PATTERN AND OUTCOME OF BIMALLEOLAR FRACTURES AT KENYATTA NATIONAL HOSPITAL

NJAU MICHAEL MWAURA

H58/76664/09

A dissertation submitted in partial fulfilment of the requirements of the degree of Master of Medicine in Orthopaedic Surgery of the University of Nairobi

DECLARATION

This study is my original work which has not been presented in any University for examination or published anywhere.

Sign _____ Date _____

Dr. Njau Michael Mwaura, MBChB

P.O Box 46-00219 Karuri, Kenya. Email: mwauranjau@yahoo.com

With the approval of the University of Nairobi department of orthopaedic surgery and that of my supervisors

Sign _____ Date_____

Dr. Richard B. Ombachi

MBChB, MMed (Surgery), AO spine fellowship (UCT)

Senior lecturer, Department of Orthopaedic Surgery, College of Health Sciences, University of Nairobi

Consultant Orthopaedic and Spine surgeon, Kenyatta National Hospital

P.O. Box 30197-00100 Nairobi, Kenya. Email: ombachir@uonbi.ac.ke

Sign _____ Date _____

Dr. Kirsteen O. Awori

MBChB, MMed (Surgery), Dip. (SICOT), FCS (Orth.) ECSA

Senior lecturer, Department of Human Anatomy, College of Health Sciences, University of Nairobi, and consultant Orthopaedic and Spine Surgeon, Kenyatta National Hospital.

P.O. Box 30197 – 00100 Nairobi, Kenya. Email: kawori@uonbi.ac.ke

CERTIFICATE OF AUTHENTICITY

This is to certify that this thesis is the original work of the author.

This research was carried out at Kenyatta National Hospital's orthopedics clinics, wards and the Accident and Emergency Department.

The KNH/UON-ERC number of approval is P465/07/2015.

Sign _____ Date_____

Professor John E.O. Ating'a

Professor and Chairman,

Department of Orthopaedic Surgery,

College of Health Sciences, University of Nairobi

P.O. Box 19370-00100 Nairobi, Kenya. Email: atinga@uonbi.ac.ke

ACKNOWLEDGEMENT

I would like to express my gratitude to Dr. Richard Ombachi and Dr. Kirsteen Awori, my thesis supervisors you stuck with me through this long research process with continuous support, patience, and kind advice, for that I am truly grateful.

I am sincerely indebted to my wife Elizabeth, daughters Melissa and Gabrielle for their encouragement and patience.

It is not possible to individually acknowledge all those who assisted in making this thesis a reality. I therefore take this opportunity to thank everyone who may have played a role in one way or the other in facilitating the execution of this thesis.

CONTENTS

LIST OF ABBREVIATIONS

AAOS: American Academy of Orthopaedic Surgeons

AO: Association for Osteosynthesis

AOFAS: Association of Orthopaedic Foot and Ankle Surgeons

FFI: Foot Functional Index

KNH: Kenyatta National Hospital

KNH-UoN ERC: Kenyatta National Hospital – University of Nairobi Ethics and Research Committee

MCS: Medial clear space

MUA: Manipulation under Anaesthesia

OMAS: Olerud and Molander Ankle Score

ORIF: Open Reduction and Internal Fixation

SSI: Surgical site infection

VAS: Visual Analog Scale

ANOVA Analysis of Variance

ANCOVA Analysis of Covariance

LEFS Lower Extremity Function Scale

RTA Road Traffic Accident

KNH/UON-ERC Kenyatta National Hospital/ University of Nairobi- Ethical Research Committee

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ABSTRACT

Background: Ankle fractures account for 10% of all fractures. Their incidence is projected to triple over the next 15 years according to Finnish statistics. Bimalleolar fractures constitute 25% of all ankle fractures where on an average basis 38 patients with bimalleolar fractures are treated at KNH every month. Bimalleolar fractures may be managed either operatively or non-operatively. There is scarcity of data on the pattern and outcome of bimalleolar fractures in Kenya.

Objective: This study aimed at determining the pattern and outcome of bimalleolar ankle fractures at Kenyatta National Hospital, the largest referral hospital in Kenya

Patients and methods: A prospective observational study of 72 patients with bimalleolar ankle fractures was carried out after institutional approval. Patients who had bimalleolar ankle fractures and presented between August 2015 and November 2015 were included and followed up for 12 weeks. The AOFAS and VAS were used to assess short term outcomes as at 12 weeks. The main outcome measures were pain, functional capacity and alignment.

Results: The patients' age ranged from 19 to 63 mean 36.4 ±10.4 years. The male to female ratio was 3:2. Falls caused 50% of the fractures, motor vehicle accidents 36.1% and motor cycle accidents 13.9%.

Closed fractures accounted for 63.9% of the cases. The most common fractures based on the Weber classification were B and C which occurred in 33 (45.8%) and 31 (43.1%) patients, respectively

At 3 months, the mean AOFAS was 78.2. The VAS between 1 and 3 was 43.1%. Twenty eight patients (38.8%) had no pain.

There was no difference in AOFAS and VAS between operative and non operative, open or closed Weber B fracture outcomes. The Weber C fractures managed operatively had a significantly lower

AOFAS, 63 compared to non-operative cases who scored 84.3. Medial clear space greater than 4mm was associated with a poor outcome.

Conclusion: Patients presenting in KNH with bimalleolar fractures are young. Delay in definitive treatment of up to a week post-fracture does not seem to adversely affect the. The main determinant of good outcome was the medial clear space that was less than 4mm.

INTRODUCTION

The ankle joint is a synovial mortise & tenon joint variety, functionally uniaxial. The lower end of the tibia and its medial malleolus, together with the lateral malleolus of the fibula and the distal tibio-fibular syndesmosis, form a mortise for the body of the talus. Ankle stability is conferred mainly by the medial and lateral ligament complexes, the distal tibiofibular ligaments, the tendons crossing the joint, the bony contours and the capsular attachments[4].

A bimalleolar fracture is a fracture of the distal tibia and fibula in which the medial malleolus of the distal tibia and the lateral malleolus of the distal fibula are fractured.[1]

Bimalleolar ankle fractures disrupt the medial and lateral stabilizing structures of the ankle joint. These fractures are commonly caused by indirect rotational, translational and axial forces. These result in subluxation or dislocation of the talus out of the ankle mortise, usually associated with a fracture complex.[5] The standard ankle radiographs include the Anteroposterior (AP), mortise and lateral views.[6]

The number and incidence of low-trauma ankle fractures in Finnish persons above 60 years of age rose substantially in a 30 year old period: the total number of fractures increased from 369 in 1970 to 1545 in 2000(a 319% increase), and the crude incidence increased from 57 to 150(a 163% increase). It is estimated that there will be a threefold increase in these fractures by the year 2030.[2] Most ankle fractures are isolated malleolar fractures, accounting for two-thirds of fractures, with bimalleolar fractures occurring in 25% of patients and trimalleolar fractures in the remaining 5% to 10%.[3] There are no published studies on the prevalence of bimalleolar fractures in Kenya.

The study was done at Kenyatta National Hospital (KNH). This is the largest referral hospital in Kenya. The purpose of the study was to establish the various presentations of bimalleolar fractures and the short term outcomes after treatment.

Most of the studies done on ankle fractures are retrospective. There is limited data on bimalleolar fractures locally; much of it is on ankle fractures generally. The study was conducted to bridge the knowledge gap and hopefully influence future management of bimalleolar fractures.

LITERATURE REVIEW

Ankle fractures are among the commonly encountered fractures at the Emergency Department, accounting for approximately 10% of all fractures. [7,8,9]

Three classification systems of ankle fractures are commonly used; The Lauge-Hansen system[3] that classifies ankle fractures based on the mechanism of injury, ligamentous and bony involvement. It combines the position of the joint prior to the injuring insult with the direction of the injuring insult. The Danis-Weber classification[10] is based on the level of the distal fibula fracture and the importance of damage to the lateral structures for ankle mortise stability. The AO classification (also known as the AO-Weber classification) [11] combines elements of the Lauge-Hansen and Danis-Weber classification systems. It takes into account the level of the fibula fracture in relation to the syndesmosis, and the fact that insufficiency of the medial structures can lead to degeneration of the joint if dynamic biomechanical stability is not restored. The Danis-Weber classification is less complex and is often used in many settings and will be used in this study.

There is a variation in the demography of ankle fractures between Africa and Caucasian populations.

In a Rwandese study, 77.4% of patients were 18-44 years with male to female ratio of 3.3:1, The commonest cause was road traffic accidents at 75% followed by fall 9.3%.[12] In a Ghanaian study 62.9% were 31-50 years, male to female ratio of 6:1; 88.6% were due to RTA[13]. In a South African study, the mean age was 39.32 years (range 13-85 years) with a male to female ratio 1.3:1. The mechanisms of injury was; motor vehicle accidents (MVA) (15.95%), falls (53.19%).[14] In the United Kingdom registry, the incidence of ankle/tibia fibula was 14.8/100,000, the male to female ratio 1:1, falls contributed to75% of the cases.[15] In Denmark the incidence was 107 per 100,000. Below the age of 50, ankle fractures were commonest in men. After this age, females' prevalence was higher and the age-specific incidence rates decreased in both sexes. The main causes of the fractures were falls at 87%. Sports, play or other leisure activities resulted in 55% of the fractures.[16]

In a Swedish study, the males with ankle fractures were younger than females, averaging 45years and 58 years respectively. The commonest fracture types in females were bimalleolar and trimalleolar (57%) and in men they were lateral malleolar (49%). Closed fractures accounted for 97% with an incidence of 71 per 100,000.[17] In the United States of America, bimalleolar fractures accounted for 27% of ankle fractures while in Canada they constituted 16% of all ankle fractures.[18] The proportion of ankle fractures according to Beuchamp was 7% for Weber A, 60% Weber B and 33% Weber C fractures.[19, 20, 21] Kitaoka et al[14] found 3% Weber A, 29% Weber B, 65% Weber C. Tunturi's study found Weber A 24%, Weber B 59% and Weber C 17%.[25] Most ankle fractures were closed. Oslon et al[43] found an incidence of 5% of open fractures in the United States of America.

Various studies have been done on modalities of treatment of bimalleolar ankle fractures with varied outcomes; Van Shie-Van der Weert et al[7] in a retrospective study on determinants of outcomes Weber B fractures, 82 patients were treated conservatively and 103 underwent operative treatment. Most conservatively treated fractures were AO-Weber B1.1 type fractures. Fractures with fibular displacement were predominantly treated operatively. The outcome scores in the non-operative group were AOFAS 98, and VAS 8. Outcome in this group was independently negatively affected by age, affected side, BMI, fibular displacement, and duration of plaster immobilization. In the surgically treated group, the AOFAS, and VAS scores were 97, and 8, respectively, with outcome negatively influenced by duration of plaster immobilization. Twenty three patients had bimalleolar fractures. The outcome between unimalleolar and bimalleolar fractures was the same.

Dietrich et al[22] did a retrospective study on conservative functional treatment of Weber B ankle fractures. The score on pain, stiffness and activities of daily living was better than in the control operative group (it is not clear which score they used).

Makwana[23] in a randomized control study on conservative versus operative treatment for displaced ankle fractures in 47 patients over 55 years of age, the Olerund and Molander score was

significantly higher for the operative group (77) than the non operative group (60). The results showed that anatomical reduction was significantly less reliable and loss of reduction significantly more common in the group with closed treatment. The number of malleoli involved did not affect the outcome.

Anand et al[24] in a retrospective review of 80 patients over the age of 60 years with ankle fractures. Forty one patients were treated conservatively by manipulation under anaesthesia (MUA) and 39 by operation (ORIF). The mean follow-up was 28 months (range 18–38 months) in the ORIF group and 25.5 months (range 12–40 months) in the MUA group. A statistically significant proportion of patients were satisfied with regard to pain, swelling, stiffness, instability and ranges of movement after ORIF. Anatomical congruity of the ankle mortice was better maintained following ORIF. Poor subjective and objective end results correlated with malalignment of the ankle mortice on the final radiograph at follow-up. The score used in these study is not named.

Beuchamp et al[19] did a retrospective study of 38 patients over 50 years with bimalleolar fractures, 17 patients were managed non operatively and 21 managed operatively. They found no significant difference in pain and instability in the ORIF and conservative groups. Patients who underwent ORIF were however more satisfied.

Tunturi et al[25] had a series of 34 bimalleolar fractures. Forty one percent had stable fractures and were managed conservatively. The unstable fractures were 42%, they all underwent ORIF. There was no significant difference in pain and stiffness between the two groups.

Yde and Kristensen[26] did a retrospective study of 89 Weber B bimalleolar fractures. Sixty patients who had displaced fractures underwent ORIF. There was significantly less pain, stiffness and instability in this group as compared to the non operative group.

The functional outcome of ankle fracture treatment is measured in terms of patient satisfaction, presence of residual pain after treatment, range of motion and ankle and foot deformity. Poorly

managed bimalleolar fractures are associated with pain, stiffness, infection, nonunion, malunion, wound complications, loss of fixation, or intraarticular or palpable screws[5]. Diabetes mellitus and peripheral vascular diseases have been associated with delayed healing.[27, 28, 29]

A considerable number of validated tools for measurement of outcomes are used in the foot and ankle clinical literature, with only a small proportion used consistently. The five most popular scales as a percentage of foot and ankle outcome articles are the American Orthopaedic Foot & Ankle Society (AOFAS) scale (55.9%), Visual Analog Scale (VAS) for pain (22.9%), Short Form-36 (SF-36) Health Survey (13.7%), Foot Function Index (FFI, 5.5%), and the American Academy of Orthopaedic Surgeons outcomes instruments (AAOS, 3.3%).[30]

The AOFAS clinical rating scales were developed in the 1990s by the AOFAS to report the clinical status of any foot or ankle disorder or procedure. [31] They consist of four 100-point anatomic scales: ankle-hindfoot, midfoot, hallux, and lesser toes. Each subscale assigns points, with variable weight, based on both subjective and objective data in three categories: pain, function, and alignment. Physician-entered variables include categorical ratings for joint range of motion, gait abnormalities, stability, alignment, shoe wear, and callus assessment.

Pain is an important prognosticator of return to full function. Wronka[36] reported 23% of patients having pain at three months after treatment, 40% to 60% of patients with bimalleolar fractures having residual pain a year after treatment.[32, 33]

Hancock et al[34] and Lin et al[35] demonstrated that pain (as measured using a 100mm VAS) and range of dorsiflexion measured within 1 week of cast removal are more predictive of 6 week and 6-month functional outcome as measured using the Lower Extremity Function Scale (LEFS) than the mode of treatment or severity of injury. [34, 35]

Wronka[23] reported 28% of patients having stiffness at 14 weeks, Rowley[36] 44% at 16 weeks and 9% at 27 months by Makwana. [37] All the patients had physiotherapy

Radiographic anatomical reduction is achieved in 57% to 91% of the ankles managed conservatively and 86% to 99% of the ankle managed operatively. [22, 23, 36, 37]

The common deformities seen include malunion of the medial malleolus and elongation of the medial malleolus. Other deformities include cavovarus and pes planus, which are rare and associated with entrapment of tibialis posterior tendon by exuberant callus formation[32]. The rate of nonunion of bimalleolar fractures is seen in 10-19% of patients treated by closed reduction and less than 2% in open reduction.[5, 23, 36]

Degree of anatomical reduction is usually a composite of several measures, including degree of contact between the fracture surfaces, transverse shift of the talus in relation to the lateral malleolus, degree of fibular shortening, and malrotation. Decreased surface contact area leads to an abnormal distribution of joint stresses, which presumably leads to post-traumatic arthritis. [39] Restoration of fibular length and rotation is critical in re-establishing a stable ankle mortise, and can be assessed radiographically at the talofibular articulation.[39] Fibular displacement is associated with a poor VAS. [7] Fibular shortening and malrotation should also be assessed when determining the adequacy of reduction in fractures of the ankle. The significant changes in contact pressures are found with as little as 2mm of shortening or lateral shift of the fibula or 5° of external rotation, and these worsen with increasing degrees of shortening, lateral displacement and malrotation.[40]

A medial clear space (MCS) greater than 4mm produces an unstable ankle, and is hence used as the threshold for a stable reduction as evidenced by Clements study that found that as the MCS increased there was an inverse decrease in the mean AOFAS score, with significant differences between the 4mm and the 6-7mm. [41]

ORIF may be possible within the first 12 hours after injury, but may also be difficult again for 2 to 3 weeks because of excessive swelling. Delayed closure and even skin grafting may be necessary when too much swelling exists at surgery. Breederveld et al. found equally good functional results with immediate and delayed open reduction and internal fixation; however, hospitalization was

briefer and pain was diminished with immediate surgery.[42] In a retrospective study of closed Danis-Weber type B bimalleolar or bimalleolar-equivalent ankle fractures treated with open reduction and internal fixation, Konvath et al. found no significant differences in complications, adequacy of reduction, range of motion, or operative time in 105 fractures treated within 5 days of injury compared with 97 fractures treated more than 5 days after injury.[43] These authors concluded that although delayed surgery may be technically more difficult, it is justified in patients with severe closed soft-tissue injury or fracture blisters. If open reduction of a fracture-dislocation is delayed, immediate closed reduction of the dislocation and splinting are mandatory to prevent skin necrosis.

JUSTIFICATION AND SIGNIFICANCE

The incidence of ankle fractures is on the rise. [2] On average 38 patients with bimalleolar fractures are managed at KNH every month. While majority of the studies done on ankle fracture studies are on the elderly[19, 23,24, 36] , in Africa, most of the bimalleolar fractures are in patients below the age of 50 years. In the elderly most of the fractures are caused by a fall whereas RTA are the main cause of the fractures in the younger age group.[12] This is the economically active age group. How well these patients are able to regain their pre-injury level of function and independence is a measure of the success or failure of the treatment regime.

Data on bimalleolar fractures in Africa are scarce. Most studies discuss ankle fractures in general. It is important to establish local data on the demographics, causation and outcomes on these fractures. Due to paucity of data, there are no clear guidelines on the treatment protocols of these fractures. The demographic patterns of bimalleolar fractures and the treatment outcomes have not been well established in our local low-resource setting. This study had not been done at KNH. Therefore, there was a need to look at the outcomes of these fractures, to inform the development of protocols and the complications associated with these fractures documented.

OBJECTIVES

Broad objective: To assess the pattern and outcome of bimalleolar fractures at Kenyatta National Hospital.

Specific objectives

1. To determine the demographic patterns of bimalleolar fractures at KNH.
2. To determine the treatment modalities of ankle fractures at KNH.
3. To determine the early outcomes of bimalleolar fractures at KNH.

PATIENTS AND METHODS

DESIGN AND SETTING

A prospective observational study of patients with bimalleolar ankle fractures. It was done at the Accident and Emergency unit, Orthopedic wards and fracture clinic at Kenyatta National Hospital, the largest referral and teaching hospital in Kenya. It was conducted between August and November 2015.

SELECTION CRITERIA

Inclusion

Consecutive patients diagnosed to have isolated bimalleolar fractures on radiography and treated at KNH within 3 weeks of injury. Weber A, B and C injuries were included.

Exclusion

- Bilateral ankle injuries
- Pre-existing ipsilateral or contralateral ankle pathology
- Pathological fracture (e.g. a stress fracture)
- Refracture of a previous ankle fracture
- Diabetes mellitus, neuropathic vascular disorders that may impair healing
- Unimalleolar and trimalleolar fractures
- Concurrent foot deformities
- Inability to attend clinic for follow-up or inability to follow the postoperative regime.
- Refusal to give consent.

SAMPLE SIZE CALCULATION

The sample size was calculated as follows. [44]

$$N = \frac{{Z_{0.975}}^2 P(1-P)}{\Delta^2}$$

Where N is the sample size of the study

P is the proportion of patients with bimalleolar ankle fractures (25%),

$Z_{0.975}$ is the reliability coefficient, given a 95% confidence level (1.96)

Δ is the precision of the proportion (10%)

N= 72 patients.

METHODS

Patients with isolated ankle injuries were identified and radiographs taken (at least the anteroposterior and lateral views). Those with bimalleolar fractures were recruited into the study and followed up. Patients' bio data on age and sex were recorded in the data sheet (Appendix 1). Fractures were classified as either Weber A, B or C. The patients were then followed-up and the modality of treatment documented, as they came for review in the fracture clinic.

Assessment was done at 2, 6 and 12 weeks. The assessment at 2 weeks was for maintenance of reduction and surgical site infection (for ORIF group), at 6 weeks for clinical and radiological union, and at 12 weeks the VAS and AOFAS scale were administered and documented.

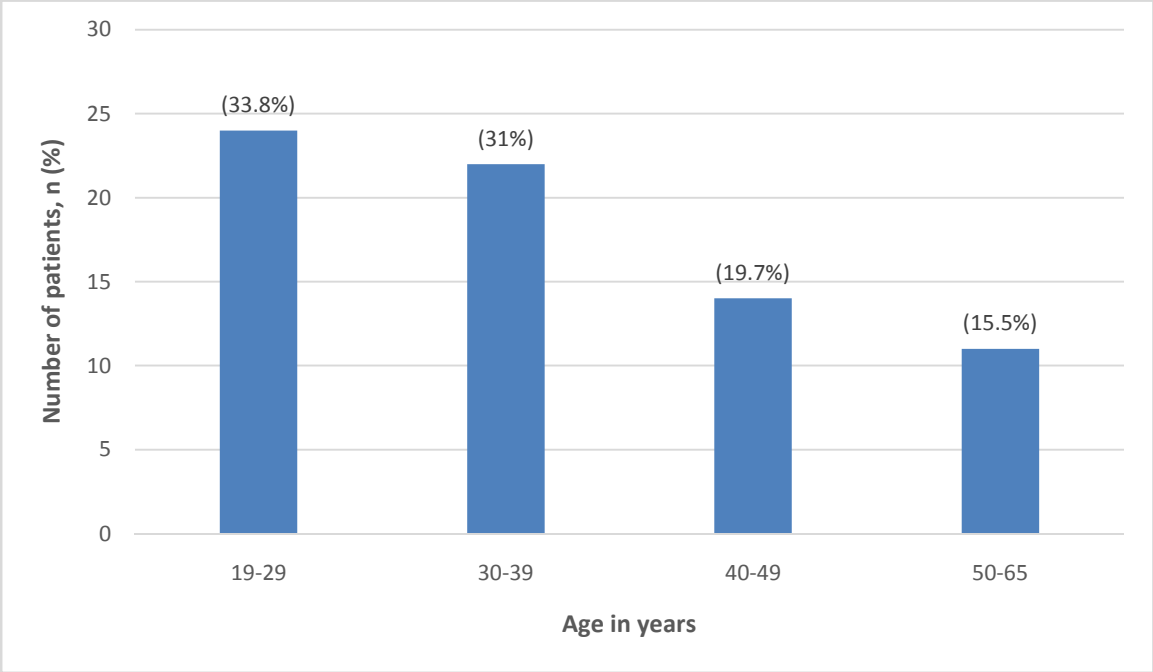
ETHICAL CONSIDERATION

Approval for the study was given by the Kenyatta National Hospital – University of Nairobi Ethics and Research Committee (KNH-UoN ERC) reference number P465/07/2015. Patients gave a written informed consent before inclusion in the study. Names of the patients' were hidden during the data collection for confidentiality purposes.

Demographic patterns of bimalleolar fractures at KNH

The mean age of the adults presenting to KNH with bimalleolar fractures was 36.4 years (SD ±10.4) with an age range between 19 and 63 years. The modal age group was between 19 and 29 years with this group accounting for 24 (33.8%) patients followed by patients aged between 30 and 39, n = 22 (31%). These 2 groups account for 64.8% of the patients.

Figure 1: Age distribution of bimalleolar fractures



Most (42, 58.3%) bimalleolar fractures occurred in male patients. There were 30 (41.7%) female patients with bimalleolar fractures resulting in a male-to-female ratio of approximately 3:2.

Anatomic presentation and etiology of bimalleolar fractures at KNH

The right limb was involved in 62% of the patients. Closed fractures comprised 63.9% (n=46). The most common fractures were Weber B and C which occurred in 45.8% and 43.1% respectively.

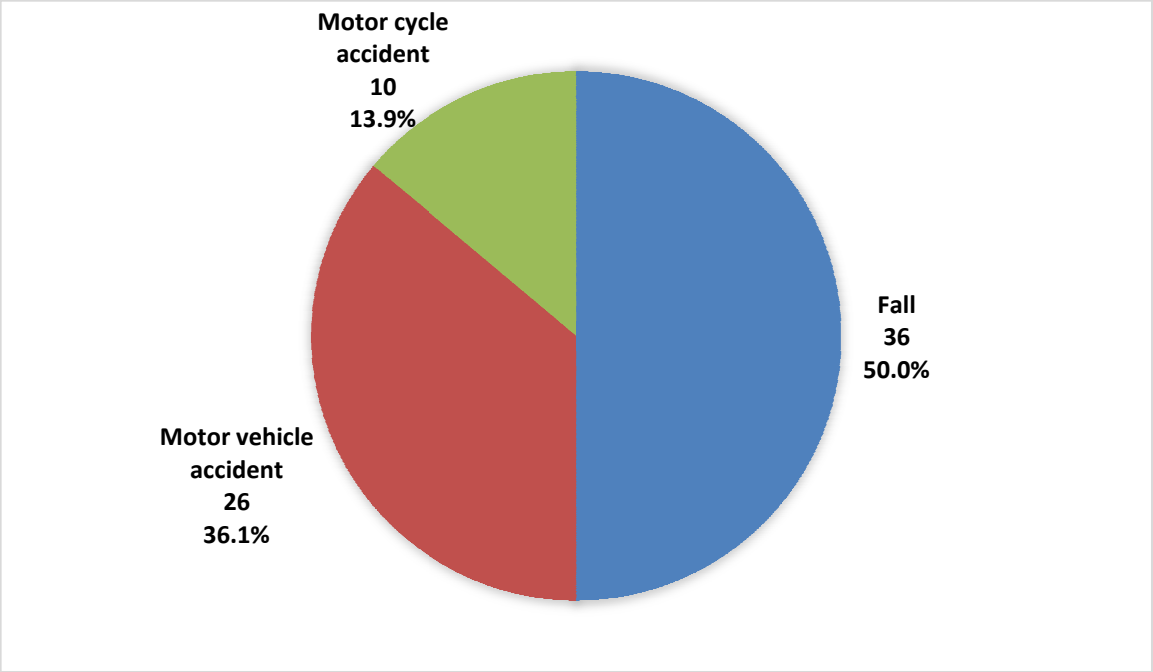
Most of the tibial fractures were transverse 58 (84.1%) while the fibular fractures were commonly of the oblique type, 50%.

Table 1: Presentation of bimalleolar fractures by site and fracture type

	Frequency	**Percent**
Fractured limb		
Right	44	62
Left	27	38
Injury type		
Open	26	36.1
Closed	46	63.9
Weber classification of fracture		
A	8	11.1
B	33	45.8
C	31	43.1
Tibial fracture		
Transverse	58	84.1
Oblique	9	13
Comminuted	2	2.9
Fibular fracture		
Transverse	21	29.2
Oblique	36	50
Comminuted	15	20.8

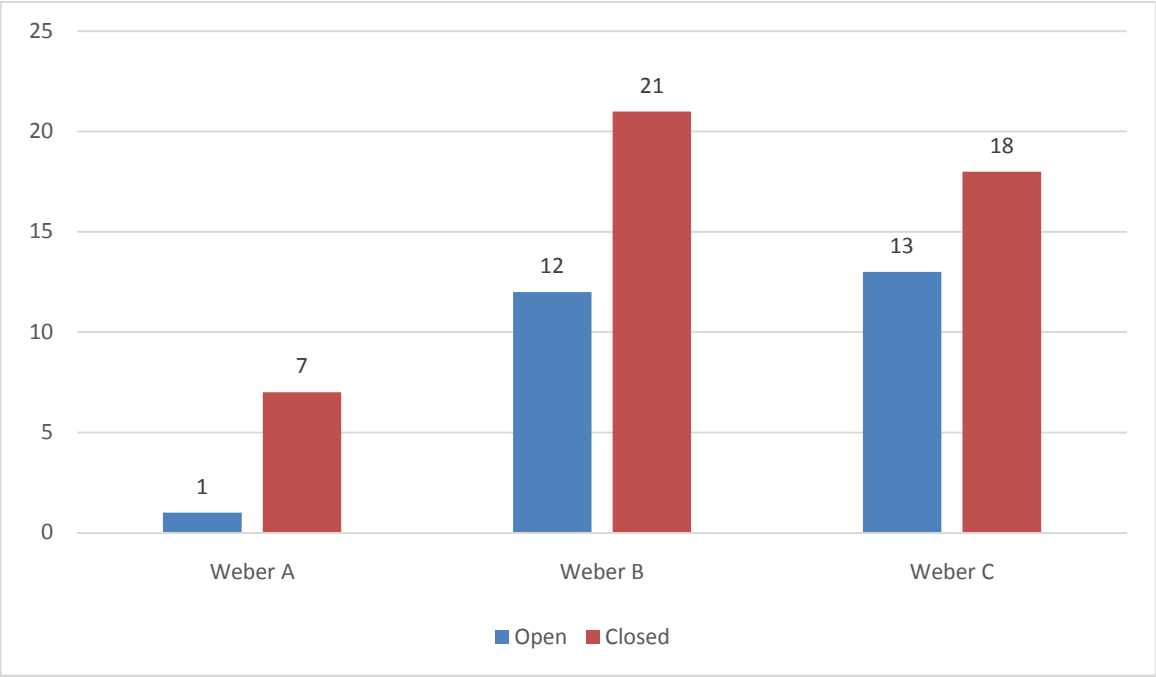
Causes of fractures

Figure 2: Causes of bimalleolar fractures in patients at KNH



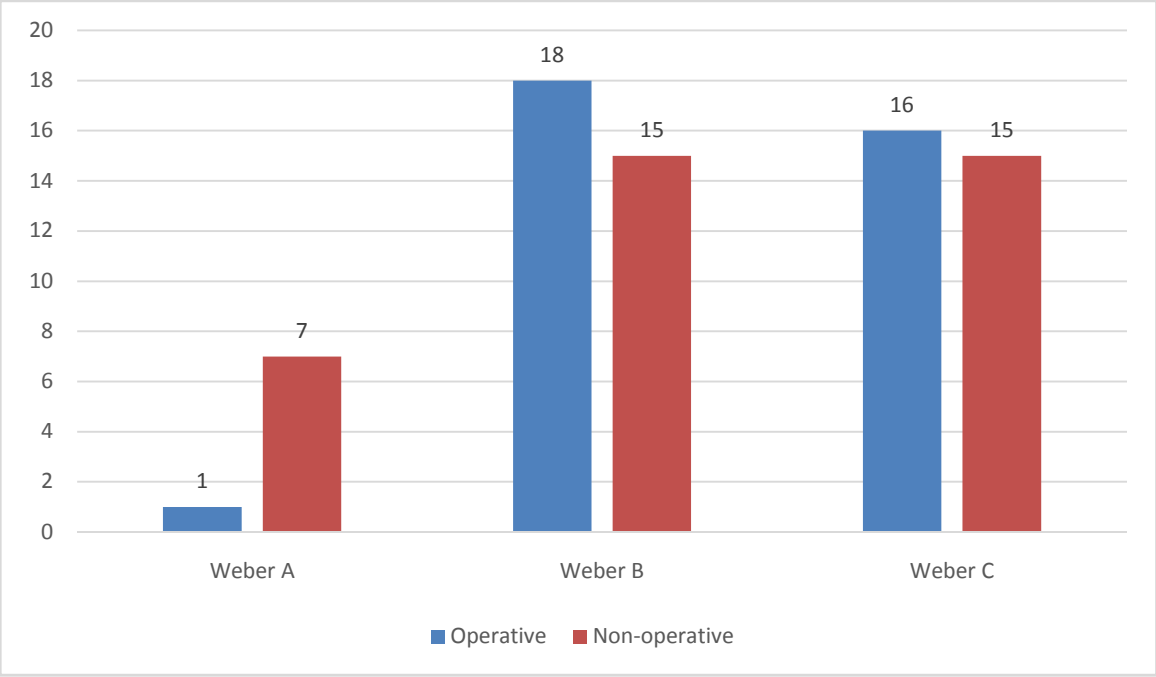
Among the Weber A fractures, 1 was open, 7 closed, Weber B; 12 open and 21 closed, Weber C; 13 open and 18 closed. Of the 35 operatively managed fractures, 1 was Weber A, 18 Weber B and 16 Weber C (figure 3-4). Indications for operative management were; open fractures, displaced fractures (lateral displacement of more than 2mm) and dislocations.

Figure 3: Proportion of open and closed bimalleolar fractures



P = 0.303

Figure 4; Proportions of operative and non operative bimalleolar fractures



P = 0.093

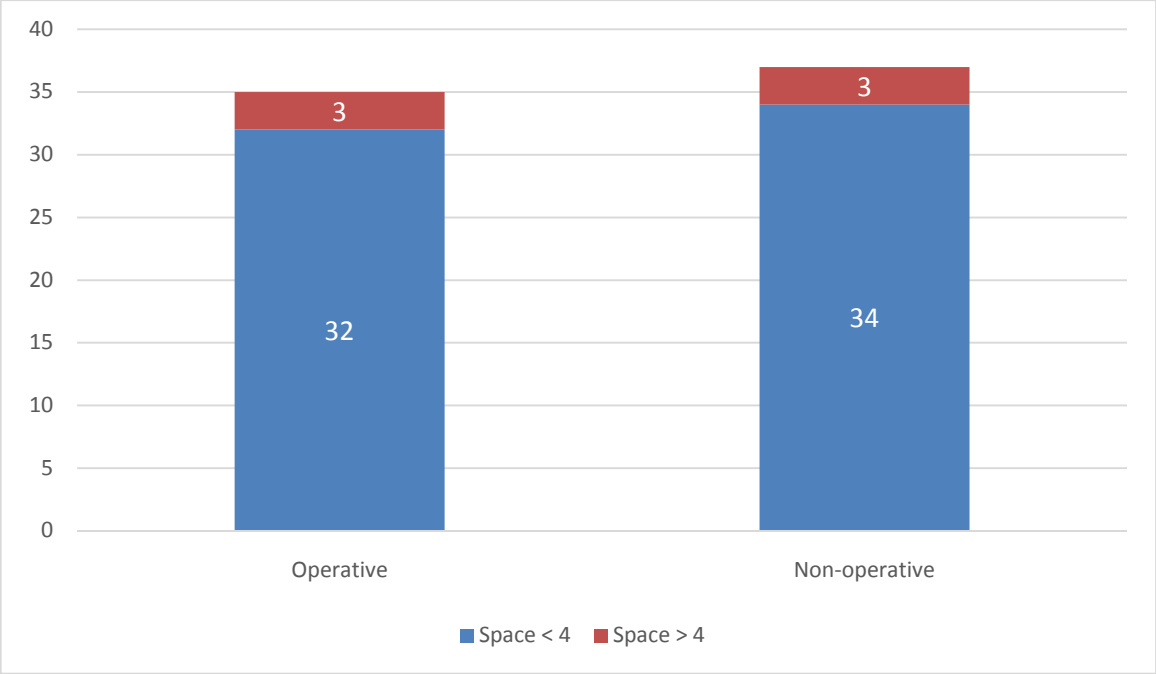
Treatment outcomes of bimalleolar fractures at 2 -6 weeks

Superficial surgical site infection was found in 2 (5.7%) patients who were managed operatively (table 2). Radiograghs taken at 2 weeks showed a medial clear space greater than 4mm in 6(8.3%) patients. Three had been managed operatively (figure 5). One was Weber B and the other 5 Weber C.

Table 2: Treatment and reassessment of patients with bimalleolar fracture in KNH

	Frequency	Percent
Treatment		
Operative	35	49
Non-operative	37	51
Surgical site infection (operative at 2 weeks)		
Yes	2	5.7
No	33	94.3
Clinical or radiologic union (at 6 weeks)		
Yes	70	97.2
No	2	2.8

Figure 5; Treatment vs. medial clear space



Outcome scores

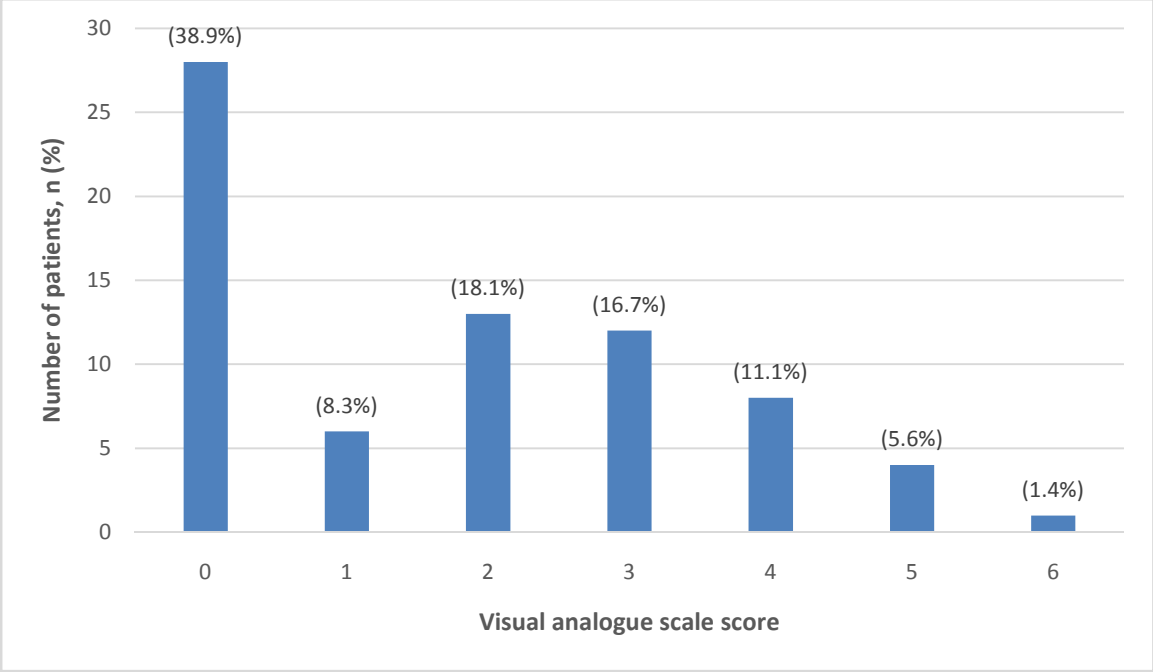
Visual Analogue Scale

Figure 6 shows patient self-reported pain based on a visual analog scale (range 0-10). There were no patients reporting severe pain (VAS score ≥7). Most patients reported mild levels of pain represented by scores between 1 and 3 (43.1%). Twenty eight patients (38.8%) scored pain at 0 and the remaining 18.1% of patients reported moderate pain (VAS scores 4-6).

There were no significant differences in the patients reported level of pain on VAS and type of treatment (p = 0.759), time since treatment (p = 0.535), type of injury (p = 0.405) or Weber classification of fracture (p = 0.478).

Most 56 (84.8%) patients with medial clear space of 0-4 mm reported VAS < 3 compared to 50% of patients with medial clear space > 4 mm who similarly reported VAS < 3 (p = 0.034).

Figure 6: Visual analogue scores for pain in patients with bimalleolar fractures in KNH



AOFAS

The mean AOFAS score for patients with bimalleolar fractures at KNH was 78.2 (SD ± 20.7), range 17 to 100. The mean AOFAS for Weber A, B and C were 96.6, 80.3 and 72.9 respectively (table 3). There were significant differences in mean AOFAS score for patients on the operative compared to non-operative treatment (p = 0.001) and patients with open compared to closed injury (p = 0.002).

Table 3: Mean AOFAS scores according to type of injury and treatment

	Mean	**SD**	**ANOVA F**	**P value**
Type of treatment				
Operative	69.6	20.6	12.28	0.001
Non-operative	85.6	17.5		
Time to treatment				
<48 hrs	77.0	20.7	0.12	0.891
<7 days	81.7	15.6		
>7 days	77.7	21.8		
Type of injury				
Open	68.3	21.1	10.65	0.002
Closed	83.8	18.4		
Weber classification of fracture				
A	90.6	12.9	2.77	0.070
B	80.3	21.2		
C	72.9	20.5		

The AOFAS score was significantly related with patient level of education (p = 0.03) but not with age (p = 0.790) or sex (p = 0.111), Table 4. Post hoc ANOVA analysis showed that patients with secondary level education on average had an AOFAS score that was15.5 points higher compared to those with primary education (p = 0.03) corresponding to less pain in patients with primary compared to secondary education. The scores for secondary and tertiary levels did not differ (p = 0.435).

There was no significant difference between open and closed, or operative and non operative Weber B fractures. Operatively managed Weber C fractures had a significantly lower score than conservatively managed fractures at 63 and 84.3 respectively (table 5-7).

Table 4: AOFAS score versus patient demographic characteristics

	Mean	SD	ANOVA F	P value
Age in years				
19-29	79.4	22.0	0.35	0.790
30-39	80.9	21.8		
40-49	73.8	21.4		
50-65	77.5	16.3		
Sex				
Male	76.5	22.1	2.08	0.111
Female	80.6	18.6		
Education level				
Primary	69.1	21.5	5.04	0.03
Secondary	84.5	15.9		
Tertiary	76.9	23.9		

Table 5: Comparison of clinical AOFAS and VAS pain scores and clinical outcomes according to weber classification

	Clinical / radiologic union, n (%)	Median VAS	Mean AOFAS	P*
	6 weeks	12 weeks	12 weeks	
Injury type				
Open (n = 26)				
Weber A (n = 1)	1 (100%)	-	-	
Weber B (n = 12)	12 (100%)	2	68.3	
Weber C (n = 13)	13 (100%)	3	66.3	0.821
Closed (n = 42)				
Weber A (n =7)	6 (86%)	1	90	
Weber B (n = 21)	21 (100%)	0	87.1	
Weber C (n = 18)	17 (94%)	2	77.6	0.121
Medial clear space				
Space <4 (n = 66)	64 (97%)	2	80.2	
Space >4 (n = 6)	6 (100%)	3.5	57.2	0.008
Treatment				
Operative (n = 35)				
Weber A (n = 1)	1 (100%)	-	-	
Weber B (n = 18)	18 (100%)	2	74.1	
Weber C (n = 16)	16 (100%)	3	63	0.117
Non operative (n = 37)				
Weber A (n = 7)	6 (86%)	1	90	
Weber B (n = 15)	15 (100%)	0	87.7	
Weber C (n = 15)	14 (93%)	1	83.4	0.523
* comparison of Weber B versus C				

Table 6: Comparison of AOFAS and VAS pain scores in patients with Weber B fractures

	Clinical / radiologic union, n (%)	**Median VAS**	**Mean AOFAS**	**P***
Weber B (n = 33)	6 weeks	12 weeks	12 weeks	
Injury type				
Open (n = 12)	12 (100%)	2	68.3	
Closed (n = 21)	21 (100%)	0	87.1	0.011
Medial clear space				
Space <4 (n = 32)	31 (100%)	1	81.3	
Space >4 (n = 1)	1 (100%)	-	-	-
Treatment				
Operative (n = 18)	18 (100%)	2	74.1	
Non operative (n = 15)	15 (100%)	0	87.7	0.064

Table 7: Comparison of AOFAS and VAS pain scores in patients with Weber C fractures

	Clinical / radiologic union, n (%)	**Median VAS**	**Mean AOFAS**	**P***
Weber C (n = 31)	6 weeks	12 weeks	12 weeks	
Injury type				
Open (n = 13)	13 (100%)	3	66.3	
Closed (n = 18)	17 (94.4%)	2	77.6	0.131
Medial clear space				
Space <4 (n = 26)	25 (96.2%)	2.5	75.5	
Space >4 (n = 5)	5 (100%)	3	59.2	0.104
Treatment				
Operative (n = 16)	16 (100%)	3	63	
Non operative (n = 15)	14 (93.3%)	1	84.3	0.004

The AOFAS score did not show any significant clinical or radiologic union, physiotherapy ($p = 0.052$), medial clear space ($p > 0.99$), surgical site infection or time of surgery (table 8).

Table 8: AOFAS and early outcomes

	Mean	SD	ANOVA F	P value
Clinical or radiologic union				
Yes	77.6	20.6	NA	NA
No	100.0	0.0		
Physiotherapy				
Yes	80.4	19.0	3.91	0.052
No	77.6	21.3		
Medial clear space				
0-4 mm	80.2	20.4	0	>0.99
> 4 mm	57.2	8.0		
Surgical site infection				
Yes	55.5	12.0	NA	NA
No	70.5	20.8		
Time since treatment				
<48 hrs	77.0	20.7	0.12	0.891
<7 days	81.7	15.6		
>7 days	77.7	21.8		

DISCUSSION

This study aimed at determining the pattern and outcome of bimalleolar fractures at KNH.

Majority of the patients were young patients under 40 years with a slight male predominance. Fifty percent of the fractures were caused by RTAs while the other 50% was by falls. African studies showed a predominance of RTAs as the main cause of the fractures majority of them being men[12,13] as opposed to Caucasian studies where the majority were caused by falls and were predominantly women,[13,15,16,18] however it was consistent with a Nigerian study that had RTAs causing 46.3% of the ankle fractures[45] and a South African study that had falls causing 53% of the injuries.[14] Road traffic injuries are common in 3rd world countries due to; social inequality, vulnerable road users– pedestrians, cyclists, motorized 2 wheelers, bus & minibus passengers.[47]

Open fractures were 26 (36%), this was higher than the Caucasian studies where open bimalleolar fractures were lower than 5%.[17] This may be related to the aetiology of the fractures where in the Caucasian population most ankle fractures were caused by falls which are low energy as opposed to the Kenyan population where the fractures were due to high energy trauma.

Weber B fractures were the most common (45.8%) which was comparable to other results by Hughes, Reuwer and Schweiberer.[20, 21, 46] Forty nine percent of the patients were managed operatively. These were patients who had displaced Weber B and C injuries and also open fractures. There was no significant difference in the AOFAS score between the operative and non operative Weber B fractures. However the operative Weber C bimalleolar fractures had a significant lower AOFAS score than the non operative Weber C fractures. The low operative AOFAS score may be as a result of the severity of the injury or syndesmotic injury, rather than the operative treatment. Operatively managed fractures were likely to be severe ankle injuries that were displaced and comminuted.

Sixty one percent had the definitive treatment done after a week. The causes of delayed treatment were; late presentation to the hospital due financial or infrastructure constraints, septic open fractures, blistering, swelling and theatre space unavailability. There was no significant difference between early and late treatment of bimalleolar fractures. These findings were similar to those of Breederveld[42] who found no difference in outcome on patients who had delayed treatment up to 8 days. Konvath[43] also found no diffence in outcome between early (mean 1.5 days from injury to surgery) and late (mean of 13.6 days from injury to surgery) treatments of bimalleolar fractures. The longest duration was 11 days due to lack of theatre space. Early surgery is recommended to reduce the hospital stay and cost to the patient, however if there is swelling or blistering treatment should be delayed until it subsides.

There was mild to moderate pain in 61.2% of the patients. Previous studies report pain at 23%-60% at one year.[6, 32, 33]The pain incidence was higher in this study because it is a short duration of follow up. It is expected to reduce with time. Patients with a medial clear space >4mm had a poorer VAS than the well reduced fractures which was similar to the Clement et al study.[41]

The functional capacity was reduced by a high medial clear space, operative management and physiotherapy. Previous studies show either a better outcome with operative treatment[22, 26] or similar outcome between the operative and non operative treatment.[7, 19, 23, 25] Makwana's study showed a better functional capacity in the non operative group although there was no difference between the two groups overall outcome.[23] Most of the above studies were on the elderly majority of whom had low energy trauma. Majority of the patients in this study were young, the patients who underwent surgery were likely to have had high energy injuries with displacement and syndesmotic injuries. The open fractures were managed operatively which has an associated with a lower AOFAS score.

Only 23.6% of patients had physiotherapy, yet these patients had reduced functional capacity. These are likely to be those who had severe injuries and therefore functional impairment was

anticipated and therefore physiotherapy. Majority of the patients had a basic and secondary level of education; these are likely to be low income earners, who walk for long distances. This may explain why the functional outcome was good despite not having physiotherapy. This study did not focus on how the physiotherapy was done to determine its effectiveness.

CONCLUSION

Patients presenting in KNH with bimalleolar fractures are young.

Delay in definitive treatment of up to a week post-fracture does not seem to adversely affect outcomes despite poorly supervised physiotherapy.

The main determinant of good outcome was the medial clear space, if it was less than 4mm.

RECOMMENDATIONS

All bimalleolar fractures should be treated operatively. Closed undisplaced fractures may be treated conservatively.

Bimalleolar fractures should be treated early. However late treatment does not have an adverse outcome.

The role of physiotherapy should be studied further to establish the effect in bimalleolar fractures.

LIMITATIONS AND DELIMITATIONS

The radiographs did not show ligamentous and chondral injuries which may have affected the outcome. There were different magnifications on the radiographs that may have affected accurate measurements. The magnifications were adjusted to 100% to give accurate measurements.

While collection of data for 3 months postoperatively may give meaningful insight into the short-term outcomes of these patients, no firm conclusions on their long-term results can be drawn.

The AOFAS-hindfoot score was used as the primary outcomes instrument. While the AOFAS score is a validated, patient-based outcome assessment tool, it was not conceived specifically for patients with an ankle fracture. Instead, it has been applied to foot and ankle conditions in general.

There were no selected skilled attenders specific to this study.

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APPENDIX 1: QUESTIONNAIRE

PATTERN AND OUTCOME OF BIMALLEOLAR FRACTURES AT KNH

At first contact

Serial No: ……..

IP Number: ……..

Date: …….

Sex: M ☐ F ☐

Age: ……..yrs

Level of Education **Primary** ☐ **Secondary** ☐ **Tertiary** ☐

Occupation **…….**

Tel: …….

Side of injury:

R ☐ L ☐

Injury Date: ……

Treatment Date …….

Weber classification:

A ☐ B ☐ C ☐

Fracture line	Transverse	Obligue	Comminuted
Tibial	☐	☐	☐
Fibular	☐	☐	☐

Cause of injury:

☐ Fall

☐ Motor vehicle accident

☐ Motor bike accident

Treatment

☐ Operative

☐ Non-operative

Injury type

☐ Open

☐ closed

At 2 weeks

Reduction Maintained on radiograph?

Medial clear space

☐ 0 – 4mm

☐ >4mm

Surgical site infection

Yes ☐ No ☐

At 6 weeks

Clinical and or radiological union?

Yes ☐ No ☐

AT 12 WEEKS

Physiotherapy

☐ Yes

☐ No

Pain: Visual Analog Scale(1-10):

AOFAS SCORE

1. **Pain (40 Points):** Over the past month, how much has your foot pain limited your daily activities?

☐ I have no pain with normal activity (40)

☐ I have slight or occasional pain with no limitation of activities (30)

☐ I have moderate pain limiting daily activities (20)

☐ I have severe pain that limits almost all activity (0)

2. **Function (50)**

Do you have activity limitation or require support?

☐ I have no limitation, I don't use support (10)

☐ I have no limitation of daily activities, I have limitation of recreational activities but I don't use support(7)

☐ I have limited daily and recreational activities, I use a cane (4)

☐ I have severe limitation of daily and recreational activities. I use a walker/wheelchair/brace/crutches (0)

How much distance can you walk?

☐ ≥ 100m (5)

☐ 50-99m (4)

☐ 10-49m (2)

- ☐ <10m (0)

Do you have difficulties walking on surfaces (7 points)

- ☐ No difficulty on any surface (5)
- ☐ Some difficulty on uneven terrain, stairs, inclines, ladders (3)
- ☐ Significant difficulty on uneven terrain, stairs, inclines, ladders (0)

Gait abnormalities (8 points)

- ☐ None, slight (8)
- ☐ obvious (4)
- ☐ marked (0)

Sagittal motion (flexion plus extension)

- ☐ normal or mild restriction >30° (8)
- ☐ moderate restriction 15°-29° (4)
- ☐ severe restriction <15° (0)

Hindfoot motion (inversion plus eversion)

- ☐ normal or mild restriction 75%-100% normal (6)
- ☐ moderate restriction 25%-74% normal (3)
- ☐ severe restriction <25% normal (0)

Ankle-Hindfoot stability (anteroposterior, varus-valgus)

- ☐ stable (8)
- ☐ definitely unstable (0)

3. Alignment (10)

- ☐ good, plantigrade foot, midfoot well aligned (10)
- ☐ fair, plantegrade foot, some degree of midfoot malalignment observed (5)
- ☐ poor, non plantigrade foot, severe malalignement, symptoms (0)

TOTAL: …….. points

MATOKEO YA MATIBABU YA MAJERAHA YA KIWIKO KATIKA KATIKA HOSPITALI YA KNH

mawasiliano ya kwanza

Nambari ya utafiti: ……..

Nambari ya hospitali: ……..

tarehe: …….

jinsia: mme ☐ mwanamke ☐

umri: ……..

kiwango cha elimu **msingi** ☐ **Secondari** ☐ **elimu ya** ☐ **juu**

kazi …….

simu: …….

Upande umeumia:

R ☐ L ☐

Tarehe ya kuumia: ……

Tarehe ya matibabu …….

Weber classification:

A ☐ B ☐ C ☐

Fracture line	Transverse	Obligue	Comminuted
Tibial	☐	☐	☐
Fibular	☐	☐	☐

Maumivu yalivyotokea:

☐ kuanguka

☐ ajali ya gari

☐ ajali ya pikipiki

matibabu

☐ upasuaji

☐ bila upasuaji

aina ya maumivu

☐ kidonda

☐ bila kidonda

Katika kipindi cha wiki mbili

Matibabu yamaemarika kwa xray?

Medial clear space

☐ 0 – 4mm

☐ >4mm

Upasuaji tovuti maambukizi

ndio ☐ la ☐

Kipindi cha wiki sita

Mifupa imeungana?

ndio ☐ la ☐

Kipindi cha wiki kumi na mbili

Mazoezi yalifanywa?

- ☐ ndio
- ☐ la

uchungu: Visual Analog Scale(1-10):

AOFAS SCORE

- ☐ **uchungu (40 Points):** kwa muda wa mwezi moja uliopita, uchungu kwa mguu umekukatiza kufanya shugli zako kwa kiwango kipi?
- ☐ Sina uchungu kwa shughuli za kila siku (40**)**
- ☐ nina maumivu kidogo au mara kwa mara bila kukatiza shughuli (30)
- ☐ Nina maumivu wastani na nikikwazo kwa shughuli za kila siku (20)
- ☐ Nina maumivu makali yanayo katiza karibu shughuli zote za siku (0)

4. Kazi (50)

Je, shughuli zako zinakatizwa au unahitaji msaada?

- ☐ Sikatizwi, na situmii msaada (10)
- ☐ Sikatizwi kwa shughuli za kila siku, sina kiwango cha juu cha shughuli za burudani lakini situmii msaada(7)
- ☐ Nakatizwa kwa shughuli za kila siku na shughuli za burudani, natumia mkongojo (4)
- ☐ I have severe limitation of daily and recreational activities. I use a walker/wheelchair/brace/crutches (0)

Unaeza tembea umbali wa kiasi gani?

- ☐ ≥ 100m (5)
- ☐ 50-99m (4)
- ☐ 10-49m (2)

- ☐ <10m (0)

Je, una matatizo ya kutembea kwenye nyuso (7 pointi)

- ☐ Sina matatizo (5)
- ☐ Hakuna shida juu ya uso yoyote (3)
- ☐ Kuna ugumu baadhi ya ardhi ya eneo kutofautiana (0)

Matatizo ya enenzi (8 pointi)

- ☐ Hamna, kidogo (8)
- ☐ wazi (4)
- ☐ dhahiri (0)

mwendo wa juu na chini (flexion plus extension)

- ☐ kawaida au kizuizi kidogo >30° (8)
- ☐ kizuizi wastani 15°-29° (4)
- ☐ kizuizi kali <15° (0)

mwendo wa wayo pande ya nyuma (inversion plus eversion)

- ☐ kawaida au kizuizi kidogo 75%-100% normal (6)
- ☐ kizuizi wastani 25%-74% normal (3)
- ☐ kizuizi kali <25% normal (0)

Kifundo cha mguu na udhabiti wa wayo (anteroposterior, varus-valgus)

- ☐ imara (8)
- ☐ imelegea (0)

5. kulaiinika (10)

- ☐ mguu umelainika (10)
- ☐ haujalainika kabisa (5)
- ☐ mguu haujalainika kwa njia yeyote (0)

jumla: …….. pointi

APPENDIX 2A: CONSENT FORM

PATTERN AND OUTCOME OF BIMALLEOLAR FRACTURES AT KNH

Study No.: _____

Hospital No.: _____

Introduction

You are invited to participate in a research study on the pattern and outcomes of bimalleolar fractures at Kenyatta National Hospital (KNH). The study will be conducted by me, Dr Michael M. Njau, a postgraduate student in the Department of Orthopaedic Surgery, University of Nairobi. It is part of the requirement of my studies to conduct the research.

You were selected as a participant because you have a bimalleolar fracture. You may not participate if you have any of the following; Bilateral ankle injuries, pre-existing ipsilateral or contralateral ankle pathology, pathological fracture (e.g. a stress fracture), refracture of a previous ankle fracture, diabetes mellitus, neuropathic vascular disorders that may impair healing, unimalleolar and trimalleolar fractures, concurrent foot deformities, inability to attend clinic for follow-up or inability to follow the postoperative regime

I ask that you read this form and ask any questions that you may have before agreeing to be in the study.

Purpose of the study

The purpose of this study is to evaluate the outcomes of bimalleolar ankle fractures treated either operatively or non-operatively at KNH. The information gathered will be useful in improving the treatment of bimalleolar fractures.

Description of the Study Procedures

If you agree to be in this study, you will be asked to do the following things: your attending surgeon will make an informed decision on whether to treat your fracture by cast or operatively. You will attend clinic at 2 weeks to check whether your fracture is still reduced through a radiogragh, at 6 weeks to check for clinical and radiograghic healing and possible removal cast and 12 weeks for scoring for the treatment outcome.

Risks and benefits

There is no risk or harm involved in the participation of this study.

Participation in the study is out of your own free will. Your treatment will not be compromised by failing to participate in the study.

Confidentiality

All your clinical data will be strictly confidential to the extent provided by the law. Your identity will be coded and will not be associated with any published results. The study results will be on group findings and not individual participants. The records of this study will be stored securely and will only be accessible to researchers.

Contact information

If you have any questions related to the study, you can contact Dr Michael M. Njau who is the primary researcher on 0721851377 or mwauranjau@yahoo.com . If there are queries on the rights on human participants, contact The Secretariat, KNH – UON Ethics and Research Committee on 020-2726300.

APPENDIX 2B: CERTIFICATE OF CONSENT

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Name of Participant_____

Signature/thumbprint of Participant _____

Date _____

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands the procedure of the research.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Name of Researcher_____

Signature of Researcher_____

Date _____

Contacts

Researcher

Dr. Njau Michael Mwaura

P.O Box 46-00219 Karuri, Kenya.

Email: mwauranjau@yahoo.com

Lead supervisor

Dr. Richard B. Ombachi

P.O. Box 29719-00202 Nairobi, Kenya.

Email: ombachi2000@yahoo.com

KNH/UON Secretariat

P.O Box20723-00202 Nairobi , Kenya

Email: uonknh_erc@uonbi.ac.ke

APPENDIX 3A: FOMU YA IDHINI

MATOKEO YA MATIBABU YA MAJERAHA YA KIWIKO KATIKA KNH

Nambari ya utafiti: _____

Nambari ya hospitali: _____

Unakaribishwa kujiunga katika utafiti kuhusu matokeo ya matibabu ya kiwiko katika hospitali kuu ya Kenyatta. Utafiti huu unafanywa na Daktari Michael M. Njau, mwanafunzi katika Kitengo cha Utabibu wa Mifupa katika Chuo Kikuu cha Nairobi.

Matokeo ya utafiti huu yatawezesha kuboresha matibabu kwa wagonjwa wenye kuvunjika kiwiko.

Hakuna athari yeyote kwa siha na mwili itakayotokana na kushiriki kwenye utafiti huu. Kushiriki katika utafiti huu ni kwa hiari yako mwenye na kutoshiriki hakuna athari yeyote katika matibabu yako.

Unaposhiriki kwenye utafiti huu hutatambulishwa kwa jina. Matokeo yatajadiliwa kwa ujumla bila kutoa habari ya mtu binafsi. Kumbukumbu za utafiti zitahifadhiwa ipasavyo.

Kwa ufafanuzi zaidi au swala lolote piga simu kwa mtafiti Michael Njau kwa nambari 0721851377 ama barua pepe: mwauranjau@yahoo.com

Pia unaweza wasiliana na Mwenyekiti wa Kitengo cha Uchunguzi Chuo Kikuu cha Nairobi na Hospitali Kuu ya Kenyatta kwa 020-2726300.

APPENDIX 3B: HATI YA IDHINI

Nimesoma habari hii, au imesomwa kwangu. Nimekuwa na nafasi ya kuuliza maswali kuhusu huu utafiti na maswali. Nimejibiwa na nikaridhika na majibu yote niliyopewa. Nakiri kwa hiari yangu kushiriki kama mshirika katika utafiti huu.

Jina la mshiriki_____

Sahihi / kidole cha Mshiriki _____

tarehe _____

Kauli la mtafiti

nimesoma habari kuhusu utafiti kwa mshiriki kwa uwezo wangu wote, na kwa uwezo wangu kuhakikisha kwamba mshiriki anaelewa utaratibu wa utafiti.

Nimethibitisha ya kwamba mshiriki amepewa nafasi ya kuuliza maswali kuhusu utafiti huo, na maswali yote yameulizwa na mshiriki nimeyajibu kwa usahihi kwa uwezo wangu.

Ninathibitisha ya kwamba sijamshurutisha mshiriki kutoa idhini, ni kwa hiari yake mwenyewe.

Jina la mtafiti_____

Sahihi ya mtafiti_____

tarehe _____

mtafiti

Dk Njau Michael Mwaura

SLP 46-00219 Karuri, Kenya.

Barua pepe: mwauranjau@yahoo.com

Kiongozi msimamizi

Dkt. Richard B. Ombachi

SLP 29719-00202 Nairobi, Kenya.

Barua pepe: ombachi2000@yahoo.com

KNH / UON Sekretarieti

SLP 20723-00202 Nairobi, Kenya

Barua pepe: uonknh_erc@uonbi.ac.ke

APPENDIX 4 AOFAS SCALE

Ankle-Hindfoot Scale (100 Points Total)

Pain (40 points)

- None.....40
- Mild, occasional.....30
- Moderate, daily.....20
- Severe, almost always present.....0

Function (50 points)

Activity limitations, support requirement

- No limitations, no support.....10
- No limitation of daily activities, limitation of recreational activities, no support...7
- Limited daily and recreational activities, cane.....4
- Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace.....0

Maximum walking distance, blocks

- Greater than 6.....5
- 4-6.....4
- 1-3.....2
- Less than 1.....0

Walking surfaces

- No difficulty on any surface.....5
- Some difficulty on uneven terrain, stairs, inclines, ladders..... 3
- Severe difficulty on uneven terrain, stairs, inclines, ladders..... 0

Gait abnormality

- None, slight.....8
- Obvious.....4
- Marked.....0

Sagittal motion (flexion plus extension)

- Normal or mild restriction (30° or more).....8
- Moderate restriction (15°-29°).....4
- Severe restriction (less than 150).....0

Hindfoot motion (inversion plus eversion)

- Normal or mild restriction (75%-100% normal)....6
- Moderate restriction (25%-74% normal).....3
- Marked restriction (less than 25% normal).....0

Ankle-hindfoot stability (anteroposterior,varus-valgus)

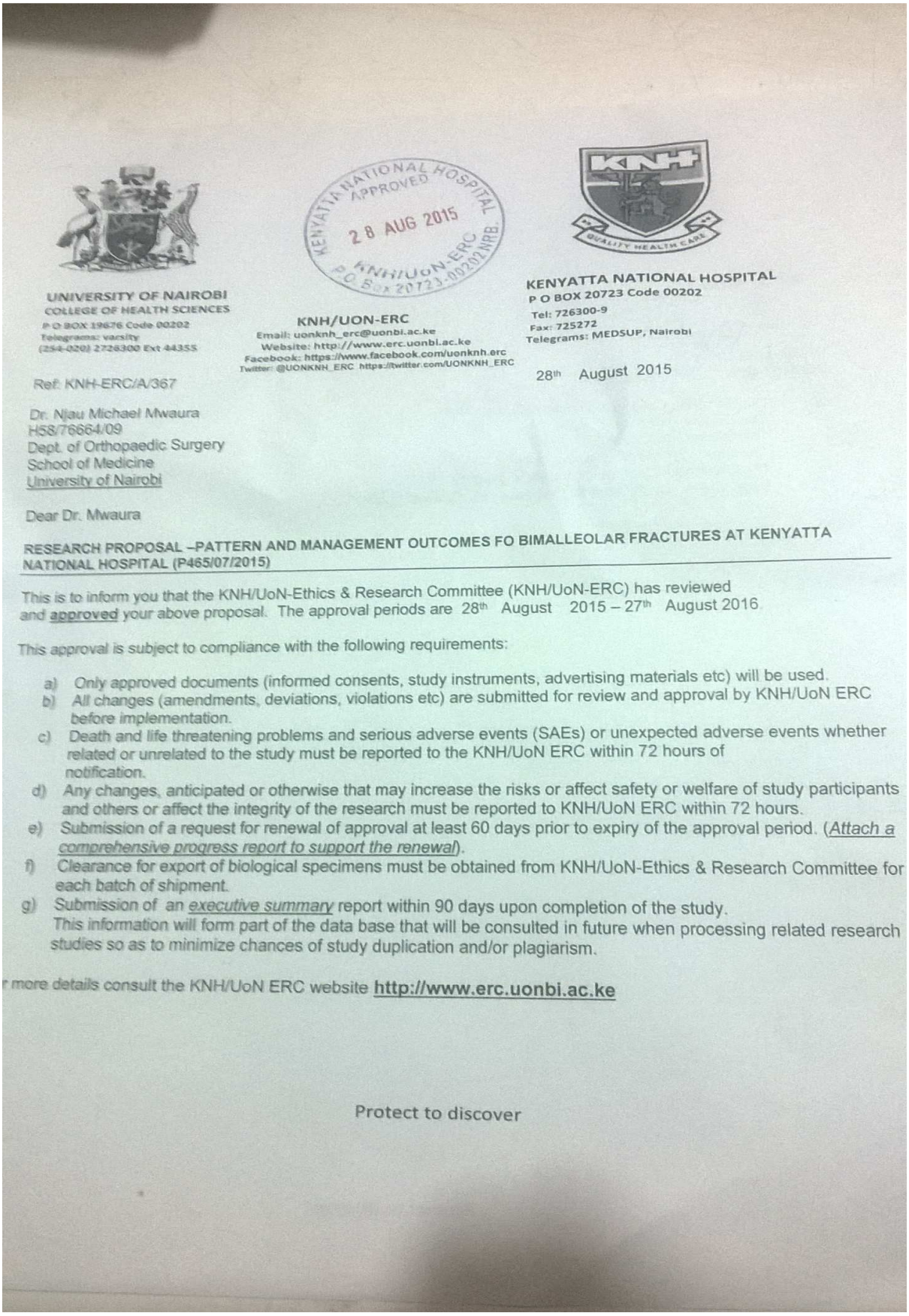
- Stable.....8
- Definitely unstable.....0

Alignment (10 points)

- Good, plantigrade foot, midfoot well aligned.....15
- Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms.....8
- Poor, nonplantigrade foot, severe malalignment, symptoms.....0

APPENDIX 5: VISUAL ANALOG SCALE FOR PAIN

APPENDIX 6: KNH/UON-ERC APPROVAL



UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
(254-020) 2726300 Ext 44355

KENYATTA NATIONAL HOSPITAL
APPROVED
28 AUG 2015
KNH/UoN-ERC
P.O Box 20723-00202 NRB

KNH/UON-ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/367

28th August 2015

Dr. Njau Michael Mwaura
H58/76664/09
Dept. of Orthopaedic Surgery
School of Medicine
University of Nairobi

Dear Dr. Mwaura

RESEARCH PROPOSAL –PATTERN AND MANAGEMENT OUTCOMES FO BIMALLEOLAR FRACTURES AT KENYATTA NATIONAL HOSPITAL (P465/07/2015)

This is to inform you that the KNH/UoN-Ethics & Research Committee (KNH/UoN-ERC) has reviewed and **approved** your above proposal. The approval periods are 28th August 2015 – 27th August 2016.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH/UoN ERC before implementation.
c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH/UoN ERC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH/UoN ERC within 72 hours.
e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
f) Clearance for export of biological specimens must be obtained from KNH/UoN-Ethics & Research Committee for each batch of shipment.
g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

r more details consult the KNH/UoN ERC website **http://www.erc.uonbi.ac.ke**

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