



KNEE FUNCTIONAL OUTCOME AND ASSOCIATED FACTORS OF PATIENTS TREATED INTRAMEDULLARY NAILING FOR FEMUR SHAFT FRACTURES

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Graduate Study Program

Comparative Study Of Knee Functional Outcome And Associated Factors
Of Patients Treated With Retrograde And Antegrade Nailing For Femur
Shaft Fracture Done At Aabet Hospital Between 2018 To 2020 GC

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Acronyms

SIGN.....	Surgical Implant Generation Network
CI	Confidence Interval
SPHMMC.....	Saint Paul’s Hospital Millennium Medical College
SPSS.....	Statistical Package for Social Science
AaBET.....	Addis Ababa Burn Emergency and Trauma center
MVA.....	Motor Vehicle Accident
AO/ASIF.....	Arbeitsgemeinschaft für Osteosynthesefragen/ Association of the Study of Internal Fixation
ETB.....	Ethiopian Birr
IMN.....	Intramedullary Nail
IRB.....	Institutional ethical Review Board
OTA.....	Orthopedic Trauma Association
RIMN.....	Retrograde Intramedullary nail
VAS.....	Visual Analog Scale
WOMAC.....	Western Ontario and McMaster Universities Osteoarthritis Index
KOOS.....	Knee Injury and Osteoarthritis Outcome Score
KSS.....	Knee Society Score
KOOS-PS.....	Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form
GC.....	Gregorian Calendar
ESOT.....	Ethiopian Society of Orthopedics and Traumatology
SPHMMC.....	St Paul Hospital Millennium Medical College
IKDC.....	International Knee Documentation Committee
KOS-ADL.....	Knee Outcome Survey Activities of Daily Living Scale
ARS.....	Activity Rating Scale
TAS.....	Tegner Activity Score

Abstract

Background: Intramedullary nailing is currently preferred method of treating femoral shaft fracture as it provide stable fixation with excellent union rate(1). It also has advantages of decreased soft tissue stripping, lower rate of malalignment, leg length discrepancy, early ambulation, and decreased hospital stay(2). Among the possible ways of intramedullary nailing of femur shaft fracture, currently antegrade fashion is considered the gold standard but retrograde technique is also gaining acceptance recently. The emerging popularity of retrograde nailing is backed by several papers reporting similar functional outcomes with that of antegrade nailing.(3–5) These studies are done in setups with proper postoperative rehabilitation protocols which is not available in this study set up. Despite both retrograde and antegrade nailing is being done frequently in the study setup, there is no any study comparing the knee functional outcomes of both technique performed so far. Thus, the study has invaluable importance as it could help to develop guidelines and as a starting point for further studies

Objective: To compare knee functional outcome and associated factors of patient with femoral shaft fracture treated with antegrade versus retrograde nail.

Methods: Comparative Retrospective crossectional study was conducted on the knee functional outcome of patients treated by nailing for femur shaft fracture, done at AaBET hospital from Jan 2018 to Dec 2020. Data was collected by standardized questionnaires from patients coming for follow up and patient chart and Sign Surgery online Data base. Data entry and analysis was done using SPSS version 26. The study was conducted from November 2021 to May 2022. The total cost of the study is 27,250 Ethiopian Birr.

Results: A total of 81 patients participated in the study. The mean WOMAC score of the Antegrade group is 9.32 with range of (0-23.9) while the that of the retrograde group is 14.99 with range of (0-32.3). In comparison, the retrograde group had significantly poorer functional outcome results than Antegrade group ($p < 0.001$). There is a negative correlation between age and preoperative time with the knee functional outcome ($p < .001$).

Conclusion: Retrograde nailing is associated with poorer knee scores in our patient population. Increasing age and preoperative time are factors associated with poorer scores.

1 Introduction

1.1 Background

Traumatic injuries cause significant morbidity and mortality in low and middle income countries(6). Road traffic accidents are responsible for vast majority of these injuries, leading to over 1.2 million deaths and up to 50 million non-fatal injuries annually(7). Among the non-fatal injuries, femoral fractures are the most common and pose a significant detriment to quality of life(8). Femur shaft fractures are one of the common injuries treated by orthopedic surgeons. They usually result from high-energy mechanisms resulting in complications of limb shortening and deformities if not treated appropriately(9)

Human femur is the longest and strongest bone in the body. The Shaft part is a long straight part which is circumferentially padded with large muscles. A femoral shaft fracture is a fracture of the femoral diaphysis occurring between 5cm distal to the lesser trochanter and 5cm proximal to the adductor tubercle(9)

Adult femur shaft fractures can be treated either non operatively(skeletal traction or cast brace) or operatively. Unlike pediatric patients, non-operative management is limited only to adult patients with such a significant medical comorbidities for whom operative management is contraindicated. Thus, operative management is the standard of care for most adult femoral shaft fractures(10). Operative stabilization can be performed by kuntscher intramedullary nail, locked intramedullary nail, sub-muscular plating or external fixator(9,10).

An intramedullary nail is a metal rod that is inserted into the medullary cavity of a bone across a fracture in order to provide a solid support for the bone. It is currently considered as the "gold standard" and superior to plate fixation of adult femur shaft fracture because of its lower rates of infection, early weight-bearing, and lesser chances of non-union. Intramedullary fixation was first introduced in 1940 GC by German surgeon, Gerhard Kuntscher. His nail was initially only used for stable infra-isthmal types(Winquist I and II) of fracture as it has no locking mechanism and does not provide rotational stability(11). Despite of these drawbacks, it is still being used in resource limited setups like Ethiopia because of its lesser duration of the surgery, cheaper implant cost, lesser radiation exposure(as the procedure can be done without image intensifier) and comparable functional outcome with an interlocking nail in these types of fractures(11). In late 1960s, Kuntscher himself recognized as his conventional non locking nail was not suitable for some types of femur fracture(Winquist III and IV) and developed first interlocking nail. This type of nail gives the advantage of closed medullary nailing with added fixation of inserted transfixion screws, introduced through pre- drilled holes at proximal or distal or both end of the nail. These nails can be used for fractures which are unsuitable for standard medullary fixation such as fractures with severe comminution, bone loss and those beyond the isthmic zone (12). Increasing

advance in design, technique, and biologic implications of intramedullary implants have further expanded its indications(13). The transition from open nailing techniques to closed techniques using image intensification and intramedullary reaming with placement of larger implants to allow improved rotational control and resistance to bending are among the advances(13).

Although interlocking nail is preferred mode of treatment of long bone fractures, it is expensive as it requires sophisticated equipment for insertion and extraction(12). Interlocking pins/bolts at times break/bend and wings may get stuck inside medullary cavity leading to difficulty in extraction of nails. It also requires image intensifier for insertion(12). Due to these reasons, management of femoral shaft fractures with locked IMN has evolved slowly in developing countries until SIGN fracture care international, a nonprofit organization, invented locked IM nailing system that can be used without fluoroscopy and fracture table in 1999(14). This nail is designed for use in the femur, tibia and humerus without the need for fluoroscopic imaging and suitable for low-cost intramedullary fixation in resource-limited settings like ours(15). The SIGN nail has got two categories; Standard SIGN nail(Fig.1A) and SIGN Fin nail(Fig.1B). Both nails are designed to be implanted without use of fluoroscopy. The Fin Nail additionally does not require placement of interlocking screws (distal screws in antegrade approach; proximal screws in retrograde approach)(16). These both implants are devices of option to treat these fractures in resource limited settings and are currently being used this study setup.



Figure 1; Sign Nail Categories; A) SIGN Standard IM Nail; (B) SIGN Fin Nail.

Source: SIGN Fracture Care International Technique Manual (2012)

IMN of adult femur shaft fracture can be performed either antegrade or retrograde technique(1). Antegrade technique is when the nail is inserted through greater trochanter or piriformis fossa while retrograde nailing 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(1,10,17). Despite both ends of the femur are suitable for nail insertion, there is debate in the literature concerning which end to use and, further in antegrade nailing, whether to choose the piriformis fossa or greater trochanter as preferred entry point(18) Furthermore, each technique has its own advantage and disadvantage(19). For instance antegrade nailing has disadvantage of risk of injury to the hip abductors or its nerve supply(20), heterotopic ossification about the hip(21) and implant-related pain which can be avoided by using retrograde nailing. It also pose difficulty of insertion in obese patients(5,22). However, it has an advantages over retrograde approach by its greater availability of nail types, familiar technique, and absence of joint violation associated with the fracture treatment(23,24) Furthermore, it has been extensively described to have as high as 99% union rates and has been considered the gold standard to date (23,25,26). However, retrograde approach through the femoral intercondylar notch is also being popularized in the recent years as an alternative (26–30) Retrograde nailing is preferred in polytrauma; ipsilateral pelvic, acetabular, tibial and femoral neck fractures; bilateral femur fractures; and obese and pregnant patients(19,23) Although , it is said to have potential complications of knee pain and reduced range of motion, many studies are reporting acceptable functional results(3,24,26,27).

An outcome measure is a tool used to assess a patient's current status of health condition. With the trend towards Evidence Based Practice in health care, outcome measures provide credible and reliable justification for treatment on an individual patient level. It can undertaken as patient reported measurement or as physician assessed outcome measures. A patient-reported outcomes(PRO) is directly reported by the patient without interpretation of the patient's response by a clinician or anyone else and pertains to the patient's health, quality of life, or functional status associated with health care or treatment. After many years of use in clinical trials, there is now growing interest in using PRO to support improvement in the safety and quality of healthcare delivery(32).

Multiple patient reported functional outcome measurements tools has been developed so far to study patients with knee problems such as injury or osteoarthritis. International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Knee Injury and Osteoarthritis Outcome Score (KOOS), Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form (KOOS-PS), Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL), Lysholm Knee Scoring Scale, Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Activity Rating Scale (ARS), and Tegner Activity Score (TAS) are among these tools(33).

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a widely used measure of symptoms and physical disability originally developed for people with osteoarthritis (OA) of the hip and/or knee. Later it has also been used as an outcome measure in evaluating the effect of other therapeutic interventions (e.g., acupuncture) and in patient groups other than OA of the hip or knee. Because of its simplicity and quick to administer, it is one of the most commonly used patient-reported outcomes. Psychometric testing indicates that the WOMAC is sufficiently reliable and valid for use in research. It uses self-administered questionnaire which has been validated for use in person, over the telephone, or electronically via a computer or mobile phone to evaluate 3 dimensions: pain, stiffness, and physical function with 5, 2, and 17 questions, respectively(33,34). It is available in 5-point Likert, 100-mm visual analog scale (VAS), and 11-box numerical rating scales. In the Likert version, each item offers 5 responses: “none” scored as 0, “mild” as 1, “moderate” as 2, “severe” as 3, and “extreme” as 4(35).

1.2 Statement of the problem

Even though, IMN can be performed through either antegrade or retrograde, there is always a debate on literature concerning which one to choose over the other as appropriate entry point to make easier nail insertion, better fracture reduction and prevent complication(18). Despite earlier popularization of antegrade nailing, it has disadvantages of implant related hip pain, risk of heterotrophic ossification of hip and pudendal nerve injury. It is also pose difficulty to identify appropriate entry point in obese patients.(31) Furthermore, antegrade nailing has limited application in treatment of femur neck with ipsilateral shaft fracture, ipsilateral pelvic or acetabular injuries, polytrauma, traumatic arthrotomy of knee and through knee amputation.(36) These disadvantages can be avoided if retrograde nailing is used in these selected patients(18,31,36) With introduction of intra-articular intercondylar approach for management of supracondylar femoral fracture, retrograde technique is now expanded to include femoral shaft fracture.(37) Although this technique is currently advocated widely, it has potential complication to the knee as it causes articular damage, cruciate ligament disruption, knee sepsis, stiffness and patellofemoral degeneration, osteomyelitis and quadriceps atrophy(37). Despite of these potential complications, most studies done so far reported acceptable functional outcomes(4,19,25,38). However, these studies are done in advanced setups using closed reduction on fracture table under fluoroscope and uses specific postoperative rehabilitation protocol by continuous passive motion or physical therapy of knee. The use of continuous passive motion functional training of the knee after IMN of femur has been shown to be significant determinant of the knee functional outcome(39).In addition, studies shows an evaluation-based rehabilitation protocol for femur fractures treated with an IM nail can facilitate restoration of function in a predictable manner(40). Thus, resource limited setup with no rehabilitation protocol requires setup based.

Closed, reamed interlocking intramedullary nail in femoral shaft fractures is currently the treatment of choice as it has advantage of earlier patient rehabilitation , shorter hospitalization, and good fracture healing(41).. Although there are debates regarding advantages of closed nailing over open operation, In theory, if one disturbs the fracture hematoma by exposing the fracture site, healing will be delayed and the risk of infection will be increased(42). Even though, Closed reduction and interlocking is preferred, it requires fracture table and fluoroscope which is not available in resource limited setups. SIGN nail is invented to solve such problems as it designed for open reduction of fracture and interlocking without C-arm(15). Although such technique and implant is currently being widely used, there is no much studies on its effect on knee function.

Furthermore, including one single research done in Africa so far on knee functional outcome of patients treated with IMN for femur shaft fracture, most of the world wide studies used clinician assessed knee functional outcome studies which is vulnerable to clinician bias(43). In this study, we used validated patient reported knee functional outcome study known as WOMAC index.

1.3 Significance of the study

Femur shaft fractures are one of the commonest traumatic injuries following high energy trauma like road traffic accidents, fall down from height, gunshot and sports activity injuries in young populations and due to trivial injuries in elderly groups. It accounts for about 10% of all femur fractures and among them around 16% are open fractures(10). Among plenty of treatment options, IMN (antegrade and retrograde technique) is treatment of choice(1). Although introducing the nail through the knee has potential to damage the intra articular structures during retrograde nailing, several reports have indicated acceptable and similar knee functional outcome in both techniques(3,4). However these studies have been performed in advanced setups using different types of nails, specifically designed for retrograde use, performed predominantly closed reduction of fractures and with specific post-operative rehabilitation by continuous passive motion or physical therapy of the knee (4,25,44,45). It has been shown that, the use of continuous passive motion functional training of the knee after intramedullary nailing of the femur to be a significant determinant of outcome highlighting the importance of a postoperative knee rehabilitation protocol(39). Furthermore, the fractures were reduced mainly by open method and this has potential to violate the extensors of the knee. For this reason, setups with no postoperative rehabilitation protocols like ours need setup based study.

Despite of the uniformly reported high success rate intramedullary nailing of femur shaft, the availability of locked IM nail has remained elusive to most surgeons practicing in the developing countries(14). SIGN Fracture Care International is a nonprofit organization that has developed and made available an intramedullary interlocking SIGN nail to surgeons in resource-limited settings like ours (46). This nail is designed for use in

the femur and the tibia without the need for fluoroscopic imaging and allows for low-cost intramedullary fixation(47). Although, we have been using this nail since five years in our setup for treatment of patient with femur shaft through both retrograde and antegrade entry technique, there is no single study done in the setup comparing knee functional outcome of patients treated with IMN. Furthermore, including one single research done in Africa so far on knee functional outcome of patients treated with IMN for femur shaft fracture, most of the world wide studies used clinician assessed knee functional outcome studies which is vulnerable to clinician bias(43).

The result of this study will be disseminated through presentation on ESOT annual meeting and SIGN conference and sent for publication on relevant scientific journals and to be disseminated online

This research will also have the following significance: -

- ✓ It helps the AaBET hospital concerned bodies by providing necessary information to develop guidelines.
- ✓ It provides base line information for other researcher who wants to conduct further study on this area

2 Literature review

Currently, surgery is preferred option of management for most femur shaft fractures as it has high union rate, low complication rate, and advantage of early fracture stabilization, which decreases morbidity and mortality (especially in polytrauma patients)(48). Among surgical management options, closed intramedullary nailing has become the primary treatment method in adult and provides healing rates of 95%-99% and relatively low complication rates(31,49,50). Kuntscher was the first person to introduce intramedullary nailing of femoral shaft fractures in 1940, which was a turning point in the area of fracture treatment for the long bones to which he later added reaming principle in 1952(4). The technique was further improved by the introduction of locking screws by Klemm and Schellmann in 1968(4). Since then, locked intramedullary nail insertion with reaming has become a standard procedure for almost all femoral diaphyseal fractures.

Nailing can be done either closed (without disruption of the fracture site with indirect reduction) or open reduction (through small incision over the fracture with direct reduction)(50,51). Syed Imran Ghouri et al assessed the results of open versus closed reduction in intramedullary nailing for femoral fractures and whether it delays union, predisposes to nonunion, or increases the rate of infection. They retrospectively reviewed all adult patients with isolated femoral shaft fractures treated by intramedullary nailing at level one trauma center between 2011 and 2015 in Hamad Medical Corporation, Doha, Qatar. They found that there is no statistical difference between the healing rates in both techniques. Thus, they suggested that, in cases where closed reduction is difficult, it is better to reduce open especially in polytrauma.

Femur shaft nailing can be done either antegrade(through piriformis fossa or greater trochanter) or retrograde(1,23,24,45,52,53). Although there are concerns with regard to the violation of the knee and its effect on subsequent knee function, retrograde nailing is technically less demanding especially if the patient is overweight(24). Fan Zhang, Lei Zhu, Yong chuan Li, Aimin Chen et al did a meta-analysis of randomized controlled trials assessing the effect on clinical outcomes of intramedullary nailing for femoral fractures via a retrograde or antegrade approach in 2015. They searched the literature in the PubMed, Embase, and Cochrane library databases and three randomized controlled trials with a total of 240(115 patients treated with retrograde intramedullary nailing and 125 patients treated with antegrade technique) patients undergoing intramedullary nailing for femoral fractures were included and analyzed. The follow up time was 1 year in one of the studies and greater than two years in the other two studies. They found that there is no statistically significant difference in the rate of union, incidence of nonunion and rate of heterotopic ossification. They also found that the incidence of knee pain was low in both groups and there was no significant difference(RR 1.10, 95% CI: 0.51–2.35, $p=0.81$, $I^2=0\%$)

Although nailing can be done through both ends of the femur, the antegrade approach through the proximal femur has gained more popularity than the retrograde approach mainly because of theoretical problems encountered in the knee namely articular cartilage damage, cruciate ligament disruption, knee sepsis, stiffness, patellofemoral degeneration, osteomyelitis, and quadriceps atrophy in retrograde technique(4,54). Even though, antegrade technique is said to be the treatment of choice for most femur shaft fractures, its applicability is limited in the treatment of common ipsilateral fracture combinations, like femoral shaft fracture with ipsilateral femoral neck, acetabular, pelvic, and/or tibial shaft fractures(27). Tucker et al did a prospective multicenter comparison study to compare results of femoral intramedullary nailing in patients who are obese versus those who are not obese. From this study they found decreased operative time(94 minute in antegrade versus 67 minute in retrograde) and radiation exposure times(247 second in antegrade versus 76 second in retrograde) for the use of retrograde technique in the treatment of femoral shaft fractures in patients who are obese. William M et al also performed a literature review on current management of femur shaft fracture management(55). They found high union rate and low complication rate in both technique and suggested that one can be chosen over the other depending on fracture characteristics, associated injuries, body habitus, and surgeon familiarity with each nailing method(1).

K, Andrzejewski et al did a study involving a group of 65 individuals with traumatic fractures of the femoral shaft(32 patients treated with retrograde IMN and 33 with antegrade IMN) who underwent stabilisation with IM nails to compare knee function after the fracture healed. Knee function was assessed with the KOOS, KSS1 and KSS2 scoring systems in both groups. With regard to KSS1 and KSS2, they revealed as there were no significant differences between the groups ($p=0.1947$, $p=0.4038$). However, Knee function as assessed with KOOS differed significantly between retrograde and antegrade nailing, with a greater incidence of poor and fair results in the former and more excellent outcomes in the latter group ($p=0.0133$). Knee pain was reported by 37.5% of the patients treated with retrograde nailing and 39.4% of those with antegrade approach ($p=0.22$). They also found that, age and presence of osteoarthritis at trauma significantly lowered the KOOS ($p=0.0027$, $p=0.005$) and KSS ($p=0.0002$, $p=0.002$) scores, as well as the knee range of motion ($p=0.0014$, $p=0.004$)(56).

Bulent Daglar et al performed a comparative study of knee function of patients treated with antegrade and retrograde intramedullary nailing for diaphyseal femoral fracture done in level I trauma centre in Ankara, Turkey in 2009. They studied prospectively on Seventy patients having OTA 32 fractures who were randomly allocated into 2 groups to be treated with either antegrade(41 patient) or retrograde(30 patient) intramedullary nails inserted with reaming. Postoperative knee range of motion, Lysholm Knee Score, and isokinetic knee muscle function testing at least 6 months after documented fracture healing, minimum 1 year postoperatively were used as outcome measures in the study. They followed the patients for mean 44 (range: 25–80 months)

months and found that mean knee flexion angle was 132 and 134 degrees, and mean Lysholm Score was 84 and 83.1 in antegrade and retrograde groups, respectively ($P = 0.893$ and $P = 0.701$). Similar results was found in isokinetic evaluation for peak torque deficiencies at 30 and 180 degrees per second and total work deficiencies at 180 degrees per second ($P = 0.05$). Knee functioning was affected by age as the higher the age of the patient is, the lower the Lysholm Score and knee flexion angle ($r = 20.449$, $P = 0.0321$ and $r = 20.568$, $P = 0.001$, respectively)(4) Based on these findings the concluded that, although increasing age affect the knee function, both technique of nailing can be used with no significant difference on knee function.

James Brewster et al did a retrospective review of prospectively collected patient registry data, patients with an isolated femoral shaft fracture treated with antegrade or retrograde femoral nailing were interviewed and their medical records analyzed. Patient reported functional outcome data were obtained via the visual analog scale (VAS) for pain and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) at 5 to 17 years postoperatively. They found that, mean WOMAC of $23.5\% \pm 23.6\%$ (range, 0%-82.3%) and $29.7\% \pm 24.0\%$ (range, 0%-88%), respectively ($P = .23$). The mean VAS scores of the antegrade vs retrograde intramedullary nailing groups were 2.5 ± 2.6 (range, 0-8) and 3.4 ± 2.8 (range, 0-10), respectively ($P = .11$). Their result of study confirm that, diaphyseal femur fractures are successfully treated with either antegrade or retrograde intramedullary nails without significantly differing long-term functional outcomes, which correlates with other reported findings in the literature at short-term follow-up(57).

DW, Sanders et al prospectively enrolled 40 consecutive skeletally mature patients with isolated, non-pathologic diaphyseal femur fractures who were treated with antegrade locked intramedullary nail to asses functional outcome and causes of persistent disability in patients with isolated femoral shaft fractures. In this study they measured functional outcome using the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) index and the Short Musculoskeletal Functional Assessment (SMFA) from baseline to six month. The study reveals that, mean scores (and standard deviations [SDs]) on the WOMAC index improved gradually from 57 (23) to 24 (22) for pain, from 57 (25) to 30 (20) for stiffness and from 70 (21) to 21 (23) for function ($p < 0.001$). The mean SMFA score (and SD) also improved from 64 (13) to 25 (20) ($p = 0.024$). However, they noted no further improvements in functional outcome measures from the 6-month to the 12-month assessment ($p > 0.21$). They also noted correlations between knee pain and WOMAC pain ($\rho = 0.748$, $p < 0.001$), function ($\rho = 0.701$, $p < 0.001$) and SMFA ($\rho = 0.733$, $p < 0.001$)(58).

Njoroge AN et al did a comparative cross sectional study in Teaching and Referral Hospital in Western Kenya on functional outcomes of the knee after retrograde and antegrade intramedullary nailing done for femoral shaft fractures. The study population ages ranged between 16 to 84 years with a mean age of 38.8 ± 15.4 years and

fractures were reduced by open method as per the SIGN® Technical Manual. The patients were followed (time of surgery to study) 70 weeks for retrograde group and 65 weeks for antegrade group which was not significantly different ($p>0.05$). The Fractures were classified according to the AO/OTA classification and outcomes were determined using the modified Hospital for Special Surgery (H.S.S) knee functional score. They found 98.3% and 92.2% of patients are found have good or excellent outcomes in antegrade and retrograde groups respectively. However only 50% of patients in the retrograde group had excellent outcomes as compared to 95% in the antegrade group($p<0.001$). They also found that increasing age is a factor associated with poorer scores especially after retrograde nailing in this study(antegrade group ($r= -.085$, $p=0.519$) versus retrograde ($r= -.445$, $p<0.001$)). Otherwise, no statistically significant difference based on level of fracture(antegrade group $p=0.82$, retrograde group $p=0.286$) and based on Gender.

3 Objectives

3.1 General objective

To compare the knee functional outcome and associated factors of patients with femur shaft fracture treated with antegrade and retrograde sign nail at AaBET hospital from January 2018 to December 2020

3.2 Specific objectives

To assess patient reported knee functional outcome of patient with femur shaft fracture treated with retrograde nailing

To assess patient reported knee functional outcome of patient with femur shaft fracture treated with antegrade nailing

To compare patient reported knee functional outcome of patient with femur shaft fracture treated with antegrade and retrograde nailing

To study factors affecting knee functional outcome of patients with femur shaft fracture treated with sign nail

4 Methodology

4.1 Study area

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 millennium hospital is teaching hospitals 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.

4.2 Study period

Data was collected from October 2021 to April 2022

4.3 Study design

The study design was a hospital based comparative retrospective crosssectional study on patient with diaphysial femur fracture treated with SIGN nail during the period between December 2018 to January 2020 in AaBET hospital, Addis Ababa, Ethiopia. The study participant patients were identified using the hospital logbook and online SIGN surgery database. The patients' functional outcome were assessed by WOMAC index which was filled by trained physicians and investigator asking the patient coming for follow up or on phone.

Table 1: Western Ontario and McMaster Osteoarthritis Index(WOMAC)

	PATIENT NAME				DOB		
WESTERN ONTARIO AND MCMASTER OSTEOARTHRITIS INDEX (WOMAC) Please circle the appropriate rating for each item.							
RATE YOUR PAIN WHEN...	NONE	SLIGHT	MODERATE	SEVERE	EXTREME	HOSPITAL USE ONLY	
Walking	0	1	2	3	4		
Climbing stairs	0	1	2	3	4		
Sleeping at night	0	1	2	3	4		
Resting	0	1	2	3	4		
Standing	0	1	2	3	4		
RATE YOUR STIFFNESS IN THE...	NONE	SLIGHT	MODERATE	SEVERE	EXTREME	HOSPITAL USE ONLY	
Morning	0	1	2	3	4		
Evening	0	1	2	3	4		
RATE YOUR DIFFICULTY WHEN...	NONE	SLIGHT	MODERATE	SEVERE	EXTREME	HOSPITAL USE ONLY	
Descending stairs	0	1	2	3	4		
Ascending stairs	0	1	2	3	4		
Rising from sitting	0	1	2	3	4		
Standing	0	1	2	3	4		
Bending to floor	0	1	2	3	4		
Walking on even floor	0	1	2	3	4		
Getting in/out of car	0	1	2	3	4		
Going shopping	0	1	2	3	4		
Putting on socks	0	1	2	3	4		
Rising from bed	0	1	2	3	4		
Taking off socks	0	1	2	3	4		
Lying in bed	0	1	2	3	4		
Getting in/out of bath	0	1	2	3	4		
Sitting	0	1	2	3	4		
Getting on/off toilet	0	1	2	3	4		
Doing light domestic duties (cooking, dusting)	0	1	2	3	4		
Doing heavy domestic duties (moving furniture)	0	1	2	3	4		
PATIENT SIGNATURE				DATE			WOMAC TOTAL SCORE /96
REVIEWED BY PHYSICAL THERAPIST				DATE			

4.4 Source population

All patients with femur shaft fracture treated with SIGN nail in AaBET Hospital

4.5 Study populations

All patients with femur shaft fracture who were managed with SIGN nail at AaBET hospital in the study period and has follow up ≥ 1 year and who lacks exclusion criteria and meets inclusion criteria

4.6 Inclusion and exclusion criteria

4.6.1 Inclusion criteria

All patients with femur shaft fracture treated with SIGN/Fin nail with at least 1 year postoperative follow up

Age greater than 13 years

Healed fracture

4.6.2 Exclusion criteria

Patients with incomplete follow up or lost chart

Patients who refused to participate in the research

Patients with obvious knee trauma/pre-existing knee pathology, incomplete medical records, bilateral femoral fractures or floating knee, pathological fractures or other fractures of lower limbs or pelvis

Patients who underwent damage control musculoskeletal surgery that had had delayed intramedullary nail stabilization more than 2 weeks after initial trauma

Grade IV knee osteoarthritis assessed from x-rays of both knees according to Kellgren and Lawrence at presentation

Patients who developed postoperative Osteomyelitis or Deep surgical site infections

4.7 Sample Size Determination and sampling technique

A single population proportion sample size determination formula was used based on confidence interval approach. There is no determined proportion of femur fracture functional outcome treated operatively from previous similar study. Hence, p is taken to be 50%, with 95% confidence interval ($Z_{\alpha/2}=1.96$) and 5% margin of error ($d= 0.05$).

$$n_o = \frac{(Z_{\alpha/2})^2 \times p(1-p)}{d^2} \quad n_o = \frac{(1.96)^2 \times 0.5(1 - 0.5)}{(0.05)^2} \quad n_o=384$$

There were 201 patients operated for femur shaft fracture treated with IMN in the study period (as counted from OR registration logbook and Sign Surgery Online Database).

Because sampling is from finite population size $N = 201$, the final sample size is calculated using formula;

$$n = \frac{n_o}{\left(1 + \frac{n_o}{N}\right)}$$

The final sample size is therefore 132. However; the study aims to include all eligible patients during the study period to make this study more powerful.

All patients with femur shaft fracture treated with sign nail, who are not excluded by the exclusion criteria, in the study period were taken as subjects of the study

4.8 Measurement

4.8.1 Study variables

4.8.1.1 Dependent Variable

Functional outcome of knee(WOMAC Index)

4.8.1.2 Independent Variable

- ✓ Age
- ✓ Sex
- ✓ Fracture type
 - OTA 32A, 32B and 32C
 - Open and Closed
- ✓ Nailing technique(Antegrade Vs Retrograde)
- ✓ Time of surgery(from injury to time of surgery)
- ✓ Mechanism of injury
- ✓ Postoperative Rehabilitation

5 Operational Definition

- Femur shaft: part of femur between 5cm distal to the lesser trochanter and 5cm proximal to the adductor tubercle.
- Femur shaft fracture types(AO classification)
 1. 32A: simple(spiral/short oblique/transverse) fracture
 2. 32B: Wedged(intact/fragmented) fracture
 3. 32C: Multifragmentary(intact/fragmented segment) fracture
- Antegrade Nailing: insertion of nail though either greater trochanter or piriformis fossa
- Retrograde Nailing: insertion of nail through femoral intercondylar space
- Postoperative Rehabilitation: is the post-surgical program of re-establishing joint motion, muscle strength around the joint and finally joint function. It is provided by Physical therapist
- Healed fracture: Fracture fulfilling both clinical(no pain or tenderness at fracture site) and Radiological(callus cortical bridging of at least three of four cortexes seen on AP and Lateral view standard xrays) signs of healing
- Preoperative time: time from day of injury to surgery in days
- Preoperative time: time in days between injury to surgery

6 Data collection procedure

- In this study, patients with traumatic femur shaft fracture (AO/OTA type 32 A-C) treated with IMN between Jan 1, 2018 to Dec 30, 2020 in AaBET Hospital were included. Of total of 201 patients with femur shaft fractures, 146 patients were treated with retrograde IMN while 55 patients were treated with Antegrade IMN. These patients' data were reviewed on online sign surgery data base and their respective charts. 115 patients fulfilled the study criteria and selected for the study. 8 patients chart cannot be found and 26 patients cannot be contacted. 81 patients (70 %), of which 31 patient treated with Antegrade group with the rest being retrograde, were available for the study and study specific check lists were filled from their respective charts and WOMAC questionnaires were filled after phone call with each patient.

7 Data Analysis Procedure

- SPSS version 26 was used for data entry and analysis. Categorical data were summarized as frequencies and continuous data were expressed as mean and standard deviation. Mann-Whitney U test was used to evaluate the differences with regard to functional outcome scores(WOMAC score) between dichotomous variables(Gender, Type of Nailing & Type of Femur Fracture) and spearman's correlation coefficient was used to assess association between continuous variables(age and time of surgery) and knee functional outcome(WOMAC score) score. According to the method of landis and kock correlation coefficients of 0-0.20 represent slight agreement, 0.21-0.40 fair, 0.41-0.60 moderate, 0.61-0.80 substantial and >0.80 almost perfect agreement. Kruskal-Wallis test was used to analyze association of categorical data(Age group, Fracture type(AO/OTA classification), mechanism of injury and type of femur fracture) with the dependent variable.

8 Results

- The ages of the study population ranged between 13 to 63 years with a mean of 30.06 ± 13.078 years. The male to female ratio was 3.26:1. Although the mean age is younger (30.06 ± 13.078 versus 38.8 ± 15.4 years), the male to female ratio is comparable (3.26:1 versus 3.3:1) to study done by Njoroge AN(25).
- Around 70% of the study patients come from Oromia region and Addis Ababa. This can be explained by the proximity of the two regions to AaBET Hospital and availability of the treatment in different parts of the country as it is being provided for free and does not sophisticated instruments(47). (Table 2)

Table 2 Socio-demographic characteristics of patients with femur fracture treated with IMN at AaBET Hospital from Jan 2018 to December 2020, Addis Ababa Ethiopia

		Frequency	Percent	Valid Percent	Cumulative Percent
Age in category	13-18 years	14	17.3	17.3	17.3
	19-44 years	52	64.2	64.2	81.5
	45-64 years	15	18.5	18.5	100.0
	Total	81	100.0	100.0	
Gender	Male	62	76.5	76.5	76.5
	Female	19	23.5	23.5	100.0
	Total	81	100.0	100.0	
Address	Tigrai	2	2.5	2.5	2.5
	Southern Nations and Nationalities	2	2.5	2.5	4.9
	Amhara	10	12.3	12.3	17.3
	Oromia	40	49.4	49.4	66.7
	Somali	2	2.5	2.5	69.1
	Addis Ababa	25	30.9	30.9	100.0
	Total	81	100.0	100.0	

- Road traffic accident accounts for majority of the case (58%), followed by fall down accident(24.7%), bullet injury(7.4%) and stick injury(2.5%). This consistent with study done Tertiary Centre in South East Nigeria by Ugezu et al in which they found road traffic accident accounting for 78% of the cases followed by fall down accident and bullet injury respectively(9). Road traffic accident(47.9%) and fall down accident(29.9%) accounted for most of femur fractures according to study done in Black Lion Hospital, Ethiopia by Bahiru et al(59). These consistent findings can be explained by the fact that there is increasing use of cars for human daily life. In addition, adult femur is the strongest bone in the body, so that it requires high energy injury to break.(figure 1)

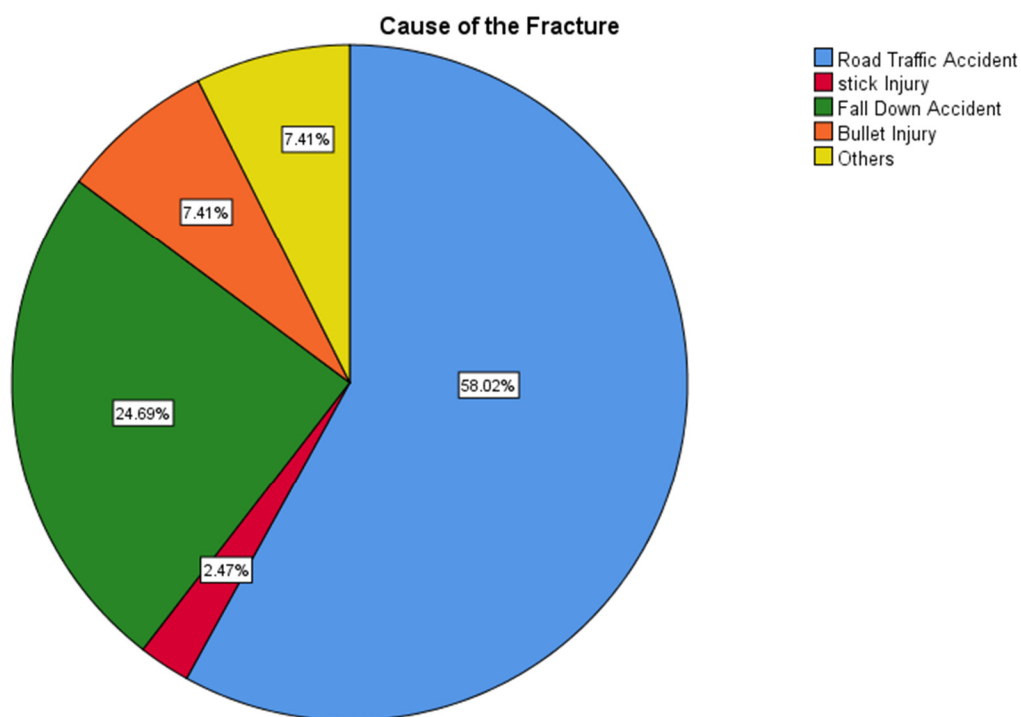


Figure 2 Mechanism of injury of patients with femur fracture treated with IMN at AaBET Hospital from Jan 2018 to December 2020, Addis Ababa Ethiopia

- As seen on the preoperative x-rays of the patients, most of the fractures(80.2%) were simple pattern (AO/OTA 32A) while the complex pattern(AO 32C) only accounts for 7.4% of the cases. Only 14.9% of the cases were open fractures(table 3).
- 53.1% of the patients were treated with Retrograde nailing while 46.9% were treated with Antegrade technique. Njoroge AN et al found similar result to this finding(25). The average duration from injury to nailing was 10.07 +13.4 days, with a range of 1 to 60 days. All fractures were reduced by open method with hand reaming as per the SIGN® Technical Manual. All patients were not started on professional physiotherapy after surgery.

Table 3 Fracture characteristics of patients with femur fracture treated with IMN at AaBET Hospital from Jan 2018 to December 2020, Addis Ababa Ethiopia

		Frequency	Percent	Valid Percent	Cumulative Percent
Fracture type(AO/OTA)	32A	65	80.2	80.2	80.2
	32B	10	12.3	12.3	92.6
	32C	6	7.4	7.4	100.0
Type of femur fracture	Closed	69	85.2	85.2	85.2
	Open	12	14.8	14.8	100.0
	Total	81	100.0	100.0	
Types of open fracture(GA classification)	Type I	6	7.4	50.0	50.0
	Type II	0	0	0	0
	Type III	6	7.4	50.0	100.0
	Total	12	14.8	100.0	

- The antegrade- and retrograde-treated patients were comparable with regard to age, sex, mechanism of injury, fracture type(AO/OTA classification and open versus closed) and time of injury to surgery(table 4). This finding avoided the effect of skewed distribution on comparison of the two groups (Antegrade and Retrograde group)

Table 4; Distribution of Patient/ variables among antegrade- and retrograde group of patient at AaBET Hospital

	Antegrade group	Retrograde group	p-value
Male/Female	31/7	31/12	P=0.315
Age in (years) ^a	23.4(7.9)	35.8(14)	P=0.06
Fracture type(AO/OTA):32A	25	40	P=0.104
32B	9	1	
32C	4	2	
Fracture Type: Closed	30	39	P=0.137
Open	8	4	
Mechanism of Injury :RTA	17	30	P=0.257
FDA	12	8	
Others	9	5	
Time of injury to Surgery (days) ^a	10.9(12.2)	11.2(14.4)	P=0.757

^a The values are given as the mean with the standard deviation in parentheses

- The mean WOMAC score of the Antegrade group is 9.32 with range of (0-23.9) while the that of the retrograde group is 14.99 with range of (0-32.3). Similarly James Brewster et al found higher mean result in retrograde group(23.5%±23.6% (range, 0%-82.3%) in antegrade group versus 29.7%±24.0% (range, 0%-88%) in retrograde group)(57).
- Retrograde group have statistically significant lower Knee Functional Outcome as compared to Antegrade group; Antegrade(median=7.29, n=38) and Retrograde(median=14.5, n=43) $U = 502.5$, $z=2.981$, $P = 0.003$ two-tailed, $r=0.33$.. It is also found that there is lower knee functional outcome with increasing age($p=0.017$) and time of surgery($p<0.01$). Njoroge AN et al also found poorer outcome in retrograde group with increasing age as significant associated factor(25). In contrast, Bulent Daglar et al found insignificant knee range of motion, Lysholm Scores, and isokinetic knee evaluation finding among the two groups(4). They however, showed decrement in knee functional outcome with increasing age.(Table 5)

- However, there is no significant effect of sex, mechanism of injury and type of fracture(AO/OTA classification or open versus closed fracture) on knee functional outcome. Similar result was consistently reported by Njoroge AN et al(25), Bulent Daglar et al(4) and Mostafa el Moumni et al(19) (Table 5)

Table 5: Association between WOMAC with other Variables of patients treated with IMN for femur shaft in AaBET Hospital

Variable		WOMAC Score		
		N	Mean rank	P value
Method of Nail entry	Antegrade	38	32.7	*P<0.05
	Retrograde	43	48.31	
Type of fracture(AO/OTA)	32A	65	42.69	P>0.05
	32B	10	33.50	
	32C	6	35.17	
Fracture type	Open	12.15	39.96	P>0.05
	Closed	13.37	47.00	
Mechanism of Injury	RTA	47	41.47	P>0.05
	FDA	20	78.50	
	Bullet injury	6	37.45	
	Stick injury	2	35.83	
	Others	6	41.83	
Gender	Male	62	42.76	P>0.05
	Female	19	35.26	
Time of injury to Surgery	Antegrade + Retrograde	81	0.471**	*P<0.05
Age	Antegrade + Retrograde	81	0.265**	*P<0.05

*Statistically significant finding; **correlation coefficient

9 Discussion

- Intramedullary nailing has become the standard treatment for femoral shaft fractures in the adult population. In general, it is associated with high union rates and low rates of complications(19). Although both ends of the femur are suitable, there is debate in the literature concerning antegrade versus retrograde entry and, in antegrade nailing, the choice of the piriformis fossa versus greater trochanter as an entry point(18). Multiple studies have been performed so far to compare the two techniques. These studies showed similar union and malunion rates(36,60). However, there is controversial results with regard to the knee functional outcomes.
- In this study, patient reported knee functional outcome study (WOMAC score) was used and found retrograde nailing to have significantly poorer knee functional outcome as compared to antegrade group($z=2.981$, $P=0.003$ two-tailed, $r=0.33$). Similar result was also reported by study done by Dr. A. N. Njoroge, in Kenya in 2013. In this study, similar type of nail (Sign Nail) was used and knee function was assessed by modified HSS score(25). Similar to our study; the study was performed in setups without established knee rehabilitative protocol which affect the outcome according to Bei C, et al. He showed that after single factor analysis, continuous passive motion functional training of the knee after nailing was one the significant determinants of outcome(39). Animal studies have suggested that retrograde intramedullary nail is associated with 49% and 52% reduction in blood supply to the posterior and anterior cruciate ligaments respectively (15). Such studies in humans have not been conducted and the effects on function of the knee are unknown. Furthermore it has been demonstrated that malposition of the entry portal may lead to encroachment of the patellafemoral articulation.
- However, study performed by Mostafa el Moumni et al in 2012 in University Medical Center Groningen, Hanzeplein Netherlands showed similar knee functional outcome between the two techniques. They studied long term functional outcome using Short Musculoskeletal Functional Assessment (SMFA), Western Ontario and McMaster University Osteoarthritis (WOMAC) index, Harris Hip Score (HHS) and the Lysholm knee function scoring scale measured at a mean of 7.8 years (± 3.5 years) postoperatively(19). Another study done in Ankara, Turkey by Moed, B. R et al also found similar result of knee range of motion, Lysholm Knee Score, and isokinetic knee muscle function testing at least 6 months after documented fracture healing for both groups(4). However, these studies were performed in settings with established post nailing knee rehabilitation protocol.

- Similarly, K, Andrzejewski et al found statistically insignificant knee function difference between 32 patients treated with retrograde technique versus 33 patients treated with antegrade technique. In this study, similar to our study, patient reported knee function outcome studies (KOOS, KSS1 and KSS2 knee scoring systems) were used to compare the knee function of patients with a healed fracture of femoral shaft fixed by antegrade versus retrograde IMN. With regard to KSS1 and KSS2, they revealed as there were no significant differences between the groups ($p=0.1947$, $p=0.4038$). However, Knee function as assessed with KOOS differed significantly between retrograde and antegrade nailing, with a greater incidence of poor and fair results in the former and more excellent outcomes in the latter group ($p=0.0133$). Consistent with our study, increasing age was found to have significant lower KOOS($p=0.0027$) and KSS ($p=0.0002$) as well as the knee range of motion ($p=0.0014$)(56)
- Increasing age is also found to negatively correlated with the knee function ($p<0.05$) regardless of the method of nailing in this study. In this study we found fair correlation (0.265) between age and WOMAC score. This finding agrees with A. N. Njoroge et al who also found negative relationship between age and knee functional outcome regardless of the method of nailing(25). In addition, Darglar et al also demonstrated poor knee functional outcome with increasing age in both methods of nailing(4). The reason for this negative relationship between age and outcome is not clear but is probably related to onset of arthritis with increasing age, motivational issues such as willingness to move the knee after surgery. Our study also found that as the time of injury to surgery increases so does the WOMAC score(moderate correlation coefficient; 0.47) indicating poorer knee function($P<0.05$). Daglar et al however found insignificant effect of preoperative and method reduction on both Lysholm knee score and isokinetic knee muscle functioning results(4). The mean preoperative time was 8.15 days in this study which is lower than that our study(11.07 days with SD of 13.372) population.
- Otherwise, gender,AO/OTA fracture types, open versus closed fractures and mechanism of injury did not show statistically significant difference on knee function. This is supported by A.N.Njoroge et al, who also could not find significant effect of gender and AO/OTA femur fracture types(25). Muhammad Tahir et al compared open femoral nailing with closed method and revealed similar outcomes in union rates, time to union, and rates of significant complications(61).

10 Limitation Of The Study

- The small sample size of this study pose difficulty of generalization of the results
- The fact that the data was collected on phone call (difficult to get the study subjects in person) may causes bias or misunderstanding
- Retrospective study with recall bias
- As study is institutional based study, generalization of the result to whole population may be unreliable

11 Conclusion

- Despite of most studies showing similar outcome, Retrograde nailing of femoral shaft fractures resulted in poorer knee outcomes when compared to antegrade group in the study population. In addition, increasing age and preoperative time affected the knee function negatively.

12 Recommendation

- Antegrade nailing should be preferred treatment of adult femur shaft fracture unless there is specific indications for retrograde nailing
- It is recommended to do femoral nailing as early as possible unless contraindicated
- All patient with femur shaft fracture treated with retrograde nailing ,especially old ages, should start knee physiotherapy after surgery
 - AaBET Hospital should develop standard protocol of rehabilitation after femoral nailing
- Nationwide awareness creation should done on the effect of road traffic accident and safety protocols

13 References

1. Ricci WM, Gallagher B, Haidukewych GJ. Intramedullary Nailing of Femoral Shaft Fractures : Current Concepts Abstract. :296–305.
2. Keeler KA, Dart PB, Luhmann SJ, Schoenecker PL, Ortman PMR, Dobbs PMB, et al. Antegrade Intramedullary Nailing of Pediatric Femoral Fractures Using an Interlocking Pediatric Femoral Nail and a Lateral Trochanteric Entry Point. 2009;29(4):345–51.
3. Salem KH, Maier D, Keppler P, Kinzl L, Gebhard F. Limb Malalignment and Functional Outcome After Antegrade Versus Retrograde Intramedullary Nailing in Distal. J Trauma - Inj Infect Crit Care. 2006 Aug;61(2):375–81.
4. Moed BR, Watson JT, BR M, JT W. Comparison of knee function after antegrade and retrograde intramedullary nailing for diaphyseal femoral fractures: Results of isokinetic evaluation. J Orthop Trauma. 2009 Oct;23(9):640–4.
5. P T, D T. Antegrade or retrograde reamed femoral nailing. A prospective, randomised trial. J Bone Joint Surg Br [Internet]. 2000 Jul 1 [cited 2021 Oct 12];82(5):652–4. Available from: <https://pubmed.ncbi.nlm.nih.gov/10963159/>
6. Gosselin RA, Spiegel DA, Coughlin R, Zirkle LG. Editorials Injuries: the neglected burden in developing countries. Bull World Heal Organ [Internet]. 2009 [cited 2021 Oct 17];87:246. Available from: <http://www.who.int/bulletin/>
7. Morshed S, Shearer DW, Coughlin RR. Collaborative partnerships and the future of global orthopaedics. Clin Orthop Relat Res [Internet]. 2013 [cited 2021 Oct 17];471(10):3088–92. Available from: https://journals.lww.com/clinorthop/Fulltext/2013/10000/Collaborative_Partnerships_and_the_Future_of.5.aspx
8. JP D, RC F, SG P. Orthopaedics in the developing world: present and future concerns. J Am Acad Orthop Surg [Internet]. 2001 [cited 2021 Oct 17];9(5):289–96. Available from: <https://pubmed.ncbi.nlm.nih.gov/11575908/>
9. Ugezu AI, Nze IN, Ihigihu CC, Chukwuka NC, Ndukwu CU OR. Management of Femoral Shaft Fractures in a Tertiary Centre , South Est Nigeria. Afrimedic J. 2018;6(1):27–34.
10. Gide A. 濟無No Title No Title No Title. Angewandte Chemie International Edition, 6(11), 951–952. 1967. 5–24 p.

11. Bharti A, Kumar S, Kushwaha SS, Gupta AK, Kumar N, Lal AK. Kuntscher Nail: A Forgotten Entity Yet a Reliable Modality in Treatment of Winquist Type I and II Closed Femoral Shaft Fractures. *Cureus*. 2020;12(9).
12. ARORA N. TECHNOLOGY UPDATE: Interlocking nails. *Med Journal, Armed Forces India* [Internet]. 1998 Jan [cited 2021 Oct 18];54(1):49. Available from: [/pmc/articles/PMC5531245/](https://pubmed.ncbi.nlm.nih.gov/17039384/)
13. Rudloff MI, Smith WR. Intramedullary nailing of the femur: Current concepts concerning reaming. *J Orthop Trauma* [Internet]. 2009 May [cited 2021 Oct 18];23(SUPPL. 5). Available from: https://journals.lww.com/jorthotrauma/Fulltext/2009/05005/Intramedullary_Nailing_of_the_Femur__Current.4.aspx
14. Soren O. Outcome of surgical implant generation network nail initiative in treatment of long bone shaft fractures in Kenya. *East African Orthop J*. 2010;3(1).
15. IC I, JD O, HR I. Achieving interlocking nails without using an image intensifier. *Int Orthop* [Internet]. 2007 Aug [cited 2021 Oct 13];31(4):487–90. Available from: <https://pubmed.ncbi.nlm.nih.gov/17039384/>
16. Sekimpi P, Okike K, Zirkle L, Jawa A. Femoral fracture fixation in developing countries: An evaluation of the Surgical Implant Generation Network (SIGN) intramedullary nail. *J Bone Jt Surg - Ser A*. 2011;93(19):1811–8.
17. Martin RF. *Trauma 2017*. *Surg Clin North Am*. 2017;97(5):xiii–xiv.
18. Hussain N, Hussain FN, Sermer C, Kamdar H, Schemitsch EH, Sternheim A, et al. Antegrade versus retrograde nailing techniques and trochanteric versus piriformis intramedullary nailing entry points for femoral shaft fractures: a systematic review and meta-analysis. *Can J Surg*. 2017 Feb 1;60(1):19–29.
19. Moumni M, Voogd EH, Jan H, 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>
20. Kao JT, Burton D, Comstock C, McClellan RT, Carragee E. Pudendal nerve palsy after femoral intramedullary nailing. *J Orthop Trauma*. 1993;7(1):58–63.
21. Furlong AJ, Giannoudis P V., Smith RM. Heterotopic ossification: A comparison between reamed and unreamed femoral nailing. *Injury*. 1997 Jan;28(1):9–14.

22. Durigan JR, Carolina A, Takata P, Zamboni C, Santili C. ANTEGRADE X RETROGRADE NAILING IN FEMORAL FRACTURES : A STUDY ON CONSOLIDATION AND INFECTION HASTE
ANTERÓGRADA X RETRÓGRADA EM FRATURAS FEMORAIS : UM ESTUDO SOBRE CONSOLIDAÇÃO E INFECÇÃO. 2019;27(6):313–6.
23. Ricci WM, Bellabarba C, Evanoff B, Herscovici D, DiPasquale T, Sanders R. Retrograde versus antegrade nailing of femoral shaft fractures. *J Orthop Trauma*. 2001 Mar;15(3):161–9.
24. CK Y, VA S, S M, ST C. Antegrade Versus Retrograde Locked Intramedullary Nailing for Femoral Fractures: Which Is Better? *Eur J Trauma Emerg Surg* [Internet]. 2007 Apr [cited 2021 Oct 12];33(2):135–40. Available from: <https://pubmed.ncbi.nlm.nih.gov/26816143/>
25. 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).
26. D H, KW W. Retrograde nailing of the femur using an intercondylar approach. *Clin Orthop Relat Res* [Internet]. 1996 [cited 2021 Oct 13];(332):98–104. Available from: <https://pubmed.ncbi.nlm.nih.gov/8913150/>
27. Moed BR, Watson JT, BR M, JT W. Retrograde nailing of the femoral shaft. *J Am Acad Orthop Surg* [Internet]. 1999 [cited 2021 Oct 13];7(4):209–16. Available from: <https://pubmed.ncbi.nlm.nih.gov/10434075/>
28. TF H, DS H. Damage control nailing. *J Orthop Trauma* [Internet]. 2007 Aug [cited 2021 Oct 13];21(7):477–81. Available from: <https://pubmed.ncbi.nlm.nih.gov/17762479/>
29. P G, J D, K K, T D, D H, R S. Ipsilateral fractures of the femur and tibia: treatment with retrograde femoral nailing and unreamed tibial nailing. *J Orthop Trauma* [Internet]. 1996 [cited 2021 Oct 13];10(5):309–16. Available from: <https://pubmed.ncbi.nlm.nih.gov/8814571/>
30. RF O, J D, R L, A P. Retrograde intramedullary nailing of femoral diaphyseal fractures. *J Orthop Trauma* [Internet]. 1998 [cited 2021 Oct 13];12(7):464–8. Available from: <https://pubmed.ncbi.nlm.nih.gov/9781769/>
31. Zhang F, Zhu L, Li Y, Chen A, F Z, L Z, et al. Retrograde versus antegrade intramedullary nailing for femoral fractures: A meta-analysis of randomized controlled trials. *Curr Med Res Opin* [Internet]. 2015 Oct 3 [cited 2021 Oct 12];31(10):1897–902. Available from: <https://pubmed.ncbi.nlm.nih.gov/26337195/>
32. Bryant D, Guyatt G, Arnold RJG. Patient-reported outcome measures. *Pharmacoeconomics: From*

Theory to Practice. 2016. 149–162 p.

33. Collins NJ, Misra D, Felson DT, Crossley KM, Roos EM. Measures of knee function: International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Knee Injury and Osteoarthritis Outcome Score (KOOS), Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form (KOOS-PS), Knee Osteoarthritis Care Res. 2011;63(SUPPL. 11):208–28.
34. McConnell S, Kolopack P, Davis AM. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): A review of its utility and measurement properties. Arthritis Care Res. 2001;45(5):453–61.
35. Salaffi F, Leardini G, Canesi B, Mannoni A, Fioravanti A, Caporali R, et al. Reliability and validity of the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index in Italian patients with osteoarthritis of the knee. Osteoarthritis Cartil. 2003;11(8):551–60.
36. Williams R, Campbell B, Edwards D, Harris T, Rasmussen S, et al. Retrograde versus antegrade nailing of femoral shaft fractures. J Orthop Trauma [Internet]. 2008 Mar [cited 2021 Oct 12];22(SUPPL. 3):161–9. Available from: https://journals.lww.com/jorthotrauma/Fulltext/2008/03003/Retrograde_Versus_Antegrade_Nailing_of_Femoral.7.aspx
37. Harris D, Williams K, Herscovici D, Whiteman K. Retrograde nailing of the femur using an intercondylar approach. Clin Orthop Relat Res [Internet]. 1996 [cited 2021 Oct 13];(332):98–104. Available from: <https://pubmed.ncbi.nlm.nih.gov/8913150/>
38. Knapik A, Murphy P, Anderson G, Maffulli S. Comparison of knee function in patients with a healed fracture of the femoral shaft fixed with retrograde and antegrade intramedullary nailing. Ortop Traumatol Rehabil [Internet]. 2013 [cited 2021 Oct 26];15(5):395–405. Available from: <https://pubmed.ncbi.nlm.nih.gov/24431251/>
39. Bei C, Wang R, Tang J, Li Q. [Effect factors analysis of knee function recovery after distal femoral fracture operation]. Zhongguo xiu fu chong jian wai ke za zhi = Zhongguo xiufu chongjian waike zazhi = Chinese J reparative Reconstr Surg. 2009 Sep;23(9):1053–7.
40. Paterno M V., Archdeacon M T. Is there a standard rehabilitation protocol after femoral intramedullary nailing? J Orthop Trauma. 2009;23(SUPPL. 5):39–46.
41. Mohammad T, Khan A, Ahmed A, Awan AS, Siddique. OUTCOMES IN CLOSED REAMED INTERLOCKING NAIL IN FRACTURES OF SHAFT OF FEMUR. J Ayub Med Coll Abbottabad. 2015;27(4):811–6.

42. Burç H, Atay T, Demirci D, Baykal YB, Kirdemir V, Yorgancigil H. The Intramedullary Nailing of Adult Femoral Shaft Fracture by the Way of Open Reduction is a Disadvantage or Not? *Indian J Surg*. 2015;77(January 2008):583–8.
43. Wolfson AM, Doctor JN, Burns SP. Clinician judgments of functional outcomes: How bias and perceived accuracy affect rating. *Arch Phys Med Rehabil*. 2000;81(12):1567–74.
44. Leung KS, Shen WY, So WS, Mui LT, Grosse A. Interlocking intramedullary nailing for supracondylar and intercondylar fractures of the distal part of the femur. *J Bone Joint Surg Am*. 1991 Mar;73(3):332–40.
45. Ostrum RF, Agarwal A, Lakatos R, Poka A. Prospective comparison of retrograde and antegrade femoral intramedullary nailing. *J Orthop Trauma*. 2000;14(7):496–501.
46. Carsen S, Park SS-H, Simon DA, Feibel RJ. Treatment With the SIGN Nail in Closed Diaphyseal Femur Fractures Results in Acceptable Radiographic Alignment. *Clin Orthop Relat Res* [Internet]. 2015 Jul 8 [cited 2021 Oct 18];473(7):2394. Available from: [/pmc/articles/PMC4457748/](https://pubmed.ncbi.nlm.nih.gov/264457748/)
47. SIGN Fracture Care International [Internet]. [cited 2021 Oct 21]. Available from: <https://www.signfracturecare.org/>
48. Diaphyseal Femur Fractures Treatment & Management: Approach Considerations, Nonoperative Therapy, General Principles of Surgical Therapy [Internet]. [cited 2021 Oct 14]. Available from: <https://emedicine.medscape.com/article/1246429-treatment>
49. Closed intramedullary nailing of femoral fractures. A report of five hundred and twenty cases - PubMed [Internet]. [cited 2021 Oct 14]. Available from: <https://pubmed.ncbi.nlm.nih.gov/6707031/>
50. SI G, A A, MM A. Does Open Reduction in Intramedullary Nailing of Femur Shaft Fractures Adversely Affect the Outcome? A Retrospective Study. *Adv Orthop* [Internet]. 2020 [cited 2021 Oct 14];2020. Available from: <https://pubmed.ncbi.nlm.nih.gov/32547791/>
51. JD L, JC K. Femoral malrotation following intramedullary nail fixation. *J Am Acad Orthop Surg* [Internet]. 2011 [cited 2021 Oct 14];19(1):17–26. Available from: <https://pubmed.ncbi.nlm.nih.gov/21205764/>
52. Zhang F, Zhu L, Li Y, Chen A. Retrograde versus antegrade intramedullary nailing for femoral fractures: a meta-analysis of randomized controlled trials. <https://doi.org/10.1185/0300799520151078783> [Internet]. 2015 Oct 3 [cited 2021 Oct 12];31(10):1897–902. Available from:

53. Ostrum RF, DiCicco J, Lakatos R, Poka A. Retrograde Intramedullary Nailing of Femoral Diaphyseal Fractures. *J Orthop Trauma*. 1998;12(7):464–8.
54. Herscovici D, Whiteman KW. Retrograde nailing of the femur using an intercondylar approach. *Clin Orthop Relat Res*. 1996;(332):98–104.
55. Tucker MC, Schwappach JR, Leighton RK, Coupe K, Ricci WM. Results of Femoral Intramedullary Nailing in Patients Who are Obese Versus Those Who are not Obese : A Prospective Multicenter Comparison Study. 2008;22(3):14–20.
56. K A, M P, A G, M S. Comparison of knee function in patients with a healed fracture of the femoral shaft fixed with retrograde and antegrade intramedullary nailing. *Ortop Traumatol Rehabil* [Internet]. 2013 [cited 2021 Oct 17];15(5):395–405. Available from: <https://pubmed.ncbi.nlm.nih.gov/24431251/>
57. Brewster J, Grenier G, Taylor BC, Carter C, Degenova D, Ebaugh MP, et al. Long-term comparison of retrograde and antegrade femoral nailing. *Orthopedics*. 2020 Aug 1;43(4):E278–82.
58. Sanders DW, MacLeod M, Charyk-Stewart T, Lydestad J, Domonkos A, Tieszer C. Functional outcome and persistent disability after isolated fracture of the femur. *Can J Surg* [Internet]. 2008 [cited 2021 Oct 17];51(5):366. Available from: [/pmc/articles/PMC2556524/](https://pubmed.ncbi.nlm.nih.gov/17556524/)
59. Bezabeh B, Wamisho BL, Coles MJM. Treatment of adult femoral shaft fractures using the Perkins traction at Addis Ababa Tikur Anbessa University Hospital: The Ethiopian experience. *Int Surg*. 2012;97(1):78–85.
60. RF O, A A, R L, A P. Prospective comparison of retrograde and antegrade femoral intramedullary nailing. *J Orthop Trauma* [Internet]. 2000 [cited 2021 Oct 21];14(7):496–501. Available from: <https://pubmed.ncbi.nlm.nih.gov/11083612/>
61. Tahir M, Ahmed N, Faraz A, Shafiq H, Khan MN. Comparison of Open and Closed Nailing for Femoral Shaft Fractures: A Retrospective Analysis. 2021;

14Annex.

14.1 Data collection format

Check list to collect data on retrospective crosssectional study of functional outcome of femur shaft fracture patient treated with IMN at AaBET hospital from 2018 to 2020, Addis Ababa, Ethiopia

Table 6 Study specific questionnaires'

S. No.	The study variables	Response	Remark
	MRN	_____	
	Phone number	_____	
1. Socio-demography of the participants			
1.1.	Sex	1. Male 2. Female	
1.2.	Age(in years)	_____	
1.3.	Area of residency (region)	_____	
2. History of the trauma of patient who presented to AaBET hospital			
2.1.	Mechanism of injury(circle the number)	1. Road traffic accident 2. Motor vehicle accident 3. Sport injury 4. Stick injury 5. Fall down 6. Bullet injury 7. Other(specify)_____	
2.2.	Type of fracture(AO classification)	1. 32A_____ 2. 32B_____ 3. 32C_____	

2.3.	Type of femur fracture	1. Closed_____ 2. Open_____	If closed, skip to Q.No. 2.5
2.4.	Types of Open fracture	Gustillo and Anderson Classification 1. Type I 2. Type II 3. Type III: A. Type IIIA B. Type IIIB C. Type IIIC	
2.5.	After how many Hours/ days of trauma the patient is operated?	Specify in hours / days _____	
2.6.	What type of fixation is done?	1. Antegrade Nailing 2. Retrograde Nailing	
2.7.	Fracture Reduction	1.Open 2.Closed	
2.8.	Canal preparation	1.Reamed 2.Non reamed	
2.9.	Postoperative Rehabilitation	1.Yes 2. No	

Table 7: WOMAC index questionnaires' (English Version)

3 The Western Ontario and McMaster Universities Osteoarthritis Index ; Please fill 'x' on the scale of difficulty						
Activities		Scale of difficulty				
		None(0)	Slight(1)	Moderate(2)	Very(3)	Extremly(4)
3.1 Pain	Walking					
	Stair Climbing					
	Nocturnal					
	Rest					
	Weight bearing					
3.2 Stiffness	Morning stiffness					
	Stiffness during day time					
3.3 Physical Function	Descending stairs					
	Ascending stairs					
	Rising from sitting					
	Standing					
	Bending to floor					
	Walking on flat surface					
	Getting in / out of car					
	Going shopping					
	Putting on socks					
	Lying in bed					
	Taking off socks					
	Rising from bed					
	Getting in/out of bath					
	Sitting					
	Getting on/off toilet					
	Heavy domestic duties					
	Light domestic duties					
Total Score: _____ / 96 = _____ %						
Comments / Interpretation (to be completed by therapist only):						

Table 8: WOMAC index questionnaires' (Afan Oromo Version)

The Western Ontario and McMaster Universities Osteoarthritis Index :Please fill 'x' on the scale of difficulty						
Skeelota Sochii Qaamaa		Scale of difficulty				
		Homaa(0)	Xiqqoo(1)	Giddugale essa(2)	Olaanaa(3)	Baay'ee olaanaa(4)
3.1 Dhukkubbii Jilbaa	Yeroo Deemsaa					
	Yeroo Tabba Ba'an					
	Halkan Yeroo Ciisichaa					
	Yeroo Taa'an					
	Yeroo Dhaabbatan					
3.2 Buusaa Jilbaa Gogsuu	Ganama Ganama					
	Guyyaa Guyyaa					
3.3 Hanqina sochi	Tabba ba'uu					
	Tabba bu'uu					
	Iddoo taa'anii ka'uu					
	Dhaabbachuu					
	Miilla dachaasuu					
	Karaa walqittaataarra deemuu					
	Konkolaataa keessa seenuu/ keessaa bu'uu					
	Gabaa Deemuu					
	Kaalsii keewwachuu					
	Sireerra Yaabbachuu					
	Kaalsii baasuu					
	Sireerraa Bu'uu					
	Kutaa dhiqannaa dhaqnaa Seenuu/Ba'uu					
	Taa'uu					
	Taa'umsa Mana fincaaniirra Taa'uu/ka'uu					
	Hojii Humnaa cimaa hojjechu(mana keessatti)					
	Hojii humnaa sasalphaa mana keessaa hojjechuu					

Table 9: WOMAC index questionnaires' (Amharic Version

3 The Western Ontario and McMaster Universities Osteoarthritis Index ; Please fill 'x' on the scale of difficulty						
መመዘኛ አስኬል		የሕመሙ ደረጃ				
		ምንም(0)	አነስተኛ(1)	መካከለኛ(2)	ከባድ(3)	በጣም ከባድ(4)
3.1 የጉልበት ህመም	ስራ-መዳ.					
	ደረጃ ስወጡ					
	ለሊት በአንቅልፍ ግዜ					
	ቁጭ ባለብት					
	ስቆሙ					
3.2 የጉልበት መገጣጠሚያ መድረቅ	ጠዋት ጠዋት					
	ቀን ቀን					
3.3 የአካል እንቅስቃሴ አጥረት	ደረጃ ስወርዱ					
	ደረጃ ስወጡ					
	ከተቀመጡበት ስነሱ					
	ስቆሙ					
	ስያጎነብሱ					
	ለጥ ያለ ሜዳ ላይ ስራ-መዳ.					
	መክና ወስጥ ስገቡ እና ከመክና ስወርዱ					
	ወደ ገቢያ ስሄዱ					
	ካልሲ ስያደርጉ					
	አልጋ ላይ ስወጡ					
	ካልሲ ስያወልቁ					
	ከአልጋ ስወርዱ					
	የገላ መታጠቢያ ቤት ስገቡ/ስወጡ					
	ስቀመጡ					
	የሽንት ቤት መቀመጫ ላይ ስቀመጡ/ ስነሱ					
	ከባባድ የቤት ውስጥ ስራ ስሰሩ					
	ቀላል የቤት ውስጥ ስራ ስሰሩ					
	Total Score: _____ / 96 = _____%					

