PATTERNS AND SHORT TERM OUTCOMES OF THORACOLUMBAR FRACTURES AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET KENYA

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THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF MEDICINE (ORTHOPEDICS SURGERY) AT MOI UNIVERSITY

DECLARATION

Declaration by Candidate

This research is the candidate's original work and, to the best of the candidate's knowledge, has not been submitted for an award of academic credit in any other university or research institution.

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DEDICATION

This work is dedicated to all those persons and organizations that have endeavored to commit their effort, time and resources in provision and improvement of the health of spinal injury patients.

DISCLOSURE

The candidate did not receive any support nor his immediate family and declares no interest whatsoever.

Sign…………………………………………………

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Thank you all.

ABSTRACT

BACKGROUND: Spine fractures are high energy injuries arising from various forms of trauma and assuming differing morphology. Ninety percent of all spinal fractures occur in the thoracolumbar region. These are associated with high morbidity due to a 15% risk of spinal cord injury. In 2013 a total of 28 patients were seen with thoracolumbar fractures at MTRH. There is no published information on the outcomes of these injuries. This study sought bridge this gap.

OBJECTIVE: To determine the etiology, morphology and short term outcomes of thoracolumbar fractures in patients seeking treatment at MTRH.

METHODS: This was a descriptive prospective study involving patients with thoracolumbar fractures carried out at MTRH orthopedics wards and outpatient fracture clinic. Approval to conduct the study was obtained from IREC (FAN 1276) and MTRH administration. The study population included patients presenting with thoracolumbar fractures at MTRH. Consecutive sampling was used. Informed consent was obtained before enrollment. Data collection was via interviewer administered questionnaire, summary of file notes and patients x-ray interpretation. At 12 weeks the patients ASIA (American Spinal Injury Association Impairment) scale was reassessed and compared with the score at initial contact. Data was entered into MS Excel and analysis done using standard software for statistical analysis and computation and presented in prose, tables and graphs.

RESULTS: A total of 40 patients were enrolled in this study with a mean age of 36.1(±13.2). The youngest patient was 18 years and the eldest 70 years. Males were more affected with a M:F ratio of 3.7:1. More than half of the fractures (52.5%) were due to falls from a height, 35.5% from road traffic accidents and 7.5% were as a result of assault. Morphologically 48% of the fractures were Magerl type A, 39% type B and 15% were type C. Less than half of patients (44%) had associated injuries with long bone fractures being the most common at 40%. Operative treatment was done in 40% of the patients while the rest were treated non-operatively. At the point of recruitment 59% of the patients were at ASIA E, 17% at ASIA D, 8% at ASIA C, 3% at ASIA B and 13% were at ASIA A. After 12 weeks of follow up there was no significant change in the ASIA category. One mortality (ASIA A) occurred during the course of the study due to severe chest injury.

CONCLUSION: Majority of the patients were young males, casual labourers with thoracolumbar fractures due to falls from a height. Magerl type A fractures were the commonest finding. Long bone fractures were the most common associated injury. Treatment was mainly conservative. There was little or no change in ASIA score after 3 months of follow up.

RECOMMENDATION: There is need for public education on the use of personal protective equipment especially in individuals working from heights. Health workers need to be on the lookout for other injuries in patients with thoracolumbar fractures as they may increase the morbidity and mortality of these fractures.

OPERATIONAL DEFINITION OF TERMS

Fractures: A break in the continuity of the cortex of a bone.

Short Term Outcomes: Patient condition after Treatment as per the ASIA scale.

Thoracolumbar: Concerning thoracic and lumbar vertebrae.

Treatment: Surgical care whether operative or non-operative given to a patient with a fracture.

Spinal Injury: Any insult to the spinal cord that results in loss of function distally either motor or sensory.

ABBREVIATION AND ACRONYMS

AMPATH	Academic Model Providing Access to Healthcare
ASIA	American Spinal Injury Association
CT Scan	Commuted Tomography Scan.
IREC	Institutional Research and Ethics Committee
ISNCSI	International Standards for Neurological Classification of Spinal Cord Injury
MRI	Magnetic Resonance Imaging
MTRH	Moi Teaching and Referral Hospital
NSCISC	National Spinal Cord Injury Statistical Centre
SCI	Spinal Cord Injury
SI	Spinal Column Injury

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CHAPTER ONE: INTRODUCTION

1.1 Background Information

The thoracolumbar region is the site where ninety percent of all spinal fractures occur. Burst type of fractures are the predominant variety(Kraemer et al., 1996). Trauma to the spine is also the commonest cause of spinal fractures and spinal cord injury(Magerl, Aebi, & Gertzbein, 1994). Due to the fact that most vertebral body fractures are associated with spinal cord injury, thoracolumbar fractures are associated with poor outcomes.

Paraplegia and paralysis are common. More so, due to the social and psychological stigma associated with these injuries most patients are lost to follow up and thus there is little published data on their outcomes.

Spinal fractures are managed operatively by open reduction, athrodesis and internal fixation. The need for additional stability, prevention of neurological deterioration, attainment of canal clearance, prevention of kyphosis and early relief of pain are the commonly quoted reasons for surgical intervention (Rajasekaran, 2010). However, there are attendant risks involved with surgery and there are few specialists involved in spinal surgery.

Non- operative management of spinal fractures involves the use of a body cast or a spinal orthosis. It offers the avoidance of a surgical intervention though it is associated with higher morbidity.

This study was aimed at gathering data on thoracolumbar fractures and their management outcomes.

It also hopes to introduce a new perspective to the management of such patients if any are found.

1.2 Problem Statement

Spinal injuries are common injuries in our setup. Due to the increase in road traffic accidents their prevalence is also on the rise (Kinyanjui & Mulimba, 2016; Udosen, Ikpeme, & Ngim, 2007). Thoracolumbar fractures are the most common spine fractures that are commonly associated with spinal injuries and subsequent neurological deficits.

At MTRH most patients with spinal fractures are rapidly lost to follow up due to the associated injuries most commonly neurological deficits. Furthermore, no published data is available on long term survival of these patients. This study seeks to find out the etiology, types and short term outcomes of thoracolumbar spine fractures and get the information published as there is hardly any in existence locally.

1.3 Study Justification

Spinal injuries are prevalent worldwide and associated risk factors are on the rise. In our set up, thoracolumbar fractures are becoming more prevalent due to a rise in road traffic accidents more so due to motorcycle accidents. There is paucity of data on outcomes of treatment of thoracolumbar fractures in our region as most studies were done outside the country. The information obtained in this study will help in future management of patients with thoracic and lumbar fractures through development of protocols. Additionally, this study may act as a baseline for development of other related studies.

The information will also be available to other stakeholders in the health sector as they implement the Kenya Health Sector Strategic Plan which includes ‘commitment to reduce the burden of violence and injuries by half by the year 2018.

1.4 Research Questions

What are the patterns and short term outcomes of treatment of patients with thoracolumbar fractures at MTRH?

1.5 Objectives

1.5.1 Broad Objective

To describe the patterns and short term outcomes of treatment of patients with thoracolumbar fractures at MTRH

1.5.2 Specific Objectives

1. To describe the aetiology and types of thoracolumbar fractures at MTRH.
2. To describe the associated injuries in patients treated for thoracolumbar fractures at MTRH
3. To assess the short term outcomes of treatment among patients with thoracolumbar fractures at MTRH using the ASIA impairment scale.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Spinal injury occurs when the vertebral column is subjected to extreme external forces causing it to give way.

Spinal trauma has a dual threat of injury to the bony structures and the neural structures. In the thoracolumbar segment 15-20% risk of neurologic injury is present when there is a thoracolumbar fracture (Denis, 1983). As such it is a severe injury with the capacity to cause serious long term morbidity.

Most injuries of the vertebral column occur in the thoracolumbar region because of its length and hypermobility (Kraemer et al., 1996).

2.2: Relevant Anatomy

2.2.1: Bony Structures

The vertebral column is a curved linkage of individual vertebrae. A continuous series of vertebral foramina runs through the articulated vertebrae posterior to their bodies, and collectively constitutes the vertebral canal, which transmits and protects the spinal cord and nerve roots, their coverings and vasculature (Browner, Jupiter, Krettek, & Anderson, 2014).

There are 12 thoracic vertebrae and 5 lumbar vertebrae. Occasionally there may be a scenario of sacralization of the 5th lumbar vertebrae or lumbarization of the 1st sacral vertebrae giving an appearance of less or more lumbar vertebrae respectively.

A typical vertebra has a ventral body, a dorsal vertebral (neural) arch, and a vertebral foramen, which is occupied in life by the spinal cord, meninges and their vessels.

Opposed surfaces of adjacent bodies are bound together by intervertebral discs of fibrocartilage. The complete column of bodies and discs forms the strong but flexible central axis of the body and supports the full weight of the head and trunk. It also transmits even greater forces generated by muscles attached to it directly or indirectly.

The foraminae form a vertebral canal for the spinal cord, and between adjoining neural arches, near their junctions with vertebral bodies, intervertebral foraminae transmit mixed spinal nerves, smaller recurrent nerves and blood and lymphatic vessels (Standring, 2015).

On each side the vertebral arch has a vertically narrower ventral part, the pedicle, and a broader lamina dorsally. Paired transverse, superior and inferior articular processes project from their junctions. There is a median dorsal spinous process.

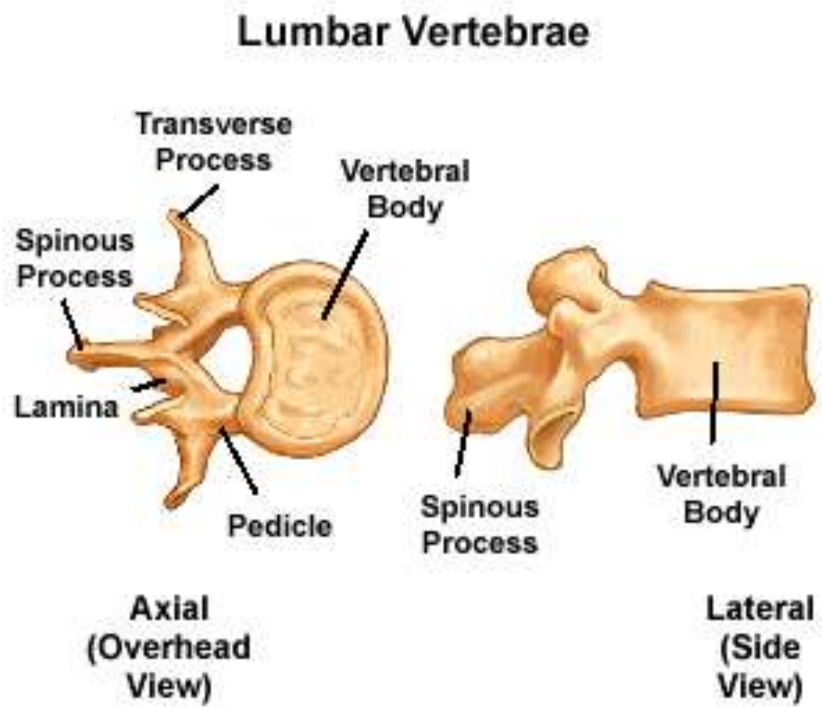


Fig 2.2.1.1: A Typical Vertebral Body(Standring, 2015).

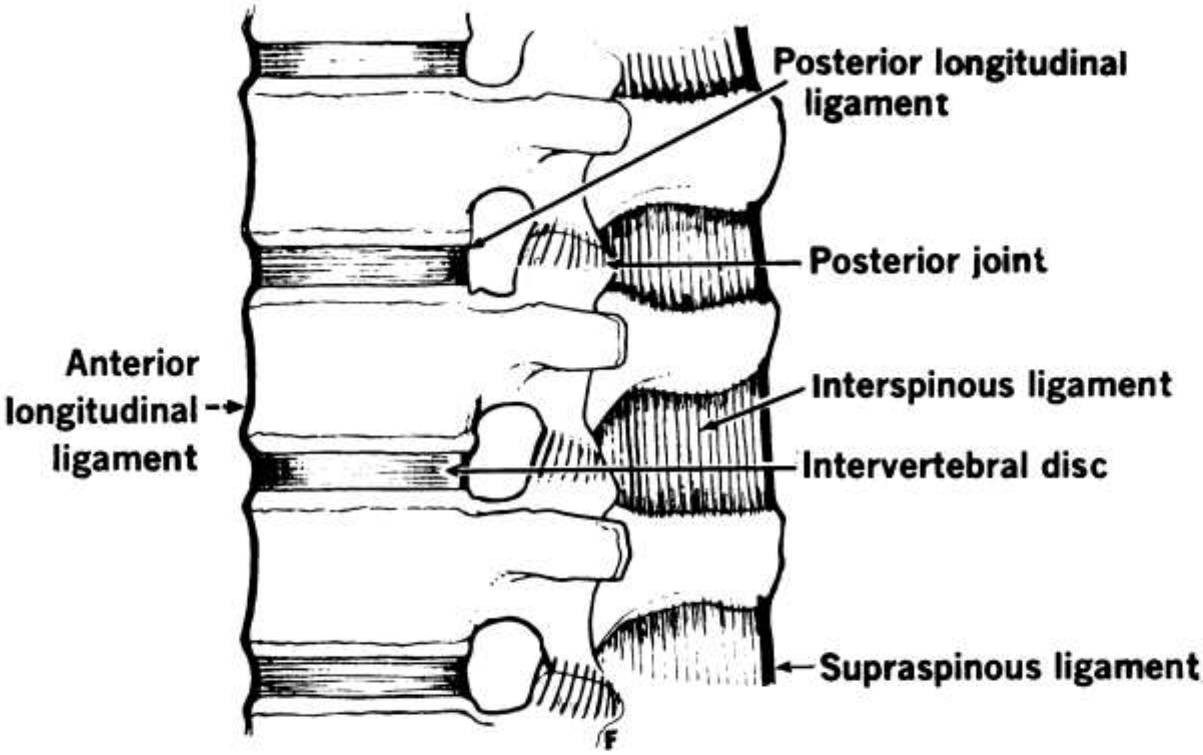


Fig 2.2.1.2: The normal anatomy of the spine (Holdsworth, 1970)

2.2.2: Ligament of the Vertebrae

The soft tissues that interconnect the bony vertebrae are a vital component to the normal function of the spine. The complex interaction of the discs, ligaments and musculature allows for stability and controlled motion. Injury to this complex may have profound effects to the stability and function of the spine (Browner et al., 2014).

Anterior Longitudinal Ligament: The anterior longitudinal ligament is a strong, broad-based ligament that runs on the anterior aspect of the vertebral body from the atlas to the sacrum. It is firmly attached to both the ventral aspect of the disc and periosteum of the vertebral body. It is a major contributor to spinal stability and limits hyperextension of the vertebral column (Standring, 2015).

The posterior longitudinal ligament also runs the length of the spinal column, but it is narrower and weaker than its anterior counterpart. Its primary function is to limit hyperflexion (Denis, 1983).

Ligamentum Flava connect laminae of adjacent vertebrae in the vertebral canal. The ligaments are thin, broad and long in the cervical region, thicker in the thoracic and thickest at lumbar levels. They arrest separation of the laminae in spinal flexion, preventing abrupt limitation, and also assist restoration to an erect posture after flexion, perhaps protecting discs from injury (Browner et al., 2014).

Interspinous Ligaments connect the facing edges of consecutive spinous processes, and extend ventrally as far as the ligamentum flavum and dorsally to the supraspinous ligament, when this ligament is present(Standring, 2015).

Supraspinous Ligament is a strong fibrous cord which connects the tips of spinous process from C7 to L3 or L4. The most superficial fibers extend over three or four vertebrae, the deeper span two or three, and the deepest connect adjacent spines and are continuous with the interspinous ligament. Most of the ligament is formed by the tendons of muscles with posterior midline attachments. Its main function is to prevent hyperextension (Browner et al., 2014).

Anatomic definition of the PLC (The posterior ligamentous complex) is the combination of ligamentum flavum, interspinous ligament, supraspinous ligament, and capsules of the facet joints (Alanay et al., 2004).

2.2.3: Factors involved in stability

The vertebral column is remarkable in that it combines mobility, stability and load-bearing capacity and also protects its contained neural structures, irrespective of its position (Standring, 2015).

Much of the stability of the vertebral column depends on dynamic muscular control, but there are also bony and ligamentous 'static' stabilizers(Browner et al., 2014).

Trauma may affect any vertebral region. Levels of specialized mobility (e.g. atlanto-axial joint) and the junctions of mobile and relatively fixed regions (e.g. cervicothoracic, thoracolumbar) are particularly vulnerable to severe structural damage, often accompanied by spinal cord and nerve injury (Browner et al., 2014).

The vertebral ligaments and facet joint capsules, are important in the maintenance of stability. The strong anterior longitudinal ligament prevents translational displacement (shear) of the vertebrae as well as extension.

All the ligaments of the posterior complex resist flexion and rotation and determine the range of movements allowed. These ligaments can support the whole column when the muscles are inactive, e.g. in quiet standing(Browner et al., 2014).

At the limit of lumbar flexion, the column is supported mainly by the thoracolumbar fascia and by collagenous tissue within the electrically silent muscles of the back.

2.3 Mechanism of Injury

Frequently, many complex forces occur at the time of injury, each of which has the potential to produce structural damage to the spine. Most often, however, one or two forces account for most of the bone or ligamentous injuries encountered (Browner et al., 2014). The forces most commonly associated with thoracic, thoracolumbar, and lumbar spine injuries are - Axial compression, Flexion, Lateral compression, Flexion–rotation, Shear, Flexion–distraction, and Extension.

Axial compression: Due to the normal thoracic kyphosis, axial loading usually results in an anterior flexion load on the vertebral body.

However, an axial load in the straight thoracolumbar region often results in pure compressive loading of the vertebral body (King, 1987).

This mechanism produces end plate failure, followed by vertebral body compression. With sufficient force, vertical fractures develop through the vertebral body and produce a burst fracture (Roaf, 1960).

This fracture then propagates through the mid portion of the posterior cortex of the vertebral body through vascular foramina. With further loading, centripetal displacement of the bone occurs, frequently with disc fragmentation and posterior disruption. This centripetal force can produce fractures at the pedicle–body junction and result in widening of the interpedicular distance and, particularly if a flexion component is present, a greenstick fracture of the lamina. With severe compression, significant disruption of the posterior elements may occur (Frei, Oxland, & Nolte, 2002).

Flexion: Flexion forces cause compression anteriorly along the vertebral bodies and discs, with tensile forces developed posteriorly. The posterior ligaments may not tear, particularly with rapid loading rates, but posterior avulsion fractures may develop (Roaf, 1960). Anteriorly, as the bone fractures and angulation increase, the force is dissipated.

With intact posterior ligaments, a stable fracture pattern most often results. Frequently, the middle column remains intact with no subluxation or retropulsion of bone or disc fragments. However, with disrupted posterior ligaments and facet capsules, instability may occur. If the anterior wedging exceeds 40 to 50 percent, posterior ligamentous and facet joint failure can be assumed, and late instability with progressive deformity may occur (Browner et al., 2014).

Flexion–compression injuries with concomitant middle element failure have a higher potential for causing mechanical instability, progressive deformity, and neurologic deficit.

Lateral Compression: Lateral compression forces produce an injury similar to the anterior wedge compression injuries previously described, except that the force is applied laterally.

Lesions may be limited to vertebral body fractures, or associated posterior ligamentous injury may occur. The former are usually stable injuries, whereas the latter may be chronically unstable and lead to progressive pain and deformity(Frei et al., 2002).

Flexion – Rotation: A flexion–rotation injury pattern includes a combination of flexion and rotation forces. It is a highly unstable injury as the ligaments and facet capsules tend to fail, with subsequent disruption of both the anterior and posterior columns (Holdsworth, 1970).

Flexion – Distraction: In this injury pattern, the axis of flexion is moved anteriorly (usually toward the anterior abdominal wall), and the entire vertebral column is subjected to large tensile forces. The posterior elements, discs, and ligaments are torn or avulsed, not crushed as typically occurs in most spinal injuries. These forces can produce a pure osseous lesion, a mixed osteo-ligamentous lesion, or a pure soft tissue (ligamentous or disc) injury (Kaufer & Hayes, 1966).

Flexion–distraction can cause a bilateral facet dislocation in the thoracic or thoracolumbar spine. The ligaments, capsules, and discs are disrupted, but the anterior longitudinal ligament usually remains intact; however, it is sometimes stripped off the anterior aspect of the caudal vertebrae.

Shear: A pure shear force produces severe ligamentous disruption, similar to the combination of flexion and rotation described previously. This force can result in anterior, posterior, or lateral spondylolisthesis of the superior vertebral segments on those inferior(Roaf, 1960). Traumatic anterior spondylolisthesis is most common and usually results in a complete spinal cord injury. Shear is frequently combined with other mechanisms to cause complex injuries (Frei et al., 2002).

Extension: Extension forces are created when the head or upper part of the trunk is thrust posteriorly; these forces produce an injury pattern that is the reverse of that seen with pure flexion. Tension is applied anteriorly to the strong anterior longitudinal ligaments and the anterior portion of the annulus fibrosus, whereas compression forces are transmitted to the posterior elements (Burke, 1971). This mechanism may result in facet, lamina, and spinous process fractures. Avulsion fractures of the antero-inferior portion of the vertebral bodies may occur.

2.4: Aetiology of Thoracolumbar fractures

The earliest written record of spinal cord injury is found in the Edwin Smith Papyrus (3000 BC). Later, Egyptian physicians noted that patients with vertebral trauma often had paralysis of the arms and legs and urinary incontinence, thus suggesting an association among vertebral injuries, spinal cord damage, and loss of function (Browner et al., 2014).

Globally it is estimated that in 2007, there would have been between 133 and 226 thousand incident cases of TSCI (Traumatic Spinal Cord Injuries) from accidents and self-harm/violence(Lee, Cripps, & Fitzharris, 2014).

Spinal injuries are attributed to high energy trauma and differ in each society. A close link is attributed to the economic activities of the region being studied. In this study done in Nigeria on 39 patients, falls from trees (kola nut) accounted for 23% spinal Injury (Solagberu, 2002).

In a study carried out in South Africa at the Groote Schuur hospital it was found that a majority of their fractures to the thoracolumbar spine arose from gunshot injuries. This was mainly because of the high rates of crime in the catchment area of the hospital (Le Roux & Dunn, 2005).

In a study carried out at Mulago Hospital in Kampala, Uganda the most common cause of Spinal injury was Road Traffic Accidents i.e. motor vehicle, motorcycle and bicycle combined. Falls were the second most common cause of spinal injury. The falls were characterized as slippage, fall into pits, objects falling on respondents etc. while the rest were from trees and buildings respectively (Okello, 2009).

Montshiwa in 2015 at MTRH found that motor vehicle accidents ranked highest in the aetiology of thoracolumbar fractures followed closely by falls from a height and gunshot injuries.

2.5: Types of Thoracolumbar Fractures

Numerous papers have been written to describe thoracolumbar spine fractures.

Sir Frank Holdsworth’s works were the first detailed presentation to thoracolumbar fractures. However he indicated that the posterior ligamentous complex played no role in the stability of the spine in contradistinction to many experimentral studies at the time (Holdsworth, 1970).

Denis then came up with the concept of the 3 column spine in 1983 and in effect revolutionized the management of spinal fractures. In his paper he divided the vertebral body into 3 distinct columns and recognized the importance of the posterior ligamentous complex.

In 1994 Magerl published his works on the comprehensive classification of thoracic and lumbar injuries. In his works he developed a classification that would allow the identification of any injury by means of a simple algorithm based on easily recognizable and consistent radiographic and clinical characteristics.

Table 2.5.1 Magerl Classification (Magerl et al., 1994)

CATEGORY	**CHARACTERISTICS**
TYPE A	COMPRESSION AND BURST FRACTURES
TYPE B	ANTERIOR AND/OR POSTERIOR ELEMENTS INJURIES SECONDARY TO DISTRACTION FORCES
TYPE C	ANTERIOR AND POSTERIOR INJURIES SECONDARY TO ROTATION FORCES

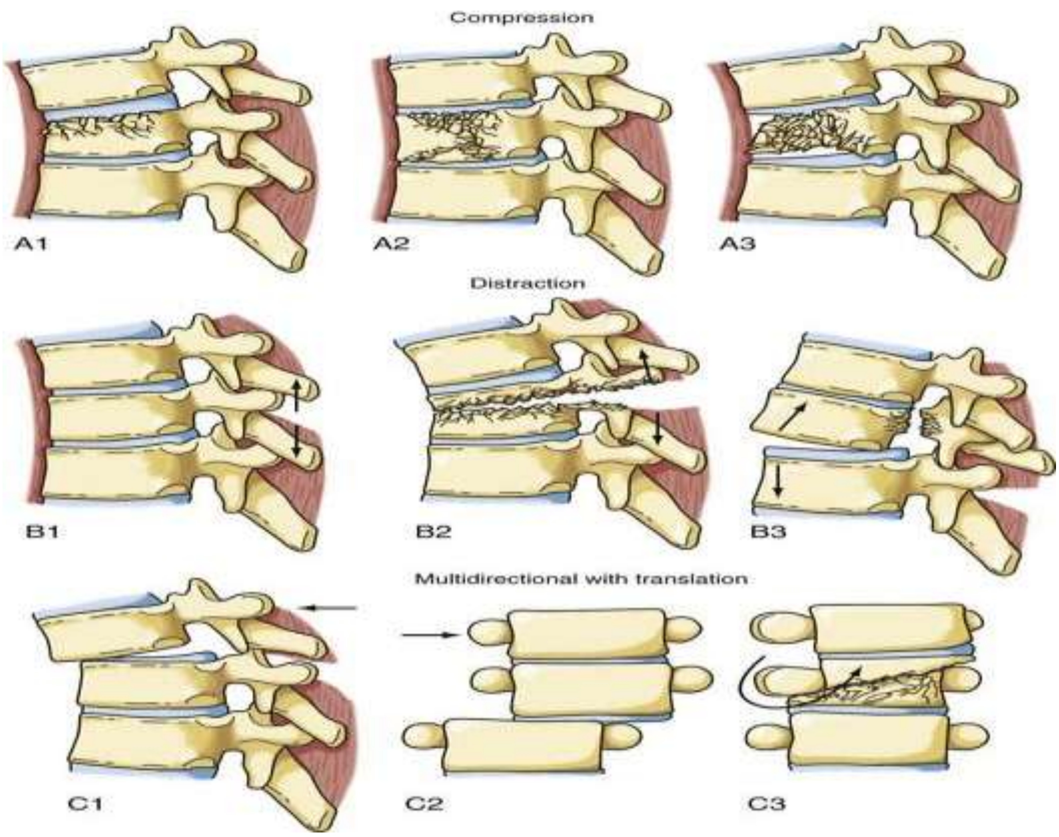


Fig 2.5.1: Diagramatic Presentation of Magerl Classification.

2.6: Diagnosis of Thoracolumbar Fractures

This is primarily done by radiographic analysis of the thoracolumbar spine.

X ray films show the bony outline in significant detail to identify fractures of the thoracolumbar spine (Holdsworth, 1970).

However, the advent of CT scans has proved invaluable in further analysis of the characteristics of spinal fractures. CT is the method of choice in investigation of spinal fractures after plain films have been obtained because it allows a fracture to be assessed more accurately than with plain films alone and it can further elucidate the instability and degree of neurologic damage(Avanzi, Meves, & Silber, 2009; McAfee, Yuan, & Fredrickson, 1983).

MRIs have also become useful in the diagnosis of thoracolumbar fractures. An MRI scan will show the soft tissue component of such injuries and help identify injury to the posterior ligamentous complex which has great implications to the stability of these fractures. Furthermore, the MRI is a useful tool in identifying the subtle trauma to the spinal cord which may have been missed. With the use of MRI such diagnoses of SCIWORA (Spinal Cord Injury Without Obvious Radiologic Anomaly) have become obsolete.

Despite the cost implications of the MRI and CT scans, these tests have become the gold standard in diagnosis and characterization of thoracolumbar fractures and the attendant spinal cord injuries.

2.7: Associated Injuries

Fractures of the thoracolumbar spine are usually as a result of high energy trauma. This occurs in the setting of road traffic crashes, falls from a height and gunshot injuries among others.

It is thus expected that other parts of the body will be injured at the same time. It is important for the clinician to detect these injuries associated with thoracolumbar fractures so as to provide comprehensive patient care (Hu, Mustard, & Burns, 1996).

In a longitudinal study carried out in Canada it was found that up-to 82% of thoracic fractures and 72% of lumbar fractures had associated injuries compared to 28% of lower cervical spine fractures. While there was no significant relationship between type of associated injury and spine fracture level, those with associated injuries were less likely to have a neural deficit (Saboe, Reid, & Davis, 1991).

The most common associated injuries of thoracolumbar fractures are head injuries, chest injury and long limb injuries (Udosen et al., 2007).

In the local study carried out by Montshiwa at MTRH it was found that in 37.5% of thoracolumbar fractures there was an associated injury to other body systems. Additionally, in 22% of these cases the injuries were in 2 or more body systems (Montshiwa, 2015).

2.8: Treatment of TLFs.

There is still debate on how to effectively treat thoracolumbar fractures.

Numerous articles have been written with acceptable outcomes of treatment by using operative and conservative methods.

Rajasekaran (2010) did a review of literature that advanced the case for non-operative management of thoracolumbar burst fractures. He found that the results of non-operative treatment for burst fractures are equal to that of surgery and also with lesser complications. His study was however only on thoracolumbar burst fractures. He pointed out the importance for the treating surgeon to clearly distinguish a burst fracture from other inherently unstable injuries like fracture dislocations, chance fractures and flexion rotation injuries which require surgical stabilization.

Surgery usually involves posterior stabilization with or without anterior stabilization, distraction of the fracture, canal clearance and correction of kyphosis with the overall aim of prevention or limitation of neurological compromise and maintenance of spinal stability. The choice of spinal stabiliziation varies widely and there are different systems to choose from without deeming one to be superior to the other(Abdou, 2013). However, the consensus seems to arise on case by case selection based on the severity of injury and the presence of neurologic compromise (Rajasekaran, 2010).

In 2005 Vaccaro came up with the Thoracolumbar Injury Severity score. This score uses 3 parameters to determine whether or not to treat the injuries conservatively or operatively (Vaccaro et al., 2005). This is shown in table 2 below:

Table 2.8.1: Thoracolumbar Injury Severity Score

MORPHOLOGY	**QUALIFIER**	**SCORE**
COMPRESSION		**1**
	BURST	**+1**
Translational/ Rotational		**3**
Distraction		**4**
NEUROLOGIC STATUS	**QUALIFIER**	**SCORE**
INTACT		**0**
NERVE ROOT		**2**
CORD, CONUS MEDULLARIS	INCOMPLETE	**3**
	COMPLETE	**2**
Cauda Equina		**3**
POSTERIOR LIGAMENTOUS COMPLEX		**SCORE**
INTACT		**0**
INjURY SUSPECTED/INDETERMINATE		**2**
INJURED		**3**

Adapted from Vaccaro, A.R.; et al. Spine 31:11(Suppl) 562–569, 2005.

2.9: ASIA Impairment Scale

The ASIA Impairment scale (a modification of the Frankel score), provides an assessment of spinal function and is used as a tool in spinal cord injury. First devised at Stokes Manville before World War II and popularized by Frankel in the 1970's, the original scoring approach segregated patients into five categories as shown below:

Table 2.9.1: ASIA Impairment Scale (Capaul et al., 1994; Frankel et al., 1969).

AIS SCALE	CHARACTERISTICS
A	Complete neurological injury - No motor or sensory function detected below level of lesion
B	Preserved sensation only - No motor function detected below level of lesion, some sensory function below level of lesion preserved
C	Preserved motor, nonfunctional - Some voluntary motor function preserved below level of lesion but too weak to serve any useful purpose, sensation may or may not be preserved
D	Preserved motor, functional - Functionally useful voluntary motor function below level of injury is preserved
E	Normal motor function - Normal motor and sensory function below level of lesion, abnormal reflexes may persist

The American Spinal Injury Association adapted the Frankel score with slight modifications in grades B, C and D as shown above. This tool shall be used to assess the neurologic status of the patients studied.

CHAPTER THREE: METHODOLOGY

3.1 Study Location

The study was conducted at the Moi Teaching and Referral Hospital in Eldoret town. Eldoret is Kenya's fifth largest urban center and headquarter of Uasin Gishu County in western Kenya. It is located 300 km North West of the capital city, Nairobi.

MTRH is a referral facility catering for the population of entire western Kenya, Southern Sudan and parts of eastern Uganda with an approximately 20 million people. The hospital has a bed capacity of 1000. It is home to AMPATH, Riley Mother and Baby Hospital among others and is a training Centre for Moi University School of Medicine and Kenya Medical Training College.

According to the central statistics of the hospital, it has an average outpatient of 210,000 per year or an average of 600 outpatients per day, with the Accident and Emergency department receiving over 10,000 outpatients per year. It also has cumulative 35,000 inpatients per year with the orthopedics department having over 1300 inpatients per year (AMPATH, 2014).

3.2 Study Design

This was a prospective descriptive hospital based study conducted from October 2014 to September 2015.

3.3 Study Population

The study population included all patients with thoracolumbar fractures who were seen at MTRH inpatient and outpatient facilities within the study period who met the inclusion criteria and consented for the study.

3.4 Eligibility Criteria

3.4.1 Inclusion criteria

All patients with thoracolumbar fractures presenting at MTRH and gave consent to participate in the study.

3.4.2 Exclusion Criteria

- Non-traumatic causes of thoracolumbar fractures e.g. pathological fractures.
- Spinal cord injury without evidence of bony anomalies.
- Any patient with prior spinal cord injury.
- Any patient who refused to consent for the study.

3.5 Sample technique and sample size

All patients with thoracolumbar fractures who sought treatment at MTRH during the study period and met the inclusion criteria were recruited. The first participant was recruited after the approval to conduct the study was granted. Thereafter consecutive sampling was done throughout the study duration. Patients were recruited within 24 hours of presentation. A total of 43 participants were recruited in the study.

3.6 Recruitment tools and Methods of Data Collection

An Interviewer administered questionnaire was used to collect data upon consenting to the study. All patients with thoracolumbar fractures were identified in casualty (admission point) and the candidate was contacted by the medical officers.

On contact with the patient at the casualty department, a careful history was taken from the patient or attendants to reveal the mechanism of injury and the severity of trauma. The patients were then assessed clinically to evaluate their general condition and the local injury. A neurological assessment was also done to determine the ASIA Impairment Scale Score.

Necessary investigations including Radiographs of the thoracolumbar spine i.e., anteroposterior and lateral views were done. Spine CT scans were done routinely for all patients with suspected spinal fractures.

MRI scans were requested for all patients with spinal fractures and neurologic injury.

Other laboratory investigations to rule out co-morbidities were done and included a full haemogram and urea, electrolytes and creatinine.

The fractures were then classified as per the Magerl classification based on the radiological findings i.e. X-ray films and CT scans. Xrays were read by the candidate and the radiologists. The radiologists usually issued reports that accompanied the CT scans and MRI films.

Initial treatment such as administration of analgesics, and treatment of other injuries was recorded. Thereafter, the definitive treatment method of fracture was recorded and the patient followed up either in the ward (General Surgery and Orthopaedic wards), neurosurgery outpatient clinic or at the orthopaedic outpatient clinic.

Files of the patients who underwent operative treatment were reviewed for the surgical technique and approaches used and the type of fixation (if any) used.

Post-operative management was also documented. Post reduction and fixation radiographs were taken to assess fracture reduction.

On discharge, patients were followed up at the orthopaedic and neurosurgical outpatient clinics. The patients were then reviewed at 2 weeks and at 12 weeks to assess the neurological outcome using the ASIA scale. The review at 2 weeks was in some cases done in the ward prior to discharge.

Their complaints at the time of follow up was also documented.

3.7 Data Management

3.7.1 Data collection

An interviewer administered questionnaire was used to collect data.

Pre and post-operative X-rays were taken immediately, at 2 weeks and at 12 weeks. Magerl classification of thoracolumbar spine fractures was utilized and the functional levels was assessed using ASIA Impairment Scale(AIS).

3.7.2 Data analysis

Data analysis was performed using SPSS version 13. Categorical variables were summarized as frequencies and their corresponding percentages obtained. Continuous variables that assumed normal distribution were summarized as mean with their corresponding standard deviation (SD) while the continuous variables that were skewed were summarized as median and the corresponding inter quartile range (IQR). The test for normality assumption was done using Kolmogorov-Smirnov test (Lilliefors, 1967).

3.9: Ethical considerations

In order to protect and respect the rights of the participants who took part in the study the relevant permission and clearance to conduct the study from IREC, MTRH and Moi University was sought.

Informed consent was obtained from every participant. The participants were given detailed information about the study both in writing and orally and a chance to seek clarification. They were also informed that their participation was voluntary with no monetary or material gains. To ensure confidentiality and privacy of the study subjects, each subject was given a code only known to the researcher.

Filled questionnaires were stored in locked cabinets with restricted access.

The collected data was locked in a secure cabinet that was only accessible to the investigators. Electronic data was stored in a password protected laptop. Backup copies were stored in a password protected external hard drive kept by the principal investigator. To further ensure and guarantee patients confidentiality and privacy, all reported data was de-identified and de-sensitized. The study report is submitted to the Moi University Library where it is available for public access. Further the candidate intends to publish the findings of this study.

3.10: Study Limitations

The candidate did not have control over the treatment modality the patients received. The decision to operate or not was determined by the hospital spine surgeons and was also influenced by the ability of the patients to buy the implants that would be used intra- operatively.

CHAPTER FOUR: RESULTS.

4.1: Introduction

In this study 43 patients with thoracolumbar fractures were enrolled. Three patients were subsequently lost to follow up. One patient died in ICU 7 days after being enrolled into the study. Thus a total of 39 patients were studied.

The mean age for the study was 36.1 ±13.2. The minimum age was 18 years while the maximum was 70 years. Gender was represented in (79%) male and (21%) female. Economic status of patients was represented in Farmers (34.2%), Bodaboda (15.8%), Business, Casual labourers and Students (13.2%), whereas the lowest (2.6%) were a truck driver and a mason.

All patients who participated in this study were Christians.

Additionally, results by multinomial logistic regression indicated that male patients were more likely to be injured as compared to female, the difference was statistically significant, (p=0.039).

Sociodemographic characteristics are shown in the table below:

Table 4.1.1: Sociodemographic Characteristics.

SOCIO-DEMOGRAPHIC CHARACTERISTICS	n	%
Gender		
Male	31	79
Female	8	21
Occupation		
Farmer	14	35.9
Bodaboda rider	6	15.4
Business	5	12.8
Casual labourer	5	12.8
Student	5	12.8
Employed	2	5.1
Truck driver	1	2.6
Mason	1	2.6
Level of Education		
Secondary	18	46.2
Primary	15	38.5
College	4	10.3
University	2	5.1
Marital status		
Married	16	41.0
Single	13	33.3
Widow	1	2.6
Not indicated	9	23.1
Religion		
Christian	39	100

4.2 Type of Referral

From the pie-chart below 21(55%) of the patients were referrals from peripheral facilities, 13(34%) self-referral while 5(11%) were from private facilities.

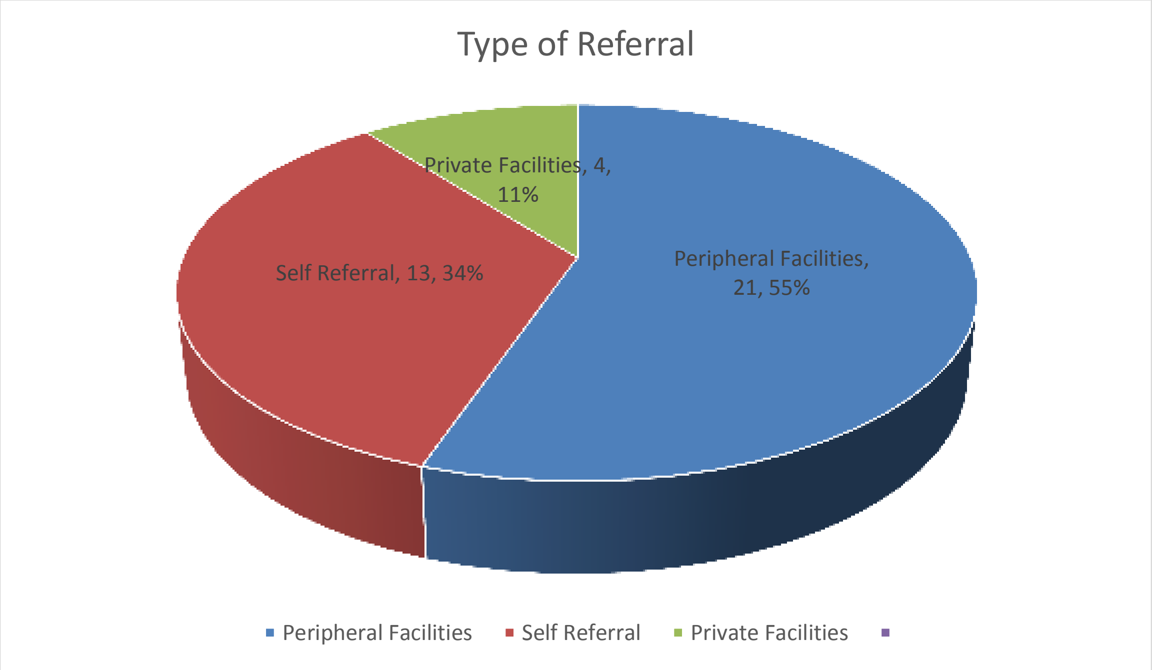


Figure 4.2.1: Type of referrals

4.3 Time of presentation

In the study it was found that 16% of participants arrived at the hospital within 6 hours of injury, 37% between 6-24 hours and 48% after 24 hours. The results further indicated a statistical significance between type of referral and time of presentation ($\chi^2 = 22.470$, df = 4, $p<0.000$). Patients who came from other facilities tended to present later as they would have received some care in the other facilities.

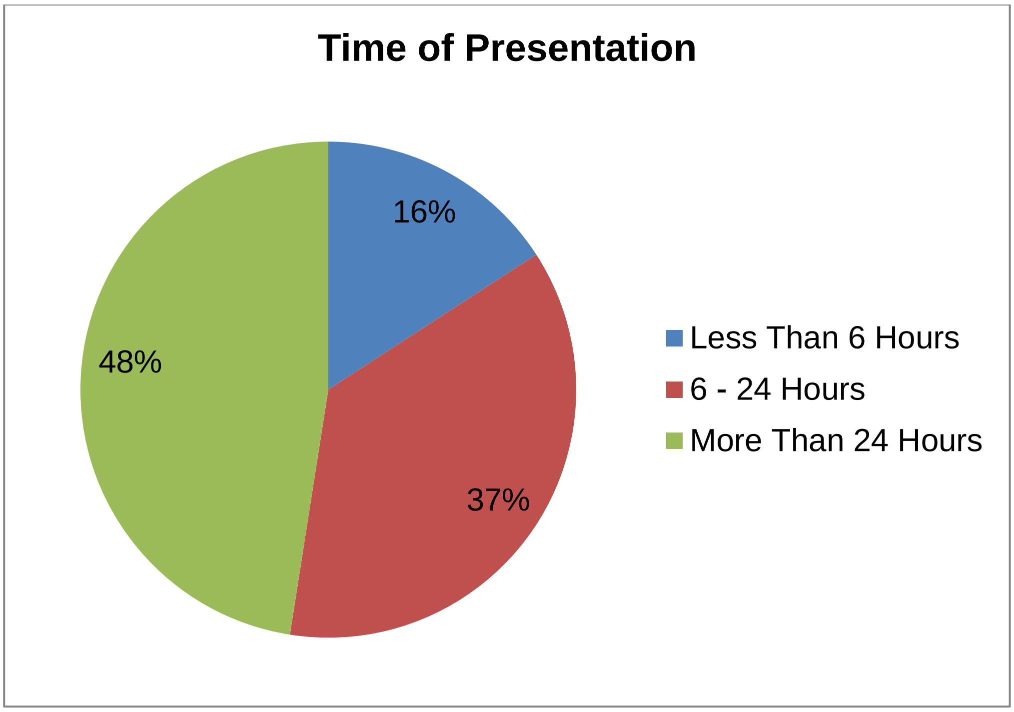


Figure 4.3.1: Time of Presentation

4.4 Aetiology of Thoracolumbar Fractures

Twenty patients (51%) indicated they sustained the injury by falling from a height, 15(38.5%) RTA, 3(7.7%) assault while 1(2.8%) was hit by falling object.

Further analysis of the results by multinomial logistic regression indicated that male patients were more likely to be injured as compared to female, the difference was statistically significant, (p=0.039).

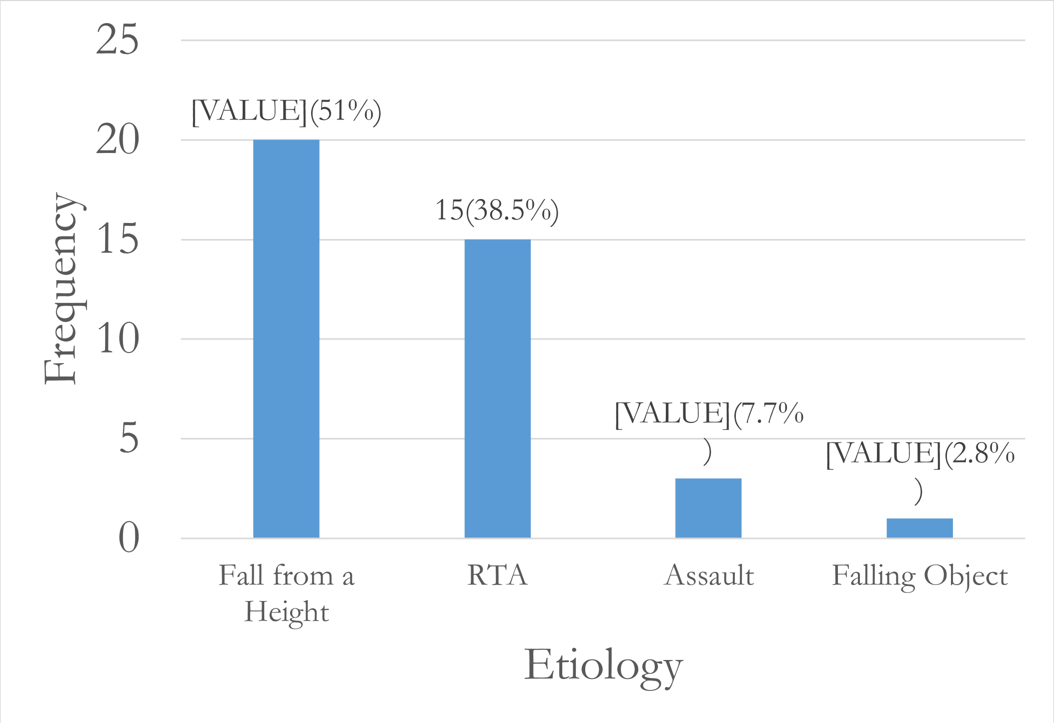


Figure 4.4.1: Aetiology of thoracolumbar fractures

4.5 Associated injuries

Twenty-one patients had isolated thoracolumbar fractures only. However, 18 of these patients had other injuries.

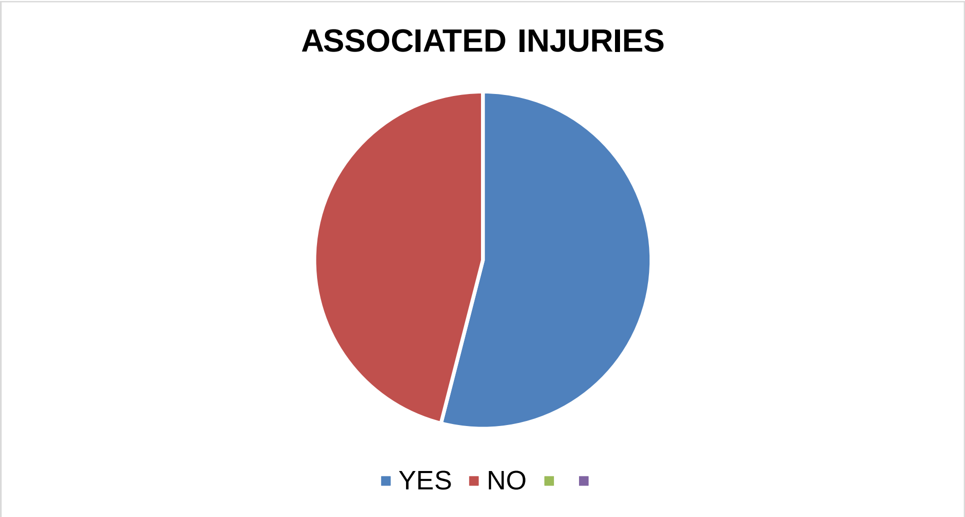


Figure 4.5.1: Associated Injuries.

Of the patients with associated injuries they were further classified into Upper limb injury, Lower limb injury, Chest injury and Head injury.

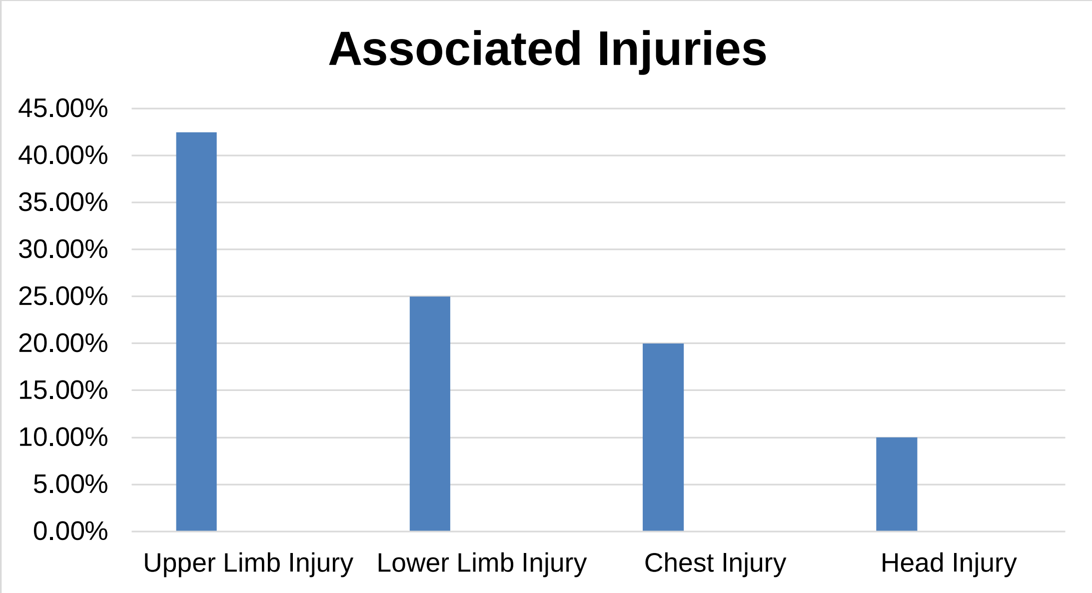


Figure 4.5.2: Associated injuries

4.6 Magerl fracture classification

Based on the Magerl fracture classification 3 categories were identified. Type A fractures were 49%, Type B were 36% and 15% Type C.

No correlation was found between the type of fracture and the etiology.

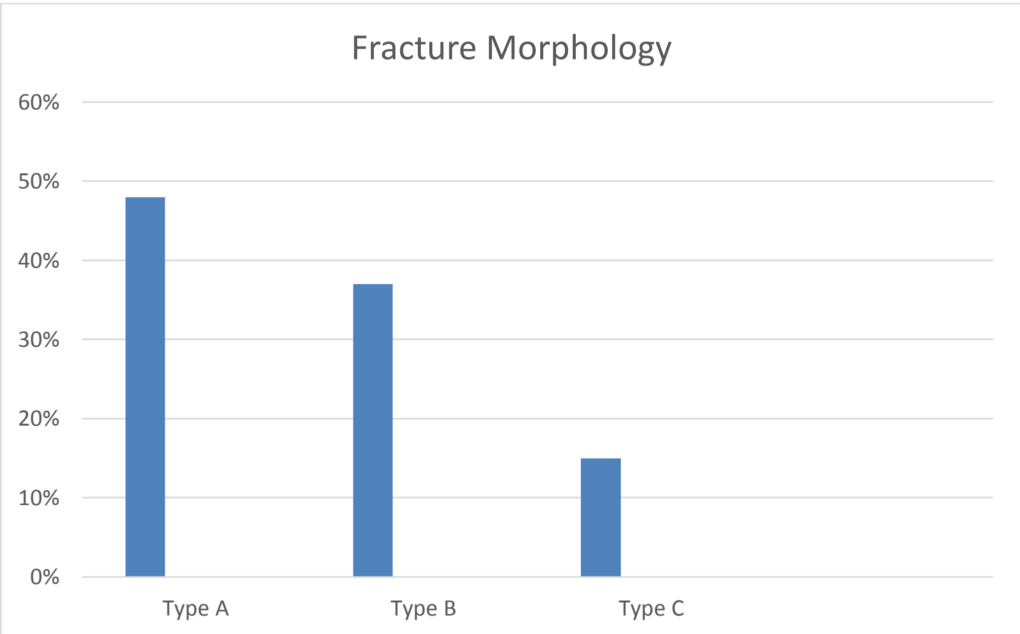


Figure 4.6.1: Fracture Morphology based on Magerl Classification.

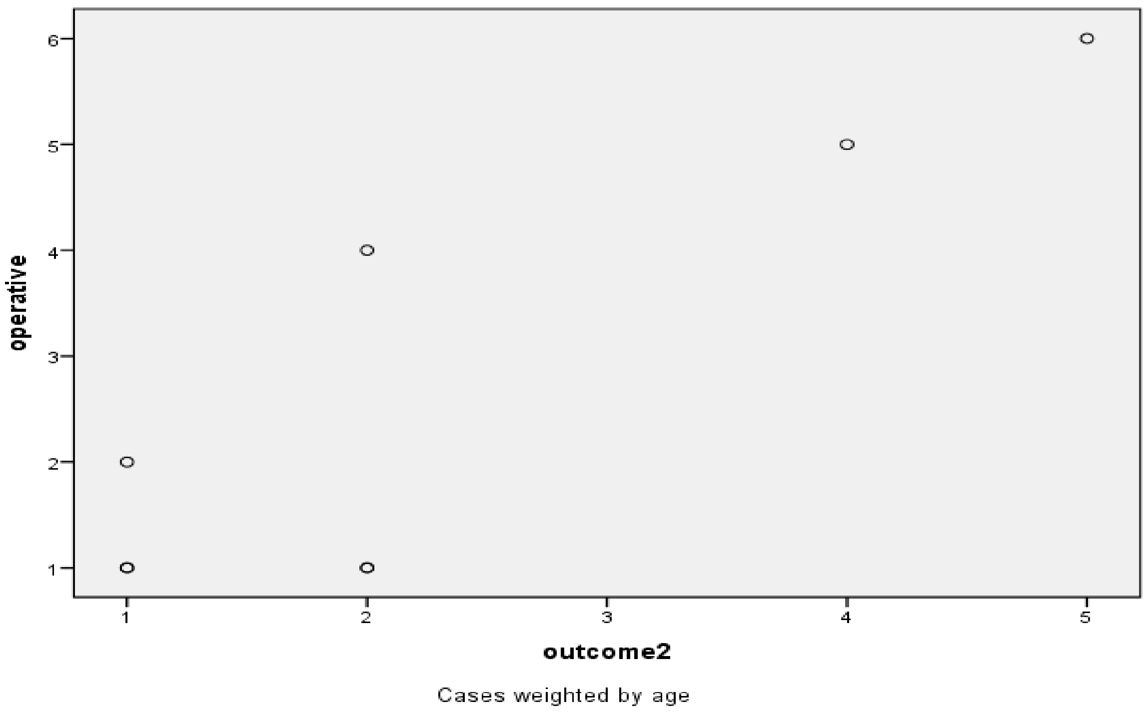
4.7 Treatment

In the study 15 patients (38%) underwent operative management of their fractures, with the rest undergoing conservative management.

Table 4.7.1: Treatment Options

TREATMENT OPTION	N	%
OPERATIVE	15	38%
NON-OPERATIVE	24	62%

The results depicted a positive correlation between thoracolumbar patients who were operated and their outcome at two weeks (r= 0.869, p=0.000). This is demonstrated in the graph below.



4.8 Neurological injury

The findings indicated that a higher number 22(56%) of the patients had neurological deficit while 17(44%) did not. Univariate model showed statistical significance between age and neurological deficit.

4.9 Frankel Score (AIS)

Frankel score was measured at T= 0 weeks, T= 2weeks and at T=12 weeks.

The score assessed at presentation (T = 0 weeks) was as follows:

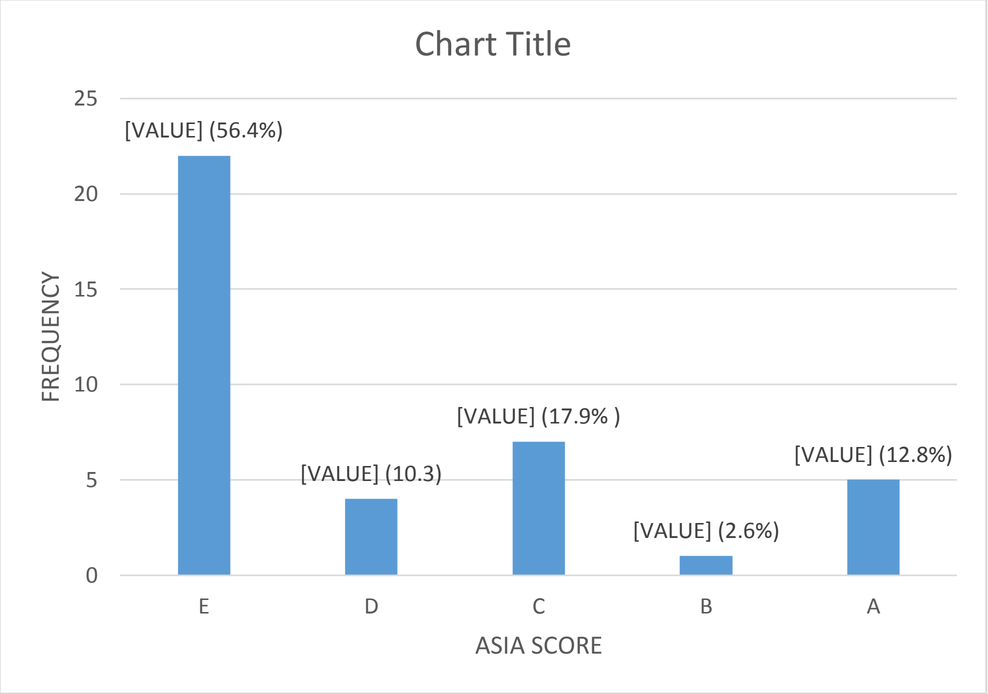


Figure 4.9.1: ASIA Scale at Enrollment into the Study.

Frankel score was also evaluated at the end of the study to determine whether any changes had occurred.

It was evident that there was little change in AIS at the end of the study.

This is shown in the figure below.

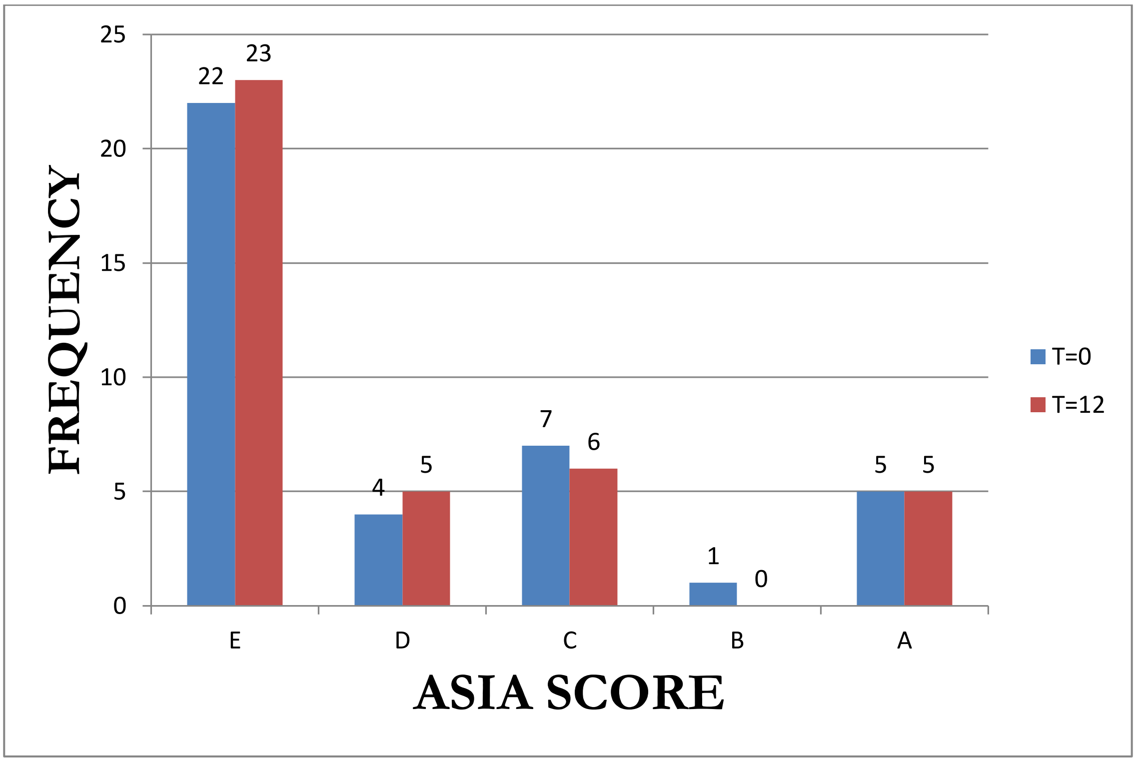


Figure 4.9.2: Graph comparing ASIA at T=0 weeks and at T= 12 weeks.

CHAPTER FIVE: DISCUSSION

5.1: Sociodemographic Characteristics

In this MTRH study the age distribution ranged from 18 years to 70 years with a male to female ratio of 3.9:1. The mean age at the time of injury was 36.1 years. The age distribution corresponds with involvement in highly active life of males in this age group that predispose them to high energy injuries. Other studies have shown similar trends in the age distribution of participants.

In the global spinal injury map by Lee B (2014) he found that in developing countries spinal injuries tend to affect the younger population.

Solagberu (2002) in Nigeria while studying the spinal injuries documented an age distribution of 19-60 years.

In his retrospective study at Mulago Hospital in Uganda, Okello (2009) found a male to female ratio of 3.2:1 with an age range of 13 years to 90 years and a mean age of 35.95 years. In a study in Brazil by Avanzi et al. in 2009 it was found that males were more affected and had an average age of 36.5 years.

In this MTRH study the majority of patients were casual labourers involved in manual labour. This finding differs with one done at the Kenyatta National Hospital that found that age distribution had a bimodal peak at 21-30 years and 41-50 years. Further he found a male to female ratio of 15.3:1 and an average age of 37.6 years (Kinyanjui & Mulimba, 2016).

5.2: Aetiology

In this MTRH study the main cause of thoracolumbar fractures was found to be falls from a height which also included objects falling onto the patients. This is in agreement with the findings by Okello (2009) at Mulago Hospital in Uganda were he found that falls from a height were the single most common cause of spinal injury.

In Brazil, Osmar Avanzi et al (2009) while studying thoracolumbar burst fractures found a similar pattern of falls causing the majority of the thoracolumbar fractures at 76.1%.

However, most studies on the subject that show road traffic accidents as the most common aetiology. In Nigeria Solagberu (2002) found that road traffic accidents alone accounted for 67% of patients presenting with spinal injuries. However, he also noted that falls from a height contributed a large percentage of these injuries but had been surpassed by road traffic accidents due to increased use of motorized transport. Further he postulated that the mechanism of injury in thoracolumbar fractures is due to vertical compressive forces that cause axial loading. These forces are mostly transmitted as such in falls from height. By excluding cervical spine injuries in this study, the aetiology is most likely to be falls from a height as the cervical spine is mostly injured in RTAs.

Additionally, the demographics of MTRH patients explain this discrepancy. Most of the patients were from a rural set up and majority of them were farmers. The mechanism of injury would usually involve falls from trees or into a ditch.

Despite this the numbers of patients affected by road traffic accidents was also significantly high. Motorized transport in the rural set up is mostly via motorcycles (boda-bodas) and the accounted for 37.5% of the injuries.

Assault cases were very few in the MTRH set up. Direct assault to the musculoskeletal system is not very common in this side of the continent. This concurs with the study by Kinyanjui and Mulimba (2016) at KNH which showed very few cases of direct assault to the spine.

Further south at Grote Schur hospital in South Africa, Le Roux and Dunn (2005) found a high number of gunshot injuries to the spine. In his series a total of 49 patients presented with gunshot injuries to the spine.

5.3: Types of Thoracolumbar Fractures

In this study Magerl Type A fractures accounted for 49% of cases. This high percentage correlated with other studies. Magerl in his 1994 paper that classified thoracolumbar fractures found type A fractures to be the most common at 66% of all the patients he studied.

Montshiwa (2015) at MTRH also found a Type A fractures as the most common at 44%.

In this study Type B fractures were found to be high at 36%. This finding contrasts with other studies. Magerl found that he had 14% of the type B fractures.

Type C accounted for 15% of the injuries picked. This is in agreement to what Magerl found at 19% of the type C fractures while Montshiwa at MTRH found a higher figure of 50%.

5.4: Associated Injuries

In this study associated injuries were present in 54% of the cases. This was attributed to the high energy nature of these injuries. This finding was in agreement with the study by Montshiwa (2015) who found associated injuries in 37.5% of cases.

Hu et al in 1996 found a 38% rate of associated injuries in his study at the University of Manitoba.

However, there was a higher rate of associated injuries in the Canadian study by Saboe (1991) at 47% with an almost equal presence of head injuries (26%), chest injuries (24%) and long bone injuries (23%).

The most common associated injury in this study was long limb injuries with the upper limb affected in most cases. The findings correlate with the study by Montshiwa who found upper limb injuries to be the most common.

In his retrospective study Saboe also found a high incidence of long bone injuries at 23% though they were not the most common.

5.5: Treatment

In this MTRH study it was found that 15 patients (38%) underwent operative management of their fractures, with the rest (24 patients) opting for conservative management. It was also found that there was no difference in their ASIA scale at 12 weeks whether operative or conservative management was done.

Rajasekaran found that there were good outcomes in the management of thoracolumbar burst fractures with conservative management.

Abodou in 2013 concluded that despite the different advances in surgery it was premature to say that either treatment modality is superior to the other.

In MTRH the choice for surgery or not is determined by many factors including the affordability of the implants which is usually shouldered by the patient.

5.6: Neurological Injury and Frankel Score/ AIS Score

The overall incidence of neurologic injury in patients with thoracolumbar fractures in this MTRH study was found to be 56%. This was in contrast with other studies.

Okello at Mulago Hospital found only 8% of patients had neurologic compromise though he studied all spinal levels.

Magerl found an overall incidence of 22% with differing degrees in all fracture types.

In the MTRH study by Montshiwa (2015) the presence of neurological injury was high and similar to the findings of this study at 65.5%.

The AIS score at first contact was found to be 59 % ASIA E (No Neurological Involvement), 17% at ASIA D, 8% at ASIA C, 3% at ASIA B and 13% were at ASIA A. After 3 months of follow up there was no significant change in the ASIA category.

Okello in 2009, 45% ASIA A, 8.6% ASIA B, 25.6% ASIA C and 20% ASIA D. This was an assessment of neurologic injury in patients with spinal trauma at Mulago Hospital.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS.

6.1: Conclusions

The most common cause of thoracolumbar fractures was a fall from a height with males affected more than females.

Magerl Type A fractures were the most common finding in this study. The most common associated injuries were long bone fractures.

Neurological deficit was present at 56% in patients with thoracolumbar fractures. As for short term outcomes there was hardly any change in AIS at 12 weeks.

6.2: Recommendations

There is need for a long term study on patients with thoracolumbar fractures to determine the eventual outcome of these injuries. This may further enhance our knowledge of the condition and improve patient management.

The use of personal protective equipment in workers who work in elevated spaces should be encouraged. This is especially important in the informal sector workers.

Health workers need to be on the lookout for any associated injuries in patients with thoracolumbar fractures as they increase the morbidity associated with TLFs.

The development of standard protocols for the management of thoracolumbar fractures in hospitals to reduce the morbidity of these injuries.

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APPENDICES

Appendix 1: Data Collection Form/ Questionnaire

STUDY TITTLE: Outcome of treatment of thoracic and lumbar fractures at Moi Teaching and Referral Hospital

Patient No:........................... PT ID:.................................

Date:..................................... IP No:.................................

Address:...............................

Age: ☐ years ☐ Sex: Male : ☐ Female: ☐

Occupation:.......................................

Education Level: Marital Status:

Religion:

Next Of Kin

Name:... ....Age:....................

Mobile Number:..

Type of referral: Self: ☐ Another facility: ☐ Other(specify): ☐

DATE of Injury:.......................

Time of Presentation from Injury: <6 Hours: ☐

Comorbidities:..............................

6 - 24 Hours ☐

Alcohol:......................................

>24 Hours ☐

Cigarette Smoking:......................................

Mechanism of Injury: Fall: ☐ RTA: ☐ Assault: ☐

Others(specify):

Sport:

Expound.........................

Other injuries: Yes: ☐ No: ☐

If Yes Specify:

....

....

PREHOSPITAL TREATMENT:...

MAGERL FRACTURE CLASSSIFICATION:..

NEUROLOGICAL DEFICIT: **................**

FRANKEL **.................**

SPINAL SHOCK **.................**

ASIA Score:		**R**	**L**
Neurological Level:	SENSORY:	☐	☐
	MOTOR:	☐	☐

Single Neurological Level ☐ Complete/ Incomplete ☐

MANAGEMENT

OPERATIVE:

NON- OPERATIVE:

2 WEEKS POST INJURY

ASIA Score: **R** **L**

Neurological Level: SENSORY: [ ] [ ]

MOTOR: [ ] [ ]

Single Neurological Level [ ] Complete/ Incomplete [ ]

NEW COMPLAINTS...

....

OUTCOME:...

AT 12 WEEKS POST INJURY

ASIA Score: **R** **L**

Neurological Level: SENSORY: [ ] [ ]

MOTOR: [ ] [ ]

Single Neurological Level [ ] Complete/ Incomplete [ ]

OUTCOME:..

Appendix 2: Consent Form

Outcomes of Treatment of Thoracolumbar Fractures at Moi Teaching and Referral Hospital, Eldoret, Kenya

Good morning/afternoon, Madam/Sir. My name is Dr. Kevin Kariuki Mwaura. I am here today from Moi University, Eldoret to collect information and data for the study on Outcomes of treatment of thoracolumbar fractures at MTRH, Eldoret, Kenya.

I will be asking for your permission to ask you some questions and to review your medical records. I plan to sample 40 participants. All information obtained will be confidential.

The Institutional Research and Ethics Committee (IREC) of Moi University have approved this research

Benefits

This is a research project and the findings will be beneficial to doctors involved in thoracolumbar fracture management surgeries.

Risks

This is a minimal risk study. However, the psychological risks that may arise among participants will be addressed through counseling.

May we proceed? Verbal consent: Yes……………No…………………..

Signature …………………………….

Date **…**………………………………..

Thank you

Contacts for the research team,

Dr. Kevin Kariuki Mwaura

MOI UNIVERSITY, ELDORET P.O BOX 4606 -0100 Eldoret, Kenya

Phone: 0721243950.

E- Mail Address: kekariuki@gmail.com

Appendix 3: IREC Approval Letter

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

Reference: IREC/2014/146
Approval Number: 0001276

19th September, 2014

Dr. Kevin K. Mwaura,
Moi University,
School of Medicine,
P.O. Box 4606-00200,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
19 SEP 2014
APPROVED

Dear Dr. Mwaura,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Outcomes of Treatment of Thoracolumbar Fractures at Moi Teaching and Referral Hospital, Eldoret, Kenya."

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1276*** on 19th September, 2014. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 18th September, 2015. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

For

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc	Director	-	MTRH	Dean	-	SOP	Dean -	SOM
	Principal	-	CHS	Dean	-	SON	Dean -	SOD

Appendix 4: MTRH APPROVAL LETTER

MOI TEACHING AND REFERRAL HOSPITAL

Telephone: 2033471/2/3/4
Fax: 61749
Email: director@mtrh.or.ke

P. O. Box 3
ELDORET

Ref: ELD/MTRH/R.6/VOL.II/2008

19th September, 2014

Dr. Kevin K. Mwaura,
Moi University,
School of Medicine,
P.O. Box 4606-00200,
ELDORET-KENYA.

RE: APPROVAL TO CONDUCT RESEARCH AT MTRH

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:

"Outcomes of Treatment of Thoracolumbar Fractures at Moi Teaching and Referral Hospital, Eldoret, Kenya."

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

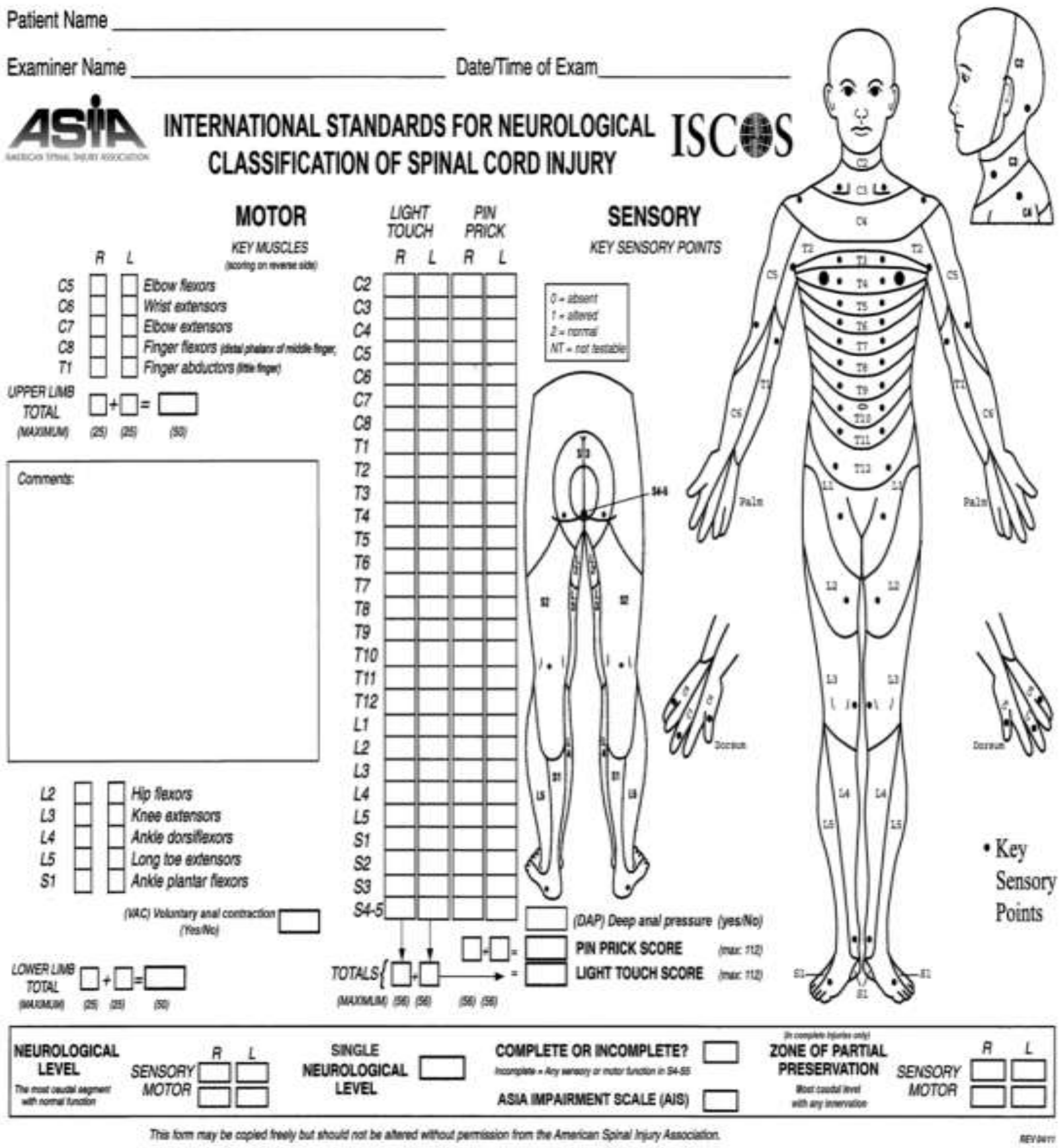
DR.JOHN KIBOSIA

DIRECTOR
MOI TEACHING AND REFERRAL HOSPITAL

CC - Deputy Director (CS)
- Chief Nurse
- HOD,HRISM

19 SEP 2014
APPROVED

APPENDIX 5: INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY.


Patient Name ______________________________

Examiner Name ______________________________ Date/Time of Exam ____________________

ASIA AMERICAN SPINAL INJURY ASSOCIATION

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

ISCOS

MOTOR

KEY MUSCLES (scoring on reverse side)

	R	L	
C5			Elbow flexors
C6			Wrist extensors
C7			Elbow extensors
C8			Finger flexors (distal phalanx of middle finger)
T1			Finger abductors (little finger)

UPPER LIMB TOTAL (MAXIMUM) □+□=□ (25) (25) (50)

Comments:

	R	L	
L2			Hip flexors
L3			Knee extensors
L4			Ankle dorsiflexors
L5			Long toe extensors
S1			Ankle plantar flexors

(VAC) Voluntary anal contraction (Yes/No) □

LOWER LIMB TOTAL (MAXIMUM) □+□=□ (25) (25) (50)

SENSORY

KEY SENSORY POINTS

	LIGHT TOUCH R	LIGHT TOUCH L	PIN PRICK R	PIN PRICK L
C2				
C3				
C4				
C5				
C6				
C7				
C8				
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
T10				
T11				
T12				
L1				
L2				
L3				
L4				
L5				
S1				
S2				
S3				
S4-5				

0 = absent
1 = altered
2 = normal
NT = not testable

(DAP) Deep anal pressure (yes/No) □

TOTALS □+□ = □ LIGHT TOUCH SCORE (max: 112)

□+□ = □ PIN PRICK SCORE (max: 112)

(MAXIMUM) (56) (56) (56) (56)

• Key Sensory Points

NEUROLOGICAL LEVEL (The most caudal segment with normal function) — SENSORY R □ L □; MOTOR R □ L □

SINGLE NEUROLOGICAL LEVEL □

COMPLETE OR INCOMPLETE? □ (Incomplete = Any sensory or motor function in S4-S5)

ASIA IMPAIRMENT SCALE (AIS) □

ZONE OF PARTIAL PRESERVATION (In complete injuries only) (Most caudal level with any innervation) — SENSORY R □ L □; MOTOR R □ L □

REV 04/11

APPENDIX 6: BUDGET

ITEMS	QUANTITY	UNIT PRICE (Kshs)	TOTAL (Kshs)
Stationery & Equipment			
Printing Papers	5 reams	500.00	2500.00
Black Cartridges	2	4000.00	8000.00
Writing Pens	1 packet	500.00	500.00
Flash Discs	1	2000.00	2,000.00
Box Files	5	200.00	1000.00
Document Wallets	5	100.00	500.00
Sub total			**14500.00**
Research Proposal Development			
Printing drafts & final proposal	10 copies	600.00	6000.00
Photocopies of final proposal	10 copies	200.00	2000.00
Binding of copies of Proposal	10 copies	200.00	2000.00
Sub total			**10000.00**
Personnel			
Biostatistician	1	30000.00	30000.00
Research Assistant	1	15000.00	15000.00
Sub total			**45000.00**
Thesis Development			
Printing of drafts and final thesis	10 copies	1000.00	10000.00
Photocopy of final thesis	10 copies	400.00	4000.00
Binding of thesis	10 copies	500.00	5000.00
Sub total			**19000.00**
Total			**88500.00**
Miscellaneous Expenditure (10% of Total)			
Grand Total			**97350.00**

APPENDIX 7: TIMELINES

	May-14	June-14	July-14	July-14	Aug 14	Jan-15	July-16	Sep-16	Oct-16	Jan - 17
Developing Proposal (Introduction, Literature review & Methodology)										
Presenting proposal to supervisors										
Developing data collection tools										
Proposal Submission to IREC										
Piloting data collection tools										
Finalization of data collection tools										
Data collection										
Data entry, coding and cleaning										
Interim analysis										
Final Analysis										
Thesis write up(results, discussion)										
Notice of intent to submit										
Mock defense										
Submission of Thesis for Examination										
Thesis defense										