FUNCTIONAL OUTCOME OF TREATMENT OF ELBOW FRACTURES IN ADULT PATIENTS AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA

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A thesis submitted in partial fulfillment of the requirements for the award of the degree of Master of Medicine in Orthopedic Surgery at Moi University

DECLARATION

DECLARATION BY CANDIDATE

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DISCLOSURE

The candidate did not receive any outside funding or grants in support of this study. Neither did the candidate nor a member of immediate family receive payments or other benefits or commitment or agreement to provide such benefits from a commercial entity.

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DEDICATION

This work is dedicated to all patients who participated in this study for better improvement of management of elbow fractures.

ABSTRACT

Background: An elbow fracture may occur in one or more of the bones that form the elbow, including the distal humerus, proximal radius and proximal ulna. Fractures of the elbow constitute about 7-10% of all fractures in adults. The most common complication of an elbow fracture is stiffness which reduce function. Although orthopaedic surgeons at Moi Teaching and Referral Hospital (MTRH) frequently manage elbow fractures, their functional outcome is not well documented and hardly any publication exists.

Objective: To describe functional outcome of treatment of elbow fractures in adult patients at Moi Teaching and Referral Hospital.

Methods: A descriptive prospective study that included adult patients with elbow fractures seen at the casualty, fracture clinic or directly admitted to orthopaedic wards. Informed consent was obtained before enrollment. Consecutive sampling was used. Patients were managed by different surgeons, who decided their treatment options. Interviewer followed patients for functional outcome assessment. Data collection was by interviewer administered questionnaire and Mayo Elbow Performance Index (MEPI) Score tool. The obtained data was analyzed using SPSS, version 21. Approval was granted from Institutional Research Ethics Committee (IREC).

Results: There were 47 patients who were recruited, 32 males and 15 females (male/female ratio 2.1:1). Among these, 16 patients (34%) had an olecranon fracture, 15 patients (31.9%) had a distal humerus fracture, 2 patients (4.3%) had a coronoid fracture, 2 patients (4.3%) had a radial head fracture, 1 patient (2.1%) had a combined olecranon and radial head fracture and 11 patients (23.4%) had fracture dislocations. Nine patients (19%) received non-operative treatment and at 6 months their mean MEPI was 76. Thirty-eight patients (81%) received operative treatment and at 6 months their mean MEPI was 85. The average time to surgery was 6.3 days (SD 3.7). Twenty-eight patients were operated before 14 days and 26 patients (93%) had good to excellent results. Ten patients were operated after 14 days and 7 patients (70%) had good to excellent results. Overall Mean MEPI at 6 weeks was 63, at 3 months was 74 and at 6 months was 83 for all elbow fractures after treatment. At 6 months the overall mean MEPI score for patients who started physiotherapy at 3 weeks was 88, at 6 weeks was 77 and at 12 weeks was 73. The observed complications were pain (13 patients), reduced range of motion (11 patients) and infection (2 patients).

Conclusions: Overall functional outcome following treatment of elbow fractures at MTRH improved with time and was good**.** Early operation, before 14 days, and early physiotherapy gave good to excellent functional outcome. The most common complications were elbow pain and stiffness.

Recommendations: Elbow fractures that require operative treatment should be operated early to achieve an excellent functional outcome. Physiotherapy should be started early and continued to achieve excellent functional outcome.

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ABBREVIATIONS AND ACRONYMS

AMPATH	Academic Model Providing Access To Healthcare
IP NO	Inpatient number.
IREC	Institutional Research Ethics Committee.
MEPI	Mayo Elbow Performance Index
MTRH	Moi Teaching and Referral Hospital.
OPD	Out-Patient Department.
ORIF	Open Reduction and Internal Fixation
POP	Plaster Of Paris
RTA	Road Traffic Accident
SPSS	Statistical Packages for Social Sciences
SSI	Surgical Site Infection

DEFINATION OF KEY TERMS

An adult patient is a person who is 18 years and above, according to the government of Kenya constitution.

Fracture is a break in the continuity of the bone.

Functional outcome is a measurable goal that helps a patient with a fracture elbow to perform specific activities of daily living after treatment.

MEPI – Tool used to measure the functional outcome of the elbow after treatment

Satisfactory functional outcome – Excellent and good functional outcome, according to MEPI

The elbow is a hinge joint connecting the forearm and the arm.

Treatment is surgical care (operative and non-operative) given to a patient with elbow fracture, followed by physiotherapy.

Unsatisfactory functional outcome – Fair and poor functional outcomes, according to MEPI

CHAPTER ONE: INTRODUCTION

1.1: Background of the study

Introduction of Elbow joint

The elbow joint is a hinge synovial joint connecting the distal humerus and proximal radius and ulna. It has 3 joint surfaces: the radio-capitellar which is a ball-and-socket joint, ulno-trochlear which is a simple hinge-joint (Standring, 2008).

Figure 1.1.1.1: bones of the elbow, adopted from (Tashjian & Katarincic, 2006).

The elbow joint and the superior radio-ulnar joint are enclosed by a single fibrous capsule. The capsule is strengthened by ligaments at the sides, but relatively weak in front and behind (Palastanga, 2012; Standring, 2008).

The joint is stabilized by many structures, including the anterior coronoid process and posterior olecranon process which resist the translational forces of the humerus on the ulna (Newman et al., 2009). Resistance to valgus stress is provided by the anterior band of the ulnar collateral ligament and the radial head. Varus stress is countered by the lateral collateral ligament complex (Newman et al., 2009). The radial head is an important stabilizer in valgus and external rotation (Kodde et al., 2015; Lapner & King, 2014). The coronoid and the radial head provide a buttress against posterior displacement and subluxation of the elbow joint. The coronoid helps prevent varus instability (Steinmann, 2008).

The elbow joint allows for movements of flexion and extension only and the proximal radioulnar joints which has pronation and supination movements (Issack & Egol, 2006). Rotation occurs between the radial head and radial notch of the ulna as well as between the radial head and the capitellum of the distal humerus (Wells & Ablove, 2008). The elbow joint coordinates movements of the upper extremity facilitating the performance of everyday actions such as hygiene and cooking. A functional arc of 100 degrees for both extension-flexion and pronation-supination is sufficient to perform most daily activities (Kodde et al., 2013).

Elbow fractures may occur in one or more parts of the three bones that form the elbow joint which are the proximal ulnar, proximal radius and distal humerus. They constitute 10% of upper limb fractures and about 5 - 7% of all adult fractures (Altiken et al., 2014). It is often injured following a fall as the individual usually puts the arms outstretched or flexed elbow (Mutiso, 2007). Trauma is a common cause of stiffness in the elbow joint with rates ranging from 3% to 20% (Mittal, 2017).

Elbow stiffness is a common problem, causing functional impairment of the elbow joint (Filh & Galvão, 2010). Elbow stiffness is generally defined as a flexion-extension arc of <100 degrees and/or flexion contracture of >30 degrees (Kodde et al., 2013). Restoration of joint motion in the posttraumatic stiff elbow can be a difficult, time-consuming, and costly (Lindenhovius & Jupiter, 2007).

Elbow fractures are challenging injuries to treat. Their management is based on fracture pattern, patient age, bone quality, associated soft tissue injuries and associated fractures (Kuntz Jr & Baratz, 1999) . Elbow fractures can be treated operatively or non-operatively followed by early physiotherapy to achieve good to excellent functional outcome (Kuntz Jr & Baratz, 1999). A healed, anatomically aligned fracture with limited elbow or forearm motion results in poor function of the patient (Filh & Galvão, 2010; Kuntz Jr & Baratz, 1999). Maximal function can be realized with a thorough knowledge of elbow anatomy, treatment options, and early postoperative motion protocols (Kuntz Jr & Baratz, 1999).

Functional outcome of elbow injuries after treatment have been measured using various scoring systems. However, only a few of these have been validated, and many assess only some aspects of elbow function (Longo et al., 2008).

Mayo Elbow Performance Index (MEPI) Score (Appendix 3) has been the most frequently used tool for assessment in most scientific studies. It has four parts which are pain, range of motion, stability and function. It classifies the results through a scoring system in which 90 to 100 points is considered excellent, 75 to 89 is good, 60 to 74 is fair and less than 60 is poor (Cusick et al., 2014; Longo et al., 2008).

There is a scarcity of data about the functional outcome of treatment of elbow fractures in Africa and Kenya. An elbow fracture in adult patients is one of presentation to fracture clinic at MTRH in Eldoret, Kenya with the outcome of the treatment not fully appreciated or known. This study therefore seeks to describe the functional outcome of treatment of elbow fractures in adult patients at MTRH.

1.2: Problem statement

The outcome of fractures of the elbow can have a major impact on the daily activities of the patients. If not treated accordingly may have a significant negative socioeconomic impact. This could cause a heavy burden on the income of many families as they may lose their jobs because most bread winners do jobs which require the use of elbows. In 2013, about 10 patients were observed with stiffness of the elbow and poor functional outcome at MTRH fracture clinic. This affected their daily activities as they could not use their elbows fully.

The functional outcome of treatment of adult elbow fractures at MTRH and the rest of Kenya is unknown, even though they are frequently managed. There is also a high increase of trauma due to increasing road traffic accidents and the elbow may also be injured.

1.3: Justification for the study

To guide surgeons in decision making to minimize elbow stiffness. The main factors that expose the elbow joint to the loss of range of motion (elbow stiffness) are the choice of treatment options, time taken to initiate treatment option, poor rehabilitation and unnecessary prolonged immobilization. Elbow stiffness may hinder daily activities of a patient, therefore treatment of elbow fractures should be aimed at returning patients to their functional state.

Elbow fractures need to be treated with appropriate treatment option for the type of fracture to avoid stiffness and improve functional outcome. Early treatment of elbow fractures, like early surgery, may minimize splinting time, hence early passive and active range of motion can be started as soon as possible. Earliest time to initiate physiotherapy for both operative and non-operative treatment may also influence functional outcome.

There is limited literature on outcome of treatment of elbow fractures in adult patients in Kenya and Africa. This study helps to close the gap between treatment options and functional outcomes of elbow fractures at MTRH. This will also benefit patients as they will have the right treatment option and satisfactory functional outcome.

The outcome of this research will be useful not only to MTRH in its quest to improve patient care, but also contribute to the knowledge in management of elbow fractures in Kenya and Africa. The findings of this study can also be used as a baseline for future researches about elbow fractures in Adults.

1.4: Research question

What is the functional outcome of treatment of elbow fractures in adult patients at Moi Teaching and Referral Hospital?

1.5: Study objectives

1.5.1: Broad objective

To describe the functional outcome of treatment of elbow fractures in adult patients at Moi Teaching and Referral Hospital.

1.5.2: Specific objectives

1. To describe treatment options of elbow fractures in adult patients at MTRH.
2. To determine functional outcome after operative treatment of elbow fractures in adult patients at MTRH.
3. To determine functional outcome after non-operative treatment of elbow fractures in adult patients at MTRH.
4. To determine the relationship between functional outcome and the time taken before operative treatment for elbow fractures in adult patients requiring operation at MTRH.

CHAPTER TWO: LITERATURE REVIEW

2.1 Elbow function and fracture morphology

2.1.1 Functions of the elbow joint

The movement at the elbow includes flexion and extension that occur at the radiocapitellar and ulnotrochlear joints, and rotation enabling supination and pronation that occurs at the proximal radioulnar joint (Standring, 2008). Loss of these movements can have major implications on functional capabilities. This includes difficulty returning to activities of daily living such as the inability to feed yourself or keep basic hygiene (P.D. Kim et al., 2005; Rommens et al., 2004).

The range of elbow movement required for most daily activities is a flexion arc of 30 to 130 degrees (normal 0-150°) and 50°of pronation and supination (normal pronation is 80°and supination 85°) (Issack & Egol, 2006; Morrey et al., 1981).

Most literature measure the functional outcome of treatment of elbow fractures using radiographs, as well as Mayo Elbow Performance Index (MEPI) score (appendix 3) (Chalidis et al., 2008; Chemama et al., 2010; de Haan et al., 2010; Erpelding et al., 2012; Kaushal & Rao, 2016; McKee et al., 2000; Munoz-Mahamud et al., 2010). MEPI often appears in scientific documentation as a golden standard for questionnaires, to measure improvement of functional outcome after treatments (Broberg & Morrey, 1986; Cusick et al., 2014).

2.1.2 Mechanism of injury

Distal humerus fractures most often results from a fall onto an outstretched hand and high energy trauma, such as road traffic accidents (Gupta & Khanchandani, 2002; Kuntz Jr & Baratz, 1999; Murray, 1940; Watts et al., 2007). Radial head fractures commonly result from a fall on an outstretched hand with the forearm in pronation (Harrison et al., 2007). Olecranon fractures can result from either direct trauma to the olecranon, forcing it into the distal humerus, or from an indirect mechanism through triceps contraction (Donegan & Bell, 2010) and also injury from a fall onto an outstretched hand (Kuntz Jr & Baratz, 1999).

The mechanism of injury for the coronoid process fracture is hyperextension of the elbow with the trochlea of the distal humerus shearing it off (Regan & Morrey, 1989). The mechanism of injury for elbow fracture dislocation is usually falling on an outstretched hand (Chemama et al., 2010; Gomide et al., 2011).

2.1.3 Patterns of elbow fractures

Fractures of the elbow constitute of 10% of upper limb fractures and about 5 - 7% of all adult fractures (Altiken et al., 2014). Distal humerus fractures are about 2% of all adult fractures and 30% of elbow fractures (Kaushal & Rao, 2016; Kuntz Jr & Baratz, 1999; Robinson et al., 2003). Radial head fractures account for 30% of elbow fractures (Harrison et al., 2007; Kodde et al., 2015; Kuntz Jr & Baratz, 1999; Li et al., 2016) and approximately 5.4% of all fractures (Donegan & Bell, 2010).

Olecranon fractures are approximately 10% of all fractures around the elbow (Donegan & Bell, 2010; Rommens et al., 2004; Veillette & Steinmann, 2008; Watts et al., 2007), however there are studies which reported 38% of all elbow fractures (Munoz-Mahamud et al., 2010).

Coronoid fractures account for less than 1-2% of all elbow fractures. Coronoid process fractures are associated with 10% to 15% of elbow dislocation (Kuntz Jr & Baratz, 1999; Wells & Ablove, 2008).

The elbow joint is the second most commonly dislocated joint in adults. The simple dislocation is characterized by the absence of fractures, while the complex dislocation is associated with elbow fractures (de Haan et al., 2010). Terrible triad injury is a complex fracture-dislocation of the elbow. It is not common and account for 10% of radial head fractures (van Riet & Morrey, 2008).

2.1.4 Classifications of elbow fractures

Elbow fractures are classified to guide treatment options and rehabilitation (Kuntz Jr & Baratz, 1999).

Classifications of distal humerus fractures

The Müller AO classification is used to guide treatment options of distal humerus fractures (Holdsworth & Mossad, 1990).

Type 1 3 A – Extra articular fracture

1. Apophyseal avulsion
2. Metaphyseal simple
3. Metaphyseal multifragmentary

Type 1 3 B – Partial articular fracture

1. Sagittal lateral condyle
2. Sagittal medial condyle
3. Frontal

Type 1 3 C – Complete articular fractures

1. Articular simple, metaphyseal simple
2. Articular simple, metaphyseal multifragmentary
3. Articular, multifragmentary

Classification of radial head fractures

Radial head fractures can be classified using the Mason classification (Hotchkiss, 1997). A type I fracture is non-displaced, a type II fracture is displaced with more than 30% of the radial head involved, and a type III fracture is comminuted (Hotchkiss, 1997). A type IV fracture was added to Mason's classification by Johnston: a radial head fracture with an associated elbow dislocation (Harrison et al., 2007; Morrey, 1995).

Classification of olecranon fractures

Several classification systems for olecranon fractures have been described with no classification being universally accepted (Hack & Golladay, 2000). However, there are 3 major classification systems, the AO classification system, the Mayo Classification System, and the Schatzker–Schmeling. Each Classification System has both advantages and disadvantages (Donegan & Bell, 2010). The first systematic classification based on the displacement and character of the fracture was developed (Colton, 1973).

The Mayo classification describes fractures based on stability, displacement, and comminution. Type I fractures are undisplaced, type II are displaced and stable and type III are displaced and unstable. Each type is further divided into subtypes, A **is** non-comminuted and B is comminuted fractures (Morrey, 1995).

Classification of coronoid fractures

Coronoid process fractures are classified into three types, based on the lateral radiographic view (Harrison et al., 2007; Regan & Morrey, 1989). Type I fractures are avulsion of the tip of the process. Type II are fractures involving <50% of the process. Type III are fractures involving >50% of the process.

2.2 Treatment options

The goals of operative and non-operative treatment are to achieve and maintain a stable, anatomic fracture reduction that allows early active elbow motion (Kuntz Jr & Baratz, 1999).

Un-displaced or minimally displaced fractures are generally managed non-operatively by splinting or full cast POP. This usually involves a period of immobilization with arm sling, collar and cuff sling. Displaced fractures, unstable fractures or more complex fractures require operative treatment (Gradl & Jupiter, 2012).

The aim of operative treatment is to restore the anatomy, secure fixation of the fragments and to allow early mobilization to prevent joint stiffness (Ring D, 1997). Open fractures should emergently and initially be treated with copious irrigation and surgical debridement (Ditsios et al., 2013; P. D Kim & Leopold, 2012). In a review for early mobilization of adult elbow fractures, there were no statistically significant differences between early and delayed mobilization in participants having a limited range of motion (Harding et al., 2011). There is a lack of strong evidence to inform on the timing of mobilization, and specifically on the use of early mobilization, after nonsurgical or surgical treatment for adults with elbow fractures (Harding et al., 2011).

2.2.1 Distal humerus fractures

The majority of patients with fractures of the distal humerus should undergo operative treatment for better functional outcome (Gradl & Jupiter, 2012). The goal of treatment is to achieve painless and good functional elbow which requires anatomical reconstruction and stable fixation (Kiran et al., 2017).

Numerous treatment methods are advised and compared for the management of these fractures, but none of them are satisfactory (Kaushal & Rao, 2016). Acceptable results are now being reported in the majority of patients treated by open reduction and internal fixation (Aitken & Rorabeck, 1986; Helfet & Schmeling, 1993). Improved surgical techniques allow early return to active motion (Helfet & Schmeling, 1993). Double plate osteosynthesis or locking compression plate can be used (Gradl & Jupiter, 2012). Non-surgical treatment is appropriate for stable, un-displaced fractures and bag of bones fractures (Anglen, 2005; Gradl & Jupiter, 2012). Restoration of elbow movements requires anatomic reconstruction of the articular surface, stable fixation and early mobilization (Kaushal & Rao, 2016). The most important indicator of the end result is the starting time of physiotherapy (Aitken & Rorabeck, 1986).

2.2.2 Radial head fractures

Treatment is influenced by fracture characteristics such as fragment number, displacement, joint stability, and associated injuries, and there are options like fragment excision, radial head excision, fixation, or replacement (Harrison et al., 2007; Lapner & King, 2014). The goal of treatment of radial head fractures is preservation of elbow stability, motion and maintenance of radial length (Li et al., 2016).

The current literature suggests that the mason classification guides choice of the best treatment modality to achieve better functional outcome (Tejwani & Mehta, 2007). Radial head fractures with no or minimal displacement, Mason type 1, can be treated non-operatively with splinting or full cast (Harrison et al., 2007; Hotchkiss, 1997; Morrey, 1995). Elbow motion is begun as soon as comfort allows (Harrison et al., 2007).

Mason type II fractures may be treated non-operatively or by open reduction internal fixation. Mason type II fractures treated operatively have better functional outcome than non-operative treated fractures (Khalfayan et al., 1992). Open reduction and internal fixation can be done using headless screws or variety of plates like L and T plates (Gradl & Jupiter, 2012).

If non-operative treatment is considered, the decision must be based on the amount of motion without any block (Lapner & King, 2014; Morrey, 1995). Early studies advocated for excision of Mason type 2 and 3 fractures. However, the biomechanical understanding of the radial head as a stabilizer and axial weight-bearing structure led to an appreciation of its functional importance (Gradl & Jupiter, 2012; Kodde et al., 2015). Excision has become less popular and arthroplasty is done for better functional outcome and stability (Kodde et al., 2015; Li et al., 2016). The radial head excision should be done in those patients with severe comminution and elderly (Hotchkiss, 1997). Mobilization is commenced at 2 weeks with active movements (Harrison et al., 2007).

2.2.3 Olecranon fractures

Treatment is done to achieve stable articular reduction and fixation with early postoperative physiotherapy. Due to the intra-articular extension of fractures, anatomic reduction and early mobilization should be achieved in any case (Chalidis et al., 2008). There are many options available for treating these injuries ranging from cast immobilization to open reduction and internal fixation (Donegan & Bell, 2010).

Non-operative treatment is done for non-displaced or minimally displaced olecranon fractures with immobilization in a splint at 45–90 degrees of flexion for approximately 3 weeks before commencing physiotherapy (Newman et al., 2009).

Displaced olecranon fractures should be operated, by plating or by tension band technique or intramedullary fixation to restore articular congruity (Donegan & Bell, 2010; Newman et al., 2009). Tension band wire fixation is by far the commonest technique of internal fixation used for the treatment of non-comminuted olecranon fractures (Nieto et al., 2015).

2.2.4 Coronoid process fractures

As most of coronoid fractures do not occur alone, the type of treatment depends on associated fractures like fracture of radial head (Ring et al., 2002). Regan type 1 fractures, simple or associated with dislocation or another fracture should be treated non-operative by splinting for 3 weeks followed by physiotherapy (Regan & Morrey, 1989). Type 2 fractures not associated with dislocation or fracture can be managed non-operatively, if associated with other fractures it should be operated.

Type 3 should be treated with ORIF, for better functional outcome and active motion should be started as soon as the fracture is stable (Regan & Morrey, 1989). Fractures of coronoid of less than 30% of the height are usually treated conservatively and those more than that should be reconstructed (Sanchez-Sotelo & Morrey, 2016).

2.2.5 Fracture dislocation (complex dislocation)

Fracture dislocation of the elbow is dislocation with any fracture that involves the elbow example; terrible triad injury is the dislocation of the elbow, radial head fracture and coronoid fracture with torn ligaments of the elbow (Chemama et al., 2010; Doornberg & Ring, 2006). Treatment principles are reduction of the joint, stabilization of associated fractures, and early motion (Hildebrand et al., 1999). They are treated as an emergency to reduce the dislocation and associated fracture (Morrey, 1995).

Proper identification of these lesions is quite demanding and their early management is a favorable prognostic factor for the final outcome (Armstrong, 2005). The fundamental goal in the management of fracture dislocation of the elbow is the restoration of the osseous articular restraints. Therefore, the majority of these complex dislocations are treated with open reduction and internal fixation (ORIF) (de Haan et al., 2010; Ring & Jupiter, 1998).

There are many long-term complications from both operative and non-operative treatment of elbow fracture-dislocations. The most common complication of elbow dislocations is loss of range of motion, which has a high correlation with prolonged immobilization (Ring et al., 2002).

2.3 Functional outcome for operative treatment

Fracture-dislocation of the humeral condyles in adults when treated operatively gives good to excellent results (Bentounsi, 2015). Systematic review indicates that functional outcomes after surgery for a terrible triad injury of the elbow are generally satisfactory (Chen et al., 2014; Gomide et al., 2011). The outcomes after operative treatment of olecranon fractures show that most of the fractures unite and the majority of patients obtain a usable range of elbow motion after starting physiotherapy as soon as possible (Chalidis et al., 2008; Morrey, 1995).

Operative treatment of distal humeral fractures results in excellent functional outcome (Erpelding et al., 2012; Kaushal & Rao, 2016; McKee et al., 2000). Acceptable functional outcomes are usually achieved with early elbow mobilization (Gupta & Khanchandani, 2002).Open reduction and internal fixation, followed by early motion, physiotherapy, when possible, may be the preferred treatment for patients who have coronoid fractures type 3 (Regan & Morrey, 1989).

2.4 Functional outcome for non-operative treatment

Patients with un-displaced olecranon fractures can be treated non-operatively with immobilization using full cast or splinting for approximately 3 weeks and have satisfactory functional outcome (Newman et al., 2009).

Isolated displaced olecranon fractures when treated non-operatively in older patients found to have satisfactory short-term and long-term functional outcomes (Duckworth, Bugler, et al., 2014). Mason type 1 fractures of radial head give satisfactory results when treated non-operatively.

Mason type 2 radial head fractures also show no difference on operative and non-operative treatment (Kodde et al., 2015). They both have satisfactory functional outcome (Kodde et al., 2015). Long-term functional outcomes are excellent following the non-operative management of isolated stable fractures of the radial head or neck (Duckworth, Wickramasinghe, et al., 2014). Most of patients with Coronoid fractures type 1 or type 2 have excellent functional outcome when treated non-operatively and started on physiotherapy as soon as possible(Regan & Morrey, 1989).

2.5 Time taken to operative treatment

The operative treatment should be done early with the aim of achieving a congruent elbow. Patients who underwent operations not more than 14 days after the trauma achieve clinical results that are statistically significant than those of the patients operated after more than 14 days had elapsed (Gomide et al., 2011).

It has been shown in studies done on fractures of the elbow that less time to surgery has good to excellent functional outcome (Bentounsi, 2015; de Haan et al., 2010; Erpelding et al., 2012).

Early operative treatment of distal humerus is preferable and functional outcomes are reported to be better with fewer complications for patients who are managed within 24 hours (Gradl & Jupiter, 2012).

2.6 Complications

The posttraumatic stiff elbow is a frequent and disabling complication after treatment and poses serious challenges for its management (P.D. Kim et al., 2005; Mittal, 2017; Nandi et al., 2009).

A surgical site infection (SSI) is the most common major complication of orthopaedic surgery (Whitehouse et al., 2002). It can contribute to other adverse outcomes, including nonunion, stiffness, arthritis, and heterotopic ossification. Orthopaedic SSIs prolong hospital stays by about 7 to 14 days and increase healthcare costs by more than 300% (Whitehouse et al., 2002). The incidence of an SSI after surgery for elbow varies from 1.3% to 6.5% (Adeli & Parvizi, 2012; Claessen et al., 2016). The ulnar nerve is susceptible to compressive neuropathy at several anatomical sites at the elbow joint. The ulnar nerve can be damaged by the initial injury or iatrogenically during operative treatment. It may become symptomatic, secondary to postoperative swelling, scarring, and thickening in its fibro-osseous tunnel (Shin & Ring, 2007).

It is important to examine for peripheral nerve function carefully prior to any operation for the treatment of an elbow injury, in order to distinguish injury-related from surgery-related palsies (Shin & Ring, 2007). If the nerve is not lacerated or entrapped by an implant or injury, then a postoperative palsy should be managed with observation; otherwise the nerve should be explored (Gupta & Khanchandani, 2002; Shin & Ring, 2007).

CHAPTER THREE: METHODOLOGY

3.1 Study site

The study was conducted at Moi Teaching and Referral Hospital (MTRH) casualty, fracture clinic and orthopaedic wards. MTRH is the second National Referral Hospital in Kenya after Kenyatta National Hospital (KNH). The Hospital is located along the Nandi Road in Eldoret town (310 kilometers Northwest of Nairobi the capital city of Kenya), Uasin Gishu County, in the North Rift region of Western Kenya. The bed capacity is about 1000 (AMPATH, 2016).

The hospital receives patients on referral from other hospitals or institutions, patients from western Kenya, parts of Eastern Uganda, and the southern Sudan for specialized health care. It also provides facilities for medical education, Moi University Medical School and other health institutions like Kenya Medical Training Centre (KMTC), University of Eastern Africa, Baraton, and the ECN (Enrolled Community Nurse) upgrading programme as well as international students on exchange programmes courtesy of Moi University (AMPATH, 2016). It serves the greater western Kenya region representing about 40% (approximately 20 million people) of the country's population.

3.2 Study design

This was a descriptive prospective study, which was done between January 2015 and June 2016.

3.3 Study population

Adult patients aged 18 years and above with elbow fractures treated at the casualty, attending fracture clinic or admitted in Orthopaedic wards during the study period.

3.4 Eligibility criteria

3.4 .1 Inclusion criterion:

1. All adult patients with elbow fractures.

3.4.2 Exclusion criteria:

1. All adult patients with previous injury or surgery on the affected elbow joint.
2. All adult patients who were treated elsewhere or in another hospital coming for follow up at MTRH.
3. All patients who did not consent to the study.

3.5 Sample size determination

This was a census study. All patients who met the inclusion criteria were recruited into the study during the duration of study which was one year of recruitment, January 2015 – December 2015. It was noticed that, from MTRH records, for previous years, 2011, 2012 and 2013, an average of 41 patients with elbow fractures were seen at the hospital.

3.6 Sampling method

Consecutive sampling technique was used, all adult patients with elbow fractures meeting the inclusion criteria were recruited. Patients were recruited from casualty, orthopaedic outpatient clinic and orthopaedic wards at MTRH after giving written informed consent (Appendix 1).

3.7 Data collection tools and technique

Research assistant was trained on recruiting patients. An interviewer administered questionnaire (Appendix 2) was used to obtain data. The treatment option of patients in this study was decided by different surgeons in the hospital. The principal investigator did the examination of patients and interpretation of radiographs and follow-up of functional outcome.

The data collected included patients socio-demographic details, clinical data that included time of presentation at MTRH, mechanism of injury, side of injury, type of injury, classification of fracture, associated injuries, treatment options, time taken to surgery. Goniometer was used to measure the arc of range of motion at the elbow.

Functional outcome measurements were recorded on the Mayo Elbow Performance Index (MEPI) (Appendix 3) score, which quantifies pain, mobility, stability and function, classifying the results through a scoring system in which 90 to 100 points is considered excellent, 75 to 89 is good, 60 to 74 is fair and less than 60 is poor. Pain scale (appendix 4)(McCaffery & Beebe, 1993) was also applied to measure pain.

Follow up after treatment was done at 6 weeks, 3 months, and 6 months and functional outcome was documented using MEPI score tool. Complications from clinical review were also documented.

3.8 Study variables

3.8.1 Socio-demographic details – age and gender.

3.8.2 Fracture Morphology - Classification, open or closed fracture, associated injuries

3.8.3 Management - Operative or non-operative treatment and physiotherapy

3.8.4 Functional Outcome (MEPI Score) - pain, mobility, stability and function

3.8.5 Complications **–** Reduced range of motion, pain, infection, and nerve palsies

3.9 Quality Control

Data was collected using validated tools like MEPI tool. Review of data after collection to check for missing data and counter checks on data entry was done by researcher using MS excel. This was to verify the data collected.

3.10 Data analysis

The data was captured from pre checked completed questionnaires, digitalized into a computer and analyzed using SPSS version 21. The data was then secured with a password. The results were illustrated in terms of linear graphs and tables.

3.11 Limitations of the study

1. Some patients did not come for their follow up visits because they had forgotten. This was mitigated by messaging or calling patients to remind them about their appointments.
2. The elbow treatment had been performed by different surgeons thereby creating variability in management techniques which may influence the functional outcome.

3.12 Ethical clearance and informed consent

Ethical clearance was provided by the Institutional Research Ethics Committee (IREC) of MTRH / Moi University (Appendices 5 - 8). The study approval number was IREC 0001272. The patients were informed appropriately on the benefits and risks of the study in a language that they fully understood and informed written consent (appendix 1) was obtained from each participant.

The participating patients were informed they were free to withdraw from the study any time they wished to do so without any consequences. All patients were informed that they will be given equal treatment, whether they consent, do not consent or withdraw from the study.

The collected data was locked in a secure cabinet that was only accessible to the investigator. 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. The disposal of the patient’s particulars after the completion of the

Masters of Medicine (MMed) programme will be as per IREC guidelines, for example shredding. The copy of this thesis will be available at Moi university library and website. Publication after completion of MMed programme to disseminate information has been planned for.

CHAPTER FOUR: RESULTS

4.1 Demographic characteristics and fracture morphology

Fifty (51) patients were recruited into the study and 4 patients were lost to follow up. Only 47 patients who were followed-up after treatment of the fracture of the elbow were analyzed. The age of the patients ranged from 19 to 90 years, with a mean age of 41.1 (SD 17) years. The mean age for males was 38.5 (SD 13) years and the mean age of females was 47.4 (SD 23) years, however this difference in mean age between males and females was not statistically significant $t(12) = -1.345$, $p=0.196$.

Table 4.1.1: Demographic characteristics and age

Variable	Male		Female	Total
Patients recruited (%)	33 (65%)		18 (35%)	51 (100%)
Loss to follow up	1		3	4
Patients followed up (%)	32		15	47
Ration (M:F)	2.1	:	1	
Mean age (SD) (years)	38.5 (13)		47.4 (23)	

Table 4.1.1 above shows the social demographic characteristics of the patients studied. The proportion of male to female was 2.1:1.

Table 4.1.2: Mechanism of injury and fracture morphology

Variable	Categories	Frequency	Percentage
Mechanism of Injury	Falls	22	47
	RTA	18	38
	Assault	7	15
Fracture laterality	Right	20	42.6
	Left	27	57.4
Elbow injured	Dominant side	22	46.8
	Non dominant side	25	53.2
Fracture classification	Closed fractures	38	80.9
(open/closed)	Open fractures	9	19.1
Associated injuries	Yes	11	23.4
	No	36	76.6
Specific other injuries	femur fracture	3	27.2
sustained	tibia fracture	4	36.4
	head injury	2	18.2
	rib fracture	1	9.1
	Clavicle fracture	1	9.1

Table above shows that most patients, 22 (47%), sustained an elbow fracture by falling. Twenty (42.6%) patients had fractures of the right elbow and 27(57.4%) patients sustained fracture of the left side. Twenty-two (46.8%) patients got injured on their dominant side while 25 (53.2%) patients were injured in non-dominant side. Only 11 (23.4%) sustained other injuries besides elbow fracture. Only 9 (19.1%) patients sustained open fracture while 38 (80.9%) patients sustained closed fractures.

Table 4.1.3: Patterns of elbow fractures

Variable	Categories	Frequency	Percentage (%)
Fracture pattern	Olecranon fracture	16	34.0
	Distal Humerus fractures	15	31.9
	Coronoid fracture	2	4.3
	Radial head fracture	2	4.3
	olecranon and radial head fracture	1	2.1
	Fracture dislocations	11	23.4
Total		**47**	**100**

The most frequent fracture pattern of the elbow was olecranon fracture with 16 (34%) followed by distal humerus fracture with 15 (31.9%) and fracture dislocations with 11(23.4%).

4.2 Treatment options

Table 4.2.1: Treatment options received for elbow fractures

Treatment option	Frequency	Percentage (%)
Non-operative	9	19.1
Operative	38	80.9
Total	**47**	**100**

The majority of patients, 38 (80.9%), received operative treatment, while 9 (19.1%) patients received non-operative treatment.

Table 4.2.2: Treatment options received for each elbow fracture classification

Fracture type	Classification	Frequency	Treatment options	
			Non-operative	Operative
Olecranon	Mayo type IIA	8	0	8
	Mayo type IIB	10	0	10
Distal Humerus	1 - 3 - A2	6	4	2
	1 - 3 - A3	1	0	1
	1 - 3 - B1	7	2	5
	1 - 3 - B2	2	1	1
	1 - 3 - C2	1	0	1
	1 - 3 - C3	3	0	3
Radial head	Mason type I	2	2	0
	Mason type II	2	0	2
	Mason type IV	2	0	2
Coronoid	Regan & Morrey type III	3	0	3
Total		**47**	**9**	**38**

Treatment options that were received were both non-operative and operative. Most patients had operative treatment.

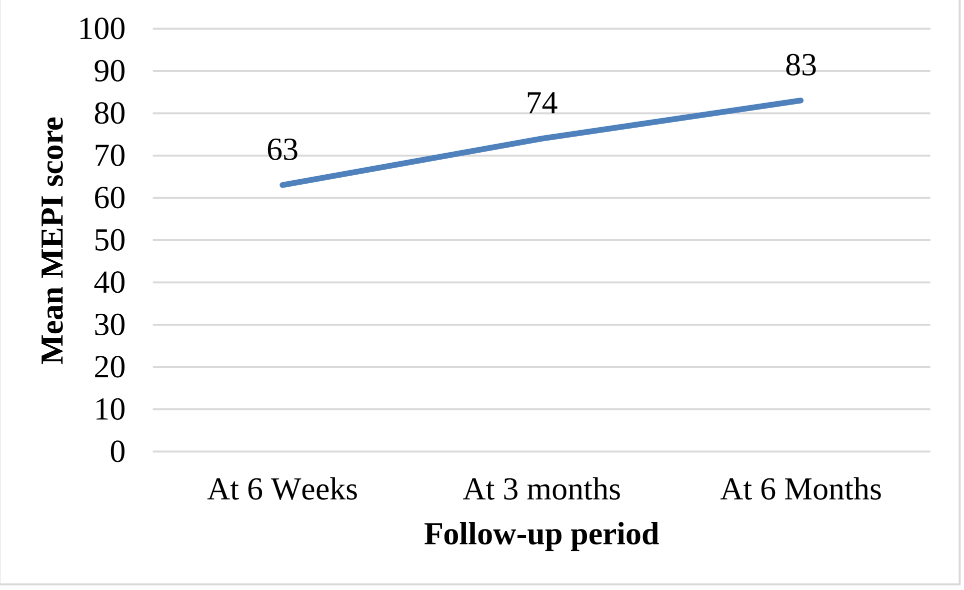

Figure 4.2.1: Mean MEPI score at follow-up visits

The average MEPI score for overall patients was increasing at each follow up

Physiotherapy after treatment

All 47 (100%) patients underwent physiotherapy, however they started at different times. Most patient who received operative treatment started within 3 weeks while most patients who received non-operative treatment started between week 3 and week 6.

Table 4.2.3: The time Physiotherapy was initiated after treatment

	Treatment option	
Time	**Non-operative**	**Operative**
0 - 3 weeks	1 (11%)	27 (71%)
>3 - 6 weeks	6 (67%)	10 (26%)
>6 - 12 weeks	2 (22%)	1 (3%)
Total	**9 (100%)**	**38 (100%)**

The above table shows that 28 patients started physiotherapy within 3 weeks, and of those 27 patients received operative treatment and only 1 received non operative treatment.

Table 4.2.4: Mean MEPI at 6 months in relation to time of starting physiotherapy

Time (weeks)	N	Mean MEPI	SD	Minimum	Maximum	Fisher's Exact test	P-value
0 - 3	28	88	7	70	95	10.971	<0.001
>3 – 6	16	78	9	65	95		
>6 - 12	3	73	3	70	75		

The time that the patients started physiotherapy had a significant association with the functional outcome (measured using MEPI at 6 months), $F (2, 44) = 10.971$, $p<0.001$

4.3 Functional outcomes for operative treatment

Thirty-eight patients (81%) received operative treatment and at 6 months their mean MEPI was 85 (SD +/- 9).

Table 4.3.1: Functional outcome of operative treatment at 6 months

MEPI Classifications	Number of patients	Percentage (%)
Fair	8	21.0
Good	12	31.6
Excellent	18	47.4
Total	**38**	**100**

Eighteen patients had an excellent functional outcome while 12 patients had good outcomes after operative treatment.

Table 4.3.2: Functional outcome of fracture types after operative treatment

Type of fracture	MEPI Classification			
	Fair	**Good**	**Excellent**	**Total**
Olecranon fracture	3	5	8	16
Radial head fracture	1	0	0	1
Distal humerus fracture	2	2	4	8
Coronoid fracture	0	0	2	2
Olecranon and radial head fracture	0	0	1	1
Fracture-dislocation	2	5	3	10
Total	**8**	**12**	**18**	**38**

Most patients had good to excellent functional outcome after operative treatment.

4.4 Functional outcomes for non-operative treatment

Nine patients (19%) received non-operative treatment and at 6 months their mean MEPI was 76 (SD +/- 8).

Table 4.4.1: Functional outcome of non-operative treatment at 6 months

MEPI Classifications	Number of patients	Percentage (%)
Fair	3	33.3
Good	5	55.6
Excellent	1	11.1
Total	**9**	**100**

Five patients had good functional outcome and 1 patient had excellent functional outcome after non-operative treatment at 6 months

Table 4.4.2: Functional outcome of fracture types after non-operative treatment

Type of fracture	MEPI Classification			Total
	Fair	Good	Excellent	
Radial fracture	0	0	1	1
Distal humerus fracture	2	5	0	7
Fracture-dislocation	1	0	0	1
Total	**3**	**5**	**1**	**9**

Only 1 patient had excellent functional outcome and 5 patients had good functional outcome

4.5 Time taken to operative treatment

For the 38 patients who underwent operative treatment option, it took on average 6.3 (SD +/- 3.7) days to have an operation (median =7 days, IQR 10) with a minimum of 2 days and a maximum of 60 days.

Table 4.5.1: Functional outcome at 6 months for preoperative time before 14 days and after 14 days.

Time taken before operative treatment	Functional outcome		Chi-square	P value
	Satisfactory (good and fair)	Unsatisfactory (poor and fair)		
Equal/less than 14 days	26 (92%)	2 (7.1%)	12.386	0.002
More than 14 days	4 (40.0%)	6 (60%)		

Twenty eight patients received operative treatment before 14 days and 26 patients had satisfactory functional outcome. Ten patients received operative treatment after 14 days and 4 patients had satisfactory functional outcome.

4.6 Complications

Table 4.6.1: Complications of elbow fractures at 6 months

Complications	Frequency	Percentage
Pain	13	27.7
Reduced Range of Motion (stiffness)	11	23.4
Infection	2	4.3
Ulnar palsy	1	2.1
Hardware irritation	2	4.3
None	27	57.4

The most common complication was elbow pain in 13 patients and 11 patients had elbow stiffness. Three patients developed iatrogenic ulnar nerve palsy during surgery and at 6 months only 1 had not recovered.

CHAPTER FIVE: DISCUSSION

5.1 Demographic characteristics and fracture morphology

5.1.1 Demographic characteristics

Fifty-one patients were recruited into the study and 4 patients were lost to follow up. The loss to follow up was because patients opted to be treated at different facilities. Therefore 47 were followed up till 6 months. The range of age distribution was wide. The ratio of male to female was 2.1:1. The difference in mean age between males and females was not statistically significant, p=0.196.

5.1.2 Mechanism of injury

In this study the most common cause of elbow fracture were falls followed by road traffic accident. This concurred with other studies done by Chemama et al., (2010), Guide et al., (2011) and Gupta et al., (2002) on elbow fractures, which found that the most common cause were falls. This could be that majority of patients in this study had risky jobs. They could be at risk of falling with outstretched arms while working on the farms or fall from trees while harvesting. RTA could be because of increased traffic, reckless driving and un-roadworthy vehicles which put them at risk.

5.1.3 Injury laterality and Dominant side

Regarding the side of the elbow, which got injured in this study, it was found that almost equal number of injuries happened on both sides. This was in agreement with studies by Chalidis et al., (2008) and McKee et al., (2000) as they showed almost equal involvement of both sides. It was also found out that the dominant hand got injured almost equally to non-dominant hand. This was in agreement with studies by Chalidis et al., (2008), Gomide et al., (2011) and McKee et al., (2000) on elbow fractures that showed almost equal fractures on dominant and non-dominant side.

There was no clear explanation of the study why the injury happened equally on both sides, but this could be influenced by mechanism of injury. The injury side could be influenced by the side they were tripped and fell on an outstretched arm to break the fall or a direct impact on that side.

5.1.4 Patterns of elbow fractures

According to this study the most frequent fracture pattern of the elbow was olecranon fracture by 34%. This was in agreement with a study by Munoz-Mahamud et al., (2010) which stated olecranon fractures to account for 38% of all elbow fractures. However, it contrasted with other studies by Donegan et al., (2010), Rommens et al., (2004) and Veillette et al., (2008) which showed that olecranon fractures account for 10% of elbow fractures.

Distal humeral fractures accounted for 31.9%. This was in agreement with the studies by Kaushal et al., (2016), Kuntz et al., (1999) and Robinson et al., (2003) who found out that it contributed 30% of all elbow fractures. Fracture-dislocations contributed 23.4 % of all elbow fractures in this study and there were no comparable studies. Coronoid fracture contributed 4.3%, this was almost double of what was found in other studies by Kuntz et al., (1999) and Wells et al., (2008) that showed they account for less than 1-2% of all elbow fractures.

Radial head fractures contributed 4.3%, this was lower than what was found in other studies where it was 30% of all elbow fractures by Harrison et al., 2007; Kodde et al., 2015; Kuntz et al., 2015; and Li et al., 2016. Olecranon combined with radial head fracture accounted for 2.1% of elbow fractures in this study, however there were no comparable studies.

5.2 Treatment options

Most patients had operative treatment, while few patients had non-operative treatment. All stable, un-displaced or minimally displaced fractures and closed fractures in the elderly were treated non-operatively by splinting or applying full cast to the elbow. This was in agreement with other studies which showed that minimally displaced fractures were treated non-operatively as documented by Anglen, 2005; Chalidis et al., 2008; Morrey, 1995; and Newman et al., 2009.

Displaced fractures, open fractures and patients with severe associated injuries were treated operatively to reduce the joint anatomically. This was in agreement with other studies by Anglen, 2005; Chalidis et al., 2008; Donegan et al., 2010; Helfet et al., 1993; Hotchkiss, 1997; Li et al., 2016 and Sanchez-Sotelo et al., 2016. Most fracture-dislocations were treated operatively. This was because they were unstable and this was in agreement with other studies by de Haan et al., (2010) and Ring et al., (2002) which showed that fracture dislocation when unstable should be treated operatively. Most of the fractures were treated with appropriate treatment options because MTRH is a teaching hospital where fractures are discussed by consultants and registrars, then the treatment option is decided for the patient based on classification and bone quality.

Few patients had open fractures while majority sustained closed fractures. This could be because most patients sustained fracture after falling which is of low energy. All open fractures were treated operatively on an emergency basis. This was in agreement with a study by Ditsios et al., (2013), which documented that open fractures were emergently and initially treated with copious irrigation and surgical debridement.

Physiotherapy is a very important part of the elbow fracture treatment. All patients were offered physiotherapy but they started at different times. Physiotherapy was offered as soon as splint or cast was removed from the elbow. Most patients started by week 3 and almost all of them had operative treatment. This was because most patients who had operative treatment had shorter time on the splint and cast while those who received non-operative treatment had longer time on the splint and full cast. However, in a review study of early mobilization for elbow fractures in adults by Harding et al., (2011) they found out that there is a lack of strong evidence to inform on the timing of mobilization, and specifically on the use of early mobilization, after non-surgical or surgical treatment for adults with elbow fractures.

Patients who started rehabilitation within 3 weeks had an excellent functional outcome, those who started by 6 weeks had a good functional outcome and those who started by 12 weeks had fair functional outcome at 6 months follow up. This showed that the earlier the patients started physiotherapy the satisfactory the functional outcome, ($P<0.001$). Most of patients who started early physiotherapy had operative treatment. This was in agreement with results seen in many studies by Aitken et al., (1986), Armstrong, (2005), Chalidis et al., (2008), Chemama et al., (2010), Gupta et al., (2002), Helfet et al., (1993) and Ring et al., (2002) on elbow fractures that early physiotherapy of the elbow gave good to excellent functional outcome.

Most patients who had operative treatment started physiotherapy within 3 weeks and had good and excellent functional outcome. While patients in non-operative treatment mostly started physiotherapy after 3 weeks, thus having good and fair results.

This was in agreement with a study by Newman et al., (2009) which showed that excellent and good results post-operation were obtained when passive movement of the elbow was started 5-7 days and for non-operation at 3 weeks provided there are signs of union.

Overall functional outcome following treatment of elbow fractures at MTRH improved with time and was good because most patients were started on physiotherapy as soon as the fractures were stable and continued with rehabilitation whether at home or physiotherapy department.

5.3 Functional outcome after operative treatment

Most patients who were treated operatively had satisfactory (good to excellent) functional outcome while a few had fair results. This could be because most patients started physiotherapy within 3 weeks as their fractures were internally stabilized.

Most olecranon fractures treated operatively had good to excellent functional outcome. This was in agreement with a study by Chalidis et al., (2008) on post-operative functional outcome of olecranon which showed that, 85.5% of patients had a good to excellent result and this was observed in a follow up of 6 to13 years. This could be because most patients were started early on physiotherapy. However, this contrasted with a study by Munoz-Mahamud et al., (2010) on plate osteosynthesis for olecranon fractures, 60% of patients attained good to excellent scores, 20% had fair scores, and 20% had poor score with a mean follow up of 11 months, this could be because in their study all fractures had soft tissue injuries..

Most patients had satisfactory (good to excellent) functional outcome after distal humerus fracture surgery. This finding was in agreement with a study by Kaushal and Rao, (2016) on functional outcome in the management of distal humerus fracture with open reduction, which showed good to excellent scores in 83% of patients and fair in 17% patients. Their study also had same follow up period with this study.

The results in this study were also in agreement with a study done in Nebraska by Erpelding et al., (2012), with functional scores of 91.7% good to excellent and 8.3% fair. Their study had longer follow up period.

The agreement on functional outcome could be because most patients started physiotherapy as soon as possible after operative treatment. This study was in contrast to a study done in Canada by McKee et al., (2000) on functional outcome after open supracondylar fractures of the distal humerus, they had average 57.7% of good to excellent scores, 30.8% fair and 11.5% poor results, with a mean follow up of 51 months. This could be because they were dealing with more complex intraarticular fractures only.

All patients with coronoid fractures had excellent scores. These are very rare fractures to happen in isolation, all fractures were treated operatively and initiated on physiotherapy as soon as possible hence good functional outcome. This could not be compared to other studies even though the functional outcome was excellent because there were few patients. The radial head fracture had 1 unsatisfactory (fair) functional outcome and this fracture was managed by excision. This patient felt pain and instability of the elbow. This outcome was in agreement with a study done by Li et al., (2016) that showed that excision of radial head has poor to fair functional outcome.

The only patient with olecranon and radial head fractures had good functional outcome. This could be because the patient was started on physiotherapy late due to pain on movement.

Most patients with fracture dislocation had good to excellent functional outcome. This was in contrast to a study done in the Netherlands by de Haan et al., (2010) on fracture-dislocations that showed less had good to excellent functional outcome. This could be because in this study there were few patients and most started early physiotherapy.

Another study in France by Chemama et al., (2010) found that the functional outcome of fracture dislocation had 100% for good to excellent at a mean follow-up of 63 months. This was in contrast with what was found in this study because they had longer follow up period.

5.4 Functional outcome after non-operative treatment

At 6 months follow up, non-operative treatment had above average good to excellent functional outcome. This could be because of longer splinting and casting time in non-operative treatment thus delaying in rehabilitation.

Most patients with distal humerus fracture treated non-operatively had a good functional outcome, others had fair functional outcome and none had excellent outcomes. This could be because fractures were splinted for long while waiting for union and this delayed initiation of physiotherapy.

The only patient with radial head fracture which was treated non-operatively had an excellent functional outcome. This could be because this fracture was Mason type 1, un-displaced and stable fracture, hence it was immobilized in backslap and started on physiotherapy early.

Even though this result was excellent, it could not be compared to other studies because of low numbers in this study. The only patient with fracture-dislocation who had non-operative treatment had fair functional outcome. This was because the patient opted for non-operative treatment as she was an elderly patient, and had to be on splint for many weeks which predisposed the elbow to stiffness.

5.5 Time taken to operative treatment

Patients who underwent operative treatment took an average of 6.3 (SD 3.7) days to have an operation. Most patients who were operated early, before 14 days, had satisfactory (good to excellent) functional outcome while most patients who were operated late, after 14 days, had un-satisfactory (fair) functional outcomes. This showed that the time to surgery had significant impact on functional outcome, ($P < 0.002$). This was in agreement with a study by Gomide et al., (2011) assessing elbows with terrible triad which found out that patients who underwent operations not more than 14 days after the trauma achieved satisfactory functional scores than those who got operated after more than14 days.

Another study by de Haan et al., (2010) found that the mean time between the injury and the operation was 13.5 days (SD=14.3) with excellent functional outcome. This study was in agreement with a study done in Algeria by Bentounsi, (2015) which found that shorter average time from injury to operation, 3.83 ± 5.26 days (0-14), had all patients with satisfactory functional outcome.

This was also in agreement with another study of elbow fractures by Erpelding et al., (2012) which found satisfactory outcome with shorter time interval to surgery with an average of 4 days (0 - 10 days). This could be because the earlier the operation means the earlier initiation of physiotherapy as the fracture has been stabilized.

The delay in operating some of the patients in this study could be because of shortage of resources like surgeons and theater space which could lead to some patients being given long bookings for surgery.

5.6 Complications

Some patients had elbow pain and reduced range of motion (ROM) at 6 months. This study had a higher number of reduced range of motion and pain because the follow up was short compared to other studies by Chalidis et al., (2008), Erpelding et al., (2012) and Chemama et al., (2010) which had longer follow up hence lower pain and ROM.

Surgical site infection was seen in very few patients (4.3%), this was in agreement with a study by Helfet and Schmeling, (1993) on distal humeral fractures in adults, which reported 4% of SSI. Another study by Classen et al., (2016) on factors that are associated with surgical site infection after operative treatment of an elbow fracture reported that 4% of patients developed SSI. The lower infection rate was because patients were given prophylactic antibiotics before surgery and continued for 3 days post-surgery and also strict adherence to sterile procedures.

Ulnar nerve palsy was very low. Very few patients developed ulnar nerve palsy post-surgery and almost all recovered completely before 6 months. This was in agreement with a study by Gupta and Khanchandani, (2002) which found out that 5.5% of patients had ulnar nerve palsy post-surgery which resolved on subsequent follow ups.

Another study by Kaushal and Rao, (2016) also showed that one patient developed ulnar nerve paresthesia post operatively which was recovered completely later on.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Operative treatment was the most common treatment option done. All patients received physiotherapy.

Most patients who had operative treatment and early physiotherapy had good to excellent functional outcome.

Patients who had non-operative treatment had good functional outcome.

Early operation gave satisfactory functional outcome.

6.2 Recommendations

Physiotherapy should be started early and continued until excellent functional outcome is achieved. Elbow fractures that require operative treatment should be operated early to achieve an excellent functional outcome. This study reflects an early functional outcome and therefore long term follow-up studies are necessary.

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APPENDICES

Appendix 1: Consent form

CONSENT FORM

STUDY TITLE: FUNCTIONAL OUTCOME OF TREATMENT OF ELBOW FRACTURES IN ADULT PATIENTS AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA

INVESTIGATOR - Goitseone Pelontle Montsho

P.O BOX 5880-30100,

Eldoret, Kenya.

I ____of PO

BOX_________________________, telephone__________________________

Hereby willingly give informed consent to participate in the above mentioned study which is being conducted at MTRH. The study has been fully explained to me by Goitseone Pelontle Montsho (or his assistants) in a language and terms I can understand. It was well explained that the information I give will be confidential. It was explained that my participation in this study is voluntary and that I am at liberty to withdraw at any point should I wish to do so without any compromise to my right of treatment at MTRH. I am reassured that principles of medical ethics; autonomy, justice, beneficence and non-maleficence will be fully adhered to in this study.

Name of participant____

Signature____

Date____

Name of witness____

Signature____

Date____

Appendix 2: Questionnaire

STUDY TITTLE: Functional outcome of treatment of elbow fractures in adult patients at Moi Teaching and Referral Hospital**,** Eldoret, Kenya

Patient no:........................... IP no:.................................

Date:...

Address:.. Mobile phone no:...................................

Age: [ ] years Sex: Male : [ ] Female: [ ]

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

Type of referral: self: [ ] Another facility: [ ] Other(specify): [ ]

Time of Presentation from Injury: <6 Hours: [ ]

6 - 24 Hours [ ]

>24 Hours [ ]

Time to surgery from time of presentation: <6 Hours [ ]

6 - 24 Hours [ ]

1 - 7 days [ ]

7 -31 days [ ]

>31 days [ ]

Mechanism of Injury: Fall: [ ] RTA: [ ] Assault: [ ] Others (specify): [ ]

Side of injury: Right: [ ] Left: [ ] Dominant side: Right: [ ] Left: [ ]

Other injuries: Yes: ☐ No: ☐ If Yes Specify: ....

Type of Fracture: Open: ☐ Closed: ☐

If Open classificaion: Gustilo Classification of the open fracture

Type I: ☐ II: ☐ IIIA: ☐ IIIB: ☐ IIIC: ☐

Radial pulse:...................... Neurological:.........................

Bone involved: Distal humerus ☐ proximal ulna ☐ proximal ☐

radius

Type of fracture.............................

Classifcation: ....

Treatment: Non-operative: ☐

Operative (specify): ☐

If Operative, Time taken before surgery: ☐ hours ☐ Days

☐ Weeks ☐ Months

FOLOW UP

At 6 weeks

Radial pulse:....................... Neurological: ....

Complication:............................

X-ray:.................................

If POP removed Physiotherapy: Yes: ☐ No: ☐

If POP removed Functional score: MEPI: [ ]

At 3 months

Radial pulse:........................ Neurological:.....................

Complication:....................

X-ray:...

Functional score: MEPI: [ ]

Physiotherapy : Yes: [ ] No: [ ]

Date Started:...

At 6months

Radial pulse:................................ Neurological: ....

Complication:..................

X ray.......................................

Functional score: MEPI [ ]

Physiotherapy: Yes: [ ] No: [ ]

Date Started:......................................

Appendix 3: Mayo elbow performance Index (MEPI) score

Pain (max., 45 points)
- None (45 points)
- Mild (30 points)
- Moderate (15 points)
- Severe (0 points)

Range of motion (max., 20 points)
- Arc > 100 degrees (20 points)
- Arc 50 to 100 degrees (15 points)
- Arc < 50 degrees (5 points)

Stability (max., 10 points)
- Stable (10 points)
- Moderately unstable (5 points)
- Grossly unstable (0 points)

Function (max., 25 points)
- Able to comb hair (5 points)
- Able to feed oneself (5 points)
- Able to perform personal hygiene tasks (5 points)
- Able to on shirt (5 points)
- Able to put on shoes (5 points)

Mean total (max., 100 points)

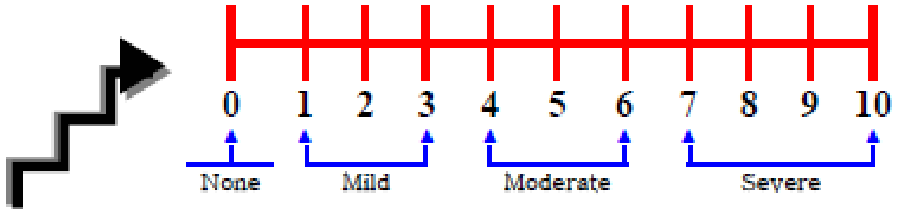
The Mayo Clinic Performance Index for the Elbow 90 points or more=excellent, 75–89 points=good, 60–74 points=fair, and less than 60 points=poor. Stable=no apparent varus-valgus laxity clinically, moderate instability=less than 10 degrees of varus-valgus laxity, and gross instability=10 degrees or more of varus-valgus laxity}. From The Journal of Bone and Joint Surgery, Inc. Broberg MA, Morrey BF. Results of delayed excision of the radial head after fracture. J Bone Joint Surg Am. 1986; 68:669–674.

Appendix 4: Pain scale

NATIONAL INSTITUTES OF HEALTH
WARREN GRANT MAGNUSON CLINICAL CENTER

PAIN INTENSITY INSTRUMENTS
JULY 2003

0 – 10 Numeric Rating Scale (page 1 of 1)



Indications: Adults and children (> 9 years old) in all patient care settings who are able to use numbers to rate the intensity of their pain.

Instructions:

1. The patient is asked any one of the following questions:
   - What number would you give your pain right now?
   - What number on a 0 to 10 scale would you give your pain when it is the worst that it gets and when it is the best that it gets?
   - At what number is the pain at an acceptable level for you?
2. When the explanation suggested in #1 above is not sufficient for the patient, it is sometimes helpful to further explain or conceptualize the Numeric Rating Scale in the following manner:
   - 0 = No Pain
   - 1-3 = Mild Pain (nagging, annoying, interfering little with ADLs)
   - 4–6 = Moderate Pain (interferes significantly with ADLs)
   - 7-10 = Severe Pain (disabling; unable to perform ADLs)
3. The interdisciplinary team in collaboration with the patient/family (if appropriate), can determine appropriate interventions in response to Numeric Pain Ratings.

Reference

McCaffery, M., & Beebe, A. (1993). Pain: Clinical Manual for Nursing Practice. Baltimore: V.V. Mosby Company.

ADL – Activities of daily living

Appendix 5: IREC approval

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/2014/147
Approval Number: 0001272

18th September, 2014

Dr. Goitseone Pelontle Montsho,
College of Health Sciences,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Montsho,

RE: FORMAL APPROVAL

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

"Outcome of Treatment of Elbow Fractures in Adult Patients at Moi Teaching and Referral Hospital, Eldoret, Kenya."

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1272*** on 18th September, 2014. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 17th 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,

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
18 SEP 2014
APPROVED
P.O. Box 4606-30100 ELDORET

For

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

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

Appendix 6: IREC continuation approval

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
Tel: 33471/2/3

18th September, 2015

Reference: IREC/2014/147
Approval Number: 0001272

Dr. Goitseone Pelontle Montsho,
College of Health Sciences,
School of Medicine,
P.O Box 4806-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
18 SEP 2015
APPROVED
P. O. Box 4606-30100 ELDORET

Dear Dr. Montsho,

RE: CONTINUING APPROVAL

The Institutional Research and Ethics Committee has reviewed your request for continuing approval to your study titled:-

"Outcome of Treatment of Elbow Fractures in Adult Patients at Moi Teaching and Referral Hospital Eldoret, Kenya".

Your proposal has been granted a Continuing Approval with effect from 18th September, 2015. You are therefore permitted to continue with your study.

Note that this approval is for 1 year; it will thus expire on 17th September 2016. 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,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc:	Director	-	MTRH
	Dean	-	SOM
	Dean	-	SPH
	Dean	-	SOD
	Dean	-	SON

Appendix 7: MTRH approval

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

18th September, 2014

Dr. Goitseone Pelontle Montsho,
College of Health Sciences,
School of Medicine,
P.O. Box 4606-30100,
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:

"Outcome of Treatment of Elbow Fractures in Adult Patients at Moi Teaching and Referral Hospital, Eldoret, Kenya."

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

for **DR.JOHN KIBOSIA**
DIRECTOR
MOI TEACHING AND REFERRAL HOSPITAL

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

Appendix 8: Title amendment approval

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
Tel: 33471/2/3

Reference IREC/2014/117
Approval Number: 0001272

22nd September, 2017

Dr. Goitseone Pelontle Montsho,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
22 SEP 2017
APPROVED
P. O. Box 4606-30100 ELDORET

Dear Dr. Montsho,

RE: APPROVAL OF AMENDMENT

The Institutional Research and Ethics Committee has reviewed the amendment made to your proposal titled:-

"Functional Outcome of Treatment of Elbow Fractures in Adult Patients at Moi Teaching and Referral Hospital, Eldoret, Kenya".

We note that you are seeking to make an amendment as follows:-

1. To change the title to above from "***Outcomes of Treatment of Elbow Fractures in Adult Patients at Moi Teaching and Referral Hospital, Eldoret, Kenya***"

The amendment has been approved on 22nd September, 2017 according to SOP's of IREC. You are therefore permitted to continue with your research.

You are required to submit progress(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,

DR. S. NYABERA
DEPUTY-CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc:	CEO	-	MTRH	Dean	-	SPH	Dean	-	SOM
	Principal	-	CHS	Dean	-	SOD	Dean	-	SON

Appendix 9: Work Plan and Budget

WORK PLAN

ACTIVITY	DURATION	PARTICIPANTS
Selection of topic	January 2014	Researcher
Finalizing the proposal	June 2014	Researcher and supervisors
Submitting proposal to IREC	July 2014	Researcher
Approval by IREC	September 2014	IREC members
Train research assistant on recruiting patients	December 2014	Researcher
Data collection	January 2015 - June 2016	Researcher and research assistants
Data analysis	September 2016	Researcher and Biostastician
Writing thesis report	January 2017	Researcher
Discussion with supervisors	March 2017	Researcher and supervisors
Thesis submission	September 2017	Researcher
Defense of thesis	August 2018	Researcher

Appendix 10: Budget

ITEMS	Ksh
6 reams of plain paper @ KSH500	3000
2 Note books @Ksh100	200
2 flash disks @ Ksh2000	4000
Pens, pencils	2000
4 research assistants @300/month	14400
IREC	1000
Biostatician	30000
Total	54600