DISTAL FEMORAL FRACTURES

PATTERN AND MANAGEMENT AT KENYATTA NATIONAL HOSPITAL (KNH): A PROSPECTIVE STUDY

DISSERTATION IN PART FULFILLMENT FOR THE AWARD OF MASTER OF MEDICINE DEGREE IN SURGERY OF THE UNIVERSITY OF NAIROBI

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DECLARATION

I declare that this dissertation is my original work and that it has not been presented elsewhere for the award of a degree in any University.

Signed;.....

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DEDICATION

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ABBREVIATIONS

1.	ACL	- Anterior Cruciate Ligament
2.	AO	- Arbeitgemeindschaft fir Osteosynthesisfragen
3.	AP	- Anteroposterior
4.	ARDS	- Adult Respiratory Distress Syndrome
5.	ASIF	- Association for the Study of Internal Fixation
6.	BCP	- Buttressing Conduylar Plate
7.	CBP	- Condylar Blade Plate
8.	CT	- Computerized Tomography
9.	DC - IM	- Dynamic Compression Intramedullary Nail
10.	DCS	- Dynamic Condylar Screw
11.	DFN	- Distal Femoral Nail (a titanium retrograde nail)
12.	ECG	- Electro Cardiogram
13.	GHS nail/GSH nail	- Green, Henry and Seligson nail (a retrograde nail)
14.	G.K. nail	- Grosse Kempf nail
15.	IM nail	- Intramedullary nail
16.	KNH	- Kenyatta National Hospital
17.	KSh. .	Kenyan Shilling, the local currency.
18.	LC - DCP	- Limited Contact Dynamic Compression Plate
19.	LISS	- Less Invasive Stabilization System
20.	MIPPO	- Minimally Invasive Plate Osteosynthesis
21.	MRI	- Magnetic Resonance Imaging
22.	ORIF	- Open Reduction and Internal Fixation
23.	PCL	- Posterior Cruciate Ligament
24.	RFN	- Reamed Femoral Nail
25.	RTA	- Road Traffic Accident
26.	TKR	- Total Knee Replacement

28. UFN - Unreamed Femoral Nail

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SUMMARY

Background.

Distal fractures of the femur affect mainly the young and economically productive age group, hence socioeconomic implications for the patient and their dependants.

Objectives.

The immediate objective of this study was to determine the presentation, management and outcome of patients with these fractures at Kenyatta National Hospital, the teaching and referral hospital located in Nairobi, the capital city of Kenya. The ultimate objective was to provide information that will assist policy makers and surgeons improve patient care and hence reduce the morbidity from this condition.

Study design and setting.

This was a prospective study conducted from August 2003 to January 2004. A total of seventy two patients met the admission criteria and were recruited into the study by convenience sampling. They were followed up in the wards and later in the outpatient clinics. Information on the demographic data, pattern of the injury, management offered and the outcome was gathered and the data obtained processed and analysed.

Results.

The mean age was thirty six years. Seventy five per cent were males and thirty nine per cent were in active employment. The most common causes of trauma were road traffic accident (42%) and gun shot (25%). Associated injuries were common (66.7% of the patients).

Plain X-ray was the main diagnostic investigation used. Sixty nine per cent

had type A, eight per cent type B and twenty two per cent type C fractures according to AO classification. Thirty one per cent had open fractures.

Most of the patients were offered conservative treatment in the form of skeletal traction and only 5.5% had operation with no initial traction. The overall mean hospital stay was fifty five days. The means for different treatment groups of patients were 49 days for conservative group, 67.5 days for those undergoing both treatments and 37.5 days for operation – only.

Complication rates for different groups of patients were 50% for operation - only, 100% for conservative - only and 60% for both treatments. The most common complications were knee stiffness (74.2%), mal-union (30.6%) and infection (20.8%).

Conclusion and recommendation.

This study revealed that most patients with this injury underwent conservative treatment with very high complication rates. Operative treatment is the most cost effective form of management of distal femoral fractures and is thus recommended.

INTRODUCTION

Distal femoral fractures can be classified anatomically as supracondylar extra-articular and condylar intra-articular fractures, and also as pure traumatic and pathological fractures. They can be transverse, spiral or oblique; closed or open fractures; simple or complex comminuted fractures.

These fractures have posed considerable therapeutic challenges throughout the history of fracture treatment [1]. Since operative treatment has become a standardised procedure, it is now recommended worldwide. Condylar blade plate or dynamic condylar screw has been the most frequently used implant for the treatment of distal femoral fractures [2]. The same trend has been seen in Kenyatta National Hospital with more cases being managed operatively unlike in the past when conservative management by traction was the rule rather than the exception. These changes have been attributed to the need of achieving patient function, and not just bone union, as the most important outcome measure. The slogan "movement is life" was adopted by the Arbeitgemeindeschaft fir osteosynthesisfragen (AO) group who initially advocated surgery using rigid blade plates to permit early movement [3]. At the same time there has been an increase in the availability of equipment and the number of specialists in this field, enabling more surgical procedures to be performed with fewer complications and overall satisfactory results.

LITERATURE REVIEW

BACKGROUND INFORMATION

Anatomical reduction, stabilis
ation, early weight bearing and short hospital stay are the major goals of fracture management. In the last two decades, there have been major changes in the management of lower limb long bone fractures. Where resources permit, surgical management of femoral fractures has become routine and skeletal traction should now rarely be used.

As in other branches of surgery, orthopaedic surgeons have adopted minimal access techniques with improved preservation of soft tissues and bone vascularity. Plating gave way to external skeletal fixation and subsequently to interlocking intramedullary nailing. Although Kuntscher invented the interlocking femoral nail, it was collaboration of Klemm & Schellmann[4] and Grosse & Kempf [5] which produced the nails that changed the treatment methods of many surgeons. The nails were passed antegrade into the femur using flouroscopy to reduce the fracture and guide the nail distally. Proximal and distal locking screws were used to maintain length and alignment. To begin with surgeons treated closed femoral fractures only, but the results were so good that they quickly adopted the technique in open fractures. Although this is not yet universally accepted, the use of intramedullary nailing in open fractures is quickly gaining in popularity as studies have shown declining incidences of infection with the technique [6,7]

Despite the advances made in the surgical management of femoral fractures,

the distal fractures still posed considerable therapeutic challenges [1]. Since operative treatment has become a standardised treatment, it is recommended worldwide. In spite of overall improvement of clinical outcome due to an increased number of surgical intervention, the rigid internal stabilisation led to a high incidence of complications, including delayed union, implant failure, and infection [8]. An overall complication rate of approximately 35% was described by Merchant et al [9] in 1992, using AO system of blade plating of closed displaced supracondylar fractures. Angular malreduction was not exceptional despite initial correct reduction [10,11,12]. The eccentric lateral location of the plate [12] and less stiffness of the bone stock in the metaphysis have been discussed to be one reason for malalignment and pseudoarthrosis [1,13]. Moreover, the iatrogenic soft tissue trauma and devascularisation of the periosteum needed to place the extramedullary fixation might play another role in the development of infection and delayed union [1]. Supplemental bone grafting is therefore frequently needed [13].

To reduce the tissue trauma caused by implantation of the extramedullary osteosynthesis, different surgical techniques have been developed. Studies applying transarticular joint reconstruction and minimally invasive percutenous plate osteosynthesis (MIPPO) with indirect closed plate positioning techniques [14] could demonstrate reduced implant failures and wound infections resulting in good functional outcome [1,15]. These techniques were reported to have the advantage of a faster union rate without the need of bone grafting [15]. Moreover, the plating technique was presented as further development of MIPPO in cases of comminuted femoral shaft fractures [1]. The less invasive stabilization system (LISS) has recently been developed to reduce malalignment due to the stable angle between the

condylar screws and the plate during implantation with minimally invasive techniques [1].

Despite placing the plate using a minimally invasive technique, however, the dissection of soft tissue around the fracture site and partial periosteal stripping with loss of vascular integrity still persist, at least in part. Other groups reported that the subsequent failure of the nutritive blood circulation resulted in a high incidence of complications [9,13]. The use of limited contact dynamic compression plate (LC-DCP) leads to an enhanced early restoration of the periosteal blood supply with callus formation, the iatrogenic destruction of soft tissue, however, remaining the major disadvantage of the extramedullary stabilisation technique. The thin cortical bone of the metaphysis also often prohibits the use of extramedullary devices, as they all require good bone stock for screw purchase [1].

The experiences made with intramedullary nailing have been incorporated in the development of fracture treatment of the distal femur. For management of fractures of the distal femur with antegrade nailing it has been shown that the incongruence of the intramedullary canal with the nail tends to dislocation of the fracture even after early start of weight bearing. Special implants and techniques had to be designed for retrograde nailing in order to avoid early axial malalignment, rotational deformities and length discrepancies.

The development of retrograde femur nailing was started to optimise stabilisation in cases where previous hip surgery or proximal femoral fractures precluded antegrade nailing. Since the 1950s, several techniques

have been developed to succeed in stabilising the distal part of the femur, in particular supracondylar fractures [1]. In the late 80s, the GHS nail was introduced by Green, Seligson and Henry with promising results [1,16,17]. The Grosse-Kempf nail proved a suitable alternative in the stabilisation of distal femoral fractures [18]. Retrograde nailing was also performed by Sanders et al in the early 90s using an AO universal femur and tibia nail [1]. A newly designed retronail, the so-called supracondylar intramedullary nail, offered the opportunity to stabilize supra or intercondylar intraarticular fractures [19].

The first clinical results with the new implants were promising. The authors advanced the nails through the medial condyle of femur taking care not to injure the femoral articular cartilage. The extraarticular entry point of the nail reportedly tended to iatrogenic fracture while being introduced in the medullary canal [1]. An increased number of malreductions were reported following insertion of the nail via an extra articular approach. To avoid complications of malreduction and iatrogenic fractures, the intra articular approach was developed [20]. Moreover, the still existing unfavorable incongruence of the implant with the wide intramedullary canal of the distal femur revealed the need for a new specially designed implant. The nails reported above also required reaming which is known to be one reason for pulmonary complications due to bone marrow embolism, especially in the multiply injured patient with chest trauma [1,21].

Owing to the great demands made on retrograde nailing of the femur, several groups and companies have developed specific nailing systems. The titanium distal femoral nail (DFN), for example, has been developed on the

basis of the unreamed femoral nail (UFN) [22]. This nail allows stabilisation of complex supra- and bicondylar fractures without the need for reaming [8,23]. Pulmonary complications in multiply injured patients are thus minimized. Titanium nail also reduces the incidence of infection, assumed when using intramedullary steel implants. It offers specific interlocking technique with proximal and distal screws and distal spiral blade that reduces the danger of malalignment in the case of less bone quality [23].

A lot of study is still needed in the management strategies for distal femoral fractures. Despite the favorable results of studies carried on DFN, further work in this area has shown contradicting results. Bosse JM [24] in 1997 compared multiply injured patients in two level-1 trauma centers in the USA retrospectively. One center favoured plating while the other preferred intramedullary femoral nailing with reaming. Patient populations were similar and the conclusion was that the use of reamed intramedullary nailing in multiply injured patients who had a thoracic injury, did not appear to increase the occurrence of ARDs, pulmonary embolism, multiple organ failure, pneumonia or death! The technique of retrograde femoral nailing became popular in the USA following work by Sanders R and Koval KJ [25] in 1993, but it has not achieved the same popularity in Europe, where many surgeons believe that an intraarticular entry point should only be used if an extraarticular point of entry is impossible. There are potential hazards with retrograde femoral nail as in placing anteroposterior proximal screws in the area of the femoral neurovascular bundle and the obvious problem of making a large bone defect inside the knee joint. Clearly, these patients may well develop knee problems in the long term although there is, as yet, no evidence of this occuring. Court-Brown CM and Will E [26] showed that patients treated with unreamed nails had a significant longer union time, a

higher incidence of non-union, a higher rate of screw breakage and a significantly greater number of secondary procedures than patients treated with reamed nails. Tornetta and Tiburzi [27] have recently shown similar findings in the femur. This could be a disadvantage of DFN and therefore more comparative trials examining antegrade and retrograde nailings are required before retrograde nailing of isolated distal femoral fractures can be advocated.

It is therefore not surprising that most centers still recognise plate osteosynthesis as the treatment of choice for distal femoral fractures [28] and focussing on "biological fixation" with dynamic condylar screw, condylar blade plate (95 degree angle plate) and condylar buttress plate. Kenyatta National Hospital falls in this class of management of the distal femoral fractures.

In 1989 at Chirurgie University Clinic, Austria, Siliski J.M [29] carried out a study on fifty two patients with distal femoral fractures twenty to one hundred and twenty months after injury. All the fractures were treated with internal fixation using ASIF interfragmentary plates and screws and the results were: average time for return to full weight bearing was 13.6 weeks, average final arc for knee motion was 107°. Two amputations and one arthrodesis were done to treat infection: age did not influence the final results although elderly patients had a longer period of hospitalization. In 1994 at Marburg University in Phillipines, Baumgaertel F; Gotzen L [30], in their prospective study of 24 patients with distal femoral fractures treated with indirect reduction and internal fixation with a condylar plate or a condylar buttress plate, gave the following results: Most fractures were

comminuted (5 type A, 10 type B and 9 type C of A.O. classification); the average age of the 14 men and 10 women was 46 years (16 - 96); in 4 cases the fracture was open; secondary bone grafting was necessary in 2 patients while one had delayed bone union and required interlocking nailing; there were no refractures and no implant failures; in 2 patients varus deformity under 10° were present after completion of bone healing; full weight bearing commenced at 14.2 weeks and bone healing time was 18.7 weeks.

PERTINENT SURGICAL ANATOMY

EMBRYOLOGY

The whole femur ossifies in cartilage. Primary center in the shaft appears at the eighth week of intrauterine life. Center for lower end appears at the end of the ninth month and its presence is accepted as medicolegal evidence of maturity. This is the growing end of the bone and the epiphysis, which bisects the adductor tubercle, unites with the shaft after 20 years [31].

GROSS ANATOMY

Lower extremity of the femur carries the two condyles, separated behind by an intercondylar notch but joined infront by a trochlear surface for the patella. They are joined below the popliteal surface of the shaft, by an intercondylar ridge that encloses the intercondylar fossa. Just above this ridge, the capsule and oblique popliteal ligament of the knee are attached in the fossa, the cruciate ligaments are attached in smooth surfaces: the anterior

cruciate ligament far back on the medial surface of the lateral condyle, the posterior far forward on the medial condyle.

The condyles are easily felt medially and laterally, and the adductor tubercle is the guide to the epiphyseal line at the lower end of the femur. The articular margin of the trochlea and the distal surfaces of the condyles are palpable if the knee is flexed. This area of the femur consists mainly of cancellous bone and very thin cortical bone stock.

When viewed in cross section, the shape of distal femur resembles a trapezoid with the medial side inclined about 25 degrees. Both the seating chisel and subsequent blade plate should be 1cm to 2cm short of the medial cortex. This is due to trapezoidal shape of the femoral condyles, which are narrower anteriorly than posteriorly. Posterior diameter is longer than the anterior; therefore a plate, which appears to be just the right size on an AP view X-ray, will be too long and penetrate the cortex and protrude medially. Correct length is 15-20mm less. The anterior surface slopes downwards to the medial side and corresponds in inclination to the patello-femoral joint. (Care must be taken therefore that any device inserted is parallel to this inclination or it will end up in patello-femoral joint). When the distal femur is seen in the lateral view, femoral condyles appear to have been added on the posterior aspect of the distal femur; therefore the target of the plate insertion is in the middle of the interior half of the condyles.

There are important structures surrounding the distal femur. Posteriorly, there are neurovascular structures consisting of popliteal vessels, tibial nerve and common peroneal nerve. The popliteal vessels are separated from the

bone distally only by the knee joint capsule and oblique popliteal ligaments; hence displaced

supracondylar fractures can easily lacerate them. Medially and proximally, the neurovascular bundle consisting of femoral vessels and the nerve to the vastus medialis. This can be injured during an attempted medial exposure. The area is well vascularised from the anastomotic arterial network formed by the genicular branches of the popliteal artery and descending genicular branches from the profunda femoris artery. There is a tendency to excessive bleeding during surgery if this is not kept in mind and thorough haemostasis observed [32].

PATHOGENESIS

MECHANISM OF INJURY

These fractures are usually caused by axial loading on a flexed knee. The force can be direct or indirect. In a non-diseased femur, tremendous force is needed to cause a fracture [33]. There is a bimodal distribution of the fractures: Low energy fractures involving older women who usually have severe osteoporosis and High energy fractures involving younger healthy males.

AETIOLOGY

Direct or indirect trauma, osteoporosis, lytic lesions like malignant melanoma, Pagets disease and bone cysts, and chronic stress are common

causes of the injury.

ASSOCIATED INJURIES

Distal femoral fractures usually occur in association with other injuries around the knee. In severe trauma, multiple injuries may be sustained involving the pelvis, spine, chest, head, and abdomen and hence these should always be looked for in such patients. Common association occurs with fractures of other bones around the knee and together these are classified as "fractures of the knee". Ligament and neurovascular injuries can also be associated [32,34].

In summary fractures of patella, tibial plateau, tibial spine, tibial tubercle, femoral shaft, femoral neck, and pelvis should be ruled out in all cases of supracondylar femoral fractures. Knee ligament injuries are usually associated in 20% of cases of distal femoral fractures. Most commonly affected is the anterior cruciate ligament followed by medial collateral ligament. Vascular injury is seen in 2-3% of the cases, and usually involves the popliteal artery [35].

CLASSIFICATION

AO classification of Muller is the most commonly used system [35] and is summarized below:

A - Extraarticular.

A 1: - Non-comminuted.

A 2: -Single comminution.

A3: - Multiple comminutions.

B:-Unicondylar fracture.

-Subdivided into:

B_1-Lateral condyle sagittal.

B_2-Medial condyle sagittal.

B_3-Coronal or Hoffa fracture. This is of special importance since only soft tissue attachment is the posterior capsule and behaves like a large loose fragment in the joint.

C:-Bicondylar fracture.

This is described as noncomminuted supracondylar (T or Y fracture) or comminuted.

C_1-Simple T or Y fracture.

C_2-Additional supracondylar comminution.

C_3-Additional intra-articular comminution.

With type C_3 : Note that the condylar blade plate may be contraindicated; Consider instead a buttress plate. There is need to restore condylar width, hence consider avoiding lag screws, and always consider need of bone graft.

PATHOPHYSIOLOGY

Distal femoral fractures result from significant force transmitted by a direct blow or from indirect force transmitted at the knee, usually in a flexed position. Pathological fractures may occur with relatively little force. This may be the result of bone weakness from osteoporosis or lytic lesions.

Fracture fragments may be displaced and lead to kinking or tear of the popliteal vessels and anastomotic arterial network around the knee with

severe haematoma formation and hypovolemic shock. Up to two litres of blood can be lost into the thigh. Compound fractures have an even higher potential for blood loss.

DIAGNOSIS

HISTORY

Patients with distal femoral fractures may have a history of significant force applied to the extremity, significant pain and deformity, axial loading with valgus or varus stress and they may be unable to ambulate.

PHYSICAL EXAMINATION

A thorough examination needs to be conducted to rule out associated injury. Hip fractures, diaphyseal fractures and ligamentous knee injuries are commonly associated. General and systemic examination of the patient should be performed to rule out life threatening injuries.

At the site of the injury, tenderness on examination and visible deformity are noted. Extremity may appear shortened and crepitus may be noted with movement. The thigh and knee are often swollen secondary to haematoma formation.

Thorough vascular examination on the extremity should be performed. Signs of vascular compromise should prompt arteriography and vascular surgery consultation [35]. Physical signs of arterial injury include expanding haematoma, absent or diminished pulses and progressive neurological deficit in a closed fracture.

At the end of the local examination, vital signs (pulse rate, respiratory rate, blood pressure, and body temperature), edema, open wounds, echymosis, deformity, limb shortening, point tenderness and effusion should have been assessed. Crepitus is not always tested for due to the pain it elicits.

DIFFERENTIALS

These include dislocation of the knee, fractures of the femoral diaphysis, tibia/fibula fractures, ligamentum knee injuries, meniscal knee injuries, Osgood-Schlatter disease, and trauma with peripheral vascular injuries.

WORK UP

IMAGING STUDIES

(a)Radiographs

At least 3 views including anteroposterior, lateral and oblique radiographs of the knee should be taken. The fat fluid level may be identified on a lateral view of the knee; this finding (lipo haemarthrosis) indicates an intraarticular fracture. Oblique views are particularly useful in detecting subtle tibial plateau fractures, which may be associated; lateral plateau fractures more

commonly than the medial plateau. A tunnel or intercondylar view provides a clear view of the intercondylar region. Additionally, a sunrise (i.e skyline, axial, tangential) view of the patella is useful for detecting vertical patella fractures, which are frequently missed if none displaced. Radiographic evidence of ligamentous injury may be present. An avulsion fracture at the site of attachment of lateral capsule ligament on the lateral tibial condyle (Segond fracture) is a marker of anterior cruciate rupture. Cortical avulsion fracture of medial tibial plateau (uncommon) is associated with tears of the posterior cruciate ligament and medial meniscus. Use of Ottawa rules for obtaining knee radiographs have proven sensitive for fracture and have reduced emergency department waiting times and costs [36]. The rules include, age 55 years or older, tenderness at head of fibula, isolated tenderness of patella, inability to flex knee 90^0, and inability to bear weight (4 steps) immediately after injury and in emergency department.

(b)**CT Scans and MRI.**

CT scans may be done to fully delineate the extent of intraarticular fractures,for example, in elderly patients who sustain low energy fractures with intra articular component. MRIs are also useful and have the added advantage of depicting associated soft tissue (e.g. ligamentous, meniscal) injury.

PROCEDURES

Arthrocentesis may be of diagnostic and therapeutic benefit for tense effusions. Presence of blood and glistening fat globules indicates lipohaemarthrosis, which is pathognomonic for intra articular knee fracture.

LAB STUDIES

Non specific lab studies are indicated. In patients with expanding haematoma, serial haematocrits and group and cross match of blood is required. Before open reduction and internal fixation (ORIF), ECG, chest x-ray and other tests as per the findings should be done.

TREATMENT

PRE HOSPITAL CARE

Documentation of the neurovascular status, application of a sterile dressing on open wounds and splinting of the injury should be done. Airway, breathing and circulation (A, B, C) should be assessed and secured for the severely injured patient as these take precedence over the specific fracture care. Parenteral analgesics should be administered for isolated extremity fracture.

EMERGENCY DEPARTMENT CARE

Reassessment and securing airway, breathing and respiration (A,B,C) should always be done. External bleeders are stopped with point-pressure bandage and intravascular volume replenished by giving intravenous fluids appropriately. Grouping and cross matching of blood is done for those who may require transfusion. All distal femoral fractures must be referred to orthopaedic-trauma surgery unit, or appropriate surgical personnel, for definitive management. Pain management should be ensured and infection prophylaxis given for all those with open fractures. Use of antibiotics with good activity against staphylococcus and good tissue penetration is

recommended until the danger of infection has passed, usually for 48 hours [37].

MEDICATION

Drugs used in fractures are generally analgesics, nonsteroidal anti-inflamatory agents, anxiolytics and, in open fractures, antibiotics.

DEFINITIVE CARE

It is now universally believed that where resources permit, surgical management of fractures of distal femur should be offered. However, there are cases when operative management is neither favourable nor possible, and therefore we hereby describe both operative and non operative management of these fractures.

Non operative treatment of supracondylar femoral fructures.

There are few indications for this, except in the elderly and osteoporotic patients with low energy extraarticular fractures, forming only a small percentage of patients [35]. These fractures have a high rate of hardware failure with operative treatment. Unfortunately, non-operative treatment in elderly patients can also be associated with high incidences of cardiopulmonary complications.

What is recommended in this type of management is dynamic traction through proximal tibial pins with the knee kept at 20-30 degrees of flexion.

A hinged knee brace and knee flection can be initiated when the fracture becomes sticky. Seven to ten degrees of saggital-coronal plane angulation can be accepted [35].

Operative treatment

(1) Surgical approaches

The lateral approach to the distal femur is preferred by most surgeons.
A lateral incision is made and the implant is placed laterally under the vastus lateralis or by reflecting the vastus lateralis muscle anteriorly. A modified anterior approach to the distal femur is useful for intra-articular supracondylar femoral fractures. A standard midline anterior knee incision is made, fascia over quadriceps split longitudinally and dissection continued laterally between the fascia and the quadriceps. Vastus lateralis is reflected medially and perforating vessels are cauterised. A side plate can be passed underneath the muscle.

(2) Types of fixation implants.

The commonly used devises are, 95 degree condylar blade plate.(CBP), 95 degree dynamic screw and side plate (DCS), condylar buttress plate(BCP), intramedullary nails for supracondylar fractures (IM), and dynamic compression intramedullary nail (DC-IM) which has the advantage of distal compression interlocking screw.

95^0 Condylar Blade Plate (CBP)

It consists of a single piece fixed angled blade plate. Provides stronger

fixation than 95-degree condylar screw. When done, it is under tension and subject to load sharing rather than load bearing. Provides distal femoral angle of 99 degrees. Can be used to bypass a point of comminution and act as an internal splint.

Advantages:

It provides more stability for short distal fragments than dynamic condylar screw (DCS) and allows fixation of low supracondylar fractures (fractures must be at least 2cm above the joint) as compared to 95 degree condylar screws (which cannot be used if the fracture is within 4cm of the joint).

Disadvantages and contra-indications:

The main technical difficulty is that it must be correctly positioned in 3 planes whereas the DCS needs only to be positioned in 2 planes. Even with correct starting hole for the chisel, the plate may still diverge off the femur, if rotation of the chisel is not taken into account.

It is poor choice in comminution extending proximally into the femoral shaft and fractures with a coronal split (Hoffa extension).

95 degree Dynamic Condylar Screw and Side Plate

This can be used with comminution extending to the femoral shaft. Ninety five degree angle is used to reconstruct the femoral axis (line form the femur to the vertical from the ground, approximately 6-7 degrees).

Characteristics:

It has two holes closest to the barrels that accept 6.5mm cancellous screws.

More proximal plate holes accept 4.5mm cortical screws, which can be applied in compression. Plate length usually ranges from 6-16 holes. Lag screws are available from 50mm to 145mm.

Disadvantages.

It doesn't provide good stability for short distal fragment, hence attempt should always be made to insert additional screws through the side plate into the distal fragment. Screws cannot be placed in relatively low supracondylar fractures (those that lie within 4cm of the joint line).

Surgical strategy:

Condyles are temporarily reduced with K-wires. Once the condyles are anatomically reduced and fixed with screws, it is then necessary to realign the condyles to the shaft. This can be performed by clamping the condylar pin insertion jig to the femoral shaft. Visually and radiologically confirm that the fracture is reduced and has proper rotation. Temporary K-wires are placed as guides to DCS insertion: One parallel to the inferior aspect of the knee across (medial and lateral condyles), one across anterior patello femoral joint (Sloping from anterior to posterior parallel to the condyles), one summation guide wire which identifies the starting chisel or tripple reamer in anterior half of femoral condyles.

Prior to dynamic screw insertion, intra articular fragments are secured with cannulated 6.5mm screws. These are inserted outside of the dynamic screw insertion site. Guide wire is inserted 2cm above the femoral joint surface and must be oriented parallel to the summation guide. Depth of guide wire is measured and 15 to 20mm of length subtracted (due to the trapezoid shape of the condyles). The

reamer and bone tap are applied, followed by the dynamic screw. At least one additional screw should be inserted in to the distal fragment in order to gain rotational stability.

The 95 degree condylar plate is seated over the screw using the circular imparcter. The lateral condylar cortex may be chiseled to further seat the plate on the bone. It is necessary to achieve eight solid cortices of fixation (4 screws) above the fracture. After achieving fracture reduction (with reduction clamps), reduction is checked on a lateral view.

The devise is contra-indicated Hoffa extension (AO type B-3 fracture).

Condylar Buttress Plate (BCP)

This is a broad cloverleaf shaped plate, which is designed to buttress comminuted supracondylar fractures. It may be especially indicated for comminuted distal fractures with a coronal shear fracture (Hoffa fracture). The plate is designed to contour to the lateral aspect of the distal femoral cortex

Indications:

These include comminution involving the lateral femoral condyle , multiple intra-articular fracture in the coronal or sagittal plane and any corona plane fracture. If there is coronal plane fracture, the only device that can be used with any reliability is condylar buttress plate. When comminution is severe, a medial buttress plate is

required to prevent varus settling of the fracture. If there was a coronal split fracture (or a fracture within most distal 2cm of femur), neither a blade plate nor a distal condylar screw will attain sufficient purchase in the

reconstructed condyles.

Disadvantages and complications:

Screws passing through the distal drill holes do not have a fixed relationship with the plate, hence plate may create a distraction or compression force producing a varus or vlgus deformity respectively. Screw head - plate junction is not rigidly locked and thus can slip with early loading of fracture.

Surgical strategy:

Indirect reduction is normally used with femoral distractor. Application of bone graft medially as well as medial buttress plate should always be considered. All type A_2,A_3,C_1,C_2 and C_3 fractures stabilised by plate require bone graft medially.

In the post operative period early weight bearing on unhealed fracture may results in varus deformity. Patients should avoid weight-bearing ambulation until fracture has healed, but early motion of the knee is allowed.

Retrograde Nailing

Several types of nails have been developed for the fixation of distal femoral fractures. Some are used on reamed femur nail (RFN) techniques whereas others are unreamed femur nails (UFN). Notable developments include: GSH (Green, Seligson and Henry) nail -RFN, GK (Grosse-Kempf) nail - RFN, AO universal femur nail -RFN, titanium distal femoral nail (DFN) - UFN, and dynamic compressional 1M nail.(DC-1M)-UFN.

It is now universally believed that the point of entry of the nail should be

intra-articular to reduce the incidences of iatrogenic fractures. Percutenous or open reduction strategy are employed. All retronails have proximal and distal interlocking screws, but the titanium distal femoral nail (DFN) has an additional alternative of a distal spiral blade that reduces the danger of malalignment in the case of less bone quality. Dynamic compression nail has a special distal screw and oval nail hole that enables compression of fracture site.

Complications:

These include secondary femoral fracture which has been documented in numerous case reports [38], anterior knee pain, heterotopic ossifications and intraarticular metallosis. [39].

Indications:

Floating knee, polytrauma with distal femoral fracture (UFN), proximal lower limb fractures with distal femoral fracture, ipsilateral femoral and tibial fractures, and complex supracondylar extraarticular and intraarticular fractures are some of the clear indications. The retronail provides a stable fixation for reconstructed condylar fragments to the femoral diaphysis. Included here are types A, C_1, C_2 and C_3 fractures.

Open Supracondylar fractures

Traumatic wound is nearly always anterior in location, and may have variable degree of damage to the extensor mechanism.

In patients with Gustilo grades I, II or IIIa open supracondylar fractures,

immediate ORIF can be done. For IIIb and IIIc fractures temporary external fixation across knee and delayed ORIF should be considered [6].

Post operative care of distal femoral fractures.

Ninety degrees of flexion in splint for 4 days should be encouraged. There is need to start early motion. Late varus collapse of the knee should be looked for, ambulation is aimed at 2 - 4 days and full weight bearing at 3 - 6 months post operatively. Delayed union is considered as persistent instability 3 - 4 months after injury. More bone grafting may be necessary to salvage inadequate union .

Sagittal alignment of less than 5 degrees antecurvatum or less than 10 degrees of retrocurvatum and frontal plane and rotational alignment of less than 5 degrees is acceptable [35].

Extension contractures are more common with non surgical treatment [40]. They result from both intraarticular adhesions and fibrosis of vastus intermedius that tie down rectus femoris to the anterior aspect of the femur.

Treatment of the contractures include: Quadricepsplasty, intrinsic release (lateral capsulotomy, removal of adhesions from the lateral gutters, suprapatella pouch and under surface of patella), and extrinsic release (release of vastus lateralis from linea aspera and elevation of vastus intermedius from anterior femoral surface).

Three to four months of rehabilitation is required before maximum flexion is reached [41,42].

COMPLICATIONS

Complications of distal femoral fractures may include neurovascular injury-mainly popliteal artery injury due to displaced distal femoral fracture, compartment syndrome of the thigh, soft tissue infection, osteomyelitis or septic arthritis secondary to an open fracture, delayed union or non-union, fat embolism, thrombophlebitis, post traumatic osteoarthritis or adhesive knee stiffness, and chondromalacia patella.

PROGNOSIS

A fair prognosis is expected with early intervention and proper management techniques. Age affects speed and quality of recovery. Patients older than 60years have complication rate of 54% and mortality rate of 17% [33,34].

MEDICAL/ LEGAL PITFALLS

Failure to conduct a careful assessment to exclude other potentially life threatening injuries, to reduce and stabilise angulated femur fractures as soon as possible, to minimize neurovascular injury and haematoma formation, to identify neurovascular injury, to check integrity of and identify injury to extensor mechanism of the knee, and to consider the possibility of child abuse in young children can constitute liability.

STATEMENT OF THE RESEARCH PROBLEM

JUSTIFICATION OF THE STUDY

Trauma remains the leading cause of morbidity in the young and productive age group (ages 1 to 44 years) [35]. Majority of such patients suffer limb injuries. A lot of work has been done elsewhere and locally for such injuries.

At Kenyatta National Hospital, no study concerning the distal femoral fracture has been done and the situation remains unclear. Studies on the proximal femur and femoral shaft fractures have been done and the results generally reflect the trend elsewhere. In 1982, John R. Malibo (KNH), in his dissertation carried out a retrospective study on operative management of femoral shaft fractures by intramedullary nailing. A total of 108 patients were treated by I.M. nailing between January 1975 - December 1980 and his findings were that complication rate was 42% with sepsis contributing 5.6%. Fifty per cent of all the patients who developed osteomyelitis had compound fractures. The average hospital stay was four weeks and the average duration before return to full weight bearing was sixteen weeks. In the same period, Peter Nyarango (KNH), in his dissertation carried out a five year retrospective study on operative management of fracture neck of femur. A total of 122 cases were evaluated. The complication rate was 22.5% with infection contributing 8.5%. The average hospital stay was twelve weeks and return to full weight bearing ranged few months to one year. No mortality was reported in both studies. A lot must have changed in the last two decades. Because of this, a study of this injury is expected to reveal the

current situation in Kenyatta National Hospital, form a basis of further work on the subject and by comparing the outcome of the different management strategies, help the surgeons and policy makers effect improvement in patient care and hence reduce the morbidity from this condition.

STUDY OBJECTIVES

Broad Objectives

To determine the presentation and management of distal femoral fractures at Kenyatta National Hospital.

Specific Objectives

(a)To identify the demographic characteristics of individuals with distal femoral fractures.

(b) To identify the aetiology of distal femoral fractures.

(c) To identify the laboratory and radiological procedures used in the investigations of the injury.

(d) To identify the treatment methods of the injury and their complications.

(e)To determine the difference in hospital stay and bill between the treatment groups.

METHODOLOGY

STUDY DESIGN

This was a prospective cross-sectional study involving all cases seen between 14 / 08 / 2003 and 31 / 01 / 2004 when the study was in progress. All patients undergoing treatment for distal femoral fractures were considered for the study and were followed up for a minimum of eight weeks from the time of injury and / or until radiological evidence of bone union is observed.

STUDY AREA

Kenyatta National Hospital (KNH): The national teaching and referral hospital located in Nairobi, the capital city of Kenya.

STUDY POPULATION

All patients diagnosed to have distal femoral fractures and received treatment at KNH. The patients were required to satisfy the eligibility criteria below.

MINIMISATION OF ERRORS AND BIASES

This was achieved by adoption of inclusion and exclusion criteria (eligibility criteria).

The inclusion criteria:

All patients attended to at KNH within the period of the study with a radiological diagnosis of distal femoral fractures.

All patients who had any of the management strategies as a definitive treatment for the disease in KNH and had a diagnosis done outside the institution, so long as definitive management was not offered there.

The exclusion criteria:

All patients who did not undergo the definitive management procedure in KNH and were being followed up in the institution.

Patients who for their own reasons, declined the treatment indicated for the condition and hence offered alternative treatment not favoured by the surgeons.

Patients who declined to consent for the study.

ETHICAL CONSIDERATION

The proposal was submitted to the KNH Ethics and Research Committee for approval. All the data was treated in a strictly confidential manner. All questionnaires and entry tables did not bear the names or ethnicity of the patients but were identified by serial numbers. Patients' identity was not revealed to unauthorised persons.

SAMPLING

Sampling unit

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

Sample size

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

$$nf = n\,[1+n/N]$$

Where : nf = The minimum desired sample size.

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

n = **385**, given a degree of accuracy of 0.05 [see below]

The calculations were done as follows:

$$n = \frac{1.96 \times 1.96 \times 0.5 \times 0.5}{0.05 \times 0.05}$$

$$= 385$$

N = **62** (an average of **61** cases in the year 2001 and **63** cases in 2002, from KNH statistics office)

Hence,

$$nf = \frac{385}{1 + 385/62}$$

$$= \underline{53} \quad \textbf{(the minimum desired sample).}$$

DATA COLLECTION, PROCESSING AND ANALYSIS

Instruments

Structured researcher administered questionnaire

Personnel

The study was by the investigator himself under the guidance of the supervisor.

Processing and analysis

The data was derived from the patients' records using a data collection form, carefully monitored and entered into a computer. Analysis using 0.05 degree of accuracy and 95% confidence interval was carried out by SPSS version 10.0 to derive descriptive characteristics and frequency distribution of the study population. Statistical significance was determined by use of Chi square analysis wherever is appropriate.

PRESENTATION OF RESULTS

Following the analysis of the data, the results were presented in tabular and graphical forms, with use of bar and pie charts.

RESULTS

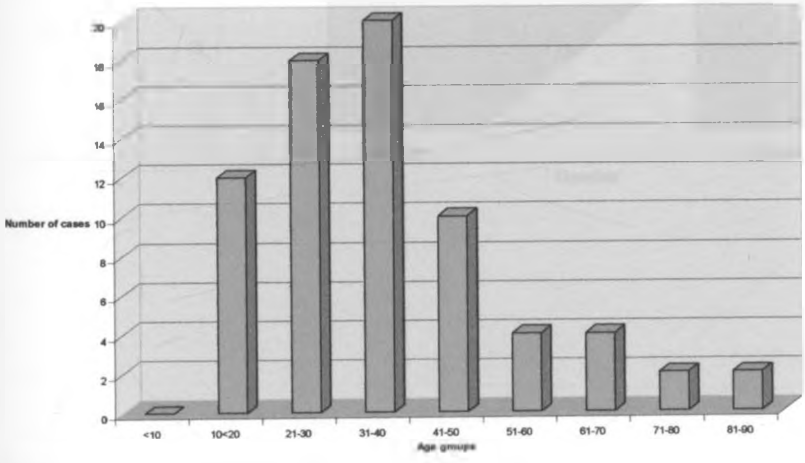
A total of seventy two patients satisfied the admission criteria and were recruited into the study. They were all admitted through the accident and emergency department of Kenyatta National Hospital.

DEMOGRAPHIC CHARACTERISTICS

AGE DISTRIBUTION OF DISTAL FEMORAL FRACTURES.

The age range was thirteen to eighty six years with a mean of thirty six and a median of thirty two years. The following age groups and bar chart illustrate the age distribution (figure 1).

Figure 1: Bar chart illustrating age distribution.

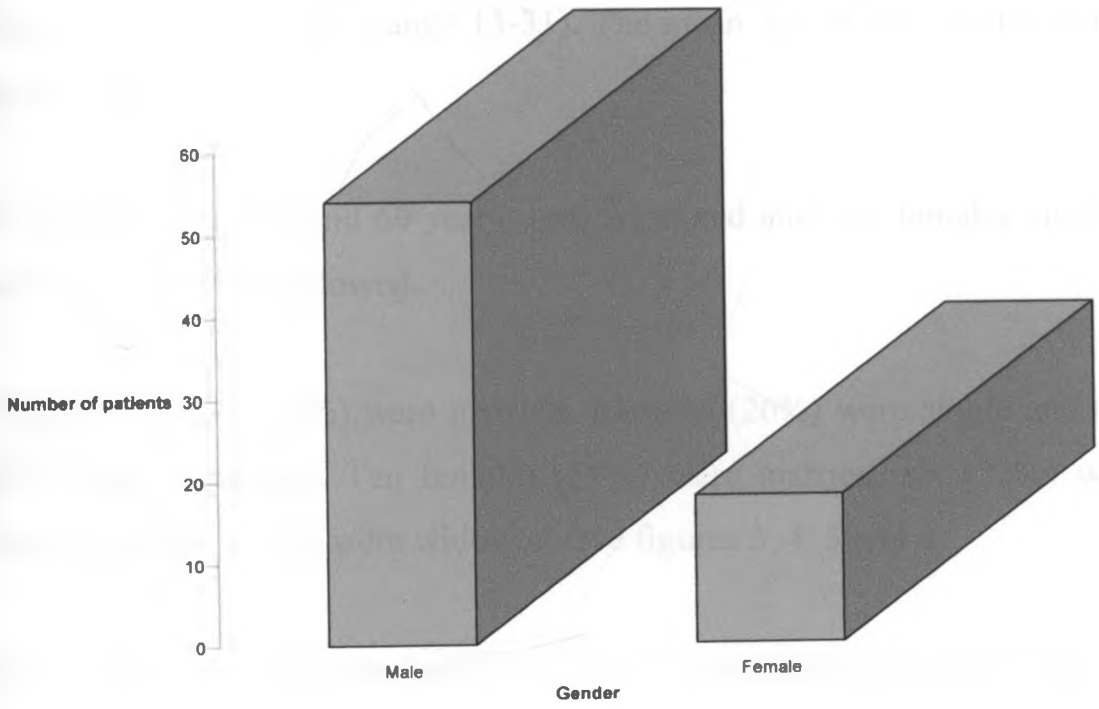


Fifty two patients (72.2%) were in 21-60 years age bracket, the economically active age group.

SEX DISTRIBUTION OF DISTAL FEMORAL FRACTURES.

There were fifty four (75%) males and eighteen (25%) females in the study population, giving male to female ratio of 3:1 (figure 2).

Figure 2: Bar chart to illustrate sex distribution.



MARITAL STATUS

Forty six (64%) patients were married. Two (3%) declined to state their marital status.

Of those who were married, the mean age was 41 years (range 20-86). Thirty six (78.2%) of them were male with mean age of 38.6 years (range 20-64). The Females had a mean age of 49.8years (range 30-86).

Twenty patients (28% of the study population) were single with a mean age of 19.8years (range 13-31). Among them, fourteen (70%) were male with a mean age of 19.8 years (range 13-31). The mean age of the females in this group was 19 years.

Two males aged 58 and 60 years were separated and two females aged 70 and 82 years were widowed.

Thirty six males (67%) were married, fourteen (26%) were single and two (4%) were separated. Ten females (55%) were married, six (33%) were single and four (22%) were widowed. See figures 3, 4, 5 and 6.

Forty out of the sixty two (64.5%) below 55 years were married, thus the injury has great socioeconomic effect on the nuclear family.

Figure 3: Bar chart to illustrate marital characteristics.

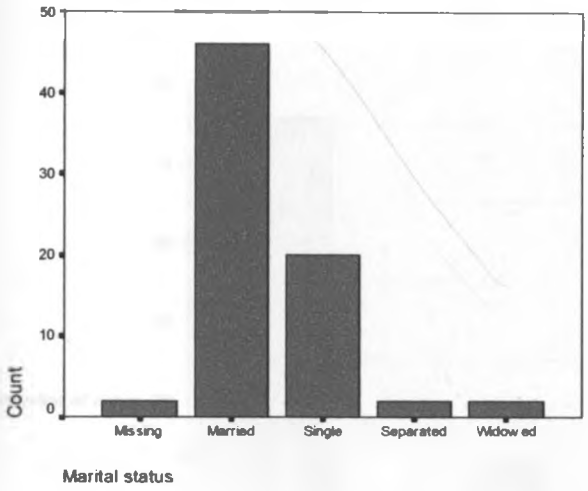


Figure 4: Bar chart to illustrate age groups and married / single status.

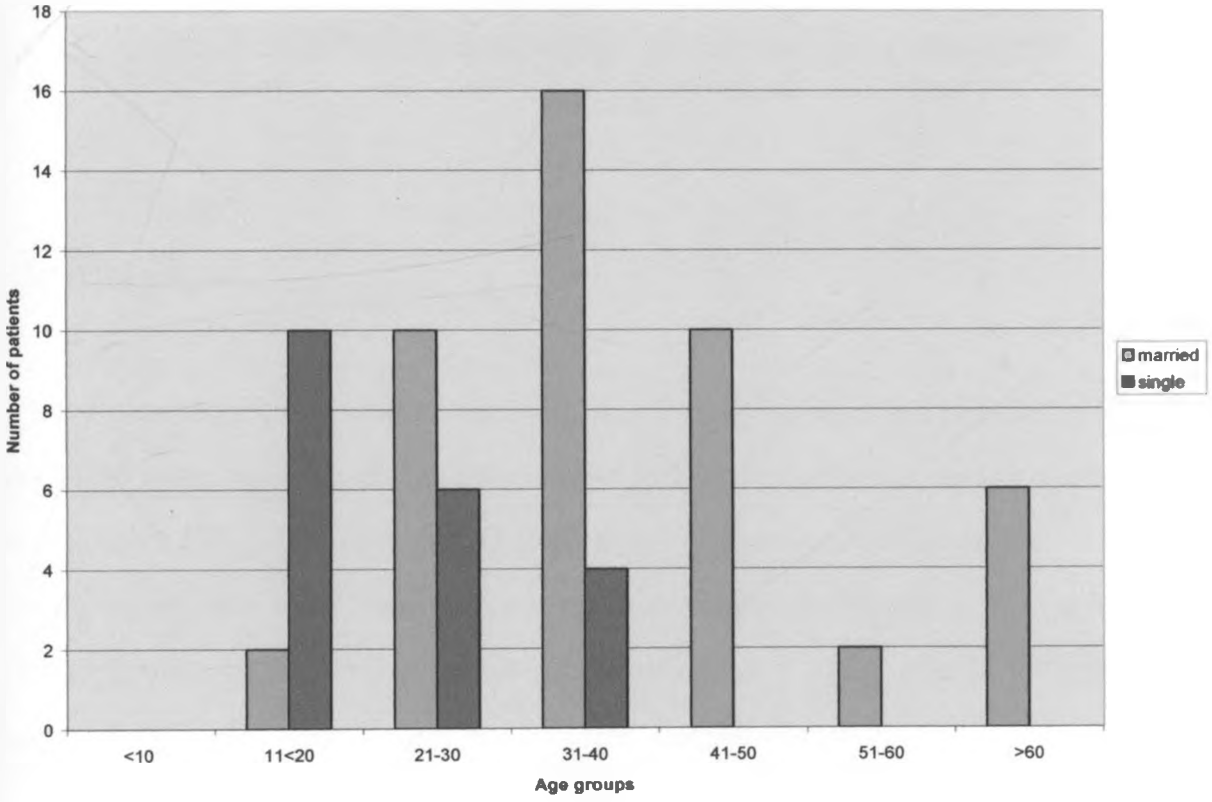


Figure 5: Bar chart to demonstrate gender and marital status

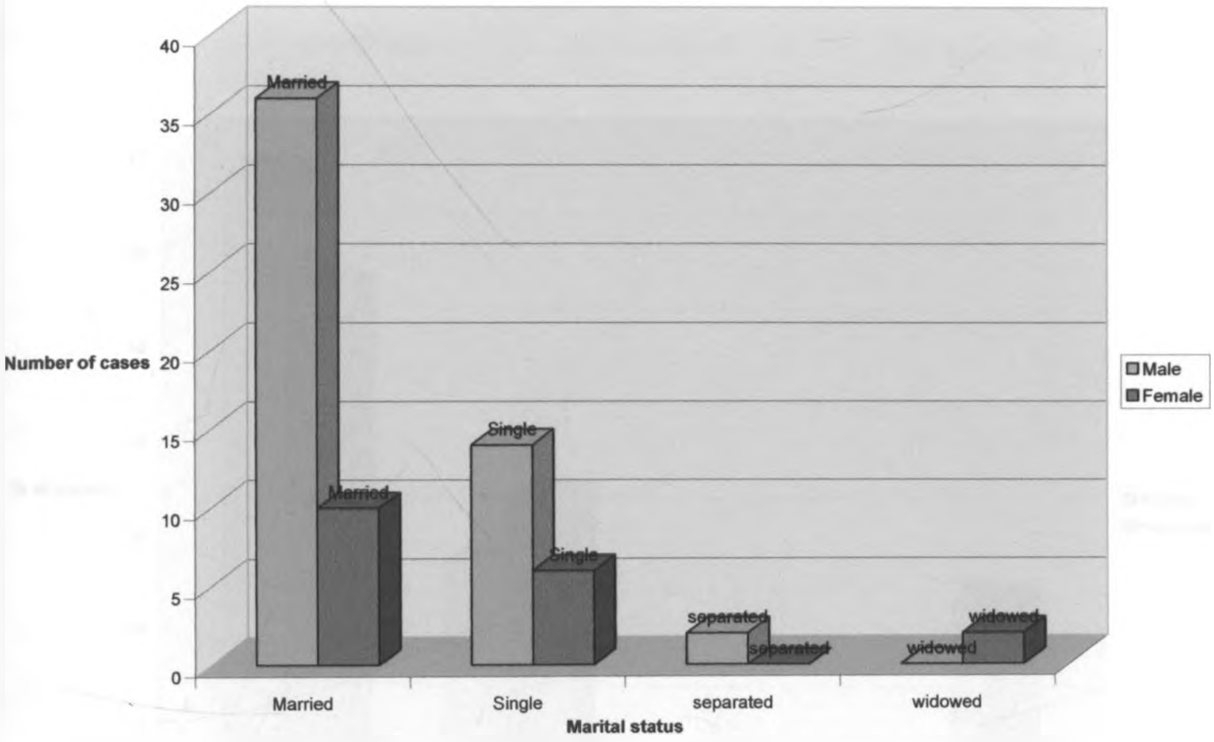
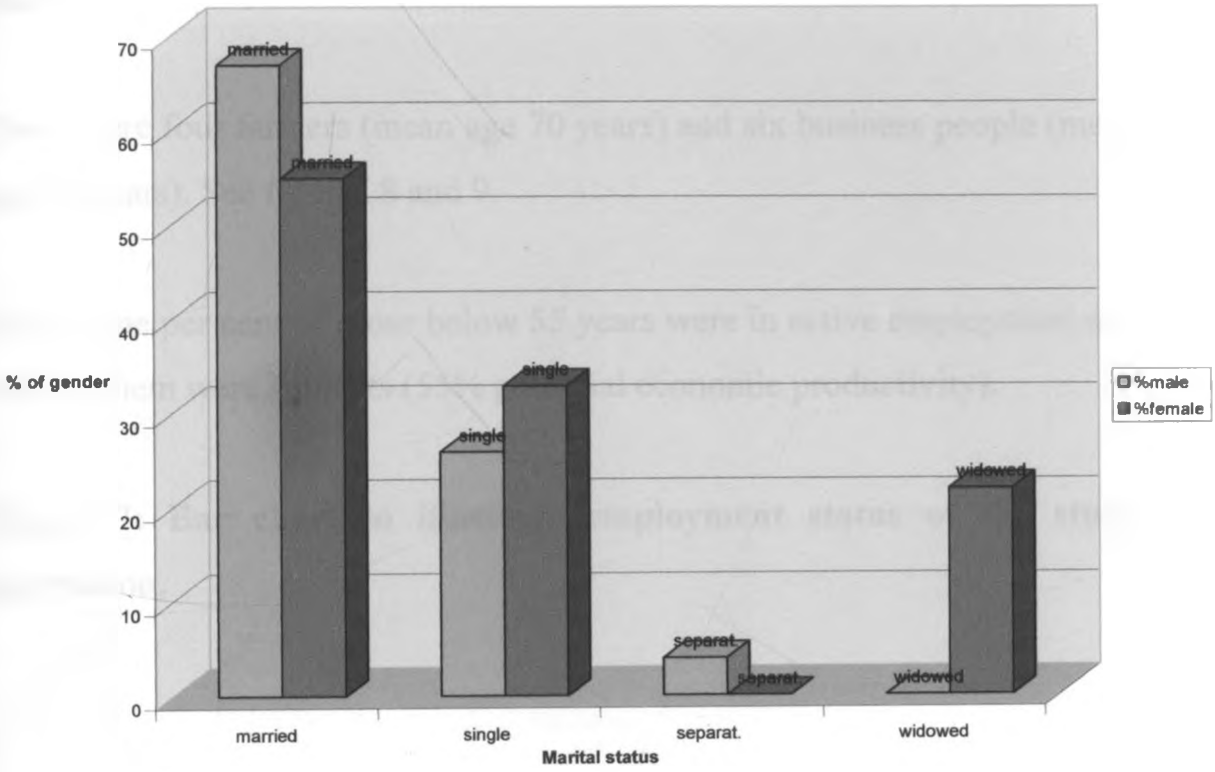


Figure 6: Bar chart illustrating percentage gender distribution along marital lines.



OCCUPATION

Of all the seventy two patients studied, thirty two (44%) were unemployed, ten (14%) were students and twenty eight (39%) were in active employment. Two of them (3%) declined to give their employment status (figure 7).

Among those who were unemployed, the mean age was 38 years (range 18-86) and twenty two (69%) of them were male with a mean age of 33 years (range 18-48). The mean age of the females was 50 (range 30-86).

Those who had salaried employment were eighteen (25%) with a mean age of 36 years (range 26-57). Sixteen (89%) of them were male.
The students had a mean age of 15 years (range 13-23). Six of them were male.

There were four farmers (mean age 70 years) and six business people (mean age 43 years). See figures 8 and 9.

Thirty nine per cent of those below 55 years were in active employment and 16% of them were students (55% potential economic productivity).

Figure 7: Bar chart to illustrate employment status of the study population.

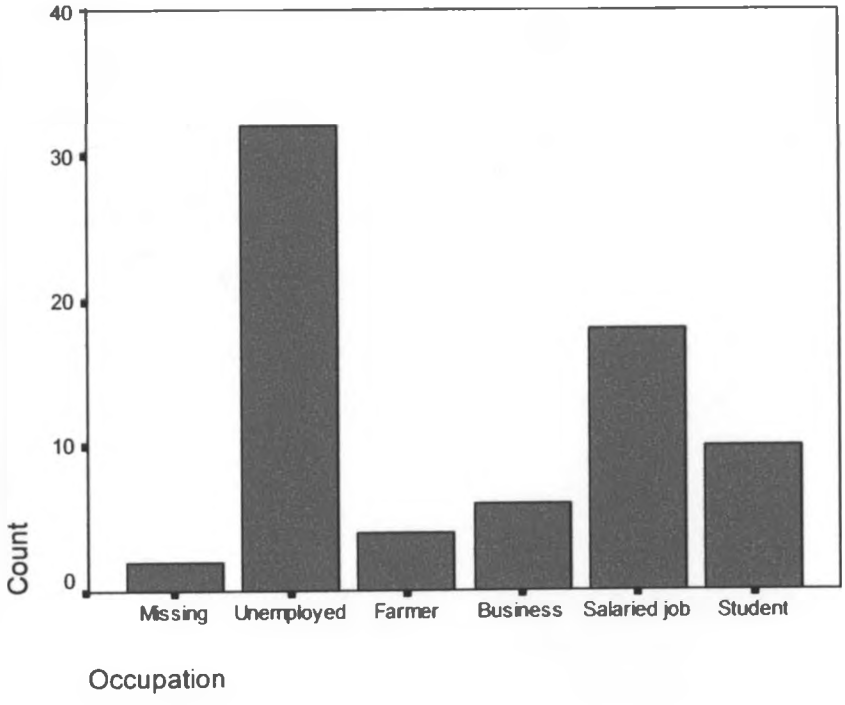


Figure 8: Bar chart illustrating age groups and employment status of the study population.

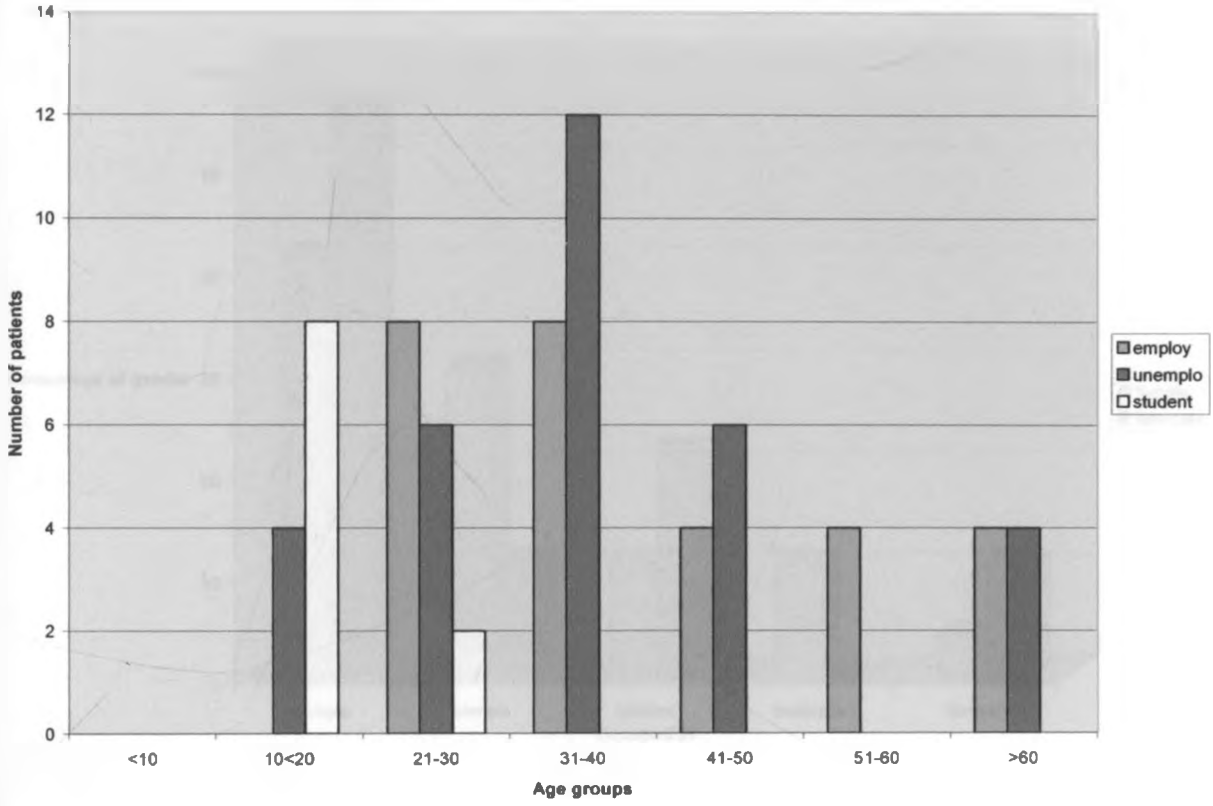
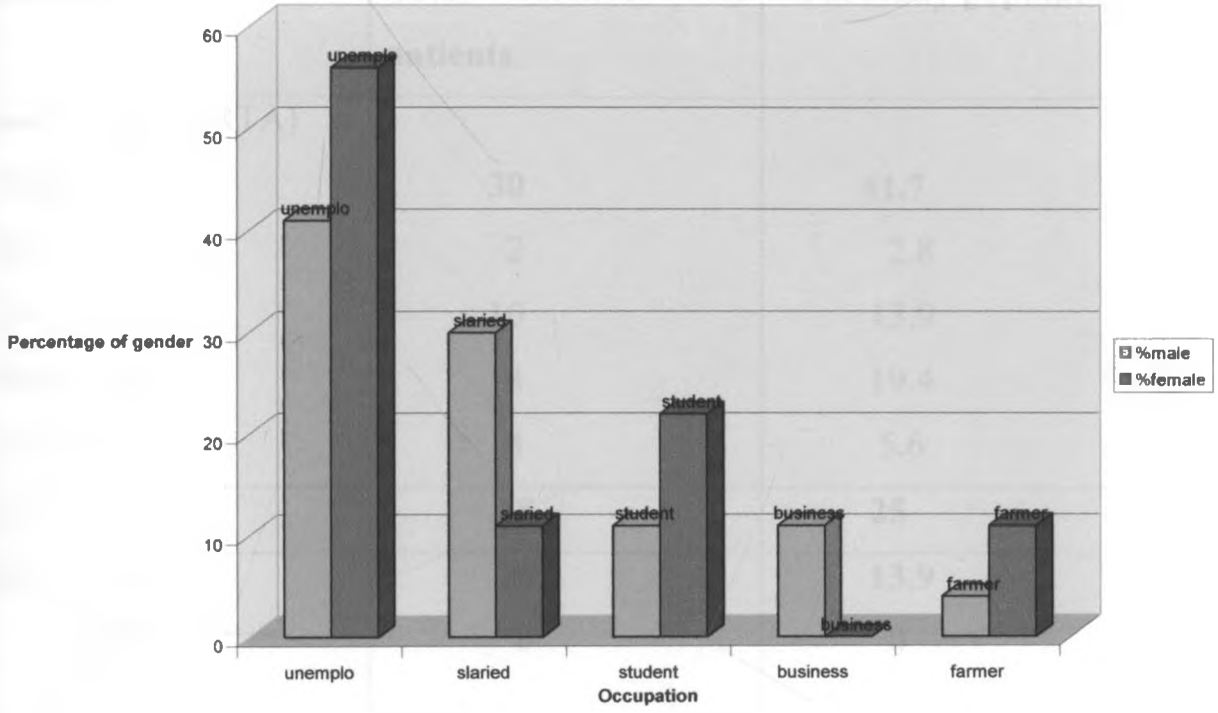


Figure 9: Bar chart illustrating percentage gender distribution and employment status.



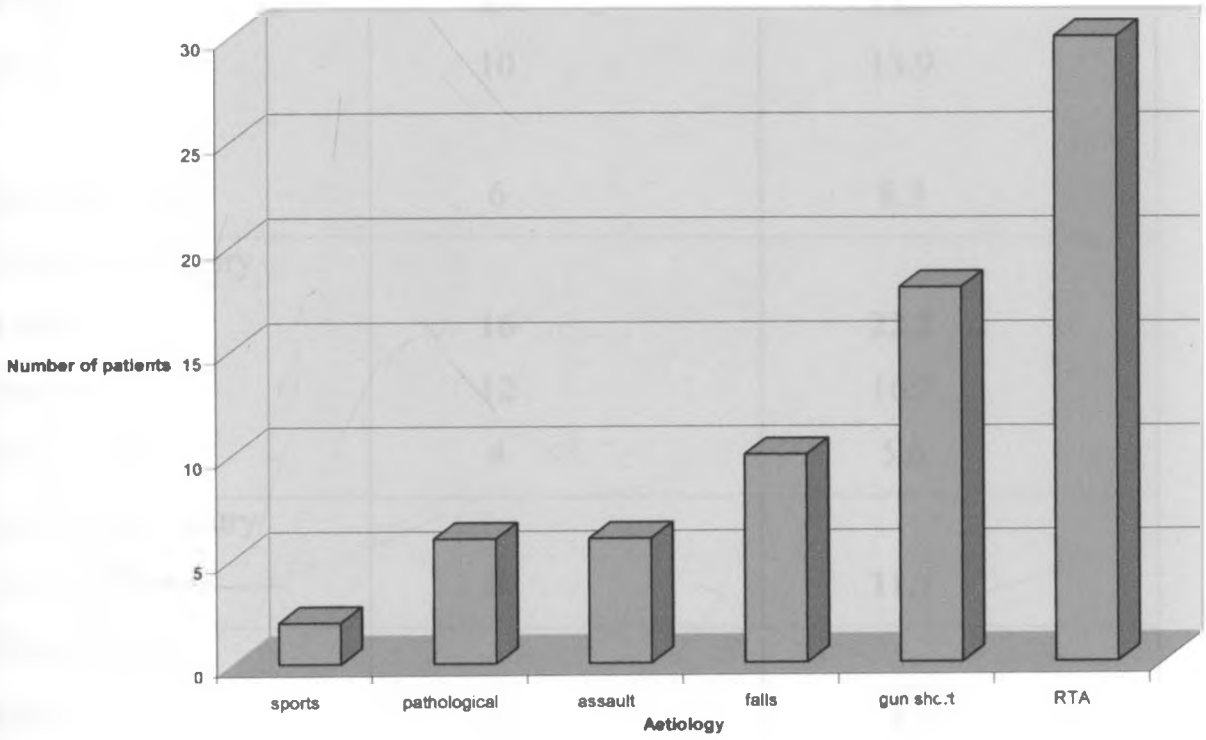
AETIOLOGY

Of the seventy two patients with distal femoral fractures, road traffic accident contributed to the majority of the cases with a total of thirty cases (42%). Gun shot injury contributed to 18 cases (25%). Other contributions in descending order included falls (14%), assaults (9%) and sports (3%). See table 1 and figure 10.

Table 1: Table of frequency distribution of aetiological factors.

Aetiology	Total number of patients	% of study population
Road accident; (RTA)		
Total	**30**	**41.7**
Driver	2	2.8
Passenger	10	13.9
Pedestrian	14	19.4
Cyclist	4	5.6
Gun shot	**18**	**25**
Falls < 3m	**10**	**13.9**
> 3m	0	0
Assault:- **Total**	**6**	**8.3**
Robbery	4	5.6
Domestic	2	2.8
Pathological		
Total	**6**	**8.3**
Osteoporosis	2	2.8
Malignancy	2	2.8
Osteomyelitis	2	2.8
Sports. (Ball game)	**2**	**2.8**

Figure 10: Bar chart to illustrate aetiological factors of distal femoral fractures



ASSOCIATED INJURIES

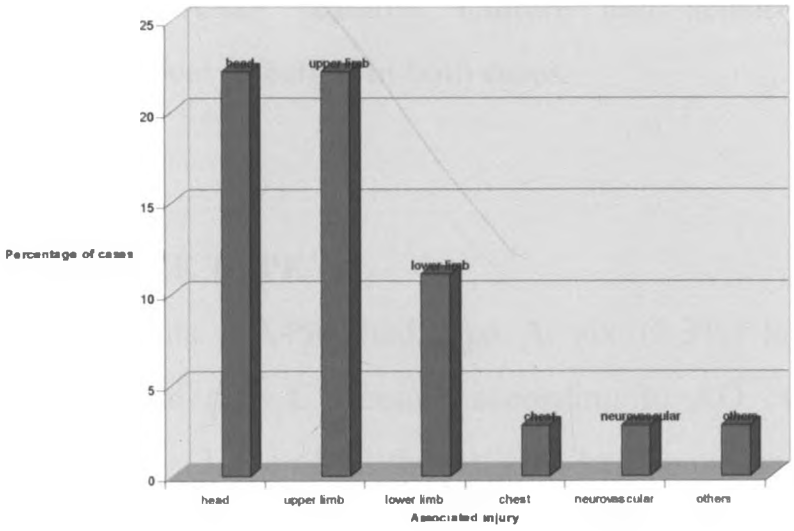
A total of forty eight patients (66.7%) of the study population had associated significant injuries.

Sixteen patients (22.2%) had head injury, sixteen (22.2%) had upper limb injuries, eight (11.1%) had other lower limb injuries, four (5.6%) had chest injury, two had peripheral neurovascular injury and two (2.8%) had other associated injuries. Head injury contributed to 33.3% of all associated injuries (table 2 and figure 11).

Table 2: Associated injuries

Associated injury	Number of cases	% of study population
Head injury		
Total	**16**	**22.2**
Closed	10	13.9
Fracture skull	6	8.3
Upper limb injury		
Total	**16**	**22.2**
Fracture	12	16.7
Dislocation	4	5.6
Lower limb injury (All fractures)	**8**	**11.1**
Chest trauma		
Total	**2**	**2.8**
Fracture ribs	1	1.4
Haemothorax	1	1.4
Peripheral neurovascular injury	**2**	**2.8**
Others	**2**	**2.8**

Figure 11: Bar chart to illustrate associated injuries.



INVESTIGATIONS USED IN THE INJURY

All the patients had plain X-ray as the main diagnostic investigation for the fractures. A total of thirty two patients (44%) had haemogram and urea / electrolyte investigation. This comprised mainly the group of patients who had compound fractures and was to undergo serial surgical toilet and for the pre-operative work up for the operative treatment group.

The two elderly women aged 82 and 86 years had diagnosis of osteoporosis based on the clinical history of minimal trauma and X-ray appearance of generalised osteopaenia. Their fractures were comminuted and displaced (types C-2 and C-3). Two patients aged 13 and 14 had fractures with suspicious X-ray features and bone biopsy and histology revealed features of osteogenic sarcoma.

The two patients who had osteomyelitis had discharging sinuses and suggestive X-ray features. Culture and sensitivity of pus revealed staphyloccocal infection in both cases.

FRACTURE TYPE

Fifty patients (69.4%) had type A, six (8.3%) had type B and sixteen (22.2%) had type C fracture according to AO classification of Muller. Twenty two (31%) of all the patients had compound fractures (table 3 and figure 12).

Table 3: Types of fracture according to AO classification of Muller.

Type of fracture	Number of patients.	Totals per group.	% of study population
A	50	50	69.44
B1 B2 B3	2 4 0	6	8.33
C1 C2 C3	0 12 4	16	22.22
Total		72	100

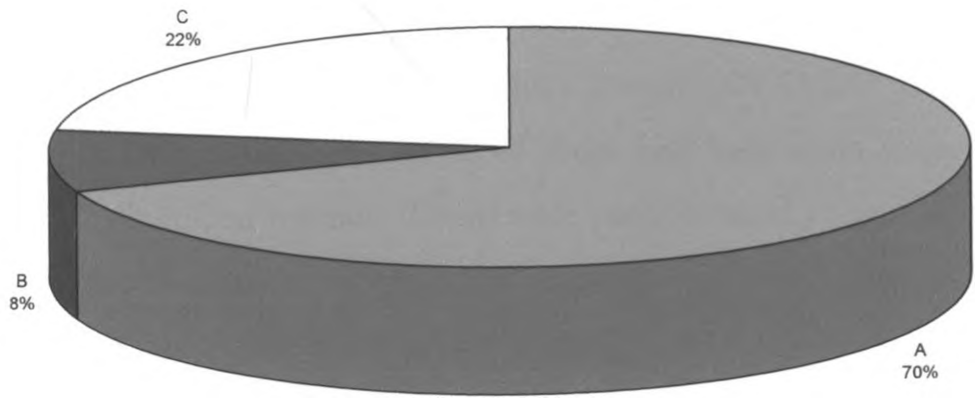


Figure 12: Pie chart to illustrate percentage distribution of fracture types.

TREATMENT

Out of seventy two patients, forty eight (66.7%) were offered conservative treatment throughout their hospital stay, twenty (27.8%) had initial conservative followed by operative treatment and only four (5.5%) had operative treatment only. The total number of patients started on conservative treatment upon admission was sixty eight (94.5%). Those who

had operative treatment before the end of their hospital stay were twenty four (33.3%).

Of the 68 patients who had conservative treatment, sixty six (97%) had skeletal traction and in thirty four (50%) of them, this was followed by a long cast (either plaster of Paris or dynacast). Twenty (29.4%) of them were finally operated on. Only two (2.9%) of them had long casts without an initial period of skeletal traction. These were patients aged 13 and 14 years with types B-1 and B-2 fractures respectively who were subsequently discharged after two and four days respectively.

Among those who underwent operation (24 patients), fourteen (58.3% of them) had plate and screw fixation. Twelve patients (50% of those operated on) had condylar blade plate and two (8.3% of them) had buttressing condylar plate as the method of internal fixation. Ten (41.7% of them) had intramedullary nail (retrograde nail) fixation.

All the ten patients who had retrograde nail fixation had an initial duration of traction ranging from twenty seven (27) to eighty four (84) days, with a mean pre-operative hospital stay of fifty-nine (59) days. Eight of the twelve patients who had condylar blade plate fixation had an initial duration of skeletal traction ranging from eleven (11) to fifty six (56) days, with a mean of twenty two (22) days of pre-operative hospital stay for the group. Both of the patients who had buttressing condylar plate had initial skeletal traction duration totaling 250 days, giving an average of 125 days pre-operative hospital stay. Only two out of the twenty two patients who had open fractures underwent operation (see figures 13, 14 and 15).

Complication rates for different groups were 50% for operative - only, 100% for conservative - only and 60% for both treatments. This is statistically significant. Chi-square test gives P-value < 0.001 (table 4 and figure 16).

Figure 13: Treatment groups- frequency distribution

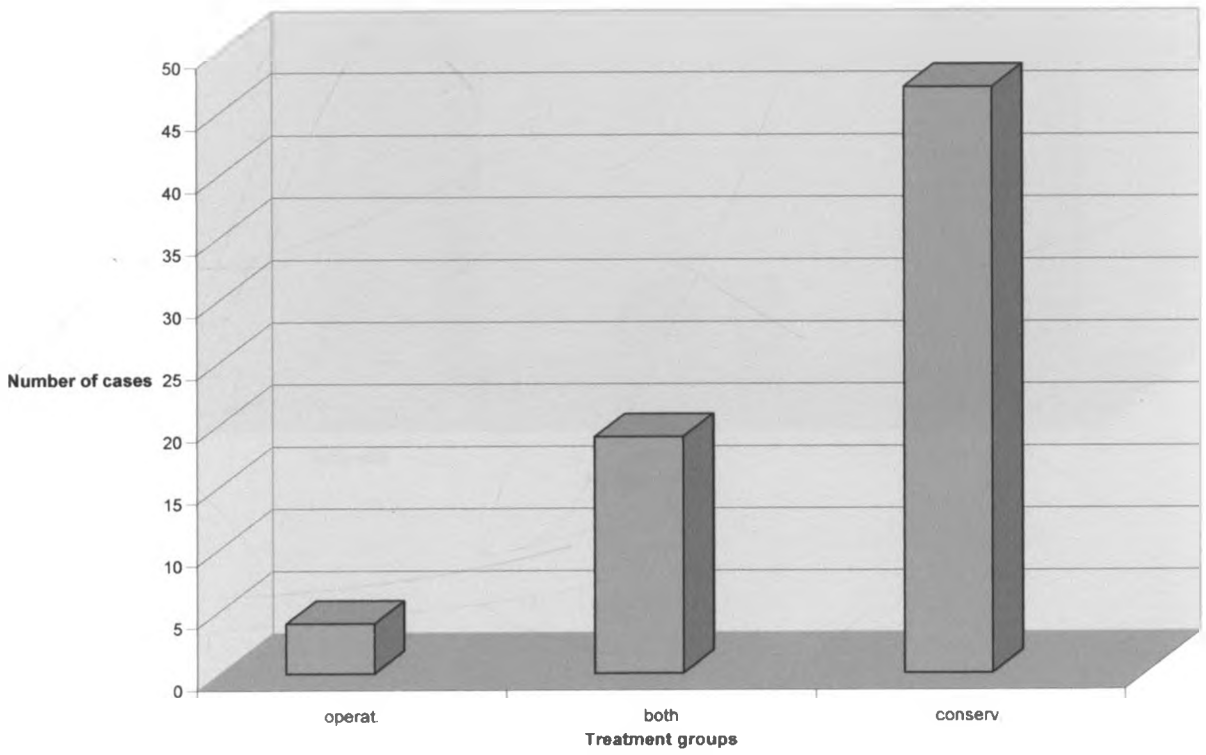


Figure 14: Bar chart illustrating operative fixation devices used.

Key: - BCP Buttressing Condylar Plate.

CBP Condylar Blade Plate.

Retro-nail Retrograde intramedullary Nail.

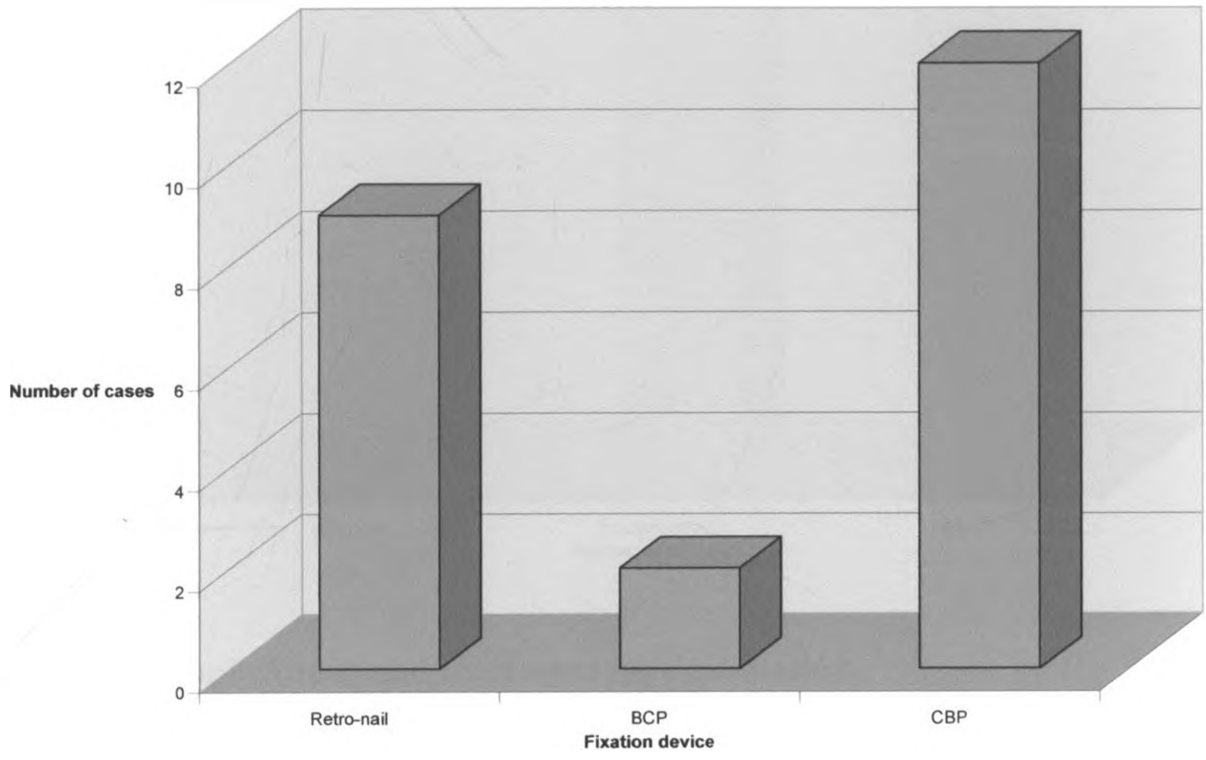


Figure 15: Conservative treatment distribution

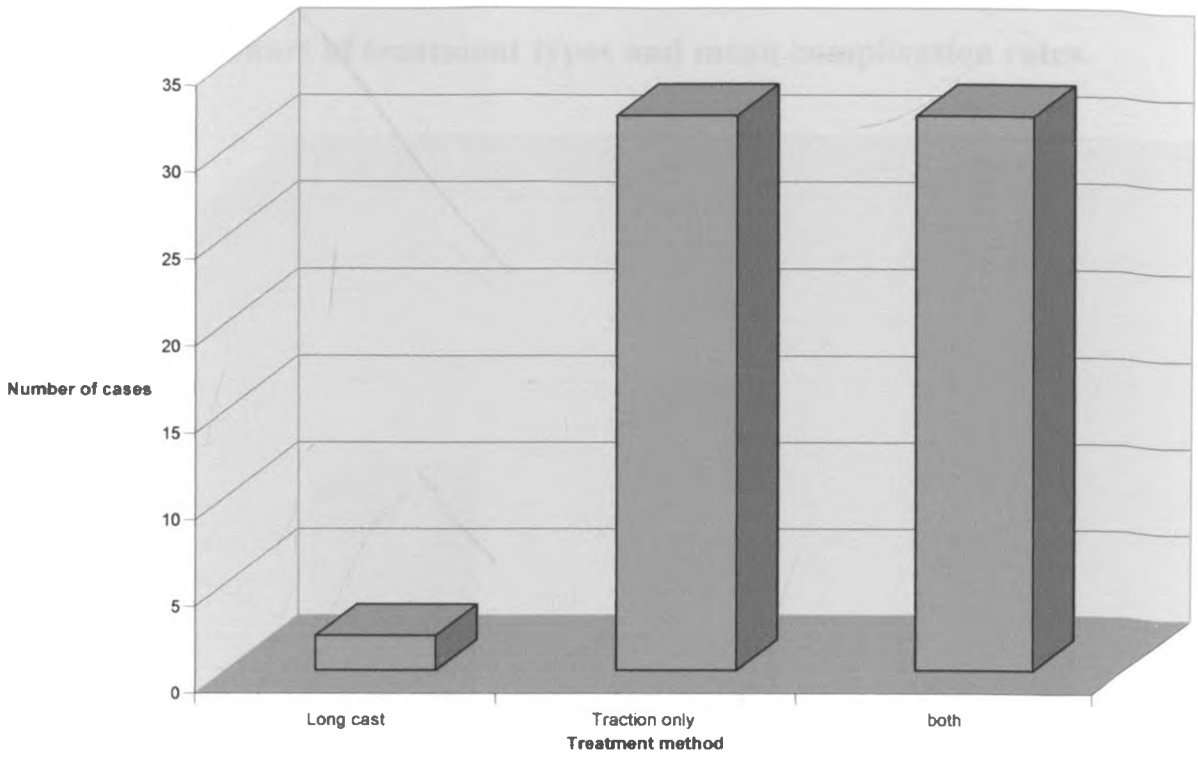
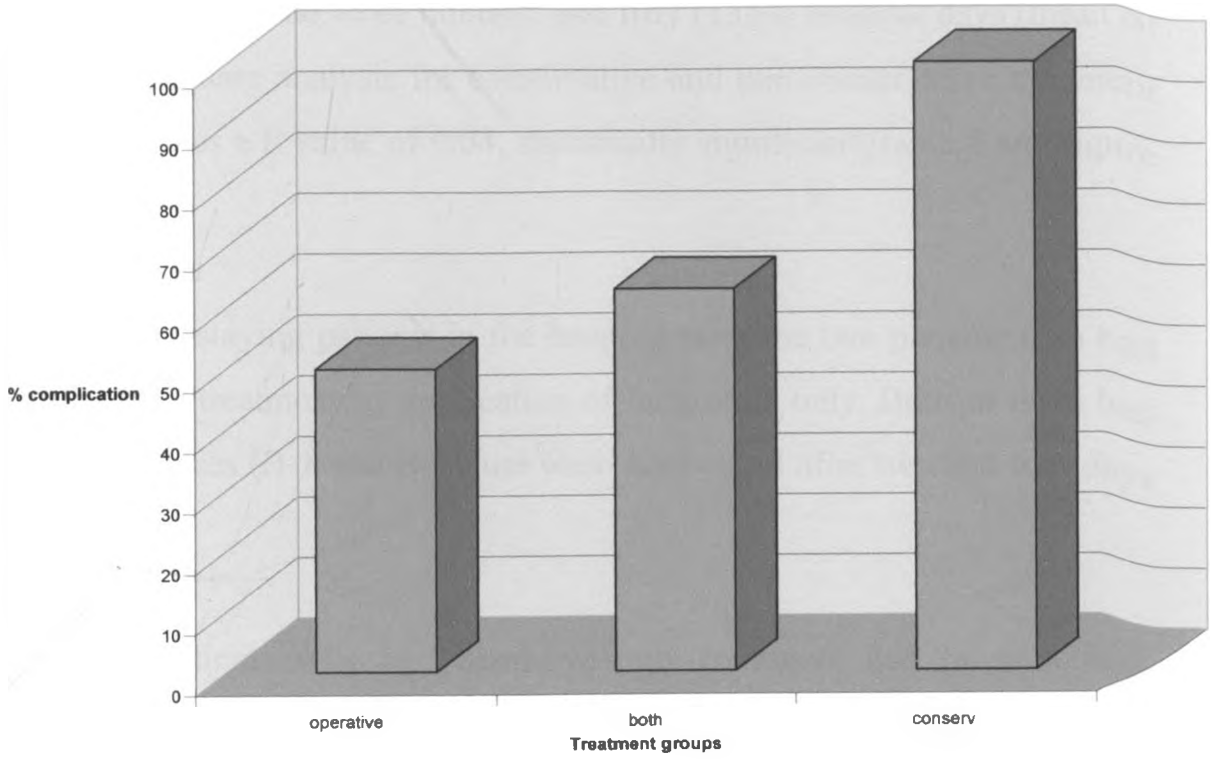


Table 4: Complications and treatment type tabulation.

	Operative only	Both treatments	Conservative only	Total
Complication				
Number of patients with complications.	2	12	48	62
Percentage	**50%**	**60%**	**100%**	**86%**

P < 0.001.

Figure 16: Bar chart of treatment types and mean complication rates.



HOSPITAL STAY

The total in-patient hospital stay ranged from two (2) to one hundred and forty one (141) days with a mean of fifty five (55) days and a median of forty eight (48) days.

Among the forty eight patients who had conservative - only treatment, the total hospital stay was two thousand three hundred and fifty nine (2359)

days (mean of 49.1). The four patients who had only operative treatment had a total hospital stay of one hundred and fifty (150) days (mean of 37.5). The twenty patients who had conservative treatment followed by operation had a total of one thousand three hundred and fifty (1350) hospital days (mean of 67.5). Chi square analysis for conservative and non conservative treatment (2 sided) gives a P value of 0.04, statistically significant (table 5 and figure 17).

The shortest staying patients in the hospital were the two patients who had conservative treatment by application of long casts only. Both of them had type B fractures (B-1 and B-2) and were discharged after two and four days in hospital.

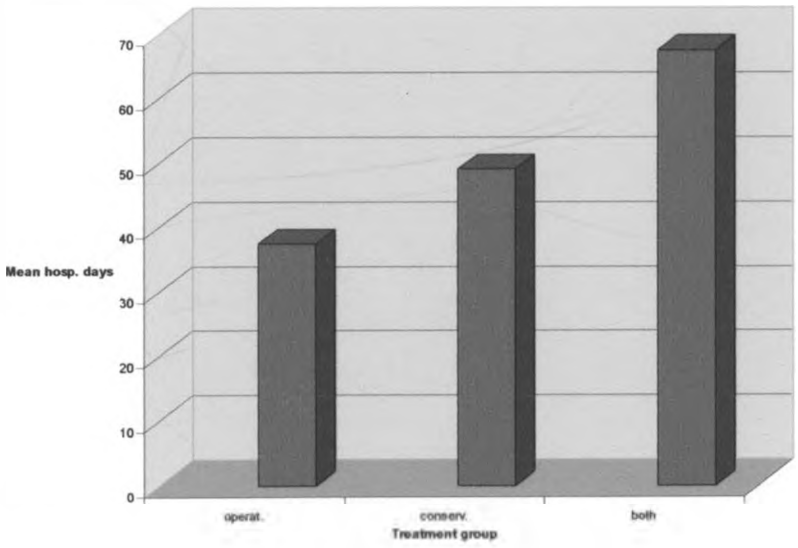
The four patients who had operative–only treatment had hospital days ranging from 6 to 106 days. Two of them left hospital within ten days (6 and 8 days). The remaining two stayed much longer upon recovery from the operation (30 and 106 days) for financial reasons.

Table 5: Table of treatment groups and hospital days.

Treatment group	Number of patients	Total in-patient hospital days	Mean in-patient hospital days
Operative only	4	150	37.5
Both treatments	20	1350	67.5
Conservative only	48	2359	49.1

P=0.04 (2 sided conservative verses no-conservative treatment).

Figure 17: mean hospital days for the treatment groups.



HOSPITAL BILL.

The in-patient hospital bill for all the seventy two patients ranged from 2150 to 121050 Kenya Shillings, with a mean of 25290 Kenya Shillings.

The mean hospital bills for different treatment groups were, KSh. 25,983.75 for conservative - only, KShs. 17,140 for operative - only and KShs. 60,132.75 for those who had both treatments.

The overall mean for the separate groups of operative (four patients) and conservative (forty eight patients) was KShs. 25,303.45. All the four patients who had operative treatment had bills below this mean, while 28 out of the 48 patients who had conservative treatment had bills below it.

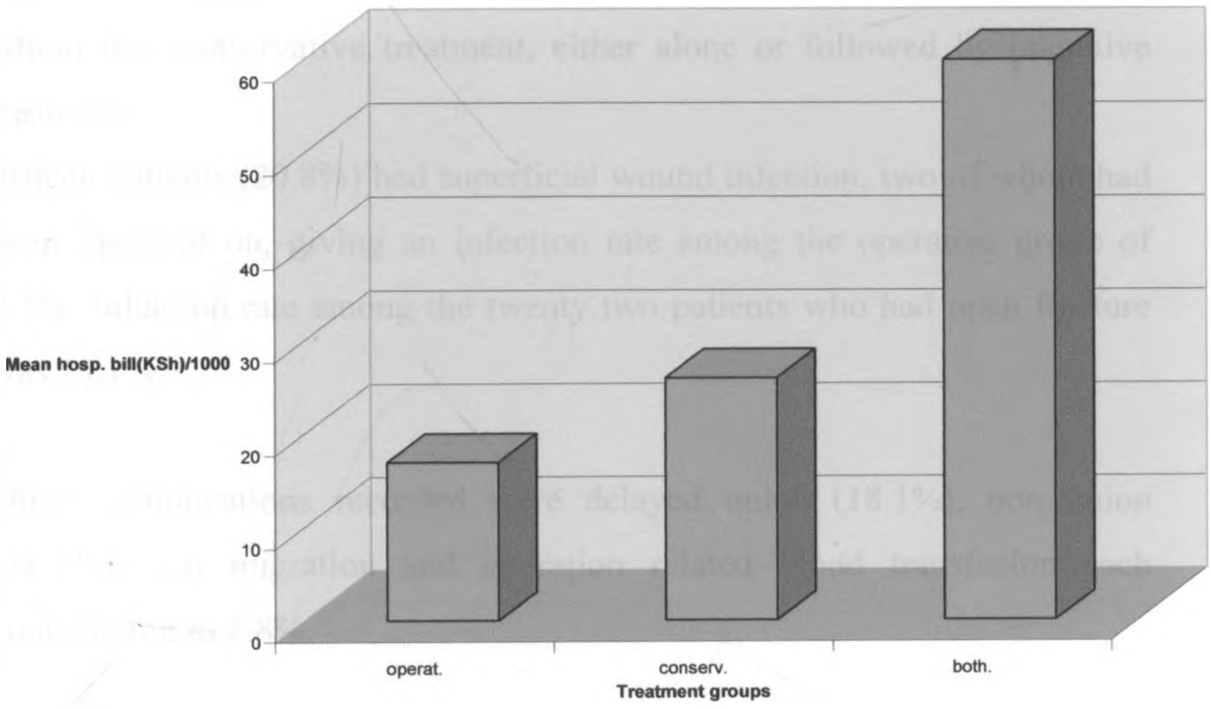
The differences in hospital bills among the treatment groups was statistically significant (**P=0.034**).See table 6 and figure 18.

Table 6: Hospital bills for different treatment groups.

Treatment group	Number of patients	Total hospital bill(KShs)	Mean hospital bill (KShs.)
1. Conservative only	48	1247220	25983.75
2. Operative only	4	68560	17140.00
3. Both treatment	20	1202655	60132.75
4. Groups 1 and 2 together	52	1315780	25303.45

P = 0.034

Figure 18: Bar graph representing mean hospital bills for the different treatment groups.



COMPLICATIONS

Out of the seventy two patients, sixty two (86%) reported one or more complication(s), as shown in figure 16, page 55. Complication rates for different groups were 50% for operative - only, 100% for conservative - only treatment and 60% for both treatments. This is statistically significant. Chi-square test gives P-value of < 0.001 (table 4, page 54).

The most common complication recorded was knee stiffness in 34 (47.2%) patients. All of these patients had conservative treatment either alone or followed by operation. Twenty two patients (30.6%) had mal-union, all of whom had conservative treatment, either alone or followed by operative treatment.

Fifteen patients (20.8%) had superficial wound infection, two of whom had been operated on, giving an infection rate among the operative group of 8.3%. Infection rate among the twenty two patients who had open fracture was 59.1%.

Other complications recorded were delayed union (18.1%), non union (11.1%), nail migration and operation related blood transfusion each contributing to 2.8%.

Complications observed in different treatment groups were: 34 and 4 cases of knee stiffness in conservative-only and both treatments respectively; 12 and 6 cases of malunion in conservative-only and both treatments respectively; 14 and 2 cases of infection in conservative-only and both treatments respectively; 14 cases of delayed union in conservative treatment only; 2 cases each, in operative-only and conservative-only of non-union, and 4 cases in both treatments of the same; and 2 cases each of nail migration and operation related blood transfusion in both treatments. See figures 16, 19 and 20.

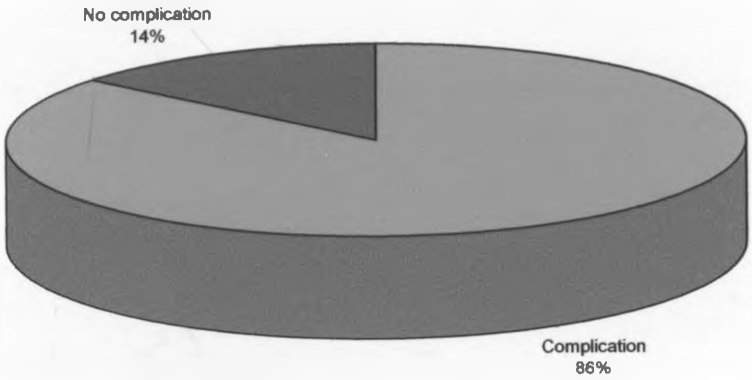
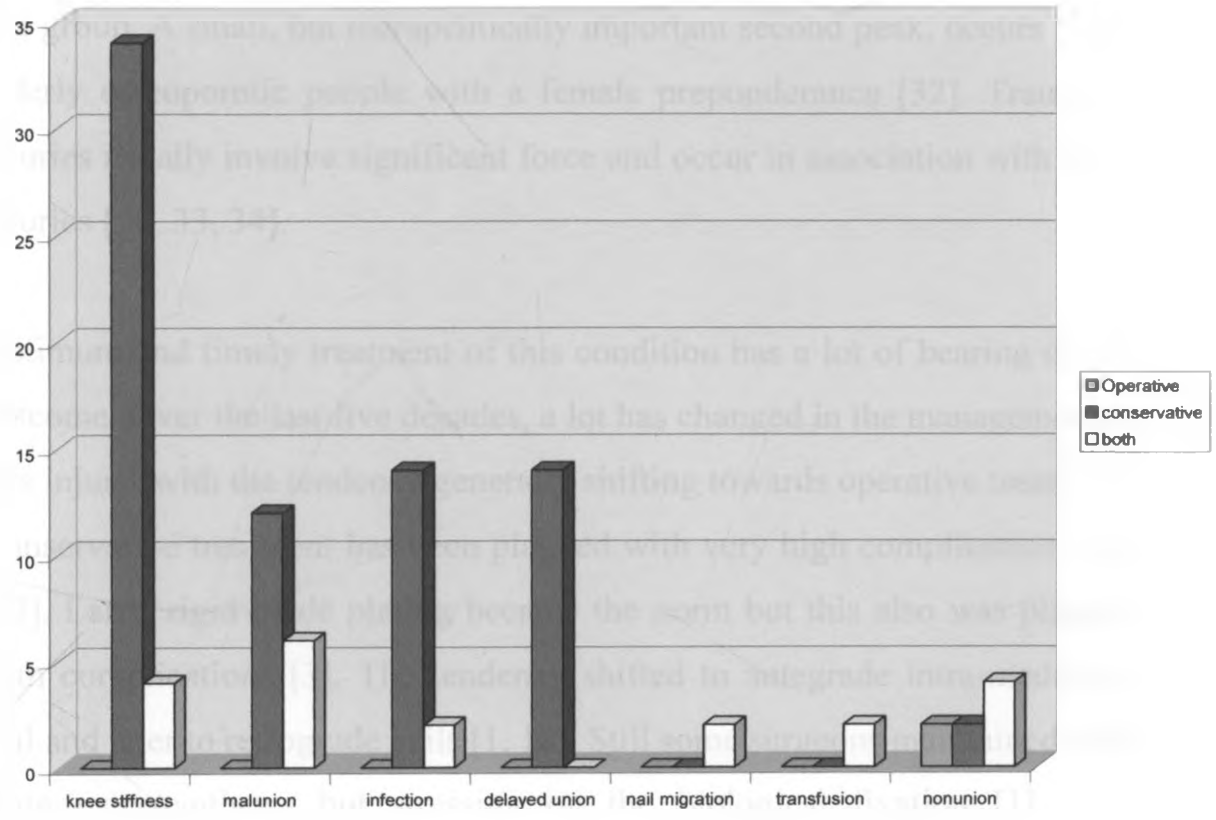


Figure 19: Pie chat to illustrate complication load.

Figure 20: Treatment groups and frequency of different types of complication.



Key:

X-axis……Complications

Z-axis…….Number of patients

DISCUSSION.

Distal femoral fractures affect mainly the young and economically active age group. A small, but therapeutically important second peak, occurs in the elderly osteoporotic people with a female preponderance [32]. Traumatic injuries usually involve significant force and occur in association with other injuries [32, 33, 34].

Optimum and timely treatment of this condition has a lot of bearing on the outcome. Over the last five decades, a lot has changed in the management of this injury, with the tendency generally shifting towards operative treatment. Conservative treatment has been plagued with very high complication rates [43]. Later, rigid blade plating became the norm but this also was plagued with complications [3]. The tendency shifted to antegrade intra-medullary nail and later to retrograde nails [1, 18]. Still some surgeons maintained rigid plate osteosynthesis but stressing on the biological fixation [1]. It is universally agreed that the fracture should be treated operatively, but there is a lot of debate on the ideal fixation device.

Studies done elsewhere gave a wide range of the patients' ages, with some giving bimodal distribution. Yang RS and Liu HC found the age distribution to be 15-80 years (mean of 46.9) [44]. Our study reveals an age distribution of 13-86 years (mean of 36). Though our study population appears to be younger, both studies reveal a unimodal age distribution. In another study by Lauri H and Jarkko P the age ranged from 20 to 86 years (mean of 52.3) with a bimodal distribution. The study population was even older [45]. It is however worth noting that there may be a variation in the figures quoted in

our study and the actual ages especially of the older patients who have no birth certificates and their ages were only approximated in relation to the past major events and natural calamities.

Like other trauma cases, males tend to be more affected, with most of the studies giving a male to female ratio of about 3:1. Yang RS and Liu HC in their study of 93 patients, reported that 71 (76.3%) were males [44]. Our study of 72 patients revealed that 54 (75%) were males. In contrast, Lauri H and Jarkko P reported that 63% were females [45]. Janzing HM and Stockman B, who restricted their study to the elderly above 65 years, reported a male to female ratio of 1:11. This can be explained by the fact that their study population was in the second peak of incidence with a female preponderance.

The current study revealed that 39% of the patients were in active employment and 64% were married. For those below 55 years (86.1% of the study population), 65% were married, 39% were employed and 16% were students (55% potential economic productivity). Most of these patients have families and are the bread winners of such families. This is quite significant to the economy considering that the trauma removes the economically active person from their productivity. Neer et al had similar findings [33]. Because of this, the slogan by AO – group "movement is life" should always be adopted in the management of this condition.

High energy trauma contributes to the majority of cases in the younger population. In the older population, majority sustain fractures due to minimal trauma. Our study revealed that the common causes of the injury

were; road traffic accidents (42%), gun shot (25%) and falls (14%). Yang RS and Liu HC in their study revealed that road traffic accidents contributed to 77.4% of the fractures (mean age 49 years and male / female ratio of 3:1) [44]. In contrast, Lauri H and Jarkko P reported that only 20% of the fractures were due to high energy trauma [45]. Their study population was older (mean age of 52.3 years and male/female ratio of 4:6). The older female population has high incidence of osteoporosis and hence low energy trauma fractures.

The non-diseased femur requires excessive force to break. The kinetic energy so dissipated usually causes injuries elsewhere. Distal femoral fractures therefore tend to be associated with other injuries which could be life threatening. Diagnosis and timely treatment of such injuries is critical in the survival of these patients. Airway, breathing and circulation take precedence over the fracture in the acute phase management of the patients. In this series, 48 patients (66.7%) had associated significant injuries. Sixteen (22.2%) had head injury, sixteen (22.2%) had upper limb injuries and four (5.6%) had chest trauma. In their study, Gregory P and DiCicco J reported that 75% of the study population had associated significant injuries [46]. Janzing HM and Stockman B [47], who restricted their study to an elderly population above 65 years, reported only 20% with associated injuries.

Patients with intra-articular fractures require adequate pre-operative assessment for optimum results as the choice of fixation device is even more critical. Some fractures may be missed altogether or their extent may be overlooked in plain X-rays. This is more so in the elderly with osteoporosis [33, 34]. The current study revealed that no additional diagnostic

investigation was done to plain X-rays. Studies done elsewhere also revealed only occasional use of CT-scan in addition to X-rays [1].

Fracture type has a direct relationship to the poor outcome of treatment. Higher grade fractures (AO types B and C) tend to have poor outcome due to their intra-articular involvement. Siliski JM [29] in his study revealed that 21% were type A, 42% type B and 37% were type C. Seventeen per cent were open fractures. The current study revealed that 69.4% were type A, 8.3% type B and 22.2% type C. Thirty one per cent of the fractures in this series were compound. It would appear from these results that type A fractures tend to be compound. The fact that the current series revealed a high incidence of gun shot injury can not adequately explain the higher percentage of open fractures as Yang RS and Liu HC [44], who reported a comparable figure of 28.6% open fractures, had road traffic accident contributing to 77.4% of the injuries. Studies designed to investigate this would reveal a clearer relationship.

Due to the poor outcome reported in studies of conservative treatment, operative treatment is now advised in all cases of distal femoral fractures. Schaltzer K and Lambart DC (1979) advocated conservative management on traction for six to eight weeks followed by cast bracing [48], but a study by Veith RG and Winquist RA (1984) revealed unacceptably high complication rates with this type of treatment [43]. The current study reveals that most of the patients underwent conservative treatment, either partly or throughout the treatment period (94.4%). For the few who had operative treatment, the results of 58.3% plate and screw fixation and only 41.7% intramedullary

nailing are comparable to the studies done in the United Kingdom [26] but in contrast to those in the United States [25].

The main aim of fracture treatment is to return the patient to gainful activity within the shortest time possible. Several studies have revealed that operative treatment is the norm for achieving this. Gregory P and DiCicco J in their study reported an average of 17 days hospital stay (range 3–57) [46], while Anastopoulos G in his study reported a range of 20–40 days [49]. Kempf I and Grosse A in their study reported hospital stay ranging 18-24 days [5], while Giles J and Heckman J reported mean hospital stay of 17 days (range 8-37) [11]. The current study revealed an overall range of 2-141 days (mean 55). The patients who underwent operation - only treatment had a mean of 37.5 days hospital stay, which is comparable to the Anastopoulos study but much more than the Gregory, the Kempf and the Giles studies. The difference in hospital stay between the treatment categories in our study was statistically significant ($p = 0.04$), at 95% confidence interval.

The significance of operative treatment is revealed in the current study by the hospital bill implication. Although most patients could be undergoing conservative treatment because of the presumed cost burden of operation, this study revealed the contrary. There was a statistically significant cost benefit of operation over conservative treatment ($p=0.034$) at 95% confidence interval. A search of a comparative study elsewhere on this aspect was unrevealing.

In their study of patients undergoing blade plating of closed distal femoral fractures, Merchant E and Maestu P reported a complication rate of 35% [9].

Yang RS and Liu HC, in a study of retrograde nailing, reported that the most complications were knee stiffness, non-union, delayed union and infection [44]. Other complications reported for operative treatment were nail migration (8%) [47], mal-union (12.5%) [50], delayed union (34%) and infection (6%) [45]. Our study revealed an overall complication rate of 86% which is higher than the above reports. This can be explained by the large fraction of the patients undergoing conservative treatment. The complication rate of 50% among the operative group is still higher than the above reports, but this could be due to the large fraction of the patients (20 out of 24) who had conservative treatment prier to operation. Despite this a statistically significant difference was realized between the two treatment groups ($p=0.001$ at 95% confidence interval).

CONCLUSIONS

From this study, the following conclusions can be made about distal femoral fractures as seen at Kenyatta National Hospital:

1. Most of the patients are young and economically productive with a peak incidence in the third and forth decades.

2. There is a male preponderance with a male to female ratio of 3:1.

3. Road traffic accident and gun shot are the commonest causes, together contributing to 66.7%.

4. Associated injuries are common.

5. The single most commonly used diagnostic investigation is plain X-ray.

6. The commonest fracture type is AO type A, contributing to two thirds of the cases. About one third of the fractures are open.

7. The most common treatment method is skeletal traction. There is a statistically significant benefit of operative treatment, both in terms of short hospital stay and lower mean hospital bill.

8. Plates and screws are used more commonly for internal fixation of these fractures.

9. Complication rate is quite high (86%) and is more common among the conservative treatment group. There is a statistically significant benefit of operative treatment as far as complication rate is concerned.

10. Most common complications are knee stiffness (47.2%) and mal-union (30.6%).

RECOMMENDATIONS.

1. More emphasis should be put in public education, enforcement of the traffic rules and measures to reduce crime and misuse of firearms. This will significantly reduce the number of patients sustaining distal femoral fractures as road traffic accident (RTA) and gun shot contribute to over 65% of the cases.

2. All these patients should be considered for operation and internal fixation. This will reduce hospital stay, improve outcome and reduce the economic burden.

3. A similar study with a larger number of cases and longer follow up should be done in the same setting and in the private sector to show a broader picture and to reveal the long term outcome.

REFERENCES

1. **Lucas E, Seligson D, Henry S.** Intramedullary supracondylar nailing of femoral fractures – a preliminary report of the GSH supracondylar nail. *Clin Ortho 1993;* **296***: 200 - 206.*
2. **Mize RD, Bucholz RW, Grogan DP.** Surgical treatment of displaced comminuted fractures of the distal end of femur. *J Bone & Joint Surg (AM) 1982:* **64 (6)**: 871 - 879.
3. **Court-Brown CM.** The management of femoral fractures. *J R. Coll. Surg. 1998*: **43**: 374-380.
4. **Klemm K, Borner M.** Interlocking nailing of complex fractures of the femur and tibia. *Clin Ortho 1986;* **212***:89-100*
5. **Kempf I, Grosse A, Beck J.** closed locked intramedullary nailing: its application to comminuted fractures of the femur. *J Bone & Joint Surg 1985;* **67A***: 709-720.*
6. **Court-Brown C.M, McQueen MM, Quaba AA, Christie J.** Locked intramedullary nailing of open fractures. *J Bone & Joint Surg 1991;* **73B***:959-64*
7. **Wittle AP, Russel TA, Tayler JC, Lavelle DG.** Treatment of open fractures of tibia shaft with the use of interlocking nailing without reaming. *J. Bone & Joint Surg 1992;* ***74A****: 1162-71.*
8. **Della Tarre P, Agletti P, Altissimi M.** Results of rigid fixation in 54 Supracondylar fractures of the femur. *Arch. Ortho Trauma Surg 1980;****97****: 177-83.*
9. **Merchant E, Maestu P, Blanco R.** Blade plating of closed displaced supracondylar fractures of the distal femur with the AO System. *J Trauma 1992;* **32***:174-8.*

10. **Chiron H, Tremoulet J, Casey P, Muller M.** Fractures of distal third of femur treated by internal fixation. *Clin Orthop 1974;* **100***:160-70.*

11. **Giles J, Delee J, Heckman J, Keever J.** Supracondylar-intercondylar fractures of the femur treated with a supracondylar plate and lag screws. *J Bone & Joint Surg [AM] 1982;***64***: 864-70.*

12. **Moore T, Watson T, Green S, Garland D, Chandler R.** Complications of surgically treated supracondylar fractures of the femur. *J Trauma 1987;* **27***: 402-6.*

13. **Mize R**. Surgical management of complex fractures of distal femur. *Clin Orthop 1989;* **240***: 77-86.*

14. **Butt MS, Kriskler SJ.** Displaced fractures of the distal femur. *J Bone & Joint Surg 1996:* **78 B:** *110-114*

15. **Kruttek C, Schandelmaire P, Miclau T, Bertram R, Holmes W, Tscherne H.** Transarticular joint reconstruction and indirect plate osteosynthesis for complex distal supracondylar femoral fractures. *Injury 1997;* **28***: 5-A 31-41.*

16. **Green S**. Distal Intramedullary fixation of supracondylar fractures of the femur. *Techn Ortho 1988;***3:** *71-6.*

17. **Siliski J.M., Mahring M, Hofer HP**. Supracondylar intercondylar fractures of the femur - treatment by internal fixation. *J Bone & Joint surg (AM) 1989*; **71 (1)**: 95-104.

18. **Lueng K, Shen W, Mui L, Grosse A.** interlocking Intramedullary nailing for supracondylar and intercondylar

fractures of the distal part of the femur. *J Bone & Joint Surg (AM) 1991;* **73:** *332-40.*

19. **Iannacone W, Bennett F, Delong W, Born C, Dalsy R.** Initial experience with the treatment of supracondylar femoral fractures using the supracondylar intramedullary nail: a preliminary report. *J Ortho Trauma 1994;***8:***332-7.*

20. **Herscovici D, Whiteman K**. Retrograde nailing of the femur using an intercondylar approach. *Clin Orthorp 1996;***332***: 98-104.*

21. **Pape HC, Regel G, Dwenger A, Sturm J A, Tscheme H.** Influence of thoracic trauma and primary femoral intramedullary nailing on the incidence of ARDS in multiple trauma patients. *Injury 1993;* **24(3)***: 82-103.*

22. **Gynning JB, Hunsen D.** Treatment of distal femoral fractures with imtramedulary supracondylar nails. *Injury 1999: **30:** 43-46.*

23. **Ito K, Grass R, Zwipp H**. Internal fixation of supracondylar femoral fractures: comparative biomechanical performance of 95 degree blade plate and two retrograde nails, *J Orthop Trauma 1998;* **12:** *259-66.*

24. **Bosse MJ**. Adult respiratory distress syndrome, pneumonia and mortality following thoracic injury and femoral fracture treatment by either intramedullary nailing with reaming or with a plate. A comparative study. *J Bone & Joint Surg (AM) 1997; **79A:**799-809.*

25. **Sanders R, Koval K J, Dipasquale, T, Helfet D, Franlde M.** Retrograde reamed femoral nailing. *J Orthop Trauma 1993;* **7:** *293-302.*

26. **Court-Brown CM, will E, Christie J.** Reamed or unreamed nailing for closed fractures. A prospective study. *J. Bone & Joint Surg. 1996*; **78B**: 580 - 583.

27. **Tornetta P, Tiburzi D.** The treatment of femoral shaft fractures using intramedullary interlocked nails with and without intramedullary reaming: a preliminary report. *J Orthop Trauma 1997;* **11:***89-92.*

28. **Dunlop D, Brenkel I.** The supracondylar intramedullary nail in elderly patients with distal femoral fractures. *Injury 1999*: **70:***29-32*

29. **Siliski JM, Mahring M:** Supracondylar-intercondylar fractures of the femur. Treatment by internal fixation: *J Bone & Joint Surg(AM) 1989;* **71(1):** *95-104.*

30. **Baumggaertel F, Gotzen L**: Plate osteosynthesis in fractures of the para-articular femur – a prospective study: *Ulfalchirurg 1994*; **97(2):** 78-84.

31. **Last RJ.** Lower extremity of the femur. In: *Anatomy, regional and applied, seventh edition* 1988. Edinburgh: Churchill Livingstone: 199 - 200.

32. **Russel RC, Norman SW, Christopher JK**: Supracondylar fractures of the femur. In: *Bailey & Love's short practice of*

surgery, 23rd edition 2000. New York: Oxford University Press: 383.

33. **Neer C, Grantham A, Shelton M.** Supracondylar fractures of the adult femur. *J Bone & Joint Surg.* (AM) *1967*; **49**: *591-613.*
34. **Giles J, Delee J., Heckman J.** Supracondylar - intercondylar fractures of the femur treated with a supracondylar plate and lag screws. *J. Bone & Joint Surg. (AM) 1982*; **64**: *864-870.*
35. **Wiss DA, Watson JT, Johnson EE:** Fractures of the knee. In: *Fractures in Adults, 4th edition* 1996. Philadelphia, Pa: Lippinctt-Raven: 1919-2001.
36. **Nichol G, Stiell IG, Wells GA:** An economic analysis of the Ottawa knee rule: *J Ann Emerg Med 1999;**34(4)**: 438-447.*
37. **Apley GA, Solomon L:** Early management of open fractures. In: *Apley's system of orthopaedics and fractures, 7th edition*, 1993. Boston: Butterworth-Heinemann Ltd: 535.

38. **Leibner E.D. et al**: Femoral fracture at the proximal end of an intramedullary supracondylar nail*; American Journal of orthopaedics. 1999:* **1:** *53-56.*
39. **Janzing H, Stockman B, Van Damme G, Rommens P, Broos P.** The retrograde intramedullary supracondylar nail; an alternative of the treatment of the distal femoral fracture in the elderly? *Arch Orthop. Trauma Surg 1998;* **118:***92-95.*
40. **Juedet R., Judet J., Lagrange J.:** A technique for freeing of the extensor apparatus in cases of stiffness of the knee*: Mem. Acad, chir. 1986;* **82:** *922-947.*

41. **Moore Charwin T.J., Green S A, Garland D E Chandler R W**: The results of quadricepsplasty on knee motion following femoral fractures; *J. Trauma 1987: **14**: 402-406.*

42. **Ebralhim N A, De Troye R. J., Saddemi SR.**: Results of Judet Quadricepsplasty: *J Orthop Trauma 1993: **7(4)**. 327-329.*

43. **Veith RG, Winquest RA:** Ipsilateral fractures of the femur and tibia: *J Bone & Joint Surg(AM) 1984*; **66***: 991 – 2002.*

44. **Yang RS, Liu HC:** Supracondylar fractures of the femur; *J Trauma* 1990**: 30(3).** 315-319.

45. **Lauri H, Jarkko P:** Retrograde intramedullary nailing in supracondylar femoral fractures; *J Ortho Trauma 2002*: **(25).** *46-51.*

46. **Gregory P, DiCicco J:** Ipsilateral fractures of the femur and tibia: *J Ortho Trauma 1996*; **10(5):.***309-316.*

47. **Janzing HM, Stockman B:** The retrograde intramedulary nail: *Arch. Ortho Trauma 1998*; **118:** *92-95.*

48. **Schatzker J, Lambart DC:** Supracondylar fractures of the femur: *Cli. Ortho 1979*; **138:** *77-83.*

49. **Anastopoulos G, Assimakopoulos A:** Ipsilateral fractures of the femur and tibia: *Injury 1992*; **23:** *439-441.*

50. **Kumar A, Jasani V:** Management of distal femoral fractures in the elderly: *Injury 2000*; **31(3):** *169-173.*

Appendix I

PATIENT INFORMATION FORM.

I am Dr Oduor from the department of surgery, the University of Nairobi. I am carrying out a study geared towards improving management of patients with fractures of the distal femur. This study has been approved by Kenyatta National Hospital Research and Ethics committee which regulates such studies. I am under the supervision of Mr. Vincent Mutiso, a consultant orthopaedic surgeon.

This study will be conducted at this hospital between 14 / 08 / 2003 and 31 / 01 / 2004. You have sustained such an injury and I would like to recruit you for the study.

In this study, you will be asked some personal questions, but this will be treated confidentially and your identity will not be revealed, as you will be marked by a code number and your name will not be included.

I will review the investigations and treatment you receive and note the benefits of the treatment and any complications of the injury and the treatment. I will not influence the treatment you receive in any way, hence the study will not have any direct positive or negative contribution to your current treatment. Since the study involves only data collection it will only benefit future patients. Your consent, or lack of it to participate, will not jeopardize your treatment whatsoever, and you are free to withdraw from it at any time.

I will be responsible for any breach of confidentiality or any negative influence that the study may impart in your care.

Patient's code Number .....

Appendix II.

INFORMED CONSENT FORM.

I voluntarily agree to participate on the study of "Distal femoral fractures - pattern and Operative Management at Kenyatta National Hospital: A prospective study" which aims at providing information geared towards improving health care for patients with such injuries. I have been informed that participation in the study or lack of it will not interfere with my treatment and that all the information obtained will be treated with utmost confidentiality. I declare that the information contained in appendix I has been availed to me.

Patient's sign: .....

Date: .....

Investigator's sign: .....

Date:.....

Appendix III.

QUESTIONNAIRE/DATE COLLECTION FORM

A. DEMOGRAPHIC

1. Study Number
2. Hospital Number
3. Age (years)
4. Gender (Male 1, Female 2)
5. Marital Status (Married - 1, Single-2, Separated-3 Widowed -4)
6. Occupation (Unemployed - 1, Farmer -2, Business-3, Salaried 4, student

B. AETIOLOGY (?)

1. R.T.A (Driver- 1, passenger-2, pedestrian3, Cyclist-4)
2. Falls - (>3m - 1, < 3m - 2)
3. Assault (Robbery-1, Domestic-2, Police-3 Mob-4, Others specify-5)
4. Pathological ([osteoporosis-1, bone cysts-2, malignancy-3, Pagets disease- 4, chronic stress-5, others-6/specify-6)
5. Gun shot
6. Sports (athletics-1, ball game-2, gymnastics-3, martial arts-4, horse racing-5, others-6 / specify)
7. Animal attacks

8. Others (specify)

C. ASSOCIATED INJURIES

1. Head injury (closed-1, fracture skull-2, intracranial bleed-3, others-4/ specify)

2. Chest trauma (pneumothorax-1, haemopneumothorax-2, haemothorax-3, major vascular injury-4, heart injury-5, chest wall-6, other-7/ specify)

3. Abdominal injury (blunt-1, penetrating-2)
4. Pelvic injury (stable-1, unstable-2)

5. Spinal Injury (cervical-1, thoracic-2, lumbar-3, lumbosacral-4, /neurological deficit-a /no neurological deficit-b
6. Upper Limb injury (fracture-1, dislocation-2, both-3)
7. Lower Limb injury (Fracture-1, Dislocation-2, both-3)
8. Peripheral neurovascular injury (Primary)

9. Others (specify)

D. INVESTIGATIONS

1. Radiology (X-Ray-1, CT-2, MRI –3)
2. Others (specify)

E. TYPE OF FRACTURE

1. ($A, B_1, B_2, B_3, C_1, C_2, C_3$) ☐

2. Open - 1, Closed - 2 ☐

F. TREATMENT

1. Conservative (Traction-1, Other - 2/Specify) ☐

3. Operative

(a) Nails:- (1.M-1, DC-1m-2) ☐

(b) Plate and Screws:- (:BCP-1,CBP - 2,DCS-3,other -4.) ☐

G. OUTCOME

1. Date of admission ☐

2. Date of discharge ☐

4. Hospital stay (days) ☐

5. Hospital bill [Kshs.] ☐

6. Complications [Recorded-1, not recorded-2]

(a) Infection ☐

(b) Secondary neurovascular injury ☐

(c) Operation related transfusion of blood ☐

(d) Malunion ☐

(e) Delayed-union ☐

(f) Non union ☐

(g) Knee stiffness ☐

(h) Implant failure ☐

(i) Others/specify ☐

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Ref: KNH-ERC/01/1918 **Date: 13 August 2003**

Dr. Oduor P Owino
Dept. of Surgery
Faculty of Medicine
University of Nairobi

Dear Dr. Oduor,

RESEARCH PROTOCOL "DISTAL FEMORAL FRACTURES - PATTERN AND MANAGEMENT AT KENYATTA NATIONAL HOSPITAL (KNH): A PROSPECTIVE STUDY" (P5/1/2003)

This is to inform you that the Kenyatta National Hospital Ethics and Research Committee has reviewed and **approved** the revised version of your above cited research protocol.

On behalf of the Committee, I wish you fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of database that will be consulted in future when processing related research study so as to minimize chances of study duplication

Yours sincerely,

PROF. A N GUANTAI
SECRETARY, KNH-ERC

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