FUNCTIONAL OUTCOMES OF DISTAL FEMUR FRACTURES TREATED OPERATIVELY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA

BY

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THESIS SUBMITTED IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE AWARD OF MASTER OF MEDICINE DEGREE IN ORTHOPAEDIC SURGERY, SCHOOL OF MEDICINE,

MOI UNIVERSITY.

DECLARATION

Declaration by the Student

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DEDICATION

This thesis is dedicated to the patients who participated, the Department of Orthopaedics and Rehabilitation and my family.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABP	Angle Blade Plate
BCP	Buttressing Condylar Plate
DCS	Dynamic Condylar Screw
HSS	Hospital for Special Surgery.
IM – ILN	Intramedullary – Interlocking Nail
IM	Intramedullary
IREC	Institutional Research Ethic Committee.
MTRH	Moi Teaching and Referral Hospital.
OPD	Out-Patient Department.

OPERATIONAL DEFINITION OF KEY TERMS

Distal femur: Comprises the region of the femur extending up to 9 centimetres above the knee joint.

Fracture: A break in cortical continuity of a bone.

Fracture patterns: This refers to form of the fracture line, shape of bone fragments, number of bone fragments and anatomical location of bone. Also refers to the presence or absence of a communicating wound the outside environment.

Implants: Bio – Mechanical devices typically made of inert metallic compounds that aid in stabilization of fracture fragments.

Operative Management: This refers to surgical treatment of fractures aided by surgical implants to stabilize the fracture fragments within normal anatomical parameters.

Functional Outcome: It refers to the knee function as described by the Hospital for Special Surgery (HSS) score.

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ABSTRACT

Background: Distal femur fractures account for 4% to 7% of all femoral fractures. They cause considerable morbidity and mortality, especially in the elderly. Operative treatment results in early return to function and early range of motion at the knee joint. This prevents knee stiffness. Locally they occur mainly in the young socio-economically active age group. Functional outcome of treatment of these injuries has however not been studied at Moi Teaching and Referral Hospital. This study aims to fill this gap and add to the body of knowledge.

Objective: To assess functional outcomes of treatment of distal femur fractures in adult patients at MTRH.

Methods: A hospital based prospective study carried out over twelve months. All patients presenting with distal femur fractures at the orthopaedic trauma wards and clinics at MTRH were studied after meeting ethical considerations. Data was collected using a questionnaire and the Hospital for Special Surgery (HSS) knee scoring tool. Fractures were classified using the AO system, where type A fracture are extra – articular, type B partially articular and type C completely intra – articular. Fractures can be classified as open or close depending on presence of a communicating wound. Functional knee score at 6 months was measured using the modified HSS score where a score of 85 points or more was excellent, 70 – 84 good, 60 – 69 fair and less than 60 was a poor score. Data was analysed using SPSS® version 21.

Results: In all fifty seven adult patients were recruited, with a male to female ratio of 1.7:1. Mean age was 34 ± 12.7 years with a range of 21 – 78 years. Patients with type A fractures constituted 52%, type B 11% and type C 37%. Mean functional outcome as measured using the HSS score 6 months after operative treatment for all were good. Patients above 60 years of age had poor outcome, while those below 60 had good outcomes. Type A and B fractures had good outcomes, type C had poor outcomes.

Conclusion: Type A and B distal femur fractures were associated with good functional outcomes. Type C distal femur fractures, open distal femur fractures and patients above 60 years of age were associated with poor functional outcomes.

Recommendations: Further studies on type C distal femur fractures, Open distal femur fractures and distal femur fractures in the elderly on factors that may improve functional outcomes in these groups of patients.

CHAPTER ONE: INTRODUCTION

1.1 Background Information

The femur is the longest and strongest bone in the body, required to bear great muscular forces and weight. Like other long bones in the body it is divided into three sections. A proximal part consisting of the head, neck and upper part of the shaft, the cylindrically shaped shaft is the second part (Sobotta., 2006).

The distal femur makes up the third section. It is flares out from the shaft, widening to form two large condyles, medial and lateral, that form a weight bearing and articular surface for weight transmission to the tibia and articulation with both the tibia and patella.

The condyles are convex in nature. The two condyles are confluent anteriorly and continue into the shaft, while posteriorly and distally, they are separated by an intercondylar fossa.

The femoral – tibial articulation and the femoral – patella articulation form the knee joint complex. The articular surface of the distal femur is broad like an inverted U. The patella surface extends anteriorly on both condyles. The tibial surface is continuous with the patella surface anteriorly, but divided by the intercondylar fossa distally. Laterally and medially, is a wide strip on the convex surface of the posterior – inferior part of the condyles (Gray et al., 2008)

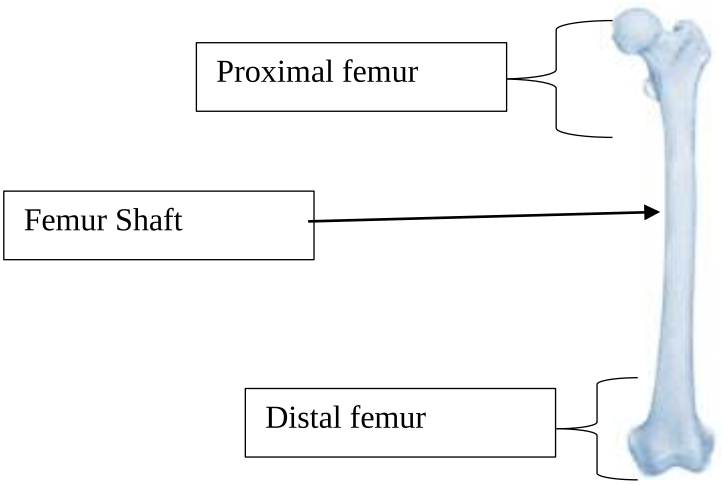

Figure 1: Parts of the femur (Adapted from Sobotta., 2006)

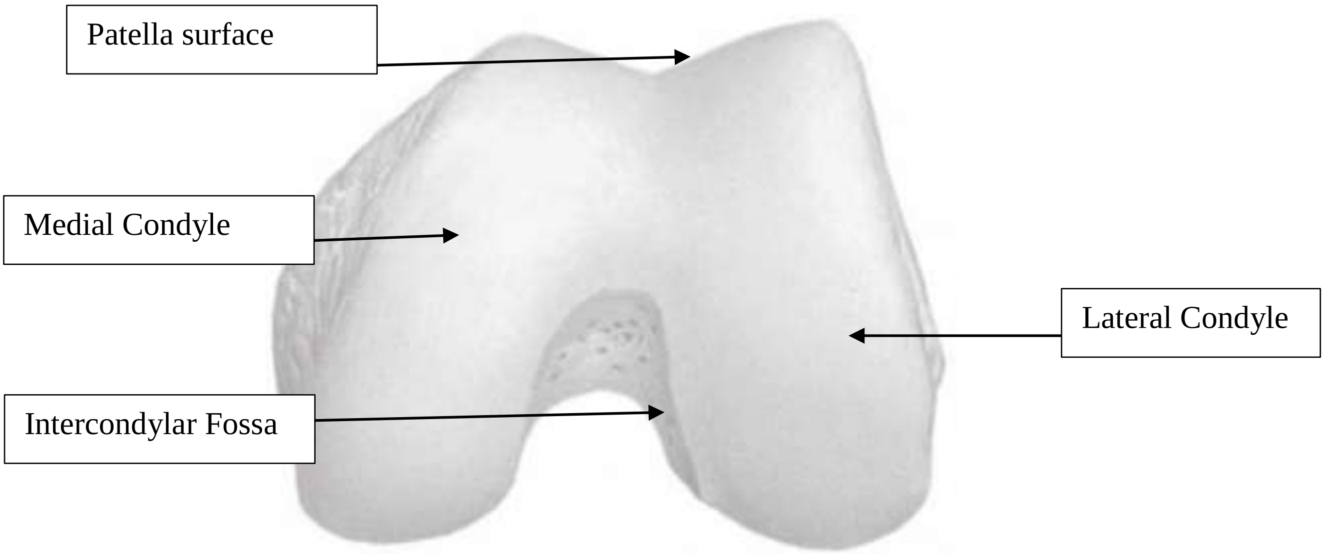

Figure 2: Illustration showing Distal femur, articular surface (Adapted from Sobotta., 2006).

The knee is the largest synovial joint in the body. It is a hinge type joint offering a fulcrum during propulsion critical to walking, running, sitting, standing and other movement of the lower limb vital to activities of daily living.

The distal femur is integral to functioning of the knee joint and any disruption to its anatomy could possibly limit optimal function of the knee and thus compromise health of a person. One such disruption occurs due to breakage or fracture of all or parts of the distal femur.

Distal femur fractures are defined as fractures that affect the lower nine to fifteen centimetres of the femur, down to the articular surface of the knee. These fractures may be the result of high energy trauma, or a simple fall from a standing height (Stover 2001). In young persons, these fractures occur due motor vehicle collision and present with a wide spectrum of injury patterns. In the elderly populace fractures commonly occur due to indirect trauma as a result of force resulting in less articular involvement. Lower energy direct force in these individuals more often results in a multifragmentary metaphyseal fracture and possible intraarticular extension. High energy mechanisms may have quite complex articular involvement associated with the multiple fragments seen in the metaphyseal area (Kolmert W., 1982; Stover., 2001). Following fracture, shortening occurs with the distal articular segment assuming a varus, extension position. The shortening is caused by the pull of the quadriceps and hamstrings, while a varus, extension deformity results from the unopposed pull of the adductors and the gastrocnemius, respectively (Stover., 2001).

These fractures can either be treated operatively or non – operatively. Stover (2001) in his review of distal femur fracture treatment states that non operative treatment usually by skeletal traction and casting were associated with the poorest of results. This included knee stiffness and early onset osteoarthritis due to poorly reduced articular surface.

Early in the 20^{th} century operative treatment of distal femur fractures by open reduction and internal fixation started developing. The use of plates and screws, pins and angle blade plates were reported between 1940 and1960. Initially, results of both treatments were comparable or worse with operative treatment (Neer et al., 1967).

Schatzker and Tile (1989), reported good too excellent results in 73% of patients treated operatively for distal femur fractures. Further research in implant design and surgical technique in various centres, developed guiding principles that inform operative treatment today.

In distal femur fractures treated by operative methods, there is no single surgical implant that can be used for all distal femoral fractures. Implant selection is determined by fracture pattern, patient age, bone density, and other injuries that the patient may have sustained. Rewarding results may be obtained with operative fracture intervention when appropriate patient and implant selection is made and the surgeon demonstrates meticulous skill and sound judgment.

Surgical reconstruction aims to restore the joint articular surface to anatomic position, restore normal axial alignment, length in addition to correcting rotation and angulation. This can be achieved through intramedullary nailing, open reduction and plating, indirect reduction using the Less Invasive Skeletal Stabilization (LISS) plate and use of external fixators (Griffin et al., 2015).

In Kenya (Oduor, 2004), found that only 5.5% of patients with fractures received operative interventions as the only treatment modality compared to 67% who were treated non - operatively. Operative management has been shown to be superior to non - operative management in most fractures (Mize RD and Grogan DP., 1982).

Distal femur fractures are a known cause for stiffness of the knee. Operative management aims to achieve early return to function. This stiffness may be due to residual pain after union of bone, post traumatic arthritis or scarring around knee joint.

1.2 Problem Statement

There has been an increase in distal femur fractures seen at MTRH due to increase in incidence of trauma. From the year 2012 to 2015 there was a forty percent increase in patients treated for distal femur fractures. This has seen a rise in operative interventions for these fractures with an aim of a quick return to full function. The benefit of these interventions have not been measured as locally no studies have been done to demonstrate that this benefit of operative treatment is conferred to the local population.

1.3 Justification

Appropriate and adequate treatment of distal femur fractures is essential to restore the integrity of the knee joint and that plays a major role in maintaining the functional status of the patient. There is little local published data on sociodemographic features, fracture patterns, implants used and functional outcomes of operative treatment of distal femur fractures. This study will generate information on the patterns, treatment and the functional outcomes of distal femur fractures at the orthopedic departments of MTRH, thereby help in planning strategies necessary for effective management of distal femur fractures and act as a basis of providing optimal care to the patient. It will also act as a foundation to carry out further research in this subject.

1.4 Research Question

What are the functional outcomes of operative management of distal femur fractures at MTRH?

1.5 Objectives

Broad Objective

To assess the functional outcomes of operative management of distal femur fractures at MTRH

Specific Objectives

1. To describe the demographic features of patients with distal femur fractures at MTRH
2. To describe patterns of distal femur fractures seen at MTRH
3. To outline implants used in operative treatment of distal femur fractures at MTRH
4. To describe knee function using the Modified Hospital for Special Surgery scoring system

CHAPTER TWO: LITERATURE REVIEW

2.1 Epidemiology of Distal Femur Fractures

An estimated 4% to 6% of all fractures of the femur account for the distal part of the bone (Kolmert W., 1982; Link B.C and Babst R, 2012) and around 0.4% of all adult fractures (Court-Brown.,1998).

Distal femur fractures are about 10 times less frequent than proximal femur fractures (Martinet et al., 2000). In the series reported by Martinet, there were 2165 distal femur fractures as compared to a total of 21,145 long bone fractures recorded over a period between 1980 and 1989. In terms of gender distribution among the patients with distal femur fractures, there were an almost equal number of male (1114) and female (1045) patients.

In the same study by Martinet et al., (2000), there was bimodal age distribution among all the patients with one peak affecting young males and the other peak elderly female patients.

Court – Brown., (1998) noted that among long bone fractures, distal femur fractures together with tibial fractures are the most complex open long bone fractures that orthopaedic surgeons have to deal with. The study further notes that, in distal femoral fractures, 50% of the open fractures were Gustilo IIIB in severity and 80% had an AO type C morphology.

Ng et al., (2011) conducted a retrospective 24 year study on non – hip femur fractures and found that 29% of all the fractures were of the distal femur. There was a similar male to female incidence in distal femur fractures with bimodal age distribution as previously noted.

The bimodal age distribution has been found to be as a result of road traffic accidents and sports for the young males and fragility fractures in the elderly female (Agunda M et al., 2013; Ng et al., 2012).

A study carried at the Kenyatta National Hospital showed that there was a higher incidence in the younger socioeconomic active age group, with motor vehicle accidents as the leading cause of distal femur fractures (Agunda et al, 2013; Oduor, 2004). In another study by Martinet et al., (2000), distal femur fractures were found to have peak incidences in two age groups. One peak comprised young males typically in their third decade who sustain high energy injuries, commonly due to motor vehicle accidents. The second peak comprised mostly of females in their sixth decade, sustaining fractures after low energy injuries due to osteoporosis.

Meek et al.,(2011), has described a third group in recent times. These are fractures occurring around previous total knee replacements, called peri – prosthetic fractures. These have a reported incidence of 0.6% of primary and 1.7% of revision knee arthroplasties at five years post-operatively.

2.2 Fracture Patterns and Classification

Distal femur fractures can be classified anatomically as supracondylar - extra-articular and condylar - intra-articular fractures, and also as pure traumatic and pathological fractures. They can be transverse, spiral or oblique; closed or open fractures; simple or complex comminuted fractures (Agunda M et al., 2013; Oduor P., 2004). Extra – articular fractures are most common and often comminuted (Martinet et al., 2000; Zlowodski et al., 2006). They can also be classified according to presence and size of communicating wounds. For peri – prosthetic fractures functionality of the implant is added to consideration in the fracture pattern

Fractures of the distal shaft of the femur may extend down the diaphysis of the femur to the metaphysis. Supracondylar fractures are located in the metaphysis and may extend as far distally as the origins of collateral ligaments. Unicondylar fractures involve the articular surface of only one condyle and do not cross the midline. Supracondylar – intercondylar fractures include both a supracondylar fracture and a vertical fracture extending into the intercondylar notch (Yuvarajan et al., 2006).

There are various systems of classification that have been developed over the years. In 1967 Neer et al. (1967) proposed a classification system based on number of fragments and degree of displacement. Type I fractures were those that were minimally displaced, Type II fractures were based on the direction of displacement of the condyles (medially or laterally relative to the shaft). Type III Neer fractures are any fractures with comminution.

Seinsheimer, (1980) published a classification of the distal 3 ½ inches of femur fractures based on his experience. His classification divided the fractures into groups based on location and degree of comminution.

The AO Classification of distal fractures of the femur was presented by Muller in the 1980s (Muller et al., 1990). The principle of this classification is an increase in the grade and severity of the fracture.

The Orthopaedic Trauma Association used the AO Mueller fracture classification to develop a comprehensive systematic illustrated classification that was published in 1996 (Orthopaedic Trauma Association Committee for Coding and Classification, 1996). The OTA Fracture Classification was revised and updated and republished in 2007 as the OTA Fracture and Dislocation Classification Compendium (Orthopaedic Trauma Association, 2007).

This classification has gained widespread, but not universal use in the orthopaedic literature, and is gaining acceptance in routine fracture care communication (Decoster et al., 2007).

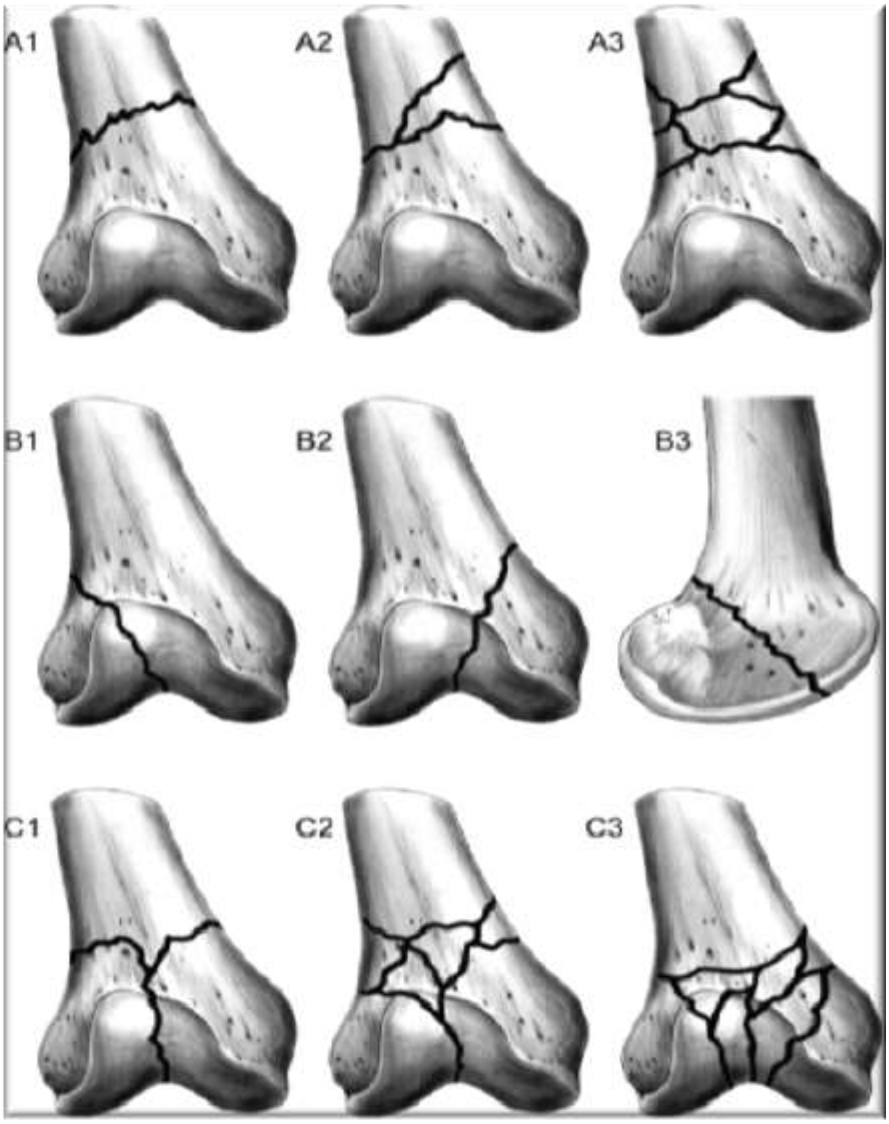

Figure 3 Illustration of AO/OTA Classification (adapted from Orthopaedic Trauma Association, 2007)

Extraarticular fracture

·33 A1: simple

· 33 A2: metaphyseal wedge and/or

Fragmented wedge

· 33 A3: metaphyseal complex

B: Partial articular fracture

· 33 B1: lateral condyle, sagittal

·33 B2: medial condyle, sagittal

· 33 B3: frontal

C: Complete articular fracture

·33 C1: articular simple,

Metaphyseal simple

· 33 C2: articular simple,

Metaphyseal multifragmentary

· 33 C3: articular multifragmentary

Figure 4: Schematic illustration of the AO/OTA Classification (adapted from Orthopaedic Trauma Association, 2007)

2.3 Treatment Modalities

The goals of management of distal femur fractures are correction of axial alignment, length, and rotation; restoration of motion; and rapid union so as to return the patient to normal function (Schatzker and Tile., 1987).

Fractures in general can be either managed operatively or non – operatively. Fractures of the distal femur are no exceptions

In selected cases, non – operative treatment can accomplish these goals. Early use of a hinged brace may be appropriate for the non – displaced or impacted supracondylar femoral fracture (Albert MJ., 1997).

When the patient's age or associated medical conditions or injuries preclude operative reconstruction, skeletal traction may be used to treat a displaced supracondylar femoral fractures (Albert MJ., 1997). In most large series of supracondylar fractures, non-union has been reported to occur in approximately 4 per cent of the patients treated with traction and a cast – brace (Hunter JB.et al., 1982).

Traction is still in use in a number of hospitals in the country. Odour P. (2004) showed that between 2003 and 2004, 67% of those admitted with fractures of distal femur received conservative treatment with traction and developed complication rate of 100% (Decoster T el al., 2007). This illustrates the pitfalls of treatment by traction.

Operative or surgical treatment is the preferred mode of treatment of distal femur fractures. In the study by Odour P. (2004), 4% of patients underwent operative treatment and 50% developed complications. Total hospital stay for non – operative treatment was 2359 days (mean 49) and for those who underwent operative treatment was 150 (mean 37).

The mean hospital bill in Kenya shillings was 25,303 for non – operative group and 17,140 for operative group.

This study done in resource limited setting similar to the one at MTRH shows that there is a benefit to operative treatment both in direct costs accrued by treatment and indirect cost of prolonged hospital stay and missed income opportunities.

2.4 Implant Selection

Available implants for fixation of these fractures include:

- Fixed angle blade plate,
- Non – locked Condylar buttress plate,
- Anatomic Locking plates,
- Dynamic Screw and side plate,
- Cancellous screws,
- Intramedullary interlocking nail.

These fixation devices are either placed extramedullary or intramedullary.

The accepted fixation targets are anatomic rigid fixation of the intra articular fragments and biological stable fixation of the articular component to the diaphyseal component (Albert MJ, 1997).

Among the extramedullary devices, Higgins et al., (2007) in their study found the locking condylar buttress plate to be a significantly stronger construct than the fixed angle blade plate. The non – locked condylar buttress plate was found to be of lesser strength as compared to fixed angled blade plate or DCS.

At the present state of fixation devices the locked condylar buttress plate would have the best of functions of the extramedullary implants with advantage of better fixation of small distal fragment and osteoporotic bones (Garnavos et al., 2012).

Multiple studies have been done to compare intramedullary and extramedullary devices. In particular there are those that have been done to examine the relative stability of retrograde nailing and fixed angle plating for supracondylar femur fractures both mechanically and clinically with variable and sometimes contradictory results.

In other studies, a 95- degree dynamic condylar screw, rather than a locking plate is more rigid than intramedullary nailing in axial loading, and a few have shown significant differences in torsional loading (Yuvarajan et al, 2009).

The advantage of intramedullary nailing over extra – medullary devices is that it can be performed with a very small incision and would take shorter surgical time and less blood loss.

In elderly patients with poor bone quality and comorbid conditions, it may be inappropriate to attempt fracture fixation (Albert MJ., 1997).

2.5 Outcomes

The goal of treatment of distal femur fractures like any other fracture is restoration of limb function (Agunda M et al., 2013).

Thus outcome measures can be designed to measure parameters of limb function after management of fracture. These include pain relief, union, weight – bearing, knee stability and range of motion. This outcomes can be measured using various scoring systems.

Outcome can also be measured based on modalities of treatment, length of hospital stay, rates of union, surgical complications, fixation failure rate and secondary revision procedures.

A systematic review found that average non – union rate of 6.0%, fixation failure rate of 3.3%, deep infection rate of 2.7% and average secondary surgical procedure rate of 16.8% (Zlowodoski et al., 2006).

Outcome can also be based on patient satisfaction which can be useful to the surgeon in deciding treatment modalities.

Garnavos et al., (2012) in their study found that the fractures healed in a mean time of 14.78 weeks. Patients in the study had no complications, neither did secondary failure of fixation occur. The patients regained full extension and 117.22° of mean flexion of the knee joint while the mean New Oxford knee score was 42.05 with 48 being best score attainable

2.4.1 HSS Score

In this study the modified HSS score was used to measure functional outcomes.

Insall et al., (1976) introduced the HSS system. Drake et al (1993) in a literature review recognized 34 different global knee rating systems, of which the Hospital for Special Surgery (HSS), was the most commonly used system. Andrews (1990) found it responsive and reproducible.

HSS knee score is a surgeon assessed weighted score. The score generates a maximum of 100 points derived from six categories:

1) Pain (30 points)
2) Function (22 Points)
3) Range of Motion (22 points)
4) Muscle strength (10 points)
5) Flexion deformity (10 points)
6) Instability (10 points)

7) Deduction if applicable for
   a) Dependence on walking aids
   b) Extension lag
   c) Varus/valgus deformity

Patient outcomes can be classified as Excellent for scores better than 85, Good for scores of 70 to 84, Fair for 60 to 69 and Poor for any scores less than 60. This scoring system is heavily weighted towards pain, range of motion and function.

Other rating systems have since been developed with each differing in terms of ease of administration, complexity, responsiveness, interobserver reliability, objectivity and subjectivity.
It was chosen for its simplicity, ease of administration and responsiveness.

Leung et al. (1991*)* in a review of early functional outcome of distal femur fractures using the modified HSS score, after interlocking intramedullary nailing obtained 35% excellent, 59% good and 5% fair outcome.

Agunda (2013), out of 46 patients 78% had good to excellent to outcomes after operative management of distal femur fracture as measured using the HSS score, with knee stiffness as the leading complication.

In a study done by Sanders et al., (1991) Forty-nine distal femur fractures were treated with the Dynamic Condylar Screw (DCS) between 1982 and 1985. Functional results were graded using a stringent traumatic knee rating scale. Excellent to good results were obtained in 71% of cases, and excellent to fair in 83% of the cases. Greater communition in fractures tended to result in less favourable results.

CHAPTER THREE: METHODOLGY

3.1 Study Site

The research was conducted at the Moi Teaching and Referral hospital (M.T.R.H), situated in Eldoret town 320kms Northwest of the Capital city, Nairobi, Kenya. The hospital (M.T.R.H) is the second largest referral facility in Kenya, after Kenyatta National Hospital. It has a bed capacity of over 1,000 and serves as a referral hospital for the western part of Kenya, with a catchment population of about 16 million people (approximately 33% of Kenyan population). The hospital provides various services ranging from primary to specialized care and serves urban, peri-urban and rural populations from near and far counties. The hospital also serves patients from neighbouring countries like Uganda, Sudan, South Sudan and Rwanda.

3.2 Study Design

This was a prospective study involving all cases seen in a 6 month duration in the course of the study. All patients undergoing treatment for distal femur fractures were considered for the study and followed up for a minimum of 6 months from date of admission.

The study was carried out between February 2016 and February 2017.

3.3 Study Population

All adult patients diagnosed to have had distal femur fractures and received treatment at Moi Teaching and Referral Hospital between February 2016 and July 2016 were considered for the study. The patients were required to fulfil the eligibility criteria below.

3.4 Eligibility Criteria

This was achieved by adoption of inclusion and exclusion guidelines.

3.4.1 Inclusion Criteria:

All adult patients attended to at MTRH within the period of the study with a radiological diagnosis of distal femur fracture(s).

3.4.2 Exclusion Criteria:

All adult patients who did not undergo operative fixation as the definitive management procedure at MTRH and were being followed up in the institution.

Patients who declined to consent for the study.

Patients below 18 years of age.

3.5 Sampling

3.5.1 Sampling technique

Convenience sampling, which entailed interviewing all cases of distal femur fractures and recruitment of all those who satisfied the inclusion criteria sequentially until the desired sample was achieved was done. Any and all patients identified as having a distal femur fracture was entered into the study.

3.5.2 Sample size

Required accuracy of 0.05 and 95% confidence interval was considered. The sample size was calculated using the formula for populations less than 100000 thus:

nf= **n [1**+n *IN]*

Where: nf = The minimum desired sample size.

N Number of cases per year, as recorded in the statistics office.

n 385, given a degree of accuracy of 0.05

The calculations were done as follows:

n 1.96 x 1.96 x 0.5 xO.5

0.05 x 0.05

385

N 44 (an average of **42** cases in the year 2013 and 46

cases in 2014, from Theatre Statistics)

Hence,

nf 385

1+ **385/62**

= **39 (the minimum desired sample).**

3.6 Study Procedure

Patients who presented with unilateral distal femur fractures were identified during admission. Informed consent taken by researcher after the patient was planned for operative fixation.

Patients with open distal femur fractures had surgical debridement done as an emergency procedure, were treated with appropriate antibiotics, analgesics and tetanus toxoid. Fractures were not stabilized with external fixators. Definitive fixation was done using the surgeons' preferred implant at the secondary debridement.

Patients with closed distal femur fractures had their fractures temporarily stabilized using a splint, analgesics administered and admitted to the ward awaiting definitive surgery

Data was collected from the patient, files and radiographs, then recorded using the study questionnaire. The patients were followed up at 2, 6, 12 and 24 weeks, where radiographs were done and recording the number of physiotherapy sessions attended.

Modified HSS knee score was recorded at 2, 6 12, and 24 weeks.

3.7 Data Collection Processing and Analysis

3.7.1 Instruments

Structured researcher administered questionnaire

Modified HSS score form

Goniometer

3.7.2 Personnel

The study was undertaken by the principal investigator himself under the guidance of the supervisors.

3.7.3 Processing and analysis

The data was derived from the questionnaire and Modified HSS score form using a data collection form, carefully monitored and entered into a Microsoft Access Database. Analysis using 0.05 degree of accuracy and 95% confidence interval was carried out by SPSS version 23 software.

Categorical variables were summarized as frequencies and the corresponding percentages.

Continuous variables that assumed the Gaussian distribution were summarized as mean and the corresponding standard deviation(SD).

Continuous variables violated the Gaussian assumptions were summarized as median and the corresponding inter quartile range (IQR).

Association between categorical variables was assessed using Pearson's Chi Square test where appropriate. Association between continuous variables was quantified using Spearman's correlation coefficient and linear regression model. Association between categorical and continuous variables was assessed using Kruskall Wallis test and two-sample Wilcoxon rank sum test.

Variables of age and the modified HSS knee score were categorized using clinically acceptable limits and the cut offs documented.

The modified HSS score was categorized as follows: <60 points – poor, 60 – 69 points – fair, 70 – 84 points good, and >85 points – excellent.

Age was categorized as 18 – 39, 40 – 59, >60.

Level of significance was chosen at $p<0.05$. Results were presented using tables, pie charts and prose form.

3.8 Ethical Consideration

Ethical approval was obtained from the Institution Research and Ethics committee (IREC), Moi University school of Medicine, and the Department of Orthopaedics and rehabilitation at MTRH before undertaking the study.

Informed consent was granted by patients recruited into the study. Access to treatment was not predicated on granting consent and patient could exit the study at any point without prejudice.

Data and information were kept strictly confidential by password protection of database and removing personal identifiers.

3.9 Study Limitations

Lost to follow up was mitigated by regular telephone contact with study participants and encourage attendance of scheduled clinics.

CHAPTER FOUR: RESULTS

A total of 57 patients satisfied the inclusion criteria and were recruited into the study. The study was conducted from February 2016 to February 2017. Three patients were lost to follow up and 54 patients who completed the study had their data analysed. They were all admitted through the accident and emergency department of Moi Teaching and Referral hospital Eldoret.

4.1 Demographic Characteristics

Mean age was 34 (SD ± 11.8) years with a range of 21 – 78 years. Majority of the patients were male 34 and females were 20. Male to female ratio of 1.7:1.

Table 1: Socio – Demographics

		Frequency
SEX	MALE	34(62.9%)
	FEMALE	20(37.1%)

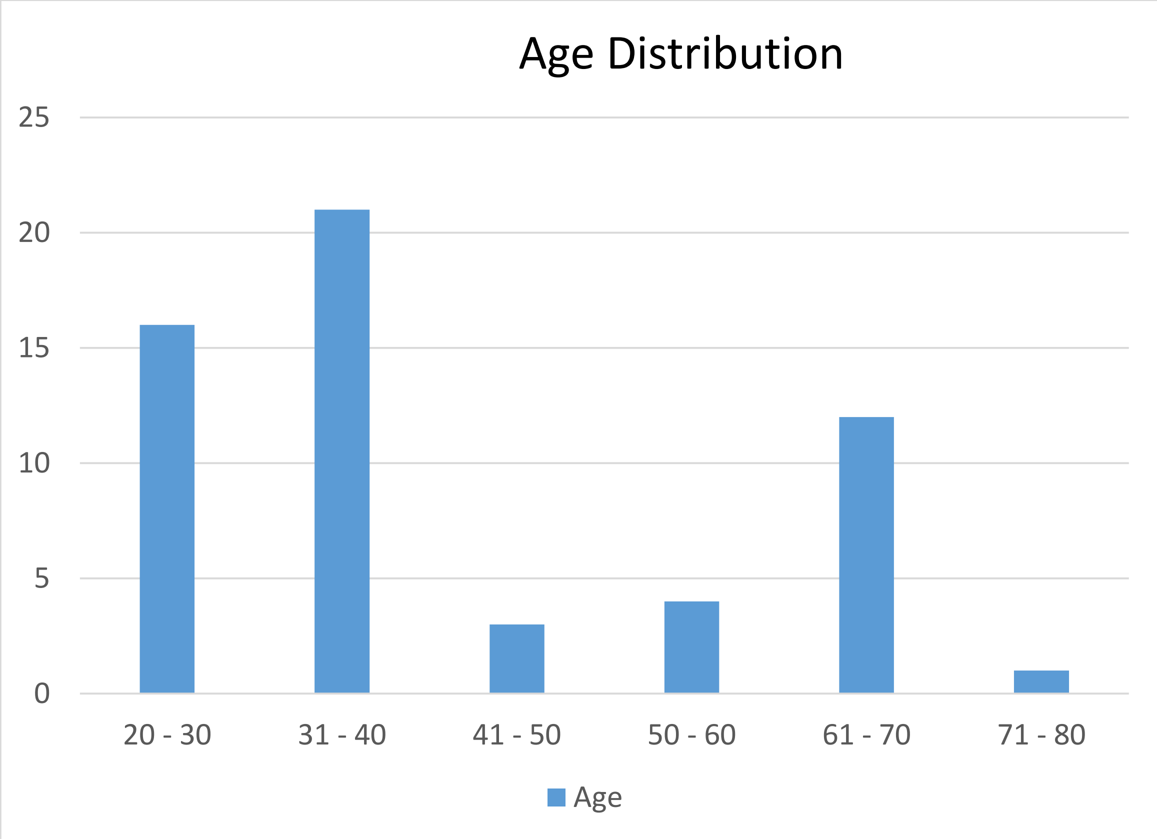

Figure 5: Graph illustrating Age Distribution

There were more males then females with bimodal peaks of age. One was between 20 – 40 years of age and another was between 60 – 70 years of age.

4.2 Distal Femur fracture patterns

Using the AO classification system, 50% of patients studied had type A, followed by 13% with type B and 37% had type C fractures.

Using the Gustillo and Anderson classification 41 patients (89%) had closed fractures and 13 patients (11%) had open fractures.

Table 2: Fracture patterns Using AO Classification

Fracture Type	**Number of patients**	**Total per group**	**Percentage of Population study**
A	27	27	50%
B1 B2 B3	3 2 2	7	13%
C1 C2 C3	2 12 6	20	37%
TOTAL	54	54	100%

Table 3: Fracture Types using Gustillo – Anderson Classification

FRACTURE TYPE	No. of Patients	No. per group	Percentage
CLOSED	41	41	76%
OPEN Gustillo I Gustillo II Gustillo III	13 2 7 4	13	24%
Totals	54	54	100%

4.3 Implants Used In Operative Management

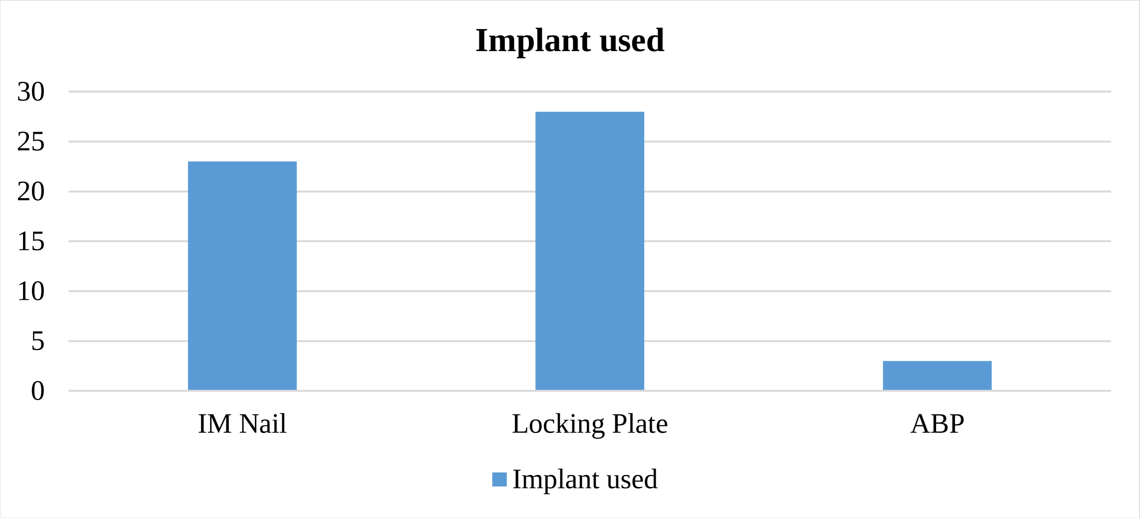

Figure 6: Implants used in Operative treatment

Three types of implants were used for definitive fracture fixation. Distal femur locking plates were used in 28 patients (52%), Retrograde intramedullary nail in 23 patients (43%) and 3 patients (5%) had Angle Blade plates used in fixation of their fractures.

4.4 Functional Knee Outcome – Modified HSS Score

Table 4: Functional Outcomes using HSS score

OUTCOMES	At 2weeks	6 weeks	12 weeks	24 weeks
Excellent (>85)			15(28%)	27(50%)
Good (70-84)		21(39%)	16(31%)	10(18%)
Fair (60-69)	35(65%)	16(31%)	19(35%)	13(24%)
Poor (<60)	19(35%)	17(30%)	14(26%)	4(8%)
Totals	54(100%)	54(100%)	54(100%)	54(100%)

Functional outcomes were measured using the modified HSS score at 2, 6, 12 and 24 weeks. Final outcomes at 24 weeks were found to be excellent in 27 patients, good in 10 fair in 13 and poor in 4 of the patients studied.

Table 5: AO Classification and HSS Score

AO TYPE	MODIFIED HSS SCORE				p VALUE
	POOR	FAIR	GOOD	EXCELLENT	
TYPE A	1	5	3	19	0.041^{r}
TYPE B	2	3	2	2	
TYPE C	2	5	5	6	
Total	4	13	10	27	

r – Fishers exact P value was reported because some cells had expected cell count less than 5.

The table above shows knee scores among the different fracture patterns as classified using the AO criteria. There was a statistical significance between the fracture classes ($p<0.05$).

Table 6: Gustillo – Anderson Type and HSS score

FRACTURE TYPE	MODIFIED HSS SCORE				p VALUE
	POOR	FAIR	GOOD	EXCELLENT	
CLOSED	1	12	7	21	0.034^{r}
OPEN	3	1	3	6	
TOTAL	4	13	10	27	

r – Fishers exact p value was reported because some cells had expected cell count less than 5.

The table above shows knee scores among people with either open or closed fracture patterns.

The difference between the knee scores was statistically significant ($p<0.05$).

Table 7: Age and Modified HSS Score

	n	MEDIAN	IQR	p - VALUE
18 – 39YRS	34	86	82 – 90.5	0.018
40 – 59YRS	7	83	74 – 90.5	
60+	13	70	59 – 80	

The table above shows the knee score across the age groups of the patients. The difference in the median score between the different age groups was statistically significant ($p < 0.05$).

CHAPTER FIVE: DISCUSSION

5.1 Demographics

In this study distal femur fractures have a bimodal age distribution between 20 – 40 years and above 60 years of age. This was in agreement with other study findings that have been reported (Martinet et al., 2000; Oduor P., 2004). Distal femur fracture was more common in males than females in this study. These findings are in agreement with studies by Martinet et al., 2000 and Oduor p, 2004. The male to female ratio of 1.7:1 was in agreement with to Martinet et al., (2000) that showed incidence rates in both male and female patients, M:F 1.6:1. The incidence in males was co – related to high incidence of high energy in trauma while in females was co-related with low energy trauma with underlying osteoporosis (Martinet et al.,2000) .

5.2 Fracture Characteristics

This study found that using the AO classification the most common fracture type was type A followed by type C and least common was type B. Type A are common in both high and low energy fractures hence could explain finding of being the most common fracture type. The study finding concur with those in Agunda M. et al 2013.

Using the Gustillo – Anderson classification closed fractures were found to be the predominant fracture pattern at 76% while open fracture pattern were found to be 24%. This concurs with findings in studies reported by Agunda M. et al., (2013) and Martinet et al., (2000) where they postulated that due to the large amount of soft tissue and musculature surrounding the bone, a lot of the energy would dissipate thereby preventing bone from protruding through the skin.

5.3 Implant used

This study found distal femur locking plates (52%) as the implant most preferred. This was followed by Intramedullary nails at 43% and angle blade plates at 5%. This in agreement with Yuvarajan et al., (2009) who reported locking plates as the preferred implant followed by the intramedullary nail. This is in contrast to Agunda M et al., (2013) where 65% were treated with a dynamic condylar screw 24% with Intramedullary nailing and 11% had angle blade plating.

5.4 Functional Outcomes

In this study patients who scored good and excellent functional outcomes were 70%. This showed that operative fracture fixation of distal femur fractures is a procedure with satisfactory results even though injury and procedures involve trauma to the knee. This is comparable to studies that show operative management of distal femur fractures have excellent functional outcomes, (Agunda M et al, 2013; Doshi, 2013; Leung 1991).

Type A fractures had better outcomes compared to type C, this is in agreement with the study by Doshi 2013, which showed type C fractures had reduced functional outcomes, possibly to intraarticular involvement in type C fracture and arthrosis after healing.

In this study the median HSS score decreased with older ages, a finding that was statistically significant. In addition expected degenerative changes of the knee joint with advancing age may make this finding to be of clinical relevance. This is in contrast to a study done by Doshi 2013, where the investigators found patients above 60 years to have good functional outcome after operative management of distal femur fractures. The contrast could be attributed to lack of a knee rehabilitation protocol after injury and surgery at MTRH which was present at that study site.

In this study the Gustillo – Anderson classification of the fractures (Open or Closed) found an association between open fractures and reduced functional outcome. This is in concurrence with other studies that have reported lower functional scores in type C open fractures (Agunda M et al., 2013).

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Conclusions

There was a bimodal age distribution with males affected more than females.

Most of the patients 52% had type A fracture patterns with 75% with closed fracture patterns, with male patients being majority with a male to female ratio of 1.7:1.

The distal femur locking plate, intramedullary nail and angle blade plate were the preferred implants for operative management, with a majority of patients receiving the distal femur locking plate.

Majority of the patients (70%), had good to excellent outcome scores after having operative distal femur fracture treatment. Type A fracture patterns were associated with better functional outcomes. Type B had good functional outcome and type C had poor functional outcomes.

Soft tissue injury was not found to have a functional influence in outcome.

6.2 Recommendations

Further studies on type C distal femur fractures, Open distal femur fractures and distal femur fractures in the elderly on factors that may improve functional outcomes in these groups of patients

Further studies comparing type of implants and fracture type to be done as this could impact on outcomes.

Development of a knee rehabilitation protocol could improve functional outcomes as it was noted patients did not follow any rehabilitation protocol.

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APPENDICES

Appendix 1: Consent Form

FUNCTIONAL OUTCOMES OF DISTAL FEMUR FRACTURES TREATED OPERATIVELY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA.

Investigator – Mwiti Fred Munene, P.O Box 420, 00200, Nairobi Kenya.

I…………………………

Tel No…………………..

Hereby voluntarily agree to participate in this study which aims at providing information geared towards improving health care for patients with such injuries. I shall volunteer information regarding my injury and undergo medical examination. I have been informed that participation in the study or lack of it will not interfere with my treatment and that all the information obtained will be treated with utmost confidentiality. I am aware that I can withdraw from this study anytime without prejudice to my right of treatment at MTRH now or in the future.

Patient sign:………………

Date:……………..

Appendix 2: Cheti Cha Kukubali Cha Mshiriki

MATOKEO YA MATIBABU KWA NJIA YA UPASUAJI KWA WA WAGONJWA AMBAO WAMEVUNJA FUPA LA PAJA KARIBU NA GOTI KATIKA HOSPITALI YA MOI TEACHING AND REFERRAL, ELDORET, KENYA.

Mtafiti – Mwiti Fred Munene, P.O Box 420, 00200, Nairobi Kenya.

Mimi……………………………………………………

Nambari ya simu……………………………………….

Nakubali kwa hiari kujiungana na utafiti kuhusu matokeo ya upasuaji kutibu kuvunjika kwa mfupa wa paja karibu na goti katika hospitali ya MTRH. Matokeo ya uchunguzi huu yanatarajiwa kutumika kutengeneza miundo msingi ya kuwatibu wagonjwa ambao wamevunja mfupa wa paja kwa njia ya upasuaji. Kujiunga kwako katika utafiti huu ni kwa hiari yako, na kutojiunga hakutafanya ubaguliwe katika matibabu yako. Habari utakazotoa zitawekwa kwa njia ya siri. Ninahabari kuwa ninaweza kujitoa katika utafiti huu kwa wakati wowote bila ya kubaguliwa na wanaotoa matibabu.

Sahihi ya Mgonjwa:………………

Tarehe:……………..

Appendix 3: Data Collection Tool – Questionnaire

FUNCTIONAL OUTCOMES OF DISTAL FEMUR FRACTURES TREATED OPERATIVELY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA.

SERIAL NO:…………………………………………………………….

NAME:…………………………….. ……………………………………….

IP NO…………………………………………..

DOB……………………………………………

SEX…………………………………………….

MOBILE NUMBER………………………………………..

LEVEL OF EDUCATION:

NONE……………………………

PRIMARY………………………..

SECONDARY…………………….

TERTIARY……………………………

DATE OF INJURY……………………………….

DATE OF ADMISSION………………………………

DATE OF DISCHARGE………………………………….

MODE OF INJURY………………………………………

RTA………………………

FALL……………………..

ASSAULT………………….

GUNSHOT………………………..

OTHERS(SPECIFY)………………………….

HOSPITAL PRESENTATION

DIRECT TO MTRH………………….

REFERRED……………………

FRACTURE INVOLVEMENT

ISOLATED FEMUR FRACTURE(STATE LEFT OF RIGHT)………………

MULTIPLE FRACTURES(STATE BONES INVOLVED)…………………

OTHER INJURIES(SPECIFY)……………………………..

PREVIOUS KNEE INJURY ON INJURED SIDE…………………….

FRACTURE CHARACTERISTICS

PATTERN: TYPE A…………..

TYPE B……………..

TYPE C……………

NATURE :

CLOSED…………………….

OPEN:

GUSTILLO –I

GUSTILLO – 11

GUSTILLO – 111

DATE OF SURGERY……………………………

TIME BEFORE DEFINITIVE SURGERY (STATE IN HOURS)……………………..

IMPLANT USED………………………….

MANIPULATION OF KNEE DONE……………………….

Appendix 4: Modified Hospital for Special Surgery Score

A) Pain (30 points)

Walking

None	15
Mild	10
Moderate	5
Severe	0

At rest

None	15
Mild	10
Moderate	5
Severe	0

B) Function (22 points)

Walking

Walking and standing unlimited	12
5 – 10 blocks, standing >30 minutes.	10
1 – 5 blocks, standing 15 – 30 minutes	8
<1 block	4
Cannot walk	0

Stairs

Normal	5
With support	2

Transfer

Normal	5
With support	2

C) Range of Motion (15 points)

80 degrees	10
90 degrees	11
100 degrees	12
110 degrees	14
120 degrees	15

D) Muscle strength (15 points)

Grade 5	15
Grade 4	12
Grade 3	9
Grade 2	6
Grade 1	3
Grade 0	0

E) Flexion deformity (10 points)

None	10
0 – 10 degrees	8
10 – 20 degrees	5
>20 degrees	0

F) Instability (5 points)

None	5
0 – 5 degrees	4
6-15 degrees	2
>15 degrees	0

TOTAL SCORE…………………………………………………………..

G) SUBTRACTIONS

One cane	1
One crutch	2
Two crutches	3

Extension lag

5 degrees	2
10 degrees	3
15 degrees	5

Deformity

(5 degrees = 1 point)

Varus ………………………………………………..

Valgus……………………………………………….

TOTAL SUBTRACTIONS…………………………………………………………

TOTAL KNEE SCORE………………………………………………………..

KEY

Excellent = 85 points or more

Good = 70 to 84 points,

Fair = 60 to 69 points

Poor = less than 60 points.

Appendix 5: Work Plan

Activity	Duration	Date	Participants
Topic selection	1 month	January- February 2015	Researcher and supervisors
Concept paper presentation to department	1 month	February- March 2015	Researcher and supervisors
Proposal writing	2 months	March- May 2015	Researcher, Biostatistician and supervisors
Submission to and approval of proposal by IREC		May 2015- September 2015	Researcher and supervisors
Data collection		October 2015- August 2017	Researcher
Thesis writing	5 months	August 2017- January 2018	Researcher and supervisors
Submission of thesis	1 month	February 2018	Researcher and supervisors
Oral defense of thesis	1 month	August 2018	Researcher and supervisors

Appendix 6: Work Plan

ITEM	QUANTITY	UNIT COST [Kshs]	TOTAL [Kshs]
USB/Flash disc	1	3,000	3,000
Printing cartridges	2	10,000	20,000
Printing paper	10 Reams	500/ Ream	5,000
Folders	20	50	1,000
Printer	1	20,000	20,000
Transport		5,000	5,000
Miscellaneous	Includes proposal writing, IREC fee and Thesis preparation and publication.		40,000
Total			94,000

APPENDIX 7: Institutional Research and Ethics Committee Approval

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P. O BOX 3
ELDORET
TEL: 33471/2/3
Reference: IREC/2015/171
Approval Number: 0001458

MOI UNIVERSITY
SCHOOL OF MEDICINE
P. O BOX 4006
ELDORET
28th July, 2015

Dr. Fred M Mwiti,
Moi University,
School of Medicine
P. O. Box 4606,
ELDORET, KENYA.
Dear Dr Mwiti

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
28 JUL 2015
APPROVED

RE: FORMAL APPROVAL

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

"Functional Outcomes of Distal Femur Fractures Treated operatively at Moi teaching and Referral hospital, Eldoret, Kenya."

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1458*** on 28th July 2015. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 27th July 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 requested to submit progress report(s) regularly as dictated by you 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,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

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