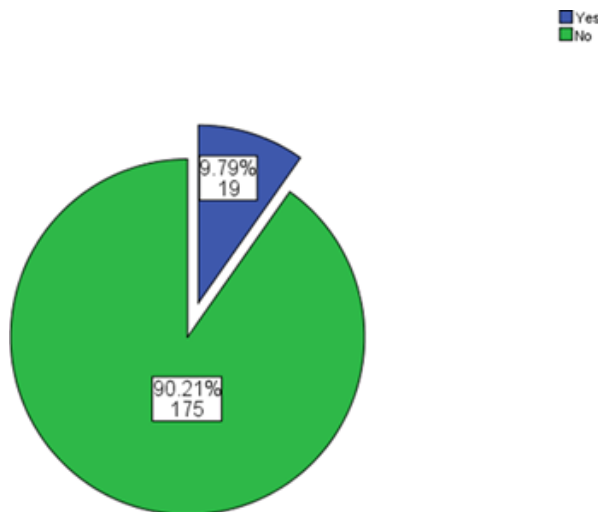


Figure 2: Distribution of acute compartment syndrome

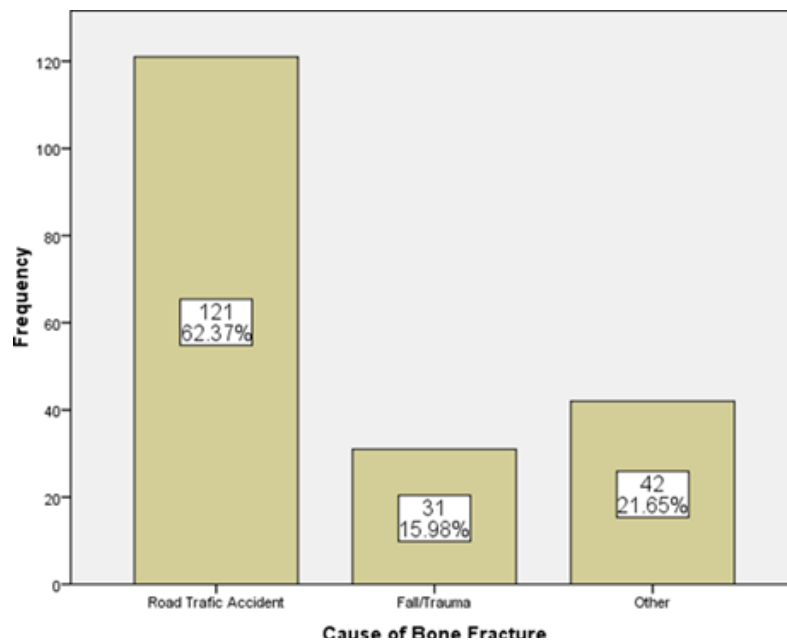


Figure 3: Distribution of causes of bone fracture

Table 1: Age wise distribution

	Frequency	Percent	Mean+SD
<= 20.00	45	23.2	29.52years +11.38
21.00 - 35.00	102	52.6	
36.00 - 50.00	31	16	
≥51.00	16	8.2	
Total	194	100	

Table 2: Age wise distribution of acute compartment syndrome

		Acute Compartment Syndrome		Total	p-value
		Yes	No		
age (in years)	<= 20.00	3(6.7%)	42(93.3%)	45(100.0%)	0.233
	21.00 - 35.00	8(7.8%)	94(92.2%)	102(100.0%)	
	36.00 - 50.00	6(19.4%)	25(80.6%)	31(100.0%)	
	51.00+	2(12.5%)	14(87.5%)	16(100.0%)	
Total		19(9.8%)	175(90.2%)	194(100.0%)	

Table 3: Comorbidity and smoking wise distribution of acute compartment syndrome

		Acute Compartment Syndrome		Total	p-value
		Yes	No		
Diabetes Mellitus	Yes	6(17.1%)	29(82.9%)	35(18.04%)	0.106
	No	13(8.2%)	146(91.8%)	159(81.96%)	
Hypertension	Yes	2(15.4%)	11(84.6%)	13(6.7%)	0.483
	No	17(9.4%)	164(90.6%)	181(93.3%)	
Smoking	Yes	8(11.4%)	62(88.6%)	70(36.1%)	0.565
	No	11(8.9%)	113(91.1%)	124(63.9%)	
Duration of Fracture (in hour)	<= 5.00	18(9.6%)	169(90.4%)	187(96.4%)	0.684
	>5.01	1(14.3%)	6(85.7%)	7(3.6%)	

Table 4: Stratification over site of fracture, ASA class, cause of bone fracture and reduction

		Acute Compartment Syndrome		Total	p-value
		Yes	No		
Gender	Male	12(9.8%)	111(90.2%)	123(63.4%)	0.981
	Female	7(9.9%)	64(90.1%)	71(36.6%)	
ASA Class	ASA I	14(12.2%)	101(87.8%)	115(59.3%)	0.178
	ASA II	5(6.3%)	74(93.7%)	79(40.7%)	
Cause of Bone Fracture	Road Traffic Accident	6(5.0%)	115(95.0%)	121(62.4%)	0.002
	Fall/Trauma	3(9.7%)	28(90.3%)	31(15.4%)	
	Other	10(23.8%)	32(76.2%)	42(21.6%)	
Site of Fracture	Right	16(11.5%)	123(88.5%)	139(71.6%)	0.201
	Left	3(5.5%)	52(94.5%)	55(28.4%)	
Reduction	Open reduction	16(11.3%)	125(88.7%)	141(72.7%)	0.235
	Closed reduction	3(5.7%)	50(94.3%)	53(27.3%)	

Table 5: Stratification over specific bone fracture and BMI

		Acute Compartment Syndrome		Total	P-Value
		Yes	No		
Specific Bone Fracture	Humerus	5(11.36%)	39(88.64%)	44(22.7%)	0.467
	Radius	4(8.89%)	41(91.11%)	45(23.2%)	
	Ulna	3(15%)	17(85%)	20(10.3%)	
	Femur	2(5.1%)	41(94.9%)	43(22.2%)	
	Tibia	5(12.8%)	37(87.2%)	42(21.6%)	
	Fibula	0(0.00%)	0(0.00%)	0(0.00%)	
BMI(Kg/m2)	<25kg/m2	6(8.8%)	62(91.2%)	68(35.1)	0.476
	>=25Kg/m2	13(10.3%)	113(89.7%)	126(64.9%)	

5. Discussion

The fascial membranes in the human limbs divide the muscle groups within the limbs into sections or compartments⁹. The compromised circulation and tissue functions as a result of the increased pressure are the main underlying mechanism of the compartment syndrome [9-10]. Accordingly, this decreased perfusion will lead to a surgical emergency called Acute compartment syndrome (ACS) [11, 12]. The estimated ACS incidence per 100,000 individuals is 0.7 to 7.3 [13].

Iatrogenic interruption of venous flow, such as when harvesting the superficial femoral vein for use as a conduit for arterial reconstruction, is associated with the development of CS in 17.8% of limbs [14]. Reported incidence rates of ACS in the treatment of tibial shaft fractures range from 3 to 11.5% and seem to be stable over the past decades [15].

Our results fall within this range. In this aspect, our study population represents a rather usual cohort of tibial shaft fracture patients. Some ACS developed during or after surgery (external or definitive internal fixation) and the surgical procedure may therefore be partly responsible for these occurrences. However, we believe that surgery only represents an aggravating factor, and that the initial fracture with soft tissue injury is the primary factor for the occurrence of ACS. Indeed, after the initial injury, there may be a certain period of soft tissue vulnerability to further surgical aggression, as recently postulated [16].

Young age is the most consistently observed independent predictor of ACS occurrence throughout the literature [15-17]. The reasons for ACS occurring more often in younger individuals are thought to be that younger patients tend to have bulkier muscle and thicker, less yielding fasciae [17].

Various risk factors are related to compartment syndrome and age is one of the important factors. Younger patients are more prone to get ACS as compared to elderly patients with the same nature of trauma [18]. Another risk factor is the type and site of injury.

Closed tibial shaft fracture is the most common cause of compartment syndrome and is comprised of one- third of all cases of ACS. One-fourth of the cases result from blunt and crushed soft tissue limb trauma while radius ulna shaft fractures are responsible for 20 percent of the cases. Foot injuries in road traffic accidents account for 6% of all cases of ACS [19], while the incidence is even lesser in lower leg injuries¹⁹. Revascularization after acute arterial injury or obstruction can also result in ACS; hence in most of cases patients need fasciotomy after revascularization [19]. Males are more prone to develop ACS which is ten times higher than females. Incidence of ACS in open and closed fractures is equal. Other less common causes of traumatic ACS include burns and blunt or crushing trauma to the limb. ACS can develop by poor positioning of legs in prolonged surgical procedures, particularly lithotomy position [20].

There are several conditions that increase the volume of compartmental contents. Several series have demonstrated that fractures are the most common cause of ACS, accounting for as much as 69% of cases [21-22]. Fractures of the tibial shaft occur most commonly, followed by distal radius and ulna fractures. Tissue swelling and hematoma formation secondary to the fracture are possible mechanisms by which ICP is elevated after a fracture [22]. Importantly, there is no difference between the ICPs of open and closed fractures meaning that all types of fractures need to be carefully monitored for signs of ACS [23]. This significant finding dispels traditional teaching that open fractures naturally decompress and may not be as prone to compartment syndrome as closed fractures. The small, transverse fascial tears that usually result from open fractures do not adequately decompress the compartment [24].

6. Conclusion

ACS is a surgical emergency caused by increased intracompartmental pressure that can cause significant morbidity and mortality. A combination of different clinical fractures along with measuring intracompartmental pressure is needed to avoid delayed and misdiagnosis. Prompt and appropriate management is the key factor in maintaining limb function and avoiding further complications.

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