



**KNEE FUNCTIONAL OUTCOME AND ASSOCIATED FACTORS AMONG PATIENTS
TREATED WITH RETROGRADE INTRAMEDULLARY NAIL FOR FEMORAL
SHAFT FRACTURE AT ADDIS ABABA BURN EMERGENCY AND TRAUMA
HOSPITAL, ADDIS ABABA, ETHIOPIA**

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Knee Functional Outcome and associated Factors among Patients Treated with Retrograde Intramedullary Nail for Femoral Shaft Fracture at Addis Ababa Burn Emergency and Trauma Hospital, Addis Ababa, Ethiopia

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List of Abbreviations and Acronyms

AaBET	Addis Ababa Burn, Emergency and Trauma Center
FSFs	Femoral Shaft Fractures
HSS	Hospital for Special Surgery knee score
INM	Intramedullary Nailing
LISS	Less Invasive Stabilization on System
PI	Principal Investigator
RN	Retrograde Nailing
RTA	Road Traffic Accident
SPHMMC	Saint Paul's Hospital Millennium Medical College
SPSS	Statistical Package for Social Science

Abstract

Background: Intramedullary nailing is currently preferred method of treating femoral shaft fracture as it provides stable fixation with excellent union rate. The need for better functional outcome with knee rehabilitative protocols in such patients continues to be discussed. However, the results are not thoroughly established in the current study setting, where intramedullary nailing is common management option and knee functionality remains to be quantified.

Objective: The aim of this study was to assessing the knee functional outcome and associated factors following retrograde intramedullary nailing of traumatic femoral shaft fractures at Addis Ababa Burn Emergency and Trauma Hospital, Addis Ababa, Ethiopia.

Methods: An institution-based, cross-sectional study was conducted among 148 consecutive patients from January 1st, 2015 through December 31st, 2021. Knee functional outcome was assessed using the Hospital for Special Surgery scoring system (HSS) at least one year after the operation. Data were entered and analyzed using SPSS version 26. Descriptive analysis was used to present the preoperative and postoperative characteristics while ordinal logistic regression was run to identify factors associated with functional outcome. A p-value <0.05 was considered significant. Texts, tables and figures were used to present the results.

Results: A total of 148 patients were studied; of these, males predominated (n=122;82.4%). Patients' median age was 30 years (interquartile range, 24.25–40). Patients' Hospital for Special Surgery score mean $\pm$ standard deviation was 85.6 ± 11.0 (range, 41–94). Overall, functional outcomes were classified as excellent in 53.4%, good in 39.2%, fair in 3.4% and poor in 4.1%. Ordinal logistic regression analysis indicated that age < 30 years (OR=19.80, p value<0.001), age 30 to 45 years (OR=11.9, p value=0.002), absence of comorbidity (OR=4.50, p value=0.002), road traffic accident (OR=5.57, p value=0.019), history of wound site infection (OR=0.15, p value<0.001), and postoperative physical therapy (OR=0.40, p-value=0.039) were the factors significantly associated with poor functional outcome in these patients.

Conclusion: Retrograde nailing is associated with favourable knee functional status in our patient population. It is associated with age, comorbidity, mechanism of injury, wound site infection, and postoperative physical therapy. Thus, use of retrograde techniques should be encouraged whenever appropriate.

Keywords: Knee functional outcome, Retrograde intramedullary nail, Hospital for Special Surgery scoring system, Associated factors, Ordinal logistic regression

1. Introduction

1.1. Background of the study

Femoral shaft fractures, fractures occurring between 5 cm distal to the lesser trochanter and 5 cm proximal to the adductor tubercle, are devastating forms of injuries commonly seen in patients sustaining multiple trauma (1). These fractures are one of the most frequent injuries treated by orthopedic surgeons. These fractures typically occur in a bimodal fashion, high-energy trauma in young adults, and lower-energy trauma (such as fall from standing) in the elderly population (2). In particular, the age of predilection spans from 15 to 49 years in males while disproportionately affecting females older than 60 years (3).

The incidence of femoral fracture may vary across climes. Globally, in 2019, there were 14.6 million new femoral shaft fractures, 43.2 million cases of acute or long-term symptoms of the fracture, and 1.85 million years lived with disability, suggesting that femoral shaft fractures represent significant global public health issues (4). Parallel to this, a high prevalence of femoral shaft fractures (FSFs) among road traffic accident (RTA) victims is reported (5). In Africa, Ethiopia included, where one of the worst road traffic accident records in the world exist on top of under-reporting problem, femoral shaft fractures are common orthopedic encounters (4,6). In fact, femoral fractures were shown to constitute significant portions of orthopaedic cases in African context, ranging from 9.9% in Malawi (7) to 39% in Tanzania (8). A similar pattern is expected to prevail in Ethiopia, in which majority (66.1%) of road traffic accidents are polytraumas (6).

In general, femoral shaft fractures in adults can be managed using many various nonsurgical or surgical modalities, depending on several factors such as surgeon's experience, availability of implants, cost, desired anatomic and functional outcomes, and complication rates (2,9,10). In practice, the treatment of choice is intramedullary fracture fixation. Further development of existing intramedullary nailing systems now offer comfortable handling and different locking options (1). Use of antegrade nailing technique has been traditionally the gold standard approach, but the retrograde intramedullary nailing, which involves a transarticular approach and offers various advantages, is currently gaining acceptance and being a viable surgical alternative

(11,12). The advantages of this technique include avoiding use of a fracture table and traction, easier patient positioning and nail insertion, and shorter operating times with less blood loss (11,13,14). In addition to its relative simplicity, high rates of rapid union and low complications (11,15,16), this technique may be preferable to antegrade nailing in situations when there is a concomitant femoral neck fracture and the presence of previously or simultaneously placed internal fixation of a proximal femoral fracture (11).

Proper technique includes an insertion site in the intercondylar notch at the apex of the Blumensaat line, which is approximately 1 cm anterior to the posterior cruciate ligament origin. With this as the starting point, the trajectory for nail insertion should be colinear with the long axis of the femur in both the anteroposterior and lateral planes. The distal end of the nail must be buried beneath the subchondral bone to avoid injury to the patella with the knee in flexion. At least two distal interlocks should be used to minimize the risk of secondary telescoping of the nail into the knee joint (17). The goal of femoral shaft fracture management includes maintenance of anatomic alignment while encouraging early functional rehabilitation (3).

1.2. Statement of the problem

Road traffic accidents are among the leading causes of death in Ethiopia, representing a growing threat to health of Ethiopian nationals and a significant public health concern. They are the commonest cause of death and contribute significantly to the mortality rates in the productive age group (18,19). As trauma is the most common mechanism of such fractures, usually involving a direct hit to the thigh or an indirect force transmitted through the knee (20–22). More importantly, in developing countries such as Ethiopia, mass casualties involving femoral shaft fractures are common, partly due to gunshot injuries resulting from active war. Moreover, in Ethiopia, residential zones with high exposure to traffic and non-signalized intersections at nighttime continue to contribute to traumatic femoral bone fractures (23). Expectedly, femur shaft fractures can be associated with a lethal outcome and non-fatal disabilities (20).

On the other hand, femoral shaft fractures are the costliest forms of fractures to treat and they often result in extended length of stay in hospital (24). The burden of femur shaft fractures can be assumed to be even worrisome in low-resource countries given that such kinds of fractures are

usually associated with other comorbidities, requiring an advanced level trauma life support assessment and interdisciplinary care (25).Monitoring the progress of rehabilitation plays an important role in motivating the patient to continue therapy and building up trust between patients and therapists (26). Also, unsatisfactory management outcomes can further affect the wellbeing of caregivers and the society at large, by wasting a large portion of their annual income (27). Although such technique and implant is currently being frequently used, there is no any systematic study that evaluated its effect on knee function in our set up, where this study was carried out.

1.3. Significance of the Study

This study was hoped to help orthopedic surgeons involved in the management of FSFs for better healing and long-term functional recovery, by providing implications of surgical treatment choices for the orthopedic society. For instance, it would help physicians, surgeons, physiotherapists examine, document, describe and quantify alterations and the progression of patients after surgical intervention. The findings from this study can be of use to local policy makers in designing rehabilitation or prolonged muscle-strengthening therapy protocols for better functional outcome for patients sustaining FSFs, and thereby enhancing health-related quality of life victims. Furthermore, this study can be used as an additional reference for researchers who wish to undergo further study and conduct necessary interventions in the subject matter.

2. Literature review

2.1. General Overview

The femur is the longest and strongest bone in the body. The shaft, or diaphysis, is the long straight part inferior to the lesser trochanter and extending to the metaphyseal flairs and condyles (3,28). Femoral shaft is circumferentially encased with large muscles. It is the most fractured long bone in the body that often necessitates surgical intervention (29). Inherent to their very nature, they typically require high energy injuries to fracture, which can be associated with life-threatening injuries (pulmonary, cerebral) and ipsilateral femoral neck fractures (25).

Femoral shaft fractures can result from high or low energy mechanisms and are often associated with other serious injuries. The most common causes include automobile accidents, falls from heights, ground-level falls in individuals with osteoporosis, and gunshots. A study from Tanzania found that 71% of FSFs were caused by high energy mechanism such as road traffic accident (8). Other less common causes of FSFs are atypical fractures from bisphosphonate use, pathologic fractures through a bone lesion, insufficiency fractures from osteoporosis, and stress fractures from overuse in athletes and military recruits (25). In Qatar, the majority of FSFs were unilateral (96.7%) and 91% were closed fractures (29).

Classification of femoral shaft fractures may be descriptive in which the location, type, angulation, shortening, comminution, rotation, and displacement is described. The most commonly used fracture classification system used is the AO/Orthopedic Trauma Association classification because of its high interobserver reliability and accuracy. The system utilizes a coding system to identify the fracture type resulting in 27 different patterns. In this classification scheme, 3 represents femur while 2 stands for diaphysis. For instance, 32A – Simple (A1 – Spiral; A2 – Oblique, angle > 30 degree; A3 – Transverse, angle < 30 degree; 32B – Wedge (B1 – Spiral wedge; B2 – Bending wedge; B3 – Fragmented wedge), and 32C – Complex (which includes C1 – Spiral; C2 – Segmental; C3 – Irregular) (30).

Depending on different factors, these fractures are managed using nonoperative or operative techniques. Intramedullary nailing (IMN) is an effective method for treating femoral shaft fracture and has evolved to become one of the preferred procedures in contemporary orthopedic

practice (16). The insertion site of an IMN is outside the zone of injury, preserving the surrounding blood flow and retains the hematoma that contains beneficial bone growth factors. Intramedullary nailing also has the benefits of early weight-bearing that helps maintain muscle mass, function, strength, and mobility (25).

Retrograde nailing (RN) is an alternative to antegrade nailing. Proper technique includes an insertion site in the intracondylar notch at the apex of the Blumensaat line, which is approximately 1 cm anterior to the posterior cruciate ligament origin. With this as the starting point, the trajectory for nail insertion should be colinear with the long axis of the femur in both the anteroposterior and lateral planes. The distal end of the nail must be buried beneath the subchondral bone to avoid injury to the patella with the knee in flexion. At least two distal interlocks should be used to minimize the risk of secondary telescoping of the nail into the knee joint. This complication can occur after fracture of the distal interlocking screws associated with comminuted, axially unstable fracture patterns (16).

The retrograde technique can be used when proximal access to the medullary canal is blocked. Although early results with retrograde nails suggested a slightly lower union rate, the difference may have resulted from other factors such as smaller diameter nails and use of unreamed nails. Use of this technique, with retrograde nails matched to the diameter of the femoral isthmus using reaming, has shown promising outcomes. Findings include healing rates and results equivalent to those of the antegrade technique, with high rates of rapid union and low complications.^{6,12-15} Entry-site problems may be equivalent between retrograde (knee symptoms) and antegrade (hip symptoms) techniques (11,13,15).

2.2. Functional Outcome of Intramedullary Nailing

Although IMN of diaphyseal femur fracture is the standard treatment for this injury, patients may experience residual functional deficits following fracture fixation. Reduced strength of the hip abductors and hip extensors as well as functional problems such as altered gait pattern and limited range of movement have been demonstrated (16). Measuring functional recovery guides clinicians to document and quantify alterations and progression of recovery processes. One of the most widely used tools to measure knee functionality is the Hospital for Special Surgery knee

score, which exhibit high sensitivity in assessing pain, difficulty performing activities of daily living and in assessing the results of physical examination of the knee joint in patients who following a therapeutic intervention (26). The tool was shown to be reasonably valid in assessing knee functionality, reflecting the outcome of the therapeutic intervention or the changes of the status of the underlying disease over time (31).

In The Netherlands, El Moumni and colleagues tried to evaluate the long-term functional outcome following intramedullary nailing of traumatic femoral shaft fractures by using one generic and three disease-specific patient-reported outcome measures. The patients included had fracture AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) type 32 A–C, and were treated with antegrade while the remaining 95 were treated with retrograde intramedullary nailing between January 1996 and December 2007. Interestingly, the study showed that the range of motion (ROM) of the hip and knee joints was comparable between the injured and uninjured leg, regardless of the nailing technique. Even years after surgery, 17% of the patients still reported moderate to severe pain. The most significant predictor of functional outcome was pain in the lower limb (32).

In a retrospective study carried out from 2003 to 2008, Hierholzer et al. analyzed 115 patients with distal femur fracture who had been treated by retrograde intramedullary nailing (59 patients) or less invasive stabilization on system (LISS) plating (56 patients). In this study, the German authors evaluate functional outcome using the Knee and Osteoarthritis Outcome (KOOS) score. A comparable functional outcome was demonstrated as those with type A fractures score 263 (RN) and 260 (LISS), while those with type C fractures 257 (RN) and 218 (LISS). The study confirmed that RN is an adequate treatment options for distal femur fractures in terms of restoring functions (33).

In India, Agarwal et al. analyzed 40 patients who were operated with either retrograde nailing or locked compression plating for intra-articular and extra-articular distal femur fractures between July 2015 and June 2017. They aimed to determine the best functional outcome for distal third femur fracture treated by closed/open reduction using retrograde nailing or locked compression plating in respect to knee-flexion, early mobilization and fracture union using Modified

Neer's criteria. Accordingly, 70% of the patients had undergone retrograde nailing showed excellent results in functional outcomes (34).

Nakamura et al. tried to evaluate the functional outcome of twelve femoral fractures treated using retrograde intramedullary nailing (INM) via an intercondylar approach at Kitasato University Hospital, Japan between 1981 and 1996. They assessed functional outcome by the knee-rating system of the Hospital for Special Surgery (HSS) and Neer's criteria. The average score was 76 points (range=44–100 points) by HSS, and 77 points (range=36–100 points) by Neer's criteria. The authors implied some concern over efficacy of the technique as they observed good outcomes in 67% (8/12) and 58% (7/12) of the patients, according to respective rating system (35).

Through their prospective comparative study, Egyptian authors attempted to evaluate functional outcomes of the knee after antegrade and retrograde intramedullary nailing for femoral shaft fractures in 40 randomly allocated adults. They used Lysholm knee scoring scale to gauge functional status. The mean $\pm$ standard deviation score was 94.05 ± 4.43 in patients undergoing antegrade IMN and 82.45 ± 8.83 in the other group, who underwent retrograde IMN. Alternatively said, 90% of the former group had excellent scores whereas 65% of the latter group had good scores (12).

In Kenya, a comparative cross sectional study was done on patients who had undergone retrograde and antegrade intramedullary nailing for femoral shaft fractures between January 2007 and December 2009. Functional outcome of the patients (n=124) was measured by means of modified HSS score, which showed an overall functional status of excellent in 71.8%, good in 23.4% and poor in 3.2%. In this study, retrograde group had significantly unfavorable outcomes than their counterparts who had undergone antegrade IMN, particularly in terms of pain score and stiffness (36). Moreover, the authors observed a negative association between age and the functional outcome in the retrograde group such that older patients had poorer scores in the modified knee ratings (36).

In summary, the reviewed literature reveals that intramedullary nailing is the preferred method for treating fractures of the femoral shaft, with either antegrade or retrograde approaches. Each

option has relative advantages, disadvantages, and indications. Moreover, a range of functional outcome was noticed, with numerous factors affecting it. Additionally, it was also noted that the existing literature is more concentrated in other regions of the world, introducing the presence of knowledge gap in the current study setting as there is scarcity of context-specific data that characterize the long-term function outcome of these surgical interventions, particularly using well-validated tools such as Hospital for Special Surgery knee score. The HSS knee rating scale is a domain-specific questionnaire developed for use as a standardized instrument capable of measuring outcomes for patients with all knee disorders, and designed specifically to evaluate patients with TKA of the knee. The instrument can be used to evaluate a patient before knee surgery and to monitor postsurgical function. The HSS knee rating scale has been addressed in a number of research studies and is widely used by physiotherapists and orthopedic surgeons in clinical settings. It has been shown to be a reliable, valid, responsive and acceptable outcome. The HSS knee score gives a maximum of 100 points and considers subjective functional (52%) as well as objective examination criteria (48%). The domains include pain, function, range of motion, muscular strength, deformity and instability. Subtractions are then made for the use of walking aids, extension lag and varus/valgus deformity (37).

2.3. Conceptual framework

This is a conceptual framework developed specifically for this study by the principal investigator after reviewing related literatures (12,32,36,38) in which this study is set to focus. The framework tries to figure out potential factors that contribute to the functional outcome among patients with femoral shaft fractures, and it is supposed to support the study entitled “*Knee Functional Outcome of Patients Treated with Retrograde Intramedullary Nailing for Femoral Shaft Fracture at Addis Ababa Burn Emergency and Trauma Hospital, Addis Ababa, Ethiopia*”.

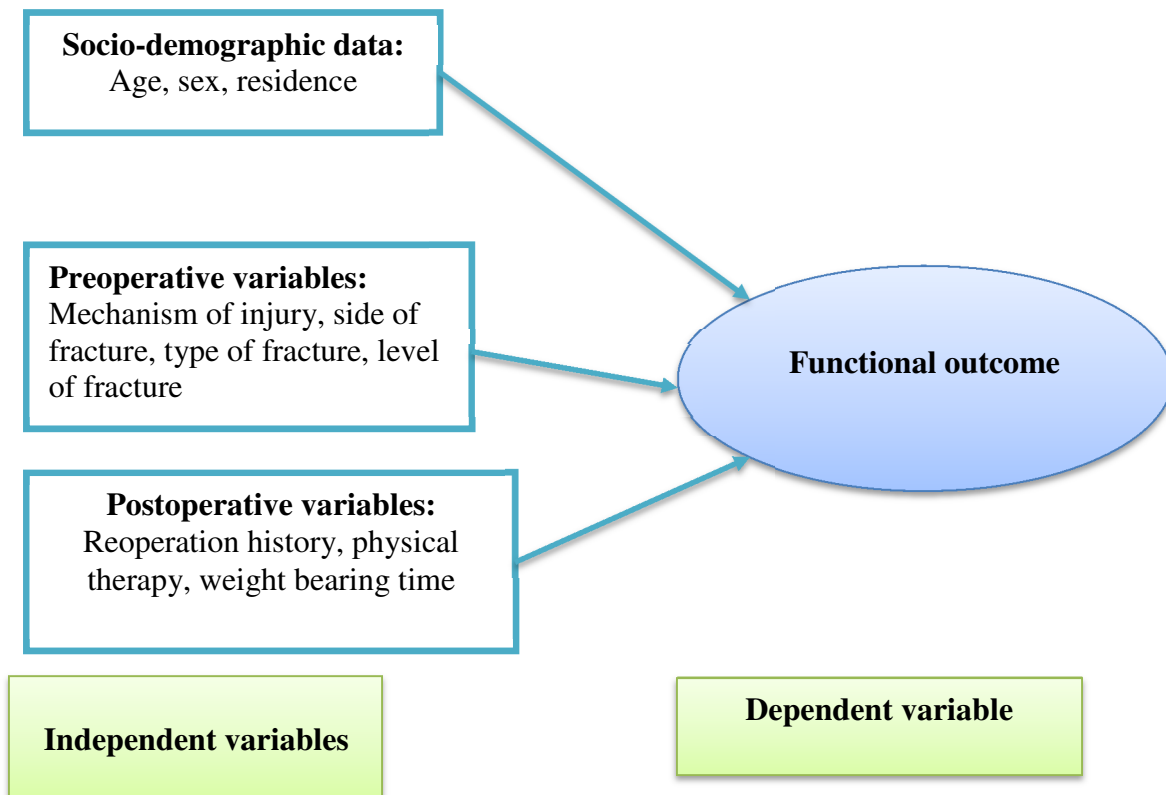


Figure 1. Conceptual framework for factors affecting knee functional outcome of patients treated with retrograde intra-medullary nailing for femoral shaft fractures (Source: (12,32,36,38))

3. Objectives of the Study

3.1. General Objective

- To assess knee functional outcome and associated factors among patients treated with retrograde intramedullary nailing for femoral shaft fractures at Addis Ababa Burn Emergency and Trauma Hospital (AaBET), Addis Ababa, Ethiopia

3.2. Specific Objectives

- To determine the knee functional outcome status of patients treated with retrograde intramedullary nailing for femoral shaft fractures at Addis Ababa Burn Emergency and Trauma Hospital (AaBET), Addis Ababa, Ethiopia
- To identify factors associated with knee functional outcome of patients treated with retrograde intramedullary nailing for femoral shaft fractures at Addis Ababa Burn Emergency and Trauma Hospital (AaBET), Addis Ababa, Ethiopia

4. Methods and Materials

4.1 Study area and Period

This study was conducted at Addis Ababa Burn Emergency and Trauma (AaBET) Hospital, a major trauma center in Addis Ababa, Ethiopia. It was established in 2015 as part of St. Paul Millennium Medical College. St Paul's Hospital Millennium Medical College is a teaching hospital that provide care to the residents of Addis Ababa and all over Ethiopia. AaBET currently provide health care service in specialties, namely orthopedics, neurosurgery, plastic and reconstructive surgery and emergency and critical care. AaBET hospital has approximately 20,000–30,000 emergency visits/year to the hospital and provides an emergency and outpatient services and elective and emergency surgeries of the respective departments. Orthopedics and traumatology is one of the departments providing outpatient service, emergency and elective surgeries. It gives fracture care including complex acetabular and pelvic injuries. The study was conducted from November, 2022 to May, 2023, with the data collection extending from March 1 to April 30, 2023.

4.2. Study Design

An institution-based cross-sectional study design was employed.

4.3. Source Population

All adult patients who underwent retrograde intramedullary nailing for femoral shaft fracture from AaBET Hospital, Addis Ababa, Ethiopia

4.4. Study Population

All adult patients who underwent retrograde intramedullary nailing for femoral shaft fracture at AaBET Hospital, Addis Ababa, Ethiopia from January 1st, 2015 through December 31st, 2021.

4.5. Eligibility Criteria

4.5.1. Inclusion Criteria

- Patients who underwent retrograde intramedullary nailing and have follow up for at least 1 year by the time of data collection

- Radiologically-confirmed skeletally mature individuals

4.5.2. Exclusion Criteria

- Patients having pathological fractures
- Patients with peri-prosthetic fracture
- Patients with documented pre-existing knee movement disorder
- Patients who had distal femoral fractures with neurovascular compromise
- Patients lost in follow up
- Patients with floating knee, ipsilateral knee injury or other lower extremity fracture
- Patients sustaining polytrauma
- Patients with delayed presentation greater than six weeks
- Patients who underwent damage control musculoskeletal surgery that had delayed intramedullary nail stabilization more than 2 weeks after initial trauma

4.6. Sample Size Determination and Sampling Technique

4.6.1. Sample Size Determination

A single population proportion sample size determination formula was used based on confidence interval approach. As there is no previous study indicating the variability (P) of femur fracture functional outcome status treated operatively from in a similar setting. Hence, p is considered to be the maximum variability, that is, 50%, with 95% confidence interval ($Z_{\alpha/2}=1.96$) and 5% margin of error ($d= 0.05$).

$$n^0 = \frac{z^2 p(1-p)}{e^2}$$

n = the required sample size

p = the proportion of patients with functional outcome having good functional outcome =0.5

$Z_{\alpha/2}$ = the critical value at 95% confidence level = 1.96

e = precision (margin of error) = 5%

N= target population

Accordingly,

$$n^0 = \frac{(1.96)^2 * 0.5(1 - 0.5)}{0.05^2}$$

$$n^0 = \frac{(1.96)^2 * 0.5(0.5)}{0.05^2}$$

$$n = 384$$

Hence, to compute the final sample size using the correction formula as the total target population at the hospital is less than 10,000 (N=219)

$$n = \frac{n^0}{1 + \frac{n^0}{N}}$$

$$n = \frac{384}{1 + \frac{384}{219}} = 139$$

Therefore, adding 10% for contingency on the calculated sample size, the final sample size obtained was 153.

4.6.2. Sampling Technique

There were 219 patients operated for femur shaft fracture treated with IMN (as counted from OR registration logbook and Sign Surgery Online Database). As the sample size required for this study is 153, the investigator aimed to include all eligible patients during the study period to make this study more powerful and given the strict eligibility criteria. Therefore, all patients with femur shaft fracture treated with retrograde sign nail, who meet the eligibility criteria, were taken as subjects of the study. Thus, 71 patients who lack eligibility criteria, including 60 patients with incomplete or lost cards, 9 patients who didn't respond their phone calls, and 2 deceased patients were excluded, and the researcher successfully obtained data from 148 patients.

4.7. Study Variables

4.7.1. Dependent Variable

- Functional knee treatment outcome status (excellent, good, fair, poor)

4.7.2. Independent Variables

- Age
- Sex of the patient
- Residence
- Side of fracture
- Mechanism of injury
- Duration of the injury
- Type of fracture
- Level of fracture
- Reaming
- Reoperation
- Weight bearing time
- Postoperative physical therapy of the knee

4.8. Operational Definitions

Femur shaft: part of femur between 5 cm distal to the lesser trochanter and 5 cm proximal to the adductor tubercle

Antegrade nailing insertion of nail through either greater trochanter or piriformis fossa

Retrograde nailing: insertion of nail through femoral intercondylar space

HSS: Clinical rating system has been the most popular method of tracking and reporting outcomes after total and partial knee arthroplasty and surgery around knee worldwide

Functional outcome: represents a return to daily living or performance, as measured by Hospital for Special Surgery knee score (HSS), at least 1 year after the surgical intervention. is instrument, which combines subjective and objective information, has six components: pain (30 points), function (22 points), range of motion (18 points), muscle strength (10 points), flexion deformity (10 points) and instability (10 points). Total score range from 0 to 100. It was further classified into excellent (85–100), good (84–70), fair (69–60) and poor (<60) based on the total score, which ranges from 0 to 100 (39).

Knee contracture: is defined as limitation in range of motion, manifesting as a flexion contracture, an extension contracture or mixed contracture in comparison to the unaffected contralateral side (40).

4.9. Data Collection Tools and Procedures

Data were collected via interviewer-administered, structured questionnaire. The data collection tool contains both closed and open ended questions specifically designed for the study; the socio-demographic and clinical characteristics contained in the data collection tool were adapted from previous literatures (32,35,36,41) and the functional outcome assessment tool adopted from Hospital for Special Surgery knee score (HSS). This instrument, which combines subjective and objective information, has six components: pain (30 points), function (22 points), range of motion (18 points), muscle strength (10 points), flexion deformity (10 points) and instability (10 points). Total score range from 0 to 100. A score of 85-100 points represents an excellent result, 70-84 points is a good result, 60-69 points is deemed fair/satisfactory, and a score below 60 is a poor result. Points are subtracted walking aids are used or in extension deficit or varus/valgus deformity (26,39,42). The HSS was shown to exhibit high sensitivity in assessing pain, difficulty performing activities of daily living and in assessing the results of physical examination of the knee joint in patients following knee surgery (26).

4.10. Data Quality Control

The questionnaire used to collect data was prepared by the principal investigator in English version. To improve data quality, brief training on the basics of the data collection tool and ethical considerations was given for two data collectors. The principal investigator provided supportive supervision to the data collectors to make sure that it was performed according to the protocol with proper tools. Close supervision was preserved during each data collection session, and questionnaires were double-checked daily for consistency and completeness by data collectors and principal investigator before analysis.

4.11. Data Processing and Analysis

Data were entered, coded and cleaned, and statistical analysis were done using SPSS (Statistical Package for Social science) version 26. Absolute and relative frequencies were used to check for missed values and variables. The demographic and clinical characteristics of patients were computed using descriptive statistics such as mean $\pm$ standard deviation for continuous variables as well as percentage and frequencies for categorical variables. Stepwise ordinal logistic

regression analyses were carried out to test the association between the outcome and explanatory variables. The model included functional outcome level (excellent, good, fair, poor) as the dependent variable, while the independent variables included sex, age, place of residence, presence of comorbidity, mechanism of injury, type of fracture, side of fracture, wound site infection, history of reoperation, and physical therapy (variables that were significantly associated with adherence level in the bivariable analysis). The goodness-of-fit test shows that deviance statistics with (p value is 0.508) was large, indicating that the model employed fitted the data well. Moreover, to maintain adequate cell count assumption variable (that is, time taken to full weight bearing time) with expected cell count <5 was removed and history of reoperation was removed from the final model for its collinearity with wound site infection. Statistical significance was set at a p-value of <0.05. Finally, the study findings were presented using narratives, diagrams, tables and figures.

4.12. Ethical Consideration

The study was conducted after obtaining Ethical clearance from Ethical Review Board of St. Paul's Hospital Millennium Medical College. A permission letter was submitted to the outpatient case team to proceed with data collection. Before interviewing clients, the purpose of the study was briefly explained to the potential respondents and informed verbal consent was obtained. During data collection, the study participants were informed that the information collected would be kept anonymous and confidential.

4.13. Plan of Dissemination of Results

The findings of this study will be submitted to the Department of Orthopedics and Traumatology of St. Paul's Hospital Millennium Medical College as a partial fulfillment of the Specialty Certificate in Orthopedics and Traumatology. It will also be presented and disseminated to other concerned stakeholders through presentation in different professional forums. Finally, there will be attempts to publish the outcome of this study in a reputable scientific journal.

5. Results

5.1 Demographic characteristics of patients

This study included data derived from 148 eligible patients who underwent retrograde intramedullary nailing for femoral shaft fracture. Out of all the included cases, most (n=122;82.4%) were males, with a male to female ratio of approximately 4.7:1. Patients' age ranged from 16 to 80 with a median (interquartile range) of 30 (24.25–40) years, and more than half (n=82;55.4%) aging 30 years or younger. Further, slightly more than half (51.4%; n=76) of the studied patients were urban dwellers while the remaining ones (48.6%; n=72) were rural residents. Majority (n=55;37.2%) of the patients were employed while the seventy-nine (53.4%) were either self-employed or unemployed (Table 1).

Table 1. Demographic characteristics of patients who underwent retrograde intramedullary nailing for femoral shaft fracture at AaBET Hospital, Addis Ababa, Ethiopia from January 1st, 2015 through December 31st, 2021

Variable	Frequency	Percent (%)
Age group		
≤30 years	82	55.4
30–45 years	51	34.5
>45 years	15	10.1
Median+ Interquartile range	30	24.25–40
Sex		
Male	122	82.4
Female	26	17.6
Residence		
Urban	72	48.6
Rural	76	51.4
Occupational category		
Employed	55	37.2
Unemployed	40	27.0
Self employed	39	26.4
Others [€]	14	9.5

[€]: Drivers, farmers, retirees, and students

5.2 Clinical profile of studied patients

About a third of the studied patients (n=47;31.8%) had some sort of comorbid medical condition, with hypertension (n=12;25.5%), diabetes mellitus (n=11;23.4%) and HIV/AIDS being the most commonly identified comorbidities. The remaining 10 comorbidities were distributed as shown in Table 2. Road traffic accident, fall down accident, and gunshot injuries were the leading mechanisms of injury, accounting for 52% (n=77), 22.3% (n=33), and 18.2% (n=27) of the cases, respectively (Table 2).

According to AO-32 classification, the most frequent types of fractures included in this study were A32 (n=75;50.7%), C32 (n=42;28.4%), and B32 (n=31;20.9%). Femoral fractures were slightly more common on the right side (n=81;54.7%). More than one-fourth (39;26.4%) of the studied population had been diagnosed with postoperative wound site infection. Thirty-nine (26.4%) of the patients were documented to be re-operated for some clinical indication. The time taken to full weight bearing was more than 4 weeks in eighty-eight (58.5%) of the patients while more than a quarter (n=39;26.4%) of all took about 3 weeks to full weight bearing. Majority (n=87;58.8%) were not given at least a single episode of physical therapy care postoperatively (Table 2).

Table 2. Clinical details of patients who underwent retrograde intramedullary nailing for femoral shaft fracture at AaBET Hospital, Addis Ababa, Ethiopia from January 1st, 2015 through December 31st, 2021

Variable	Frequency	Percent (%)
Comorbidity		
No	101	68.2
Yes	47	31.8
Type of comorbidity (n=47)		
Hypertension	12	25.5
Diabetes mellitus	11	23.4
HIV/AIDS	11	23.4
Cardiac disorder	5	10.6
Others	5	10.6
Mechanism of injury		
Road traffic accident	77	52.0
Fall down accident	33	22.3
Gunshot injury	27	18.2
Other	11	7.4
Type of fracture		
Type 32A	75	50.7
Type 32B	31	20.9
Type 32C	42	28.4
Side of fracture		
Right	81	54.7
Left	67	45.3
Wound site infection		
Yes	39	26.4
No	109	73.6
Reoperation		
Yes	39	26.4
No	105	73.6
Time taken to full weight bearing time		
1 week	4	2.7
2 weeks	17	11.5
3 weeks	39	26.4
≥4 weeks	88	59.5
Physical therapy given		
Yes	61	41.2
No	87	58.8

5.3 Knee functional outcome status

The knee functional status was measured using HSS in this study. The mean $\pm$ standard deviation HSS score of the study population was 85.6 ± 11.0 (range, 41–94). The incidence of pain (mild to moderate) was 43.9% in the pain sub-score. Most (n=137;92.6%) were rated to have good to

excellent knee functional outcome 12 months after surgery. On the other hand, only 7.5% (11 of 148 patients) had either fair or poor functional outcome (Figure 2).

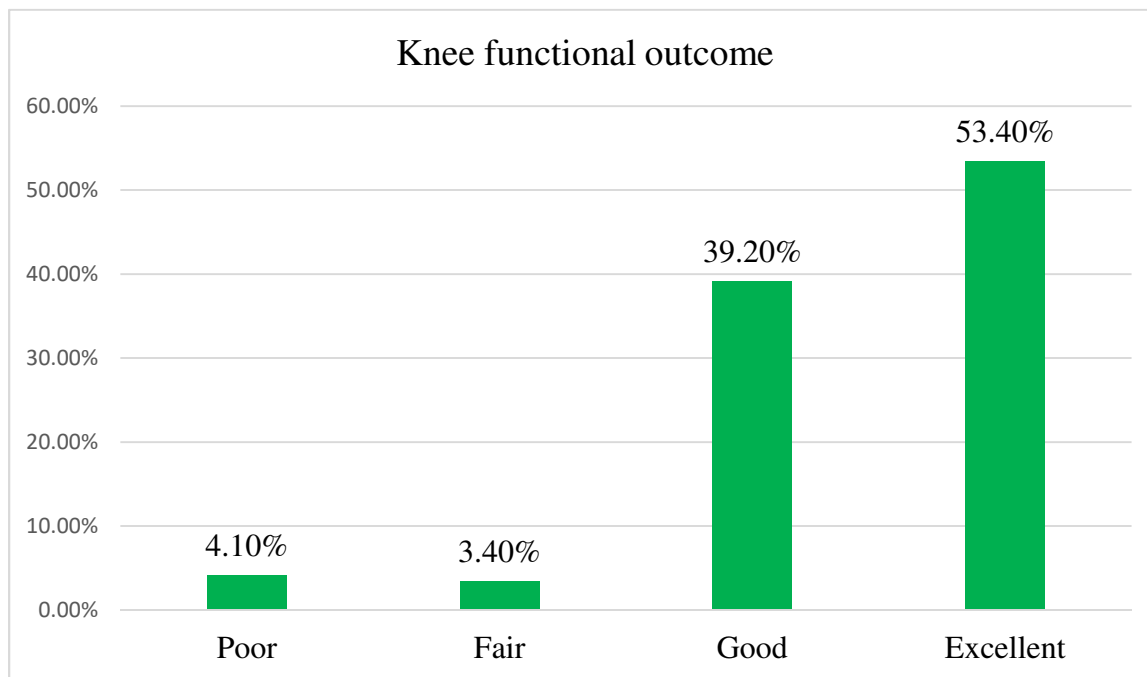


Figure 2. Knee functional outcome of patients who underwent retrograde intramedullary nailing for femoral shaft fracture at AaBET Hospital, Addis Ababa, Ethiopia from January 1st, 2015 through December 31st, 2021

5.4 Factors associated with functional outcome

In this study, eleven variables, namely, sex, age, place of residence, presence of comorbidity, mechanism of injury, type of fracture, side of fracture, wound site infection, history of reoperation, time taken to full weight bearing time, and physical therapy were considered. Following ordinal logistic regression analysis, factors such as age, presence of comorbidity, mechanism of injury, wound site infection, and physical therapy showed statistically significant association with knee functional outcome in individuals who underwent retrograde intramedullary nailing for femoral shaft fracture. As shown in the results, patients older than 45 years were disproportionately prone to poorer functional outcomes in reference to the ones aging 30 years or younger. Presence of comorbidities was significantly associated with poorer outcome. Type 32C fractures were more frequently associated with poorer functional outcome when compared with types 32A and 32B (Table 3).

On the other hand, road traffic accident injury as a mechanism of trauma was consistently associated with better functional results in comparison those sustaining other forms of injuries. Wound site infection with subsequent reoperation was also significantly associated with poor outcomes (OR = 0.15, p-value <0.001). Interestingly, patients who were given physical therapy postoperatively had higher likelihood of HSS scores in comparison with those who did not take any form of physiotherapy (OR = 0.40, p-value=0.039). Further, as demonstrated in the regression output, the coefficient of determination (Pseudo R²) equals 0.522, which grossly means that the determinants included in the model explain only 52.2% of the variance in level of knee functional level among the patients while the remaining 47.8% were accounted for by error terms and unconsidered factors (Table 3).

Table 3. Ordinal logistic regression of factors associated with functional outcome among patients who underwent retrograde intramedullary nailing for femoral shaft fracture

Variable	Knee functional outcome				COR	AOR	95% CI		P value
	Poor n(%)	Fair n(%)	Good n(%)	Excellent n(%)			Lower	Upper	
Age group									
≤30 years	1(1.2)	1(1.2)	26(31.7)	54(65.8)	30.62	19.80	3.70	106.12	<0.001
30–45 years	0(0)	2(3.9)	26(51.0)	23(45.1)	213.60	11.92	2.50	56.71	0.002
>45 years	5(33.3)	2(13.3)	6(40)	2(13.3)	Ref.	Ref.	-	-	-
Sex									
Male	6(4.9)	3(2.4)	46(37.7)	67(54.9)	0.75	0.21	0.522	0.19	0.210
Female	0(0)	2(7.7)	12(46.2)	12(46.2)	Ref.	Ref.	-	-	-
Place of residence									
Urban	0(0)	3(4.2)	27(37.5)	42(58.3)	1.60	0.84	0.36	1.96	0.691
Rural	6(7.9)	2(2.6)	31(40.8)	37(48.7)	Ref.	Ref.	-	-	-
Comorbidity									
No	1(0.9)	2(1.9)	36(35.6)	62(61.4)	3.25	4.50	1.71	11.85	0.002
Yes	5(10.6)	3(6.4)	22(46.8)	17(36.2)	Ref.	Ref.	-	-	-
Mechanism of injury									
Road traffic accident	2(2.6)	1(1.3)	19(24.7)	55(71.4)	4.58	5.57	1.33	23.41	0.019

Fall down accident	3(9.1)	0(0)	18(54.5)	12(36.4)	1.10	1.57	0.38	6.54	0.539
Gunshot injury	0(0)	2(7.4)	18(66.7)	7(25.9)	0.86	1.79	0.33	9.78	0.503
Other	1(9.1)	2(18.2)	3(27.3)	5(45.4)	Ref.	Ref.	-	-	-
Type of fracture									
Type 32A	1(1.3)	3(4.0)	21(28.0)	50(66.7)	3.08	3.00	0.96	9.40	0.059
Type 32B	4(12.9)	0(0)	13(41.9)	14(45.2)	1.17	1.31	0.35	4.84	0.686
Type 32C	1(2.4)	2(4.9)	24(58.5)	15(36.6)	Ref.	Ref.	-	-	-
Side of fracture									
Right	5(6.2)	4(4.9)	23(28.4)	49(60.5)	1.50	1.20	0.55	2.60	0.653
Left	1(1.5)	1(1.5)	35(52.2)	30(44.8)	Ref.	Ref.	-	-	-
Wound site infection									
Yes	1(2.6)	3(7.7)	26(66.7)	9(23.1)	0.23	0.15	0.05	0.41	<0.001
No	5(4.6)	2(1.8)	32(29.4)	70(64.2)	Ref.	Ref.	-	-	-
Physical therapy given									
Yes	5(8.2)	3(4.9)	32(52.4)	21(34.4)	0.26	0.40	0.16	0.95	0.039
No	1(1.1)	2(2.3)	26(29.9)	58(66.7)	Ref.	Ref.	-	-	-

Nagelkerke's Pseudo R square = 0.522

COR: Crude odds ratio; AOR: Adjusted odds ratio; CI: Confidence interval

6. Discussion

The purpose of this retrospective study was to evaluate knee functional outcomes and identify associated factors among patients treated with retrograde intramedullary nailing for femoral shaft fractures. It was indicated that knee functional outcomes were predominantly good or excellent following the operative fixation. Besides, age, presence of comorbidity, mechanism of injury, wound site infection, and postoperative physical therapy were found to be significantly associated with knee functional outcomes.

Notably, in this study, males constituted 82.4% of the patients with the male to female ratio being 4.7: 1. This male preponderance indicates that femoral shaft fractures are disproportionately common in males at their highly productive age range and this might have profound direct and indirect unfavourable socio-economic impact within the society. The preponderance of males over females in this study is not surprising since more males are usually involved in trauma than females. Men are more outgoing, adventurous and aggressive about making it in life and thus engage in lots of travels with the attendant possibility of predisposition to various forms of trauma that include the femur (3).

Specifically, this study demonstrated that by the end of one year after retrograde intramedullary nailing, good or excellent level of knee functional outcomes (92.6%) was achieved. This finding is consistent with the favourable knee functional outcome status (92.2%) observed in Kenyan population (36). Additionally, the current finding, which showed the incidence of pain of 43.9% in the pain sub-score, was similar to that of Njoroge et al. who documented a comparable prevalence of knee pain (37.5%) among patients who underwent retrograde fixation (36). Moreover, the average HSS score for retrograde nailing was 85.6, which was close to the figure obtained in Kenyan context (84.1) (36). The comparable results can be in part attributed to the similarity of the healthcare infrastructures in both settings.

On the contrary, the present finding is quite different from the report of Acharya and Rao, which documented an excellent or good function scores of 73% among Indian patients (43). Also, the average HSS knee score obtained in this study was higher than of Leggon and Feldmann (80.4%) (44). Further, the prevalence of knee pain was different from the result obtained by Breyer et al., who reported that pain was occurred in 64% of patients (45). Similarly, the prevalence of pain was higher than the knee pain observed by Ostrum et al. (23%) among patients who underwent

retrograde femoral nailing (13). Different from what is observed in this study, El Moumni reported that 17% of the patients had moderate to severe pain (32).

This discrepancy in could also be related to different parameters used to assess the knee joint functionality, variations in the postoperative time at which functionality was assessed, and the joint mobilization protocol. For example, Breyer et al. used the Oxford Knee Score (OKS) and the Patient-Reported Outcomes Measurement Information System (PROMIS) Physical Function Short Form 6b while this study used HSS as its primary tool.

There was a negative association between increasing age and the functional outcome in patients undergoing retrograde nailing, and this was consistent with what was observed by Njoroge et al. Among Kenyan patients (36). This can be attributed to the decline in knee kinematics that occur with aging. Besides, as it was anticipated, AO classification type C were significantly associated with poorer functional outcomes, which can due to the fact that these fractures are complex and are important risk factors of non-union in patients with femoral fractures (46).

Of interest, this study showed that patients who were provided physical therapy postoperatively had lower knee functional outcomes in comparison with those who did not take any form of physiotherapy. This is in contrast to the existing literature, which emphasize that increased number of physiotherapy visits is associated with improved outcomes. However, the author believes a though research might be required for this finding, and it can be postulated that the poorer outcomes in these groups can be the possibility that those who were subjected to physiotherapy sessions could have been those with unfavorable short-term outcomes such as knee stiffness (contractures) for which physical therapy was ordered.

7. Strength and Limitations

7.1 Strength

- ✓ This study used both primary and secondary data, which is believed to improve the accuracy of the data analyzed.
- ✓ The study used a stronger statistical analytical technique (that is: ordinal logistic regression) which can produce a more informative and powerful analysis.

7.2 Limitations

- ✗ An essential limitation of this study is its retrospective nature, which may limit the generalizability of the findings to other contexts.
- ✗ Besides this, the study was conducted at a single center with a modest number of individuals, which might limit generalization of the findings to wider contexts.
- ✗ Another potential limitation of this study is lack of control group, as a result of which comparison of results was done with the published literature.

8. Conclusion and Recommendation

8.1 Conclusion

As the results indicate, reamed retrograde IM nail fixation seems to be safe and a viable option in patients sustaining femoral shaft fracture as knee functional outcome was predominantly good or excellent one-year following the operative procedure. Functional outcome was associated with certain factors such as age, history of comorbidity, mechanism of injury, history of surgical site infection, and postoperative physical therapy. Thus, patients who older than 45 years, have a comorbidity, history of surgical site infection, and postoperative physical therapy should be treated with other alternative approaches for better functional outcomes.

8.2 Recommendation

In view of the results obtained in this study, the following recommendations can be forwarded.

For surgeons,

Practitioners should seriously consider retrograde femoral nailing as an alternative to other surgical techniques such as antegrade femoral nailing for patients with proper clinical indications. Surgeons should counsel patients on postoperative expectations in terms of functional outcomes, so achievable postoperative expectations can be anticipated. Surgeons should consider alternative techniques for patients who are older than 45 years, have a comorbidity, history of surgical site infection, and postoperative physical therapy.

For management bodies,

Local guidelines should reinforce the continued use of retrograde techniques whenever appropriate. Knee rehabilitative protocols on the background of widespread use of the retrograde techniques should designed, with consideration of individuals with certain factors.

For researchers,

Multi-center, well-controlled prospective studies to determine the long term outcomes of the knee in patients following intramedullary nailing are necessary to validate the current results. Prospective comparison of patients receiving retrograde femoral nailing versus control would

allow a more rigorous evaluation of functional outcome in prognosticating the efficacy of the procedure and should be considered in the future studies in this setting.

9. References

1. Neumann M V, Südkamp NP, Strohm PC. Management of femoral shaft fractures. *Acta Chir Orthop Traumatol Cech* [Internet]. 2015;82(1):22–32. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25748658>
2. Khan AM, Tang QO, Spicer D. The Epidemiology of Adult Distal Femoral Shaft Fractures in a Central London Major Trauma Centre Over Five Years Abstract : 2017;44(0):1277–91.
3. Ugezu AI, Nze IN, Ihigihu CC, Chukwuka NC, Ndukwu CU OR. Management of Femoral Shaft Fractures in a Tertiary Centre , South Est Nigeria. *Afrimed J*. 2018;6(1):27–34.
4. Wu AM, Bisignano C, James SL, Abady GG, Abedi A, Abu-Gharbieh E, et al. Global, regional, and national burden of bone fractures in 204 countries and territories, 1990–2019: a systematic analysis from the Global Burden of Disease Study 2019. *Lancet Heal Longev*. 2021;2(9):e580–92.
5. Sonbol AM, Almulla AA, Hetaimish BM, Taha WS, Mohmmmedthani TS, Alfraidi TA, et al. Prevalence of Femoral Shaft Fractures and Associated Injuries among Adults After Road Traffic Accidents in a Saudi Arabian Trauma Center. 2018;1–4.
6. Woyessa AH, Heyi DW, Ture HN, Moti KB. Patterns of road traffic accident , nature of related injuries , and post-crash outcome determinants in western Ethiopia - a hospital based study. *African J Emerg Med* [Internet]. 2021;11(1):123–31. Available from: <https://doi.org/10.1016/j.afjem.2020.09.008>
7. Schade AT, Mbowuwa F, Chidothi P, MacPherson P, Graham SM, Martin C, et al. Epidemiology of fractures and their treatment in Malawi: Results of a multicentre prospective registry study to guide orthopaedic care planning. *PLoS One* [Internet]. 2021;16(8 August):1–14. Available from: <http://dx.doi.org/10.1371/journal.pone.0255052>
8. Hollis AC, Ebbs SR, Mandari FN. The epidemiology and treatment of femur fractures at a northern Tanzanian referral centre. *Pan Afr Med J*. 2015;22(338):1–6.
9. Fakhry SM, Rutledge R, Dahners LE, Kessler D. Incidence, management, and outcome of femoral shaft fracture: a statewide population-based analysis of 2805 adult patients in a rural state. *J Trauma* [Internet]. 1994 Aug;37(2):255-60-1. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8064926>
10. Feldman G, Mosheiff R, Nasrallah K, Shabtai R, Davidson A, Weil YA. Evolution of treatment of femoral shaft fracture in polytrauma: Did damage control orthopaedics improve the outcome? A retrospective study. *Injury* [Internet]. 2021 Jul;52(7):1886–90. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0020138321003405>

11. DeCoster T, Patti B. Retrograde Nailing for Treating Femoral Shaft Fractures: A Review. UNM Orthop Res J. 2018;7(1):18.
12. El-Seedy A, Zaki E, El-Sheikh I, Sakr S. Long-term functional outcome of knee after antegrade versus retrograde intramedullary nailing for femoral fracture. Menoufia Med J. 2022;35(2):899.
13. Ostrum RF, Agarwal A, Lakatos R, Poka A. Prospective comparison of retrograde and antegrade femoral intramedullary nailing. J Orthop Trauma [Internet]. 2000 Jan 17;14(7):496–501. Available from: <http://journals.lww.com/00005131-200009000-00006>
14. Ricci WM, Bellabarba C, Lewis R, Evanoff B, Herscovici D, DiPasquale T, et al. Angular malalignment after intramedullary nailing of femoral shaft fractures. J Orthop Trauma. 2001;15(2):90–5.
15. Mounasamy V, Mallu S, Khanna V, Sambandam S. Subtrochanteric fractures after retrograde femoral nailing. World J Orthop. 2015;6(9):738–43.
16. Ricci WM, Gallagher B, Haidukewych GJ. Intramedullary Nailing of Femoral Shaft Fractures. Case Competencies in Orthopaedic Surgery. 2016. p. 149–59.
17. Krupp RJ, Malkani AL, Goodin RA, Voor MJ. Optimal entry point retrograde femoral nailing. J Orthop Trauma. 2003;17(2):100–5.
18. Anteneh A, Endris BS. Injury related adult deaths in Addis Ababa , Ethiopia : analysis of data from verbal autopsy. 2020;1–8.
19. Mekonnen FH, Teshager S. Road traffic accident : The neglected health problem in Amhara National Regional State , Ethiopia. 2008;(7).
20. Kouris G, Hostiuc S, Negoii I. Femoral fractures in road traffic accidents. Rom J Leg Med. 2012;20(4):279–82.
21. Salminen ST, Pihlajamäki HK, Avikainen VJ, Böstman OM. Population based epidemiologic and morphologic study of femoral shaft fractures. Clin Orthop Relat Res [Internet]. 2000 Mar;80(372):241–9. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/10738433>
22. Weiss RJ, Montgomery SM, Al Dabbagh Z, Jansson K-Å. National data of 6409 Swedish inpatients with femoral shaft fractures: Stable incidence between 1998 and 2004. Injury [Internet]. 2009 Mar;40(3):304–8. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0020138308003343>
23. Beshah T, Hill S. Mining road traffic accident data to improve safety: role of road-related factors on accident severity in Ethiopia. In: In: AAAI spring symposium series. 2010.

24. Mughal M, Dix-Peek S, Hoffman E. The epidemiology of femur shaft fractures in children. 2013;12(4):23–7.
25. Denisiuk M, Afsari A. Femoral Shaft Fractures [Internet]. Vol. Updated 20, StatPearls. 2022. StatPearls Publishing. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/10738433>
26. Slupik A, Bialoszewski D. A Comparative Analysis of the Clinical Utility of the Knee Replacement Patients – Preliminary Report *Analiza porównawcza przydatności klinicznej skal Staffelstein-Score i Hospital for Special Surgery Knee Score (HSS) w monitorowaniu.* 2009;(February).
27. Von Kaeppler EP, Kramer EJ, Donnelley CA, Wu HH, Marseille E, Eliezer E, et al. The initial economic burden of femur fractures on informal caregivers in Dar es Salaam, Tanzania. *Malawi Med J.* 2021;33(2):135–9.
28. Alturki AA, Alaqeely KS, Almugren TS, Alzimami IS. Analysis of femoral fracture post motor vehicle accidents. *Saudi Med J.* 2019;40(1):41–4.
29. Ghouri SI, Asim M, Mustafa F, Kanbar A, Ellabib M, Al Jogol H, et al. Patterns, management, and outcome of traumatic femur fracture: Exploring the experience of the only level 1 trauma center in Qatar. *Int J Environ Res Public Health.* 2021;18(11).
30. The Orthopaedic Trauma Association and the AO Foundation. Fracture and Dislocation Compendium—2018. Vol. 32, *Journal of orthopaedic trauma.* 2018. p. 23–71.
31. Ryd L, Kärrholm J, Ahlvin P. Knee scoring systems in gonarthrosis. Evaluation of interobserver variability and the envelope of bias. *Acta Orthop Scand.* 1997;68(1):41–5.
32. El Moumni M, Voogd EH, Ten Duis HJ, Wendt KW. Long-term functional outcome following intramedullary nailing of femoral shaft fractures. *Injury [Internet].* 2012;43(7):1154–8. Available from: <http://dx.doi.org/10.1016/j.injury.2012.03.011>
33. Hierholzer C, Rüden C, Pötzel T, Woltmann A, Bühren V. Outcome analysis of retrograde nailing and less invasive stabilization system in distal femoral fractures: A retrospective analysis. *Indian J Orthop.* 2011;45(3):243–50.
34. Agarwal S, Udapudi S, Gupta S. To assess functional outcome for intra-articular and extra-articular distal femur fracture in patients using retrograde nailing or locked compression plating. *J Clin Diagnostic Res.* 2018;12(3):RC21-RC24.
35. Nakamura T, Yokoyama K, Saita Y, Aoki S, Tsukamoto T, Itoman M. Functional outcome of retrograde intramedullary nailing for femoral fractures. *Eur J Orthop Surg Traumatol.* 2001;11(1):29–33.
36. Njoroge A, Mwangi H, Lelei L. Functional Outcomes of the Knee after Retrograde and

- Antegrade Intramedullary Nailing for Femoral Shaft Fractures. *Ann African Surg.* 2013;10(2).
37. Narin S, Ünver B, Bakirhan S, Bozan Ö, Karatosun V. Cross-cultural adaptation, reliability and validity of the Turkish version of the hospital for special surgery (HSS) knee score. *Acta Orthop Traumatol Turc.* 2014;48(3):241–8.
 38. An N, Hr M, Lk L. Functional Outcomes of the Knee after Retrograde and Antegrade Intramedullary Nailing for Femoral Shaft Fractures. *Ann African Surg.* 2013;10(2).
 39. Ranawat CS, Shine JJ. Duo-condylar total knee arthroplasty. *Clin Orthop Relat Res* [Internet]. 1973;(94):185–95. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/4743449>
 40. Trudel G, Uhthoff HK, Goudreau L, Laneuville O. Quantitative analysis of the reversibility of knee flexion contractures with time: An experimental study using the rat model. *BMC Musculoskelet Disord.* 2014;15(1):1–7.
 41. Outcomes F, The OF, After K, Hospital R, Nduati NA, Sciences H, et al. FUNCTIONAL OUTCOMES OF THE KNEE AFTER INTRAMEDULLARY NAILING FOR FEMORAL SHAFT FRACTURES AT MOI TEACHING AND REFERRAL HOSPITAL, KENYA. 2012;
 42. Gore DR, Murray MP, Sepic SB, Gardner GM. Correlations Between Objective Measures of Function and a Clinical Knee Rating Scale Following Total Knee Replacement. *Orthopedics* [Internet]. 1986 Oct;9(10):1363–7. Available from: <https://journals.healio.com/doi/10.3928/0147-7447-19861001-08>
 43. Acharya KN, Rao MR. Retrograde nailing for distal third femoral shaft fractures: a prospective study. *J Orthop Surg (Hong Kong).* 2006;14(3):253–8.
 44. Leggon RE, Feldmann DD. Retrograde femoral nailing: a focus on the knee. *Am J Knee Surg* [Internet]. 2001;14(2):109–18. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/11401168>
 45. Breyer G, Usmani K, Hwang R, Begley B, Mashru RP, Gutowski CJ. Knee Pain and Functional Outcomes after Retrograde. 2023;218(3):218–24.
 46. Ghouri SI, Mustafa F, Kanbar A, Al Jogol H, Shunni A, Almadani A, et al. Management of Traumatic Femur Fractures: A Focus on the Time to Intramedullary Nailing and Clinical Outcomes. *Diagnostics.* 2023;13(6):1147.

Annex

Annex I: Information sheet

St. Paul's Hospital Millennium Medical College

Department of Orthopedics and Traumatology

Participant Information Sheet and Informed Consent Form

Hello dear respondents, my name is_____. I am here to collect data for the research purpose which is conducted to complete a thesis for the Specialty Certificate in Orthopedics and Traumatology at SPHMMC.

The purpose of this study is to evaluate the functional outcome and associated factors following retrograde intramedullary nailing of traumatic femoral shaft fractures at Addis Ababa Burn Emergency and Trauma Hospital, Addis Ababa, Ethiopia.

You are selected to be one of the participants for this study. I would like to ask you to fill this questionnaire that takes 10 to 15 minutes of your time. No harm is imposed to you except the time you commit for interview but some of the question may look too personal but it is helpful for the study. In addition, there is no payment for participation even though the result of the study may benefit as a citizen. The participation in this study is entirely voluntary, you have the right to refuse or withdraw from the study at any time for any reason without penalty. However, your honest answers to these questions are important since it provide relevant information to assess the functional outcome of retrograde IMN

The information you provide is confidential and it will be used only for study purpose, and it will not be disclosed to anyone. A code number will be used to identify the participant therefore, writing your name is not needed.

If you have something that is not clear about the study please contact the principal investigator, Dr. Mohamed Ahmed (Mobile phone: +251912646885, email: mgaryar@gmail.com) at any time.

Are you willing to participate in this study? 1. Yes 2. No

Signature of data collector certifying verbal informed consent_____

Thank You!!!

Annex II: Data collection format

001. Data collector: code ____/____/____ Name _____

002. Date of data collection ____/____/____ Time _____

003. Checked by Supervisor: Signature _____ day _____ month _____ year _____

I. Background data			
SN	Question	Response	Skip
1.1	Age in years		
1.2	Sex	1. Male 2. Female	
1.3	Residence	1. Urban 2. Rural	
1.4	Occupational status	1. Unemployed 2. Employed 3. Self-employed 4. Other (Specify _____)	
Section 2: Pre- and post- operative variables			
2.1	Any history of chronic medical illness	1. Yes 2. No	
2.2	Mechanism of injury	1. Fall down injury 2. Road traffic accident 3. Gunshot injury 4. Other (specify)	
2.3	Type of fracture	1. Type 32A fracture (Simple) 2. Type 32B fracture (Wedge) 3. Type 32C fracture (Complex)	
2.4	Side of fracture	1. Right 2. Left	
2.5	Reaming	1. Yes 2. No	
2.6	Postoperative wound site infection	1. Yes 2. No	
2.7	Reoperation	1. Yes 2. No	
2.8	Time taken to full weight bearing in weeks	_____	
2.9	Physical therapy given	1. Yes	

		2. No	
Section 3: Hospital for Special Surgery Knee Rating Scale items			
3.1	Pain (30 points)	– No pain – Mild pain – Moderate pain on walking – Severe pain on walking	
3.2	Function (22 points)	– Walking ability (12 points) – Climbing stairs (5 points) – Transfer activity (5 points)	
3.3	Range of movement (18 points)	– More than 100° – 81-100° – 61-80° – Less than 61°	1 point for each 8 degrees (max 18 points)
3.4	Stability (10 points)	– Stable 0-5° – Mild instability 6-10° – Moderate instability 11-15° – Severe instability, more than 15°	
3.5	Flexion deformity (10 points)	– No flexion deformity – Less than 5° – 5-10° – More than 10°	
3.6	Muscle strength (10 points)	– Cannot break quadriceps power – Can break quadriceps power – Moves through arc of motion – Cannot move through arc of motion	