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SCHOOL OF MEDICINE

DEPARTMENT OF SURGERY

**A COMPARATIVE STUDY OF OUTCOMES OF OPERATIVE
MANAGEMENT OF GARTLAND III SUPRACONDYLAR
FRACTURES OF THE HUMERUS IN CHILDREN USING LATERAL
AND POSTERIOR APPROACH AT UNIVERSITY TEACHING
HOSPITAL, LUSAKA.**

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**A DISSERTATION SUBMITTED TO THE UNIVERSITY OF ZAMBIA IN
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DECLARATION

I hereby declare that this dissertation entitled **COMPARATIVE STUDY OF OUTCOMES OF OPERATIVE MANAGEMENT OF GARTLAND III SUPRACONDYLAR FRACTURES OF THE HUMERUS IN CHILDREN USING LATERAL AND POSTERIOR APPROACH AT UNIVERSITY TEACHING HOSPITAL, LUSAKA**, represents my own work and has not been presented either wholly or in part for a degree at the University of Zambia or any other University elsewhere. Acknowledgement for referenced materials has been appropriately made.

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CERTIFICATE OF APPROVAL

THIS DISSERTATION BY DR. PENELOPE KANTU MACHONA IS APPROVED AS FULFILLING PART OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF MEDICINE IN ORTHOPAEDICS AND TRAUMA SURGERY BY THE UNIVERSITY OF ZAMBIA.

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ABSTRACT

Background

Supracondylar fractures of the humerus are the second most common fracture in children at the University Teaching Hospital (UTH). The average age of occurrence being between 5 to 6 years. Gartland type III fractures pose management challenges hence are treated operatively, using either the lateral or posterior surgical approach. The study has been done to compare which surgical approach gives better outcomes at UTH regarding the cosmetic and functional outcomes using the Flynn's criteria at 6 and 12 weeks. In addition, the rate of post operative infections between the two approaches was then compared.

Methods

50 patients with Gartland III supracondylar fractures treated operatively using either lateral or posterior surgical approach were enrolled and followed up for a period of 12 weeks. Data collected included post of measurement of the cosmetic and functional outcome using Flynn's criteria at 6 and 12 weeks and post operative infection (surgical wound and pin site) at 3 week. Additional demographic characteristics (sex, age), cause of injury, affected limb and associated swelling, intra-operative data such as surgical approach used, level of surgeon and method of Kirschner-wire fixation were also collected. Data was analysed using frequency tables, associations using chi square and logistic regression to determine associated factors using SPSS version 20.

Results

Of the recruited patients, 33 (66%) were male (p -value = 0.02). The median age was 6.43yrs. 40% were treated using the lateral approach while 60% with the posterior approach (p -value = 0.16). Postoperatively, 3 weeks follow up showed complication rates as follows: surgical wound infection (5% lateral and 20% posterior), pin site infection (10% lateral and 20% posterior). At 6 weeks, patients that underwent lateral surgical procedure had 71% reduced odds for unsatisfactory cosmetic factor result (OR = 0.29, CI = 0.047 – 1.74). At 12 weeks, there was significant association between cosmetic and functional factors versus surgical approach (P -value < 0.01). Patients that underwent lateral surgical procedure had 82% reduced odds for unsatisfactory functional factor result (OR = 0.18, CI = 0.05 – 0.63).

Conclusion

This study established significant progressive improvement in both cosmetic and functional factor according to Flynn's criteria from 6 weeks to 12 weeks follow-up using the lateral approach as compared to the posterior approach was noted. Furthermore, the complication rates were found to be more in the lateral approach than the posterior though this finding was not statistically significant (p -value = 0.219 & 0.450). Therefore, the lateral approach yielded better outcomes as compared to the posterior approach in the operative management of Gartland III fractures at UTH.

DEDICATION

Above all, I thank the Almighty God for his blessings and strength for all this work I have managed to accomplish thus far. To my loving and supportive husband, Makasa Katongo, for his encouragement and help during all the long hours away from home, I say thank you my love. To Joshua and Hannah, my babies this is for you.

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ABBREVIATIONS AND ACRONYMS

A & E	ACCIDENT AND EMERGENCY
CT	COMPUTED TOMOGRAPHY
CF	COSMETIC FACTOR
FF	FUNCTIONAL FACTOR
K-WIRES	KIRCHSHNER WIRES
LOR	LOSS OF REDUCTION
MRI	MAGNETIC RESONANCE IMAGING
MUA	MANIPULATION UNDER ANAESTHESIA
PSI	PIN SITE INFECTION
UTH	UNIVERSITY TEACHING HOSPITAL
UNZABREC	UNIVERSITY OF ZAMBIA BIOMEDICAL RESEARCH AND ETHICS COMMITTEE

DEFINITIONS

1. **Cubitus Varus Deformity:** A deformity of the elbow in which the forearm deviates toward the midline of the body when extended.
2. **Surgical Wound Infection:** Any superficial infection that occurs at the site of a surgical incision.
3. **Loss of Reduction:** This is a state of loss of fracture alignment due to loosening of k-wire after fixation.

CHAPTER ONE

1.1 INTRODUCTION

Supracondylar fracture of the humerus is the second most common fracture in children (Kumar et al, 2002). These fractures occur most frequently in young children aged 5 to 6 years and represent approximately sixty percent (60%) of fractures around the elbow joint (Lee et al, 2008). Boys have a higher incidence of this type of fracture, but the difference in comparison with girls seems to be equalizing, and higher rates in girls have actually been reported in some series (Pretell-Mazzini et al, 2011). Children fall on an outstretched hand as a protective mechanism, which explains the high incidence of fractures of the upper extremities (Smajic et al, 2011).

Supracondylar fractures appear in two (2) basic types: more common extension type (98%) and rarer flexion type (2%). Extension type fractures usually occur as a result of fall on an outstretched arm with the elbow in hyperextension whereas flexion type as a result of direct force to the posterior side of the elbow (Smajic et al, 2011). Type III Gartland supracondylar fractures are associated with significant complications.

The gold standard for the treatment of Type III Gartland fractures is closed reduction with percutaneous pinning under image guidance. However, in the absence of imaging equipment, management of these fractures involves open reduction with pin insertion. There is no clear evidence in literature regarding which surgical approach could bring about the best functional, cosmetic, and radiological outcomes, while at the same time ensuring fewer complications, when an open surgery of a Type III supracondylar fracture is performed (Pretell-Mazzini et al, 2010).

Different surgical approaches can be used for open reduction and pinning of Gartland type III fractures; however, there is controversy regarding the effect on the functional and cosmetic outcomes (Pretell-Mazzini et al 2010). Approaches which can be used for open reduction include; anterior, medial, lateral, posterior and double incision (medial and lateral), (Eren et al 2005).

Mulla et al demonstrated that percutaneous fixation techniques offer a compromise between conservative treatment and open surgical methods however this is not

possible with inadequate resources. Due to inconsistent availability of imaging equipment and radiographers at the University Teaching Hospital (UTH), the operative method is preferred. At the University Teaching Hospital (UTH), two approaches are commonly used for open reduction and pinning of Gartland type III fractures, namely lateral and posterior approach. The surgeon carrying out the operation determines the approach used by preference. No departmental protocol exists regarding the surgical approach in the management of Gartland type III fractures at UTH.

The aim of this study will be to comparatively consider the outcomes of operative management of Gartland type III fractures in children. Under consideration will be; the functional and cosmetic outcomes of the lateral and posterior approaches using Flynn's criteria at UTH. Flynn's criteria are used to determine the success of treatment of supracondylar fractures, which include measurement of the degree of carrying angle, flexion and extension of the arm (Smajic et al, 2011).

1.2 CASE DEFINITION OF GARTLAND III SUPRACONDYLAR FRACTURE OF THE HUMERUS

A female or male child, aged below ten (10), admitted to the surgical wards at UTH for operative management of Gartland type III fractures of the humerus the eligibility criteria.

Supracondylar fractures are classified into three (3) types using Gartland classification. The three (3) types are:

- I. Type I: Undisplaced
- II. Type II: Displaced with intact posterior cortex and,
- III. Type III Displaced, no cortical contact posteromedial or posterolateral

(Smajic et al, 2011).

1.3 OUTCOME MEASUREMENT TOOL FOR GARTLAND III

The main tool for the outcome of Gartland III supracondylar fractures of the humerus in the patients for this study was Flynn's criteria. The loss of degrees of flexion or extension at the elbow was measured using a goniometre. This was measured at 3 weeks post operation then subsequently at 6 and 12 weeks in the outpatient orthopaedic clinic.

In this study, Flynn's criteria at 6 and 12 weeks were then compared for the lateral and posterior approach for cosmetic and functional factor (see APPENDIX A table 2).

1.4 LITERATURE REVIEW

Supracondylar fractures of the humerus have been recognized since the time of Hippocrates and are one of the more common fractures in children (Marquis et al, 2008). These fractures account for 70% of the elbow fractures in childhood and 97% of these fractures are extension type (Eren et al, 2005). The fracture is a metaphyseal injury that does not involve the physis nor epiphysis. The injury is analogous to other periosteal sleeve injuries and therefore is capable of being successfully managed in a variety of ways as modeling in the sagittal plane is almost always excellent (Marquis et al, 2008). The connective tissue laxity, the process of metaphyseal remodeling and the thin cortex in the supracondylar area are the anatomic factors that play a role in pathophysiology of these fractures (Eren et al, 2005).

The mechanism of injury is a hyperextension load on the elbow from falling on the outstretched arm (Lovell & Winters, 2006). The distal fragment displaces posteriorly (i.e., extension) in more than 95% of fractures. The medial and lateral columns of the distal humerus are connected by a very thin area of bone between the olecranon fossa posteriorly and the coronoid fossa anteriorly. The central thinning and the surrounding narrow columns predispose this area to fracture. As the elbow is forced into hyperextension, the olecranon impinges in the fossa, serving as the fulcrum for the fracture (Lovell & Winters, 2006). The collateral ligaments and the anterior joint capsule also resist hyperextension, transmitting the stress to the distal humerus and initiating the fracture. Flexion type supracondylar fractures result from a direct fall onto the flexed elbow (Lovell & Winters, 2006).

Extension fractures are classified using Gartland's classification which groups them into three (3) types: Type I: Undisplaced, type II: Displaced with intact posterior cortex and type III: Displaced, no cortical contact posteromedial or posterolateral (Smajic et al, 2011). Flynn's criteria are used to determine the success of treatment, which includes the measurement of degree of carrying angle, flexion and extension. The carrying angle is a clinical indicator of varus-valgus angulation of the arm with the elbow fully extended and forearm fully supinated (Smajic et al, 2011). This angle defines the section line that runs along the middle axis of the humerus and the line that runs along the middle axis of the forearm. There is no significant difference in carrying angle values for men and women, but there is significant difference

according to age. At the age of 0-4 years it is about 15° and 17.8° in adults. Increase in this angle indicates a valgus deformity and a decrease shows a varus deformity (Smajic et al 2011). However, with all forms of treatment in flexion the carrying angle is not seen until full extension of the elbow is regained after months of injury (Piggot et al, 1986).

Flynn's Criteria

TABLE 1. Evaluation of Treatment Outcome Using Flynn Criteria

Result	Rate	Cosmetic Factor Carrying Angle Loss, degrees	Functional Factor Movement Loss, degrees
Satisfactory	Excellent	0-4.9	0-4.9
	Good	5-9.9	5-9.9
	Fair	10-14.9	10-14.9
Unsatisfactory	Poor	≥15	≥15

(Lee et al 2008)

The main aim of the treatment of severely displaced supracondylar fractures, Gartland type III, is to gain a functional and cosmetically acceptable extremity, with no deformity nor residual neurovascular deficits (Pretell-Mazzini et al, 2010). Closed reduction with percutaneous pinning has gained support as the preferred method of treatment and in situations where closed reduction fails, open reduction and internal fixation is applied (Eren et al, 2005). Closed or open reduction of displaced supracondylar fractures, followed by K-wire fixation, is an excellent method of management in experienced hands with strict adherence to protocols (Gadgil et al, 2005). The main goal of surgery in paediatric supracondylar fractures is the safe creation of a construct that is stable enough to prevent axial rotation and hyperflexion and extension of the distal fragment and thus avoid postoperative deformity which has been reported to be as high as 17% (Lee et al, 2008).

A study done in Spain, showed that no clear evidence in literature exists as to which surgical approaches could bring about the best functional, cosmetic, and radiological outcomes, as well as fewer complications, when an open reduction and pinning of

severely displaced supracondylar humerus (Pretell-Mazzini, 2010). Nevertheless, a preferred surgical approach should permit a safe and rapid reduction, with full anatomic alignment, obtaining adequate functional and cosmetic outcomes, as well as few complications (Pretell-Mazzini et al, 2010). Anterior, medial, lateral, posterior and double incision (medial and lateral) approaches can be used for open reduction (Eren et al, 2005).

The most commonly used surgical techniques are the posterior and lateral approach. Reitman and Waters indicate that highly satisfactory results can be obtained with the posterior approach (Ensafdaran et al, 2005). In a study by Gennari et al (1998), carried out in Marseille, France, had excellent results with the anterior approach compared to the posterior approach. The authors state that through the anterior approach no new lesions are caused because the approach crosses an area already affected by trauma where as the posterior approach crosses an uninjured area leading to additional trauma with longer recuperation in the children with this approach (Gennari et al, 1998).

Marquis et al, 2008, advised that if an open approach is required, it should be done with tourniquet in place, but not through a posterior approach. The posterior approach does not give access to the neurovascular structures most likely to be damaged and will disrupt the tissues that are most likely to be uninjured (Marquis et al, 2008). Various authors have also suggested that the posterior approach predisposes to post-operative stiffness. A medial or antero-medial approach would allow access to the most commonly injured structures, visualisation of the ulnar nerve and allow access to the area of comminution, and the area that tends to be displaced when the fracture rotates (Marquis et al, 2008).

Timing of surgery is another area of debate in operative management of these fractures. A study done in the United States of America by Abbott et al, 2014, found no significant correlation between the time to surgery and complications, operative time, or need for open reduction. The findings supported the trend of treating Gartland type III supracondylar humerus fractures in a less urgent manner. In addition, their study supported the concept that cross pinning leads to more complications than lateral pinning, including an 8-fold increase in iatrogenic nerve injury (Abbott et al, 2014).

Ensafdaran et al (2005), conducted a comparative study of lateral versus posterior approach for surgical management of supracondylar fractures in children in Shiraz, Iran in which they showed that exposure of the fracture site is more difficult in the lateral approach but the results are more acceptable than the posterior approach. Their study further showed that in the posterior approach the intact posterior structures were damaged and led to decreased range of motion, additional trauma and poor results (Ensafdaran et al 2005). Advocates of the posterior approach are more numerous, however, for more than 20 years the percentages of excellent and good results have not increased. The posterior approach injures the extension apparatus unnecessarily hence results in an important limitation of extension. After comparison of the results from the study, the authors' proposed the lateral approach as a good alternative to the posterior approach with lesser complications and better long term results (Ensafdaran et al, 2005).

For functional outcome, a high frequency of excellent results was found within the lateral and medial approaches, and a high frequency of good results within the anterior approach in a study done by Pretell-Mazzin et al in Madrid, Spain, 2010. The study showed a high frequency of poor results within the posterior approach. For cosmetic outcome, there was a high frequency of fair results within the posterior and lateral approaches, and a high frequency of poor results within the posterior approach (Pretell-Mazzini et al, 2010). Pretell-Mazzini et al concluded that a combined antero-medial approach could be the method which allows the achievement of better functional and cosmetic outcome according to Flynn's criteria (Pretell-Mazzini et al, 2010).

Some authors demonstrated no correlation between stiffness and the type of surgical approach used, especially regarding the posterior approach (Pretell-Mazzini et al, 2010). Eren et al, 2005, also found no significant differences between the lateral and medial approaches in terms of functional and cosmetic results; the medial approach may be more convenient due to a lower risk for ulnar nerve injury and to lesser acceptability of the medial incision scar on the part of patients (Eren et al, 2005).

Bamrunghin, (2008), carried out a study in Thailand, where he showed that the posterior approach had a shorter operative time than the lateral approach. Overall

scores by Flynn's criteria showed that good and excellent outcomes were 80.7% in the posterior approach group and 80% in the lateral approach group; hence there were no significant differences in terms of results and complications. Management of Gartland type III fractures at UTH is done by open reduction and pinning using either the lateral or posterior approach. Fixation methods used also differ depending of the surgeon, but three types observed by the researcher using K-wires (1,5mm or 2mm): 2 cross K-wires (1 medial and 1 lateral) or 2 parallel medial K-wires or 2 parallel medial and 1 lateral K-wires. The choice of which approach is usually at the surgeon's preference as no protocol currently exists restricting the surgical approaches. No study has been done at the UTH or anywhere in Zambia to compare the outcomes between lateral and posterior surgical approaches to the elbow in the management of Gartland III fractures in children. Therefore, it is my hope that this study will show which approach gives excellent results functionally and cosmetically using the Flynn's criteria and serve as a guide to the surgeons at UTH.

1.5 STATEMENT OF THE PROBLEM

The operative management of Gartland III supracondylar fractures in children at the UTH, Lusaka is achieved using either of two surgical approaches namely; the lateral approach and posterior approach. Currently no trauma register exists at UTH but according the UTH emergency theatre book, 136 cases of supracondylar fracture were attended to in period of 1yr (April 2012-April 2013). Fifty-five (55) cases were managed operatively using either of the above mentioned approaches (Emergency theatre and Elective theatre registers 2012-2013). Furthermore, 148 cases were reviewed with 67 cases treated operatively during the period April 2011-March 2012 (Emergency theatre and Elective theatre registers 2011-2012). However the comparative outcomes in terms of cosmetic and functional clinical outcomes between the two are not known. Therefore it is difficult to objectively recommend one surgical approach over the other.

1.6 STUDY JUSTIFICATION

There is no clear evidence in the literature regarding which surgical approaches could bring about the best functional, cosmetic and radiological outcomes with fewer complications (Prettell-Mazzini 2010). Knowledge of the treatment outcomes of the operative management of Gartland III supracondylar fractures at UTH will objectively inform orthopaedic surgeons about which is the better surgical approach for Gartland III supracondylar fractures and thereby improving the operative management of these fractures. The study will further show which of the two approaches gives better functional and cosmetic outcome for operative management of Gartland III fractures at UTH.

1.7 RESEARCH QUESTION

How do the outcomes of the operative management of Gartland III supracondylar fractures using the lateral approach compare to those using the posterior approach, at UTH using Flynn's criteria at 6 and 12 weeks?

1.8 NULL HYPOTHESIS

There's is no difference in outcomes of operative management of Gartland III supracondylar fractures using either lateral or posterior approach as measured by Flynn's criteria at 6 and 12 weeks at UTH.

CHAPTER TWO

2.0 OBJECTIVES

2.1 GENERAL OBJECTIVE:

To compare the outcomes of operative management of Gartland III supracondylar fractures in children using the lateral approach or posterior approach at UTH.

2.2 SPECIFIC OBJECTIVES:

1. To establish the clinical characteristics of Gartland III supracondylar fractures in the patients undergoing operative management by either the lateral or posterior approach.
2. To compare the rates of complications (surgical wound infection, pin site infection and loss of reduction) 3 weeks post operation by the two approaches.
3. To compare at 6 and 12 weeks the outcomes as measured by Flynn's criteria for the lateral and posterior approaches.

CHAPTER THREE

3.0 METHODOLOGY

The study was an observational prospective cohort study conducted at UTH department of surgery, Lusaka, for a period of 7 months from August 2014 to February 2015. All patients below 10 years, who presented to UTH with Gartland III Supracondylar fractures undergoing operative management, whose parents/guardians consented to be included in this study were enrolled using convenient sampling method. A total number of 53 patients were enrolled but only 50 had full information and were subjected to data analysis.

Data collection was done using standardized questionnaire administered by the author to the patient's parents/guardians. Further data was obtained from the patients file regarding the intra operative information.

Patients were then followed up for a period of 12 weeks in the orthopaedic outpatient clinic as they came for their routine reviews under their respective operating firms. During these reviews, the patients were examined for possible postoperative complications and measurements of loss of degrees of carrying angle and movement loss at the elbow were measured at 6 and 12 weeks.

3.1.0 INCLUSION AND EXCLUSION CRITERIA

3.1.1 INCLUSION CRITERIA

The following was the inclusion criteria:

1. Patients with Gartland type III fracture of the humerus below the age of 10 years.
2. Patients with extension type of supracondylar fracture of the humerus
3. Patients who had no associated complications of supracondylar fracture of the humerus prior to surgery
4. Patients whose fractures were treated operatively and parents/guardians gave written consent to be included in the study

3.1.2 EXCLUSION CRITERIA

The following types of patients were excluded from the study;

- a) Patients who had flexion-type fracture
- b) Patients above the age of 10 years
- c) Patients with bilateral fractures
- d) Open supracondylar fractures
- e) Associated pre-operative neurovascular injury
- f) Patient whose parents/guardians refused to be enrolled or withdrew from the study

3.2.0 VARIABLE DESCRIPTIONS

3.2.1 DEPENDENT VARIABLES

1. Primary outcomes

- i. Cosmetic factor as measured by Flynn's Criteria at 6 and 12 weeks
- ii. Functional factor as measured by Flynn's Criteria at 6 and 12 weeks

2. Secondary outcomes

- i. Surgical wound infection rate at 3weeks
- ii. Pin site infection rate at 3weeks
- iii. Loss of reduction at 3weeks

3.2.2 INDEPENDENT VARIABLES

1. Age
2. Sex
3. Mechanism of injury
4. Associated swelling of affected limb
5. Gartland classification of the fracture
6. Surgical approach

3.2.4 SAMPLE SIZE CALCULATION

Convenient sampling method was used for purposes of data collection. All patients with Gartland III supracondylar fractures that were eligible for enrolment during the study period were captured.

The objective was to have a sufficient sample size which gives clinically and statistically significant differences between the two approaches.

From the records obtained the UTH Main operating theatre log book a total of 159 cases of Gartland III supracondylar fractures had been operated on from January 2011 to December 2013, giving an average of 53 cases per year. Sample size was calculated using this average using the formula below. Confidence interval used as 0.5 or 95%.

$$ss = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)

p = percentage picking a choice, expressed as decimal

(.5 used for sample size needed)

c = confidence interval, expressed as decimal

(e.g., .04 = ±4)

CORRECTION FOR FINITE POPULATION

$$\text{new ss} = \frac{ss}{1 + \frac{ss-1}{pop}}$$

Where: pop = population

From the given data:

$Z = 3.8416$ (from the z table, we the value of confidence level, that is 1.96)

by applying given data in the formula

$$SS = Z^2 p (1-p) C^2$$

$$SS = (1.96)^2 0.5(1-0.5) 0.042 = 600.25$$

$SS=600$ (after rounding to nearest whole numbers)

The sample size calculated for the finite population.

$$New\ SS = \frac{SS \cdot Pop}{SS + (Pop - SS)},\ New\ SS = \frac{600 \cdot 1}{600 + (600 - 599)}$$

New SS = 48

Sample size was adjusted by 10% to take into account loss.

$$\begin{aligned} N(\text{uncorrected}) &= 48 \\ N(\text{corrected}) &= \frac{N(\text{uncorrected})}{(100-10)\%} \\ &= \frac{48}{(100-10)\%} \\ &= \underline{53} \end{aligned}$$

Therefore the sample size in this study was **53**.

3.2.5 RECRUITMENT

Patients meeting the recruitment criteria were identified by the researcher on admission wards in the Accident and Emergency (A & E) department during admission days and from the surgical wards. The patient's guardians were requested to participate in the study after the study information had been presented to them. The patient's/guardians that agreed to participate in the study were asked to sign a consent form.

3.2.6 OPERATIVE PROCEDURES

Operative technique in group 1(Posterior Approach)

With the patient under general anaesthesia, an eschmarch tourniquet was applied to the arm in decubitus position, by midline posterior elbow skin incision, the ulnar nerve is isolated and secured. Deep dissection was done through triceps muscle splitting longitudinally and after exposure of the fracture site was reduced and fixed with either two percutaneous lateral parallel K-wires or two percutaneous medial and lateral crossing K-wires. The muscle and fascia was closed in layers by interrupted vicryl sutures. K-wires were cut short bent and left proud for easy removal in outpatient orthopaedic clinic after 3 weeks post operation. The subcutaneous tissue was also closed by vicryl and the skin by continuous nylon sutures. A posterior long arm splint in 80° of elbow flexion and neutral rotation of forearm was applied. Post operative X-rays were taken and documented. After 3 weeks the sutures and K-wires were removed by the managing unit and patient was then started on physiotherapy for supervised elbow range of motion exercises in the physiotherapy department at an institution closest to their home.

Operative technique in group 2 (Lateral Approach)

The patients in this group were operated in supine position. An eschmarch tourniquet was applied to the arm. An incision was made over the lateral epicondyle to 5-6cm proximally and 4-5cm distally. After dissection between the triceps muscle and the origin of the brachioradialis, the posterior interocious nerve (PIN) is dissected and secured, the fracture site was exposed, and open reduction was performed and fixed by two parallel or cross K-wires in the lateral column similar to that in the first group. Wound closure and postoperative care was the same as for the first group.

3.2.7 FOLLOW-UP PLAN

All patients recruited were followed-up by the researcher in outpatient orthopaedic clinic or A & E department during their normal scheduled appointment by their orthopaedic unit. Participants were followed up through an outpatient clinic by the researcher and physiotherapist where they will be re-evaluated at:

Three (3) weeks – removal of dressing and sutures and K-wires and started active elbow motion.

Six (6) weeks – measurement the cosmetic and functional range using Flynn's criteria

Twelve (12) weeks – measurement of the cosmetic and functional using Flynn's criteria.

Patients were followed up for a total of twelve weeks. A data collection sheet was used (see Data collection sheet in Appendix 3)

At each visit the treatment outcome for participant's limb was assessed as per Flynn's criteria in terms of cosmetic and functional factor, with angles documented as per goniometre. Post operative complications were documented on the data collection sheet: surgical wound infection, pin site infection and neurological status of the limb. Complications found, were treated accordingly.

3.2.8 DATA MANAGEMENT

The author administered the data-collecting tool and questionnaire to ensure uniformity see APPENDIX 3. No personal details that help identify participants appeared on the data collection form except on the checklist to avoid loss to follow up. Identification numbers were used for data collection and entry purposes. Data was entered in Statistical Package for the Social Sciences (SPSS) version 20 software.

3.2.9 STATISTICAL ANALYSIS

The data was transferred from EXCEL to SPSS database for analysis. Frequency tables and figures were used to describe the socio-demographic characteristics of Gartland III fractures. Chi square was used to test for associations for categorical variables and t-test was used for continuous variables where p value of < 0.05 was considered statistically significant. Univariate logistic regression was used to determine factors associated with the outcomes of Gartland III fractures, this being the dependent variable as described in the objectives above and multivariate logistic regression to adjust for confounders at confidence level of 95% (p value =0.05). .

3.3.0 ETHICAL ISSUES

Ethical approval was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC). Permission to carry out the research was granted by the UTH Management and the Department of Surgery and informed parental/guardian assent was obtained. All information pertaining to patient identity (name, age and file number) was kept strictly confidential. There were no anticipated ethical risks because standard methods of care for operative management of Gartland III fractures currently used at UTH were employed. However each patient was followed up for twelve (12) weeks and assessment was done at each review for this study.

Parents/guardians were asked to sign a consent form after a clear explanation of the study. The study information was verbally explained to the guardians who could not

read. It was made clear to the patient's parents/guardian that their participation in the study was purely voluntary and that there was no monetary benefit to them nor the researcher. They were able to withdraw from the study at any time, without any prejudice to further medical care. Patients meeting eligibility criteria were then recruited. . Attached to the consent form was an information sheet that was well detailed in reference to the risks and benefits of the procedure and study as a whole.

Only serially coded numbers were used to identify all data entry on data collecting forms. The data entry sheets were locked in a secure cabinet and all electronic entries were password protected on the researcher's laptop.

Appropriate recommendations have been made in accordance to the study's findings on outcomes of operative management of Gartland III supracondylar fractures at UTH using either the lateral or posterior approach.

CHAPTER FOUR

The study enrolled 53(fifty-three) patients with Gartland III supracondylar fracture of the humerus during the period of study from August 2014 to February 2015. The sample size for the study was 53. Unfortunately 3 patients were lost to follow up so data analysed was only for 50 patients.

4.0 SOCIAL DEMOGRAPHICS OF PATIENTS

4.1.1 AGE DISTRIBUTION OF THE PATIENTS

The youngest was aged three years while the oldest were aged nine years. The average age was **6.34** years. Thirty-two percent of the patients were 3-5 years old; 46% were 6-7 years old; and the remaining 22% were 8-9 years old. .

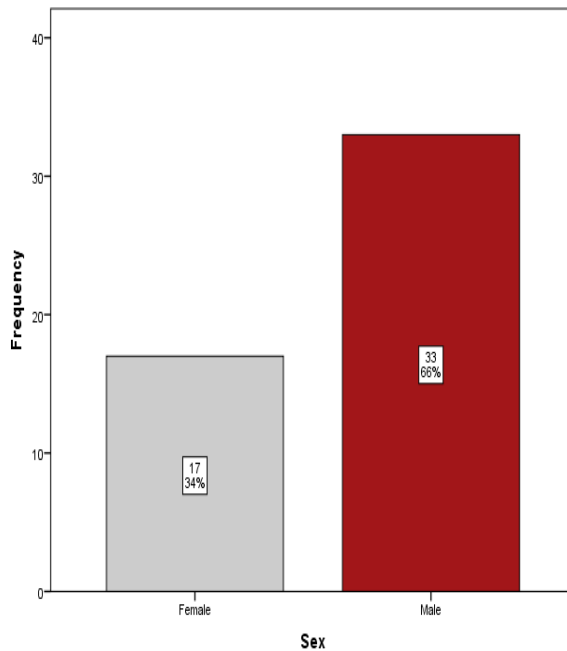
TABLE 1: AGE DISTRIBUTION OF THE PATIENTS

Age	Frequency	Percent (%)	Cumulative Percent (%)
3	1	2.0	2.0
4	3	6.0	8.0
5	12	24.0	32.0
6	13	26.0	58.0
7	10	20.0	78.0
8	5	10.0	88.0
9	6	12.0	100.0
Total	50	100.0	

4.1.2 GENDER DISTRIBUTION OF THE PATIENTS

There were 33(66%) male and 17 (34%) female children.

Figure 1: GENDER DISTRIBUTION OF THE PATIENTS



4.1.3 CAUSE OF INJURY

Most of the injuries were as a result of a fall from a height. Figure 2 shows that 38 (76%) of the injuries were a result of a fall from a tree, oxcart, swing or bicycle and 12 (24) were during physical play.

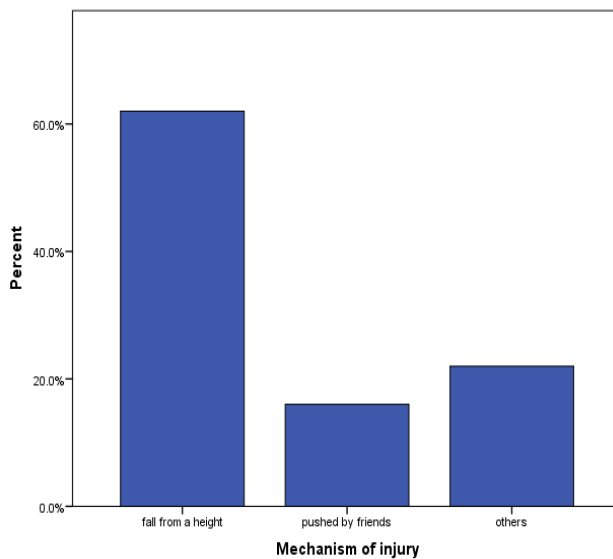


FIGURE 3: CAUSE OF FRACTURE

4.1.4 CLINICAL CHARACTERISTICS OF GARTLAND III SUPRACONDYLAR FRACTURES

The affected arm in 72% (36) of the patients was the left arm while in 28% (14) of the patients the affected arm was the right arm. Affected limbs had associated swellings of varying degrees: 6 % (3) mild, 66% (33) moderate, and 28% (14) severe. None of the patients had a diminishing radial pulse. None of the patients enrolled had any associated injuries either skeletal or soft tissue.

TABLE 2: CLINICAL CHARACTERISTICS OF AFFECTED LIMB

Variable		Frequency	Percentage (%)
Affected arm	Left arm	36	72.0
	Right arm	14	28.0
Associated swelling	Mild	3	6.0
	Moderate	33	66.0
	Severe	14	28.0
Diminishing Radial pulse	None	50	100.0
Associated injuries(skeletal or soft tissue)	Yes	0	0.0
	No	50	100.0

4.1.5 OPERATIVE MANAGEMENT FINDINGS AND TIMING OF SURGERY

Twenty-five (50%) patients were admitted the same day they suffered an injury. The other twenty-five were admitted between day 1 and day 7.

TABLE 3: DURATION FROM INJURY TO ADMISSION

# days	Frequency	Percent (%)	Cumulative Percent (%)
0	25	50.0	50.0
1	10	20.0	70.0
2	9	18.0	88.0
3	4	8.0	96.0
4	1	2.0	98.0
7	1	2.0	100.0
Total	50	100.0	

Patients were operated on between day 1 to day 9 of admission. Sixty (60) of the patients were operated on with seventy-two (72) hours of injury. Six (6) percent were operated on after seven (7) days.

TABLE 4: INTERVAL BETWEEN ADMISSION AND DATE OF OPERATION

# days	Frequency	Percent (%)	Cumulative Percent (%)
0	0	0.0	0.0
1	4	8.0	8.0
2	15	30.0	38.0
3	11	22.0	60.0
4	7	14.0	74.0
5	4	8.0	82.0
6	2	4.0	86.0
7	4	8.0	94.0
8	1	2.0	96.0
9	2	4.0	100.0
Total	50	100.0	

4.1.6 SURGICAL APPROACH

Out of the total 50 patients enrolled 20 (40%) were operated on using the lateral approach while in the remaining 30 (60%) the posterior approach was used.

TABLE 5: SURGICAL APPROACH USED

Surgical approach	Frequency	Percent (%)
Lateral	20	40.0
Posterior	30	60.0
Total	50	100.0

4.1.7 Method of Kirschner wire fixation used

Medial and lateral crossed K-wire fixation method was used on 37 (74%) children and 2 parallel lateral K-wire fixation method was used on 13 (26%) of the patients.

TABLE 6: K-WIRE FIXATION METHOD USED

Method of K-wire Fixation	Frequency	Percent (%)
Parallel (lateral)	13	26.0
Crossed (medial & lateral)	37	74.0
Total	50	100.0

4.1.8 Competence Level of Orthopaedic Surgeon

Consultant orthopaedic surgeons operated on 24 (48%) of the enrolled patients while 26 (52%) were conducted by orthopaedic registrars.

TABLE 7: COPMETENCE LEVEL OF OPERATING SURGEON

Level of orthopaedic surgeon	Frequency	Percent (%)
Consultant	24	48.0
Registrar	26	52.0
Total	50	100.0

4.1.9 Postoperative Tourniquet Palsy

Eight (16%) of the patients in the study developed tourniquet palsy while 42 (84%) did not develop tourniquet palsy of the forearm operated on.

TABLE 8: POSTOPERATIVE TOURNIQUET PALSY

Development of tourniquet palsy	Frequency	Percent (%)
Yes	08	16.0
No	42	84.0
Total	50	100.0

4.2 POST-OPERATIVE FOLLOW-UP OUTCOMES

4.4.1 RATE OF POST OPERATIVE INFECTIONS AT 3 WEEKS

At 3 weeks follow up twenty (20) percent of the patients treated via the posterior approach developed SWI and PSI while five (5) percent and ten (10) percent developed SWI and PSI respectively.

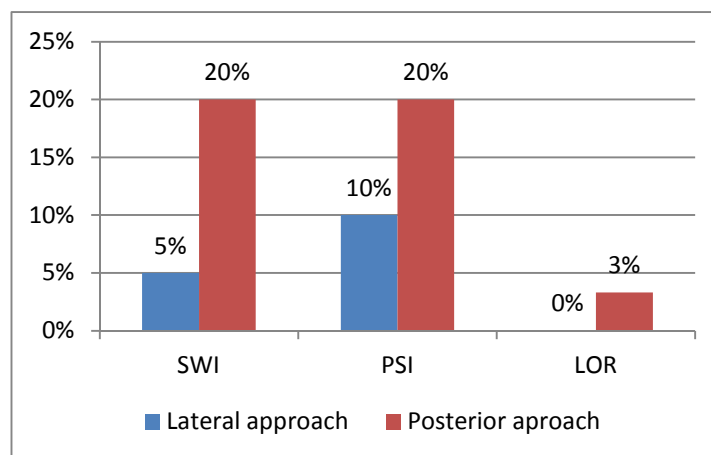


Figure 4: Complications rate at 3 weeks

TABLE 9: ASSOCIATION BETWEEN SURGICAL APPROACH AND SWI AT 3 WEEKS

			SWI at 3 weeks		
			Yes	No	
Surgical approach	Lateral	Count	1	19	20
		Expected Count	2.8	17.2	20.0
	Posterior	Count	6	24	30
		Expected Count	4.2	25.8	30.0
Fishers exact=2.243; df=1; p=.219, p>0.05					

TABLE 10: ASSOCIATION BETWEEN SURGICAL APPROACH AND PIN SITE INFECTION AT 3 WEEKS

			PIS at 3 weeks		Total
			Yes	No	
Surgical approach	Lateral	Count	2	18	20
		Expected Count	3.2	16.8	20.0
	Posterior	Count	6	24	30
		Expected Count	4.8	25.2	30.0
Fishers exact =.893; df=1; p=.450, p>0.05					

TABLE 11: ASSOCIATION BETWEEN SURGICAL APPROACH AND LOR AT 3 WEEKS

			LOR at 3 weeks		Total
			Yes	No	
Surgical approach	Lateral	Count	0	20	20
		Expected Count	.4	19.6	20.0
	Posterior	Count	1	29	30
		Expected Count	.6	29.4	30.0
Fishers exact =.680; df=1; p=1.000, p>0.05					

4.2 OUTCOMES OF OPERATIVE MANAGEMENT OF GARTLAND III FRACTURES

Overall cosmetic factor was satisfactory for 88.0% of the participants with 12.0% having unsatisfactory results at 6 weeks compared to 46.0% satisfactory results and 54.0% unsatisfactory results at 12 weeks. Function was found to be satisfactory in 34.0% and unsatisfactory in 66% at 6 weeks while satisfactory in 68.0% and unsatisfactory in 32 % at 12 weeks.

TABLE 12: OVERALL OUTCOMES ACCORDING TO FLYNN'S CRITERIA

Flynn's Criteria		6 weeks		12 weeks	
		n	%	N	%
Cosmetic Factor	Satisfactory	6	12.0	23	46.0
	Unsatisfactory	44	88.0	27	54.0
Functional Factor	Satisfactory	17	34.0	34	68.0
	Unsatisfactory	33	66.0	16	32.0

4.2.1 COMPARING OUTCOME OF COSMETIC FACTOR OF LATERAL VS POSTERIOR AT 6 WEEKS

Eighty (80) of the patients had unsatisfactory outcomes using the lateral approach while ninety-three (93) percent had unsatisfactory outcome using the posterior approach.

TABLE 13: OUTCOMES OF COSMETIC FACTOR ACCORDING TO FLYNN'S AT 6WEEKS AS PER SURGICAL APPROACH

Flynn's Criteria			Surgical Approach		Total
			Lateral	Posterior	
CF6Weeks	Satisfactory	Count	4	2	6
		% within Surgical Approach	20.0%	6.7%	12.0%
	Unsatisfactory	Count	16	28	44
		% within Surgical Approach	80.0%	93.3%	88.0%
Total	Count	20	30	50	
	% within Surgical Approach	100.0%	100.0%	100.0%	

Statistical Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Continuity Correction ^b	.955	1	.328		
Likelihood Ratio	1.981	1	.159		
Fisher's Exact Test				.202	.164
Linear-by-Linear Association	1.980	1	.159		
N of Valid Cases	50				

4.2.2 COMPARING OUTCOME OF FUNCTIONAL FACTOR OF LATERAL VS POSTERIOR AT 6 WEEKS

Eighty (50) of the patients had unsatisfactory outcomes using the lateral approach while seventy-seven (77) percent had unsatisfactory outcome using the posterior approach.

TABLE 14: OUTCOMES OF FUNCTIONAL FACTOR ACCORDING TO FLYNN'S AT 6WEEKS AS PER SURGICAL APPROACH

Flynn's Criteria		Surgical Approach		Total	
		Lateral	Posterior		
FF6Weeks	Satisfactory	Count	10	7	17
		% within Surgical Approach	50.0%	23.3%	34.0%
	Unsatisfactory	Count	10	23	33
		% within Surgical Approach	50.0%	76.7%	66.0%
Total	Count	20	30	50	
	% within Surgical Approach	100.0%	100.0%	100.0%	

Statistical Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Continuity Correction ^b	2.707	1	.100		
Likelihood Ratio	3.781	1	.052		
Fisher's Exact Test				.071	.050
Linear-by-Linear Association	3.727	1	.054		
N of Valid Cases	50				

4.2.4 COMPARING OUTCOME OF COSMETIC FACTOR OF LATERAL VS POSTERIOR AT 12 WEEKS AS PER FLYNN'S CRITERIA

Thirty (30) percent had unsatisfactory outcomes with the lateral approach while seventy (70) percent had unsatisfactory outcomes using the posterior approach.

TABLE 15: OUTCOMES OF COSMETIC FACTOR ACCORDING TO FLYNN'S AT 12WEEKS AS PER SURGICAL APPROACH

Flynn's Criteria			Surgical Approach		Total
			Lateral	Posterior	
CF12Weeks	Satisfactory	Count	14	9	23
		% within Surgical Approach	70.0%	30.0%	46.0%
	Unsatisfactory	Count	6	21	27
		% within Surgical Approach	30.0%	70.0%	54.0%
Total	Count	20	30	50	
	% within Surgical Approach	100.0%	100.0%	100.0%	

Statistical Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Continuity Correction ^b	6.203	1	.013	.009	.006
Likelihood Ratio	7.908	1	.005		
Fisher's Exact Test					
Linear-by-Linear Association	7.575	1	.006		
N of Valid Cases	50				

4.2.5 COMPARING OUTCOME OF FUNCTIONAL FACTOR OF LATERAL VS POSTERIOR AT 12 WEEKS AS PER FLYNN'S CRITERIA

Five (5) percent had unsatisfactory functional outcomes with the lateral approach while fifty (50) percent had unsatisfactory functional outcomes using the posterior approach.

TABLE 16: OUTCOMES OF FUNCTIONAL FACTOR ACCORDING TO FLYNN'S AT 12WEEKS AS PER SURGICAL APPROACH

			Surgical Approach		Total
			Lateral	Posterior	
FF12Weeks	Satisfactory	Count	19	15	34
		% within Surgical Approach	95.0%	50.0%	68.0%
	Unsatisfactory	Count	1	15	16
		% within Surgical Approach	5.0%	50.0%	32.0%
Total	Count	20	30	50	
	% within Surgical Approach	100.0%	100.0%	100.0%	

Satisfactory Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Continuity Correction ^b	9.195	1	.002	.001	.001
Likelihood Ratio	13.158	1	.000		
Fisher's Exact Test					
Linear-by-Linear Association	10.944	1	.001		
N of Valid Cases	50				

4.5 CONFOUNDING FACTORS INFLUENCING OUTCOMES

Statistical tests were conducted to establish whether there was any relationship between:

- a) level of orthopedic surgeon and functional factor
- b) level of orthopedic surgeon and cosmetic factor

TABLE 17: FISHER'S EXACT TEST REGARDING RELATIONSHIP BETWEEN LEVEL OF SURGEON AND COSMETIC FACTOR

			Cosmetic factor at 12weeks		Total
			Satisfactory	Unsatisfactory	
Level of orthopaedic surgeon	Consultant	Count	17	7	24
		Expected Count	11.0	13.0	24.0
	Registrar	Count	6	20	26
		Total	50	100.0	
Fisher's Exact Test=11.458; df=1; p=0.002					

TABLE 18: FISHER'S TEST REGARDING RELATIONSHIP BETWEEN LEVEL OF SURGEON AND FUNCTIONAL FACTOR

			Functional factor at 12 weeks		Total
			Satisfactory	Unsatisfactory	
Level of orthopaedic surgeon	Consultant	Count	21	3	24
		Expected Count	16.3	7.7	24.0
	Registrar	Count	13	13	26
		Expected Count	17.7	8.3	26.0
$(\chi^2=12.791; df=1; p=.004, <0.5$					

CHAPTER FIVE

5.0 DISCUSSION

Supracondylar fractures are the second most common fractures in children below the age of ten (10) years presenting to the A & E department at UTH, the most common being forearm fractures of the radius and ulna (Oranmore-Brown, 2014). Management of supracondylar fractures of the humerus for Gartland type I and II at UTH is done by closed method – Manipulation under anaesthesia (MUA) with casting at 90 degrees elbow flexion for 3 weeks. However, for Gartland III fractures initially MUA is attempted, if reduction is not acceptable, open reduction with K-wire fixation is then the treatment of choice. The rate of conversion from closed reduction to open reduction ranges from 3 to 46%, however, this is a multifactorial issue and rates could vary from one centre to another (Pretell-Mazzini, 2010). Open reduction at UTH is carried out by either of the two (2) surgical approaches; Lateral or Posterior depending on the surgeons preference which is in line with a study done by Ensafdara et al, 2005.

5.1 AGE AND SEX DISTRIBUTION

This study found that supracondylar fractures commonly occurred between the age ranges of 3 to 9 years, with a mean age of 6.4 years (Table 1). This is in line with literature which also shown that this fracture commonly occurs at the age of less than 7 years (Marquis, 2008). In this study, males had a higher incidence of this fracture at sixty-six (66) percent compared to females. Pretell-mazzini et al, 2011 also found males to have a higher incidence as compared to females. This fracture was commonly due to fall from some height or fall whilst playing activities which are seen more in male children.

5.2 CAUSE OF INJURY

The majority of the fractures in this study were sustained after a fall from height, seventy-six (76) percent (Figure 2). Lovell & Winters, 2006 also found that

majority; sixty-five (65) percent of this extension type of fracture was secondary to a fall from a height.

5.3 CLINICAL FINDINGS OF SUPRACONDYLAR FRACTURES

This study found that the most commonly affected arm in 72% (36) of the patients was the left arm. Furthermore, it was noted that the affected limb had associated swellings of varying degrees with twenty-eight (28) percent having severe swelling on admission. A study done by Smajic et al, 2011, also found supracondylar fractures in more than 70% of cases are the result of a fall onto the outstretched hand, and are more common in the non-dominant limb. None of the patients enrolled developed diminishing radial pulse. This was because prompt initial management by elevation of the limb or lateral traction was instituted upon admission. Repeated assessment of the circulation should be carried out during the first week in traction. On its own, an absent radial pulse is not an indication for arterial exploration; colour, temperature, capillary return of the nail bed, sensation and pain on passive extension of the fingers must all be considered (Piggot et al, 1986). All the patients had no neurological deficits prior to operative management.

5.4 DURATION OF PRESENTATION AND TIMING OF OPERATIVE TREATMENT AT THE HOSPITAL

Fifty (50) percent of the patients were admitted on the day of the injury to UTH (Table 3). However, the other 50 % delayed due to the referral system, as most of the patients came from far off places. This study further found that 60% of the patients were operated on within seventy-two (72) hours of admission. Delay in operation at UTH could be attributed to the fact that these fractures are not operated on in the emergency theatre but rather are put on the earliest available elective list for the admitting orthopaedic unit. Time from injury to surgery has been an issue of controversy regarding its effect on complication as well as open reduction rates with some of the reasons for delay found in literature being severe swelling or skin problems around the elbow and health facility problems such as: availability of a medical facility, surgeon, and anaesthesiologist (Pretell-Mazzini, 2010). In 2011, a study done in China by Han Qing-Lin et al showed that delay in surgery, regardless

of whether it is closed or open, for more than 12 hours after injury does not influence the perioperative complications and clinical results for displaced supracondylar humeral fractures in children.

5.5 COMPETENCE LEVEL OF THE OPERATING SURGEON

Two surgical approaches were used in this study with sixty 60% (30) patients having their fractured managed through the posterior approach (Table 5). The choice of the approach was implored by the operating surgeon. Preference is due to having no guiding protocol at UTH. Registrars follow which ever approach the unit consultant prefers and 60% of them use posterior approach. Gartland III supracondylar fractures are handled mostly by registrars. This is supported by the findings of this study as fifty 52% (26) patients were operated on by orthopaedic registrars (Table 7). Registrars preferred to use the posterior approach as seen in a study done in Iran by Esafdarani et al, 2005 which showed that exposure of the fracture site is more difficult in the lateral approach. Placement of the K-wires was noted to be easier through the posterior approach after isolation of the ulnar nerve. This would support the observation that inexperienced surgeons prefer to use the less difficult approach.

Placement of K-wire fixation can either be done using 2 cross medial and lateral or 2 lateral parallel 2mm wires. In this study, 74% (37) participants' fractures were fixed with cross k-wires leaving 26% (13) which were fixed with parallel k-wires. The lateral configuration, rather than the cross-pin configuration, may be the better option and several authors of retrospective clinical studies have recommended lateral pin fixation of these fractures for adequate fixation and avoiding iatrogenic ulnar nerve injury (Lee Young Ho et al, 2008). When using the posterior approach, most surgeons dissect the ulnar nerve to avoid injuring the nerve during k-wire fixation as was the case in this study at UTH. No ulnar nerve injury was documented in this study. However, the rate of ulnar nerve lesions has been reported to be 7-16% after percutaneous pinning of supracondylar fractures (Eren et al, 2005). A similar study done by Pretell-Mazzini et al, 2011, found iatrogenic neurological injury rate between to be 2 and 6% for the ulnar nerve which occurred most frequently during placement of the medial K-wires. This finding has made the cross-pinning configuration a less popular construct among some orthopaedic surgeons therefore to

avoid nerve injury during a medial pin insertion, they recommend identifying the ulnar nerve and isolating it prior to pin placement (Pretell-Mazzini, 2011).

An association was found between the level of the operating surgeon and the surgical approach used. Fisher's exact test was conducted at significance level of 0.05 giving a p-value of 0.002 for cosmetic factor while for functional factor p-value of 0.004. This showed that there was a significant relationship between the level of orthopedic surgeon and cosmetic factor. Cosmetic factor and functional factor had more satisfactory outcomes in operative management involving consultants than in those involving registrars. Interestingly, the study revealed that more consultants used the lateral approach. There was significant association between level of orthopaedic surgeon and surgical approach, P-value < 0.01. Compared to registrars, consultants had 86% reduced odds to undertake the posterior approach (OR = 0.14, CI = 0.04 – 0.51).

5.6 INFLUENCE OF EARLY INFECTION ON OUTCOME

The rate of post-operative infections at 3 weeks follow-up was compared for the two approaches as shown in figure 3. Complications considered included surgical wound infection (SWI) and pin site infection (PSI). The study found a higher complication rate for patients who underwent the posterior approach for the above complications when compared to lateral approach: SWI 20%, 5%; PSI 20%, 10% for posterior versus lateral respectively. The higher infection rate for the posterior approach can be attributed to the following factors; increased soft tissue dissection, increased operation time as it's done by registrars. Despite there being patients who developed infection, it was treated early with cephalosporins and wound care therefore none of the cases complicated to acute osteomyelitis. When statistical tests were conducted to establish whether there was an association between the occurrence of complications at 3weeks and the surgical approach used, no association was found. Fisher's exact tests were conducted at significance level of 0.05 giving a p-value of 0.219 and 0.450 for SWI and PSI respectively (Tables 9, 10 and 11).

5.7 COMPARING CLINICAL OUTCOMES AT 6 AND 12 WEEKS

The clinical outcomes at 6 weeks were found to be eighty (80) percent unsatisfactory for the lateral approach compared to ninety-three (93) percent unsatisfactory for the lateral posterior approach for cosmetic factor (Table 13). Of note is that at three (3) weeks the limb was noted to be stiff on removing the plaster of Paris (POP) cast. Furthermore, for some patient's physiotherapy had to be delayed for a few days in order to treat the surgical wound infection. At six and twelve week follow up of these patients, early infection was not found to have any influence on the clinical outcome. Fisher's exact test was conducted at significance level of 0.05 and found no statistical association between cosmetic factor and surgical approach giving a p-value of 0.20 (OR= 0.29, CI= 0.05).

However, for the functional factor a marginal association between surgical approach and functional factor for patients at 6weeks. Functional factor for lateral approach had 50% unsatisfactory and 76.7% unsatisfactory for posterior approach (Table 11). The Fisher's exact test conducted giving a p-value of 0.05. Therefore patients who underwent lateral approach had a 70% reduced odds for unsatisfactory functional factor result at UTH (OR = 0.30, CI= 0.09- 1.03).

Patients were followed up for a further 6 weeks for assessment of cosmetic and functional factor. At twelve (12) weeks the study found the lateral approach to have thirty (30) percent unsatisfactory results while posterior approach had seventy (70) percent (Table 12). Similarly, for functional factor, lateral approach had five (5) percent unsatisfactory results while posterior approach had seventy (70) percent (Table 13). This finding is supported by literature which found that, with posterior approach, time is necessary for the elbow to regain its functional range of motion since the intact triceps muscle is severed (Eren et al, 2005). The results showed a progressive improvement in the cosmetic and functional factor for the patients who had their fractures operated using the lateral approach with a lower percentage of unsatisfactory outcomes. Nevertheless, studies done by Smajic et al, 2011, showed that the movement of the injured elbow improves with the length of the postoperative period. The results of previous studies have shown that the return of the full range of motion to the elbow takes at least three months, and sometimes up to a year, and

parents of children with supracondylar fracture should be aware of this fact (Smajic et al, 2011).

Statistical tests done for association between cosmetic factor and surgical approach at significance level of 0.05 gave a Fisher's exact test with p-value 0.009 showing significant association. Overall, children that underwent lateral approach had an 82% reduced odds for unsatisfactory cosmetic factor outcome (OR= 0.18, CI= 0.05 – 0.63). The lateral approach had better outcomes when compared to the posterior approach regarding functional factor at 12 week of follow-up.

In the posterior approach the intact posterior structures will be damaged and lead to decreased range of motion, additional trauma and poor results Esafdarani et al, 2005. Most surgeons have given up the posterior approach due to the high incidence of elbow stiffness, which give unsatisfactory results (Hussain et al, 2014). The findings by Hussain et al are in line with my study which also showed a high percentage of unsatisfactory outcomes at the end of 12 weeks. Statistical tests done for association between cosmetic factor and surgical approach at significance level of 0.05 gave a Fisher's exact test with p-value 0.001. Overall, children that underwent lateral approach had 95% reduced odds for unsatisfactory result for functional factor (OR= 0.05, CI= 0.01 – 0.45).

CHAPTER SIX

6.0 CONCLUSION

The main objective of this study was to establish the outcomes of operative management of Gartland III supracondylar fractures in children using either the lateral or posterior approach using Flynn's criteria at UTH. This study has established that:

1. The lateral approach yielded better outcomes as compared to the posterior approach in the operative management of Gartland III fractures at UTH.
2. Significant progressive improvement in both cosmetic and functional factor according to Flynn's criteria from 6 weeks to 12 weeks follow-up using the lateral approach as compared to the posterior approach
3. The complication rates were not statistically dependant on the approach used to manage these fractures.

CHAPTER 7

7.0 LIMITATIONS

The following were study limitations

1. Some participants were referred from far off hospitals were lost to follow up due to the transport cost for the follow up reviews.
2. Physiotherapy services are not offered at most of the local clinics where the patients were coming from therefore some patients did not follow the full physiotherapy regime.
3. Lack of theatre time in the emergency and elective theatre lead to a delay in instituting the operative management of these patients
4. Convenient sampling was used therefore the results cannot be used for the general population.

CHAPTER 8

8.0 RECOMMENDATIONS

The gold standard worldwide for Gartland III supracondylar fractures worldwide is closed reduction with percutaneous pinning under image guidance. The researcher therefore recommends the following to improve the outcomes of operative management of these fractures:

1. The department of surgery should make a deliberate policy to train the registrars in the lateral approach to improve on the outcomes of the operative management.
2. There is need to incorporate more physiotherapy services in the local clinic to reduce on transport costs for these services which are essential in the post operative care of these patients to further improve on the outcomes of the fractures.
3. An image intensifier should be procured for UTH to be used in the emergency theatre in the management of these fractures.
4. A randomized control trial is therefore recommended to established results that will be used on the general population to improve operative management of Gartland III supracondylar fractures of the humerus in children.

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APPENDICES

APPENDIX 1: PATIENT INFORMATION SHEET

Introduction

My name is Dr. Penelope Kantu Machona, a Registrar in Orthopaedics and Trauma Surgery, Department of Surgery at the University Teaching Hospital. I am conducting a study on **Comparative Study of Outcomes of Operative Management of Gartland III Supracondylar Fractures of the Humerus in Children Using Lateral and Posterior Approach at University Teaching Hospital, Lusaka.**

Procedure

I am requesting you to participate in the study by

- I. Accepting to have your child's supracondylar fracture which will be managed surgically through one of the above approaches as part of my study.
- II. Your child will then be followed up for a period of 12 weeks to assess the outcomes of the surgical management of his/her fracture.
- III. Your child will have X-rays of the fractured limb, pre-op and post-op and will undergo physiotherapy at Department of Physiotherapy, UTH.

Foreseeable Risk

No anticipated risk because these are standard operative methods to be used

Benefits

Your child will benefit directly from this study in that his/her fracture will be followed up optimally hence any complications associated with this fracture will be

noted and addressed timely as per UTH protocol. Secondly, your child will make major contribution to the information that will be obtained from this study to improve the management of these fractures at UTH. The study will neither delay your treatment nor prolong your stay in the hospital.

Confidentiality

The researcher will keep the records and results of related to your child locked in a cabinet and the keys will be kept by the researcher. The results will not be disclosed to other people, neither will other people be told of you participation in the study.

Voluntariness

If you feel that you have been injured or inconvenienced as a direct consequence of participation in the study, you are at liberty to withdraw from the study at any time without any penalty or loss of benefits.

Contact Details

In the case where you have any questions or seek clarification, please contact me Dr. Penelope Kantu Machona on mobile number 0977 860355, Department of Surgery, University Teaching Hospital, P/B RW1X, Lusaka.

You may also contact the Chairman of the University of Zambia Biomedical and Research Ethics Committee. Ridgeway Campus. P.O Box 50110, Lusaka, Zambia, telephone 0211-256067 if you would like to know your rights as a research participant.

APPENDIX 2: ASSENT FORM

Your signing this form means that you understand the information presented and that you want your child to participate in the study. You understand that participation is voluntary and you may withdraw your child from the study at any time. If you agree to have your child participate in the study, kindly sign the consent form that follows.

Iof address.....

On this day ofmonth ofof the year..... do understand the nature of this study and the risks of participating in this study have been explained to me. I have read the foregoing information, or it has been read to me. I have had an opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily that my child be a participant in this research and agree to the terms of the study as laid out by the researcher.

Signature or Thumb print of participant

Name of the participant

Date..... (Day / month / year)

Statement by a Witness

I have witnessed the accurate reading of the consent form to the participant’s parent/guardian, and they have had an opportunity to ask questions. I confirm that the participant’s parent/guardian has given consent freely

Name of witness:

Signature _____ of _____ witness:
.....

Date: (Day / month /
year)

Statement by the Researcher

I have accurately read out all information regarding the study to the participant's parent/guardian and to the best of my ability am sure that the participant's parent/guardian understands that the following will be done:

1. X-rays of the fractured limb before and after theatre
2. Follow-up period of 3 months for the duration of the study

I confirm that the participant's parent/guardian was given an opportunity to ask questions and all the questions have been answered correctly and to the best of my ability. I confirm that the participant was not coerced into giving consent and consent has been given freely and voluntarily.

Name _____ of _____ researcher:
.....

Signature of Researcher:.....

Date:..... (Date / Month
/Year)

APPENDIX 3: DATA CAPTURE SHEET

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

Study Site: University Teaching Hospital, UTH

Researcher: Dr Penelope Kantu Machona

A. General Information

1. Participant's No:
2. Name of Participant:
3. Age of Participant
4. Sex : Female Male
5. Contact No:

B. Fracture Information

1. Date of Injury
2. Mechanism of Injury
3. Date of Admission
4. Hospital

C. Physical Examination

1. Affected arm: Right Left
2. Associated Swelling of the arm: mild moderate severe
3. Radial pulse: absent low volume good
4. Neurological deficit present: Yes No
5. If Yes, to question (4), state modality:

Radial Median Ulna

6. Associated injuries: Yes No

7. If Yes to question (6) state injury:

8. Radiological classification of fracture: I II III
 (Gartland classification)

D. Intra-operative Information

1. Date of Operation:

2. Surgical approach: lateral posterior

3. Method of K-wire fixation used: parallel crossed

4. Level of Orthopaedic surgeon: consultant SR R

5. Any intra-op complication: Yes

6. If Yes, to question (5), state complication:

E. Post-operative follow-up

	3 weeks	6 weeks	12 week
Superficial wound infection			
Pin site infection			
Loss of reduction			
Cubitus varus deformity (degrees)			