A COHORT STUDY ON EARLY OUTCOMES OF FEMUR SHAFT FRACTURES IN ADULTS TREATED BY INTERLOCKING INTRAMEDULLARY NAILS AT THE UNIVERSITY TEACHING HOSPITAL, LUSAKA.

By

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A dissertation submitted to the University of Zambia in partial fulfilment of the

requirements for the degree of Master of Medicine in orthopaedics and Trauma Surgery.

THE UNIVERSITY OF ZAMBIA, LUSAKA.

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DECLARATION

I, Dr. **Malao Mulemwa Brian,** hereby declare that this dissertation herein presented for the Degree of Master of Medicine (Orthopaedic and Trauma Surgery) has not been previously submitted wholly or in part for any other degree at this or any other university nor is it being currently submitted for any other degree.

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APPROVAL

This dissertation of Dr. Malao Mulemwa Brian is approved as fulfilling part of the requirements for the award of a Degree of Master of Medicine in Orthopaedics and Trauma

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ABSTRACT

The management of femur shaft fractures has evolved from the historical non-operative methods to the most recent intramedullary nail fixation. Interlocking nails have broadened the roles for closed intramedullary nailing of femur fractures. Early ambulation after fractures of the femur shaft has been shown to have a significant advantage in terms of both joint mobility and economic impact, which are very well attained by the use of interlocking nails. Shortening of the limb and malalignment along with contractures of the knees due to prolonged immobilization have traditionally plagued the Orthopaedic surgeons' management of patients with these injuries.

The proportion of Femur shaft fractures seen at the University Teaching Hospital (UTH) is anecdotally high. In keeping with this, the use of interlocking nails has equally increased. However, the outcomes of the use of interlocking nails in this setting are not documented. This study looked at the early outcomes of femur shaft fractures treated by interlocking intramedullary nails at UTH. Femur shaft fractures are serious injuries that generally result in short-term disability and pain; but also have a high risk of long term deformity and disability. This study was aimed at evaluating the early outcomes of using interlocking intramedullary nails in the treatment of patients with closed femoral shaft fractures at the University Teaching Hospital, Lusaka.

The objective was to explore the early outcomes of closed fractures of the shaft of the femur that were treated using interlocking intramedullary nails at the University Teaching Hospital, Lusaka.

The study was a prospective cohort study carried out between August 2019 and February 2020 at the University Teaching Hospital, Lusaka. During this period, a total of 63 patients that underwent interlocking intramedullary nailing were followed up for 6 weeks. The study participants were evaluated using the Thoresen criteria for short term outcomes.

The rotational deformity was the most prevalent outcome, with 68% of participants having rotational deformity, external rotation was the most common (40%) deformity. There was a statistically significant correlation (p-.006) between comminution and rotational deformity. Infection was very low, as only one participant (1.6%) had recorded a superficial infection. A limb shortening prevalence of 59% was found in this study, significant shortening (more than 2cm) was 7.9%. However, 92 per cent had combined good or excellent Thoresen outcome scores. An overall knee flexion of less than 90 degrees was found in 24% of the patients in this study.

The early outcomes of treatment using interlocking IMN for femur shaft fractures at UTH is good to excellent (based on the Thoresen score criteria) in terms of limb length discrepancy, rotational deformity and knee flexion combined. The proportion of post-surgery infection among patients with femoral shaft fracture treated with interlocking IMN was low (1.6% -superficial infection).

Keyword: femur shaft fracture, interlocking intramedullary nail, Thoresen criteria, short term outcomes.

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LIST OF ABBREVIATIONS

UTH University teaching Hospital

IMN Interlocking intramedullary nail

LLD limb length descrepancy

CHAPTER ONE- INTRODUCTION.

1.1 Background

The management of femur shaft fractures has evolved from the historical non-operative methods to the most recent intramedullary nail fixation (Ricci et al, 2009). Interlocking nails have broadened the roles for closed intramedullary nailing of femur fractures (Deepak et al, 2012). Early ambulation after fractures of the femur shaft has been shown to have a significant advantage in terms of both joint mobility and economic impact, which are very well attained by the use of interlocking nails (Deepak et al, 2012). Limb shortening and malalignment along with contractures of the knees due to prolonged immobilization have traditionally plagued the Orthopedist's management of these patients with these injuries (Mohammad et al, 2011).

In trying to understand and better the outcomes of femur shaft fractures treated by interlocking nails, a couple of studies have documented various outcomes. An average of 0.58 centimeters shortening was found in 98% of femur shaft fractures, 7% of which had limb shortening of more than 1.25 centimetres (Herscovici and Scaduto, 2013). Jaarsma R and Van Kampen A in their review on Rotational malalignment after fractures of the femur found rotational malalignment to be between 20 and 30% patients after interlocking nailing (Jaarsma and Van Kampen, 2004). In a systematic review of SIGN Online Surgical Database on Risk Factors for Infection following 46,113 Intramedullary Nail Surgeries in Low- and Middle-income Countries showed infection rates of 3.2% with 33% of the infections being in male patients (Young S et al, 2012). In a prospective observational study by Mung'athia, findings of rotational malalignment in excess of 15.5%, shortening was as high as 7.1% and knee flexion of less than 90 degrees at 12.2% (Mung'athia et al, 2017). Mrita et al (2012) in a study in Tanzania found shortening of 20%, a rotational deformity of 15.2%, knee range of motion less than 90 degrees at 20%, the infection was 5%.

The proportion of Femur shaft fractures seen at the University Teaching Hospital (UTH), Lusaka was anecdotally high. In keeping with this, the use of interlocking nails had increased. However, the outcomes of the use of interlocking nails in this setting are not documented. This study looked at the early outcomes of femur shaft fractures treated by interlocking intramedullary nails at UTH. Femur shaft fractures are serious injuries that generally result in short-term disability and pain but also have a high risk of long term deformity and disability. However, these complications are not inevitable and may be reduced by a good treatment program. It is based on results from this study that advocacy for improved orthopaedic services can be generated.

1.2 Statement Of The Problem

Femur shaft fractures contribute a significant proportion of orthopaedic patients of which some get treated by interlocking IMNs. The outcomes of this mode of treatment in a low resource setting are unknown. This study was set out to identify the early outcomes of femur shaft fractures treated using interlocking IMNs in a low resource setting.

1.3 Study Justification

Early outcomes of femur shaft fractures treated by IMN have a direct bearing on final functional outcomes. The findings obtained from this study will provide information on the early outcomes of IMN in a low resource setting. This is information that can be used to further the management of femur shaft fractures in this setting.

1.4 Research question

What are the early outcomes of femur shaft fractures treated by IMN at the University Teaching Hospital, Lusaka?

1.5 Objectives

1.5.1 General Objective

To explore the early outcomes of fractures of the shaft of the femur that are treated using IMN's.

1.5.2 Specific Objectives

1. To determine the proportion of patients who develop infection post-surgery among patients with femoral shaft fracture treated with interlocking IMN.

2. To determine the limb length discrepancy among patients with femoral shaft fractures treated with interlocking IMN.

3. To find out the limb rotational deformity among patients with femoral shaft fractures treated with interlocking IMN.

4. To assess the range of motion of knee joint among femoral shaft fracture patients treated with interlocking IMN.

CHAPTER TWO: LITERATURE REVIEW

2.1 Incidence

Fractures of the femoral shaft are among the most common fractures encountered in orthopaedic practice. These fractures have age and a gender-related bimodal distribution, with injuries occurring most frequently in young males following high-energy trauma. The femoral shaft fractures have an annual incidence of 21 per 100,000, and the majority are in young males (68%) with an average of 38 years (Enninghorst et al, 2013).

Femur fractures are commonly presenting in males under age 30. Femur fracture was most commonly caused by motor traffic accidents in males and falls in females. The participants aged 21-30 were the most commonly affected range by femur fractures (20% n=42). In this group, motor traffic accidents (MTA) were the cause of 71% of injuries. For males, MTA's accounted for 59% of all femur fractures, while falls were the most common cause of femur fractures in females(70%). In the 51-100 age group, 80% of the fractures were caused by falls. In both male and female groups, the most common fracture seen was midshaft femoral fracture (males 33%, females 25%). This is according to a retrospective study of patient records in the orthopaedic department at Kilimanjaro Christian Medical centre in Tanzania (Hollis et al, 2015).

Comminuted shaft fractures of femur refer to fractures with multiple bone fragments and multiple fracture lines (Dalahay and Sauer, 2007). Wolinsky reported that comminuted femoral shaft fractures were seen in 14% of patients with femoral shaft fractures in a typical urban United States of America city. The degree of the fracture comminution is often classified using the Winquist-Hansen classification (Wolinsky, 1999).

Comminuted and segmental fractures pose a challenge to treatment due to their vertical and rotational instability. The classification of the fracture in terms of type, location and degree of comminution may influence the method of treatment (Whittle and Wood, 2012). The treatment goal in patients with femoral shaft fractures included the restoration of the alignment, length and rotation; preservation of blood supply to aid union and prevention of infection and rehabilitation of the extremity as well as the patient (Whittle & Wood, 2012). Currently, surgery is indicated for most femur fractures because of the high rate of union, low rate of complications, and the advantage of early fracture stabilization which decreases the morbidity and mortality in patients (especially polytrauma patients) with these fractures(Gillespie and Welenkamp, 2010). Interlocking nailing for comminuted fractures with proximal and distal locking screws provides rotational, transaxial and translational stability(Thorasen et al, 1985) and additionally the nail functions as load-sharing rather than bearing (Scalea et al, 2000). Femur shaft fractures treated operatively with interlocking nails can be either open or closed methods. The open method of nailing is advantageous as it is less technically demanding compared to the closed method which is more time consuming and has increased exposure to radiation for both surgeon and patient (Mukherjee, 2015). No special fracture or operating table is required, no preliminary traction is required to distract the fracture. The absolute anatomical reduction is easier to obtain compared to the closed method, and direct visualization may identify undisplaced and undetected comminution on radiological studies. Interdigitation improves rotational stability and axial alignment. In segmental fractures, the middle fragment should be stabilized to prevent torsion associated with medullary reaming in closed reduction.

Fractures of the femoral shaft can lead to a major physical impairment, not because of disturbed fracture healing, but rather due to fracture shortening, malalignment, or prolonged immobilization of an extremity by casting or traction in an attempt to maintain the limb length and alignment during the early phases of healing (Bucholz and Brumback, 1996). Even minor degrees of shortening and malalignment can eventuate in a limp and posttraumatic arthritis (Bucholz and Jones, 1991; Bucholz and Brumback, 1996). The art of femoral fracture care is a constant balancing of the often conflicting goals of anatomic alignment and early functional rehabilitation of the limb (Bucholz and Brumback, 1996).

2.2 Limb length discrepancy

The limb length discrepancy (LLD) outcomes on comminuted femoral shaft fracture treated by interlocking IM nail has been reported by numerous authors. Previously, femoral shortening often followed from conservative treatment (Kootstra, 1973), and later, more infrequently, dynamic or simple nailing of an unstable fracture pattern in oblique or comminuted femoral shaft fractures (Winquist,1993). The reported frequency of shortening has been 4.1% (Böstman, 1989). Shortening of up to 1 to 1.5 cm is compatible with good function, while in 1.3% of the fractures, shortening exceeds 2 cm (Böstman, 1989).

Tüzüner et al reported from his study on comminuted femoral shaft fractures treated with interlocking IM nailing that limb length discrepancy of more than 1cm occurred in 14.3%, and 2.3% of patients had shortening of more than 2.5cm (Tüzüner,2002). Also, the limb length discrepancy of more than 1cm occurred in 1.8% of patients as reported by Wiss et al. According to Thoresen's criteria, the results were excellent and good in 89% of patients.

A mean LLD of 0.58 cm was reported in 98% of the participants, but only 6 (7%) participants had an LLD of greater than 1.25 cm. No fracture pattern or the presentation of bilateral injuries demonstrated a greater incidence of LLD. Although residual LLDs may be common in comminuted femurs treated with IM nails, most LLDs do not appear to be functionally relevant. When an LLD of greater than 1.5 cm is identified, it should be discussed with the affected patient, who should be explained to that potential complications may occur with larger LLD's (Herscovici, 2013).

The mean LLD was 12.3±15.2 [12-(-60)] mm by orthoroentgenography and 12.9±13.7 [10-(-60)] mm by manual measurement (all fracture types included). The correlation between orthoroentgenography and manual measurements was significant at the 0.01 level. In seven cases, LLD was not observed. The greatest shortening was 60 mm, and the greatest lengthening was 12mm for the 28 (44%) femurs with an LLD greater than 10mm (27 shortenings, 1 lengthening). There was no statistical correlation between LLD and open or closed fractures or poly-trauma, although there was a tendency for a greater discrepancy in comminuted fractures. The cases were divided into two groups showing the time to operate as =7 and >7 days. LLD <1 cm was accepted as no discrepancy and LLD =1 cm as a significant discrepancy. There was no significant difference in LLD with regard to time to operation (p=0.31)(Karapina, 2009).

LLD with a resultant change in weight-bearing of the hip joint is a potential contributing factor to Osteoarthritis in the hip (Kelvin, 2015). Compensatory pelvic tilt occurring due to LLD may reduce the contact area of articular cartilage in the joint due to alteration of normal skeletal alignment and increase in joint loading forces, these effects may translate to increased pressure on the cartilage and the subchondral bone which may lead to the development of osteoarthritis (Kelvin, 2015).

2.3 Rotational deformity

There is a notably wide range of intra-individual femur rotational differences (Strecker, 1994). This influences the correct anatomical rotation and therefore may complicate the accurate intraoperative reduction. The original femoral rotation of the fractured side is unknown and therefore the rotation of the healthy opposite side is used for reference. Strecker et al. showed that intra-individual femoral malrotation is significant and in 99% of the cases can be up to 15° (Strecker, 1994)

Rotational malalignment of femur shaft fracture may not just result in cosmetic deformity but could lead to arthritis or impaired function. Internal rotation of a femur shaft fracture more than 45° resulted in frontal plane malalignment. External rotation of any degree resulted in a posterior shift of the weight-bearing axis in the sagittal plane, with increasing posterior deviation occurring with increasing external rotation. Posterior axis deviation may result in increased quadriceps action and trunk shift and will affect gait (Gugenheim, J.J., Probe, R.A. and Brinker, M.R., 2004).

To achieve as little restrictions for the patient as possible with a good clinical postoperative result, femoral malrotation of 15° to the healthy opposite side can be tolerated (Strecker et al,2004). A clinical examination to detect the femoral malrotation should be the first step of the analysis. Moreover, it should be analyzed if the femoral malrotation displays a clinical relevance for the patient. Studies have pointed out that the clinical examination is not sufficiently reliable to determine femoral malrotation of > 15° (Strecker et al, 2004). Computed tomography scanning is still considered to be the gold standard for the detection of malrotation and enables the display of hidden rotational differences (Grote et al, 1980).

In this study, true rotational malalignment (>15°) after closed intramedullary nailing of femoral shaft fractures was found in 33.33% of patients. This is independent of fracture location, fracture type, implant design or implant metallurgy. Torsional deformities of femur >15° affect the knee and lower limb function as a whole. External and internal rotational deformities perform equally (Sharma et al, 2017)

The fracture morphology of the 16 patients, who were diagnosed with increased femoral malrotation, was inhomogeneous. Malrotation occurred in type A as well as in type B and C fractures (according to AO). Increased femoral malrotation according to type C, as published in a study, could not be demonstrated in this analysis (Hufner et al, 2011)

A femoral rotational malalignment of ≥10° is problematic for the patients with the hip, knee, and patellofemoral joints being affected. Karaman et al in their study found 10 of 24 participants (41.7%) had a CT-detected true rotational malalignment of ≥10° compared with the normal side. Patients without rotational malalignment tolerated ascending inclines better than those with rotational malalignment. Patients who could not tolerate climbing stairs consistently complained of anterior knee pain (Karaman, 2014).

A study in the Netherlands involving Seventy-six patients, 59 men and 17 women, with a mean age of 28.4 years (15-88) treated patients on a fracture table using an antegrade reamed AO nail (n = 46) or Grosse Kempf nail (n = 30) for a unilateral femoral shaft fracture between 1988 and 1998. Rotational malalignment after intramedullary nailing for femoral fractures was found in 28% of the patients in this study. These patients had difficulties with more demanding activities, especially when they had an external torsional deformity. Twenty-one patients (28%) had a rotational malalignment of 15 degrees or more. The difference in rotational deformity with either the AO or Grosse Kempf nail was not significant. The incidence of malrotation was independent of the fracture level. Patients with a torsional deformity had difficulties with more demanding activities like running, sports, and climbing stairs. Patients with an external rotational malalignment (n = 12) had more functional problems than patients with an internal rotational malalignment (n = 9). Clinically determined rotation differences are not accurate (+/-20degrees) compared with the established computed tomography measurements (Jaarsma, 2004).

At the National Orthopedic Hospital in Igbobi in Nigeria, Interlocking IMN was introduced as an option of surgical treatment for femur shaft fractures. This retrospective study included all cases of femur shaft fractures that were treated with locked IMN between March 2002 and September 2003. During 19 months, 19 patients with 19 fractures were treated for fracture of the femoral shaft with locked IMN using the Russell-Taylor (18 fractures) and Grosse-Kempf (1 fracture) nails. Thirteen fractures (68.5%) had comminution of the Winquist-Hansen type III and IV 12 of which were statically locked. There were three intra-operative technical problems, including the case of a subtrochanteric fracture, where the nail missed the medullary canal of the proximal segment. There were 2 patients with superficial wound infection, which responded to treatment. Although limb length discrepancy and rotational mal-alignment were not assessed routinely during the follow-up of patients, no symptomatic malrotation was noted (Fadero, 2008).

Wiss and others reported from their study that external rotation deformities occurred in 7.0% of patients (Wiss, 1986). Søjbjerg et al reported from his study external rotation deformity of 5 - 100 occurred in 7.5% of patients (Søjbjerg, 1990). Borel et al did a study on complex femoral fractures treated by closed locked IMN in adults and found external rotation deformity of 10-35 degrees occurred in 6% of patients (Borel, 1993).

Arpacioglu and others did a study on 46 patients with comminuted fracture treated with interlocking IM nail and found that 2.2% of patients had an internal rotation of 10 degrees. By Thoresen criteria, 88.6% of patients had excellent or good limb alignment outcomes (Arpacioglu, 2003). White et al studied 92 comminuted femoral shaft fractures patients treated by closed locking nail and reported that significant rotational deformities did not occur (White, 1986).

81 patients who underwent closed IM nailing of femur shaft fractures were reviewed after fracture union. The rotational malalignment was measured using CT scans and clinical methods. CT based rotational deformity >15° was considered significant. Functional outcome was assessed using Harris hip score (HHS), lower extremity functional scale (LEFS) and WOMAC osteoarthritis index for the knee. On CT 30 (37%), 24 (29.6%) and 27 (33.33%) patients had rotational malalignment of <10°, 10°-14° and >15° respectively. The malalignment was independent of the fracture location, fracture morphology, implant type. The clinical method of assessing femoral rotation was less accurate (sensitivity 18.52% and specificity of 79.63%) as compared to CT based method though the difference was not statistically significant. However, LEFS (P=0.009) and WOMAC (P=0.033) scores were statistically poorer in patients with true rotational malalignment (>15°). However, there was no significant difference noted between the groups in HHS. Patients with external and internal rotation deformities had comparable functional results (Sharma, 2016).

2.4 Post-Operative Infection

Winquist and Hansen Jr studied comminuted femoral shaft fractures treated by IMN and found the infection rate was at 0.4 % (Winquist, 1984). In another study by Winquist et al, it was reported that infection occurred in 0.9% of patients. Kempf et al did a study on closed, locked IMN in comminuted fracture and reported that infection occurred in 1.9 % of patients (Kempf, 1985). Wiss et al reported that no patient developed deep wound infection (Wiss et al,1986). In a study by Mrita in Tanzania showed four patients (5%) developed postoperative surgical site infection. Deep infections were encountered in 2 patients (2.5%), and superficial infections occurred in 2(2.5%) patients (Mrita, 2012)

Anastopoulos et al did a study in 108 patients with severely comminuted and segmental femoral shaft fractures treated by closed intramedullary interlocked nailing and reported that no patient developed infections (Anastopoulos, 1993.). Also, Søjbjerg et al reported from his study that no patient developed an infection (Søjbjerg, 1990).

2.5 Knee range of motion

Wiss et al did a study on the interlocking nail for treatment of segmental fractures of the femur and reported that no patient had a flexion contracture and 2 patients (0.06%) had less than 90-degree flexion(Wiss, 1986). Søjbjerg and others did a study on the interlocking nail of comminuted and unstable fracture of the femur, which found 7.5% of patients had knee flexion of 60 to 90 degrees (Søjbjerg, 1990).

Nipatasaj et al reported that all patients had at least 90 degrees flexion within 2 weeks and went on to full range of motion of the knee within 2 months of surgery (Nipatasaj et al, 1995). Bitta et al from his study in Tanzania showed from their study that there was no major difference in Knee flexion outcomes among patients treated with antegrade or retrograde IMN. Retrograde IMN did not result in significantly higher knee complications compared to antegrade nailing (Bitta, 2010).

2.6 Weight-bearing

Two studies of immediate weight-bearing following statically locked IM nail fixation to manage comminuted femur shaft fractures show good results. Brumback et al described 28 patients with comminuted femur shaft fractures (i.e. Winquist types III and IV) treated with reamed IM nailing utilizing a statically locked 12-mm nail, one oblique 6.4-mm proximal locking screw, and two 6.4-mm distal locking screws. Patients were allowed to bear-weight as tolerated postoperatively. Twenty-six patients progressed to full weight-bearing by 6 weeks (93%). All fractures united, with one patient requiring surgical dynamization of the nail at 5 month s to promote union (Brumback, 1999).

Similarly, Arazi et al 38 treated 30 patients with comminuted femur shaft fractures (Winquist types II, III, and IV) with IM nailing, which were statically locked. Patients were allowed to immediately bear weight as tolerated; however, no patient began weight bearing on the injured extremity by 1 week. Twenty-three (96%) patients went on to full weight bear by the second postoperative month. All fractures healed without complication. No construct failures were reported (Arazi, 2001).

Immediate weight-bearing for stable Winquist and Hensen type 0 to 2 fractures for which dynamic locking IMN was recommended showed no complications. Early weight-bearing was replicated as in Brumback's study with n o evidence of complications for statically locked femurs (Erturer, 2005)

2.7 Assessment of functional outcome

Functional outcomes of femur fractures can be assessed by functional outcome scores such as the Thoresen scoring system that has been used to classify malalignment and the knee range of motion. The outcome of the scores ranges from excellent to poor, as shown in table 1 (Thoresen et al, 1985).

Table1. Thoresen Scoring criteria. (Thoresen et al, 1985)

Variables	**Excellent**	**Good**	**Fair**	**Poor**
Malalighment				
Varus/valgus(degree)	<5	5	10	>10
Procuvatum/recurvatum(degree)	5	10	15	>15
Internal rotation (degree)	5	10	15	>15
External rotation (degree)	10	15	20	>20
Shortening (in cm)	1	2	3	>3
Range of motion (knee)				
Flexion (degree)	>120	120	90	<90
Extension deficit (degree)	5	10	15	>15
Pain or swelling	None	Sporadic	Minor significant	Severe

CHAPTER THREE: METHODOLOGY

3.1 Study Design

A Cohort study was conducted at UTH in Lusaka.

3.2 Study Site And Population

The study site was the Department of Surgery Adult Hospital, UTH, Lusaka, Zambia. Participants were adult patients with fractures of the shaft of the femur treated with IMN at UTH.

3.3 Eligibility Criteria

3.3.1 Inclusion Criteria

1. Signed informed consent.

2. All the patients with fractures of the shaft of the femur who were treated with interlocking IMN during the study period and were consented to participate in the study.

3.3.2 Exclusion Criteria

1. Patients with pathological fractures of the femur.

2. Patients with lower limb deformity, for example, polio, major joint contracture, and amputees.

3. Patients with articular fractures of the ipsilateral femur.

4. Patient with multiple orthopaedic injuries.

5. Patients with an associated head injury.

3.4 Sample Size

The sample size calculation was done using the Cochran's formula:

n = (Z2 x P(1-P))/e2

Where:

- Z = value from standard normal distribution corresponding to the desired confidence level (Z=1.96 for 95% CI)

- P was expected true proportion (the expected prevalence of patients who undergo femoral shaft intramedullary locked nailing admitted to the University Teaching Hospital.)

- e was desired precision (half desired CI width i.e. 0.05).

Prevalence of femur shaft fractures is 12.7% (70) and of those that underwent intramedullary nailing in Kenyatta National Hospital from April 2015 to March 2016 were 30.7%. That gives 3.9%

Total of nailed femur fractures (Mung'athia, 2017)

N = 57 + 10% possible drop out (6)

TOTAL=63 PATIENTS

3.5 Variables

3.5.1 Independent variables

i. Age

ii. Sex

iii. Fracture comminution.

iv. Timing of surgery.

3.5.2 Dependent variables

i. Rotational mal-alignment

ii. Limb length discrepancy

iii. Knee range of motion

iv. Surgical site infection.

3.6 Sampling Strategy

Systematic random sampling was employed to identify post interlocking IMN patients who were recruited to this study. A random starting point was identified, and a sampling interval of 2 was used based on the projected total number of cases that would be done in the period for data collection against the calculated sample size.

3.7 Procedure

Consented patients were recruited to participate in the study. A brief history and physical examination were performed. Pre-operative imaging was assessed and classified using the Winquist and Hansen classification for comminution.

3.7.1 Data collection procedures

Participants were recruited based on inclusion criteria

Mechanism of injury, age, sex and fracture personality for each participant were obtained from prior assessment by the admitting units.

Procedure and Number of days to the operation were recorded after surgery.

Postoperatively, clinical and radiological findings were recorded immediately post-operatively as per unit protocol. After discharge, study participants were requested to follow up reviews in the Orthopedics out-patients clinic in the 2nd and 6th weeks postoperatively. At these visits, the researcher assessed the surgical wound, the limb length, rotational alignment and knee range of motion by physical examination.

Findings at each review were recorded in a data collection form. These findings were scored based on the Thoresen criteria (Table 1).

3.7.2 Measurement of limb length discrepancy

To assess the true limb length discrepancy, the examiner identified the patient's ASIS and placed the free end of the tape measure onto it. The free end was held as the examiner unwound the tape measure in a straight line towards the distal tip of the medial malleolus.

The examiner recorded the distance and performed the same on the contralateral lower extremity. If the lengths differed significantly, a true limb length discrepancy was present. A difference of 5mm or less is difficult to accurately assess by this method of measurement. Significant limb length discrepancy is considered as an LLD of more than 2 centimeters.

If the affected limb length was shorter than the normal limb, it would mean there was a shortening deformity, and if the affected limb was longer than normal limb, it would indicate the presence of limb lengthening deformity.

3.7.3 Measurement of rotational malalignment

Lower limb rotational malalignment, i.e. internal/external rotation, was assessed clinically by observing the position of the patella with a tightly held tape measure extended from ASIS to the second toe on the same side.

If the patellar was in line with the tape measure, it would indicate no rotational deformity present, if the patella lay lateral to the tape measure it would indicate the presence of external rotation deformity and if patella lay medial to the tape measure it would indicate the presence of internal rotation deformity.

The degree of limb rotation deformity was assessed with the patient lying supine, the patient was asked to lie comfortably on the examination table with hips and knee extended, and then by using goniometer, the angle between an imaginary line along the medial border of the foot and vertical axis were measured and compared with the contralateral limb.

If both angles were the same, it meant no rotational malalignment was present, if the affected limb rotational angle was larger than the normal limb rotation angle it meant angular difference is the degree of external rotational malalignment. If the affected side's rotational angle was less than the normal limb rotational angle it meant, the angular difference was the degree of internal rotational malalignment.

3.7.4 Measurement of range of knee motion

Knee flexion was assessed by asking a supine patient to flex the knee as far as possible. A goniometer was placed on the lateral aspect of the flexed knee to measure the degree of knee flexion. The two sides were compared.

3.8 Data Management and Analysis

3.8.1 Data collection

Data was collected using a specially designed hospital record card, including a patient's age and sex, past medical history, drug history, as well as intraoperative findings. After the operation, a special questionnaire was completed to capture information regarding variables of interest.

3.8.2 Data entry

Data collected by the investigator was de-identified and entered onto a personal computer into an excel spread-sheet for analysis.

3.8.3 Data analysis

Statistical analysis was done using SPSS version 25.0(Released 2017 IBM Corporation, Armonk, NY). Data analysis of the patient's age and sex were performed by descriptive statistics.

Statistical significance was defined by p=0.05 and 95% confidence interval. Continuous data were presented as mean, mode, median and range. Associations between comminution and the dependent variables were tested for significance using Chi-squares.

3.8.4 Dissemination of results

The results from the study were communicated to the participants and submitted for publication to journals.

3.9 Ethical consideration

The study was done according to the principles of research involving human subjects as prescribed by the Declaration of Helsinki (World Medical Association in 2008)

1. Risks:

There were no direct risks or injuries associated with this study, as this was an observational study. There may have been psychological trauma due to some questions asked during the patient interview.

2. Benefits:

There were no monetary benefits to the patient. No financial remuneration was provided to the patients recruited in the study as all procedures, investigations and follow up were confined to routine procedures that were part of standard care and management.

3. Voluntarism:

Participation in this study was purely voluntary. Patients participated in their own accord; no coercion was used, and if the patient felt injured or inconvenienced, they were allowed to withdraw from the study at any time without any implications to their management.

4. Written informed consent:

Written informed consent from every patient participating in the study, was obtained before their enrolment into the study.

5. Confidentiality

The data collected was kept confidential and available only to the researcher. It was kept in a locker with keys kept by the researcher. Once transferred to a personal computer; the data was kept securely under password protection accessible only by the researcher.

Ethical clearance and approval were sought from and granted by the University of Zambia Biomedical Research Ethics Committee (UNZABREC). Permission was obtained from UTH Management and the Department of Surgery.

CHAPTER 4: RESULTS AND DATA ANALYSIS.

4.1 Results and Data Analysis

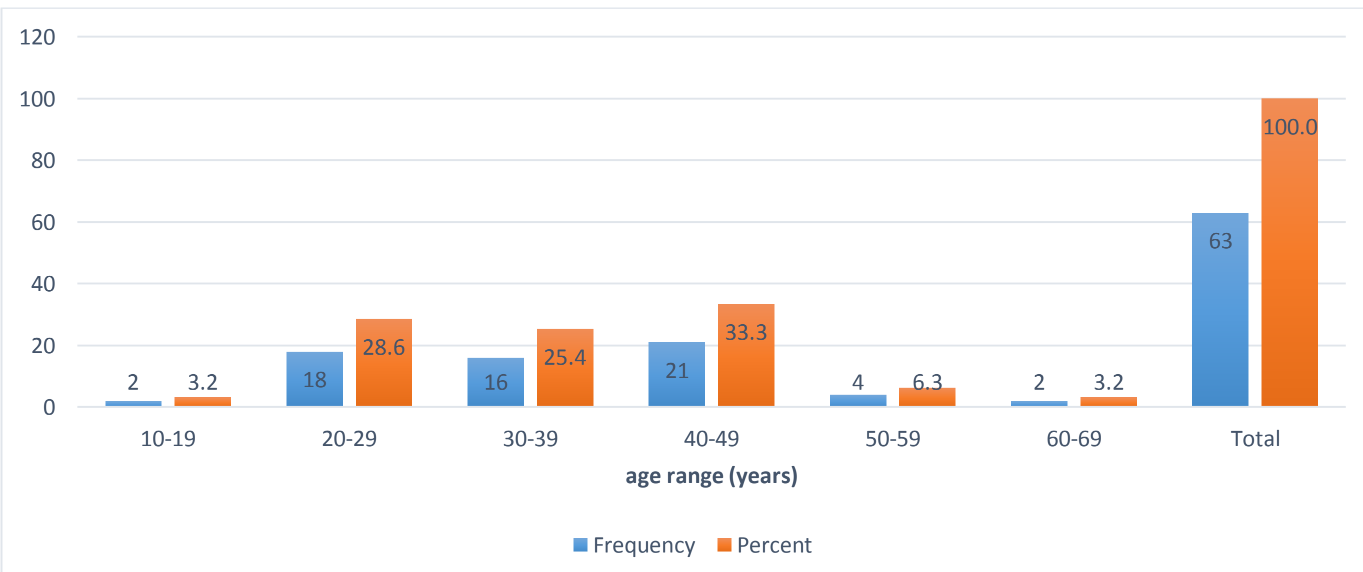
A total of 63 patients with closed femur shaft fractures were included in the study and analyzed. These were followed up for six weeks after surgery. The age range was 19-67 with the median age of 35 as in table 4.1, the most commonly affected age group was 40-49 (graph 4.2).

Table 4.1 Age distribution

Variable	N	Minimum age	Maximum age	Median
Age	63	19	67	35

N=

Graph 4.2 Age distribution



Males were seen to have been the majority of cases, representing 82.5% of the study participants. The male to female ratio was 4.7:1. This is shown in table 4.3 below.

Table 4.3 Sex distribution

Sex	Frequency(n)	Percentage (%)
Male	52	82.5
Female	11	17.5

A majority of cases were reported to be from urban areas as compared to rural areas which represented 7.9% of the sample size

Table 4.4 Locality of patient

	Frequency (n)	Percentage (%)
Urban	58	92.1
Rural	5	7.9

Road traffic accident contributed to the majority of trauma, and the highest cause was vehicle occupants/passengers on motor vehicles, 47.6%, followed by pedestrians hit by motor vehicles at 36.5% as shown in table 4.5

Table 4.5 Cause of injury

	Frequency (n)	Percentage (%)
Passenger	30	47.6
Motorbike rider/passenger	4	6.4
Pedestrian	23	36.5
Fall from height	5	7.9
Other	1	1.6

The table above shows middle 1/3 shaft fractures as the most frequent anatomical location (66.7%).

Table 4.6 Anatomical location of the fracture

	Frequency (n)	Percentage (%)
Proximal 1/3	6	9.5
Middle 1/3	42	66.7
Distal 1/3	15	23.8

Table 4.7 below shows the distribution of fracture classification, Type IV fractures, the Winquist Hansen classification were the most common (41.3%). Type 1 fractures were the least frequent.

Table 4.7 classification of fracture

	Frequency (n)	Percentage (%)
Type I	1	1.6
Type II	16	25.4
Type III	18	28.6
Type IV	26	41.3
Segmental fracture	2	3.2

Limb shortening was observed in 58.7% of the cases, 41.3% had an unaffected limb length post-operatively, as shown in table 4.8 below.

Table 4.8 Postoperative limb length

	Frequency (n)	Percentage (%)

Equal length	26	41.3
Shortening	37	58.7

Limb shortening of less than 1 centimetre was noted to be the highest proportion compared to only 7.9% with more than 2cm as in table 4.9 below.

Table 4.9 limb length discrepancy/shortening

	Frequency (n)	Percentage (%)
No shortening	26	41.3
Less than 1cm	21	33.3
1-2cm	11	17.5
More than 2cm	5	7.9

Table 4.10 below shows those that presented with postoperative shortening being 58.7%. Those with significant (more than 2cm) were found to be 7.9%.

Table 4.10 Limb shortening

	Frequency (n)	**Percentage (%)**
No shortening	26	41.3
Less than 2cm	32	50.8
More than 2cm	5	7.9

Table 11 below shows the limb lengths throughout the study period, and there was no note of changes in the limb lengths throughout the follow-up period.

Table 4.11 limb length discrepancy during follow up

Limb length discrepancy	Week 2 N (%)	Week 4 N (%)	Week 6 N (%)
None	26(41.3)	26(41.3)	26(41.3)
<1	21(33.3)	21(33.3)	21(33.3)
1-2cm	11(17.5)	11(17.5)	11(17.5)
>2cm	5(7.9)	5(7.9)	5(7.9)

The rotational deformity was observed in 68.3% of the patients as in table 4.12 out of which the type of rotational deformity was distributed into internal and external rotational deformity as shown in table 4.13 below with external rotational deformity having a higher proportion of 39.7%.

Table 4.12 Rotational deformity

Rotational deformity	Frequency (n)	Percentage (%)
Yes	43	68.3
No	20	31.7

Table 4.13 Type of rotational deformity

	Frequency (n)	**Percentage (%)**
External rotation	25	39.7
Internal Rotation	18	28.6
No rotation	20	31.7

Rotational deformity during the follow up was as depicted in tables 4.14 and 4.15 below. Notably, there were no extremes of either external or internal rotational deformity and no changes in rotation were observed.

Table 4.14. Internal rotational deformity during follow up

Rotational deformity(degrees)	Week 2 N (%)	Week 4 N (%)	Week 6 N (%)
<5	10(15.9)	10(15.9)	10(15.9)
5-10	6(9.5)	(9.5)	6(9.5)
10-15	1(1.6)	1(1.6)	1(1.6)
>15	1(1.6)	1(1.6)	1(1.6)

Table 4.15. External rotational deformity during follow up

External rotational deformity (degrees)	Week 2 N (%)	Week 4 N (%)	Week 6 N (%)
<10	24(38.1)	24(38.1)	24(38.1)
10-15	0(0.0)	0(0.0)	0(0.0)
15-20	1(1.6)	1(1.6)	1(1.6)
>20	0(0.0)	0(0.0)	0(0.0)

The majority of patients had an excellent range of motion in the knee joint at 6 weeks postoperatively. Table 4.16 below shows the frequency of various ranges of motion.

Table 4.16 Knee flexion at 6 weeks

Knee flexion	**Frequency n (%)**
Less than 90 degrees	15(23.8)
90 to 120 degrees	22(34.9)
More than 120 degrees	26(41.3)

Infection was noted in only 1(one) patient as in table 4.17 below. The one case that was recorded was a superficial infection.

Table 4.17. Infection

	Frequency n (%)
Present	1(1.6)
Absent	62(98.4)

The number of locking screws used to lock the femoral nails was 4.8% and 95.2% for three and four nails respectively as in table 4.18 below.

Table 4.18. Number of locking screws

Number of screws	Frequency n (%)
Three	3(4.8)
Four	60(95.2)

The outcome scores for the various variables were generally excellent to good, and one case had a poor outcome in terms of rotational deformity. Table 4.19 below shows the outcome scores based on the Thoresen criteria

Table. 4.19 Thoresen criteria

	Results			
Variable	Excellent N (%)	Good N (%)	Fair N (%)	Poor N (%)
Internal rotation	10(15.9)	6 (9.5)	1 (1.6)	1 (1.6)
External rotation	24 (38.4)	0 (0.0)	1 (1.6)	0 (0.0)
Shortening	47(74.6)	11(17.5)	5(7.9)	0(0.0)
Knee Range of Motion	>120	120	90	<90
Flexion	26(41.3)	22(34.9)	15(23.8)	0(0.0)

Associations.

Table 4.20 below shows the associations between comminution and the various outcome measures, the only statistically significant correlation was between fracture comminution (classification of fracture) and rotational deformity. The other variables showed no correlation with comminution.

Table 4.20. Correlation of classification of fractures with independent variables

		Classification of fractures
Limb length discrepancy	Pearson correlation	.171
	Sig.	.181
	N	63
Rotational deformity		-.340
		.006
		63
Knee flexion		-.136
		.289
		63

CHAPTER FIVE: DISCUSSION

This was a prospective study involving 63 participants presenting with femoral shaft fractures treated by interlocking intramedullary nails. Early postoperative outcomes of shortening, rotational deformity, infection and range of knee motion all had excellent outcomes. Complications were inevitable, but they were statistically insignificant. These could ultimately contribute to good final functional outcomes on further follow up of the patients.

There was a predominance of males 53 (82.5%) with a male to female ratio of 4.7: 1. This, compared to a study by Iyidobi et al (2015) in Enugu, Nigeria that had a male to female ratio of 2.3:1 and another study by Hollis et al (2015) done in northern Tanzania that showed a male to female ratio of 1.9:1(Iyidobi, 2015; Hollis et al, 2015). In a local study by Phiri (2015), the majority of the patients at both hospitals (UTH and Zambia-Italian Orthopedic Hospital (ZIOH)) were males, at 83.5%. The average age was 31.5 and 34.4 years at UTH and ZIOH, respectively (Phiri, 2015). This difference could be explained by the generally higher exposure to high energy mechanisms of injury amongst males (de Moraes, 2009).

The age range for the study was from 19 to 67 years with the majority of patients falling in the 40-49 (33.3%) age group which was similar to Mrita et al (2012) that reported 21-45 age groups as being highest. Iyidobi et al (2015) reported the commonly affected group to have been 21-30 age group. Based on the population index, most(53.05%) of the adult population in Zambia fell in the age group between 25-54.(CIA World Factbook, 2019). This distribution favours the probability of trauma victims falling in this age group.

The commonest cause of injury was RTAs (n=57) most of which were motor vehicle occupants/passengers (47.6%) and pedestrians (36.5%). This compared with Iyidobi who reported 76.9% of trauma is due to RTA while Hollis et al (2015) reported 49% trauma being secondary to RTA. This finding could be as a result of the cases being predominantly in urban areas (n=58) compared to 7.9% being from rural areas. Locally a study done at hospitals in Lusaka on Road traffic accidents accounted for the majority of femur fractures; 82% at UTH (Phiri, 2015). The commonest cause of trauma in the young was due to high energy mechanisms (Salminen, 2000).

Middle 1/3 femoral fractures accounted for 66.7% of cases with distal 1/3 and proximal 1/3 having 23.8% and 9.5% respectively. Winquist Type IV (41.3%) were the most frequent as with the study done at Enugu Iyidobi that had Type III (51.9%) as the most prevalent (Iyidobi, 2015). Phiri (2015) in his study demonstrated that Kuntsher-nail systems were more likely to migrate than interlocking nail system with associated loss of reduction. At the UTH, proximal 1/3 fractures are commonly treated by Kuntsher nails and distal 1/3 fractures by plating. Winquist et al (2001) noted that interlocking devices ensure cortical contact which is a challenge to achieve and maintain in segmental and comminuted fractures, thereby reducing the risk of alignment loss, limb shortening, angulation, and rotational deformity. This attribute makes interlocking IMNs a superior implant of choice for diaphyseal femur fractures and is the most commonly used in the western world (Egol, 2010).

In this study, there was no note of deep infection; the superficial infection that was noted was found in only one patient (1.6%). The infection was still present through follow up but was noted to have improved at the end of follow up, the attending unit did treat with debridements and antibiotic cover. In their series, Mrita et al (2012), deep wound infection was encountered in 2 patients (2.5%). Implants were removed in both patients who had deep wound infections, followed by thorough debridement and antibiotic therapy (Mrita, 2012). Nearly equivalent results were obtained by Kempf et al (1985) who reported deep infection was seen in 1.9% (n=52). However, the infection rate was higher than that reported by Hansen Jr et al and Winquist et al that infection occurred in 0.4% and 0.9%, respectively (Winquist et al, 1980:1984). The postoperative infection rate was observed in 11.8% and 7.4% patients at UTH and ZIOH, respectively (Phiri, 2015. This is a higher proportion compared to our findings which is a significant improvement in outcomes. The observed infection rate in our study might also be due to short follow up time discharge and lower nosocomial wound infection chances at home. However, there is no current literature relating to reduced infection rates to early discharge in our setting. Based on Phiri's (2015) findings, he noted the infection rate was related to delayed surgery which was not the case in this study. Prophylactic antibiotic targeted at the commonest surgical site infection causing organisms at the UTH as outlined in Mulenga's (2015) study were a contributor to the low infection rate noted.

Infection rates should for no reason be higher in a low resource setting when well-trained surgeons have access to the basic surgical requirements, such as autoclaves, antiseptic wash, and the right prophylactic antibiotics, as seen even in the poorest countries. In a large randomized study of prophylactic antibiotic use in Uganda, the infection rate following inguinal hernia repair reduced from 7.5 to 0 % with appropriate antibiotic usage (Reggiori A et al 1996). In their study, Young et al (2013) prophylactic antibiotics reduced the infection risk by 29 % (OR 0.71, 95 % CI: 0.55–0.91). his study seems to confirm the expected increase in postoperative infection risk in low-income countries compared to countries with higher income levels, and presumably better infrastructure, but their increase in infection rates was small (0.5–1.2 %). The overall rate of infection were low, and within acceptable levels, hence, suggesting that it was safe to do the IM nailing in low-income regions. The fact that operations for non-union have twice the risk of infection compared to primary fracture surgery further supports the use of IM nailing as the primary treatment for femur fractures in LMIC. A prospective multi-centre study comparing results of a standardized IM nailing technique between a South African trauma centre and European centres showed lower complication rates in South Africa and a near-identical infection rates despite more serious injuries in the South African patients (Gross et al. 2010). This is indicative of infection rates being similar irrespective of location

In our study, 41.3% of patients had normal limb lengths, while 50.8 % had limb shortening of less than 2cm. The limb lengths postoperatively were maintained throughout the follow-up period. Based on the Thoresen criteria, 74.6% of patients had an excellent outcome at 6 weeks. Cumulatively, the Thoresen criteria score at 6 weeks was 92.1% for excellent and good length outcome. Normal limb length was seen in 80% of patients (Mrita, 2012). Limb shortening of more than 2cm was encountered in only 3.8% of patients which was lower than those in our study (7.9%). In Mrita's study, by Thoresen criteria score, 96.2% of patients had excellent or good limb length outcome. The difference in findings could be due to the fact that in other studies the patients affected limb length was compared with normal limbs and maintained by traction table, and the length of the nail was estimated from a radiograph of normal contralateral femora. In Phiri's (2015) study, he recorded more patients with postoperative LLD of 35.3% at UTH than 16.0%.at ZIOH. He attributed his finding to the long waiting list for operative management, necessitating the need for osteotomies intraoperatively, consequently contributing to shortening besides the shortening contributed by comminution. In our study, LLD was higher (58.7%) than in Phiri’s (2015) study despite the waiting times being significantly shortened, waiting time in our study was at most 5weeks which was notably shorter than in Phiri's (2015) study. Kuntscher nailing was used in Phiri’s(2015) study and whats well established is its indication for proximal 1/3 femur fractures which were very few in our study (9.5%) of which only 1(1.6%) had limb shortening.

Improved limb length outcome by open nailing of comminuted femoral fracture can be obtained by maintaining traction after aligning fracture fragments and before locking the intramedullary nail. Of note in this study is that there was no correlation between comminution (Winquist classification) and limb shortening (p value= .171). Herscovici (2014) found no significant relationship between fractures comminution and shortening. The unavailability of direct measurement of femur length as was the case in our study may have contributed to lack of association.

The Thoresen criteria score for both external and internal rotational deformity had an excellent to a good score of 63.8%. In our study, we had 1.6% of patients with fair and poor outcomes each for internal rotational deformity, external rotational deformity’s worst outcome score was fair(1.6%). The proportion of patients without rotational deformity was 31.8%. In Mrita’s study, External rotation deformity of more than 20 degrees occurred in 6.3% of patients and internal rotation of more than 15 degrees was encountered in 7.9% (Mrita, 2012). According to Thoresen criteria score 76.3% of patients had excellent limb alignment outcomes. A study by Sabiri et al (2017) found 7% and 3% for external and internal rotation respectively and that there was no relationship with age, sex and fracture location (Sabiri, 2017). Compared with our findings, the high rates of rotational deformity could be attributed to the lack of traction tables. The obtained difference may be due to the fact that in other studies, limb alignment is maintained by traction table before locking the nail. Rotational outcomes in resource-limited areas with no traction tables can be improved by assessing and maintaining proper alignment of the affected limb before and during locking the nail. For proximal femoral fractures, the initial rotation of the proximal fragment is externally due to the action of the iliopsoas, glutei and the external rotators of the hip. In distal fractures, the distal fragment rotates outward because of the action of the plantar and lateral gastrocnemius muscles. Based on this, it is expected that a relationship exists between the site of the fracture and the amount or direction of malalignment. With the inadequate reduction, a proximal fracture will produce internal malrotation and the distal fracture external malrotation of the femur. However, we could not establish this pattern, and no other studies comment on this assumption.

Rotational malalignment happens intraoperatively during IMN secondary to fracture mal-reduction. Usually, the lesser trochanter is the anatomical landmark used to avoid rotational malalignment (Deshmukh et al,1998). To reduce the chances of rotational malalignment, Kim et al (2001 Kim JJ, Kim E, Kim KY (2001)) suggested the shape of the contralateral lesser trochanter for use as a reference landmark suggested the shape of the contralateral lesser trochanter for use as a reference for the lesser trochanter of the fractured femur using a C-arm image intensifier. Jaarsma et al (2005) reported in a more recent in vitro cadaver study that looked at the profile of the lesser trochanter alone on the injured side was an inaccurate method that results in a rotational malalignment of up to 19 degrees. Similar to Kim et al. (2001(Kim JJ, Kim E, Kim KY (2001)), they suggested using the profile of the contralateral lesser trochanter as a reference and found differences of only up to 4 degrees. The use of this method may facilitate avoidance of rotational malalignment. Computer navigation systems had offered a hopeful method to assess rotation intraoperatively (Kendoff et al, 2007).

Based on the Thoresen criteria Knee flexion at 6 weeks was excellent to good in 76.2% of patients, no patients were noted to have flexion less than 90 degrees flexion. In Mrita’s study, the overall knee flexion of less than 90 degrees was encountered in 7.5% of patients in the 18th week (Mrita, 2012). The rate of knee stiffness was higher among patients treated with retrograde compared with antegrade nailing. These results concurred with Søjbjerg et al(Sojbjerg, J.O., Eiskjaer, S. and Moller-Larsen, F., 1990) who reported that 7.5% of patients had knee flexion of 60 to 90 degrees. Contrary results were reported by Wiss et al (1986), that no patient had a knee flexion contracture. Nipatasaj et al (1995) found that all patients had more than 90-degree knee flexion at 2 weeks postoperatively. The outcome at 6 weeks is not the final outcome, therefore, there is likely room for improvement of outcome. The outcome could improve with physiotherapy and improved pain tolerance. Early knee range of motion could improve outcomes. Wiss et al(1986) did a study on the interlocking nail for treatment of segmental fractures of the femur and reported that no patient had a flexion contracture and 2 patients (0.06%) had less than 90-degree flexion (Wiss, 1986). Søjbjerg et al(1990) and others did a study on the interlocking nail of comminuted and unstable fracture of the femur which found 7.5% of patients had knee flexion of 60 to 90 degrees. Interlocking IMN in our study were all inserted antegrade, there was no anticipated difference in outcome as there is no difference in outcome between retrograde and antegrade nailing (Daglar, 2009).

The major limitation of this study was the short follow-up period. Being an observational study, it was not possible to intervene in the management of the bad outcomes. Clinical assessment alone could have missed out any possible infection. Moreover, patients had to acquire their interlocking nails meaning only those that could afford participated in the study, therefore, could have been a misrepresentation of cases. Availability of more accurate measurement modalities as CT scan for assessment of bone alignment.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The early outcomes of treatment using interlocking IMN for femur shaft fractures at UTH were good to excellent (based on the Thoresen score criteria) in terms of limb length discrepancy, rotational deformity and knee flexion combined. The proportion of post-surgery infection among patients with femoral shaft fracture treated with interlocking IMN was low (1.6% -superficial infection).

6.2 Recommendations

1. A longer follow up period should be considered to be able to follow up on the long term outcomes.

2. An interventional study should be considered to enable collection and analysis of parameters as pus swabs for infection.

3. Engagement of radiology department for more accurate assessment using CT scan of bone alignment.

4. Interlocking IMNs should be made readily available.

5. there is need for procurement of traction tables which are a vital requirement in averting rotational deformity and limb length restoration.

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8. APPENDICES

8.1 Participant's Information Sheet

A study to determine the short-term outcome of femoral shaft fractures patients treated with locking intramedullary nail at UTH, Lusaka.

PARTICIPANT'S INFORMATION SHEET

My name is Dr. Malao Brian Mulemwa, a Medical Doctor pursuing a Master's Degree in Orthopaedic and Trauma Surgery at the University Teaching Hospital.

As part of my academic qualification, I am conducting a study to determine the short-term outcome of femoral shaft fractures patients treated with locking intramedullary nail at UTH, Lusaka. This will help in knowing the outcomes of Interlocking IMN and will set a standard procedure for better management.

What is a research study?

A research study is when people like me collect a lot of information about a certain thing to find out more about it. Before you decide if you want to be in this study, you need to understand why we are doing the research and what is involved.

Please read this form carefully. If you have questions about this research, feel free to ask me.

Why are we doing this study?

We are doing this study to determine the short-term outcome of femoral shaft fractures patients treated with locking intramedullary nail at UTH, Lusaka. This will help in knowing the outcomes of Interlocking IMN and will set a standard procedure for better management.

What will happen if you are in this study?

If you agree to be in the study and you give permission, we will do the following:

1.) Several questions will be asked by me to find out more information about you.

2.) Trained and experienced medical personnel will examine and take the necessary measurements

The information collected will be entered into a data collection form.

Furthermore, you can skip any questions on the data collection sheet that you do not wish to answer and this will have no bearing on your management.

If you don't want to be in the study, what can you do instead?

You have the right to refuse to participate in this study and you will still be treated like any other patient who comes with infection in the joint at the University Teaching Hospitals.

Are there any benefits to being in the study?

There are no personal benefits as you will be taken care of like any other patient who presents with infection in the joint. Though for the benefit of others, we hope that the results of this research will improve the management of patients with infection in the joint at the University Teaching Hospitals.

Are there any risks or discomforts to being in the study?

There are very minimal risks associated with participating in the study.

Who will know about your study participation?

Apart from yourself and the researcher, no one will know about your participation and the results as the information will be kept private. Group results, however, will be communicated to you and will get published in journals.

Will you get paid for being in the study?

You will not get paid for taking part in this study.

Do you have to be in the study?

No, you do not. Research is something you do only if you want to. No one will be annoyed with you if you do not want to be in the study. And whether you decide to participate or not, will not affect the routine treatment you get at the University Teaching Hospitals.

Do you have any questions?

You can contact the University of Zambia Biomedical Research Ethics Committee or me if you have questions about the study, or if you decide you do not want to be in the study anymore. You can talk to me or someone else at any time during the study.

If you decide to participate we will give you a copy of this form to keep for future reference.

Who to contact:

A committee that works to protect research participant rights and welfare reviews all research.

If you have any other questions regarding this study, feel free to contact me or the numbers outlined.

Dr. Malao Brian

Orthopedic Surgery Registrar

Principal Investigator

Department of Surgery

University Teaching Hospital

Lusaka

0977480130

brianmalao@yahoo.co.uk

Dr. Jonathan Sitali
Orthopedic Senior Registrar
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0977582061
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Dr. P Machona.

Orthopedic Consultant, Department of Surgery.

School of Medicine. University Teaching Hospital, Lusaka.

0977860355.

The Chairperson

UNZABREC

School of Medicine.

Ridgeway Campus,

Nationalist Road,

PO Box 50110 Lusaka.

8.2 Consent form

A Cohort Study on Early outcomes of femur Shaft Fractures in Adults Treated by Interlocking Nails at The University Teaching hospital, Lusaka.

Consent form

Consent to participate in the study titled "A Cohort Study on Early outcomes of femur Shaft Fractures in Adults Treated by Interlocking Nails at The University Teaching hospital, Lusaka"

I____ have read the above information, or it has been read to me. I have had the opportunity to ask questions concerning the study and these have been answered to my satisfaction. Furthermore, I understand I can skip any questions on the data collection sheet that I do not wish to answer and that I am free to withdraw from the study at any time and this will have no bearing on my management.

I consent voluntarily to participate in this study.

Name of participant_______________________________________

______________________________ Date: ____________________

Signature or thumb print of participant.

-- Date: --------------------------------

Signature of the investigator.

-- Date: --------------------------------

Witness.

8.3 Data Collection Sheet

A Cohort Study on Early outcomes of femur Shaft Fractures in Adults Treated by Interlocking Nails at The University Teaching hospital, Lusaka.

Data Collection Sheet

Code/ serial number:………….

1. SOCIODEMOGRAPHICS

1.2 Age

1.3 Sex1.3.1. Male 1.3.2 Female

1.4 Residence 1.4.1 Urban 1.4.2 rural

1.5 Phone no: ……………………….

1.6 .1 Date of injury:………1.6.2 Date of operation:..…1.6.3 Date of discharge…………….

1.7 Post-operative stay 1.7.1 <2days 1.7.2 2-5 days 1.7.3 More than 5 days

1.8 Cause of injury:

1.8.1Motor vehicle 1.8.2. Motorbike 1.8.3. Pedestrian 1.8.4 Falling from a height

1.8.5 Sports 1.8.6 Others: specify…………..

1.9. Side of femoral fracture

1.9.1) Right 1.9.2) Left femur 1.9.3) Bilateral femoral shaft fractures

1.10. Anatomical location of the fracture

1.10.1. Proximal 1/3 1.10.2. Middle 1/3 1.10.3. Distal 1/3

1.11. Classification of comminuted femoral shaft fracture by Winquist – Hansen classification:

1.11.1 Type I 1.11.2 Type II 1.11.3 Type III 1.11.4 Type IV 1.11.5 Segmental

1.12. Other associated injuries:

1.12.1 Present 1.12.2absent …………

1.13. Other associated injuries:

1.13.1 Head injury1.13.2 Pelvic injury 1.13.3 Visceral injury 1.13.4 Chest injury

1.13.5) Other injuries: specify ……………

2. OPERATIVE EVALUATION

2.1. Affected Limb length postoperatively:

2.1.1 Normal length 2.1.2 Shortening 2.1.3. Lengthening

2.2 If there is a change in limb length:

2.2.1 Less than 1 cm 2.2.2 1 cm- 2cm 2.2.3 More than 2 cm

2.3. Limb rotation deformity:

2.3.1 Yes 2.3.2 No

2.4. If yes, there is a rotational deformity:

2.4.1 External rotation 2.4.2 Internal rotation

2.5. Degree of rotational deformity:

2.5.1 < 5 degrees 2.5.2 5-10 degrees2.5.3 10 -15 degrees2.5.4 More than 15 degrees

2.6. The number of the interlocking screw:

2.6.1 Two screws 2.6.2 Three screws 2.6.3 Four screws

3. POSTOPERATIVE PATIENT FOLLOW-UP

3.1 Limb length deformity:

3.1.1 At 2 weeks 3.1.1.1 Yes (If yes specify in cm)…………… 3.1.1.2 No

3.1.2 At 4 weeks 3.1.2.1 Yes (If yes specify in cm)…………… 3.1.2.2 No

3.1.3) At 6 weeks 3.1.3.1 Yes (If yes specify in cm)…………… 3.1.3.2 No

3.2. Limb rotation deformity

3.2.1 At 2 weeks 3.2.1.1 present (Specify type/degrees) …………..3.2.1.2Absent

3.2.2 At 4 weeks 3.2.2.1 Present (Specify type/ degrees)………..…3.2.2.2 Absent

3.2.3 At 6 weeks 3.2.3.1 present (Specify type/degrees) …………. 3.2.3.2 Absent

3.3. Wound infection Post operatively:

3.3.1 At 2 weeks3.3.1.1 Present (Specify deep/superficial) 3.3.1.2 Absent

3.3.2 At 4 weeks 3.3.2.1 Present (Specify deep/superficial) 3.3.2.2 Absent

3.3.3 At 6 weeks 3.3.3.1 Present (Specify deep/superficial) 3.3.3.2 Absent

3.4. Knee range of motion:

3.4.1 Less than 90 degrees

3.4.2 90 to 120 degrees

3.4.3. More than 120 degrees

8.4 Curriculum Vitae

CURRICULUM VITAE

PENELOPE KANTU MACHONA

The University of Zambia,

School of Medicine

University Teaching Hospital

Department of Surgery (Orthopedics)

Private Bag RW1x

Lusaka

Residential address: 67 Nyumba Yanga, Lusaka.

Mobile: **+260 977 860 355**

Email: **dockantu@yahoo.com**

PERSONAL DETAILS

Date of Birth:	25th April 1978
Nationality:	Zambian
Sex	**Female**
Marital status:	Married
Number of children:	Three (3)
NRC No.:	637308/11/1
Driver's license:	Valid
Occupation	Lecturer/Medical Doctor
Field of Specialization	Orthopedics and Trauma Surgeon
The current Employer	University of Zambia, School of Medicine
Affiliations:	Full Registration with Health Professions Council of Zambia
Denomination:	Christian

PROFILE

- Self-motivated, highly innovative and forward-looking individual
- Dedicated and dependable
- A team player commanding excellent interpersonal skills
- Excellent command of written and oral/aural communication skills in English
- Computer literate: Microsoft Word, PowerPoint, Internet Browsing

PROFESSIONAL OBJECTIVES

- To advance my career in the field of medicine and Research (Trauma in Public Health)
- To advance in the field of Orthopedics and Trauma

AREA OF EXPERTISE

Orthopedics and Trauma

Lecturing

PROFESSIONAL QUALIFICATIONS

2017 – 2018 Postgraduate Diploma in Lecturing/Teaching Methodologies
Obtained from the University of Lusaka.

2011 – 2015 Masters in Orthopedics and Trauma (MMED)

Obtained from the School of Medicine, University of Zambia

2003– 2006 Bachelor of Medicine and Bachelor of Surgery (MBChB)

Obtained from the School of Medicine, University of Zambia

2004 – 2006 Bachelor of Science (Human Biology) (BScHb)

Obtained from the School of Natural Sciences and School of Medicine, University of Zambia

ACADEMIC QUALIFICATION

1993 – 1995 School Certificate 'O' Level with distinction

Obtained at David Kaunda Secondary Technical School

1990 – 1992 Junior Secondary School Leaving Certificate

Obtained at St. Mary's Secondary School (Lusaka)

PROFESSIONAL COURSES

March 2009 – AO SEC Course on Nonoperative Fracture Treatment

Obtained a Certificate of participation from AO foundation

December 2011 – AO SEC Course Principles in Operative Fracture Management

Obtained a Certificate of participation from AO Foundation

October 2011 – Management of Surgical Emergencies

Obtained Certificate of completion of the course from Association of Surgeons of Great Britain and Ireland

June 2012 – Advanced Pediatric Life Support Course (APLS)

Obtained a Certificate of APLS Provider from Advanced Life Support Group

September 2012 – Basic Surgical Skills Course

Obtained a Certificate of completion from Surgical Society of Zambia

December 2012 – Instructional Course on Foot and Ankle conditions

Obtained a Certificate of participation from South Africans Foot Surgeons Association

July 2013 – Primary Trauma Care Course

Obtained a Certificate of attendance from Surgical Society of Zambia

April 2014 – COSECSA Oxford Orthopedic Link (COOL) Spine Course

Obtained Certificate of attendance from COOL

July 2014 - COSECSA Oxford Orthopedic Link (COOL) Hip and Knee Course

Obtained Certificate of attendance from COOL

April 2019 – Medscholar for Health Professions' Educators

Obtained Certificate of attendance from University of Zambia

WORK EXPERIENCE

February 2018 – To date **University Teaching Hospitals- Adult**
Department of Surgery (Orthopedics and Trauma)

University of Zambia Lecturer/ Consultant Orthopedics

Responsibilities:

- Course coordinator for 7^{th}-year undergraduate students
- In Charge of day to day running of the Orthopedic unit in the Department of Surgery
- Supervision of Postgraduate Students in Orthopedic Research
- Training of undergraduate and postgraduate students in Orthopedics and trauma surgery

September 2017 – February 2018 Cavendish University
Part-time Lecturer

Responsibilities

November 2016 - February 2018 Kabwe Mine Hospital (KMH),
Department of Surgery (Orthopedics and Trauma)

Acting Consultant and Head Clinical Care

Responsibilities:

- Overall supervision of all Clinical Areas at Kabwe mine hospital
- Chairperson for RMNCH G2G funded projects at Kabwe Mine Hospital
- Coordinate and provide timely quality diagnostic services to ensure effective patient management
- Coordinate and provide Orthopedic and Trauma screening procedures and interventions to ensure effective patient management and surveillance
- Spearhead capacity building and implementation of programs to impart appropriate skills and knowledge in Orthopedics and Trauma
- Monitor and evaluate regularly activities in the delivery of Orthopedics and Trauma services in Central Province
- Coordinate and supervise research in clinical care to generate information for evidence-based clinical care

- Manage the utilization of human resource at the hospital and coordinate all clinical areas
- Supervision and training of junior doctors
- Supervision and teaching of medical students
- Ward management in liaison with the sister-in-charge

September 2015 - October 2016 - University Teaching Hospital (UTH),
Department of Surgery (Orthopedics and Trauma)

Senior Registrar

Responsibilities:

- Inpatient care – diagnosis of disease, ordering of appropriate laboratory tests and prescribing the necessary treatment
- Outpatient care – general and specialist clinics
- Critical care – triage of patients, managing of patients in the emergency theatre and elective theatre
- Management of trauma patients – diagnosis, treatment and follow up.
- Supervision and training of junior doctors
- Supervision and teaching of medical students
- Ward management in liaison with the sister-in-charge

March 2011 to September 2015 - University Teaching Hospital (UTH),
Department of Surgery (Orthopedics and Trauma)

Registrar

Responsibilities:

- Inpatient care – diagnosis of disease, ordering of appropriate laboratory tests and prescribing the necessary treatment

- Outpatient care – general and specialist clinics
- Critical care – triage of patients, managing of patients in the emergency theatre and elective theatre
- Management of trauma patients – diagnosis, treatment and follow up.
- Supervision and training of junior doctors
- Supervision and teaching of medical students
- Ward management in liaison with the sister-in-charge

August 2009 to March 2011 - University Teaching Hospital (UTH),
Department of Internal Medicine (Staff Clinic)

Senior House Officer

Responsibilities

- Attending to UTH staff members, medical students and student nurses
- General day to day running of the clinic
- Making sure patients were investigated appropriately and received the correct treatment.

March 2008 - June 2009 Monze Mission Hospital, Southern Province

Medical Officer-in-charge of Surgical Wards

Senior Resident Medical Officer

Responsibilities

- Inpatient surgical patients care - diagnosis and treatment
- Outpatient care- follow up of surgical and patients after discharge
- Management of acutely ill and acutely injured patients
- Handling of referred cases from the rural health posts
- Theatre work experience – elective and emergency cases in General Surgery, Orthopedics and Trauma, Urology, Obstetrics, and Gynaecology.

October 2007 - March 2008 University Teaching Hospital (UTH), Department of Obstetrics and Gynecology

Senior Resident Medical Officer (SRMO)

Responsibilities

- Inpatient care - diagnosis and treatment
- Outpatient care
- Critical care – triage of very ill patients, resuscitation, treatment of critically ill patients

April 2006 – October 2007 University Teaching Hospital

Junior Resident Medical Officer (JRMO)

Responsibilities

- Inpatient care - diagnosis and treatment
- Outpatient care
- Critical care – triage of very ill patients, resuscitation, treatment of critically ill patients

Details of Internship

Department	Duration	Supervising consultant
Pediatrics	3 months	Dr. Mulenga
Surgery	6 months	Dr. Arkteav
Obstetrics / Gynaecology	6 months	Dr Kasonka
Medicine	3 months	Dr. Kalincheko

Professional Affiliations

- Zambia Orthopaedics and Trauma Association (ZOTA) – **Vice President**
- Zambia Medical Association

Research work

1. Comparative Study of Outcomes of Operative Management of Gartland III Supracondylar Fractures of the Humerus in Children Using Lateral and Posterior Approach at University Teaching Hospital, Lusaka.

2. Timing of Prophylactic Preoperative Antibiotics and Surgical Wound Dressings: Attitudes, Knowledge and Practice of Orthopaedic Surgeons at University Teaching Hospital (UTH) Lusaka.

Masters Dissertations Examined

1. Post Surgery Lactate levels in Orthopaedic Patients with or without HIV after tourniquet Use. (Dr. Logizomai E Chipasha, MMED Orthopaedics & Trauma Surgery)

2. Presentation, Management and Short-term Outcomes of Extradural spinal Tumours at the University Teaching Hospital (UTH), Lusaka. (Dr. Hilgard Mutembo, MMED Orthopaedics & Trauma Surgery)

3. Potential Predictors of Musculoskeletal Manifestations in Pediatric Patients with Sickle Cell Disease at UTH, Lusaka. (Raymond Musowoya, MMED Orthopedics & Trauma Surgery)

4. Characterization of Musculoskeletal Injuries in Children Seen at UTH, Lusaka. (James Nyimbili, MMED Orthopedics & Trauma Surgery)

INTERESTS/HOBBIES

Reading motivational books,
Spending time with my family
Swimming, traveling
Going on safari

LANGUAGES: English, Bemba, Nyanja, Tonga

REFEREES

Prof Yacob Mulla
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Associate Professor of Physiology and Cardiovascular Health
School of Medicine, UNZA
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Lusaka.

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CURRICULUM VITAE

Dr. Jonathan Ikachana Sitali

Flat No. 1 Solwezi Court, Fairview, Lusaka. Phone Number: +260977582061
Email: ikachana@yahoo.co.uk

DEMOGRAPHICS:

Date of Birth: 04/02/1978 Marital Status: Married Number of Children: 1

EDUCATION:

Period	Institution	Qualification
1984-1990	Ndola Primary/ Basic School	Grade VII Certificate
1991-1992	Kansenshi Secondary School	Grade IX Certificate
1993-1995	Hillcrest Technical Secondary School	School Certificate
1997-2003	University of Zambia	Bachelor of Science (Human Biology)
2003-2006	University of Zambia	Bachelor of Medicine and Bachelor of Surgery
2008-2012	University of Liverpool	Master of Public Health
2012-2015	University of Zambia	Master of Medicine in Orthopedics
2013	University Teaching Hospital	Member of the College of Surgeons (COSECSA)

CONFERENCES, COURSES AND WORKSHOPS ATTENDED:

- 4th and 5th February 2008: Attended New Antiretroviral Therapy Protocols Orientation Course.
- 18th to 22nd February 2008: Attended Comprehensive pediatric HIV care and Treatment course for health workers.
- 21st November 2009: Attended Preventing Mother to infant transmission of HIV in Zambia.
- 17th to 21st October 2011: Attended The management of surgical emergencies course, Lusaka, Zambia.
- 2nd to 4th December 2011: Attended AO SEC Course Principles in Operative fracture management, Lusaka, Zambia.
- 7th to 9th December 2011: Attended College of surgeons of East, Central and Southern Africa, annual general meeting and scientific conference-Lusaka, Zambia.
- 26th to 28th September 2012: Attended Basic surgical skills course, Lusaka, Zambia.
- 3rd and 4th December 2012: Attended Instructional course on foot and ankle conditions, Addis Ababa, Ethiopia
- 5th to 7th December 2012: Attended College of surgeons of East, Central and Southern Africa, annual general meeting and scientific conference-Addis Ababa, Ethiopia.
- 6th to 24th May 2013: Attended Basic science anatomy course held under the auspices of the College of Surgeons of East, Central and Southern Africa and the University of Zambia School of Medicine.

- 8th to 11th July 2013: Attended COSECSA Oxford Orthopedic Link (COOL) Advanced Pediatric Orthopedic Course (BCIH) Blantyre, Malawi.
- 26th and 27th July 2013 Attended Zambia Medical Association Symposium in Pediatric and Adult Rheumatology, Lusaka.
- 6th and 7th August 2013: Attended the COSECSA and Surgical Society of Zambia Primary Trauma Care course. Siavonga, Zambia.
- 8th and 9th August 2013: Attended Regional COSECSA and Surgical Society of Zambia annual general meeting held in Siavonga, Zambia.

- 13th and 14th August 2013: Attended COSECSA Basic Sciences Training University Teaching Hospital, Pediatrics Center of Excellence, Lusaka, Zambia.
- 2nd and 3rd September 2013: Attended Zambia clubfoot program Posenti method training, Beit Cure hospital, Lusaka, Zambia.
- 3rd to 4th October 2013: Attended AO SEC Course – Nonoperative Fracture Treatment, Chingola, Zambia.
- 24th to 26th February 2016: Attended Integration of Leadership, management and Governance into pre-service medical education curriculum design and skills-building workshop.
- 29th June to 1st July 2016: Attended as faculty at the AO Alliance Foundation Course Basic Principles of Fracture Management for Operating Room personnel, Lusaka, Zambia.
- 21st to 22nd July 2016: Attended AO Spine Principles Course Spine Trauma and Infection

SOCIAL ORGANIZATIONS AND RESPONSIBILITIES DURING STUDENT YEARS:

During Secondary School and University, I was an active member of several clubs/ associations and I was in the executive in several of these student organizations:

1991-1992:

- Member of the Kansenshi Secondary School Debate Society
- Member of the Kansenshi Secondary School JETS club
- Member of the Kansenshi Secondary School Interact club

1992:

- Secretary Kansenshi Secondary School Debate Society

1993-1995

- Member of Hillcrest Secondary School Debate Society
- Member of Hillcrest Secondary School Students Council

1994:

- Secretary Hillcrest Secondary School Debate Society
- Secretary Hillcrest Secondary School Students Council

2001-2006:

- Member of UNZA Ridgeway Campus Christian Medical Fellowship
- Member of UNZA Ridgeway Campus Bread of Life Fellowship

2002-2003:

Secretary of UNZA Medical School Students Association Disciplinary Committee

2004-2005

- Chairman UNZA Ridgeway Campus Christian Medical Fellowship
- Chairman UNZA Ridgeway Campus Bread of Life Fellowship

WORK EXPERIENCE:

2004-2005 Research Triangle Institute, Zambia Electronic Perinatal System

2006-2007 Junior Resident Medical Officer, Ndola Central and Arthur Davidson Hospitals

2007 Honorary Lecturer Ndola School of Midwifery

2007- 2012 Senior Resident Medical Officer Macha Mission Hospital

2010 Guest Lecturer Erastus University / Macha Research Trust course for Premed Students on Tropical Medicine

2012- to date Orthopaedics and trauma Registrar, UTH.

2013 to date Senior Lecturer of Public Health at University of Lusaka – Part-Time

2013 - 2015 Newspaper columnist (Post Newspapers) writing weekly health articles for the Zambia Medical Association health column as the main author and editor for all other articles written under this column.

2014 COSECSA Oxford Orthopedic Link Research Fellowship/ grant award

2014 External examiner for Dissertation for the master of project management at the University of Lusaka

2014 – 2015 Health columnist in local social, a non-academic magazine “zwedding”.

2014 to date Member of National Faculty AO SEC Operative Room Personnel Course

2014 to date Member of the National Faculty of AO Non-operative Management of fractures course

2014 Dissertation supervisor at the University of Lusaka.

2015 to date Consultant Orthopaedic Surgeon Pearl of Health hospitals, Lusaka

2016 to date Consultant Orthopaedic Surgeon MedCross Hospital, Lusaka

2016 to date Senior Registrar Orthopaedics and Trauma, University Teaching Hospital

2017 to date Honorary Lecturer Orthopaedics and Trauma University Teaching Hospital

Administrative Responsibilities at Macha Mission Hospital

2009-2010 Acting Medical Officer in Charge

2009-2012 Member of the Choma District Clinical Care Team

EXTRA CURRICULUM ACTIVITIES AND SOCIAL RESPONSIBILITIES

2012 – 2013 Committee member - Resident Doctors Association of Zambia, University Teaching hospital, Branch.

2013 - 2015 Zambia Medical Association Chairman of Public Health Committee

2013 Member of the Northmead Assemblies of God Church.

l2013 to date Board Member, Zambia Medicines and Allied Substances Regulatory Authority (ZAMRA)

2015 to date Zambia Medical Association Secretary-General

2016 to date Vice President Zambia Orthopaedic and Trauma Association

2016 to date Board Chairman, Zambia Association of Literacy

2016 to date Committee Member Health Professions Council Medical, Dental and Audiology Professional Subcommittee

2017 to date Member, Internally Generated Funds Committee, University Teaching Hospital

REFEREES:

1. Dr. John Spurrier, Medical Advisor to the Executive Director, Macha Mission Hospital. P. O. Box 630340, Choma. Email: johnspurrier@gamil.com
2. Dr. James Munthali. Phone: +260 966765422. Head of Surgery Department, UTH. P. O.Box 50110, Lusaka. e-mail: jcmunthali@yahoo.com
3. Mr. Chimuka Hampango, Provincial Public Health Logistics Advisor, John Snow Inc. P. O. Box, Kabwe. Cell: +260977648553. E-mail: Champango@jsi.co.zm
4. Mr. Michelo Mwiinde, Internal Auditor, Spectra Oil, Lusaka, Zambia, P.O. Box: 343504, Lusaka. Cell: +260977648098, E-Mail: michelo.mwiinde@spectraoil.com
5. Mr. Exnobert Zulu, Principal Resident Magistrate-Livingstone. P. O. Box, Livingstone. Cell: +260977655566. email: exnobert@yahoo.com