TIBIAL DIAPHYSEAL FRACTURES: AETIOLOGY, MORPHOLOGY AND TREATMENT IN ADULT PATIENTS AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA

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ABSTRACT

Background: Tibial Diaphyseal Fractures (TDFs) arise from various forms of trauma and assume different patterns. They are responsible for high morbidity and mortality.
Objective: To describe the mechanism of injury, morphology and treatment methods of tibial diaphyseal fractures in adult patients at Moi Teaching and Referral Hospital, Eldoret, Kenya.
Methods: A descriptive prospective study on 89 adult patients with tibia shaft fractures. An interviewer-administered questionnaire was used to collect data. Association between categorical variables was assessed using Pearson's Chi Square test.
Results: The median age was 28.0 years (IQR: 24.0-40.0) with a male to female ratio of 3.2:1. Most of the TDF (67.4%) were due to Road Traffic Accidents (RTAs); fall 16 (18.0%) and the least, gunshot 3 (3.4%). Up to 40.9% of the fractures were open type while (59.1%) were closed. Middle 1/3 tibia shaft was the commonest site of fracture at 52.7%. Fibula fracture was the most associated injury at 62.9%. Operative management was done in 61.6%.
Conclusion: Road Traffic Accidents were the major cause of TDF with motorcycles injuries leading. Most TDF were closed type; mainly at mid third level. Fibular fractures were the most associated injuries. Treatment of TDF was mainly surgical using locked intramedullary nail.

Key words: Tibia Diaphyseal Fractures (TDFs), Road Traffic Accidents (RTAs), Motor Vehicular Accident (MVA)

INTRODUCTION

Tibial Diaphyseal Fractures (TDFs) are among the most common long bone fracture encountered by the orthopaedic surgeon (1). They are often difficult to manage especially in resource constrained settings (2). In developing world, non-operative treatment of tibial fractures has been, and in some centers, is still the mainstay mode of treatment.

The tibia bone has a subcutaneously located anteromedial surface with very little soft tissue coverage. As such, this makes it susceptible to severe bone and soft tissue injury as may be the case in high energy trauma. Moreover, the tibia bone records high levels of open fractures compared with other long bones and these are extremely challenging to treat. These injuries are different and vary in their presentation, and their outcomes are unpredictable (3).

The mechanism of injury in TDFs can be direct or indirect (2). Direct mechanisms of injury are often high-energy fractures (road traffic accidents), penetrating injuries, and 3-point bending injuries. High-energy mechanisms produce transverse or comminuted displaced diaphyseal injuries. These have higher incidence of bone exposure and soft-tissue injury. In Kenya, injuries to motorcyclists are increasing at an annual rate of approximately 29% with Road Traffic Accidents (RTAs) responsible in 49.5% of cases reported (4, 5). Indirect mechanisms are mainly torsional, low-energy injuries. The resulting fracture morphology is mainly spiral, non-displaced, minimally comminuted fractures with little or no soft-tissue damage.

MATERIALS AND METHODS

This prospective descriptive study was done at the Moi Teaching and Referral Hospital, Eldoret, Kenya. Adult patients with TDFs referred or seeking treatment at MTRH, and who met the inclusion criteria and consented for the study were recruited. Patients with tibia shaft fracture treated elsewhere but followed up at MTRH, and those who did not complete treatment at MTRH for whatever reason were excluded.

A total of 89 participants with 93 TDFs were recruited. Interviewer administered questionnaires were used for data collection. It contained information on patient's socio-demographic factors, occupation, detailed mechanism of injury, age of the injury, and whether the patient was primarily seeking treatment

or referred from another facility. Morphological classification of the fracture was also documented as discerned from the radiological investigation and clinical evaluation. Type and nature of any associated injury(s) was also documented.

Institutional research and ethics approval was obtained prior to starting the study. Informed consent was sought from all eligible patients in a language that they fully understood and his/her written consent sought. Any risks or benefits accrued to the research were explained to each participant. This was voluntary participation and no patient was denied treatment whether he/she gave consent or not. Utmost confidentiality with regards to the participants was assured. The participants had the leeway to withdraw from the study at any stage even after consenting and this did not affect their medical care.

RESULTS

A total of 89 participants with 93 TDFs were recruited. Over half of the participants were attended to first at MTRH after injury while 41 (46.1%) were referrals.

In terms of the affected limb, 4(4.5%) participants had bilateral injury, 33 (37.1%) participants left leg while 52 (58.4%) had the right leg affected.

Table 1

Socio-demographic characteristics

Variable	Sample size	No. (%) or Median (IQR)
Age (years)		28.0 (24.0, 40.0)
Male	89	68 (76.4)
Female	89	21 (23.6)

Table 1 shows the social demographic characteristics of the patients studied. Median age was 28.0 (IQR: 24.0-40.0) years with a minimum and maximum of 18 and 75 years respectively. Over three quarters of the patients (75.3%) were 40 years and below aged. Male participants comprised more than three quarters of those recruited with a male to female ratio of 3.2:1

Table 2

Aetiological mechanisms of injury

Variable	Sample size	No. (%)
Degree of injury		
High energy	89	69 (77.5)
Low energy		20 (22.5%)
Mechanism		
RTAs		60 (67.4)
Fall		16 (18.0)
Direct blows/ assault		6 (6.7)
Sports	89	4 (4.5)
Gunshot		3 (3.4)

Over three quarters of the participants, 69 (77.5%) sustained high energy injury. The specific injuries show that two thirds of the participants 60 (67.4%) sustained injuries due to RTAs. Those who sustained injuries due to falls comprised 16 (18.0%). Three (3.4%) had gunshot injuries, 4 (4.5%) had sports related injuries and 6 (6.7%) were injured as a result of assault or direct blows.

Table 3

Association between the degree of injury and the mechanism of injury

	Degree of injury		
Mechanism	High energy	Low energy	P-value
Direct blows/assault	5 (7.2%)	1 (5.0%)	1.000[f]
Fall	3 (4.3%)	13 (65.0%)	<0.0001[f]
Gunshot	3 (4.3%)	0 (0.0%)	1.000[f]
RTAs	57 (82.6%)	3 (15.0%)	<0.0001
Sports	1 (1.4%)	3 (15.0%)	0.034[f]
Overall	69 (100%)	20 (100%)	

A significantly higher proportion of those who had low energy injuries were due to falls, 13 (65.0%) vs. (3 (4.3%), p<0.0001. A significantly higher proportion of those who had high energy injuries were due to RTAs, 57 (82.6%) vs. 3 (15.0%), p<0.0001. Sport injuries were also associated with low energy mechanism of injury, p=0.034.

Table 4

Fracture morphology

Variable		Open	Closed	No. (%)
Levels	Mid 1/3	16	33	49 (52.7)
	lower 1/3	14	13	27 (29.0)
	Upper 1/3	8	9	17 (18.3)
Total		38 (40.9)	55 (59.1)	93 (100)

Up to 40.9% of the fractures were open while 59.1% were closed type. Slightly more than half of fractures were in the mid 1/3 level while 29% of them were in the lower 1/3 and 18.3% had an upper 1/3 fracture level respectively.

Table 5

Correlation between age and level of the fracture

		Age (years)		Fisher's Exact test P-value
		≤40	>40	
Level of fracture	Lower 1/3	22 (31.0%)	5 (22.7%)	0.720
	Mid 1/3	37 (52.1%)	12 (54.5%)	
	Upper 1/3	12 (16.9%)	5 (22.7%)	

There was no association between the age of the participants and the level of fracture, *p = 0.720.*

Table 6

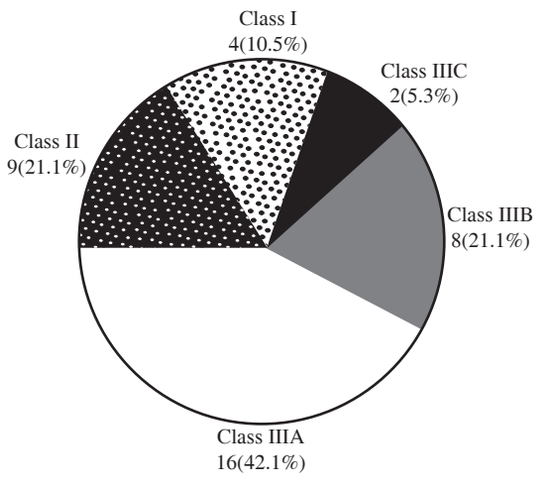
Orthopaedic Trauma Association fracture classification

OTA classification	Sub-groups	Open	Closed	No. (%)
Unifocal-A Type	Spiral	3	7	10 (10.7)
	Oblique	4	17	21 (22.6)
	Transverse	4	9	13 (14.0)
Wedge-B Type	Intact spiral wedge	2	2	4 (4.3)
	Intact bending wedge	6	4	10 (10.7)
	Comminuted wedge	2	8	10 (10.7)
Complex-C Type	Spiral wedge	4	4	8 (8.6)
	Segmental	6	3	9 (9.7)
	Comminuted	7	1	8 (8.6)

Overall, type A fractures were the most common comprising 47.3% while type B and C recorded almost similar numbers. However, among open fractures, type C patterns were the most common at 44.7% of open fractures. Notable among type C open fractures, comminuted ones recorded the highest number. In closed fractures, type A were the most common at 60% with the oblique subtype recording the highest number.

Figure 1

Gustilo classes among open fractures types



Majority of the open fractures were in Gustilo class IIIA at 42.1% followed by class II and IIIB at 21.1%. The least were in class IIIC.

Table 7

Associated injuries

Injury (n=89)	No. (%)
Fibula	56 (62.9)
Upper limb	15 (16.9)
Femur	14 (15.7)
Head	12 (13.5)
Ankle	11 (12.4)
Chest	5 (5.6)
Knee	4 (4.5)
Pelvis	3 (3.4)
Foot	2 (2.2)
Abdomen	2 (2.2)

Assessment of the associated injuries revealed that there were 56 (62.9%) participants with an associated fibula injury followed by upper limb at 15 (16.9%), and femur at 14 (15.7%). The least associated injuries involved both the foot and abdomen at 2 (2.2%).

Table 8

Treatment methods

Variable (N=89)		No. (%)
Patient category		
	Inpatient	58 (65.2)
	Outpatient	31 (34.8)
Non-operative		
	Casting	34 (38.4)
Operative-	Unilateral leg fractures	
	Amputation	4 (4.5)
	Debridement + Casting	4 (4.5)
	Debridement + IM nailing	18 (20.2)
	IM Nailing	18 (20.2)
	Debridement+ External fixator	5 (5.6)
	IM Nailing + Plating	1 (1.1)
	Plating	1 (1.1)
Operative-	Bilateral legs fractures	
	Debridement + IM nailing, Debridement+ External fixator	2 (2.2)
	IM Nailing, Debridement+ External Fixator	1 (1.1)
	Debridement + IM nailing, Amputation	1(1.1)

Over half of the participants were admitted into the wards. Casting was done to all the participants treated as outpatients. Of those who underwent operative treatment, majority 43% were treated using IM nailing with more than half undergoing debridement before nailing. Plating was the least used modality of treatment at 1.1% (Table 8).

DISCUSSION

In this study majority of the participants were young. Male participants were dominant with a male to female ratio of 3.2:1. This concurs with a study in Edinburg which reported a closely similar ration of 3.42:1 (6). However, in a study by Irfanullah *et al* (8), 2013 in Lahore Pakistan, a male to female ratio of 7.3:1 was reported with age range of 17-60 years. The same study reported many participants at 40 years and below at 72%. Male domination may be reflective of a society where the male is largely the provider to the family thus takes more risks in his economic quest. Younger age domination may be explained by the fact that this is the most productive age group in the population and with huge risk appetite thus likely to encounter situations leading to injuries such as TDF.

The specific injuries showed that majority of the injuries were due to RTAs. A similar study in India reported similar findings with MVAs (motorcycle, automobiles, bicycle and overruns) as the most frequent cause of TDFs at 65% and falls at 16.7% (8). A study in Edinburg on the other hand reported RTAs contribution to TDFs at 37.5% (6). The high contribution by RTA, in our setup may be explained by recklessness by motorists and inconsistencies in the enforcement of traffic laws. Considerable numbers of unroadworthy vehicles and unqualified drivers may also partly explain the situation. Another possibility is that many passengers may fail to raise their voices in the face of carelessly driven public service vehicles only doing so when an RTA has occurred.

A higher proportion of RTA related injuries involved motorcycles. This compares well with a study in Uganda where motorcycles contributed 73% of the trauma patients (9). A study in Nigeria by Ibeanusi *et al* (11), looked at the epidemiology of open tibial fractures in a teaching hospital reported that road accident constituted most of the injuries (91.4%), of which 51.5% were motorcycle related. In contrast, the Edinburg study reported 22.4% contribution by motorcycles in TDFs (6). High contribution by motorcycles to these injuries may be explained by increased number of motorcycles on our roads for commercial use without provision of cycle lanes. Also partly may be due to their affordability, quick and ease of accessibility as a means of transport and poor regulation of their use. Moreover, most of the cyclists may be poorly trained with some not licensed as riders. In addition, there's a likelihood that many cyclists inconsistently put on reflective jackets especially at night hence may easily be knocked down by other road users.

A study in Uganda found out that majority of the fractures were in the lower limb with the leg being more involved (9). Another study in western Kenya reported that tibia fibular fractures predominated at 29.3% of the all motorcycle injuries (12). This may be explained by the fact that the lower limbs are relatively exposed with the leg dangling dangerously as the motorcycle weaves through traffic.

The study showed that close to two thirds of RTA injuries involved pedestrians knocked by cars, cyclists and pillions. Toro *et al* (13) in 2005 reported that likelihood of sustaining lower limb fractures is higher in cyclists and pedestrians due to the impact on the lower limbs by car bumpers.

From this present study, closed fractures were slightly more than open fractures with more than half of fractures occurring in the mid 1/3 level. A study in India reported similar findings with closed fractures at 65% and open type at 35%. However lower 1/3 level was the most affected at 49.2% (9). However, a study that was exclusively looking at motorcycle injury patterns at a county referral hospital in Kenya reported 75% tibia fractures were closed (10). Similarly in the Edinburg series reported 77% of tibial diaphyseal fractures being closed, while 60% of open fractures were type III. Tscherne Grade1 fractures comprised 53% in closed fractures (7). The relatively higher proportion of open fractures in this study may be attributed to RTAs especially motorcycles being the major cause of injuries which in essence are high energy mechanism. Also the relatively superficial anteromedial border of the tibia bone leaves it poorly cushioned by soft tissues hence likely to lead to open fractures.

This study found out that majority of the participants had an associated fibula injury. This is similar to the study in India which reported 55% associated fibula injury (9). However the Edinburgh study reported associated fibula fracture in 77.7% of tibia diaphyseal fractures which was slightly higher than reported in this study (6). Depending on the level of the fibula fracture, this may have an implication on the outcome of treatment of TDFs based on whether the fibula fracture is fixed or not. The level of fibula fracture also helps determine the energy magnitude of the fracture. The high proportion of associated fibula

fracture in this study may be due to majority fractures arose from high energy injury mechanisms. The fibular bone is anatomically located in juxtaposition with the tibia and absorbs the same forces deforming the tibia during injury hence the association.

Majority of the patients in the study were managed as inpatients despite many of the fractures being closed. This is explained by severe associated injuries some of which warranted inpatient observation and or treatment. Partly contributing may be the severe and displaced fractures requiring inpatient operative treatment.

Operative management was the most common approach used for TDFs in this study accounting for 61.6% with locked intramedullary nailing being popularly used. This compared will with the study in India which reported 51.7% of the patients being managed operatively (9). Other studies (14,15) have reported that locked intramedullary have shown lower rates of nonunion and malunion as compared to the other methods of fixation.

CONCLUSIONS

Majority of the participants were relatively young with the males being more affected. Road Traffic Accidents (RTAs) especially motorcycle injuries were the major cause of Tibial Diaphyseal Fractures (TDFs). Most of the TDFs were closed type; mainly type A with mid third being the most affected level. Fibular fracture was the most common associated injury. Treatment of TDFs was mainly surgical using locked intramedullary nail.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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