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Assessment of Functional Outcome of Open Reduction and Internal Fixation of Distal Femur Fracture with distal femur locking plate and its associated factors

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COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF MEDICINE DEPARTMENT OF ORTHOPAEDICS & TRAUMA SURGERY

ASSESSMENT OF FUNCTIONAL OUTCOME OF OPEN REDUCTION AND INTERNAL FIXATION OF DISTAL FEMUR FRACTURE BY DISTAL FEMUR LOCKING PLATE AND ITS ASSOCIATED FACTORS AT TIBEBE GHION SPECIALIZED HOSPITAL, BAHIR DAR, ETHIOPIA.

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THESIS REPORT TO BE SUBMITTED TO BAHIR DAR UNIVERSITY, COLLEGE OF MEDICINE AND HEALTH SCIENCES, DEPARTMENT OF ORTHOPEDIC SURGERY FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR SPECIALTY IN ORTHOPEDIC AND TRAUMA SURGERY

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Study	*Title*	*Assessment of Functional Outcome of Open Reduction and Internal Fixation of Distal Femur Fracture with distal femur locking plate and its associated factors*
	Study Design	*Prospective cohort*
	Study Area	*Department of Orthopedic Surgery, TGSH, Bahir Dar, Ethiopia*
	Study Period	*August /2022 to August 2023, GC*

Declaration

This is to certify that the thesis entitled “to assess the functional outcome of distal femur fracture treated with open reduction and internal fixation using distal femur locking plate and its associated factors in TGSH” submitted to department of orthopedics and trauma surgery, Bahirdar university for partial fulfillment of the requirements for specialty in Orthopedic and Trauma Surgery, is the record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during the course of this study have been duly acknowledged.

_____	_____	_____
Name of principal investigator	Date	Place

Approval of thesis for Defense

I hereby to certify that I have supervised, read, and evaluated this thesis titled "To assess the functional outcome of distal femur fracture treated with open reduction and internal fixation using distal femur locking plate and its associated factors in TGSH "by Dr Yonatan Abie prepared under my guidance. I recommend the thesis to be submitted for oral defense.

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III

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Abstract

Background: Distal femur fracture accounts 6 % of all femur fractures. Treatment of distal femur fracture is one of the orthopedic challenges. Historically nonoperative management was the mainstay of management which now evolved to operative management. There is no single implant used for all type of distal femur fractures. Implants are evolving with time parallel with advancement of technology.

Objective: To assess functional outcome of open reduction and internal fixation of distal femur fracture by distal femur locking plate and its associated factors at Tibebe Ghion Specialized Hospital, Bahirdar, Ethiopia.

Material and Method: This prospective cohort study was carried out among adult patients with distal femur fracture treated by open reduction and internal fixation using distal femur locking plate at Tibebe Ghion Specialized Hospital from august 2022 to July 2023. Using convenient sampling technique, a total of 60 patients with both AO Type A and Type C fracture were included. All patients were followed at 2 wks., 6wks ,12 wks. and 6 months. Functional outcome was assessed using Neer's scoring system. Data was entered and analyzed using SPSS 27. Frequency, mean and cross tabulation were used to summarize descriptive statistics. Multinomial logistic regression was used to test the association of independent variables with functional outcomes.

Result: In this study out of 60 patients, 48.3% patients had excellent, 30% had good, 10% had fair and 11.7% of patients had poor functional outcome by Neer's score system**.** On the last follow up, 23.6 % of patient had stiffness, 16.7% had pain and 8.3 % had infection. Compared to patient with open fracture patient with closed distal femur fracture had 49 % higher chance of having excellent functional outcome (AOR (2.49(5.8 ,1.07)). Patient who had regular follow up had 7 times higher probability of excellent functional outcome than those who had no regular follow up (AOR 7.16(1.11,46.22)).

Conclusion and recommendation: This study found higher functional outcome among patients with AO Type A and Type C distal femur fracture treated by open reduction and internal fixation using distal femur locking plate. Closed fractures and having regular follow up were factors associated with excellent functional outcome. Public awareness about gun handling and peaceful conflict solving culture by government should be advocated. All patient should have regular follow up.

Key words: distal femur fracture, Neer's score, distal femur locking plate, ORIF, Functional outcome.

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Acronym

AO: Arbeit gemeinschaft für Osteosynthesefragen

K-wire: Kirschner wire

DF LCP: distal femur locking compression plate

Ex -Fix: External fixator

FDA: Fall Down Accident

IM Nail: Intramedullary Nail

IRB: Institutional Review Board

KSS: Knee Society Score

LISS: Less Invasive Stabilization System

MVA: Motor Vehicle Accident

ORIF: Open Reductio and Internal Fixation

OTA: Orthopedic Trauma Association

PI: Principal Investigator

RTA: Road Traffic Accident

SPSS: Statistical Package for Social Science

1. Introduction

1.1 Background

The femur is the longest, strongest and heaviest tubular bone in the human body and one of the principal load bearing bones in the lower extremity[1]. Distal femur includes from metaphyseal-diaphyseal junction distally extending to intraarticular surface. The most common mechanism of injury is road traffic accident. The mechanism of injury depends on age of the patients. In young patient high energy injury are the most common causes like road traffic accident and in old patient its usually caused by low energy mechanism like fall from standing height. Distal femur fracture also occurs in periprostatic area in those patients who had knee total arthroplasty. Distal femur fractures cause significant morbidity with different debilitating complication if it's not managed appropriately [2].

Fractures of the distal femur have an estimated incidence ten per 100 000 and account for 6% of all femoral fractures [3]. These injuries have a bi-modal distribution with the first peak being seen in the young resulting from high-energy trauma and the second peak being seen in the elderly osteoporotic population [1, 4, 5]. It causes considerable morbidity and mortality, especially in the elderly [6]. Many treatments have been used in the management of these injuries. Historically, people were treated in bed with skeletal traction. More recently, surgical fixation of distal femur fracture has become mainstay of treatment. Implant used for surgical fixation include 95-degree angle blade plate (ABP), dynamic condylar screw (DCS), distal femur locking plate, intramedullary nail, External fixator, arthroplasty and distal femur replacement. With advancement of technology , these implants have been evolved particularly distal femur locking plate advanced by incorporating hybrid screw hole for locking and compression screw depend on fracture pattern and it also provide multi-plane screw trajectory to hold many small fragment and coronal fractures components [2, 7, 8]. Despite these advances, Controversy still exists regarding the surgical treatment method of distal femoral fractures. Internal fixation procedures are dependent on fracture type, patient status and the surgeon's preference. While intramedullary nails have comparable advantages as locking plates such as percutaneous placement, indirect fracture reduction, soft tissue protection, success in osteoporotic bone, and high healing rates, locking plates have become the most commonly used method to treat distal femur fracture [7, 9].There is currently no consensus about the best way to treat these fractures [10].

1.2 Statement of Problem

Distal femur fractures are becoming complex, often displaced, comminuted, intra-articular and present a huge challenge to the orthopedic surgeon[11]. The management of distal femur fracture has both conservative and surgical method [12]. In current practice, distal femur fractures are commonly treated with open reduction and internal fixation (ORIF) using locking plates, condylar screws, blade plates and intramedullary nails (IMN)[13]. Surgical treatment with open reduction and internal fixation improves alignment and provides stability to the bone and surrounding soft tissues and is generally indicated to allow early rehabilitation. The presence of osteoporosis, comminution, and intra-articular extension often makes it challenging to use intramedullary fixation. Hence, extramedullary implants such as 95° condylar screw plate, 95° Angle Blade Plate (ABP), and locking plate are more favorable in such cases. Although open reduction and internal fixation is achievable , a wide surgical exposure particularly in the complex fracture patterns risks nonunion and infection due to soft tissue compromise and less stable fixation[2, 14, 15].

The adverse outcomes of distal femoral fracture treatment include intera - operative complication like neurovascular injury and mal-reduction, early post- operative complication in the form of superficial infection, deep infection, a thromboembolic complication, pneumonia, urinary tract infections or myocardial infarction and late complications such knee pain, knee stiffness, late deep infection, implant failure, malunion, delayed union and nonunion. Complication following open reduction and internal fixation negatively affect the functional outcome of the patient which has significant impact on the patient's life [1, 2, 5, 12, 15,16].

Studies have shown good to excellent functional outcome following treatment of adult patient with ORIF using DF LCP which was assessed by different validated outcome scoring system including Neer's score, knee society score (KSS), Mize criteria and Modified Mize criteria. Neer's scores is used more frequently because of its simplicity. Different factors associated with good to excellent functional outcome were reported which includes, closed or minimally open fractures, proper soft tissue management, low energy fractures (AO type A), proper selection of implant, careful preoperative planning, wise case selection, accurate positioning and respecting all basic principle of fracture of fixation[17, 18,19].

In our hospital we use DF LCP for treatment of adult patient with distal femur fracture. However, in developing countries specifically in Ethiopia there is scarcity of evidence on management of distal

femoral fracture and functional outcome of distal femoral fracture fixed with an angular-stable locking plate. Therefore, this study was intended to fill this gap by providing evidence on functional outcome of distal femur fracture treatment using DF LCP for better practice.

1.3 Significance of the study

There is an increment of distal femur fracture in the country particularly from road traffic accident and fall down injury. This study will enable us to know the functional outcome of the treatment of distal femur fracture treated by ORIF using DF LCP which we are using frequently in our hospital currently. The finding of this study will help surgeons to identify factors associated to good to excellent and poor functional outcomes and developing methods to prevent poor outcomes.

Currently most literature recommends treatment of distal femur fractures by open reduction and internal fixation (ORIF) using distal femur locking plate. Developed countries manage this fracture appropriately based on the clear indications and asses their functional outcomes by which they make revision their treatment protocol. On the other hand, in resource limited countries like Ethiopia there are tendencies to operate patients by the implant we have at hand without local evidence on the functional outcome just based on report of other continent study. Studies shows functional outcomes vary with pattern of trauma in different geographic area. For the above-mentioned reasons and lack of research in the study area, distal femur fracture fixation outcome is unpredicted in our hospital and in our country at large. So, knowing the functional outcome and identifying the factors associated with treatment of distal femur fracture by ORIF using DF LCP helps professionals to prepare treatment protocol.

In addition, the study also can be used as base point for large scale studies in our country. Moreover, the findings of the study help professionals in the area to improve the current clinical service practices by improving case managements

1.4 Literature Review

Magnitude

Currently because of industrialization and life style change, trauma particularly, road traffic accident is becoming highly prevalent and has increased the incidence of complex distal femur fracture. Femur fracture account for 10.6 % from all extremity injury. Distal femur fracture accounts for 6.7% of all femur fracture and 0.4 % of all fracture[1,17]. Although its less common than hip fracture its becoming more challenging because of its increased tendency in incidence and complexity[21].

Sociodemographic pattern

Distal femur fracture has bimodal age distribution with young age healthy males and old age osteoporotic females [21].

In Italy, prospective study was done in 2018 on 42 patients with distal femur fracture treated with DF LCP and included patients with age range of between 19 and 101 years old with mean age of 65years old. Among them 66.7% patient were old osteoporotic female[11].

In Spain retrospective study was done in 2018 on 30 patient with distal femur fracture treated with less invasive stabilization system (LISS) and included patient with age ranging from 20 up to 101 years of old with mean age of 71 years old. Among them 90% were female with female to male ratio of 9:1[19].

Another retrospective study in India was done in 2021 which included 25 patients with distal femur fracture treated by ORIF using DF LCP and showed the age distribution between 19 years old and 72 years old with mean age of 42.5 years old. It found that about 72% of patient were younger than 47 years old. Male patients were dominate with 80% with male to female ratio of 4:1[22].

Prospective study in Nigeria which was done in 2019 showed the age distribution more in young individual with most patients were in between 20 and 30 years of age among both female and male. Most patients were male with 75% incidence and male to female ratio was 26:1 ratio[1]

Mechanism of injury

Mechanism of injury depends on age of the patient. Young patient sustain the fracture from high energy injury like road traffic accident ,high level fall and old osteoporotic patients sustain from low energy mechanism such as fall from standing height[23].

Road traffic accident has been reported as predominant mechanism (88%) followed by Fall down accident (12%)in 2021 by prospective study done in India which involved 25 patients with distal femur fracture treated with ORIF in which 72% of patients were between 18 and 47 years old[22].

In other retrospective study on 42 patent in 2020 in India, found RTA as the most common mechanism of injury (76%) followed by FDA(19 %) and sport injury(5%)[11].

Low energy mechanism by fall down from standing height was reported as predominant mechanism (80%) in Spain by prospective study done in 2018 on 30 patient and high energy mechanisms including RTA and FDA accounts for only 20%. In this study most patient were old with mean age of 71years old which included patient as old as 101 years of old[19].

Treatment options

Before 1960 distal femur fracture was been treated nonoperatively but the complication including angular deformity ,knee stiffens and poor functional outcome lead to surgical treatment[21]. The treatment of distal femur fracture has evolved since 1960's from totally conservative management to current definitive surgical management. [24].

Distal femur fractures are usually associated with soft tissue injury, intraarticular extension, extensor mechanism injury and severe commination which pose extra challenge in treatment. Wide canal and poor bone quality add to challenge too[18].

The goal of treatment of distal femur fracture is anatomic reduction and fixation of articular surface with absolute stability, achieving length and rotation of meta-diaphyseal with relative stability and allowing early mobilization. Open reduction and internal fixation is the most reliable method to achieve this goal[25].

There are different surgical options of management for distal femur fracture including blade plate, Dynamic condylar screw, non- locking buttress plate, retrograde nailing and distal femoral locking plate.

Before advent of DF LCP using single lateral plate was associated with nonunion and malunion with varus collapse and addition of medial plate causes more soft tissue injury. DF LCP became the gold standard for treatment of distal femur fractures. Because of its very biomechanical nature it provides fixed angel construct between plate and screw which theoretically prevent varus collapse and allow to be used as internal splint without compression with flexibility at fixation which promote callus formation. Up to 90% union rate was reported even with complex intraarticular distal femur[23, 25].

Treatment outcomes and factors

In India in 2018, prospective study was done on 34 patients with AO Type A and Type C distal femur fractures by open reduction and internal fixation with DF-LCP. After 1 year follow up, functional outcome was assessed using Neer's outcome scores[27]. They found 62 % patients had excellent, 32% satisfactory and 6 % of patient had unsatisfactory. They concluded that DF -LCP has better outcome for both young and old patients with short duration of operation, faster recovery, faster union rate and excellent functional outcome with low rate of complication. They mentioned also careful preoperative planning, wise case selection, accurate positioning and respecting all basic principle of fracture fixation were the key factors for better outcome[15].

In another study at Michigan State University/Orthopedic Associates of Michigan, US in 2018, 243 patients with distal femoral fractures (AO/OTA 33) surgically treated by locking plate were retrospectively followed. The result showed 20%of patient developed nonunion and 9.9 % of patients had hardware failure. Closed and minimally open fracturs showed higher rate of union. They concluded that despite modern fixation technique used it may result persistent disability and worse clinical outcomes. It also found the association of soft tissue management and soft tissue status at time of fracture with clinical and functional outcome[17]

In new Delhi, India retrospective study was done in 2018. It was done on 61 patients with type 33A and type 33C fractures treated with distal femur locking plate. Functional outcome and radiological outcomes were assessed by Mize criteria[28] and aLDFA respectively[29]. The result showed patient with type 33A distal femur fracture had 96.66 % union rate and excellent functional outcome but patient with type 33C distal femur fracture particularly those with C3 type of fracture had higher rate of varus deformity with failure functional outcome according to Mize- Modified criteria and relatively lower rate

of union. The conclusion was using dual plating and cortical strut graft for fractures with comminution and bone lose can address the varus collapse but it was associated poor functional outcome[18].

Prospective study in 2018 on 30 patient with distal femur fractures including type A, B & C treated by Less Invasive Stabilization System (LISS) plate was done in Department of Orthopedic Surgery and Trauma, University of Barcelona, Spain. They studied the consolidation index and clinical outcome measured by Knee Society Score (KSS)[30]. The result showed the average consolidation time is 16 weeks confirmed by radiological sign of healing and the average functional outcome score was 77.3 %. They found 26.7 % of patient had good, 66.7 % acceptable and 6.7 % of patient had bad functional outcome. The conclusion was LISS has shown good or acceptable result in 94 % of patients. It showed better result specially for Type C (84.25 % KSS mean score) and osteoporotic bone. The outcome was better with longer plate used particularly for type C fracture and osteoporotic bone[19].

1.5. Conceptual framework

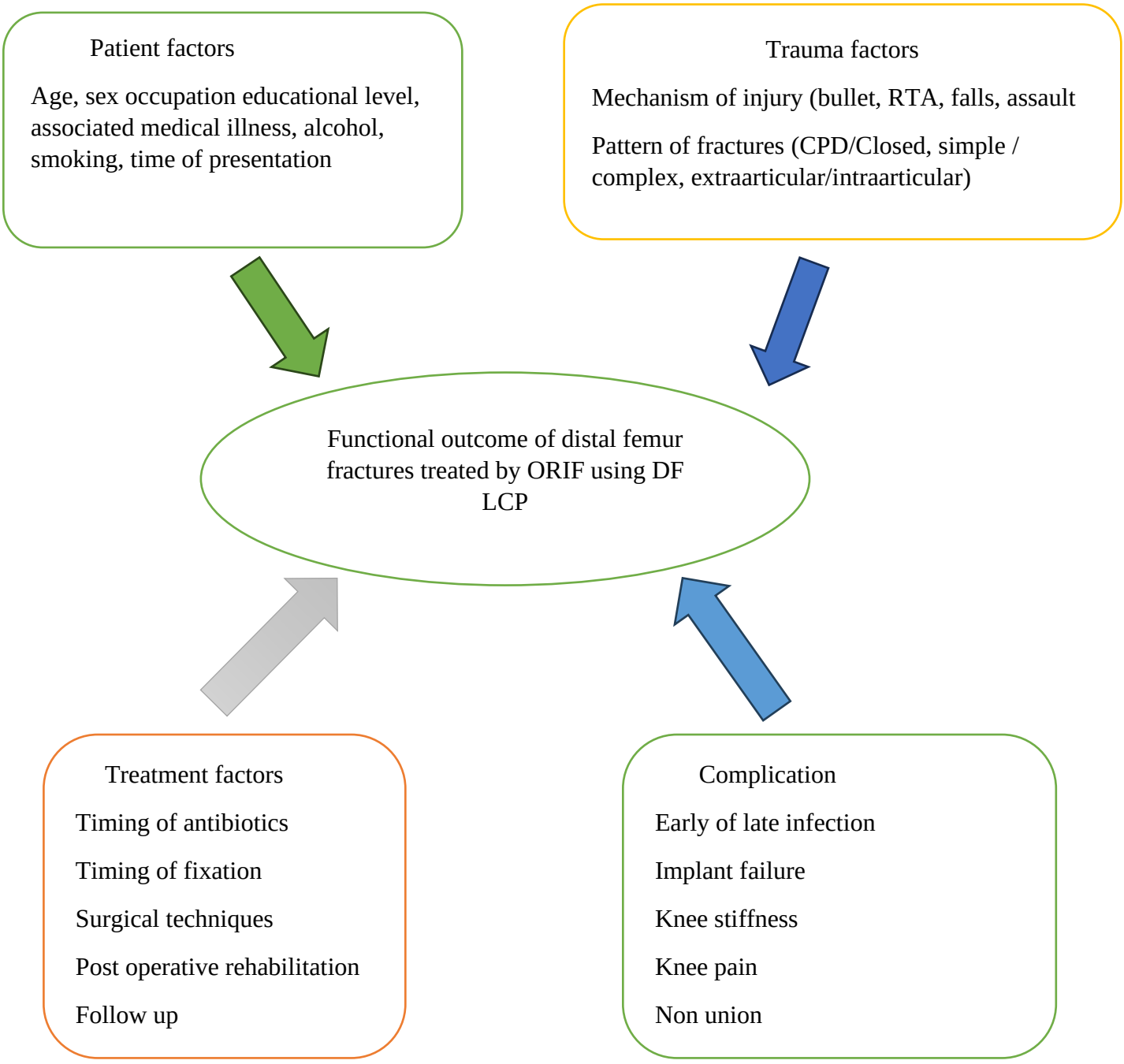


Figure 1: showing conceptual frame work of functional outcome of distal femur fractures treated by ORIF using DF LCP and associated factors[15,22, 23]

2. Objective

General objective

To assess the functional outcome of distal femoral fracture treated by distal femur locking compression plate (DF LCP) and its associated factors at Tibebe Ghion comprehensive specialized hospital, Bahirdar, Ethiopia, from August 2022– July ,2023.

Specific objective

To assess functional outcome of distal femoral fracture treated by distal femur locking compression plate.

To determine associated factors with functional outcome of distal femoral fracture treated with distal femur locking plate.

3. Methods and Materials

3.1. Study area and period

This study was conducted in the department of orthopedics & trauma surgery in TGSH. TGSH is one of the biggest specialized university hospitals in Amhara region and in the country at large. It was established in 2018. The hospital has more than 500 beds in all wards.

There are 67 beds in orthopedics and trauma surgery ward. It has 3-unit; general orthopedic unit, pelvic and acetabulum unit and pediatric orthopedic unit. Currently there are 7 general orthopedic surgeons, 2 pediatric orthopedic surgeon, 1 Arthroplasty and Sport surgeon and 2 pelvic and acetabulum surgeons. The department started postgraduate program since 2007 and it graduated 4 batch with total of 25 orthopedic surgeons so far. Currently there are 28 residents attending their specialty training in orthopedic surgery. The department has its own major operation room with two operating tables and major operations are done 5 days in a week on elective base and daily for emergency cases. This study was conducted from August ,2022 GC up to July 2023

3.2. Study design

A prospective cohort study was conducted.

3.3. Source and study population

Source population: Study population was all adult patient with distal femur fracture treated with open reduction and internal fixation by locking distal femur plate and those who had followed up at TGSH.

Study population: Study population was all adult patient with distal femur fracture treated with open reduction and internal fixation by locking distal femur plate and those who had followed up at TGSH.

3.4. Inclusion and Exclusion criteria

Inclusion Criteria:

All adult patient of ≥18 years old with distal femur fracture treated by ORIF using DF LCP.

Exclusion Criteria

Patient with pathological fracture, peri-prosthetic fracture and associated ipsilateral fracture

3.5. Sample size

From previous studies, the incidence of each outcome measure was assessed for the purpose of sample size determination; of which 'excellent' outcome was having the largest sample estimate by having 62 % occurrence in one study[15]. So, the minimum number of samples required for this study was determined by using single population proportion formula.

$$\boldsymbol{n = \frac{p(1-p)Z^2}{e^2}}$$

n = the minimum required sample size

p = the percentage occurrence of the outcome (good in this case) = 62% = 0.62

e = Absolute precision or tolerable margin of error= 5 % (0.05)

z = standard normal distribution (Z=1.96), CI of 95% = 0.05

sample size : $\boldsymbol{n = \frac{p(1-p)Z^2}{e^2} = \frac{0.62(1-0.62)x1.96^2}{(0.05)^2}}$ 362.203 ≈362

10 % contingency for no respondent or lost follow up = 362 +37 =399

However, census was done and all operated patient with distal femur fracture were included. Since TGSH is the main center in the region where this kind of surgery can be done attaining the calculated number of patients was difficult.

3.6. Sampling Procedure

Using convenient sampling method all adults with distal femur fracture treated with open reduction and internal fixation and fulfilling the inclusion criteria, from August 2022 – July, 2023 at the orthopedic department of TGSH were included in the study.

3.7. Data Collection Tools and Data Collection Procedures

Data collection tool was adopted from different literature [11, 15, 22, 23]. Questioners were written in English. Data were collected by structured face to face interview, clinical examination and investigation (X-ray, ESR, CRP.) in each follow up day.

3.8. Variables

Dependent variable:

Functional outcome of distal femur fracture treated by open reduction and internal fixation

Excellent

Good

Fair

Failure

Independent variables:

Age

Sex

Educational level

Residence/place (urban or rural)

Occupation

Alcohol

Cigarette smoking

Mechanism of injury

Co-morbidity (HIV, diabetes mellitus, peripheral vascular disease, hypertension)

Fracture type (closed open and AO type)

Arrival time

No of debridement for open fracture

Definitive fixation time

Mode of fixation (one/two column, surgical approach)

Postoperative complication

Time of physiotherapy initiation

Follow up

3.9. Operational Definitions

Open Reduction and Internal Fixation (ORIF): Immobilization of fractured bone surgically using different implants till the fracture heals[21]

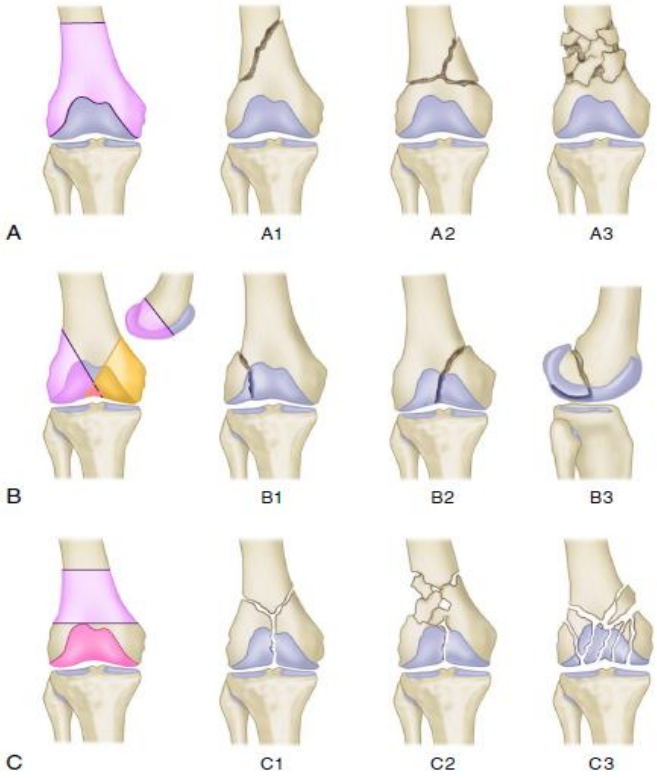
Neer's score: A scoring system to measure the functional outcome of distal femur fracture.it has functional and anatomic factors which are scored out of 70 and 40 respectively with total score of 100. Then score > 85 = Excellent ,70 – 85 = Good, 55 - 70 = Fair, < 55 = Failure[27].

Functional Outcome: The patient's physical ability or recovery to the pre-injury activity level. The outcome could be excellent, good, fair or poor based on four parameters (pain, stability, knee range of motion and ability to perform routine daily activities)[12]

Union: defined as complete formation of at least 3 cortices and patient can weight bear without pain[24].

AO classification: Distal femur fracture is classified by AO Classification system depending on the involvement of the articular surface (figure 2)[31] **.**

*Figure 2:*Showing AO/OTA classification of distal femur fracture



3.10. Data quality control

Data was collected by orthopedic surgery residents and supervision was conducted by the PI to control the quality of data. Brief training session regarding data collection was given for data collectors ahead of the study period.

3.11. Data entry, Management and Analysis

Data was coded and entered to SPSS 27. Frequency and cross tabulation were used to summarize descriptive statistics. In model fitness by using bi-bivariate multinomial logistic regression 2 variables were selected for multivariate multinomial regression test. Final model multivariate multinomial logistic regression was used for the presence of associations among selected independent variables and dependent variables where P-value < 0.05 was considered as statistically significant.

3.12. Ethical clearance

Ethical clearance was obtained from the IRB of BDU research ethics committee with protocol no 618/2022 and informed written consent was taken from patients.

3.13. Dissemination

The finding of this study will be presented as one of the partial fulfillments of specialty certificate in the department of orthopedic surgery, Bahir Dar University and it will be published on journals. It will be presented also to national/international conferences accordingly.

4. Results

Sociodemographic characteristics of study participants

A total of 60 adult patient with distal femur fracture were treated by ORIF using DF LCP. Males were involved more than females which was in ratio of 14:1. The mean age was 27.5 years old. The youngest patient was 18 years old and the oldest patient was 66 years old. Most patient were younger than 40 years of age (88.2%). (Table 1).

Table 1: sociodemographic characteristics of adult patient with distal femur fracture treated with open reduction and internal fixation who had followed up at TGSH, Bahir Dar, Ethiopia,2023

Variables	Category	Frequency (%)
Age	18 – 40 years	53(88.3%)
	40- 65 years	5(8.3%)
	Above 65 years	2(3.4%)
Sex	Male	56(53.3%)
	Female	4(6.7%)
Educational status	Higher education	2(3.3%)
	Secondary education	19(31.7%)
	Primary education	20(33.3%)
	Illiterate	19(31.7%)
Occupation	Farmer	23(38.3%)
	Military	23(38.3%)
	Private work	7(11.7%)
	Government employee	3(5%)
	Un employed	4(6.7%)
Residence	Rural	38(63.3%)
	Urban	22(36.7%)
Associated medical illness	HTN	1(1.7%)
	DM	1(1.7%)
	No medical illness	58(96.7%))

Mechanism of injury, fracture pattern and treatment approach.

In this study the most common mechanism of injury was bullet injury which accounts for 65 % (39) followed by RTA, 21.7% (13) and fall down injury, 13.3% (8). No other mechanism of injury was seen in this study. The left side was more commonly affected, 51.7 % with 31 patients, than the right side, 48.3% with 29 patients.

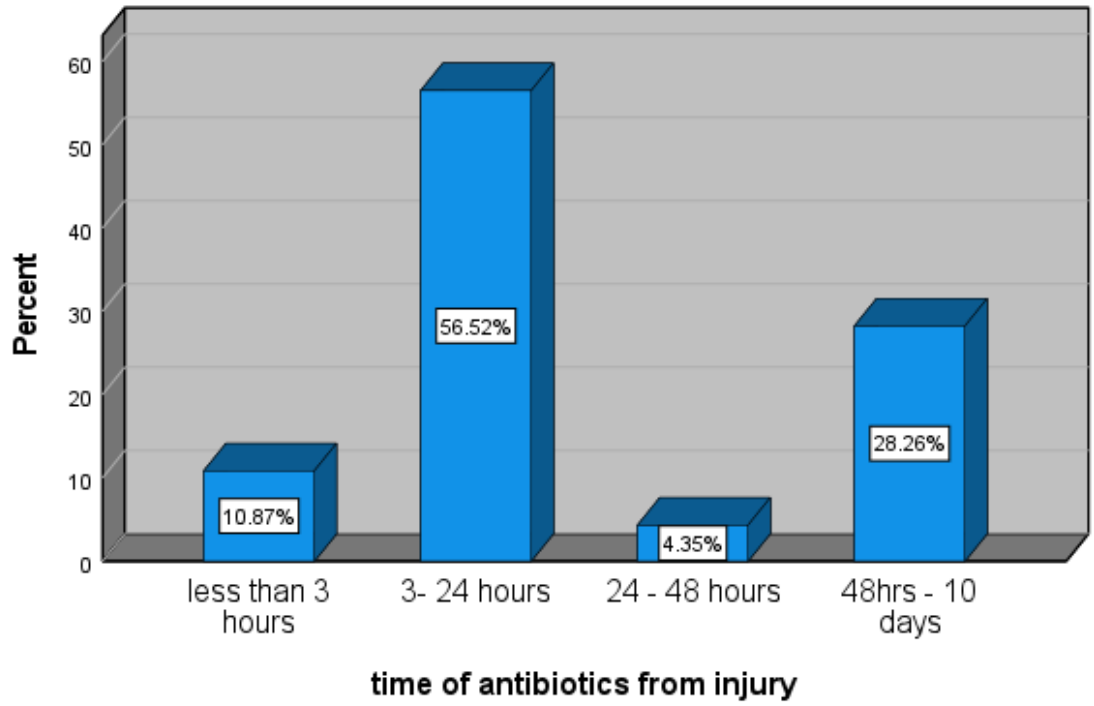
In this study 48 patients (80%) had open fractures, whereas 12 patients (20) had closed fracture. The most common fracture pattern was intra-articular (AO type C1, C2, C3) 32(53.4%) and 28 (46.6%) patients had extra- articular fracture (AO type A1, A2, A3) (Table 2). In this study Only 29 (48.3%) patients arrived in our hospital within 24 hours. whereas more patient didn't arrive in golden hour. Twenty-one patient (35 %) arrived with in first week and 10 (16.7%) patients arrived between 1^{st} and 2^{nd} weeks after trauma.

For five patients with open fractures debridement was done two times whereas for remaining 43 patients with open fractures single debridement was done before definitive fixation. Only five (10.8%) patient took antibiotics before three hours after trauma (figure 2). For 38 patient knee spanning external fixation and for 10 patient distal tibia skeletal traction was done after irrigation and debridement. For the remaining 12 patient posterior gutter was applied. Fifty-seven patients were admitted to ward for elective surgery. For three patient definitive fixation was done in emergency time. For 52 patient knee CT scan was done to study the fracture pattern and for pre op planning. All admitted patient were prepared as protocol for elective surgery

Table 2: AO classification pattern of distal femur fracture treated by ORIF using DF LCP among adult patient who had follow up at TGSH, Bahir Dar, Ethiopia,2023

AO type	Frequency (%)
A1	17(18.33%)
A2	9(15%)
A3	2(3.3%)
C1	12(20%)
C2	10(16.7%)
C3	10(16.7)

Figure 3:showing time of antibiotics initiation for open distal femur fracture after trauma

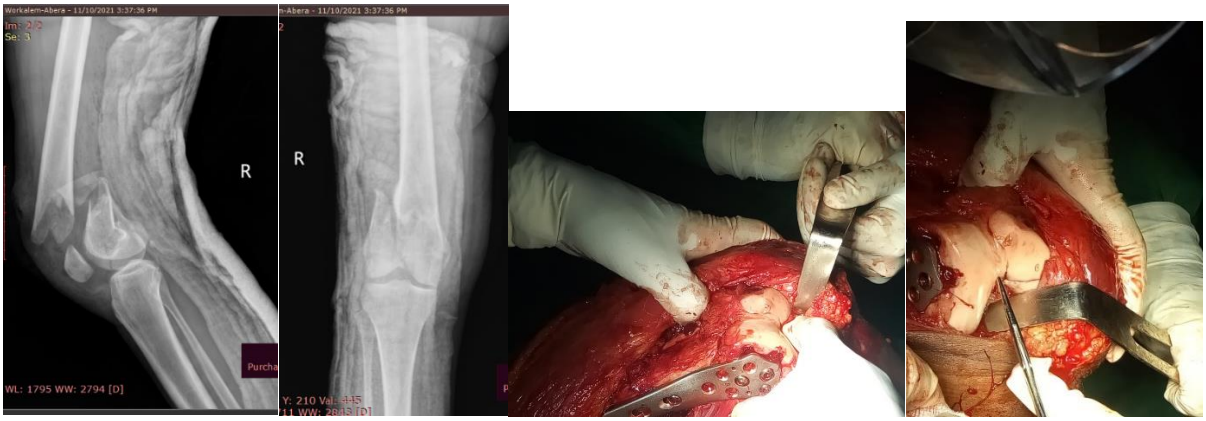


Definitive surgical treatment.

In the first week of admission 70% (42) of patients were operated for definitive fixation in elective surgery. Whereas 17 (28.3 %) patients were operated between the 1st and 2nd week post admission because of their wound status and patient burden during the war time. Only one patient was operated after two weeks of admission due to contaminated wound which needed two times

debridement. About 95% (57) of patients had lateral column fixation only and three (5%) patients had both column fixation. The most commonly used surgical approach was lateral parapatellar approach ,34 in 56.7 %. Swashbuckler approach was used in 23 (38.33%) patients and combined approach was used in three (5%) of patients (figure4).

Figure 4 : distal femur fixation technique using DF LCP by swashbuckler approach of 32 years old pregnant patient after she sustain RTA of 5hrs duration



Pre operative x-ray Intra operative images

Follow up

In immediate post operative day control knee x-ray, post operative CBC and starting of knee ROM were done. Except 4 patient all patient were discharged on 2-nd and 3rd post operative days with 2-week appointment. They were advised about danger signs and the precautions they should take.

The follow up was at 2wks, 6wks, 3 month and 6 months after definitive surgery. At 2nd week, the stich was removed, knee ROM was assessed and the patients were linked to physiotherapy clinic. On 6th week, 12th week and 6 month follow up day; AP and latera knee x-ray was sent (figure 5), fracture healing was checked clinically and radiographically, knee range of motion was evaluated, weight bearing status was checked and assessment for any complication was done.

In this study only 41(68.3%) of the patient had regular follow up according to the schedule whereas 19(31.7%) patients missed one schedule but all had catch up schedule with 2-to-4-week delay from regular one. All were linked to physiotherapy (Table3).

Table 3: Time of initial physiotherapy of adult patient with distal femur fracture treated with ORIF and had follow up at TGSH, Bahir Dar, Ethiopia, 2023

Time of physiotherapy	Frequency	Percentage
6 weeks	36	60 %
12 weeks	18	30 %
More than 12 weeks	6	10 %

Figure 5 :Follow up x-ray 32 years old pregnant patient with distal femur fractures treated with ORIF by DF LCP, 1st po day, 12weeks and 6 months.

Control x-ray

3rd month follow up

6th month follow up

Out of 60 patient, 51 (85%) patients had bony union between 4 and 5 months, five (8.3%) patients had bony union at 6 months, whereas four (6.7 %) patients had bony union at more than 6 month (table 4).

Table 4: Fracture union time of distal femur fracture treated by ORIF using DF LCP and had follow up at TGSH, Bahir Dar, Ethiopia, 2023.

Time of union	Frequency	Percentage
4 months	36	60%
5 months	15	25%
6 months	5	8.3%
More than 6 months	4	6.7%

On the last follow up day functional outcome assessment was done using Kneer's functional outcome score. Out of 60 patients; 48.3% (29) patients had excellent (>85%), 30 % (18) good (70-80%) ,10% (6) fair and 11.7 % (7) of patients had poor functional outcome. In this study all patient with AO type A1 distal femur fracture (36.7%) had excellent functional outcome. The poor outcome was seen among patient with AO type C2 and C3 only (Table 5).

Table 5: Cross tabulation of AO type with functional outcome of distal femur fracture treated by ORIF using DF LCP and had follow up in TGSH, Bahirdar, Ethiopia, 2023.

AO Type	Excellent	Good	Fair	Poor	total
A1	22(100%)	0	0	0	22
A2	7(77.8%)	2(22.2%)	0	0	9
A3	0	2(100%)	0	0	2
C1	0	10(83.3%)	2(16.7%)	0	12
C2	0	2(40%)	2(40%)	1(20%)	5
C3	0	2(20%)	2(20%)	6(60%)	10
Total	29	18	6	7	60

Regarding the range of motion, the mean range of motion was 88-degree flexion with minimum of 20 degree and maximum flexion of 135 degree. Six patient (10 %) patient achieved normal or 130-degree knee flexion, 50 % (30) achieved 100-degree flexion and 16.7 % (10) had 80- 90-degree flexion at the 6th month follow up. Otherwise, 23.3 % (14) patient could only achieve 60 degree and less.

Complication

Only 4 patients had immediate post operative complication before their discharge. Two of them had wound dehiscence whereas two patient developed deep infection for which one debridement and culture specific antibiotics was given. All of them discharged improved.

On the 6th months follow up about 23.6 % (14) patient had stiffness, 10(16.7%) had pain and 5(8.3 %) had infection (figure 3). Two patients had superficial infection which responded for oral antibiotics and wound care. Three patients had deep infection for which the implant was removed for 2 patients and incision and drainage was done or 1 patient. Culture specific antibiotics was started for all patient with deep infection and they respond well. (Figure 6)

Figure 6 :distal femur fracture with DF LCP which was exposed infected at 6-month post-surgery day of 32 years old male patient.

Associated factors

Comparing to patient with open fracture patient with closed distal femur fracture had 2.5 times higher chance of having excellent functional outcome (AOR (2.49(5.8 ,1.07)). Patient who had regular follow up had 7 times higher probability of excellent functional outcome (AOR 7.16(1.11,46.22)) (Table 5).

Table 6: Multinomial regression of factors with functional outcome of adult with distal femur treated with ORIF by DF LCP and had follow up at TGSH, Bahir Dar, Ethiopia, 2023.

Functional outcome (Neer's score)	Factors	Frequency	COR	AOR
Excellent (≥85%)	Closed fracture	8/12	1.855(4.67 ,7.35)	2.49***(5.8 ,1.07)
	Open fractures	21/48	-	-
	Regular follow up	25/41	8.33(1.335,52.03)	7.16*(1.11,46.22)
	No regular follow up	4/19		
Good (70 – 85 %)	Closed fracture	4/12	2.47(2.47,2.47)	2.77(2.77,2.77)
	Open fractures	14/48		
	Regular follow up	10/41	1.66(0.286,9.708)	1.45(0.23, 8.78)
	No regular follow up	8/19		
Fair (55 -70%)	Closed fracture	0/12	1.00(1.00,1.00)	1.103(1.10, 1.10)
	Open fractures	6/48		
	Regular follow up	3/41	1.33(0.14,11.92)	1.33(0.14,11.92)
	No regular follow up	3/19		

**: p value 0.025 -0.05*

***: p value 0.0125-0.025*

****: p value <0.0125*

5. Discussion

The mean age in this study was 27.5 years with 88.2% of our patient were younger than 40 years of age. In contrary, in other studies the mean age was more than 40 years [23, 32]. The mechanism of injury in this study was not related with osteoporosis. In this study 57 male patients with only three female patients were involved. Similar pattern was also reported in other studies which included 28 male and two female patient[33]. In this study, the most common mechanism was bullet injury (65%) followed by RTA (21.7%) and fall down injury (13.3%). This is because, in this study area male civilian are armed and they shoot in different public gathering including weeding, mourning, religious holydays and so on. There was also war in the last 3 years particularly in northern part of Ethiopia. However, in other studies RTA is the most common mechanism (74.6%) followed by fall down accident (23.6%) with no bullet injury [15]. Based on AO classification of fracture, this study showed 32(53.4%) patients had AO type C and 28 (46.6%) patients had AO type A , which was similar with other studies report in which 65 % of patient had AO type C, 20% had AO Type B and 15% of patients had AO type A [23].

Infection was found in 5 (8.3%) patients in this study. Similar rate infection was reported in 1 study with 8% [25] incidence however this study finding was slightly higher than other reports which had less than 8% rate [22, 26].

This study found knee range of motion 20 to 135 degree. Generally, 76.6 % of patient had range of motion of 90 degree and above, 23.4% of patients had 60 degree and less ROM. Earlier studies support this finding ; Saini *et al*[24] found knee ROM 0 to 110 degrees, neetin et al reported ROM up to 130 degrees[23].Those patients with 60 degree and less ROM complain stiffness at 6^{th} month their follow up.

Distal femur fracture union was defined as complete formation of at least 3 cortices and patient can weight bear without pain. In this study the union rate was 85% at 4.63 months with delayed union of 15% .Similar results was reported in Amin et al study [25], with mean union time was 4.86 months.

Functional outcome was assessed at the 6th month follow up using Neer's score. Out of 60 patients ,48.3% (29) of patients had excellent functional outcome (≥85), 30% (18) had good (70-85)) ,10% (6) had fair (55-70) and 11.7% (7) of patients had unsatisfactory functional outcome (<55). Overall, 78.3% of patients had good to excellent outcome. with 21.7 % fair to unsatisfactory outcome. In contrary, Neetin *et al,* in study of 30 cases found 33% excellent , 52% good , 11% fair and 4% unsatisfactory outcome[23] . In other study ,Saini et al found out of 34 patient; 62% excellent , 32% good and 6% fair outcome with no finding of unsatisfactory outcome[15].

This study showed that closed fracture was significantly associated with excellent functional outcome. Soft tissue is most important biologic environment for fracture union. When it's injured the blood supply of the fracture will be disturbed which will increase risk of infection and decrease chance of healing. In closed fracture soft tissue is more likely to be preserved which will improve fracture union and decrease chance of infection with better functional outcome[20]. In contrast the study done at India in 2021 found comparable outcome between closed and open fracture with no significant difference[22].

In this study, having regular follow up had significant impact on functional outcome. Previous studies also showed similar finding[21]. In regular follow up, patient condition and fracture status are assessed to pick and treat any complication early before it gets more worse. The level of adherence to rehabilitation protocol is also checked and rearrangement can be done. If they miss the regular follow-up, it would be difficult to assess their progress and chance of having complication will be higher[31]. In this study, we found those who had regular follow up ended up with excellent outcome.

6. Strength and limitation

Strength

- Its prospective cohort study with continuous follow up by detailed clinical, radiologic and laboratory evaluation of all patients.
- Its first study in Tibebe Gihon Specialized Referral Hospital.
- The number of patients included in this study were more than other studies reviewed.

Limitation

- The follow up duration was short period
- Some data were collected by senior orthopedic residents so, health professional effect cannot be avoided.

7. Conclusion

This study found excellent to good functional outcome in most of patient with distal femur fracture treated using DF LCP for ORIF of both AO type A and AO type C with some preventable complication. Closed fracture and regular follow up were determining factors for better functional outcome. Closed fracture preserves biologic environment which facilitate early fracture healing and return the patient to routine activity. Having regular follow up allows physician to evaluate the clinical and radiological status of the fracture fixation which helps to pick and treat complication early. Patient who has no regular follow up had poor functional outcome because of missed complication and fail to do the rehabilitation properly. This study concluded that DF LCP is reliable option for treatment of AO type A and AO type C distal femur fracture.

8. Recommendation

To Tibebe Ghion Specialized Hospital

- Awareness and training should be given to all nurses including physicians in orthopedic department about basic and advanced techniques of wound care, handling of patient with fractures and fracture related infection prevention.
- Liaison office should accept patient per bed available only in orthopedic ward to decrease patient burden and admission of trauma patient to other department ward which makes difficult to give proper care.
- The hospital should develop reminding techniques to increase patient follow up adherence

To law enforcing organs

- Public awareness should be created among the community to reduce, if possible, to avoid shooting in different public gathering and should be trained on how to handle their gun.
- Government should Advocate culture of solving conflict in peacefully way without gun.

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10. Annex I: Permission Form

Title of the Research Project: Assessment of functional outcome of open reduction and internal fixation of distal femur fracture and its associated factors at Tibebe Ghion Specialized Hospital, Bahir Dar, Ethiopia

Name of Investigator: Yonatan Abie (MD, Orthopedic Resident)

Name of the Organization: Bahir Dar University, College of Medicine and Health Sciences

Name of Sponsor: Bahir Dar University

Introduction: This information sheet is prepared for Bahir Dar University, college of medicine and health sciences administration to make concerned offices clear about the purpose of this research, data collection procedures and get permission to conduct the research.

Purpose of the Research Project: To assess the **functional outcome of open reduction and internal fixation of distal femur fracture treated by distal femur locking plate.**

Procedure: In order to achieve the above objective, information which is necessary for the study will be taken from patient interviews, physical examination and investigation.

Risk and/or Discomfort: Since the study will be conducted by taking appropriate information mainly from patient interview, it will not inflict any harm on the patients.

The name or any other identifying information will not be recorded on the questionnaire and all information taken will be kept strictly confidential and in a safe place. The information extracted will be kept secured. After the data will be entered into the computer, it will be locked by password. The information retrieved will be used only for the study purpose.

11. Annex II: Participant Consent Information Sheet

I have been invited to take part in this study for the assessment of functional outcome of open reduction and internal fixation of distal femur fracture and its associated factors in adults at Tibebe Ghion Specialized Hospital. My role in this study is to complete an attached questionnaire. I acknowledge that the research procedures have been explained to me and that any questions that I have asked to have been explained to my satisfaction. I have been informed of the alternatives to participation in this study including the right to not participate. I also understand that I may not benefit directly from the research and that my participation is totally voluntary. I have also been informed that the confidentiality of the information I will provide will be safeguarded and my privacy and anonymity will be ensured in the collection, storage, and publication of the research material.

I……..... have fully understood the aims, methods, and conditions to participate in this study; I therefore consent to my participation

Participant's signature: ……

Researcher's signature: ……

12. Annex III: Data Collection Format Sheet

Cases	**Case 1**	**Case 2**	**Case 3**	**Case 4**
Card No.				
Age				
Sex				
Residence 1. Urban 2. Rural				
Occupation 1. Farmer 2. Government employee 3. military 4. private worker 5. unemployed				
Educational status 1. Higher education 2. Secondary education 3. Primary education 4. None				
History of smoking? 1. Yes 2. No				
History of alcohol? 1. Yes 2. No				
Any co-morbidity 1. HIV 2. Diabetes mellitus 3. Peripheral vascular disease 4. Hypertension				

Mechanism of the injury 1. RTA 2. Fall down injury 3. Injury during sport activity 4. Bullet injury 5. Stick injury 6. Assault 7. Others				
Fracture side 1. Left 2. Right 3. Both sides				
Arriving time to hospital from the injury 1. _____hrs 2. _____ days 3. _____ weeks				
Type of fracture involvement (AO type) 1. Extra-articular (A1, A2, A3) 2. Partial articular (B1, B2, B3) 3. Complete articular (C1, C2, C3)				
Is the fracture is CPD or closed? 1. CPD 2. Closed				
If fracture is CPD, how many debridement done before definitive fixation? 1. None 2. One 3. Two 4. Three or more				

If the fracture is CPD: time from injury to antibiotics 1. Less than 6hours 2. 6-24hours 3. 24-48hours 4. 48hours-10days 5. more than 10days				
Time to definitive surgery after injury 1. First week 2. 1 to 2 weeks 3. More than 2 weeks				
Fixation mode for: 1. ORIF 2. IM nail 3. Ex Fix 4. Screw				
If ORIF was done 1. One column 2. Both column				
If both columns are fixed Medial column is fixed with 1. Anatomic distal femur plate 2. DCP plate 3. Screws only 4. others				
Lateral column is fixed with 1. Anatomic distal Femur plate 2. DCP plate 3. Others				
If IM nail 1. With screw 2. With out screw				

Surgical approach: 1. Lateral 2. Swashbuckler 3. Medial 4. Lateral parapatellar 5. Medial parapatellar 6. Combined				
How many weeks were the patient has been non weight bearing after fixation 1. One week 2. 1-3wk 3. 3-6weeks 4. 6weeks and more				
Any complication in immediate post-operative days 1. Wound dehiscence 2. Infection 3. Reoperation 4. None				
Did the patient have a regular follow up? 1. Yes 2. No				
Did the patient linked to physiotherapy? 1. Yes 2. No				
If the answer for above question is yes, when 1. 2wks 2. 6wks 3. 12 wks 4. More than 12wks				
Time laps from fixation day to data collection: 1. 2wks. 2. 6wks. 3. 12wks 4. 3 months 5. 6 months 6. 12 months				

Any current complaint 1. knee stiffness 2. Distal thigh deformity 3. Knee pain 4. infection 5. Others _____				

13. Annex IV: Functional Assessment Parameter Based on Neer's score

Functional unit (70)		Anatomic unit (30)	
Pain (20)		Gross Anatomy (15 unit)	
1. No pain	20	1. Thickening only	15
2. Intermittent pain	16	2. 5 degrees angulations or 0.5 cm short	12 9
3. With fatigue	12	3. 10 degrees angulations or 2 cm short	6
4. Restrict function	8	4. 15 degrees angulations or 3 cm short	3
5. Constant or at night	4-0	5. union but greater deformity	0
		6. Nonunion or chronic infection	
Function ((20 unit)		Radiology (15 unit)	
1. As before	20	1. near normal	15
2. Mild restriction	16	2. 5 degrees angulations or 0.5 cm displacement	12
3. Restricted; stairs sideways	12	3. 10-degree angulations or 1 cm displacement	9
4. Cane or severe restriction	8	4. 15 degrees angulations or 2 cm displacement	6
5. Crutches or brace	4 - 0	5. Union but with greater deformity;	3
Motion (20 unit)		6. spreading of condyles; osteo-arthritis	
1. Normal or 135 degrees	20	7. non-union or chronic infection	0
2. 100 degrees	16		
3. 80 degrees	12		
4. 60 degrees	8		
5. 40 degrees	4		
6. degrees or less	4 - 0		
Work (10 unit)			
1. As before injury	10		
2. Regular but with handicap	8		
3. Alter work	6		
4. Light work	4		
5. 1-0. No work	2 - 0		