CHARACTERISTICS OF MOTORCYCLE RELATED FEMORAL SHAFT FRACTURES AND DIRECT COST AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET.

MUKWA SAMUEL NABISWA

Thesis submitted in partial fulfillment of requirement for the award of the degree of master of medicine (Orthopaedic Surgery) of Moi University.

DECLARATION

Declaration by the author

This thesis is author's original work and has not been presented for a degree in any other university. No part of this thesis may be reproduced without prior written permission of the author and or Moi University.

MUKWA SAMUEL NABISWA

SM/PGORT/07/14

SIGN ………………………..……… DATE ……………………………

Declaration by supervisors

This thesis has been submitted for examination with our approval as Moi University supervisors.

DR. LELEI L. KIBOR

Consultant Orthopedic Surgeon and Senior Lecturer,

Moi University, School of Medicine, Eldoret

SIGN: ……………………………. DATE: ……………………………..

DR. ONGARO NEFORD

Consultant Orthopedic Surgeon and Honorary Lecturer,

Moi Teaching and Referral Hospital, Eldoret, Kenya

SIGN: …………………………….. DATE: …………………………….

DR. BARGORIA VICTOR

Consultant Orthopedic Surgeon and Honorary Lecturer,

Moi Teaching and Referral Hospital, Eldoret, Kenya

SIGN: …………………………….. DATE: ……………………………

DEDICATION

The author dedicates this research work to the loving family members for their endless support, and the public for the awareness of the burden of management of fracture shaft femur.

ACKNOWLEDGEMENTS

The author's sincere gratitude to Almighty God, the supervisors Dr. Lelei Kibor, Dr. Ongaro Neford and Dr. Bargoria Victor for their guidance in the thesis development. The author is grateful to the IREC proposal reviewers, the Principal College of Health Sciences, the Dean School of Medicine, the Department of Orthopaedic and Rehabilitation, colleagues and family members for their support. The author passes appreciation to Ngeresa Anthony and Keter Alfred (Biostasticians) for the input on the methodology as well as all the records officers and the dedicated research assistant. The author acknowledges the research patients.

ABSTRACT

Background: Femoral shaft fractures have been attributed to high energy mechanism mainly resulting from road traffic accidents and have been associated with high morbidity and mortality. Recently in Kenya there has been an increase in the use of motorcycles as a means of transport and form of employment among the youths; however motorcycle accidents have been on the rise causing severe injuries and fatalities to the riders, passengers and pedestrians. Previously the use of non-operative treatment methods in the management of femoral shaft fractures was associated with adverse complications but currently the use of surgical implants has resulted in reduction of length of hospital stay, early mobilization, healing and return to premorbid state with minimal complications. Locally there is insufficient published data of femur shaft fractures resulting from motorcycle accident with the cost of patient care.

Objective: To determine the characteristics of motorcycle related femoral shaft fractures and direct cost to patient care at MTRH.

Methods: The descriptive prospective study design was used. Study population were patients who sustained femoral shaft fractures as a result of a motorcycle crash managed at MTRH between January 2016 to December 2016. One hundred and forty-two patients were consecutively sampled after meeting inclusion criteria. The data captured by structured questionnaire after consent included patients' demographic characteristics, fracture pattern based on Arbeitsgemeinschaft fűr Osteosynthesefragen classification (simple, wedge, complex), associated injuries, duration of hospital stay and direct medical costs. Data was analyzed using Statistical Analysis System software version 9.1. Associations between categorical variables were assessed using Pearson's chi square test. Results were presented using tables and figures.

Results: A total 112 males and 30 females were recruited with a mean age of 32 years. Forty-two percent (42%) had primary school education as their highest level of education attained. Seventy-four percent (74%) engaged in informal employment. Passengers (48%) were most affected, riders made up to 40% whereas 12% were pedestrians. Fifty-six percent (56%) had fractures of the right femur with none of the patients having bilateral. Apart from the femur fractures, 15% of associated injuries were in the lower limbs. Fifty-eight percent (58%) of the injuries resulted from motorcycle versus motor vehicle collision, 16% motorcycle versus pedestrians and the rest were motorcycle versus motorcycle and lone accidents. Closed fractures (82.39%) were commonest injuries. Simple type A fracture pattern (74.63%) were majority. All patients underwent operative treatment with 92.96% using locked intramedullary nail, 7.04% used external fixator and 2.82% had an external fixator that was later changed to an intramedullary nail. Mean time to surgery was 9 days (1-31). The average length of hospital stay was 18 days (2 - 120). The average direct medical cost for care amounted to Ksh. 74,142/=

Conclusion: Characteristics of femur shaft fractures as a result of motorcycle crash at MTRH were similar to other studies; however, the cost of care was higher.

Recommendation: Emphasis on road safety to all road users, targeting shortening hospital stay through subsidizing implant fee and steady supply, prompt provision of operative treatment, health insurance sensitization to the public. Further study with long term follow-up to ascertain the total burden of the fracture.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

AO	Arbeitsgemeinschaft fűr Osteosynthesefragen (German)
AP	Antero-posterior
ASIF	Association for the Study of Internal Fixation (A.O – English Translation)
Cm	Centimeter
CT Scan	computerized tomography Scan
IREC	Institution Research and Ethics Committee
KNH	Kenyatta National Hospital
KSh.	Kenya Shilling
Mm	Millimeter
MRI	Magnetic Resonance Imaging
MTRH	Moi Teaching and Referral Hospital
NTSA	National Transport and Safety Authority
OTA	Orthopaedic Trauma Association
RTA	Road Traffic Accident
SAS	Statistical Analysis System
SD	Standard deviation
SIGN	Surgical Implant Generation Network
USD	United States Dollar
WHO	World Health Organization

OPERATIONAL DEFINITION OF VARIABLES AND KEY CONCEPTS

Direct Cost: The total medical bill that can be attributed to provision of the following services: Drugs, Radiographs, Laboratory investigations, Theatre fee, Physiotherapy as in patient, implant cost and Daily bed charges.

Femoral shaft: Region within the femur bone situated between 5cm distal to lesser trochanter and 6cm proximal to distal point of medial femoral condyle (see appendix 8)

Fracture: A break in the cortical continuity of a bone.

Fracture characteristic: Both physical and radiological fracture patterns/ feature that may define the fracture management.

Motorcycle: Automobile with two wheels in line and powered by a motor/fuel engine.

Motorcycle Related Fracture: Fractures involving motorcycle rider, passenger and pedestrians.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Femur is one of the principal load-bearing bones in the lower extremity; femur fractures can cause prolonged morbidity and extensive disability unless treatment is appropriate (Eastwood & Lavernia, 2015). Femur shaft fractures are attributable to high-energy mechanisms, with the majority being road traffic accidents although the open fractures are uncommon they tend to be seen in patients with multiple injuries (Giannoudis, Papakostidis, & Roberts, 2006; Salminem, Pihlajamaki, & Avikainen, 2000).

The United States department of transportation's national highway traffic safety administration in 2010 indicated that 11% of all roadway accidents that occurred in United States involved motorcycles. The police reported 4518 motorcyclists were killed and 96,000 were injured. In 2010, motorcycle crashes cost USD 13.5 billion in economic impacts, and USD 66 billion in societal harm as measured by comprehensive costs (Environmental_Protection_Agency, 2010).

In developed countries motorcycling is for fun, sports and outing. However in most African countries motorcycles are used as a means of public transport and as a form of employment for the youth (Naddumba, 2004). There has been an increase of motorcycle accidents resulting into musculoskeletal injuries reported in a number of African countries. In Nigeria, motorcycle crushes were responsible for 54% of all injuries seen at University of Benin Teaching Hospital although with no data on femoral shaft fractures (Umebese & Okukpo, 2001). In Uganda it was noted that motorcycle crushes were responsible for 25%

of all road traffic accidents victims seen at Mulago Teaching Hospital with femoral fractures accounting for 21.4% of the injuries with no data on diaphyseal fracture femur (Naddumba, 2004) which was also noted from a study done at former Western Provincial Hospital, Kakamega in Kenya which showed fracture femur accounting for 19.8% of the motorcycle injuries (Khanbhai & Lutomia, 2012).

In Kenya, injuries to motorcyclists are increasing at an annual rate of approximately 29 percent (Bachani et al., 2012) and the usage has gained massive popularity in the country after the government of Kenya waived duty on motorcycles below 250cc (Matheka, Omar, Kipsaina, & Witte, 2015). According to the World Health Organization (WHO), between 2005 and 2011, motorcycle registration increased almost 40-fold and in 2011, motorcycles made up to 70% of all newly registered vehicles (Matheka et al., 2015).

According to accident statistics by the National Transport and Safety Authority (NTSA), 291 riders died in 2014, compared to 234 who were recorded in the same period in 2013 (Kenyan_Forum, 2014) as reported in an article by the Daily Nation newspaper indicated motorcycle accident victims were forming the largest number of patients admitted in accident wards countrywide.

Operative management of femoral shaft fractures using internal fixation has resulted in decreased complication rate and shorter hospitalization which has psychological, social and economic advantage over non-operative treatment (Reeves, Ballard, & Hughes, 1990).

1.2 Problem statement

Femoral shaft fractures are a major contributor to all musculoskeletal injuries in low and middle income countries estimated at 17% (Bach, 2004). Hemorrhage is one of the major immediate cause of death during trauma, however, with isolated femur fracture the patient is likely to loose atleast 1.5 litres of blood hence presenting in a hypovolemic shock state and this can easily cause irreversible shock. Femur is one of the principle load bearing bones in the lower extremity and its fracture in adults frequently requires surgical management for better functional outcome and prevention of complications. Therefore if left untreated it carries a disability weight of 0.272 (Mathers, Fat, & Boerma, 2008). There has been an observed increasing trend of femur fracture patients getting admitted in MTRH orthopaedic wards between 2011 to 2015 with majority resulting from motorcycle accidents. With the increased use of motorcycles for transportation, these injuries may continue to constitute a significant burden of the morbidity seen at MTRH yet the common occurance, their pattern and cost of management of these injuries remain unknown.

1.3 Justification of the study

In April 2011 the government of Kenya waived duty on motorcycle hence popularizing their use in Kenya. This was associated with reckless riding despite users disadvantaged on safety equipment exposing them to severe injuries and fatality. Injuries to motorcyclists have been increasing at an approximated annual rate of 29 percent (Anyaehie, Ejimofor, Akpuaka, & Nwadinigwe, 2015). There is no formal training on motorbike riding. This increases the risks to both rider and passengers.

Femur shaft fractures result from high energy trauma (Eastwood & Lavernia, 2015) and these fractures also have been noted within motorcycle accidents. Intramedullary nailing has been used as gold standard for management of femur shaft fractures in adults.

The burden of treating femur shaft fractures is high and by studying the direct cost of treatment of these fractures would hope to help policy makers and clinicians to effectively utilize resources in resource poor setting. This information will be useful at various levels such as individual, community, hospital management, stakeholders and orthopaedic practioners, within and outside this country (Kenya).

1.4 Research question

What are the characteristics of femur shaft fractures as a result of motorcycle crash and the direct cost to patients at MTRH?

1.5 Study objectives

1.5.1 Broad objective

To evaluate the characteristics of motorcycle related femoral shaft fractures and direct cost to patients at MTRH?

1.5.2 Specific objectives

1. To assess the socio-demographic characteristics of patients with femoral shaft fractures secondary to motorcycle crash at MTRH.
2. To determine the characteristics of femoral shaft fractures secondary to motorcycle crash at MTRH.
3. To evaluate the direct cost of care for femur shaft fractures due to motorcycle crash at MTRH.

CHAPTER TWO

LITERATURE REVIEW

2.1 Socio-demographic characteristics

The incidence of femoral shaft fractures in skeletally mature patients was estimated by (Salminen, S., Pihlajamaki, H. K., and Avikainen, V., 2000) in semi-urban county in Finland where the review over a 10-year period was 9.9 per 100,000 person-years. The bimodal distribution of young males (15 - 25 years) and elderly females (about 75 years) was confirmed.

A study done in Nigeria focusing on motorcycle injuries and the vulnerability of riders, passengers and pedestrians found out riders were mostly affected (53.6%), passengers 32.1% and pedestrians 14.3% respectively (Solagberu et al., 2006), another study conducted among rural dwellers in Irura, Nigeria also found that riders (47.1%) were mostly affected, passengers (42.9%) and pedestrians (9.8%) among the victims from motorcycle related injuries. They also noted the average age of 33.2 years (Dongo et al., 2013).

The *boda boda* (motorcycle taxi) injuries observed at Mulago Hospital in Uganda over a 9 month period indicated young females and males (ratio 1:3.5) in their most reproductive years were mostly affected (Galukande, Jombwe, Fualal, & Gakwaya, 2008). These findings are similar with another study done at Thika level 5 hospital in Kenya by Opondo *et al.*, (2013) where they found males had a significantly higher frequency compared to females with a ratio of 1:3.5. They further indicated that 75.7% of the patients with femoral shaft fractures were aged between 18 - 50 years with a mean age of 42 years which are also consistent with findings of patients being managed at Kenyatta National

Hospital (KNH) for diaphyseal fracture femur (Kamau, Gakuu, Gakuya, & Sang, 2013). Fractures of femur have shown to be more common between 20 – 40 years, with men more affected than women (Mulimba & Muyembe, 2000; Otieno, Woodfield, Bird, & Hill, 2004). In a three month retrospective review of the patients seeking treatment at Mulago Hospital, in Uganda it was noted majority 54.7% of the victims were self-employed (Naddumba, 2004).

2.2 Femoral shaft fractures

2.2.1 Surgical anatomy of femoral shaft

The femur is the longest, heaviest and strongest bone in the entire human body. The bone supports all the body weight during activities such as walking and running. It is divided into 3 parts with the femoral shaft being referred to as the distance between 5cm distal to the lesser trochanter and 6cm proximal to the most distal point of medial femoral condyle (Dencker, 1963).

The femoral shaft is slightly twisted and curved with convexity forward, partially accounting for the fullness of anterior thigh. It is mostly cylindrical in the middle third, above and below is slightly flattened antero-posteriorly and widens towards lower end. Posteriorly has *linea aspera* where its cortical thickening is greatest and serves as a site of attachment for the fascia (Netter, 2015) (see Appendix 8). The proximal and distal metaphyseal widening of the tube in subtrochanteric and supracondylar region of bone results in stress concentration at these levels (Emami Meybodi et al., 2014).

Slightly proximal to mid-shaft is the isthmus, where the circular medullary cavity is narrowest with a diameter of 8mm to 16mm compared with the otherwise more oval medullary canal (Dencker, 1963).

The femoral shaft is covered by strong muscles and it is impalpable, having 3 distinct fascial compartments: 1)- Anterior compartment (Sartorious, Quadriceps femoris), containing strong extensor muscles. 2)- The posterior compartment contains flexor muscles (Biceps femoris, Semitendinosus and Semimembrenosus) 3)- The medial compartment contains adductor muscles (Gracilis, Adductor longus, Adductor brevis and Adductor magnus) (Hoppenfeld & deBoer, 1984; Kootstra, 1973; Thorek, 1962).

2.2.2 Femoral shaft fracture biomechanics

During an accident, certain force acting on the bone to cause fracture will depend on factors such as magnitude, direction, nature of the load and also the mineral concentration of the bone. The direction of the forces are torsion, compression, shear and bending (Kootstra, 1973). Alms (1961) further describes the fracturing forces to be either direct or indirect which includes rotational, axial, compression and bending.

Understanding both the direction in which the force acts and the type of force by which a fracture is caused provides information on lesions of the soft-tissues, and can be useful in fracture reduction (Kootstra, 1973).

A bending load applied to a diaphyseal bone results in transverse fractures (Alms, 1961; Gozna, 1982) where the location of soft-tissue hinge is on the concave side. Torsion or twisting causes spiral fractures with long, sharp, pointed ends, and a soft-tissue hinge on the vertical segment (Gozna, 1982).

Moderate axial compression together with bending results in oblique-transverse or butterfly fractures by simultaneous interruption of continuity in two directions. The soft-tissue hinge is on the concave side of the butterfly fragment (Gozna, 1982), where compressive stresses produce an oblique fracture line due to shearing stresses (Kootstra, 1973).

Combinations of tension, compression, shear and torque produce a very complex stress pattern. Here, the stresses which occur in the bone are so great that the limit of elastic formation is exceeded several times (Kootstra, 1973), while the additional force is dissipated on the soft-tissues.

The femoral shaft commonly fractures because it is the most vulnerable part of the femur that receives most of the impact when there is trauma to the thigh due to its length. At the time of impact, there is a direct force transmitted to the femur when hit an obstacle or thrown off the motorcycle and land on the road thus resulting into femur fracture (Williams, Itodo, Daniel, Joseph, & Stephen, 2015).

Following femoral shaft fracture, the musculature that acts as deforming forces on proximal segment to cause abduction include muscles inserting in greater trochanter (Gluteus medius and minimus) while flexion is caused by muscles inserting in the lesser trochanter (iliopsoas). Muscles acting on distal segment to cause varus include adductor muscles inserting on medial aspect of distal femur while gastrocnemius cause extension.

2.2.3 Classification of femoral shaft fractures

Fracture classification system should guide the surgeon in the treatment options and also predict the outcome (Neumann, Sudkamp, & Strohm, 2015).

The stability of diaphyseal fractures is based on the *Winquist-Hansen classification* of the fracture comminution (Winquist & Hansen, 1980; Winquist, Hansen, & Clawson, 1984): segmental fracture, Type 0 fracture (no comminution), Type I fracture (fracture with a small fragment 25% or less of the width of the femoral shaft and not affecting the fracture stability), Type II fracture (fracture with a fragment 25% to 50% of the width of the femoral shaft), Type III fracture (fracture with a fragment over 50% of the width of the femoral shaft), and Type IV fracture (fracture with circumferential comminution over a segment of bone). The degree of fracture comminution has implications for the preferred form of medullary fixation and locking of the major fracture fragments (Bucholz & Brumback, 1996).

The femoral shaft fractures are classified according to the alphanumeric coding system of Arbeitsgemeinschaft für Osteosynthesefragen (AO), which is an Germany referring to the Association for the Study of Internal Fixation (ASIF) (Neumann et al., 2015)(See Appendix 7) into 3 main types (simple, wedge, and complex) with 3 main groups, and 3 subgroups according to the fracture location, with additional two to five ramifications in the complex type of fractures. The simple fractures are subdivided according to the obliquity of the single fracture line into spiral, oblique, or transverse fractures. Wedge fractures can have a spiral, bending, or fragmented configuration. Complex fractures include spiral and segmental fractures, and fractures with extensive comminution over a long segment of the diaphysis (Muller, Nazarian, Koch, & Schatzker, 1990).

For sufficient description and classification of open fractures, Gustilo and Anderson classification system (see Appendix 7) is used (Neumann et al., 2015). The system has 3 categories: Grade I - clean puncture wound 1 cm or less; Grade II - laceration less than 5 cm without contamination or extensive soft-tissue flaps, loss, avulsion, or crush; Grade III - extensive soft-tissue damage with contamination or crush including Grade IIIA - adequate soft-tissue coverage of bone; Grade IIIB - extensive soft-tissue loss with periosteal stripping and bone exposure; and Grade IIIC - major arterial injury present demanding vascular repair or reconstruction (Gustilo & Anderson, 1976; Gustilo, Mendoza, & William, 1984; Gustilo, Merkow, & Templeman, 1990).

2.2.4 Femoral shaft fracture characteristics

Various studies have shown that the right femur is mostly affected, Deepak *et al.* (2012) found the right femur (60%) was affected more commonly than the left side (40%) although a higher prevalence (81.1%) was found in a local study done at Thika Level 5 Hospital, Kenya which also indicated the severe trauma was due to road traffic accidents in 83.1% of the patients (Opondo, Wanzala, & Makokha, 2013).

These fractures are caused by high energy trauma with road traffic accidents being the most common cause although it is not clear on what fraction has motorcycle injuries has contributed to it (inclusive of its users and the pedestrians) (Mulimba & Muyembe, 2000; Otieno et al., 2004) however Salminem *et al.*(2000) noted road traffic accidents contributed to 75% of these injuries.

A 12-month prospective population based study was performed in Maitland Hospital and John Hunter Hospital in New South Wales involving 126 patients with 136 femoral shaft fractures mainly from high energy trauma. They noted 72% constituted of closed fractures while 18% accounted for open fractures ranging from Gustilo Type I to IIIB (Enninghorst, McDougall, Evans, Sisak, & Balogh, 2013). An epidemiological analysis of open long bone fractures conducted over a period of 6 years between 1988 to 1993 in Edinburgh Orthopaedic Trauma Unit found out 62.7% of open femoral diaphyseal fractures were Gustilo type III and these injuries were noted to be less in motor vehicle occupants as compared to pedestrians and motorcyclist who tend to have Gustilo Type IIIB injuries. They further reported only 32.2% were A.O type C (Court-Brown, Rimmer, Prakash, & McQueen, 1998).

In East Africa, Uganda, it was noted that motorcycle crashes were responsible for 25% of all road traffic accidents seen at Mulago Teaching Hospital in Uganda with femoral fractures accounting for 21.4% of the injuries (Naddumba, 2004).

Considering the status of the victims, in Nigeria, 52.8% were motorcycle riders (Umebese & Okukpo, 2001) while a study done in Kenya at Kitale County Referral Hospital reported riders were accounting for 45.1% and 38.8% were pedestrians (Sisimwo, Mwaniki, & Bii, 2014) and they further found that the mechanism of motorcycle crash injury among the victims were motorcycle versus motor vehicle (47%), motorcycle versus motorcycle (23%), motorcycle versus pedestrian (19%), motorcycle versus bicycle (8.4%) and lone accidents (2.6%).

A number of African countries have reported the common mechanism of injury to motorcycle user were resulting from motorcycle versus motor vehicle collision, at Mulago Teaching Hospital was 61% (Naddumba, 2004) while in Kenya 45.6% (Sisimwo et al., 2014); however, at University of Benin Teaching Hospital was slightly lower at 36% (Umebese & Okukpo, 2001).

Study done at Paz University Hospital, Madrid, Spain, Rodriguez-Merchan, Moraled and Gome-Gaidero (2013) noted injuries associated with femoral shaft fractures were very frequent (46.4%), having 25.5% undetected at the time of injury but were noticed during surgery while others were noted during post-operative and during follow-up clinic, however, limb examination may be difficult in the presence of fracture thus recommended examination under anaesthesia and those patients with high suspicion of knee ligament injury required further evaluation with MRI scans.

Bucholz and Brumback, (1996) noted that non-displaced fractures of the neck of femur are often missed because of the overlying shadow of a splint or inadequate quality of radiographs. The anatomical site of injuries among motorcycle injuries seen at Kitale County Referral Hospital were noted to be involving the upper extremity accounting for 15.3% while majority were head and neck injuries 42% (Sisimwo et al., 2014).

A study done at former Western Provincial Hospital in Kakamega Kenya, indicated that Tibia-fibular fractures predominated at 29.3% while Femur fractures accounted for 19.8% and other injuries included chest (10.3%), soft tissue injuries (20.7%), head injuries (12.1%), foot injuries (3.4%), ankle injuries, hip dislocations and forearm bone fractures (1.7% each) and high mortality were commonly associated with head injury (Khanbhai & Lutomia, 2012).

Femur fractures of the middle 1/3 of the diaphysis were 79% while the majority (77%), of all fractures were transverse, oblique, or oblique transverse; 48% of fractures were AO Type A, 39% were Type B, and 13% were Type C fractures (Anyaehie et al., 2015; Salminen, Pihlajamaki, Avikainen, & Bostman, 2000). Another study done on 30 diaphyseal femur fractures managed by locking intramedullary nailing indicated the common location of the fractures was the middle third of the diaphysis comprising of 56.66% with lower third comprising 20% and the rest as the upper third (Deepak et al., 2012).

A retrospective cohort study of 200 patients conducted at the Hospital de Acidentdos, Santa Isabel clinic from 1990 to 2005 found that 80% of femur shaft fractures were closed and open accounted for only 20%. They also noted the left side was mostly affected (50.5%) while the males accounted for 70% of the patients (de Moraes et al., 2009).

Open fractures of femur are uncommon but they can occur as a result of high energy trauma which is mostly associated with other life threatening injuries like head and neck, spine, abdomen and pelvic. A study done on the incidence of open femur fractures which were resulting from road traffic accidents, falls and direct impact in 2000 to 2001 noted Gustilo type I 29%, Gustilo type II 25% and Gustilo type III 46% respectively (Kovar, Jaindl, Schuster, Endler, & Platzer, 2013).

2.2.5 Diagnosis of femur shaft fractures

The clinical diagnosis of the fracture of the femoral shaft is usually made when patient presents with pain, deformity, swelling, and shortening of the thigh (Bucholz & Brumback, 1996). Further examination may reveal the patient is also unable to lift the leg or flex the knee joint (Neumann et al., 2015).

Due to the high energy required to cause a femur fracture, there tends to be associated injuries. The pelvis and hip are some of the areas injured and it is thus important to examine for signs such as swelling and tenderness as these may signal concomitant pelvic disruption or hip fracture (Chaturvedi & Sahu, 1993). Posterior hip dislocation can be denoted by fullness of the buttock associated with flexion and adduction of the proximal femur (Bucholz & Brumback, 1996).

Ipsilateral knee examination before skeletal traction and also after intramedullary nailing because of high incidence of associated injuries with femoral shaft fracture should be done (Rodriguez-Merchan, Moraled, & Gome-Gaidero, 2013; Vangsness, DeCampos, Merritt, & Wiss, 1993).Neurovascular injuries though rarely associated with closed fracture shaft femur, a complete pre-operative examination for vascular and neurologic damage is mandatory. Distal pulses should be palpated and circulatory status evaluated (Bucholz & Brumback, 1996).

The radiological investigations required to make a diagnosis are x-rays done with leg in traction as recorded by Bucholz and Brumback (1996) who described the importance of applying longitudinal traction or splint of the extremity to ensure minimal additional soft-tissue injury to the thigh before doing the diagnostic radiographs. The radiographs should include an AP view of the pelvis, AP and lateral views of the knee and the entire femur to allow detection of longitudinal cracks and non-displaced comminution of the proximal and distal fragments. Lateral and oblique radiographs are also recommended to rule out fractures of the femoral condyles in the coronal plane. CT-Scans should be performed in multiple injured patients for exclusion of ipsilateral hip or acetabular fractures and for further planning in complex fracture (Neumann et al., 2015).

2.2.6 Treatment of femur shaft fractures

The fracture pattern will give a guide on the treatment method to be applied and also the emergency care for the patient. Immediate care for the patient includes pain control, bleeding and shock management, tetanus toxoid and antibiotics for open fractures, splinting of the fracture before considering the definitive fixation of the fracture (Neumann et al., 2015).

Initially femoral shaft fractures were treated with skeletal traction which was associated with complications resulting from prolonged bed rest and hospitalization such as pin tract infections, decubitus ulceration, mal-union, non-union, limb shortening, osteoporosis due to disuse, irritation of nearby nerves and blood vessels (Gosselin & Lavaly, 2007). Other treatment options for femoral shaft fractures include spica casting, external fixation, compression platting and flexible or locked intramedullary nailing (Beaty, 1995). Femur shaft fracture takes approximately 6-12 weeks to unite and 16-24 weeks for consolidation.

The preferred method for treating fractures of the femoral shaft currently is the use of intramedullary nail. The greater trochanter or piriformis fossa may be used for ante-grade approach while making incision in line with the fibers of gluteus maximus, alternatively retrograde approach may be used via making a split incision through patellar tendon or going medial to the tendon. The two techniques each has its own indications, advantages and disadvantages (Ricci William, Gallagher, & Haidukewych George, 2009).

Open or closed femoral intramedullary nailing should be based on type of fracture and its pattern of injury, equipment and instruments available and most certainly the experience of surgeon. Closed intramedullary nailing is for treatment of diaphyseal femur fractures in patients with poly-traumatic injuries. Open intramedullary nailing method should be tried in case where an adequate reduction cannot be achieved by closed methods (Kimmatkar, Jaya, Hemnani, & Jiani, 2014).

A local study done at MTRH to assess the functional outcome of SIGN intramedullary nailing in the management of open long-bone fractures (tibia and femur) found good results from the use of intramedullary nailing for Gustilo-Anderson grade I, II and IIIA open fractures and further recommended treatment of these injuries by adequate debridement then followed by immediate or delayed intramedullary nailing (Lelei, Ongaro, Ayumba, & Lagat, 2009).

2.2.7 Length of patient stay in the hospital

In 2007, the Surgical Implant Generation Network (SIGN) nailing system was introduced at Provincial Trauma Hospital in Cambodia. Its effectiveness of replacing the use of skeletal traction in the management of femur shaft fractures reduced the length of hospital stay from 52 days to 35 days. They further noted the average time in traction was 21 days as compared to 14 days after nailing (Gosselin, Heitto, & Zirkle, 2009).

With the introduction of surgical Implant Generation Network nailing system in Kenyan hospitals, its impact has been evident through early discharge from hospital, weight bearing, healing and return to pre-morbid status. Hospital stay for patients done SIGN intramedullary locked nail (3-22 days; mean 10 days) was remarkably reduced compared to the patients treated by traditional methods of traction (42- 84 days; mean 62 days) (Soren, 2009).

A study done at KNH for surgical management of closed femur shaft fracture indicated the mean (SD) length hospital stay of 11.48 days (raging 4 – 19 days) with a mean average of 4 days before surgery (Kamau et al., 2013).

In a similar study done at Thika Level 5 Hospital, Opondo *et al.,* (2013) noted that the surgery group had an average hospital stay of 30 days and 81.4% of the surgery group were discharged within a month.

2.2.8 Rehabilitation after surgery - Physiotherapy

Impairments and functional limitations following surgical management of diaphyseal femur fractures using intramedullary nailing may often persist beyond 1 year after surgery, limiting the patient's ability to resume activities of daily living and normal gait (Gustilo et al., 1990). Immediate weight bearing with early muscle strengthening activities may result in early resolution of impairments, functional limitations and decreased disability (Paterno, Archdeacon, Ford, Galvin, & Hewett, 2006).

With the use of SIGN intramedullary nail, majority (78%) of patients could partially bear weight between four and six weeks. It was further noted these surgically stabilized patients could therefore get back to their socio-economic activities earlier (Soren, 2009).

2.3 Direct cost of care for femur shaft fractures

Economic analysis in health sector has played a great role in decision-making in resource allocation. A number of cost effectiveness studies have been conducted by comparing the various treatment methods for managing femur diaphyseal fractures with more emphasis put on pediatric fractures. The use of locked intramedullary nail has been shown to be more cost effective method of managing diaphyseal femur fractures as compared to traction method in studies conducted in adult population (Kamau et al., 2013; Ugezu A.I. et al., 2018).

The current recommended treatment for fracture shaft femur is the use of locked intramedullary nail. Surgical Implant Generation Network (SIGN) Nail is used at MTRH for management of these fractures (Lelei et al., 2009). SIGN Fracture Care International is a nonprofit organization that has developed and made available to surgeons in resource-limited settings as an intramedullary interlocking nail for use in the treatment of femoral and tibial fractures (Carsen, Park, Simon, & Feibel, 2015). The cost of buying an intramedullary nail from a private supplier costs approximately Ksh. 30,000. However, there is no study done at MTRH to evaluate the cost of management of the diaphyseal femur fractures.

A study done at a Provincial Hospital in Cambodia after the introduction of SIGN nailing system noted the 37 patients who were evaluated had an average cost of USD 820 and the bigger portion (66%) was the sum of the hospital per diem. Other actors that were put into consideration included the operating room time, equipment used, the used of blood products, physiotherapy, x-rays and drugs (Gosselin et al., 2009).

The cost of management of diaphyseal femur fracture was evaluated at Muhimbili Orthopaedic Institute in Tanzania where the surgical fixation was done using intramedullary devises and the total cost per patient was USD 530.87 with a mean variable of USD 419.87 (Kramer et al., 2016). They further noted the highest portion was for services rendered by the medical personnel, followed by implant then medication.

A study done at Queen Elizabeth Central Hospital in Malawi evaluated 65 patients with isolated femur shaft fractures, the average cost for treating the fracture using intramedullary nailing amounted to $596.97. The items factored in within the cost included ward personnel fee, medication, investigations, surgical implants, disposable supplies and procedure instruments (Mohamed Mustafa Diab et al., 2018).

In Kenya, the Health Medical and dental Professional Fee (2016) indicated the cost for management of long bone fractures through open reduction and internal fixation to be a minimum of Ksh. 72,000 and maximum cost of Ksh. 144,000 while on the other hand open reduction and external fixation was set at a minimum of Ksh. 48,000 and a maximum cost of Ksh. 96,000, however the figures had been adjusted using the inflation rate from the year 2013 to March 2015 as adjusted by the Kenya National Bureau of Statistics (Kenya_Subsidiary_Legislation, 2016).

A cost effectiveness analysis comparing the use of skeletal traction against surgical management using intramedullary nailing showed better clinical outcomes obtained at a lower cost for the surgical group making it more cost effective (Kamau et al., 2013; Opondo et al., 2013). The average surgery cost at Thika Level 5 Hospital was Ksh. 9,761 (USD 95). Reduction in the hospital stay led to reduction in hospital charges, physiotherapy and radiological costs (Opondo et al., 2013). At KNH the average cost for surgical management of fracture shaft femur was Ksh. 53,380.44 (USD 524) (Kamau et al., 2013). The items that were put into consideration during the study for the treatment analysis included: 1)- Cost of ward bed, 2)- Drugs, 3)- Radiographs, 4)- Laboratory investigations, 5)- Physiotherapy, 6)- Theatre fee (Opondo et al., 2013).

CHAPTER THREE

METHODOLOGY

3.1 Study setting

The study was carried out at Accident and Emergency room and Orthopaedic Wards: Longonot (male ward) and Sergoit (female ward) at Moi Teaching and Referral Hospital (MTRH), Uasin Gishu county, Kenya. MTRH is about 310 km northwest of Nairobi.

MTRH is the second largest National Referral Hospital in Kenya after Kenyatta National Hospital (KNH) with a bed capacity of about 1000. The hospital offers outpatient, inpatient and specialized health care services. The hospital serves approximately 24 million people comprising mainly of residents from Western Kenya, parts of Eastern Uganda and Southern Sudan (MTRH_Hospital_background, 2014).

3.2 Study design

This was a prospective, descriptive study of all patients with femur shaft fractures as a result of motorcycle crash seeking treatment at MTRH over a one-year period (January 2016 to December 2016). The study involved follow-up of individual patients from the time of admission to the time of discharge from the ward.

3.3 Study population

Patients with femoral shaft fractures as a result of motorcycle crash admitted in the Orthopedics Wards at MTRH.

3.4 Eligibility criteria

3.4.1 Inclusion criterion

1. All patients with femur shaft fractures as a result of motorcycle crash.

3.4.2 Exclusion criteria

1. Patients with bilateral femur shaft fractures due to motorcycle crash.
2. Patients with femur shaft fractures due to motorcycle crash but declined to participate.

3.5 Sampling technique and sample size determination

Consecutive sampling was done limited to time between 1st January 2016 to 31st December 2016. During this period 142 patients met the inclusion criteria.

3.6 Study methods (See Appendix 6)

3.6.1 Data Collection

Data was collected using a structured questionnaire (Appendix 5) whereby comprehensive data including patient's age, gender, cause and circumstance of injury and fracture patterns were obtained. Imaging findings were recorded after detailed review by both radiologists and Orthopaedic Consultant.

The data on the direct medical cost of treating the patients was sourced from the finance department. Different units were outlined as per the services offered with their respective costs. This was done at the time the patient was discharged from the hospital and the specific parameters considered included: Cost of ward bed, drugs, radiographs, laboratory investigations cost, theatre fee and physiotherapy as in-patient.

The patients were discharged from the study on the final day of leaving the hospital after the final hospital bill had been generated.

Information gathered was de-identified and entered into a computer database that was encrypted to ensure confidentiality then backed up to ensure data safety and prevent data loss. The forms or questionnaires were kept in safe cabinets under lock and key under the investigator's custody.

3.6.2 Data analysis and presentation

Data obtained was analyzed using Statistical Analysis System (SAS) software version 9.1. Categorical variables were summarized as frequencies and the corresponding percentages. Continuous variables that assumed the Gaussian distribution was summarized as mean and the corresponding standard deviation while the continuous variables that violated the Gaussian assumption was summarized as median and the corresponding interquartile range (IQR). Results were presented using tables and figures.

3.7 Ethical consideration

Prior to the study, approval was obtained from Moi University/MTRH, Institution Research and Ethics Committee (IREC) - Formal Approval Number 1491.

Patients were required to fill an informed written consent after the aim of study was fully explained in a language they understood with assurance of no harm would be imposed or exposed to them following their participation in the study. Data collection from patients who were under the legal age of 18 years required the guardian to consent and the minor to fill the assent form. The patients were also free to withdraw from the study at any given time if they changed their mind.

The consenting process for the patients to participate in the study was only done after the patient had been fully been stabilized and out of danger from the injuries. The data collected was secured under locked safe and electronic data was secured with passwords. After the use of patients' particulars, they were disposed-off as per regulations.

3.8 Study limitations

Poor quality x-ray films were noted whereby the anatomical site of interest was not properly focused; however, this was overcome by repeating the X-ray with focusing the anatomical site and the recommended views considered.

CHAPTER FOUR

RESULTS

4.1 Socio-demographic characteristics

This study evaluated 142 patients with diaphyseal femur fractures (142 fracture cases). Majority of the patients were male, age range was 16 - 76 years while mean (SD) was 32 (SD 13.89) years. There were 112 males (78.9%) and 30 females (21.1%). Majority of the patients 60 (42%) had their highest level of education attained as primary school level with 74.6% engaged in informal employment. Summary of sociodemographic characteristics of the patients is represented in Table 4.1.1.

Table 4.1.1: Socio-demographics Characteristics

Characteristics	**N=142**
Age (mean SD)	32.68 (13.89)
Gender Male (%)	112 (78.9)
Female (%)	30 (21.1)
Education	(%)
None	15 (11)
Primary	60 (42)
Secondary	49 (34)
Tertiary	18 (13)
Occupation	(%)
Formal employment	8 (5.63)
Informal employment	106 (74.65)
Unemployed	28 (19.72)

Table 4.1.2: Association between gender and occupation

Gender	Level of occupation			
	Formal Employment	**Informal Employment**	**Unemployed**	**Total**
Female	Frequency 2 Percentage 1.41 Row percent 6.67 Column percent 25.00	17 11.97 56.67 16.04	11 7.75 36.67 39.29	30 21.13
Male	6 4.23 5.36 75.00	89 62.68 79.46 83.96	17 11.97 15.18 60.71	112 78.87
Total	8 5.63	106 74.65	28 19.72	142 100.00

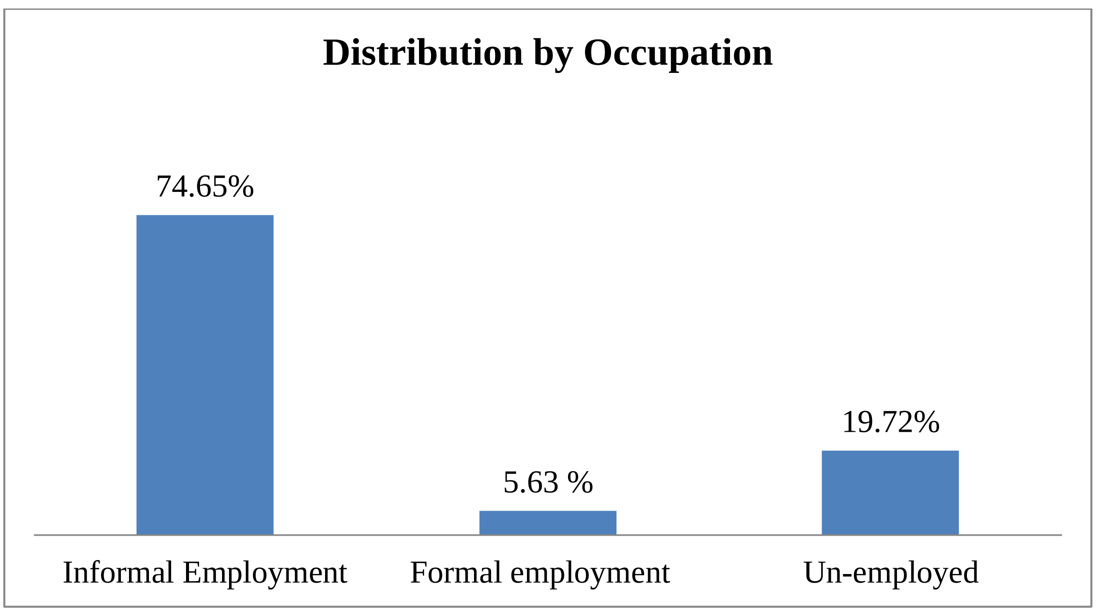


Figure 4.1.1: Distribution of patients by occupation

The patients were grouped into three categories: formal employment, un-employed and informal employment.

About three in four of the patients (74.65%) engaged in informal employment compared to a small proportion who indicated they were engaged in formal employment (5.63%). A proportion of 19.72 % were un-employed. The distribution of the patients according to their occupation is shown in Figure 4.1.1.

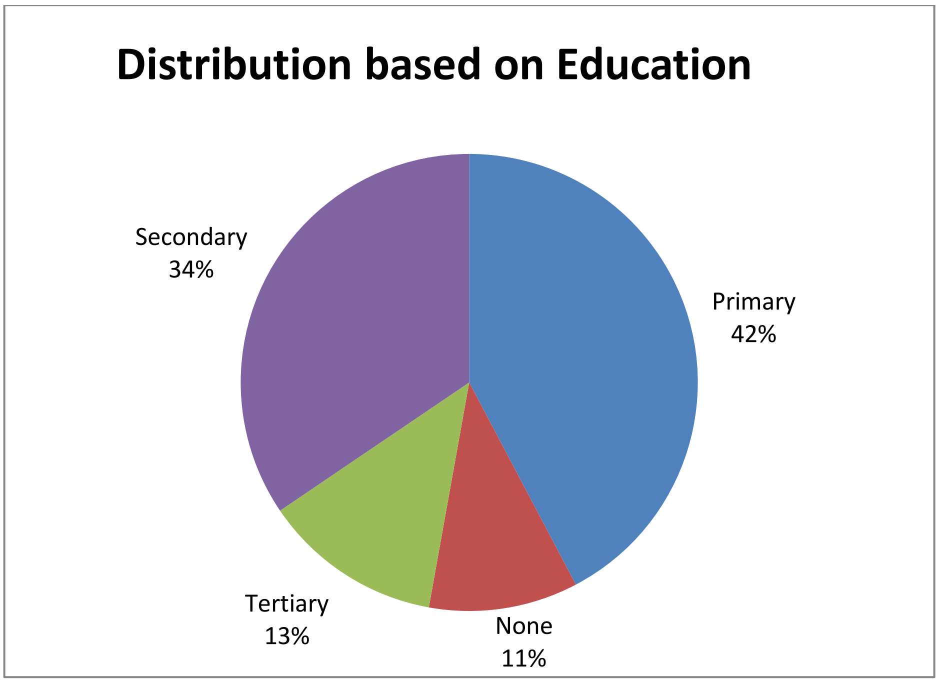


Figure 4.1.2: Distribution of patients based on Education

About 60 (42%) of the patients had primary school education as their highest education level attained, followed by 48 (34%) with secondary school education, 13% (18) had completed tertiary level of education with 16 (11%) indicating to have received no education as represented in Figure 4.1.2.

Majority of the patients who participated in the study in relation to the motorcycle, 68 (48%) were passengers, compared to riders who formed about 57 (40%) and pedestrians made up about 17 (12%) as shown in Figure 4.1.3.

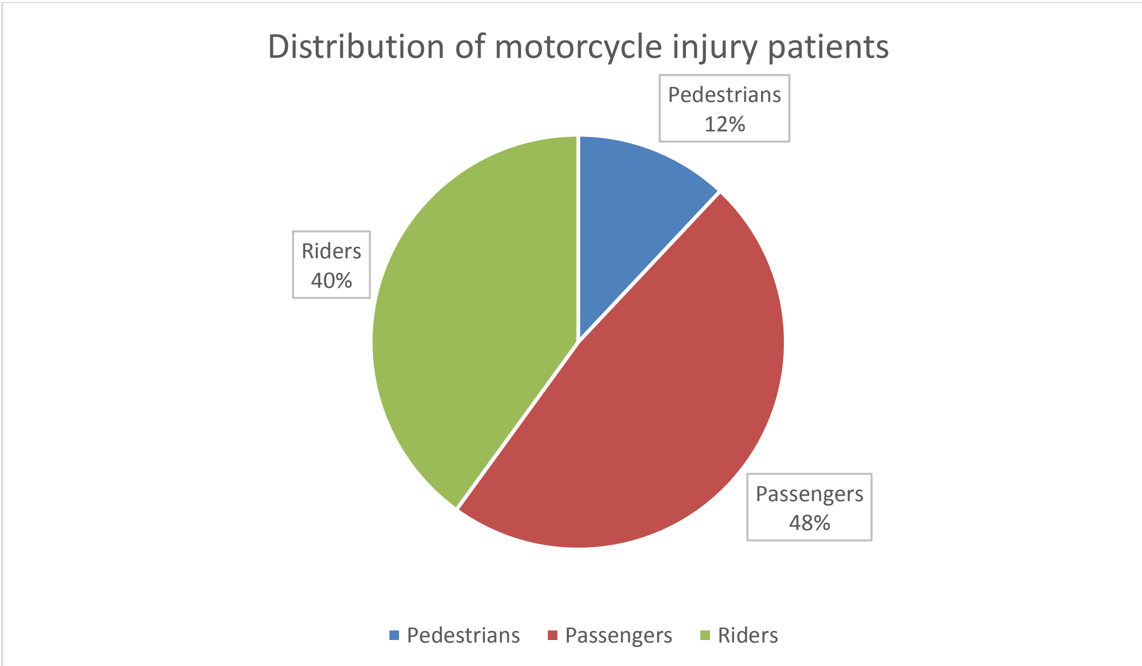


Figure 4.1.3: Distribution of motorcycle injury patients

4.2 Femoral shaft fracture characteristics

4.2.1 Nature of collision

From Table 4.2.2.1 more than half, 82 (57.75%) of the injuries resulted from motorcycle versus motor vehicle collision, motorcycle versus pedestrian accounted for 23 (16.20%), motorcycle versus motorcycle collision represented 20 (14.08%) of the victims with 17 (11.97%) of the collisions involving lone motorcycle accidents.

The laterality of affected limb revealed that 80 (56%) of the injuries to the right, with the remaining having injuries to the left limb. There was no patient with bilateral shaft fracture femur.

4.2.2 Fracture characteristics

Femoral shaft characteristics for the injuries revealed majority of the patients sustained closed fractures compared to patients with open fractures (82.39% to 17.61%) respectively as represented in Table 4.2.2.1.

Table 4.2.2.1: Association between nature of collision versus type of fracture

Type of fracture	**Nature of collision**				
Frequency Percentage Column percentage Row percentage	**Lone Accident**	**Motorcycle versus Pedestrian**	**Motorcycle versus Motorcycle**	**Motorcycle versus Motor vehicle**	**TOTAL**
Closed fracture	15 10.56 88.24 12.82	18 12.68 78.26 15.38	14 9.86 70.00 11.97	70 49.30 85.37 59.83	117 82.39
Open fracture	2 1.41 11.76 8.00	5 3.52 21.74 20.00	6 4.23 30.00 24.00	12 8.45 14.63 48.00	25 17.61
TOTAL	17 11.97	23 16.20	20 14.08	82 57.75	142 100.00

More than half of the open fractures (52%) were Gustilo Type III with majority, 10 (40%) being Gustilo Type IIIA and 3 (13%) being Gustilo Type IIIB. This is represented in the pie chart, Figure 4.2.2.1.

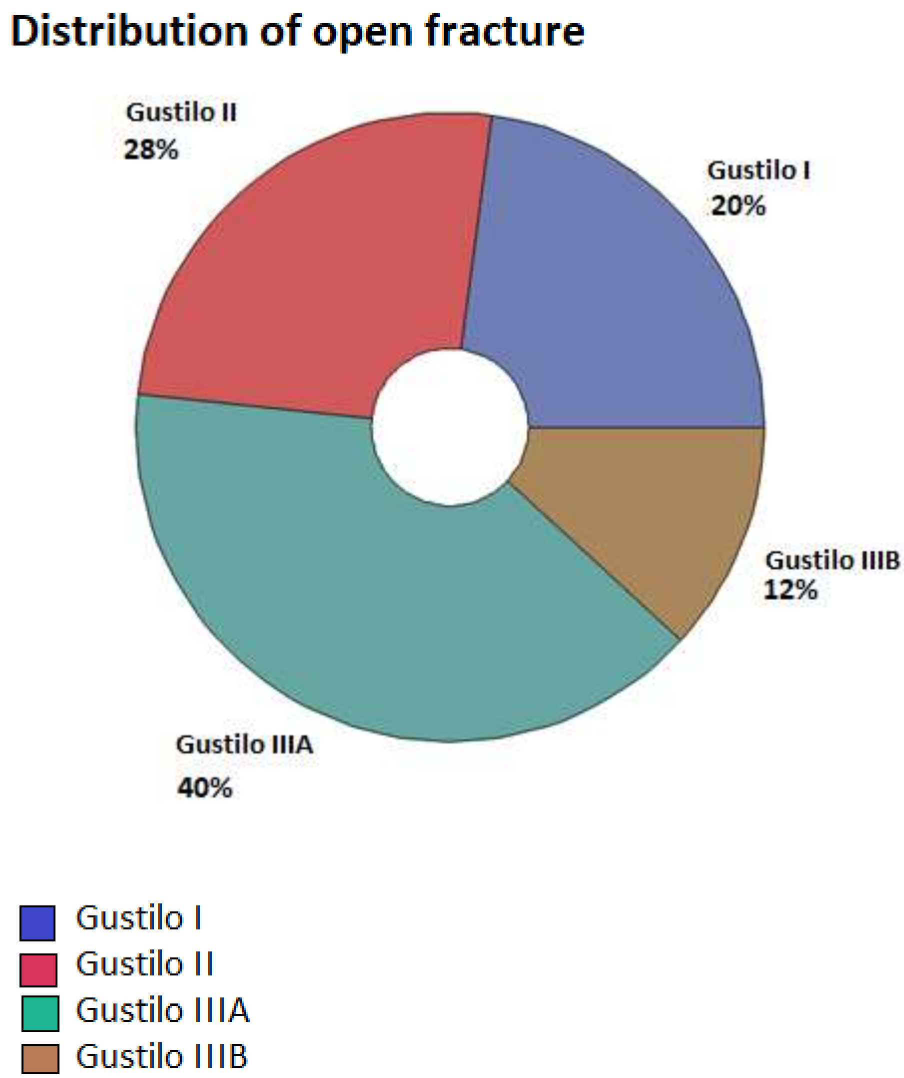


Figure 4.2.2.1: Distribution of Open fracture (Gustilo-Anderson classification)

Table 4.2.2.2: Association between fracture level versus age

Age category	**Fracture level**			
Frequency Percentage Column percentage Row percentage	**Lower third**	**Middle third**	**Upper third**	**TOTAL**
Age < 40 years	19 13.38 44.19 24.05	48 33.80 65.75 60.76	12 8.45 46.15 15.19	79 55.63
Age > 40 years	24 16.90 55.81 38.10	25 17.61 34.25 39.68	14 9.86 53.85 22.22	63 44.37
TOTAL	43 30.28	73 51.41	26 18.31	142 100.00

Majority of the patients had mid-shaft (middle third) fractures as per the x-ray finding. The distribution as per x-ray findings is shown in Table 4.2.2.2.

Table 4.2.2.3: Fracture pattern (AO classification)

X- ray fracture pattern	**Frequency**	**Percentage**
Type A	100	70.4%
Type B	22	15.5%
Type C	20	14.1%

The fracture description as per x-ray findings based on AO classification system indicated majority of the fractures were Simple Type A pattern 100 (70.4%) the subtypes are represented in the Table 4.2.2.4, Type B and C fractures represented 42 (29.6%) combined as shown in Table 4.2.2.3.

Table 4.2.2.4: Distribution of Type A (simple fracture pattern)

X-ray fracture pattern (A)	Frequency	Percentage
Type A1	30	30%
Type A2	18	18%
Type A3	52	52%

4.2.3 Associated injuries

The associated injuries were mainly found in the lower extremity 21 (14.7%) (with the exclusion of the ipsilateral femur shaft) as represented in Table 4.2.2.5

Table 4.2.2.5: Distribution of associated injuries

Associated injuries	Frequency	Percentage
Head	9	6.3%
Spine	2	1.4%
Thoracic	4	2.8%
Abdominal	6	4.2%
Pelvic	2	1.4%
Upper extremity	11	7.7%
Lower extremity	21	14.7%

4.2.4 Treatment options

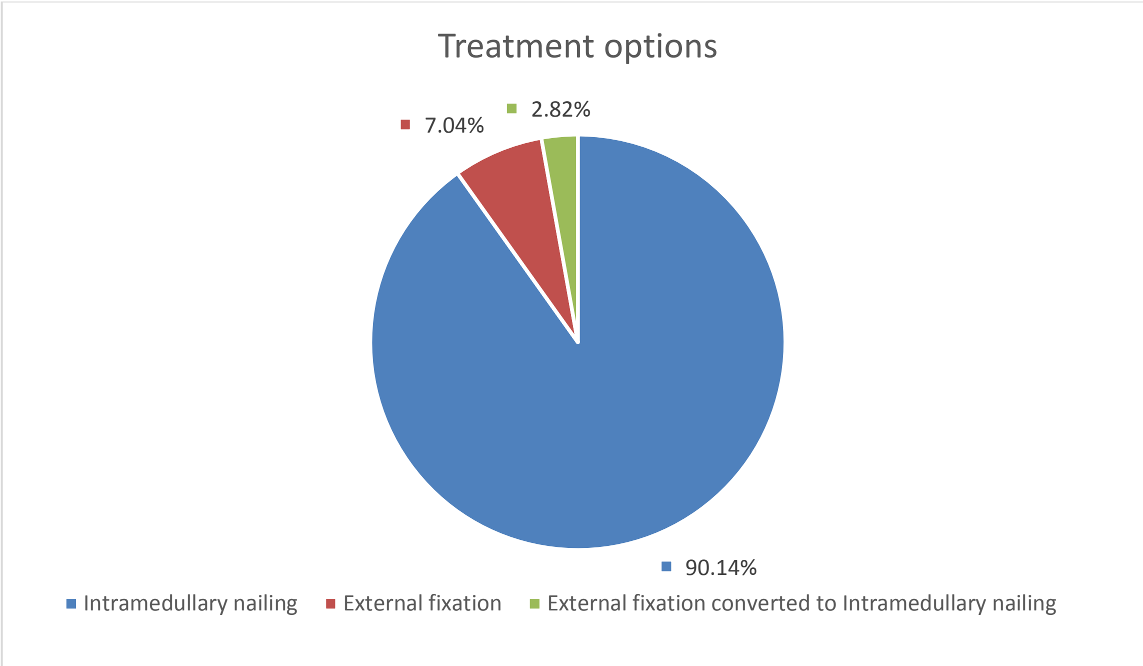


Figure 4.2.4.1: Treatment options

All the patients had initial traction (skeletal or skin traction) as they awaited the definitive treatment. Nine out of ten patients (90.14%) had primary intramedullary Nailing (SIGN Nail) compared to 2.82% who had an external fixator used for temporary fixation, later converted to an intramedullary Nail. Only 7.04% of the patients had an external fixator during the entire study period. The distribution of the treatment modalities used is represented in Figure 4.2.4.1.

4.2.5 Length of hospital stay

The average length of hospital stay was 18 days, with 2 days being minimum number of days, compared to 120 days as the maximum period of hospitalization. This was counted from the day of admission to the day of leaving the hospital. Majority (82.39 %) had length of hospital stay less than 30 days as shown in Figure 4.2.5.1. The mean length of days from admission to definitive time of surgery was 9.29 days with the minimum being less than 24 hours compared to maximum of 31 days.

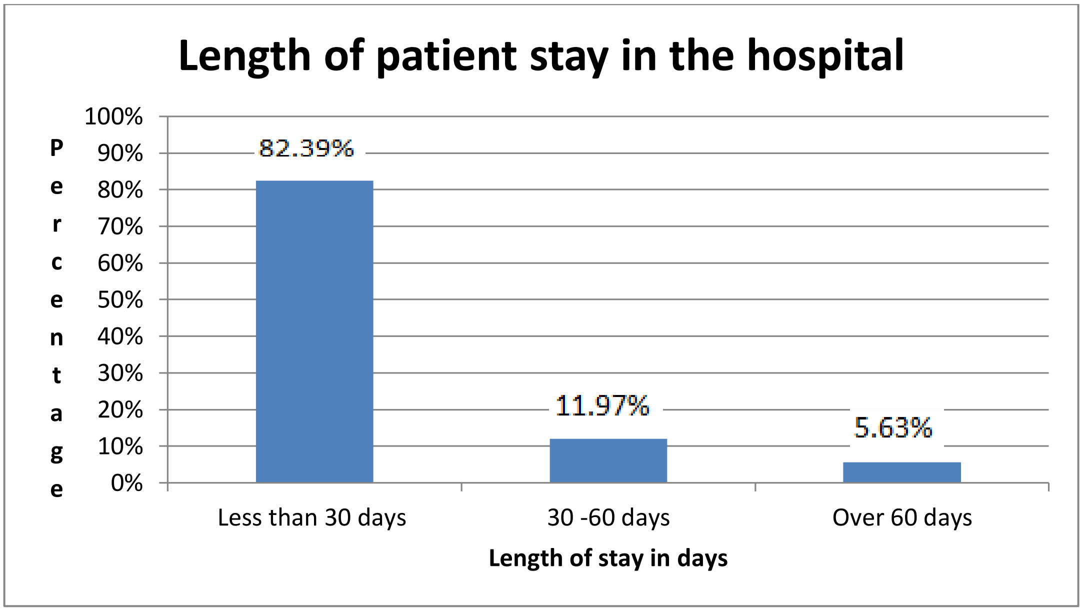


Figure 4.2.5.1: Length of patient stay in the hospital

4.3 Direct cost of care for femur shaft fractures
Direct cost summaries

Table 4.3.1: Distribution of length of hospital stay with direct cost for all group of patients

Variable	N	Mean	SD	Minimum	Maximum
Hospitalization days	142	18.60	13.152	2	120
Direct costs		44,142.08	23,501.49	14,516.00	140,004.00

The average cost for the management of femur shaft fracture was Ksh. 44,142.08, ranging from Ksh. 14,516.00 to 140,004.00 without the cost of the surgical implant. The results are shown in Table 4.3.1.

Table 4.3.2: Cross tabulations of Length of Hospital stay against cost implication

Table of Length of Hospital stay against Cost Implication				
Direct Cost	**Hospital stay**			
	Hospitalized for less than 30 days	**Hospitalized for 30-60 days**	**Hospitalized for over 60 days**	**Total**
Direct costs of less than Ksh. 30,000	42 29.58	0 0.00	0 0.00	42 29.58
Direct cost Ksh 30,000-Ksh45,000	46 32.39	0 0.00	0 0.00	46 32.39
Direct cost Ksh 45,000-Ksh60,000	21 14.79	9 6.34	0 0.00	30 21.13
Direct costs of Ksh60,000-Ksh 75,000	7 4.93	4 2.82	0 0.00	11 7.75
Direct cost Ksh 75,000-Ksh90,000	2 1.41	2 1.41	1 0.70	5 3.52
Direct cost Ksh 90,000-Ksh105,000	3 2.11	0 0.00	0 0.00	3 2.11
Direct cost of over Ksh 105,000	0 0.00	3 2.11	2 1.41	5 3.52
Total	121 85.21	18 12.68	3 2.11	142 100.00

About one in two patients were found to have used between Ksh. 30,000 - Ksh 45,000 as direct costs (46%) and of all the patients majority reported to have been hospitalized for less than 30 days (85.21 %) as represented in the Table 4.3.3.

Table 4.3.3: Association between type of fracture versus length of hospital stay

Type of fracture	**Length of hospitalization**			
Frequency *Percent* *Row Percent* *Column Percent*	**Hospitalized for less than 30 days**	**Hospitalized for 30-60 days**	**Hospitalized for more than 60 days**	**Total**
Closed fracture	104 73.24 88.89 88.89	8 5.63 6.84 47.06	5 3.52 4.27 62.50	117 82.39
Open fracture	13 9.15 52.00 11.11	9 6.34 36.00 52.94	3 2.11 12.00 37.50	25 17.61
Total	117 82.39	17 11.97	8 5.63	142 100.00

From Table 2.3.3 Majority of patients, 104 (73.24%) patients with closed fracture spent less than 30 days of hospitalization.

About one in four patients (24.65%) had to purchase the surgical implant from private supplier. Fourteen (9.86%) were external fixators and 21 (14.79%) were intramedullary nails. The rest of the patients used intramedullary nails provided by donation through the SIGN Nail project.

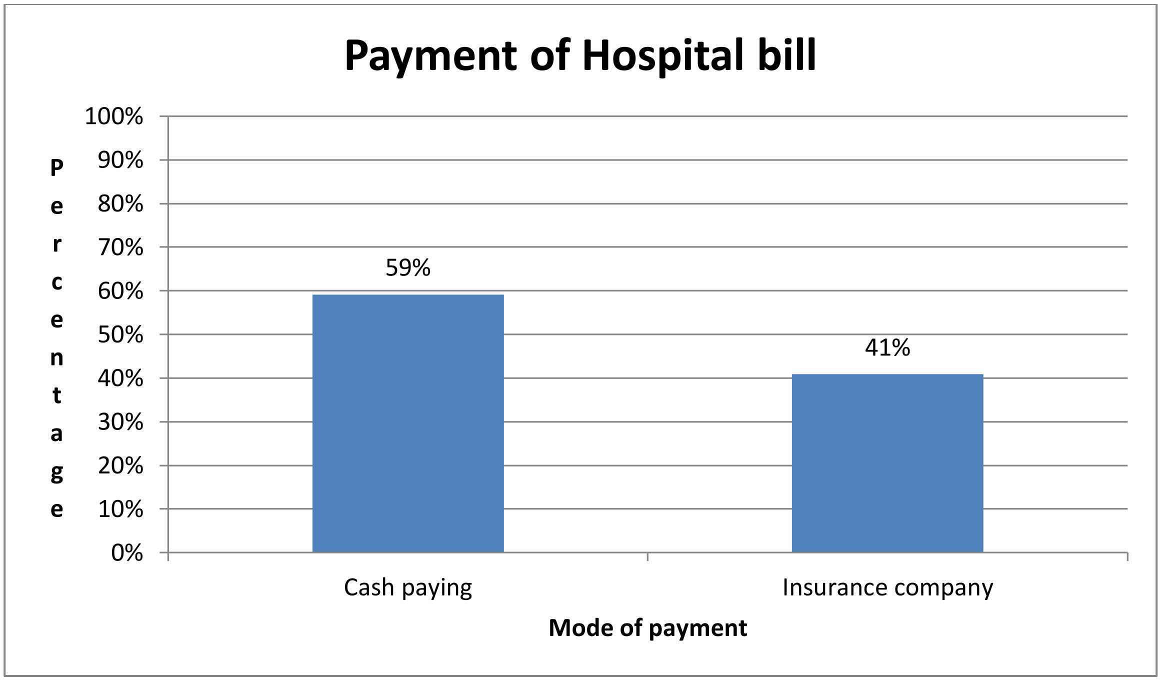


Figure 4.2.5.2: Mode of payment of Hospital bill

Based on data analysis it was found that 59% of the patients had to pay the hospital bill using their personal finances (cash paying) as compared to 41% who had their hospital bills paid by their health insurance firm as represented on Figure 4.2.5.2

CHAPTER FIVE

DISCUSSION

5.1 Socio-demographic characteristics

In this study more males than females sought treatment for femur shaft fractures at MTRH, the findings are in agreement with a study done at Thika level 5 hospital by Opondo et al., (2013) as well as another study from KNH by Kamau et al., 2013. The current findings could be explained by the fact that *boda boda* business is dominated by male youths as a means of livelihood as documented by Bundi et al., 2015. Male dominance may also be a reflection of the community where majority of the bread winners are males, who are exposed to such injuries during their daily activities. In this society males are also the more likely to work as motorcyclists.

The mean age of patients who presented for treatment was in agreement with that by Bundi et al., (2015) who found motorcycle crash victims were aged about 29 years which is the peak age group which femoral shaft fractures as a result of high energy mechanism are seen.

Three in four of patients engaged in informal employment, while one in four were either unemployed or had formal employment. The findings contrast with what was found in a study by Naddumba *et al.*, (2004) who found that businessmen and students were mostly injured from motorcycle accidents because they rush through heavy traffic to business and school.

Passengers were most affected and pedestrians' least affected. The findings were contrasting those in a study done in Nigeria University of Benin Teaching Hospital which reported the riders were mostly affected (52.8%) as documented by Bundi et al., 2015.

The low pedestrian numbers that sustained fractures can be explained by the current improvement in the infrastructure within crowded places like towns whereby pedestrians have been assigned a special foot path with safety barriers along to protect them from automobiles. The high number of passengers could be explained by overloading and carrying passengers beyond recommended capacity as documented by Bundi et al., 2015.

5.2 Femur Shaft Fracture characteristics

The most common mechanism of injury resulted from motorcycle versus motor vehicle collision while least injuries were resulting from lone motorcycle accidents indicating that the motorcyclist and the passengers were at a higher risk of sustaining the injury. These findings are in agreement with what was reported at Mulago National Referral and University Teaching Hospital in Uganda whereby motorcycle versus motor vehicle crashes accounted for 61% of all motorcycle accidents as documented by Naddumba, 2004. The findings of this study contrasts those of a study conducted at Kitale County Referral Hospital that recorded 45.6% of the injuries sustained through motor vehicle versus motor cycle collision. The prevalence of motorcycle to pedestrians is the same (19%) as documented by Sisimwo et al., (2014) although the variations could be arising from the different population catchment areas. The current study also focused on one anatomical region injury unlike the previous studies that dealt with general injuries. The increasing number of motorcycle accidents may be explained with the recent increase in the use of motorcycles as a means of transport as evident by the increased registration of motorcycles and also motor-vehicles.

This study found that the common associated injuries were found in the lower limbs with the exclusion of the thigh injuries then followed by upper limbs. These findings are at variance with those in other studies that found head and neck injuries were most common injuries resulting from motorcycle accidents as documented by Anyaehie et al., 2015 and Rodriguez-Merchan et al., 2013. A local study done at Kitale County Referral Hospital also noted the most common injuries resulting from motorcycle accident were involving the head and neck region (42%) followed by lower extremity injuries (25.7%) as documented by Sisimwo et al., 2014. Such injuries occur because the body parts of the victims at the time of impact are vulnerable to injury from direct contact with motor vehicle / obstacle or thrown off the motorcycle and land on the road as documented by Williams et al., 2015. The current law enforcement regarding the use of helmets has had an impact in the reduction of the head injuries thus explaining the contrast from what other studies found. The other authors (Anyaechie et al., 2015, Rodriguez-Merchan et al., 2013 and Sisimwo et al., 2014) were also interested in the general injuries resulting from motorcycle crashes unlike the current study that is focused on the femur shaft fractures.

This study constituted mostly of patients with closed femur shaft fractures which are in agreement with what de Moraes *et al.,* (2009) found that closed femur shaft fractures constituted 80% of the 200 patients treated with femur shaft fractures between 1990 to 2009 at the Hospital de Acidentados, Santa Isabel clinics. About half of the open fractures were mainly Gustilo Type III indicating that these were the most severe type of these injuries reported. The open fracture findings are in agreement with what was found in an epidemiological study of open long bone fractures that reported higher prevalence, greater than 60%, of open fractures are Gustilo Type III as documented by Court-Brown et al., 1998. The higher prevalence of closed fractures is due to the anatomical coverage of the bone by strong muscles described by Hoppenfel and deBor, (1984) and considering these injuries were all arising from RTA, to some extent the fractured sharp parts could penetrate the strong muscle coverage or foreign objects penetrating from the external environment due to the high energy impact hence presenting as the most severe type of injuries as documented by Gustilo et al., 1990.

In the current study, the radiologic findings revealed majority of the patients had mid-shaft (middle third) fractures which is in agreement with most of the studies as documented by Anyaehie et al., 2015, Deepak et al., 2012 and Salminem et al., 2000. Simple type A fracture pattern accounted for majority of the fractures having its sub-type A3 (transverse fracture) accounting for more than half of the fractures within the subclass which is in agreement with what was found in Finland where 77% of fracture shaft femur was simple type either transverse or oblique as documented by Salminem et al., 2000. The high proportion of transverse fractures in this study were due to high energy transmitted to the femur at the time of the accident.

All the patients in this study were admitted and had to undergo operative treatment. The type of surgical implants used included locked intramedullary nail and the use of an external fixator which were in agreement with the standard care as documented by Kimmatkar et al., (2014) who described the treatment of such fractures was based on fracture pattern and the available equipment. The current recommended implant of choice for management of diaphyseal femur fracture at MTRH is a locked intramedullary nail. SIGN-Nail has been popularly used since MTRH is among the beneficiaries from the project donations.

The treatment of open fractures required antibiotic coverage depending on degree of injury, level of wound contamination, surgical debridement with/without definitive fixation which was in agreement with findings by other authors such as Kim et al., 2012. The use of intramedullary nail in some of open fractures is in keeping with what Lelei et al., (2009) who documented good results for intramedullary nailing for open fractures Gustilo-Anderson Grade I to Grade IIIA at MTRH.

5.3 Direct cost

The findings from the current study found the average length of patient stay in the hospital to be 18 days; however, it took half of duration of stay for these patients to receive the definitive surgical treatment. The study findings have also shown that most of the patients were treated and discharged home in less than thirty days.

The over-all average direct cost of care with the inclusion of the surgical implant is within the recommended cost by Kenya Medical and Dental fee 2016. A higher cost of care was also noted in a study done at a provincial hospital in Cambodia by Gosselin et al., (2009) whereby despite similar length of hospital because of the higher cost of hospital per diem and the variation was because the previous study was conducted in a private facility of which the cost of services was higher.

The study findings at Muhimbili by Kramer *et al.,* (2013) and those found in Malawi by Mohamed *et al.,* (2018) found the cost of care to be lower as compared to the current study and this could be attributed to the study patients included only had closed fractures. In Uganda, Naddumba, (2004) conducted a retrospective review of motorcycle victims managed at Mulago Teaching and Referral Hospital and found that the cost of managing injuries resulting from motorcycle accidents was estimated to be lower although his study was based on general injuries sustained.

In kenya, the current study findings can be compared to a study done at KNH by Kamau *et. al.,* (2013) as both the two facilities are at National Referral Hospitals level. However, the findings from the current study are high and this could be attributed to the inclusion of open fractures that prolonged the pre-operative and post-operative hospitalization days, the challenges arising from the inconsistency in the supply of the surgical implants. The least cost was found at Thika Level 5 by Opondo *et al.,* 2013.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusions

Majority of the patients who presented at MTRH for treatment of femur shaft fractures as a result of motorcycle crash were young males in their early third decade, informally employed and having their highest level of education at primary level which is similar to what was found in other studies.

Closed femur shaft fractures were mostly of Simple Type A patterns involving the mid shaft. Open fractures were about 10 times less common as closed fractures with mainly Gustilo Type III pattern. Associated injuries were mostly in the lower limbs. Majority of these injuries were resulting from motor cycle versus motor vehicle crashes. The fracture characteristics were comparable to other studies.

This study has shown that despite the direct cost of medical care being within recommended Kenya Medical and Dental Professional Fee, it was higher than what was found in other studies from other centers. The primary driver to the higher cost was most commonly caused by challenges in availing the surgical implants, prolonged pre and post-operative hospitalization.

6.2 Recommendations

Road safety education and law enforcement to all road users

Associated injuries are variable thus each individual patient requires thorough evaluation and high suspicion index to determine these injuries.

Interventions by MTRH targeting shortening hospital stay such as:

- Prompt and steady supply of the surgical implants
- Subsidizing implant cost with market expansion
- Provision of prompt operative treatment
- Integration of implant cost within the insurance package
- Health insurance sensitization to the public.

Further study with longer follow-up including indirect costs until the fracture completely heals so as to ascertain the total burden of these fractures.

REFERENCES

Alms, M. (1961). *Journal of bone and joint surgery*. *British 43*, 162-166.

Anyaehie, U., Ejimofor, O., Akpuaka, F., & Nwadinigwe, C. (2015). Pattern of femoral fractures and associated injuries in a Nigerian tertiary trauma centre. *Nigerian Journal of Clinical Practice, 18*(4), 462-466. doi:10.4103/1119-3077.151761

Bach, O. (2004). Musculo skeletal trauma in an East African public hospital. *Injury, 35*(4), 401-406. doi:10.1016/S0020-1383(03)00290-0

Bachani, A. M., Koradia, P., Herbert, H. K., Mogere, S., Akungah, D., Nyamari, J., ... & Stevens, K. A. (2012). Road traffic injuries in Kenya: the health burden and risk factors in two districts. *Traffic injury prevention*, *13*(sup1), 24-30.

Beaty, J. H. (1995). Femoral-Shaft Fractures in Children and Adolescents. *JAAOS - Journal of the American Academy of Orthopaedic Surgeons, 3*(4), 207-217.

BUCHOLZ, BW. "Fractures of the shaft of the femur." *Rockwood and Green's fractures in adults* (1996): 1903-1906.

Calder, P. (2014). Tibial Varus Deformity and Blount's Disease. *European Surgical Orthopaedics and Traumatology: The EFORT Textbook*, 4371-4384.

Carsen, S., Park, S. S. H., Simon, D. A., & Feibel, R. J. (2015). Treatment with the SIGN nail in closed diaphyseal femur fractures results in acceptable radiographic alignment. *Clinical Orthopaedics and Related Research®*, *473*(7), 2394-2401.

Chaturvedi, S., & Sahu, S. (1993). Ipsilateral concomitant fractures of the femoral neck and shaft. *Injury, 24*, 243-246.

Court-Brown, C. M., Rimmer, S., Prakash, U., & McQueen, M. M. (1998). The epidemiology of open long bone fractures. *Injury, 29*(7), 529-534.

de Moraes, F. B., da Silva, L. L., Ferreira, F. V., Ferro, A. M., da Rocha, V. L., & Teixeira, K.-I.-S. S. (2009). Epidemiological and radiological evaluation of femoral shaft fractures: Study of 200 cases. *Revista Brasileira de Ortopedia (English Edition), 44*(3), 199-203. doi:https://doi.org/10.1016/S2255-4971(15)30068-9

Deepak, M., Jain, K., Rajamanya, K., Gandhi, P., Rupakumar, C., & Ravishankar, R. (2012). Functional outcome of diaphyseal fractures of femur managed by closed intramedullary interlocking nailing in adults. *Annals of African Medicine, 11*(1), 52-57. doi:10.4103/1596-3519.91025

Dencker. (1963). Fracture of the shaft femur. A clinical study based on 1003 fractures treated in swedish hospital during the three-year period 1952-1954. *University of Gothenburg,*, 1-135.

Dongo, A. E., Kesieme, E. B., Eighemherio, A., Nwokike, O., Esezobor, E., & Alufohai, E. (2013). Motorcycle Related Injuries among Rural Dwellers in Irrua, Nigeria: Characteristics and Correlates. *Emergency medicine international2013*, 569103. doi:10.1155/2013/569103

Emami Meybodi, M. K., Ladani, M. J., Emami Meybodi, T., Rahimnia, A., Dorostegan, A., Abrisham, J., & Yarbeygi, H. (2014). Concomitant ligamentous and meniscal knee injuries in femoral shaft fracture. *Journal of Orthopaedics and Traumatology : Official Journal of the Italian Society of Orthopaedics and Traumatology, 15*(1), 35-39. doi:10.1007/s10195-013-0255-x

Enninghorst, N., McDougall, D., Evans, J. A., Sisak, K., & Balogh, Z. J. (2013). Population-based epidemiology of femur shaft fractures. *Journal of Trauma and Acute Care Surgery, 74*(6), 1516-1520. doi:10.1097/TA.0b013e31828c3dc9

Environmental_Protection_Agency. (2010, November 17, 2010). *Light Duty Automotive Technology, Carbon Dioxide Emissions and Fuel Economy Trends: 1975 through 201*. Retrieved from www.epa.gov/otaq/fetrends.htm

Galukande, M., Jombwe, J., Fualal, J., & Gakwaya, A. (2009). Boda-boda injuries a health problem and a burden of disease in Uganda: a tertiary hospital survey. *East and Central African Journal of Surgery, 14*(2), 33-37.

Giannoudis, P. V., Papakostidis, C., & Roberts, C. (2006). A review of the management of open fractures of the tibia and femur. *The Journal of bone and joint surgery. British volume, 88*(3), 281-289.

Gosselin, & Lavaly, D. (2007). Perkins traction for adult femoral shaft fractures: a report on 53 patients in Sierra Leone. *International orthopaedics, 31*(5), 697-702. doi:10.1007/s00264-006-0233-5

Gosselin, Heitto, M., & Zirkle, L. (2009). Cost-effectiveness of replacing skeletal traction by interlocked intramedullary nailing for femoral shaft fractures in a provincial trauma hospital in Cambodia. *International Orthopaedics, 33*(5), 1445-1448. doi:10.1007/s00264-009-0798-x

Gozna, E. (1982). *Biomechanics of musculoskeletal injury*. Baltimore: Williams & Wilkins.

Gustilo, R. B., & Anderson, J. T. (1976). Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective analysis. *Journal of Bone Joint Surgery AM, 58*, 453-458.

Gustilo, R. B., Mendoza, R. M., & Williams, D. N. (1984). Problems in the management of type III (severe) open fractures: a new classification of type III open fractures. *The Journal of trauma, 24*(8), 742-746.

Gustilo, R. B., Merkow, R. L., & Templeman, D. (1990). The management of open fractures. *Journal of Bone Joint Surery Am, 72*(2), 299-304.

Hoppenfeld, S., & deBoer, P. (1984). *Surgical Exposure in Orthopaedics*. Philadelphia: JB Lippincott Company.

Kamau, D. M., Gakuu, L. N., Gakuya, E. M., & Sang, E. K. (2013). comparison of closed femur fractures: skeletal traction and intramedullary nailing cost-effectiveness. *East African Orthopaedic Journal, 8*.

Kenya_Subsidiary_Legislation. (2016, July 22). Health Medical and Dental Professional Fee 128-131 C.F.R. , pp. 128-131.

Khanbhai, M., & Lutomia, M. B. L. (2012). Motorcycle Accident Injuries seen at Kakamega Provincial Hospital in Kenya. *East and Central African Journal of Surgery, 17(1)*.

Kimmatkar, N., Jaya, Hemnani, & Jiani, S. K. (2014). Diaphyseal Femoral Intramedullary Nailing: Closed or Open Intervention? *International Journal of Scientific study, 1*(15), 15-18.

Kootstra, G. (1973). *Femoral shaft fractures in Adults. A study of 329 consecutive cases with a statistical analysis of different methods of treatment*. van Gorcum. *Thesis. University of Groningen*.

Kovar, F. M., Jaindl, M., Schuster, R., Endler, G., & Platzer, P. (2013). Incidence and analysis of open fractures of the midshaft and distal femur. *Wien Klin Wochenschr, 125*(13-14), 396-401. doi:10.1007/s00508-013-0391-6

Kramer, E. J., Shearer, D. W., Marseille, E., Haonga, B., Ngahyoma, J., Eliezer, E., & Morshed, S. (2016). The Cost of Intramedullary Nailing for Femoral Shaft Fractures in Dar es Salaam, Tanzania. *World Journal of Surery, 40*(9), 2098-2108. doi:10.1007/s00268-016-3496-z

Lelei, L., Ongaro, N., Ayumba, B., & Lagat, J. (2009). Use of sign intramedullary nailing in open tibia and femur fractures at Moi Teaching and Referral Hospital, Eldoret, Kenya. *East African Orthopaedic Journal, 3*(2).

Matheka, D. M., Omar, F. A., Kipsaina, C., & Witte, J. (2015). Road traffic injuries in Kenya: a survey of commercial motorcycle drivers. *Pan African medical journal, 21*(1).

Mathers, C., Fat, D. M., & Boerma, J. T. (2008). The Global Burden of Disease. *Geneva, World Health Organization.*

Mohamed Mustafa Diab, David W. Shearer, James G. Kahn, Hao-Hua Wu, Brian Lau, Saam Morshed, & Chokotho, L. (2018). The Cost of Intramedullary Nailing Versus Skeletal Traction for Treatment of Femoral Shaft Fractures in Malawi: A Prospective Economic Analysis. *World journal of surgery*, *43*(1), 87-95.

MTRH (2014). Hospital background. Available from: www.mtrh.go.ke/index.php/about/history?layout=edit&id=188.

Mulimba, J. A., & Muyembe, V. M. (2000). Patterns of road traffic injuries at Kenyatta National Hospital. *Medicom, 15*, 93-101.

Muller, M. E., Nazarian, S., Koch, P., & Schatzker, J. (1990). *The comprehensive classification of fractures of long bones*. Berlin Heidelberg.

Naddumba, E. K. (2004). A cross-sectional retrospective study of boda boda injuries at Mulago hospital in Kampala-Uganda. *East and Central African Journal of Surgery*, *9*(1).

Neumann, M. V., Sudkamp, N. P., & Strohm, P. C. (2015). Management of femoral shaft fractures. *Acta Chir Orthop Traumatol Cech, 82*(1), 22-32.

Opondo, E., Wanzala, P., & Makokha, A. (2013). Cost effectiveness of using surgery versus skeletal traction in management of femoral shaft fractures at Thika level 5 hospital, Kenya. *Pan African Medical Journal*, *15*(1).

Otieno, T., Woodfield, J. C., Bird, P., & Hill, A. G. (2004). Trauma in rural Kenya. *Injury*, *35*(12), 1228-1233. doi:10.1016/j.injury.2004.03.013

Paterno, M. V., Archdeacon, M. T., Ford, K. R., Galvin, D., & Hewett, T. E. (2006). Early Rehabilitation Following Surgical Fixation of a Femoral Shaft Fracture. *Physical Therapy*, *86*(4), 558-572. doi:10.1093/ptj/86.4.558

Reeves, R. B., Ballard, R. I., & Hughes, J. L. (1990). Internal fixation versus traction and casting of adolescent femoral shaft fractures. *Journal of pediatric orthopedics*, *10*(5), 592-595.

Ricci William, M., Gallagher, B., & Haidukewych George, J. (2009). Intramedullary Nailing of Femoral Shaft Fractures: Current Concepts. *JAAOS - Journal of the American Academy of Orthopaedic Surgeons, 17*(5), 296-305.

Rodriguez-Merchan, C., Moraled, L., & Gome-Gaidero, P. (2013). Injuries associated with Femoral Shaft Fractures with special emphasis on occult injuries. *The Achive of bone and Joint surgery*, *1*(2), 59-63.

Salminem, S., Pihlajamaki, H., & Avikainen, V. (2000). Population based epidemiologic and morphologic study of femoral shaft fractures. *Clinical Orthopeadics*(372), 241-249.

Salminen, S. T., Pihlajamäki, H. K., Avikainen, V. J., & Böstman, O. M. (2000). Population based epidemiologic and morphologic study of femoral shaft fractures. *Clinical Orthopaedics and Related Research®*, *372*, 241-249.

Sisimwo, P. K., Mwaniki, P. K., & Bii, C. (2014). Crash characteristics and injury patterns among commercial motorcycle users attending Kitale level IV district hospital, Kenya. *The Pan African medical journal*, *19*.

Solagberu, B. A., Ofoegbu, C. K. P., Nasir, A. A., Ogundipe, O. K., Adekanye, A. O., & Abdur-Rahman, L. O. (2006). Motorcycle injuries in a developing country and the vulnerability of riders, passengers, and pedestrians. *Injury Prevention*, *12*(4), 266-268. doi:10.1136/ip.2005.011221

Soren, O. O. (2009). Outcome of surgical implant generation network nail initiative in treatment of long bone shaft fractures in Kenya. *East African Orthopaedic Journal, 3*.

Thorek, P. (1962). *Anatomy in surgery* (2nd Ed.). philadelphia Toronto: Lippincott Company.

Ugezu A.I., Nze I.N., Ihegihu C.C., Chukwuka N.C., Ndukwu C.U, & R.O., O. (2018). Management of femoral shaft fractures in a tertiary centre, south east Nigeria. *East African Orthopaedic Journal, 6*(1), 27-34.

Umebese, P. F. A., & Okukpo, S. U. (2001). Motorcycle accidents in a Nigerian University campus. A one year study of the pattern of Trauma sustained in the University of Benin campus. *Nigerian Journal of Clinical Practice*, *4*(1), 33-36.

Vangsness Jr, C. T., DeCampos, J., Merritt, P. O., & Wiss, D. A. (1993). Meniscal injury associated with femoral shaft fractures. An arthroscopic evaluation of incidence. *The Journal of bone and joint surgery. British volume*, *75*(2), 207-209.

Williams, Y. T., Itodo, E. C., Daniel, M. D., Joseph, N., & Stephen, A. (2015). Femoral shaft fractures: Mechanisms, patterns and associated injuries in Makurdi, Nigeria. *Ibom medical journal, 10*.

Winquist, R. A., & Hansen, J. S. (1980). Comminuted fractures of the femoral shaft treated by intramedullary nailing. *The Orthopedic clinics of North America*, *11*(3), 633-648.

Winquist, R. A., Hansen, S. T. J., & Clawson, D. K. (1984). Closed intramedullary nailing of femoral fractures. A report of five hundred and twenty cases. *Journal of Bone Joint Surgery Am, 66*(4), 529-539.

APPENDICES

Appendix 1: IREC approval letter

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

9th September, 2015

Reference: IREC/2015/156
Approval Number: 0001491

Dr. Mukwa Samuel Nabiswa,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
09 SEP 2015
APPROVED

Dear Dr. Nabiswa,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Characteristics of Motorcycle Related Femoral Shaft Fractures and their Economic Burden at MTRH."

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1491*** on 9th September, 2015. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 8th September, 2016. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

For

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc	Director -	MTRH	Dean	-	SOP	Dean	-	SOM
	Principal -	CHS	Dean	-	SON	Dean	-	SOD

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

28th September, 2016

Reference: IREC/2015/156
Approval Number: 0001491

Dr. Mukwa Samuel Nabiswa,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
28 SEP 2016
APPROVED
P.O. Box 4606-30100 ELDORET

Dear Dr. Nabiswa,

RE: CONTINUING APPROVAL

The Institutional Research and Ethics Committee has reviewed your request for continuing approval to your study titled:-

"Characteristics of Motorcycle Related Femoral Shaft Fractures and direct cost to patients at MTRH".

Your proposal has been granted a Continuing Approval with effect from 28th September, 2016. You are therefore permitted to continue with your study.

Note that this approval is for 1 year; it will thus expire on 27th September, 2017. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

For

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc:	CEO	-	MTRH
	Dean	-	SOM
	Dean	-	SPH
	Dean	-	SOD
	Dean	-	SON

Appendix 2: MTRH approval letter

MOI TEACHING AND REFERRAL HOSPITAL

Telephone: 2033471/2/3/4
Fax: 61749
Email: director@mtrh.or.ke
Ref: ELD/MTRH/R.6/VOL.II/2008

P. O. Box 3
ELDORET

9th September, 2015

Dr. Mukwa Samuel Nabiswa,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

RE: APPROVAL TO CONDUCT RESEARCH AT MTRH

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:-

"Characteristics of Motorcycle Femoral Shaft Fractures and their Economic Burden at MTRH".

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

DR. JOHN KIBOSIA
DIRECTOR
MOI TEACHING AND REFERRAL HOSPITAL

CC - Deputy Director (CS)
- Chief Nurse
- HOD, HRISM

Appendix 3: Consent form

CONSENT FORM FOR ADULT (ABOVE 18 YEARS)

I ………………………………of………………..phone number…………………………..

Hereby voluntarily agree to participate in the study mentioned regarding CHARACTERISTICS OF MOTORCYCLE RELATED FEMORAL SHAFT FRACTURES AND DIRECT COST TO PATIENTS AT MTRH. The nature of the study has been clearly been explained to me by Dr. Mukwa Samuel Nabiswa / his assistant in a language that I understand.

No force has been used or any form of special treatment promised to attract me to participate in the study however I may withdraw from it if I wish to and I shall not be treated differently or be mistreated.

No harm as a result of my participation in the study has been assured.

Name of patient……………… ………...Signature…………………. Date………………

Name of witness………………………...Signature…………………. Date………………

CONSENT FORM FOR MINOR. FILLED BY PARENT/ LEGAL GUARDIAN

I…………………………………of ……………………. phone number…………

As the parent/ legal guardian hereby voluntarily agree my son/ daughter to participate in the study mentioned above. Terms and conditions explained as above will be adhered to.

Name of patient…………………………...Signature…………………. Date………………

Name of witness………… ……………...Signature…………………. Date……………

IDHINI YA ALIYE ZAIDI YA MIAKA 18

Mimi ....wa..................................nambari ya simu............................

Kwa hiari ninakubali kujumuishwa katika uchunguzi uliotajwa hapo juu kuhusu majeraha ya kuvunjika kwa mfupa wa paja yanayotokana na ajali za pikipiki na namna yananavyozorotesha uchumi kwa majeruhi katika hospitali kuu ya MTRH. Nimeelezwa ipasavyo kuhusu uchunguzi huu na daktari Mukwa Samuel Nabiswa /msaidizi wake kwa lugha niliyoelewa.

Sikulazimishwa kujiunga wala sikuahidiwa matibabu maalumu kwa kujiunga na ninaweza kujiondoa kwa wakati wowote bila madhara yoyote.

Kujiunga kwangu hakutanisababisha madhara yoyote.

Jina la mgonjwa ....

Sahihi...

Tarehe...

Shahidi...

Sahihi...

Tarehe..

Uhusiano..

IDHINI YA ALIYE CHINI YA MIAKA 18

Mimi..wa..............................nambari ya simu.................................

Nimekubali mwanangu kujumuishwa katika uchunguzi uliotajwa hapo juu. Yote yaliyotajwa hapo juu yatashurutishwa.

Jina la mgonjwa..

Sahihi…………………………………………….....

Tarehe...

Uhusiano..

Appendix 4: Introductory letter

I am Dr. Mukwa Samuel Nabiswa, a medical doctor (A8944) currently pursuing my master's degree in Orthopedic surgery at Moi University, College of Health Science- Eldoret. I am conducting a study on femur shaft fractures as a result of motorcycle accidents under the topic of: **CHARACTERISTICS OF MOTORCYCLE RELATED FEMORAL SHAFT FRACTURES AND DIRECT COST AT MTRH, ELDORET.**

You are being asked to take part in a research study. This information is provided to tell you about the study. Please read this form carefully. You will be given a chance to ask questions. If you decide to be in the study, you will be given a copy of this consent form for your records.

Taking part in this research study is voluntary. You may choose not to take part in the study. You could still receive other treatments. Saying no will not affect your rights to health care or services. You are also free to withdraw from this study at any time. If after data collection you choose to quit, you can request that the information provided by you be destroyed under supervision and thus not used in the research study. You will be notified if new information becomes available about the risks or benefits of this research. Then you can decide if you want to stay in the study

The purpose of the study is to find out the nature of fractures sustained on the thigh bone (femur shaft fractures) following involvement in a motorcycle accident. The process of your participation will involve examining your injuries, review of your investigations done (radiographs), oral interviews and also follow-up telephone conversations.

You have been chosen to participate in the study because you were involved in a motorcycle accident that resulted in the fracture of your thigh bone. The duration of your participation in the study will be up to the time u leave the ward after being discharged. Your participation in the study will not change the treatment you will be receiving at the hospital or neither will it prolong your hospital stay.

Information you will provide will be kept private and safe in a manner no one is able to trace it back to you.

For more information concerning your rights as a research subject: You may contact Institutional Review Ethics Committee (IREC) telephone number 053 33471 Ext.3008. IREC is a group of people that reviews studies for safety and to protect the rights of study subjects.

Yours faithfully,

…………………..

Dr. Mukwa Samuel Nabiswa
Address 675-50205 Webuye
+254724844497

BARUA YA UTANGULIZI

Mimi ni daktari Mukwa Samuel Nabiswa. Nimehitimu kama daktari na kusajiliwa na Bodi ya Madaktari ya Kenya (A8944). Kwa sasa ninasomea shahada ya juu (masters) ya udaktari wa upasuaji wa magonjwa ya mifupa (orthopaedic surgery) katika chuo kikuu cha Moi. Ninafanya uchunguzi kuhusu majeraha ya kuvunjika kwa mfupa wa paja yanayotokana na ajali za pikipiki na namna yananavyozorotesha uchumi kwa majeruhi katika hospitali kuu ya MTRH.

Ningependelea ujiunge na uchunguzi huu. Maelezo yafuatayo yanahusu uchunguzi huu. Unatakiwa usome kwa uangalifu. Utapewa nafasi kuuliza maswali. Iwapo utaamua kujiunga, utapewa nakala yako ya maelezo haya na idhini.

Kujiunga kwako ni kwa hiari. Kutojiunga hakutaathiri matibabu yako. Unaweza pia kujiondoa katika uchunguzi wakati wowote ule. Ni iwapo utajiondoa baada ya kutoa maelezo yako, waweza kuamua kuharibiwa kwa maelezo yako palipo na ushahidi ili yasitumike kwenye uchunguzi. Utaelezwa iwapo kuna maelezo mapya kuhusu uchunguzi huu ili uamuweiwapo utaendelea kujihusisha.

Uchunguzi huu unahusu majeraha ya kuvunjika kwa mfupa wa paja yanayotokana na ajali za pikipiki. Kujiunga kwako kutahusisha kupimwa kwa majeraha, kuangaliwa kwa picha za uchunguzi, mazungumzo ya moja kwa moja na pia kupitia simu.

Umechaguliwa kuhusishwa na uchungi kwa kuwa umepata majeraha ya kuvunjika mfupa wa paja kupitia ajali ya pikipiki. Kijiunga kwako kutachukua hadi wakati utakapo maliza matibabu ya kulazwa hospitali na kuenda nyumbani. Kujiunga kwa vilevile hakutaathiri matibabu ya kawaida wala hakutaongezeamda wako wa kuwa katika hospitali.

Maelezo utakatotoa yatahifadhiwa vyema ili usiweze kujulikana.

Unapohitaji maelezo zaidi, wasiliana na IREC kupitia nambari ya simu (053 33471

Ext.3008):

Mimi wako,

....

Dr. Mukwa Samuel Nabiswa

S.L.P 675-50205 Webuye

+254724844497

Appendix 5: Questionnaire

1. Socio-demographic Information

Patient Code ____

In Patient Number ____

Age ____

Gender Male ☐ Female ☐

Occupation ____

Subject status in relation to the motorcycle

Rider ☐

Passenger ☐

Pedestrian ☐

Others ☐

Level of Education

None ☐

Primary ☐

Secondary ☐

Tertiary ☐

2. Affected Femur

Right ☐

Left ☐

Both ☐

3. Other associated injuries apart from the femur

4. Nature of collision

Motorcycle versus Motor-vehicle collision ☐

Motorcycle versus Motorcycle collision ☐

Lone Motorcycle accident ☐

Motorcycle versus Pedestrian collision ☐

Motorcycle versus Bicycle collision ☐

Others ☐

5. Femoral Shaft Characteristics
    - Closed fracture ☐
    - Open fracture ☐
        i. Gustillo I ______________________________________
        ii. Gustillo II ______________________________________
        iii. Gustillo III ______________________________________

Orthopedic Trauma Association (OTA) classification (X-ray finding)

Upper third (Proximal) ☐

Middle third (Mid-shaft) ☐

Lower third (Distal) ☐

Type A (Simple) ____

Type B (Wedge) ____

Type C (Fragmented) _____________________________________

6. Treatment option applied

Intramedullary device ☐

Plate ☐

External Fixator ☐

P.O.P ☐

Traction

Skeletal ☐

Skin ☐

7. Duration of Hospital Stay (Days) ____________________________________

8. Direct Cost.

Total Hospital charges ____

Daily bed charges ________________________

Lab Investigations ________________________

Radiographs ________________________

Drugs ________________________

Theatre fee ________________________

Physiotherapy (as in-patient)_________________

9. Mode of payment for the hospital bill

Cash paying ☐

Insurance company ☐

Government program ☐

10. Time from admission to definitive surgery

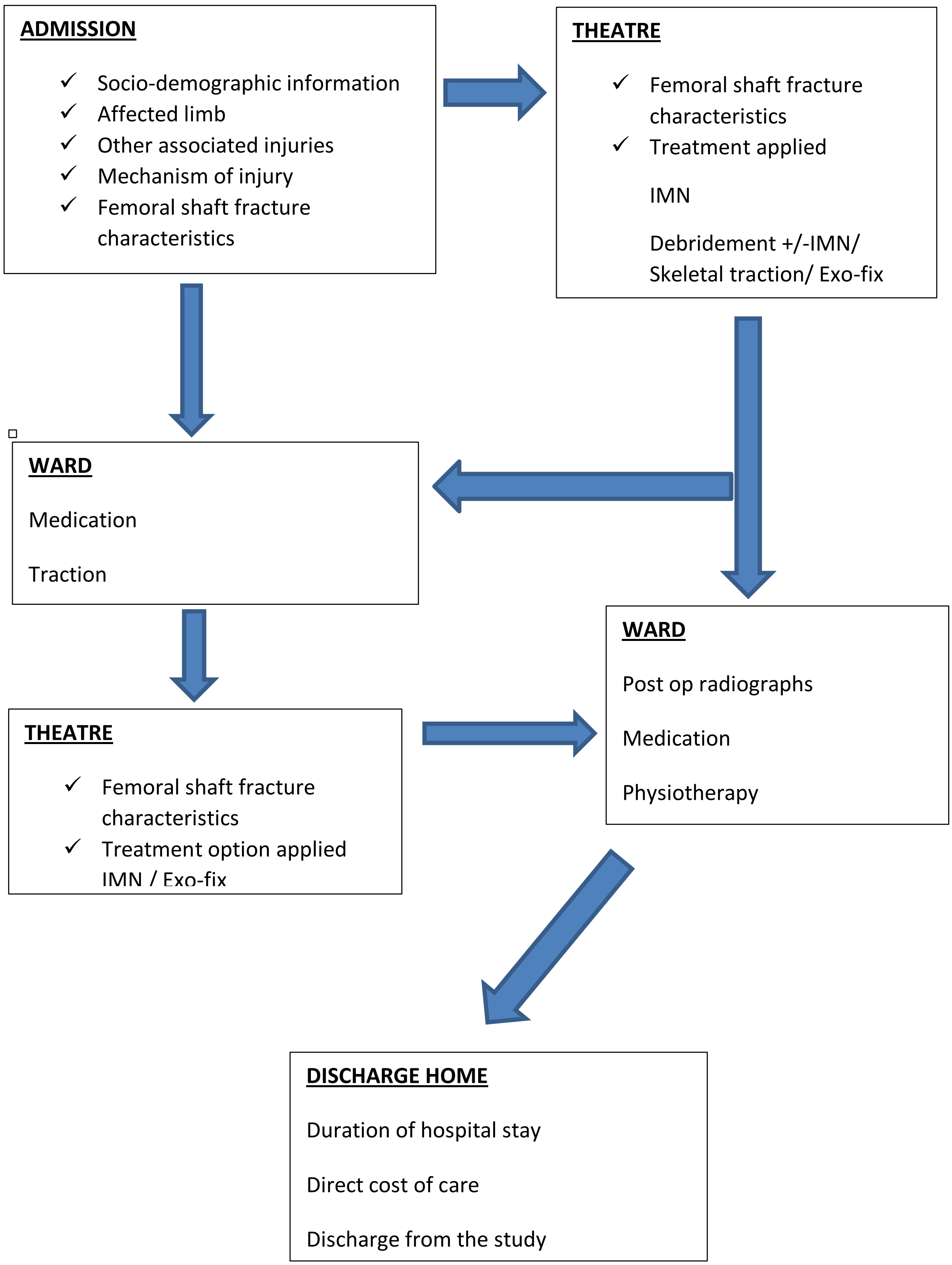
____

11. Source of surgical implant used

Donation ☐

Purchased from private supplier ☐

Appendix 6: Sequence of events



Appendix 7: Fracture Classification

Gustilo Anderson Classification of Open Fractures

Grade I

- The skin opening is 1 cm or less.
- This injury is most likely due to an inside-out mechanism.
- Muscle contusion is minimal.
- The fracture pattern is transverse or short oblique.

Grade II

- The skin laceration is greater than 1 cm, with extensive soft-tissue damage, flaps, or avulsion.
- A minimal to moderate crushing component may be noted.
- The fracture pattern is simple transverse or short oblique, with minimal comminution**.**

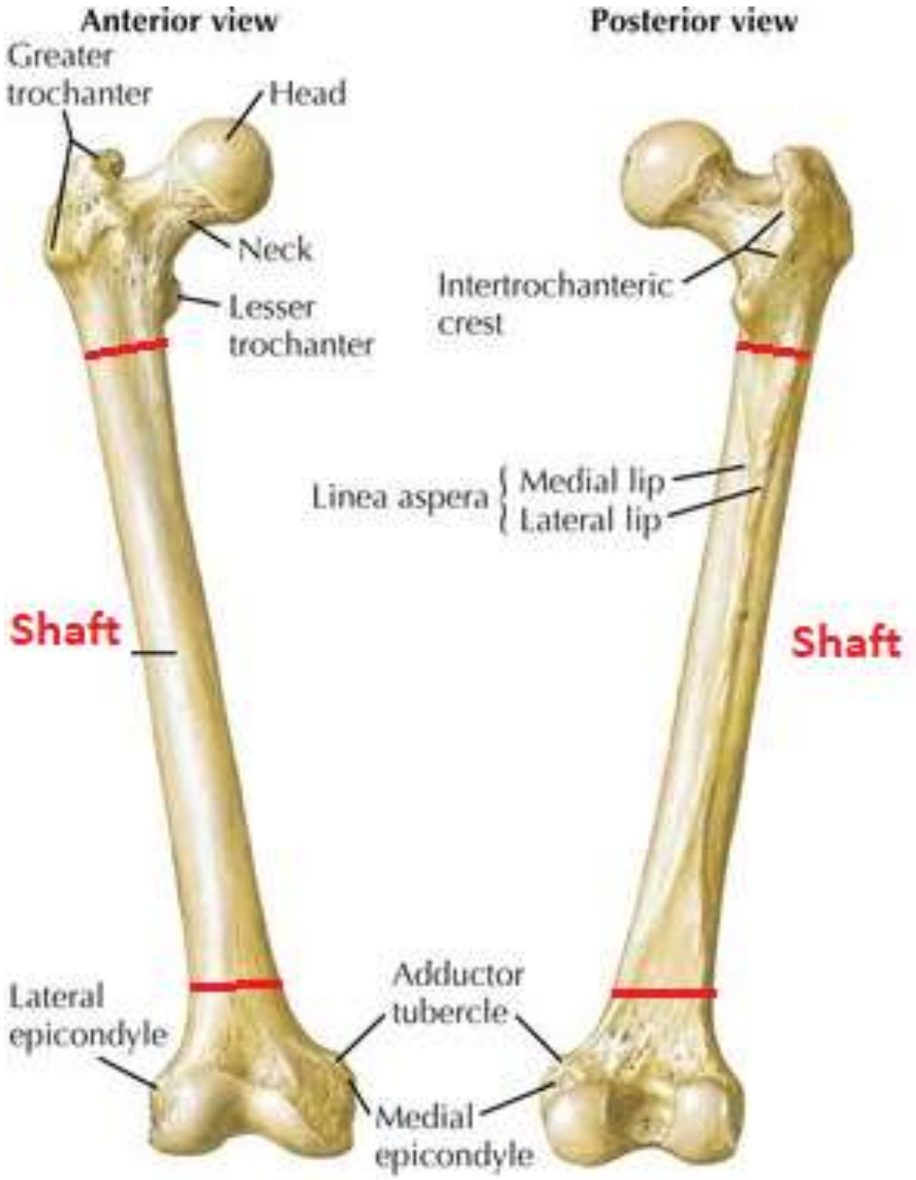
Grade III

- Extensive soft-tissue damage includes the muscle, skin, and neurovascular structures.
- This is a high-velocity injury with a severe crushing component.
    - **Grade IIIA**: Involves extensive soft-tissue laceration (10 cm) but adequate bone coverage and includes segmental fractures and gunshot wounds.
    - **Grade IIIB:** Consists of extensive soft-tissue injury with periosteal stripping and bone exposure. This grade is typically associated with massive contamination and inadequate bone coverage. The treatment requires flap advancement or a free flap.
    - **Grade IIIC:** Has vascular injury that requiring repair.

Orthopedic Trauma Association (OTA) classification (Femur Shaft Fracture)

Femur 3, Shaft/Diaphysis 2

Appendix 8: Femur anatomy



Anatomy of the femur bone, extracted from the Atlas of Human Anatomy –Frank Netter, Seventh edition. Plate 479

Appendix 9: Budget

ITEM	**COST**
Reams of printing papers @ 500	2000
Pens, pencils, rubber, Box file	1000
Flash disks (2)	2000
Research proposal printing	2000
IREC fee	2000
Research assistant 2000p.m	24000
Data handling	20000
Printing and binding thesis	5000
TOTAL	**58,000**

Appendix 10: Work plan

DATE	DURATION	ACTIVITY
Jan 2015 – Feb 2015	1 month	Topic selection
Feb 2015 – March 2015	1 month	Presentation of the concept paper to the department
March 2015 – May 2015	2 months	Proposal writing
May 2015 – September 2015	-	Submission to IREC
Jan 2016 – Dec 2016	12 months	Data collection
Jan 2017- May 2017	5 months	Writing thesis
January 2018	-	Abstract submission
April 2019	-	Submission of the thesis
9 September 2019	12pm – 1pm	Oral defense