Ghana College of Physicians and Surgeons

Faculty of Surgeons

TREATMENT AND OUTCOMES OF PEDIATRIC SUPRACONDYLAR HUMERAL FRACTURES IN KORLE-BU TEACHING HOSPITAL.

Submitted to the Faculty of Surgeons, in partial fulfilment of the requirements for the conferment of a Fellow of the Ghana College of Surgeons (FGCS)

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December, 2015

DECLARATION

I hereby certify that the information contained in this research represents the work I did at the Orthopedics and Trauma unit of Korle–Bu Teaching Hospital, Kumasi-Ghana. This was done from January, 2014 to January, 2015 for the part II FGCPS in Trauma and Orthopedic surgery.

This work has not been used for other degrees or diplomas, nor has it been submitted elsewhere for any publication or award in the past. Where other sources have been used, they have been duly acknowledged.

Signed

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Dr Baidoo, Paa Kwesi

CERTIFICATION

Approved for submission

Supervisor:

_____

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Senior Lecturer, Department Of Surgery-Orthopedics.

Date: _____

DEDICATION

This thesis is dedicated to God Almighty for his daily blessings.

To Velarie Ansu, for been there for me throughout this stressful period and for the words of encouragement and most importantly believing in me.

This study would have been incomplete without the participation of the wonderful children who made it a success. Your smiles even though you were injured gave me the reason to carry on with this study and above all made me humble. Thank you and God bless you.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to Mr Henry Holdbrook Smith, Orthopaedic surgeon and lecturer of University of Ghana Medical School and to all my consultants, for their tireless efforts, support, invaluable advice and constructive criticism towards this study.

Special thanks goes to Amber Caldwell, Director of Development, Institute of Global Orthopaedics and Traumatology (IGOT) UCSF Department of Orthopaedic Surgery for her immense contribution towards my development in the field of orthopaedics and research.

To Kushal Patel, thank you for your assistance with using REDCap. My data analysis would have been incomplete without the help of Wu Hao-Hua, IGOT Fellow and David Shearer, MD all of University of California San Francisco. Your assistance and constructive criticism made this study a success.

My sincere thanks goes to my mentor Scott Patrick Kaiser of UCSF for his encouragement and guidance throughout my career and research studies. I am very grateful.

Finally I would like to thank all my colleagues, nurses and records staff of the Orthopaedic unit. Many thanks to my family for always cheering me on. Without your support this work would not have been possible.

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ABBREVIATIONS

SD – Standard deviation

Km – Kilometer

CRPP- Closed reduction and percutaneous pinning

POP- Plaster of Paris

OPERATIONAL DEFINITION

A supracondylar fracture of the humerus is a fracture of the distal humerus just above the epicondyles.

STRUCTURED ABSTRACT

BACKGROUND

Supracondylar humeral fractures are the most common elbow fractures in the pediatric population. These normally result from either a fall on the outstretched hand or the flexed elbow resulting in either the extension or flexion types respectively. They are usually associated with complications such as neurovascular injuries, compartment syndrome, pin tract infections and malunion which in the end after the cosmetic and functional outcomes according to the Flynn's criteria.

The objective of this study was to determine the treatment and outcomes of pediatric supracondylar fractures of the distal humerus at Korle Bu Teaching hospital.

METHODOLOGY

This was a prospective study carried out at the trauma and orthopedic unit of Korle Bu Teaching Hospital, Accra. Patients for this study were recruited over a year period from January 2014 to January 2015. An evaluation form was filled by the principal investigator and attached to patient's folders. One hundred and one patients

were entered into the study. Treatment of supracondylar humeral fractures in children were guided by the department's protocol.

Patients were followed up over a six (6) month period . Data collected during this period were entered into the REDCap data base, which is a secured web based data collection tool hosted by the University of California, San Francisco (UCSF). The results were then analysed using SPSS version 23.

RESULTS

The mean age was 5.2 years with a peak of 4-5 years. There were seventy three (73) males and twenty eight (28) females with a ratio of 2.6:1. Most of the injuries occurred at home (64.3%) followed by at school (27.7%). The left arm (non-dominant) was the most injured (62%) compared to the right (38%), though most of the patients seen were right hand dominant (92%).

Gartland type III (43.6%) was the commonest fracture followed by type I (31.7%) and type II (24.7%) respectively. Outcomes of management of these fractures were satisfactory based on Flynn's criteria in over 95 % of the patients. The pediatric quality of life outcome was significantly affected at three weeks after the injury. However, they returned to the population normal at six month.

Pin tract infections (5 patients), nerve injury (3 patient), vascular (1 patient), cubitus varus (1 patient), elbow stiffness (1 patient) and myositis ossificans (1 patient) were the complications observed in the study and were mostly associated with high energy injuries (type III fractures).

CONCLUSIONS

Pediatric supracondylar humeral fractures are very common injuries and their diagnosis and treatment presents a major difficulty to us as orthopedic surgeons. However, through this study, it is concluded that the outcomes of treatment of these fractures at our institution is satisfactory and comparable to other places where they manage such fractures.

KEYWORDS

Pediatric, supracondylar, fractures, humerus, Gartland, Flynn's criteria

CHAPTER ONE

I. INTRODUCTION

Supracondylar fractures of the distal humerus are the most common pediatric elbow fractures (1-3). The reported incidence is between 50% and 70% of elbow fractures (4) and about 13% of the fractures that occur in children (5). It commonly occurs between the ages of 5 to 7 years and it is also reportedly more common in boys than in girls with a ratio of 2:1(6, 7). Some recent publications, however, put the incidence as being equal (REF) and others even quote higher incidence in girls (7, 8). The left hand or the non-dominant hand is mostly affected in almost all studies (7-10).

There have been lots of discussions and controversies for many years regarding the management of pediatric supracondylar humeral fractures. Historically, these fractures were associated with complications such as malunion resulting in cosmetically and functionally poor results. More recently, modern management techniques have led to reduction of these types of complications (11-14).

With the introduction of the image intensifier which enables accurate pin placement, the advice or caution by Blount (15) against surgical management is now of historic interest. In spite of all the advances made, controversies still exist concerning the treatment of pediatric supracondylar humeral fractures. These are:

1. How long after injury is surgery safe and effective?
2. Are there differences in outcome using cross pins and lateral entry pin configurations?
3. Should type II supracondylar fractures be managed surgically or non-surgically?
4. Does a pulseless hand need an urgent surgical intervention?

The objective of this study is to determine the treatment outcomes of patients with supracondylar fractures of the distal humerus in Korle-Bu Teaching Hospital.

A. PROBLEM STATEMENT

Even though supracondylar fractures of the distal humerus are the most common pediatric elbow fractures (1-3), the ideal or optimal treatment is still controversial especially fractures that are displaced and those with compromised

neurovascular status (16, 17). In Ghana and the sub-region, these fractures can lead to permanent disability and even threaten the life of the patient. This is as a result of what we term “bonesetter’s limb or gangrene”, which destroys all the soft tissues of the fractured limb when the child does not die from the gangrene(18). There are many options for treating these fractures and with all these options, one need to assess the severity of the injury including the neurovascular status. Non-displaced fractures require immobilization of the arm in a cast for about 3 – 4 weeks. Displaced fractures are initially managed by closed reduction. If adequate reduction is not achieved, then open reduction with percutaneous pinning using K-wires is needed and followed with plaster of Paris (POP) cast or splint. Other options include side-arm skin traction, overhead skeletal traction or external fixation (19).

These fractures are managed by all subspecialty trained orthopedic surgeons including pediatric orthopedic surgery; thus making it difficult for orthopedic surgeons to come to a uniform agreement on the optimal management of these fractures (20). It is for this reason that the knowledge of the epidemiology and treatment outcome of supracondylar fractures of the distal humerus in Korle Bu Teaching Hospital will improve the quality of care given to these children.

B. JUSTIFICATION

With the limited availability of data, there is the need to have a baseline data on incidence, etiology and treatment outcome of supracondylar fracture of the distal humerus of children in Korle-Bu Teaching Hospital. This knowledge will provide a medical audit of the current management of supracondylar fracture of the distal humerus of children and to help guide future recommendations on the management of these fractures in Korle-Bu Teaching Hospital.

C. GENERAL AIM

This study seeks to establish the types of supracondylar fractures presenting to Korle Bu Teaching Hospital and how management of these fractures affect the function of the affected limb.

D. OBJECTIVES

The objectives of this study are:

1. To establish the types of supracondylar humeral fractures presenting to Korle Bu Teaching Hospital.
2. To find out how supracondylar humeral fractures are managed in this hospital.
3. To find out whether time to fracture fixation affect the outcome using Flynn's criteria.
4. To test if there are any associated complications of these fractures

CHAPTER TWO

II. LITERATURE REVIEW

A. Types of supracondylar fractures

Supracondylar fractures of the distal humerus can be classified into extension and flexion types with 97% to 99% being of the extension type (6, 21) and the rest being of the flexion type (21).

B. Mechanism of injury

The extension type of supracondylar fracture is caused by a fall on the outstretched hand (FOOSH) with the elbow in full extension whereas the flexion type has a direct fall on the elbow as the mechanism of injury.

C. Anatomy

The anatomy of the distal humerus is unique in that the medial and lateral condyles are connected by a segment of thin bone due to the presence of the olecranon fossa posteriorly and the coronoid fossa anteriorly. The area is therefore prone to this kind of fracture. There is however an atomic variation such as the absence of the olecranon fossa and in its place, a supracondylar process. This occurs in about 1.5% adult cadavers studied (22).

In the extension type of this injury, with hyperextension of the elbow, the olecranon fossa is engaged by the olecranon and acts as a pivot or fulcrum through which the extension force propagates the fracture across the medial and lateral columns respectively. Laxity of the ligaments around the elbow with an accompanying hyperextension force may lead to a supracondylar fracture (23). In all these cases, an intact periosteal hinge provides stability and actually makes reduction easier(24).

It is generally believed that the direction of displacement of the distal fragment is important and that medial displacement of the distal fragment is much more common than lateral displacement. In the extension type, lateral displacement of the distal fragment puts median nerve and brachial artery at risk (25, 26) and medial displacement endangers the radial nerve. In the flexion type of supracondylar fracture,

the distal fragment is anteriorly displaced and may migrate proximally if the fracture is completely displaced placing the ulnar nerve at risk (27-30).

D. Classification

The extension type of fracture is classified using the Gartland classification (31) as in Table 1.1.

Table1.1. Gartland Classification of supracondylar humeral fractures

Types	Features	Comments
I	Undisplaced	Fat pad may be the only feature present acutely. Anterior humeral line intersect capitellum
II	Hinged posteriorly	Anterior humeral line is anterior to capitellum
III	Displaced	No significant cortical contact

The classification of the flexion type is similar to that of the extension with emphasis on how displaced the distal fragment is (25, 32). The Gartland classification has a high intra- and inter observer variability (33).In spite of these limitations, the Gartland classification remains the preferred system for categorizing supracondylar humeral fractures since the fracture type correlates well with severity of injury and outcome.

E. History and physical examination

i. History

The clinician should suspect an elbow injury in a child with history of fall associated with either pain around the elbow or failure to use the upper limb, no matter how minor the fall may seem. One should also not lose sight of other potential

causes of elbow pain like infection and fractures of the condyles. Clinically there may or may not be any evidence of deformity of the elbow safe elbow pain and restricted range of motion of the elbow. This is true of type I fractures where there may not be any obvious deformity and in type III with marked elbow deformity in the form of an 'S' shape with gross swelling (figures 1.1a and 1.1b).

Figure 1.1a: S-Shape deformity of the elbow of a patient in this present study

Figure 1.1b: S-Shape deformity of the elbow of a patient in this present study

In some instances, the proximal fragment may penetrate the brachialis muscle and fascia and engage the dermis of the skin anteriorly given rise to the 'pucker' sign (figure 2), an indication of severe soft tissue trauma (34-36).

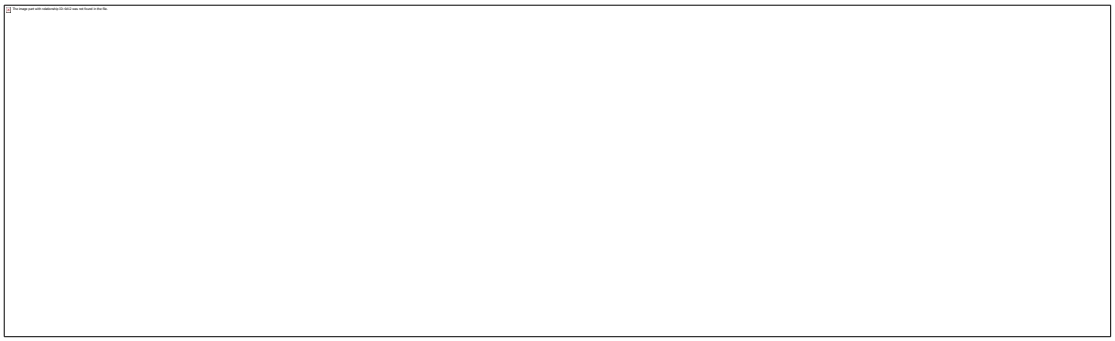

Figure 1.2: Patient with pucker sign as taken by author of this study

ii. Physical examination

a. Nerve status

One needs to perform a thorough of examination of the motor and neurovascular systems in all patients. The following nerves are assessed: dorsal aspect of the first web space (radial nerve), palmar aspect of index finger (median nerve) and palmar aspect of the little finger (ulna nerve). Motor examination should also be done in all patients. Assessment of the anterior interosseous nerve (AIN) is done by asking the child to oppose the thumb and index finger whilst checking the strength of the dorsal interosseous muscle.

b. Vascular status

It is also important to check the vascular status for the presence of radial pulse, capillary refill and color of the hand as vascular impairment has been reported in as many as 12%-20% of cases of supracondylar fractures of the distal humerus (32, 37, 38). Following examination of the vascular status of the hand, the status may be class as:

(i) Palpable radial pulse with well perfused hand
(ii) Absent radial pulse with well perfused hand and
(iii) Poorly perfused hand with absent pulse.

Finally the presence or absence of compartment syndrome should also be confirmed or excluded at this stage by examining all the compartments of the injured arm and forearm.

c. Radiological investigations

The next step in the assessment of a patient with history of fall on the out stretched hand or direct fall on the elbow involves thorough radiological investigations. A true anterior posterior (AP) view of the distal humerus and a true lateral radiographic view of the elbow with the limb in anatomic position are obtained. Occasionally, an oblique view of the distal humerus should be obtained when supracondylar humeral or condylar fractures are anticipated from the history but the AP and lateral view do not show that. There is often no need for radiological imaging of the contralateral elbow except for the evaluation of the ossification centers.

Supracondylar fractures are often difficult to visualize on X-ray in children. The posterior fat pad sign (figure1.3), which is seen on the lateral radiographs, can serve as a reliable way to spot occult supracondylar fractures in children (39-41). The posterior fat pad sign can be seen anytime the posterior fat pad is displaced out of the olecranon fossa due to distension of the intact elbow joint capsule. This displacement is from the olecranon fat pad and is invisible on lateral x-rays of the uninjured elbow as they are held deep in the fossa by the triceps and anconeus muscles.

Figure 1.3a (Source: author of study) Figure 1.3b (Source: Wikipedia)

Figure 1.3: Lateral radiograph with posterior fat pad sign of a patient

Anterior humeral line (AHL) and humeral-capitellar angles (Baumann's angle) are the two radiologic features used in assessing the presence of supracondylar fracture. AHL is a line drawn along the anterior surface of the humerus on the true lateral view and should bisect the capitellum in the uninjured elbow (figure 1.4a). In the extension type of fracture, the line is anterior to the capitellum (figure 1.4b) and posterior to the capitellum in the flexion type.

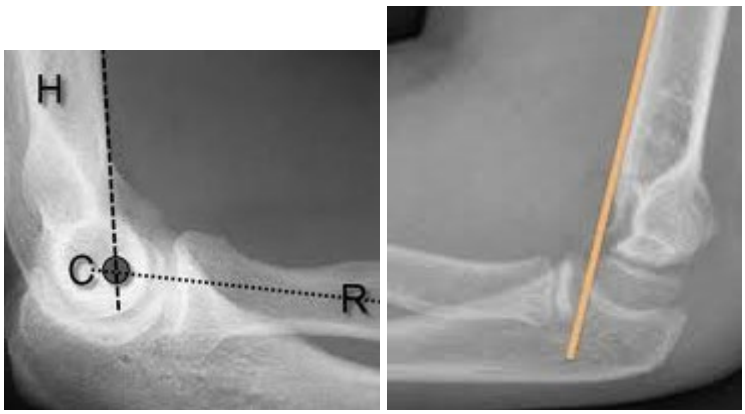

Figure 1.4a (Source: Wikipedia) Figure 1.4b (Source: Wikipedia)

The Baumann's angle is the angle formed by the long axis of the humeral shaft and the physeal plate of the capitellum as seen on an AP views (figure 1.5).

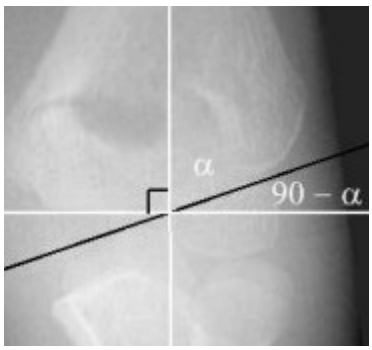

Figure 1.5 Baumann's angle on AP radiograph (Source: Wikipedia)

The normal value is 75^0-80^0 (42). An increase in this angle means a medial tilt of the distal fragment and the possibility of the patient getting a cubitus varus deformity. The Baumann's angle is the same for both elbows in children without any elbow injury. For this reason the angle for the uninjured elbow could be used to assess how good the reduction is (43, 44). Baumann believed that 90- alpha gives you the carrying angle (normal value is between 9^0-26^0). Though this is not entirely true, it can still be used to assess the adequacy of one's reduction and indicate the presence of varus angulation.

The carrying angle can be measured physically with the person standing in the anatomic position with the forearm in full extension and supinated. The obtuse angle formed with the arm (physiological valgus) is the carrying angle. It is about 1^0-3^0 greater in females (45, 46).

F. Management of Supracondylar humeral fractures

The fractures are managed the moment the patient is brought to the hospital with splinting of the upper limb with the elbow flexed at 20^0 to 40^0. The neurovascular status is checked before and after application of the splint. The splint should not be overly tight so as not to compromise the blood supply of the limb and to minimize the risk of compartment syndrome (47-49). The clinician then proceeds to examine the patient for other injuries after which radiographies are requested accordingly. Further management depends on the type of fracture.

i. Type 1 Supracondylar humeral fractures

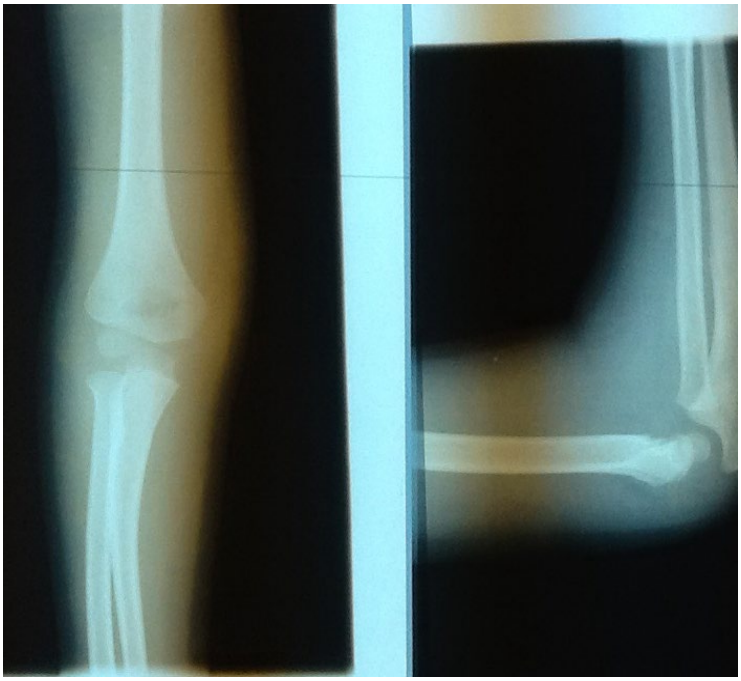

Figure 1.6:Anteroposterior (AP) and lateral x-ray views of patient from current study with type I fracture.

Type I fractures require simple cast with immobilization of the elbow at 60^0 to 90^0 elbow flexion for about 3 weeks (5, 50-52). Mapes et al in their study 'The effect of elbow position on radial pulse by ultrasound after surgical treatment of supracondylar elbow fractures in children' found that there was a decrease in the blood flow through the brachial artery in pronation and increasing flexion (49). X-ray of the elbow is done at one week to make sure the fracture has not displaced. There is no need for formal physiotherapy following the cast removal. The patient is seen a month after the cast removal to assess elbow range of motion and strength. At this point if the clinician is not satisfied, physiotherapy is started.

ii. Type II supracondylar fractures

Figure 1.7: Anteroposterior (AP) and lateral x-ray views of patient from current study with type II supracondylar humeral fracture.

The recommended treatment of type II supracondylar fractures is by closed reduction and percutaneous pinning (12,17, 56, 57) because casting in these types of fractures have high rates of reduction loss which may need re-manipulation, cubitus varus deformities, elbow stiffness and risk of compartment syndrome. In children less than 3 years of age, conservative management with cast could be done, as remodeling is possible. However in children more than 8 years of age, only 10% of growth remains in the distal humerus making remodeling less likely if adequate reduction is not achieved and malunion more likely(1).

Some authors however do not agree wholly with this. Hadlow et al (53) recommend initial conservative management of some type II fractures. In their work 'A selective treatment approach to supracondylar fractures in children' noted that if pinning had been done for all their type II fractures, 77 %(37 of 48) would have undergone an unnecessary surgery. Parikh et al(54) are in agreement with this view as

their retrospective reviews of 25 elbows came out with similar results. However, 14% (2 of 14) and 2% (2 of 25) of the patients from these respective studies had unsatisfactory results per the Flynn's criteria (55).

However many orthopedic surgeons support closed reduction and pinning for the management of supracondylar humeral fractures that are displaced as it is safe and reliable at maintaining adequate reduction(12, 17, 56, 57). In a study done by Skaggs et al in 2004(12), in which 69 children with type II fractures were treated surgically, they found no radiological or clinical evidence of loss of reduction, cubitus varus, hyperextension or loss of motion, nerve injury and none of the patients required re-operation.

In a review of 191 patients in 2008 by Skaggs and Sankar (56) of patients treated with pinning, they only found 4(2%) pin tract infections, were successfully treated with no other complications. Thus closed reduction and percutaneous pinning remains very safe and reliable. One other advantage of pinning is the prevention of compartment syndrome (48) as the degree of hyper flexion to which unpinned type II fractures is great with the resultant risk of compartment syndrome due to the decrease in blood flow to the limb(49).

iii. Type III supracondylar fractures

Type III fractures should be managed closed and pinned, as they are inherently unstable. However in situations of impaired circulation to the limb example pale hand with no pulse, when the fracture is opened, when close reduction fails or when there are other forearm fractures, open reduction and pinning should be considered (58-60).

Figure 1.8: Anteroposterior (AP) and lateral x-ray views of patient from current study with type III supracondylar humeral fracture

Figure 1.9: Post-operative anteroposterior (AP) and lateral x-ray views of patient from current study with type III fracture

Patient outcomes are evaluated using Flynn's criteria (55). See table II. Excellent and good assessments for both cosmetic and function are classified as satisfactory and fair and poor outcomes are classified as poor.

Table 1.2: Grading of results according to Flynn's criteria

Range	**Cosmetic assessment** **Change in carrying angle (degrees)**	**Functional assessment** **Loss of motion** **(degrees)**
Excellent	0^0-5^0	0^0-5^0
Good	5^0-10^0	5^0-10^0
Fair	10^0-15^0	10^0-15^0
Poor	$>15^0$	$>15^0$

G. Controversies

Pin configurations

Controversies exist as to what pin configuration should be used for types II and III supracondylar fractures once we opt to pin them. Should it be crossed pins or lateral pin configuration and how many pins should be used? The main aim of pinning is to achieve fracture stability, maintenance of reduction and alignment whilst reducing the risk of damage to the neurovascular structures.

Medial and lateral entry pinning (cross pinning) has been touted by many studies to be superior biomechanically relative to the lateral pinning configurations (51, 61-64). The popularity in the use of the lateral pin configuration is on the increase as it decreases the risk of injury to the ulna nerve (9, 61, 65, 66). Brauer et al (67) in a review found the chances of injury to the ulna nerve to be almost 1.84 times higher with cross pinning compared to the lateral pinning technique. However Kocher et al (11) and Topping et al (9) in their respective prospective randomized clinical trials found no difference between the two methods of pinning statistically.

There is also a role for traction (skin or skeletal traction) in the management of supracondylar humeral fractures in children. In situations of grossly swollen elbow where surgery may compromise the soft tissue integrity, traction may be done for a couple of days to allow the soft tissue to recover. In situation where anesthesia cannot be given or where there is lack of the surgical knowledge, traction may be performed.

G. **Complications following supracondylar humeral fractures**

Malunion and cubitus varus

These are well noted complications of traction(68)and it is estimated at 9% to 33% in some studies(69, 70). Other studies however reported results that were very good (71, 72). It has been proposed by some authors that unequal growth in the distal humerus is the cause of cubitus varus; however, this is unlikely since not enough growth remains in this region to cause cubitus varus(73, 74). A more probable reason for the deformity in patients with cubitus varus is malunion (32, 55, 72, 75, 76).

Achieving an intact Baumann's angle at the time of reduction and maintaining it during fracture healing can prevent Cubitus varus. This observation is true from the study done by Pirone et al(38) in which 8(7.9%) of 101 patients with supracondylar fractures treated with cast had cubitus varus relative to 2(1.9%) in 105 managed with pinning. The ages of their patients' ranges from 1.5 to 14 years with an average of 6.4 years. Other modern studies in which pinning were done showed a decrease in frequency of cubitus varus (38, 55, 77-81).

Treatment of this deformity was considered primarily cosmetic procedure in the past. However complications of cubitus varus such as risk of lateral condylar fracture, pain and tardy posterolateral rotatory instability is an indication for supracondylar humeral osteotomy (82-87)

I. Vascular injuries

About 10% to 20% of cases of type III supracondylar fractures presents with absent pulse (37, 38, 88, 89). A non-palpable radial pulse is not all that alarming per se as pediatric limbs often remain well perfused by collateral circulation. Urgent fracture reduction and pinning may restore the pulse (90). However, it becomes a real emergency if the arm is poorly perfused and it is pulseless. Patients with grossly displaced supracondylar fractures and poorly perfused extremity presenting to the

hospital should have the limb splinted in about 20^0 to 40^0 of elbow flexion(91). The pulse is usually restored once fracture reduction is achieved. Hence the process should not be delayed waiting for angiographic studies (92). Several studies have shown that angiography really has no bearing on the treatment and is unnecessary (37, 38, 88, 93).

In a series of 143 type II supracondylar humeral fractures by Shaw et al(37) of which 17 had vascular impairment, all of them had reduction and percutaneous pinning without angiogram preoperatively. Blood flow to the hands was restored without any complications except in 3 that required open exploration. They concluded that pre-reduction angiography adds nothing to the treatment of these injuries. Copley et al (93) used angiogram in 4 of 17 patients with vascular compromise following supracondylar humeral fractures, the course of management in all of these cases were not altered by the angiogram.

If anatomic reduction is not achieved closely in the certain of vascular compromise, open reduction through an anterior approach is advised as this allows evaluation of the vital structures at risk of entrapment between the fragments(94, 95).

J. Nerve injuries

Campbell et al(32) reported the incidence of associated nerve injury to be in the region of 49% of children with supracondylar humeral fractures, but most modern studies put the incidence between 10% and 20%(96, 97). The radial nerve was believed to be the most commonly injured(57, 66, 69, 73, 98), but as Spinner and Schreiber(99) first noted, the anterior interosseous nerve (AIN) appears to be the nerve most commonly injured in the extension type of fracture(60, 89, 99-101). The long flexors of the thumb and index finger are paralyzed in AIN injuries without any sensory loss. Complete injury to the median nerve due to contusion or transection of the nerve at the level of the fracture results in sensory loss in the distribution of the median nerve as well as motor loss of all muscles innervated by the nerve(99, 102). Transection of nerves is uncommon and almost exclusively involves the radial nerve (101, 103-105). Most nerve injuries recover within 6 months.

K. Compartment syndrome

Incidence of compartment syndrome in supracondylar humeral fractures is estimated to be 0.1%-0. 3% (48). Blakemore et al(106) found the prevalence of compartment syndrome to be 9% in patients with supracondylar fractures with associated ipsilateral radial fracture. Flexion of the elbow between 90^0-120^0 increases the forearm pressure and consequently the risk of compartment syndrome as indicated by Battaglia (48) hence the need to immobilize the elbow in a position below 90^0 of flexion.

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L. Pin tract infections

Pin tract infections associated with percutaneous Kirschner wire pinning of fractures in children is estimated to be 0% to 21% (107, 108). That associated with supracondylar humeral fractures ranges from 0%-6.6% (6, 12, 80, 96, 108). In the evaluation of 202 fractures by Battle et al(107) of which 92.5%(187) involved the upper extremity, they reported an 8% infection rate. 12 of the 16 infections needed oral antibiotics and local pin care, one needed antibiotics intravenously and 3 required incision and debridement. Skaggs et al(12) found only one pin track infection in a series of 124 fractures which resolved with antibiotics and removal of pins. Gupta et al(109) found only one pin track infection in their series of 150 patients which also resolved with oral antibiotics and pin removal. In a series of 304 patients using 'semi-sterile' technique, Lobst et al(108) reported no infections even though only 207 patients received antibiotics peri-operatively. From these discussions, it can be deduced that pin tract infections mostly resolve with oral antibiotics and pin removal.

M. Myositis ossificans or Heterotopic Ossification

Myositis ossificans is a rare complication of supracondylar fracture but it does occur.it is usually associated with open reduction, but excessive pre-operative manipulations or physiotherapy is mostly the chief cause (38, 110). This however disappears spontaneously within two years (111, 112).

CHAPTER THREE

III. METHODOLOGY

A. RESEARCH DESIGN

This study was a longitudinal study of supracondylar humeral fractures in the pediatric population at the Orthopedic and Trauma Unit, Department of Surgery of Korle Bu Teaching Hospital.

B. STUDY SITE:

The study was conducted at the Korle-Bu Teaching Hospital's orthopedic unit. The hospital is located in Accra, the capital town of Ghana. It is the largest in the country with a bed capacity of over 2000. Orthopedic and trauma unit is under the surgical department, one of the 17 departments in the hospital. This unit receives referrals from most parts of the country and sees on average about a thousand new cases and about 11,000 follow up cases per year. Participants of this study were recruited from new cases seen at the orthopedic unit.

C. STUDY PERIOD:

This study was conducted over a one-year period between January 2014 and January 2015. The study population was children mainly pre-school and primary school after permissions were asked from the parents or caretakers. On average about 5 cases of supracondylar humeral fractures in children are seen per week at the orthopedic clinic at the Korle Bu teaching Hospital.

D. SAMPLING PROCEDURE

In this study, an evaluation form was used to evaluate the mechanism of injury, classification of supracondylar humeral fractures, the time interval between injury and arrival at Korle-Bu Teaching Hospital for treatment, presence or absence of pin tract infection after treatment in theatre, the method of fracture stabilization and also deformity and loss of elbow movement as per the Flynn's criteria.

The evaluation form was filled by the principal investigator after the surgery and attached it to the folder.

E. RESEARCH INSTRUMENT

An evaluation form was used (see attached data collection instrument).

F. INCLUSION CRITERIA

The inclusion criteria for this study were:

a) Children aged from zero to 13 years

b) Fracture: all types of Supracondylar fracture humerus

c) Consenting parents or guardians of wards with supracondylar humeral fractures

F. EXCLUSION CRITERIA

This study excluded the following:

a) Anesthetically unfit patients.

b) Other associated serious injuries.

c) Fractures treated by traditional bonesetters

d) Fractures that were over three weeks old

H. SAMPLE SIZE DETERMINATION ASSUMPTIONS

Sample size

The literature review of pediatric supracondylar humeral fractures showed a good outcome in 95% of cases, and poor outcome in 5%(113). It was assumed that this study will achieve 80% success rate and 20% poor outcome. Using a simple proportion formula of good outcome of 95% and poor outcome of 5%, using Epi Info version 4.3.1 at the 95% confidence interval, and a power of 90%, a sample size of 79 was obtained.

Accounting for contingencies (loss to follow up, incomplete data), the sample size was increased by 10%. Hence the total sample size was 87.

I. SAMPLING

All consecutive patients who fulfilled the inclusion criteria and presenting to the Accident Centre of the Korle-Bu Teaching Hospital from January 2014 till January 2015 were recruited for this study.

J. STUDY PROCEDURE

i. Type I supracondylar fracture

Patients with Type I supracondylar fractures were placed in a well-padded long arm cast with 60^0 to 70^0 of elbow flexion for 3 weeks. X-rays were obtained at approximately one week to ensure the fracture remains reduced.

ii. Preoperative Plan for Types II and type III fractures

All cases of Gartland type III and types IIb were done using closed reduction and percutaneous pinning method and where there was the need to open the fracture site that was done under General Anesthesia and with the aid of an image intensifier.

iii. Type of Anesthesia

All Surgical procedures were done under General Anesthesia with intubation or sedation when the need arose.

iv. Operative Procedure

Position:

All patients were operated in the supine position.

v. Tourniquet:

There was no need for tourniquet application except in cases that needed open reduction and pinning

Technique:

Under anesthesia and thorough prepping, the patient's fractures were reduced closed with the aid of image intensifier. Traction and counter-traction was applied to the limb in extension followed by flexion of the elbow joint with thumb pressure on

the patient's olecranon. With the aid of the image intensifier, anterior-posterior (AP) correction was obtained followed by correction in the coronal or medial-lateral plain.

After reduction has been achieved on the AP and lateral views, a 1 cm incision was made at the entry sites and the dissection carried to the bone to protect the neurovascular structures. Two (2) Kirschner wires with diameter of 2.0mm or 2.5mm were passed using a protecting sleeve ensuring neurovascular structures are protected. In the end the two pins were made to cross in the proximal fragment. Stress was then applied in varus and valgus under fluoroscopy to make sure the reduction is stable. The two wires were then bent and cut leaving about 2cm outside the skin followed by sterile dressing and above elbow back slab POP splint in 45^0 to 70^0 degree of elbow flexion. The patients were then given collar and cuff and discharged home after 24 hours of observation to exclude the development of compartment syndrome.

J. Postoperative Care and follow up

The pins and or POP slab were removed at 3 weeks and the patient asked to perform active exercises. The patients were subsequently followed up at 3 weeks, 6 weeks and 6 months respectively at which time any complication that arose either from the treatment or the fracture itself, the range of motion of the elbow as well as the carrying angle were measured and documented as per the Flynn's criteria (table II) as well as the Pediatric quality of life documentation.

N. DATA HANDLING/STATISTICS

Data were collected and managed using REDCap electronic data capture tools hosted by University of California, San Francisco (UCSF). REDCap (Research Electronic Data Capture)(114). This is a secure, web based application designed to support data capture for research studies. It provides:

1. An intuitive interface for validated data entry
2. Audit trails for tracking data manipulation and export procedures
3. Automated export procedures for seamless data downloads to common statistical packages and
4. Procedures for importing data from external sources.

The results were analyzed statistically using IBM Statistical Package for Social Sciences version 23.0 (SPSS). For continuous socio-demographic data for like age, gender, mode of transport etc., summary tables of frequencies and percentages were used. The mean and standard deviations were presented where appropriate. Chi-square test was used to compare categorical variables like time of injury to time of presentation to the hospital, marital status of parents and time of presentation to the hospital and educational levels of parents and time of presentation to the hospital. This was done to test associations by finding out if there were any relationships between the categorical variables.

The Flynn's criteria were used for evaluating the physical outcomes of management (Gartland types I, II and III) of the supracondylar fracture of humerus. Measurement of the health related quality of life scores using the pediatric quality of life assessment were done at 3 weeks and 6 months respectively. Test of significance using the paired sample t-test with P-values were also done to find if there were any associations between variables. Assessment of physical functioning, emotional functioning, social functioning and school functioning were done on a scale of 1-5 with 1=almost always, 2=often, 3=sometimes, 4=almost never and 5=never.

Data on gender, age, nationality, school grade of the patient, distance travelled, mode of transportation, marital status of parents or guidance, time of injury, primary reasons for delay in coming to the hospital if any, mechanism of injury, duration of time of injury to theatre for those who needed fixation, the type of fracture and how they were managed, outcome using the Flynn's criteria and the pediatric quality of life at 3 weeks and 6 months post injury were collected and analyzed.

3.4 DISSEMINATION OF RESULTS

The results will be analyzed for submission to:

Ghana College of Physicians and Surgeons

Surgical Research Society

College of Health Science Research Forum

Publications

5 ETHICAL ISSUES

5.1 ETHICAL CONSIDERATION

The proposal was submitted to the Ethical and Protocol Review Committee of the University Of Ghana Medical School for approval.

All respondents consented before participating in the study.

5.2 INFORMED CONSENT

Voluntary written informed consent (Appendix 2) and permission was sought from the parents or guardians of patients before inclusion in the study.

When eligible persons are identified, full explanation of the study was provided. All explanations and consent procedures were be in English and/or local dialect spoken by the particular patient and relatives.

The right to decline inclusion into the program at any time was emphasized without penalty or alteration in the quality of health care provided and risks and benefits of participating.

Consent given was documented on the attached Consent Document Form, and was approved, by the Ethical and Protocol Review Committee of the University of Ghana Medical School.

5.3 CONFIDENTIALITY

The collected data were handled anonymously and confidentially. The questionnaire was collected and handled by the principal investigator only, stored and then secured in a locked file cabinet until data entry only. Database files were accessible to the principal investigator and supervisor only and was password protected.

6 LIMITATIONS

This study was without limitations, these were:

1. Pronation and supination were not measured, as these range of motions are not specifically known to be associated with these injuries.
2. Measurements were done by one orthopedic surgeon hence there could be a possibility of bias in the measurements. However, great steps were taken to prevent or minimize all forms of bias that could affect this study results..
3. Surgery for the children who needed it were done by several orthopedic surgeons instead of one person and this may have influenced the quality of reduction.

CHAPTER FOUR

IV: RESULTS

This study is a prospective review of 101 consecutive pediatric supracondylar humeral fractures admitted to Korle Bu Teaching Hospital. It was done over a year period between January 2014 and January 2015 and managed by a team of 4 orthopedic surgeons and senior residents were evaluated.

Table 4.1 below shows the demographic data of children who participated in this study. The study populations were mainly Ghanaians (98%) and more boys (72%) as compared to girls (28%).The mean age of the patients were 5.2 years (SD 2.3). Eighty percent of the patients were between the ages of 2 to 7 years. The peak incidence was within the 4 to 5 year age group representing 31.7 % of the total.

Almost all of the participants (99%) were in either pre-school or primary school. More than half of our participants (62%) travelled for more than 10km with their main mode of transportation being a taxi (44%) and private transportation (27%). Interestingly only 1% of the participants came in an ambulance while 27% of the parents and caretakers brought the children with their personal vehicles.

Figures 4.1, 4.2 and 4.3 highlights the level of education of the parents of the patients, distance traveled to the hospital and their mode of transportation respectively as depicted in a histogram.

Table 4.1: Demographic data of children

Childs demographics	Frequency	Percentage (%)
Gender		
Male	73	72.3
Female	28	27.7
Age		
0-1	2	2.9
2-3	24	23.8
4-5	32	31.7
6-7	25	24.8
8-9	14	13.9
10-11	4	4.0
Nationality		
Ghanaian	97	98.0
Non-Ghanaian	2	2.0
Patient Grade		
Pre-School	60	59.4
Primary School	40	39.6
Junior High	1	1.0
Distance Travelled		
Less than 5km	17	16.8
5-10 km	21	20.8
More than 10km	63	62.4
Mode of transport		
Taxi	44	44.0
Trotro	11	11.0

On foot	7	7.0
Private transport	27	27.0
Public transport	10	10.0
Ambulance	1	1.0

Figure 4.1. Histogram showing patients level of education.

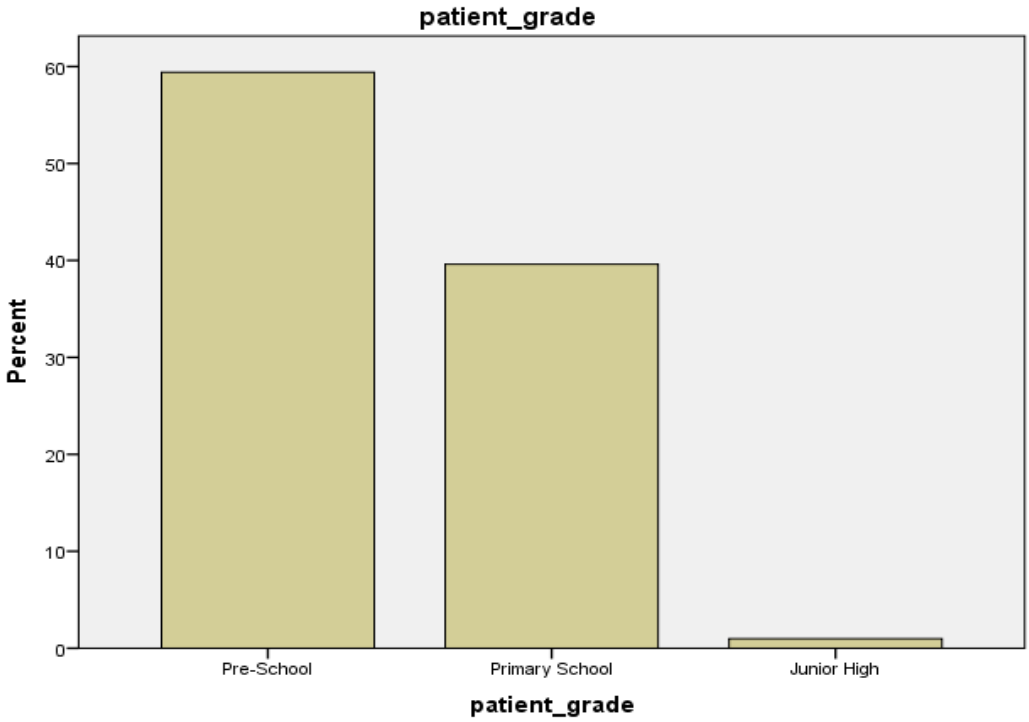


Figure 4.2: Histogram showing distance patients had to travel to the hospital

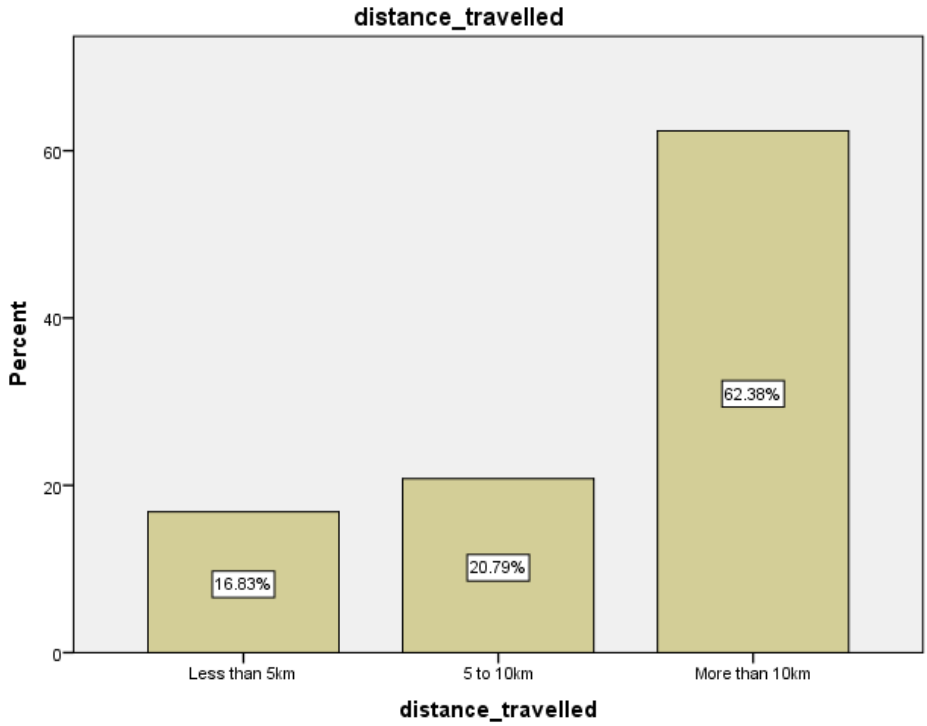
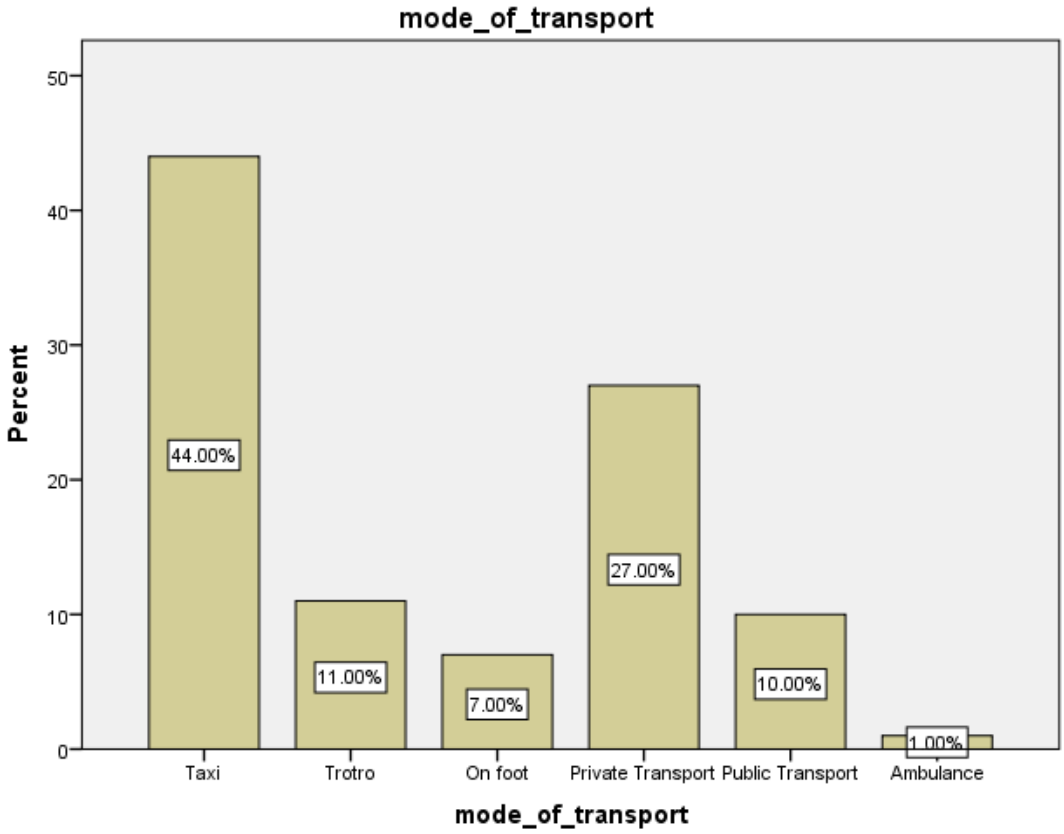


Figure 4.3: Histogram showing the mode of transportation of patients from home to the hospital



Demographics of parents of children who participated in this study

In this study, ninety-three percent of the parents were married. The single parents in this study (7%) were mostly women. (Table 4.2 and Figure 4.4). Majority of the parents or caretakers has had either Junior high or senior high school education (68. %) with less than a quarter of the participants (22%) having had university education. Almost 6% had no form of formal education. (Table 4.2 and Figure 4.5) Ninety-five percent of responders resided in an urban area with the remaining 5 % residing in a rural or urban area. (Table 4.2 and Figure 4.6). These factors are depicted in a bar chart (marital and educational status) and pie chart (area of residence) below.

Table 4.2: Demographic data for parents

Parents demographics	Frequency	Percentage (%)
Marital status of parents		
Married	93	93
Single	7	7
Parental educational level		
Primary	4	4
Junior High	35	34.7
Senior High	34	33.7
University	22	21.8
No education	6	5.9
Area of residence		
Urban	96	95
Rural	5	5

Figure 4.4: Bar chart showing marital status of parents/caretakers of children who participated in study

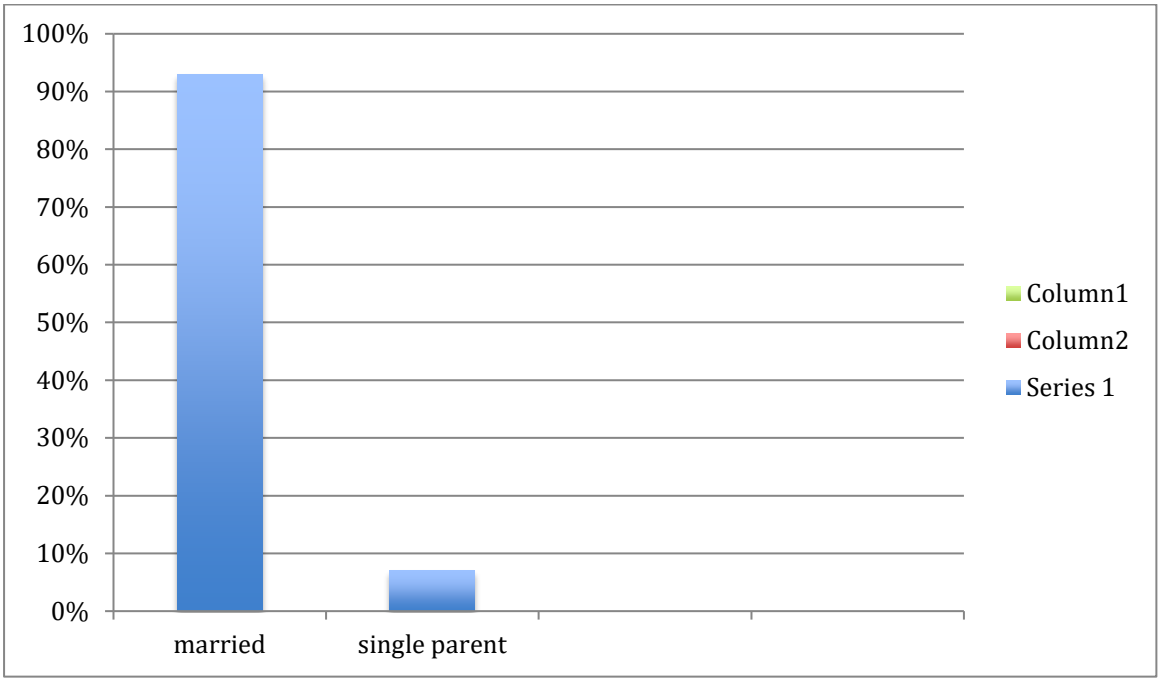


Figure 4.5: Educational background of parents of children who participated in study

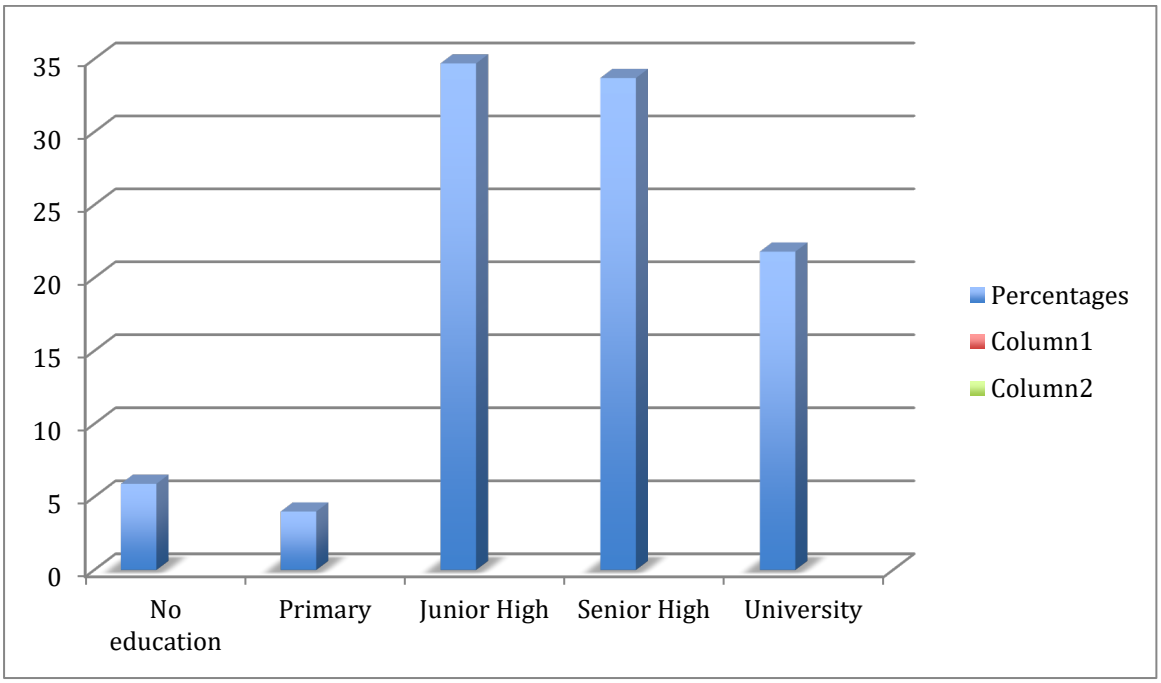
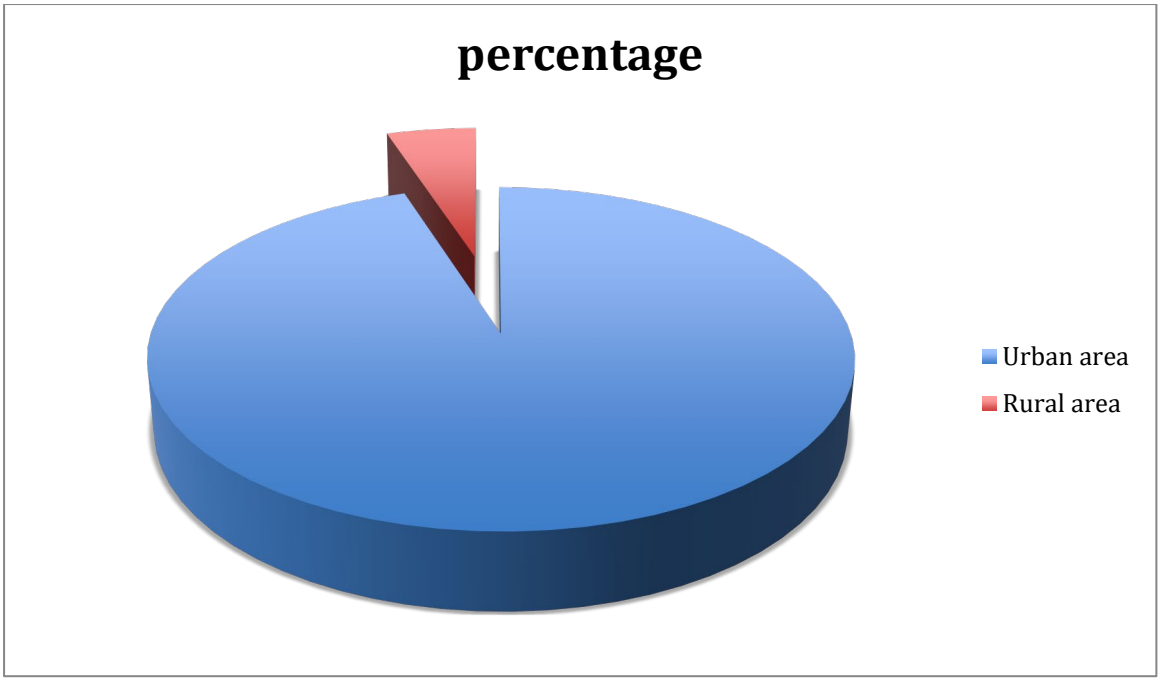


Figure 4.6: Pie chart showing area of residence of parents and children who participated in study



A: Injury characteristics and mechanisms

The time of injury were classified into four groups, these were morning, afternoon, evening and night. It was observed that a significant number of injuries occurred in the afternoon (44%) followed by almost an equal numbers in the morning and evening respectively. The least number of injuries happened at night as shown in Table 4.3 below.

Table 4.3: Time of Injury

Time	Frequency	Percentage (%)
Morning	22	21.8
Afternoon	44	43.6
Evening	25	24.8
Night	10	9.9

B: Location or place where injury occurred

The home environment was where most of the injuries occurred (64%) and was followed by the school environment (27.7%). Eight percent of the remaining patients sustained their injury either at the recreational areas or whilst playing at church.

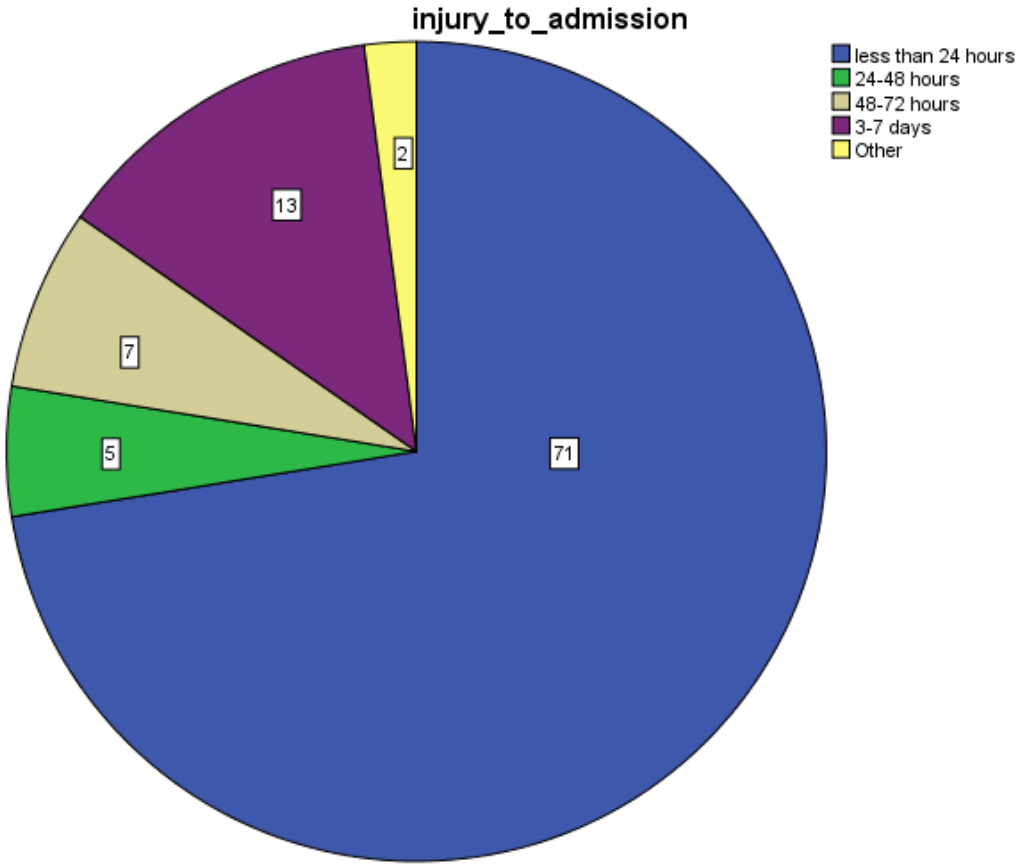
Table 4.4: Place where injuries occurred

Place of injury	Frequency	Percentage frequency
Home	65	64.3
Recreational area	4	4.0
School	28	27.7
Other	4	4.0

C: Time of presentation to the hospital and reasons assigned for delays if there was

Figure 4.7: Pie chart showing time of injury to admission

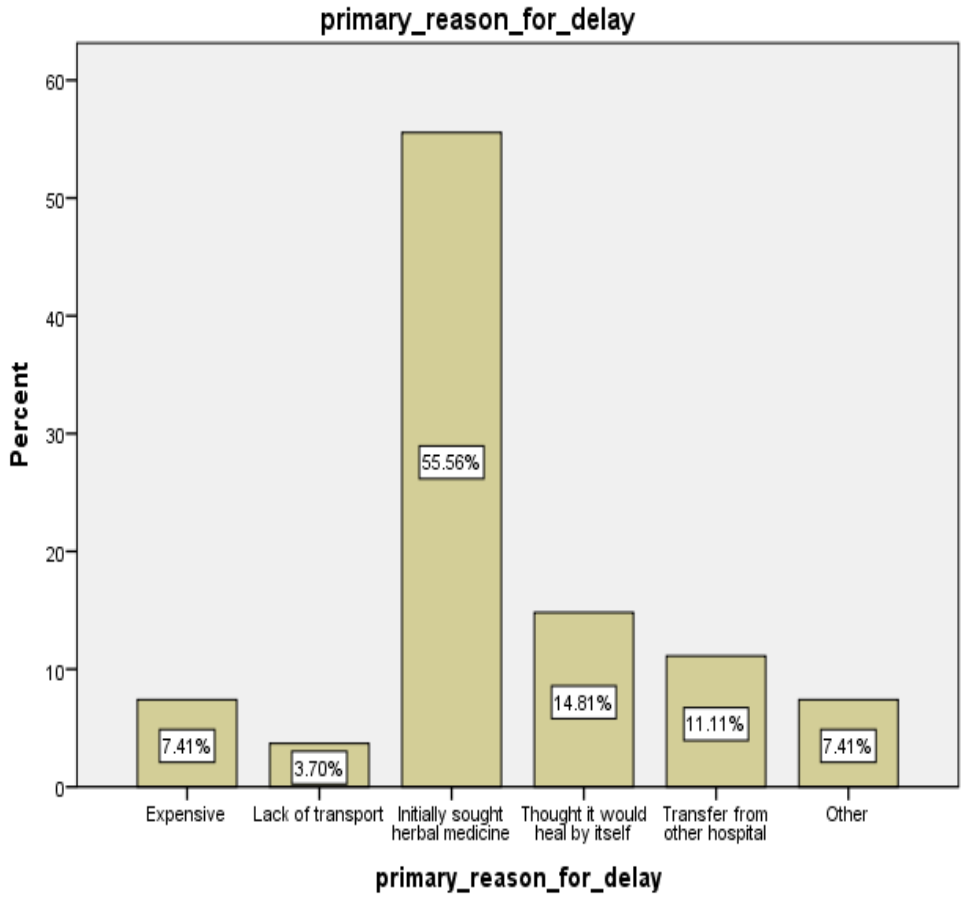
Of the 101 patients with supracondylar humeral fractures seen at our facility, 70.4% presented within the first 24 hours of the injury with the remaining 29.6 presenting after 24 hours following the injury.



D: Reasons assigned for presentation after 24 hours

Of the 29.6% that presented after 24 hours of injury, 55.6% were initially sent to traditional bonesetters especially women who have had twins, . 14.8% of parents thought the injury was not serious and was going to heal on their own whereas 11.1% were transferred from another hospital to our facility. 3.7% did not obtain transportation by virtue of where they stay.

Figure 4.8: Bar chart indicating reasons for late presentation to hospital



E: Mechanism of injury

Table 4.5: Type of supracondylar fractures

Type	Frequency	Percentage (%)
Extension	97	96.0
Flexion	4	4.0

Ninety-six percent% of the injuries were of the extension type of supracondylar fracture with the remaining (4%) being the flexion type.

Figure 4.9: Pie chart indicating the proportion of extension and flexion types of supracondylar humeral fractures

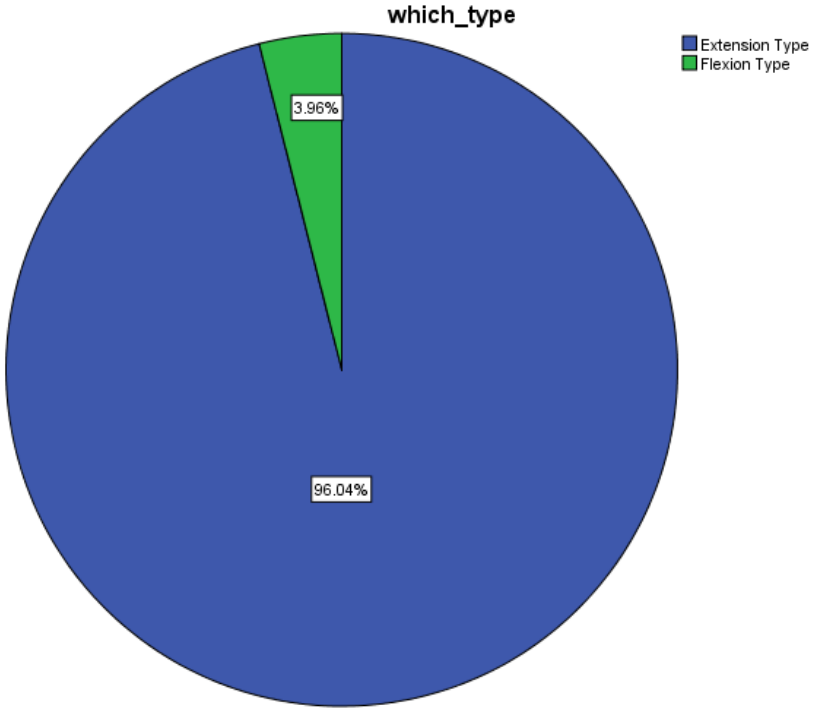
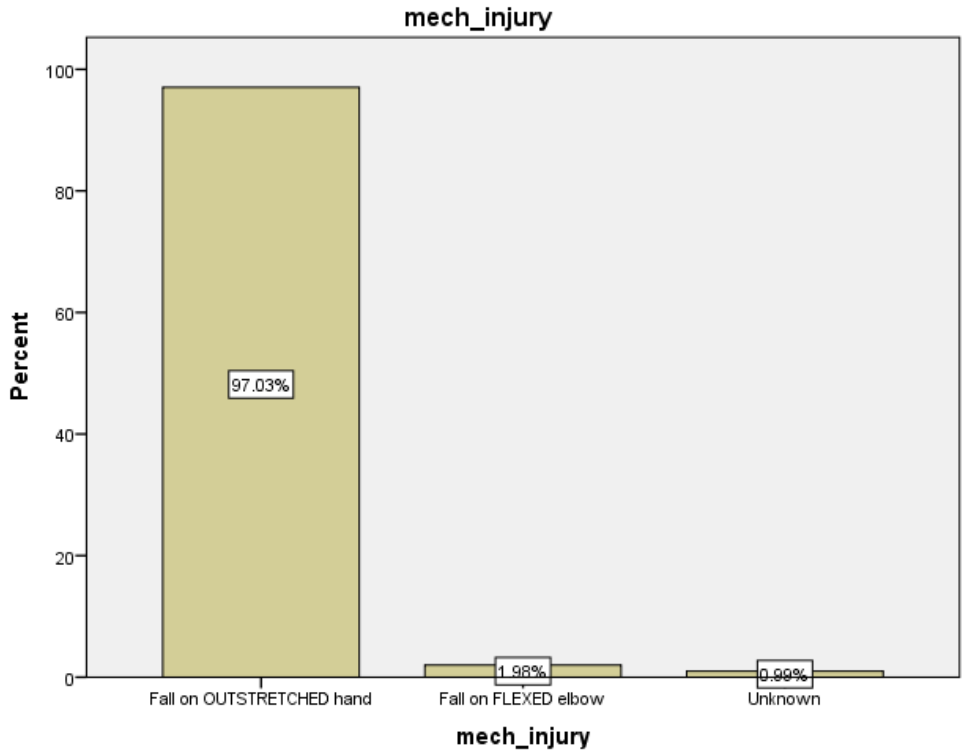


Figure 4.10: Bar chart showing the mechanism of injury

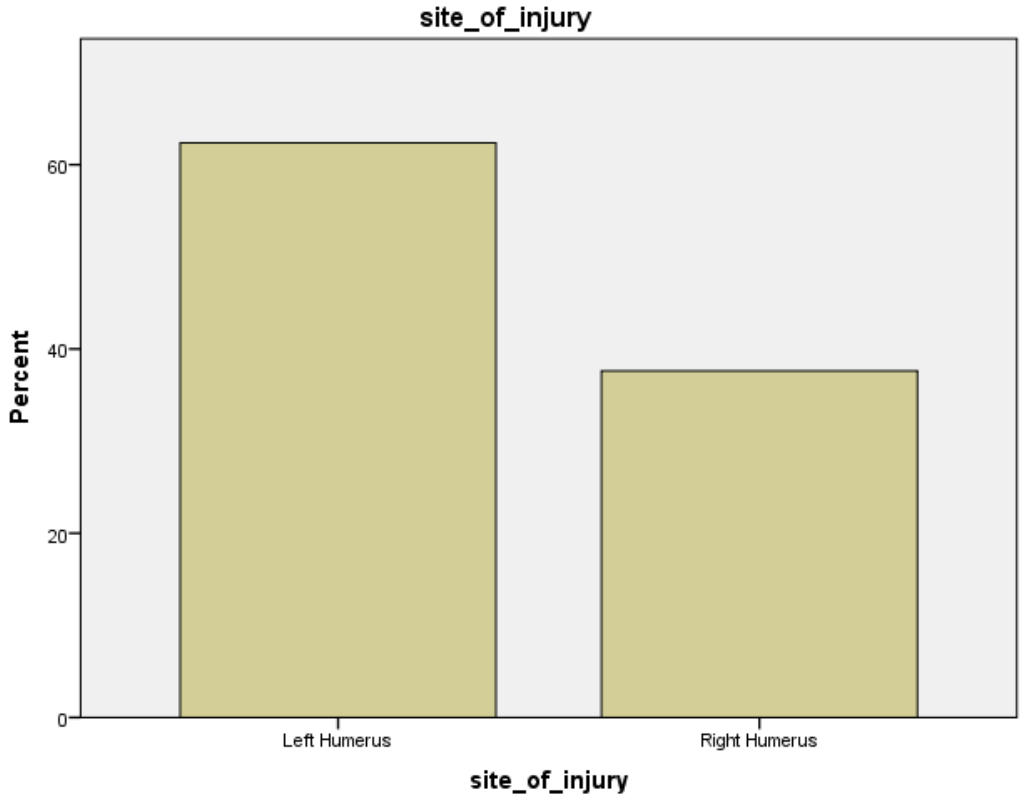


Ninety-seven of the injuries were sustained following a fall on the outstretched hand with the rest sustaining their injuries after falling on the flexed elbow.

F: Arm injured

The left elbow was the most injured (62%) compared to the right elbow (38%). None of the patients however sustained simultaneous injuries to both supracondylar areas of the humerus.

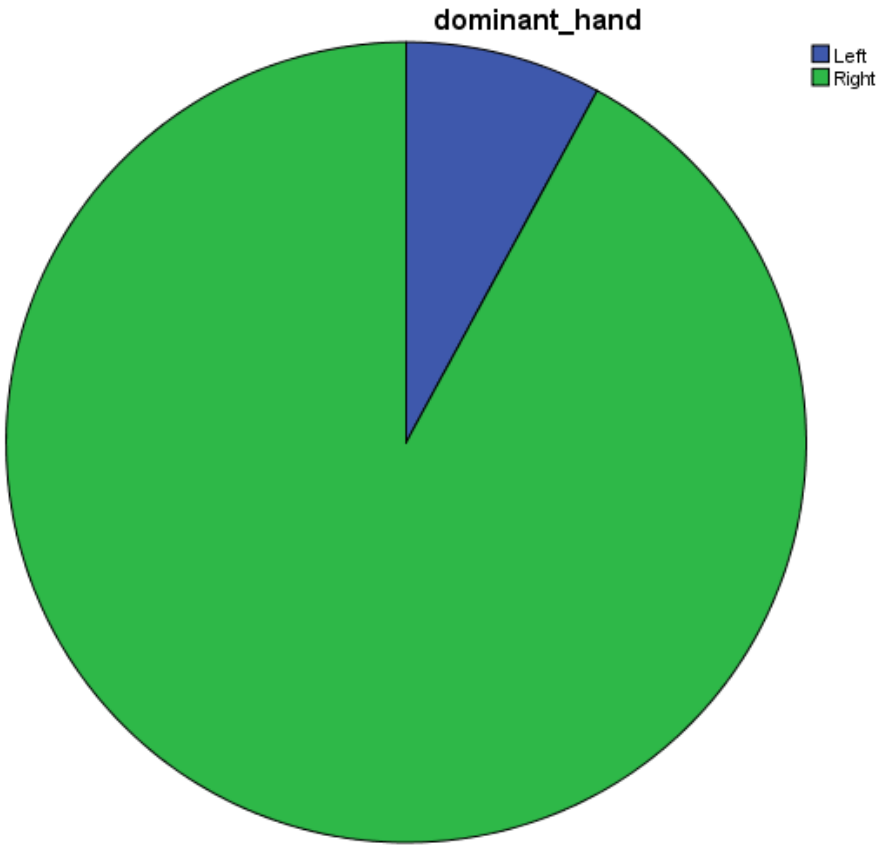
Figure 4.11: bar chart depicting the arms that were injured



G: Dominant hand of patients

As shown below, 92% of the injured patients were right hand dominant compared to 8% who were left hand dominant.

Figure 4.12: Pie chart showing dominant hand of patients



H: TEST OF ASSOCIATIONS

Table 4.6. Distance travelled vs. Time of day patient presented to hospital:

Distance travelled vs. Time patients presented to hospital (Cramer's V)	**<5 km traveled**	**5-10 km traveled**	**>10 km**
Morning	3	3	22
Afternoon	7	11	5
Evening	4	5	25
Night	3	2	10

Cramer's V = 0.33, *P=0.012* (means farther folks had to travel, the more likely they would present to hospital at evening or night)

A multivariate regression analysis was done to find out the effect of distance patients have to travel to hospital and the time of day they presented.

From Table 4.6, distance travelled was a significant predictor of time of day patients presented to the hospital for treatment *(P=0.012).* This meant that the further patients had to travel, the more likely they would present to the hospital in the evening or at night.

Table 4.7: Distance travelled vs. Time patients presented to hospital

Time of Injury vs. Time Patients presented to hospital (Cramer's V)	<5 km traveled	5-10 km	>10 km
<24h	11	15	45
24-48 hours	2	1	2
48-72 hours	1	1	5
3-7 days	3	3	7

Cramer's V = 0.118, *p=0.85* (means no association)

From table 4.7, there was no association between distance patient had to travel and the time from injury to the time they presented to the hospital *(p=0.85).*

Table 4.8: Time of Injury vs. Time patients presented to hospital

Time of Injury vs. Time Patients presented to hospital	*Morning*	*Afternoon*	*Evening*	*Night*
<24h	10	30	21	10
24-48 hours	1	2	2	0
48-72 hours	4	3	1	0
3-7 days	5	7	0	0

Cramer's V = 0.24, *P = 0.065* (no significant association)

A multivariate regression analysis was done to find out whether there was any association between the time of injury and the time patients were brought to the hospital. From the table above, it can be deduced that there was no significant association between these two parameters.

Likewise there was no association between marital status of parents or caretakers and the time the children were brought to hospital following the injury (p=0.78) as can be seen in table 10 below.

Table 4.9: Marital status vs. time of presentation to hospital

Marital Status vs. time patients presented to the hospital	**<24h**	**24-48 hours**	**48-72 hours**	**3-7 days**
Married	64	5	7	12
Single	6	0	0	1

Cramer's V = 0.11, *P=0.78* (no significant association)

Table 4.10: Parental education vs. time patients presented to hospital

Parental Education vs. Time patients presented to hospital	**<24h**	**24-48 hours**	**48-72 hours**	**3-7 hours**
No education	6	0	0	0
Primary	3	1	0	0
Junior High	22	2	2	7
Senior High	26	1	4	2
University	14	1	1	4

Cramer's V = 0.199, *p = -.498* (no significant association)

The educational level of the parents and or caretakers had no significant influence on the time the children were brought to the hospital following injury *(P=0.498)*.

Table 4.11: Duration from time of injury to theatre

Duration	Frequency	Percentage
Less than 6 hours	4	4.0
6-24 hours	29	29.0
24-72 hours	11	11.0
3-7 days	16	16.0
8-14 days	2	2.0
Not applicable	38	38.0

Of the 62 patients with supracondylar humeral fractures who needed to be sent to theatre for either manipulation under anesthesia with or without pinning, 33 representing 53.2% were sent to theatre within the first 24 hours of presentation. Forty-four of patients were operated upon from the second day of admission up to the first week of coming to the hospital.

Table 4.12: Fracture type and percentage distribution

Fracture type	Number of patients	Percentage
Type I	32	31.7
Type II	25	24.7
Type III	44	43.6

Of the 101 patients seen, 32 (31.7%) had Gartland type I supracondylar fractures, 25 (24.7%) were of Gartland type II fractures and 44 representing 43.6% being Gartland type III fractures.

Figure 4.13: Bar chart showing percentages of the various types of supracondylar humeral fractures

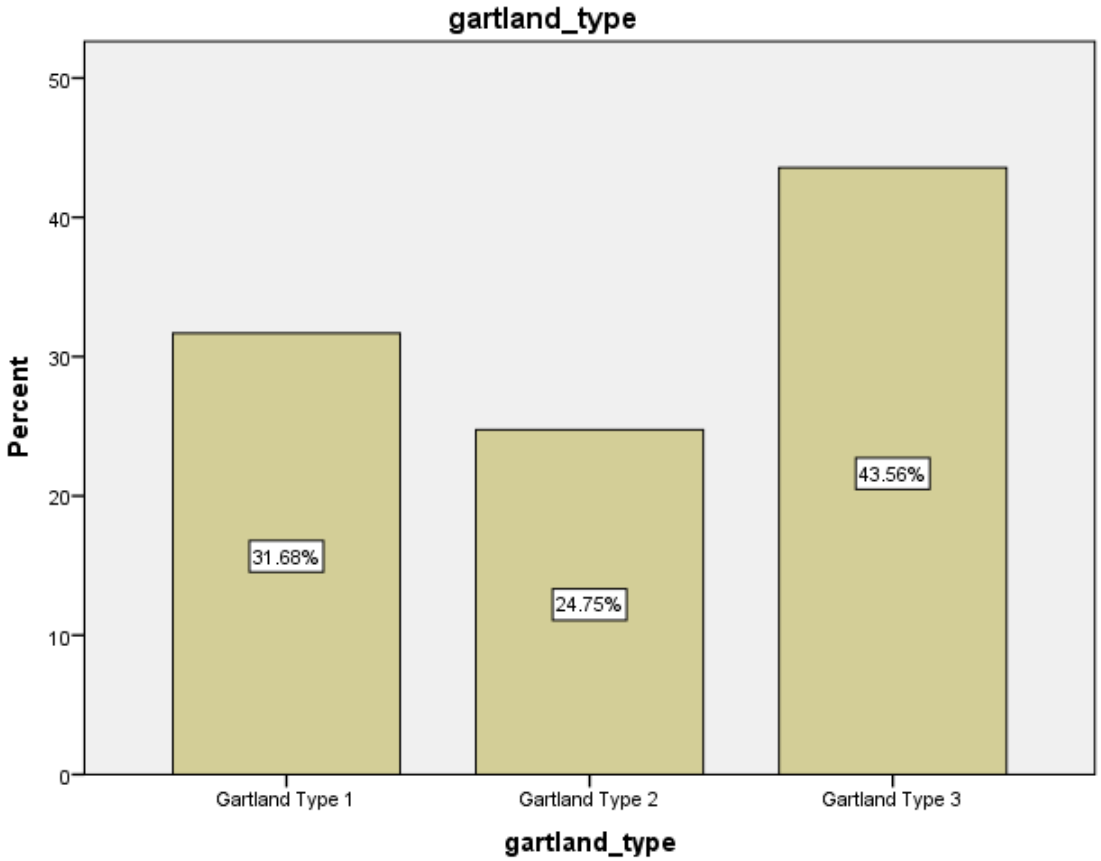


Table 4.13: Method of fracture management

Gartland type	Closed reduction and percutaneous pinning	Open reduction and pinning	Closed manipulation and Plaster of Paris (POP)	POP without manipulation
I	0	0	0	32
II	12	0	11	2
III	42	1	1	0

From table 4.13, all the patients who sustained Gartland type I supracondylar humeral fractures were managed non-operatively using Plaster of Paris without manipulating the fracture.

Half of the patients who sustained Gartland type II fractures were managed using closed reduction and percutaneous pinning using Kirschner wires whereas the remaining half had closed manipulation under anesthesia followed by application of above elbow Plaster of Paris.

Of the 44 patients who sustained Gartland type III supracondylar humeral fractures, 42 of them representing 95.5% were managed by closed reduction and percutaneous pinning. Only 1 patient had open reduction of the fracture and pinning as the image intensifier at the unit was out of service as of the time he presented to the hospital.

Another patient with type III fracture was managed using just Plaster of Paris as she presented after two weeks from the time of injury.

Due to concerns about differences between the fracture types and age and sex of the patients, logistic regression (multivariate analysis) was done to control for the differences seen. The results are as presented in tables 4.16 and 4.17.

Table 4.14: Fracture type and sex

Fracture type vs. sex	Gartland 1	Gartland 2	Gartland 3
Male	20	18	35
Female	12	7	9

Cramer's V = 0.16, p=0.26 (no significant association)

ANOVA

The ANOVA table below shows a significant difference among fracture type and age (type 3 fractures had older patients than type 2 and 1).

Table 4.15: Fracture type and age

32 Gartland type 1, mean age [SD]	25 Gartland type 2, mean age [SD]	44 Gartland type 3, mean age [SD]	F-ratio, [p-value]
4.4 [2.2]	4.6 [1.9]	6.0 [2.43]	5.68 *(P=0.005)*

The multivariate analysis did not show any significant association between fracture type and the sex of patients *(p=0.26)*.

There was however a significant difference (table 4.15) among the fracture types and age (F-ratio=5.68, p-value=0.005). Older patients in this study tended to sustain type III fractures than types II and types I.

I: OUTCOMES OF MANAGEMENT OF SUPRACONDYLAR FRACTURES USING FLYNN'S CRITERIA

Table 4.16: Outcomes of type I fracture using Flynn's criteria

Type I	Excellent	Good	Fair	Poor	Total
Functional assessment	31	1	0	0	32
Cosmetic assessment	32	0	0	0	32

From table 4.16 above, all the type I fractures had excellent or good outcomes for both cosmetic and function using the Flynn's criteria.

Table 4.17: Outcomes of Gartland type II fractures using Flynn's criteria

Type II	Excellent	Good	Fair	Poor	Total
Functional assessment	20	5	0	0	25
Cosmetic assessment	24	1	0	0	25

Of those who sustained Gartland type II fractures, all had excellent or good outcomes for both cosmetic and function using the Flynn's criteria (table 4.17).

Table 4.18: Outcome of type II fractures managed with pinning (CRPP) or manipulation and POP (functional assessment)

Method of treatment	Excellent	Good	Fair	Poor	Total
Pinning (Closed reduction and pinning	8	4			
Manipulation and pop	10	1			

Comparing the functional assessment of type II fractures managed with either closed reduction and percutaneous pinning and those who had manipulation and POP, there was no difference

Table 4.19: Outcomes of type III fractures using Flynn's criteria

Type III	Excellent	Good	Fair	Poor	Total
Functional assessment	37	5	1	1	44
Cosmetic assessment	42	0	2	0	44

Forty-two of the patients with Gartland type III fractures had satisfactory outcome for functional assessment, defined as excellent or good outcomes based on the Flynn's criteria. One had fair outcome and the other had poor functional outcome. Cosmetically, 42 of the 44 patients had satisfactory outcome, two (2) fair and none of the patients had poor outcome.

J: PEDIATRIC QUALITY OF LIFE (PedQOL) ASSESSMENT AS A MEASURE OF OUTCOME OF SUPRACONDYLAR HUMERAL FRACTURES

The health related quality of life (HRQOL) scores were measured using the PedQOL 4.0 generic core for the supracondylar fractures of the humerus at 3 weeks and 6 months respectively.

To determine whether there was a significant difference in the various parameters under the various components at 3 weeks and 6 months respectively, a paired-sample t-test was conducted. The means, standard deviations as well as the p-values are shown in the tables below.

Table 4.20: Pediatric quality of life assessment (3 weeks vs. 6 months)

Physical Functioning of PedQOL

Physical Functioning PQOL Questions (problems with…)	**3 weeks Average Score on the 5-Point Likert Scale (n=97)**	**6 months Average Score on the 5-Point Likert Scale (n=97)**	**P-value (student t-test)**
Walking more than one block	4.91 +/- 0.33	5 +/- 0	0.008
Running	4.78 +/- 0.64	5 +/- 0	0.001
Participating in sports activity or exercise	4.41 +/- 0.95	5 +/- 0	<0.001
Lifting something heavy	2.23 +/- 1.13	4.93 +/- 0.30	<0.001
Taking a bath or shower by himself/herself	1.75 +/- 1.01	4.91 +/- 0.33	<0.001
Doing chores around the house	3.26 +/- 1.36	4.96 +/- 0.17	<0.001
Having hurts or aches	4.47 +/- 0.90	4.99 +/- 0.10	<0.001
Low energy level	4.85 +/- 0.53	5 +/- 0	0.006
Total	3.83 +/- 0.86	4.97 +/- 0.18	<0.001
(Never = 5, Almost Never = 4, Sometimes = 3, Often = 2, Almost Always = 1)			

There was significant difference in all the various parameters under the physical functioning component of the PedQOL between 3 weeks and at 6 months as shown by the various p-values.

Table 4.21: Emotional Functioning of PedQOL

Emotional Functioning PQOL Questions	3 weeks Average Score on the 5-Point Likert Scale (n=97)	6 months Average Score on the 5-Point Likert Scale (n=97)	p-value (student t-test)
Feeling afraid or scared	4.90 +/- 0.44	5 +/- 0	0.03
Feeling sad or blue	4.77 +/- 0.57	4.99 +/- 0.10	<0.001
Feeling angry	4.84 +/- 0.53	4.98 +/- 0.20	0.02
Trouble Sleeping	4.70 +/- 0.72	5 +/- 0	<0.001
Worrying about what will happen to him/her	4.84 +/- 0.51	4.99 +/- 0.10	0.01
Total	4.81 +/- 0.55	4.99 +/- 0.08	0.002

(Never = 5, Almost Never = 4, Sometimes = 3, Often = 2, Almost Always = 1)

There was significant difference in all the various parameters under the emotional functioning component of the PedQOL between 3 weeks and at 6 months as shown by the various p-values.

Table 4. 22: Social Functioning of PedQOL

Social Functioning	3 weeks Average	6 months	p-value (student t-

PQOL Questions	Score on the 5-Point Likert Scale (n=97)	Average Score on the 5-Point Likert Scale (n=97)	test)
Getting along with other children	4.91 +/- 0.52	5 +/- 0	0.09
Other kids not wanting to be his/her friend	4.92 +/- 0.34	5 +/- 0	0.02
Getting teased by other children	4.76 +/- 0.59	5 +/- 0	<0.001
Not able to do things that other children his/her age can do	4.60 +/- 0.69	5 +/- 0	<0.001
Keeping up when playing with other children	4.52 +/- 0.71	5 +/- 0	<0.001
Total	4.74 +/- 0.57	5 +/- 0	<0.001
(Never = 5, Almost Never = 4, Sometimes = 3, Often = 2, Almost Always = 1)			

With the exception of the "children getting along with other children" component (p=0.09) of the social functioning which was not affected by the injury sustained, there was significant difference in all the other parameters under the emotional functioning component of the PedQOL between 3 weeks and at 6 months as shown by the various p-values

Table 4.23: School Functioning of PedQOL

School	3 weeks Average	6 months Average	p-value (student t-

Functioning PQOL Questions	**Score on the 5-Point Likert Scale**	**Score on the 5-Point Likert Scale**	**test)**
Pay attention in class	4.53 +/- 1.01	4.98 +/- 0.14	<0.001
Forgetting things	4.87 +/- 0.42	5 +/- 0	0.003
Keeping up with schoolwork	3.66 +/- 1.14	4.98 +/- 0.14	<0.001
Missing school because of not feeling well	3.14 +/- 1.28	4.97 +/- 0.17	<0.001
Missing school to go to the doctor or hospital	2.79 +/- 0.89	4.94 +/- 0.22	<0.001
Total	3.80 +/- 0.948	4.97 +/- 0.13	<0.001
(Never = 5, Almost Never = 4, Sometimes = 3, Often = 2, Almost Always = 1)			

There was significant difference in all the various parameters under the school functioning component of the PedQOL between 3 weeks and at 6 months as shown by the various p-values.

From the fore going, it could be deduced that the injury had significant effect on the total well-being of the children, however they returned to how well they were doing by 6 months post injury.

K: Complications following supracondylar humeral fractures

Table 4.24: Early complications based on fracture types

Complications	Fracture type			Total
	I	II	III	
Vascular injury			1	1
Nerve injury			3	3
Compartment syndrome				

From table 4.24, there were no documented cases of compartment syndrome during the study period.

There was one case of vascular injury (pink pulseless hand) in a patient with type III supracondylar fracture of the humerus.

Three (3) patients with extension type of supracondylar fracture (type III) sustained nerve injuries. From the study, the most commonly injured nerve was the anterior interosseous nerve (2 patients) followed by a patient with ulnar nerve injury.

L: Late complications of supracondylar fractures

Table 4.25: late complications of supracondylar fractures

Complications	Fracture type			Total
	I	II	III	
Pin tract infection		2	3	5
Cubitus varus			1	1
Elbow stiffness			1	
Myositis ossificans			1	1

M: Pin tract infection

Five (5) patients with either type II or Type III fractures that were pinned developed pin tract infections. However the infections were treated within 3 weeks on antibiotics and pin removal. None of them went on to develop bone infection.

N: Cubitus Varus

One patient out of 101 with type III extension type of fracture developed cubitus varus from malreduction of the fracture as shown below.

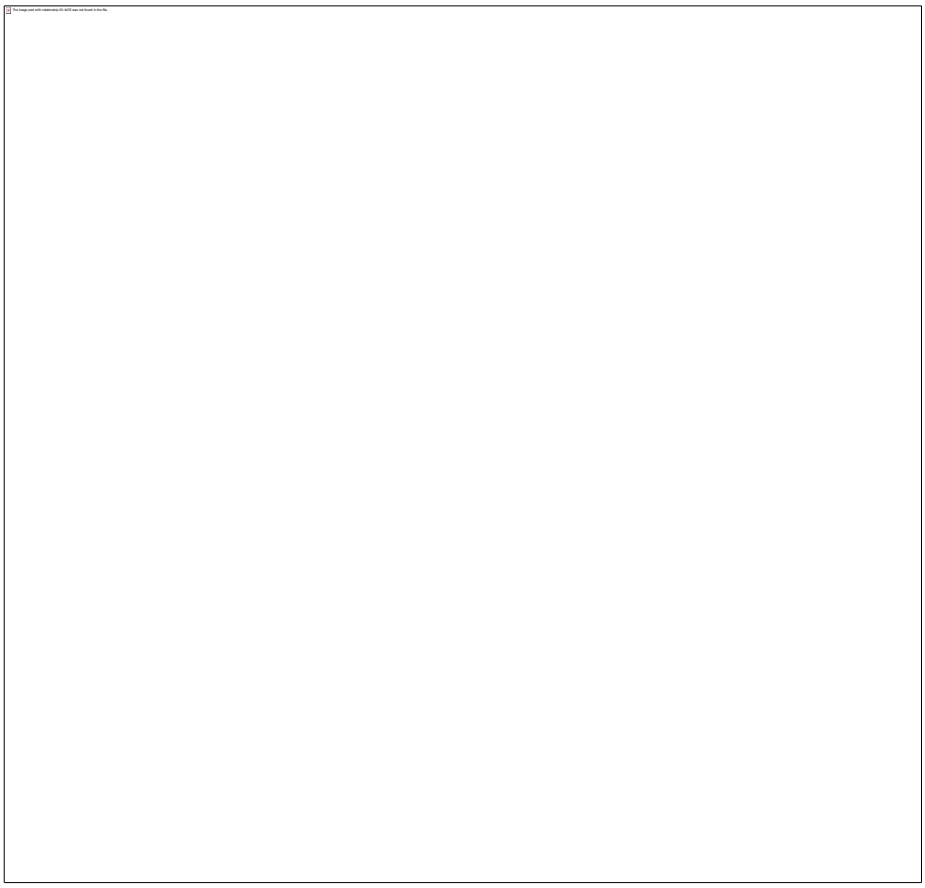


Figure 4.14: Post-operative x-ray of patient from this study who had type III supracondylar fracture showing inadequate reduction initially.

O: Elbow stiffness

One child who sustained type III fractures which underwent closed reduction and percutaneous pinning developed elbow stiffness from prolonged immobilization of the elbow following removal of the pins and POP.

P: Myositis ossificans

A patient who had type III fracture and had open reduction and pinning went on to develop heterotopic ossification on the anterior aspect of the elbow joint as shown in the figure below.

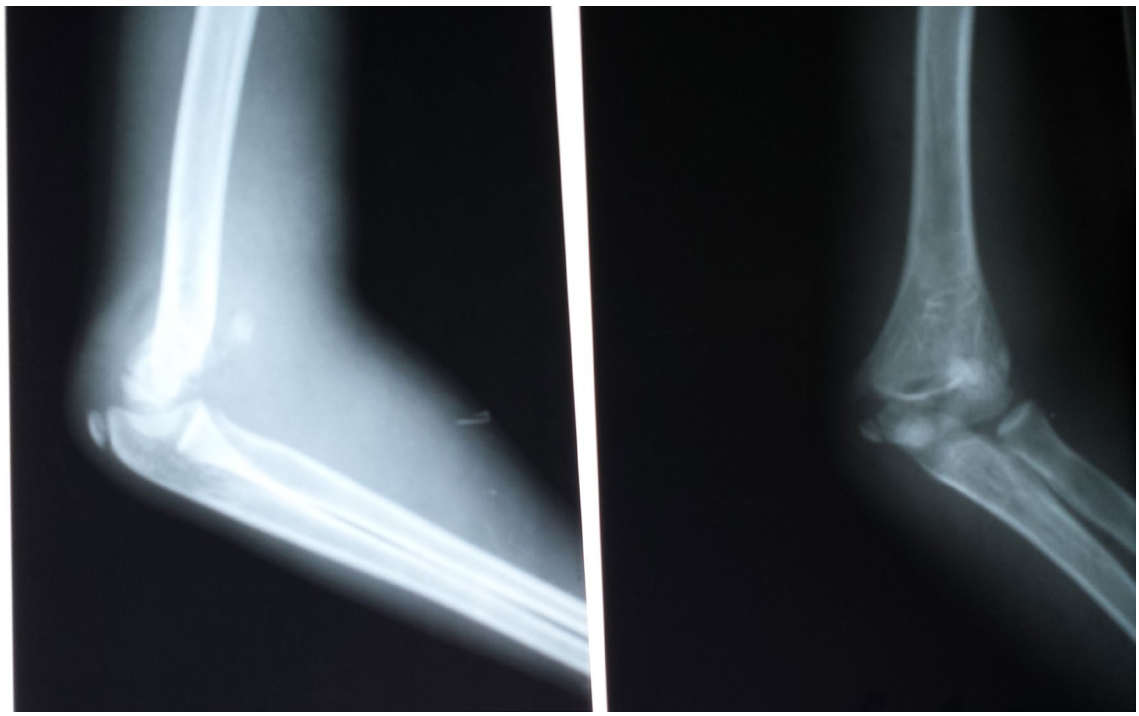


Figure 4.22: X-ray of the elbow of a patient from current study showing heterotopic ossification on the anterior aspect of the elbow.

Q. DISCUSSION OF RESULTS

The purpose of the study was to highlight the treatment, outcome and complication associated with Supracondylar humeral fractures that presented to Korle Bu Teaching Hospital (KBTH).

i. Demographics of patients (Table 4.1)

Over 80% of the injuries occurred in patients between the ages of 2 – 7 years (Mean 5.2 years) with the peak incidence among 4 – 5 year age group. The reason for this high incidence within this age group is probably because, the supracondylar area at this moment is undergoing remodeling and has a thinner and slender cortex due to the presence of olecranon fossa posteriorly and the coronoid fossa anteriorly predisposing it to this kind of fracture.

From the results, the proportion of males was higher (72%) than females (23%) with a ratio of 2.6:1. This probably could be due to the fact that the males seen during this study period were more active and "aggressive".

This findings were consistent with those of Cheng et al (6) and Farnsworth CL et al(115). Gaudeuille et al(116) in their study found 62% of patients with supracondylar humeral fractures to be boys between the ages of 3 – 8 years, further supporting the findings in this study.

Contrary to our findings, Farnsworth CL et al(115) in their study observed the incidence to be higher in females than in males while Weiland et al(117) did not observe any sex predilection in their study.

Ninety-eight percent of patients seen were Ghanaians probably due to the study location with almost all of them (90%) being in either preschool or primary school. Public transportation (55%) made up mainly of taxis and trotro buses were the main mode of transportation to the hospital and this was because the parents and or caretakers did not have their own vehicles. Only 1% of patients seen at Korle Bu Teaching Hospital (KBTH) were brought in an ambulance, perhaps a reflection of our health or ambulance delivery system. Only a few of the parents knew they could call

the national ambulance service to convey the children to the hospital and of those who knew, cost was a deterring factor.

Sixty two percent of patients travelled more than 10km to the hospital (table 4.6) and this was seen as a contributing factor to the time they presented to the hospital following the injuries and this had a significant effect on the time of day they got to the hospital (*P=0.012)*.

ii. Demographics of parents (Table 4.2)

Ninety-three percent of parents or guardians surveyed were married with 68% of them having attained either Junior or senior high school education. 95% of them resided in an urban area. It was found from analysis that neither the marital status (p=0.78) nor the educational level of the parents or guidance (p=0.488) had an effect of the time it took to bring the children to the hospital following their injuries.

iii. Time of injury (Table 4.3)

Forty four (44) percent of the injuries occurred in the afternoon followed by evening, morning and at night respectively. This probably was due to the fact that most of the children were either at home or in school playing around this time. A review of the literature shows this study probably is the first to have made these observations.

iv. Place of injury (Table 4.4)

Most of the injuries were sustained whilst the children were at home (65%) and were followed closely by the school environment (28%).
These findings (home environment) is consistent with the study done in 2014 by Barr L. V. which corroborated the observation that children sustained more supracondylar humeral during school holidays compared to when school was in section(118). Mangwani et al (119) in their study " supracondylar humeral fractures in children, Ten years' experience in a teaching hospital" found 62% of injuries occurring at home, 23% in school and 14% at the playground. The home environments therefore play a significant part in these fractures.

v. Time of presentation and reasons (Figures 4.7, 4.8)

Seventy percent of patients were brought to the hospital within 24hours of injury with the rest coming to hospital after 24hours and up to 14 days of the injury. The chief reason for these delayed presentation were parents sending the kids to the traditional bonesetters (56% of cases that presented after 24 hours). The penchant for traditional herbal application in treating these fractures in the sub region has in some cases lead to permanent disability and even threatened the life of the patients (18).

Some parents also took or take the injured children to women who have had twins as it is believed that they possess the power to treat these fractures. It was noticed from this study that of the five patients who had pin tract infections, four were initially managed with herbs and that probably could account for the high infection rate.

vi. Fracture type and mechanism of injury

The study found most of the fractures to be of the extension type (96%) with 4% been of the flexion type.

This is consistent with the studies done by Cheng JC et al and Mahan ST et al (6, 21) and Otsuka N.Y (120). Of these 97% sustained the injury through fall on the outstretched hand usually from a height whilst playing and this tended to be high in pre-school and early primary school children. Farnsworth et al (7) noticed a similar pattern from their study.

vii. Laterality (site of injury) and dominant hand

It was apparent from this studies that the left limb was the most injured (62%). 92% of patients were however right dominant hand. Several authors (7 – 10) found same in their studies.

Houshians S et al (8) postulated that, only 8 – 15% of the world population is left hand dominant. During a fall on the outstretched hand however, it is this non-dominant hand that hit the ground first and hard as the person tries to break the fall, accounting for above observation.

viii. Duration from time of injury to theatre

Of the 62 patients who need surgery, 33 of them (53%) had surgery done within the first 24hours. The primary reasons were delayed in presenting to our facility. Once at the facility, issues such as: lack of theatre space, image intensifier that has broken down temporarily and chief among them, been parents not having money to pay upfront for the services.

The hospital operates an indirect cash and carry system. From the study however, there was no significant difference in outcome or complications between patients in terms of whether surgery was done within or after 24hours.

This observation is supported by a study by Gupta Neeraj et al (109) "Effect of surgical delay on perioperative complications and need for open reduction in supracondylar humerus fractures in children".

ix. Fracture type and percentage distribution

In this series, 43.6% of the fractures were Gartland type III, 24.7% were type II and the remaining 31.7% were type I fractures. This contrast a study done by Barr(118) that found a higher proportion to be type I fractures (46%) followed by type II (28%) and type III (26%) respectively. It however agrees with the study done by Mangwani et al(119) which found a higher proportion of injuries to be type III (56%), type II were 25% and 19% Gartland type I fractures respectively.

Due to concerns about differences between the fracture types and age and sex of the patients, logistic regression (multivariate analysis) was done to control for the differences seen. The multivariate analysis did not show any significant association between fracture type and the sex of patients (p=0.26).

There was however a significant difference (table 17) among the fracture types and the age of the patient (F-ratio=5.68, p-value=0.005). Older patients in this study tended to sustain type III fractures than types II and types I. These findings are in agreement with the studies done by Mitchelson et al (121) in which they concluded that patients with type III fractures were significantly older than those with types I and II respectively.

x. Methods of fracture management

Non-operative management without and with manipulation is recommended for all type I fractures (5, 50- 52) and some type II fractures (54, 55) respectively.

All our type 1 fractures were managed with cast without manipulation for 3 weeks. Half of type II fractures were managed with cast after manipulation under anesthesia. It must be emphasized however that there is the need to follow up these patient weekly for the first 3 weeks with a weekly X-ray in order to spot any displacement that may occur early.

Fifty (50) percent of type II fracture in our study had closed reduction and percutaneous pinning (CRPP). CRPP is the recommended method of treatment for most type II fractures (12, 17, 56, and 57) as it is safe and reliable at maintaining adequate reduction. Surgeons should not hesitate to reduce and pin type II fractures with the following features.

i) Presence of gross swelling which may interfere with maintenance of reduction
ii) Medial communition with varus angulations on the AP radiograph.
iii) Presence of vascular injury
iv) Fractures which needs excessive flexion of the elbow in order to maintain reduction.

Type III fractures

Closed reduction and percutaneous pinning remains the preferred method of treating type III fractures, as they are inherently unstable and the outcomes are good(120).

Ninety-eight percent of the patients with type III fractures were managed by closed reduction and percutaneous pinning and achieved 95% satisfactory results. Cheng et al (10) achieved 90% good results in the patient's treats by closed reduction and percutaneous pinning.

One (1) patient was treated with open reduction and pinning using an anterior approach and the reason been that our image intensifier was not working at time of presentation.

He developed heterotopic ossification (figure 22). However his outcome was cosmetically excellent and functional fair as per the Flynn's criteria. In the study by Ababneh et al(122), 74% of at their displaced fractures managed with open

reduction and pinning achieved excellent and good results. This method should be employed when there is:

i) Vascular injury

ii) Failure of closed reduction as a result of the fragments button-holing through the brachialis muscle or from interposition of periosteum between the fragments.

iii) When the fracture is opened.

xi. Outcomes using Flynn's criteria

All the patients from this study with types 1 and II fracture had satisfactory outcome (defined as excellent or good using Flynn's criteria) for both function and comesis.

There was no difference in method of managing type II (that is closed reduction and pinning or manipulation P.O.P application) once the right indications are followed. However the advantage of pinning is less review visits within first 3-4 weeks as compared to the P.O.P group, where regular visits is important for detection of any loss of reduction should it occur.

Forty- two (42) patients out of 44 with type III supracondylar fractures (95.5%) had satisfactory outcome, 1 fair and one poor (this patient presented after 3 weeks of injury and was managed conservatively). This confirms the notion that pinning is safe and reliable where indicated (12, 17, 56, 57).

This observation is supported by a study done by Ucar B.Y et al "treatment approaches and outcomes in childhood supracondylar humeral fractures"(123), in which 17.5% of the cases were type II and 82.5% had type III supracondylar humeral fractures respectively, they observed cosmetic results to be excellent in 92.5% and good in 7.5%. Functional results were excellent in 90% and good in 7.5% and 2.5% of patients.

Kahn MA et al (124) found 93.3% excellent and 6.7% good results. None of the patients had fair or poor outcome. This was a study on type III supracondylar humeral fractures.

From the foregoing, the treatment outcome of supracondylar humeral fractures in children based on Flynn's criteria is mostly satisfactory.

R. OUTCOMES BASED ON HEALTH RELATED QUALITY OF LIFE (HRQOL)

The health related quality of life has become an important outcome tool in clinical studies and can give significant insight into the psychological, physical and social impart of some treatment modalities.

Pediatric quality of life (PedQOL) 4.0 generic core scale employed for the purposes of this study has been validated and is a reliable way of assessing health related quality of life in children aged 2 to 18 years of age (125, 126).

There are twenty-three (23) items made up of physical functioning (8 items), emotional functioning (5 items), social functioning (5 items), and school functioning (5 items). Each item is graded using a 5-point Likert scale, which is subsequently changed to a scale of 0 to 100 after it has been reverse scored. A higher score means better outcome.

There are two ways of dealing with or reporting the outcomes:

1. By scoring the various components separately using the mean scores of all the items under that domain.
2. By using the total score of the means of all the domains.

With the exception of the “children getting along with other children” component ($p=0.09$) of the social functioning which was not affected by the injury sustained, there was significant difference in all the other parameters under the domains of the PedQOL between 3 weeks and at 6 months as shown by the various p-values.

From this series, it could be deduced that the injury had significant effect on the total well-being of the children, however they returned to how well they were doing by 6 months post injury.

S. COMPLICATIONS ARISING FROM THE FRACTURE OR ITS MANAGEMENT

i. EARLY COMPLICATIONS

Nerve injury associated with supracondylar humeral fractures in children

Studies report incidence of nerve injury to be between 10-20% (81, 82) with Campbell et al (32) putting the incidence around 49%. The radial nerve is the most injured according to earlier studies (57, 66, 83, 84). However, Spinner and Schreiber (85) noticed that the anterior interosseous nerve (AIN) is the most injured in the extension type of supracondylar humeral fractures. Several other authors (60, 74, 85-87) support this view.

From this study, 3% (3 0f 101) of patients sustained nerve injuries (2 had AIN and 1ulnar injuries). None of the patients in our series had radial nerve injury. It was observed that the patients with these injuries had Gartland type III fractures that were extension type (which are high energy injuries). All the patients however recovered spontaneously within 6 months.

This is supported by the finding by Culp R.W et al (103) and Severijnen R.S et al (127) both of whom noticed that type III fractures (due to the high energy needed to cause them) were most likely to be associated with neurological deficits.

ii. VASCULAR INJURY

One patient with type III extension type fracture had vascular injury (Pink, pulse less), however it resolved spontaneously within hours of closed reduction and percutaneous pinning. The patient was however monitored for forty-eight hours in the hospital to exclude compartment syndrome, which is a complication of vascular injury and the associated sequelae of Volkmann's ischemic contracture.

Incidence of type III fractures with vascular injury from some studies (37, 38, 73, 74) ranges from 10 -20%.

iii. COMPARTMENT SYNDROME

There was no observed or documented incidence of compartment syndrome within the study period. This was not surprising as the incidence of compartment syndrome in supracondylar humeral fractures is estimated to be less than 1% (48)

iv. LATE COMPLICATIONS

Pin site infections

Battle et al and Lobst et al (107, 108) estimated the incidence of pin tract infection following pining of pediatric supracondylar humeral fractures to be 0% to 21%. Which mostly resolved with pin removal and antibiotics.

Five (5) out of 54 patients (9.3%) in our series had pin site infections, which healed within 3 weeks of pin removal and oral antibiotics administration. We did not observe any evidence of bone infection arising from the pin site infections.

Studies from Skaggs et al (12) and Gupta et al (109) supports our management of the pin site infection in this study.

The common observation was that 4 of the 5 patients went for herbal treatment prior to presentation to our facility. Further studies are needed to determine whether there is any association between herbal treatment and pin site infections.

v. Cubitus varus

This complication remains the most frequent angular deformity following supracondylar humeral fractures in the pediatric population (46-48). It is mainly due to malunion (32, 53, 72, 94, and 95) from inadequate reduction and maintenance of the reduction.

One patient out of one hundred and one from this study representing 0.99% developed cubitus varus. The initial injury was an extension type of Gartland type III fracture. This was as a result of mal-reduction of the fractural. In the past, treatment of this deformity was considered cosmetic, however because of complications such as pain, tardy posterolateral instability and risk of lateral condylar fractures, correction through osteotomy is recommended (101-106).

vi. Elbow stiffness

One patient (0.99%) with the type III fracture had elbow stiffness with associated poor outcome using Flynn's criteria at follow up. This was due to prolonged immobilization of the elbow in collar and cuff following removal of the Kirschner wires at 3 weeks.

A study done by Wilson M. Kiraitu (128) found 51.9% of their patients with mainly type III fractures had elbow stiffness at follow up. Similar frequencies of the complication were noticed by Piggott et al (129) and Attenborough(130).

vii. MYOSITIS OSSIFICANS (heterotopic ossification)

Myositis ossificans or heterotopic ossification is a rare complication of supracondylar fractures and usually associated with open reduction, however excessive pre-operative manipulations or physiotherapy may result in the same complication (38, 110). This however disappears spontaneously within 2 years (111, 112).

One patient (0.99%) with type III supracondylar humeral fracture who had open reduction and pinning developed heterotopic ossification (figure 22). His final outcome according to Flynn's criteria was functionally fair and cosmetically excellent.

V. CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Based on these results it can be concluded that:

1. Supracondylar humeral fractures are one of the common pediatric fractures seen at Korle Bu Teaching Hospital.

2. It is more common in males (72.3%) than in females (27.3%) as a result of the males been more active during the peak age of 4 to 5 years from this study.

3. Most of the injuries occurred whilst the children were at home (64.3%) due to falls from heights commonly found at home.

4. The commonest mode of transportation to the hospital was public transport made up mainly of taxis and trotro with ambulance services the least utilized due to lack of knowledge that anybody can summon an ambulance in times of need.

5. Multivariate regression analysis indicated the distance travelled was a significant predictor of the time of day the patient presented to the hospital.

6. The left elbow was the most injured though most of the injured patients were right hand dominant.

7. Gartland type III was the commonest supracondylar humeral fracture seen at our facility followed by type I and type II respectively

8. Outcome of treatment of the various types are satisfactory once the right management protocols are followed.

9. The time from injury to fixation has effect on outcome.

10. The Pediatric quality of life was affected significantly 3 weeks after these injuries and return to the population normal by 6 months.

11. Complications seen were mostly related to type III fractures probably due to the high energy involved.

B. RECOMMENDATIONS

From this study's findings and for the purpose of future practice and implications it will be recommended that:

1. As most of the injuries occurred at home, a monitoring mechanism by parents at home should be encouraged.

2. Parents and caretakers should be educated on the harms from resorting to herbal treatment such as the bonesetters disease

3. Surgery where indicated should be done as it is safe and has a predictable outcome.

4. There is the need for further studies to determine whether there is a significant association between pin site infection and herbal treatment

5. The hospital (Korle Bu Teaching Hospital) should put mechanisms in place where children of parents who cannot pay the cost of treatment will still have the surgery done and the cost recovered subsequently. This is to forestall the delays in treatment and also to discourage the children been taken to herbalist.

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APPENDIX ONE

SUPRACONDYLAR HUMERAL FRACTURE STUDY

SECTION 1 - DEMOGRAPHIC DATA

1. INITIALS……
2. **AGE** ------ 1. 0-4 2. 5-9 3. 10-14
3. **SEX**...1. MALE 2. FEMALE
4. **NATIONALITY** ……1. GHANAIAN 2. NON-GHANAIAN
5. **PATIENT GRADE** ……..1. PRE-SCHOOL 2. PRIMARY SCH

SECTION 2- CAREGIVER SURVEY

NAME OF CAREGIVER…….. …… **PHONE NO**……..

6. **HOW FAR DID YOU TRAVEL TO REACH THE HOSPITAL?** 1. <5km 2. 5-10km 3. >10km
7. **HOW DID YOU GET TO THE HOSPITAL?** 1. PUBLIC TRANSPORT (e.g. taxi, trotro) 2. ON FOOT 3. PRIVATE TRANSPORT
8. **WOULD YOU DESCRIBE YOUR AREA OF RESIDENCE** AS 1. URBAN OR 2. RURAL
9. **ARE YOU MARRIED?** 1. YES 2. NO
10. **LEVEL OF EDUCATION OF PARENT**
    1. PRIMARY 2. JNR HIGH 3. SNR HIGH 4. UNIVERSITY OR HIGHER

11. **STATUS OF EMPLOYMENT**….. 1. UNEMPLOYED 2. ARTISAN 3. PROFESSIONAL

12. **NUMBER OF CHILDREN**….. 1. 1-3 2. 4-6 3. >6

13. **WHAT IS THE APPROXIMATE HOUSEHOLD WEEKLY INCOME**?

1. 0-20GH 2. 20-50GH

3. 50-100GH 4. 100GH PLUS 5. DECLINED TO STATE …… (Reason may be personal)

SECTION 3 – EVENT DATA

14. **TIME OF INJURY**……1. MORNING 2. AFTERNOON 3. EVENING

15. DURATION FROM TIME OF INJURY TO HOSPITAL ADMISSION

1. <24HRS 2. 24-48HRS 3. 48-72HRS 4. 3-7DAYS 5. OTHER……..

16. **IF DURATION FROM TIME OF INJURY TO HOSPITAL ADMISSION IS >24HRS, MARK THE PRIMARY REASON FOR DELAY IN ADMISSION TO HOSPITAL**

1. DISTANCE TO HOSPITAL IS FAR
2. EXPENSIVE
3. LACK OF TRANSPORT
4. INITIALLY SOUGHT HERBAL TREATMENT
5. FEAR OF ATTENDING HOSPITAL
6. OTHER…….

17. MECHANISM OF INJURY (CHECK ONE)

1. .FALL ON OUTSTRETCHED HAND

2. FALL ON FLEXED ELBOW

18. **PLACE WHERE INJURY OCCURRED**

1. HOME
2. RECREATIONAL AREA

3. SCHOOL

4. ROAD/STREET

5. UNKNOWN

19. **DURATION FROM TIME OF INJURY TO THEATRE**

1. <6HOURS

2. 6-24HOURS

3. 24-72HOURS

4. 3-7 DAYS

5. 8-14 DAYS

6. NOT APPLICABLE

20. **IF "NOT APPLICABLE" FROM QUESTION 6, THEN WHAT OPTIONS ARE USED?**

1. POP ONLY 2. POP + COLLAR & CUFF 3. COLLAR + CUFF

SUPRACONDYLAR FRACTURE OF THE HUMERUS

21. **GARTLAND TYPE (TICK ONE)** 1. …… 2… 3…..

22. **WAS THERE A NEUROLOGICAL DEFICIT** 1. YES 2. NO

23. **IF YES, WHAT NERVE** …..

1. AIN

2. RADIAL NERVE

3. ULNAR NERVE

4. MEDIAN NERVE

24. **WAS THERE VASCULAR COMPROMISE?** 1. YES 2. NO

25. **WHICH TYPE**? 1. EXTENSION TYPE 2. FLEXION TYPE

26. **LOCATION OF FRACTURE ANATOMICALLY**

1. LEFT HUMERUS

2. RIGHT HUMERUS

3. BOTH

27. **DOMINANT HAND** … 1. LEFT 2. RIGHT

SECTION 4- INJURY DIAGNOSTIC PROCEDURE

28. **WHICH RADIOLOGICAL INVESTIGATION WAS USED?**

1. X-RAY

2. CT SCAN

3. MRI SCAN

SECTION 5- MANAGEMENT PROFILE

29. **BY WHAT METHOD(S) WILL INJURY DEFINITELY STABILIZE?**

1. BACKSLAB POP

2. K-WIRE

3. OTHER (please state) ……

30. **DURATION BETWEEN HOSPITAL ADMISSION TO DEFINITIVE STABILIZATION**

1. <6HRS

2. 6-24HRS

3. 1-2 DAYS

4. 3-7 DAYS

5. 7-14 DAYS

SECTION 6 FOLLOW-UP INFORMATION (3WEEKS POST OPERATIVELY)

TEAM HANDLING PATIENT – ……

31. **PRESENCE OF PIN TRACT INFECTION?** 1. YES 2. NO

GRADING OF RESULTS

	1ST VISIT		**FINAL VISIT**	
ASSESSMENT / ORIENTATION	**ELBOW FLEXION (IN DEGREES)**	**CARRYING ANGLE (IN DEGREES)**	**ELBOW FLEXION (IN DEGREES)**	**CARRYING ANGLE (IN DEGREES)**
LEFT				
RIGHT				
DIFFERENCE				

	Cosmetic assessment change in carrying angle (degrees)	Functional assessment Loss of motion (degrees)
1.Excellent	0^0-5^0	0^0-5^0
2.Good	5^0-10^0	5^0-10^0
3.Fair	10^0-15^0	10^0-15^0
4.Poor	$>15^0$	$>15^0$

32. **Grading of results according to Flynn's criteria FOR COSMETIC ASSESSMENT (REFER TO ABOVE)**

1. EXCELLENT 2. GOOD 3. FAIR 4. POOR

33. **Grading of results according to Flynn's criteria FOR FUNCTIONAL ASSESSMENT (REFER TO ABOVE)**

1. EXCELLENT 2. GOOD 3. FAIR 4. POOR

APPENDIX TWO

INFORMED CONSENT FORM

Treatment and outcomes of Supracondylar humeral fractures in Korle-Bu Teaching Hospital.

RESEARCH SITE: Orthopedic and Trauma Unit, Of Korle-Bu Teaching Hospital

PRINCIPAL INVESTIGATOR: Dr. Paa Kwesi Baidoo

Telephone number 0206300668

PLACE OF INVESTIGATION: Orthopedic and Trauma Unit, Korle Bu Teaching Hospital

Project title: Treatment and Outcome of supracondylar fractures in Korle-Bu Teaching Hospital.

I…….have been invited to take part in the above mentioned research.

I have been told the purpose of this research study is to find the Treatment and Outcome of supracondylar fractures in Korle-Bu Teaching Hospital.

As part of the study, all persons presenting with supracondylar humeral fracture will be examined.

I have been told the procedure of the study: interview about the mechanism of injury, injury sustained, complete physical examination, radiological and laboratory investigation if necessary will be performed on me.

All these investigations are not harmful but assist in confirming diagnosis and helping in management.

The information from my medical records will be entered in a questionnaire and kept confidential.

Participation in the study is voluntary. If you wish to withdraw at any point you may do so. Your treatment and care will however not alter in any way.

The benefits are: to establish the outcome of treatment of supracondylar humeral fractures and to highlight the challenges we face in the management of supracondylar humeral fractures in Korle-Bu Teaching Hospital. This information will help

clinicians to manage these fractures effectively so as to minimize any possible complications to the patient.

I have been told that this proposal has been reviewed and approved by the University of Ghana Medical School Ethical and Protocol Review Committee.
This is the committee whose job it is to ensure that research participants are protected from harm. If I wish to find out more about this committee, I may contact the chairman of the committee.

CONTACT INFORMATION

If I have any questions I may ask now or later. If I wish to ask questions later I may contact DR PAA KWESI BAIDOO, orthopedics and Trauma Unit, Department of Surgery, Korle Bu Teaching Hospital.

Email address: pakvandal@hotmail.com
Telephone number: +233206300668

CONFIDENTIALITY

All information collected from this research will be kept confidential. The findings of this study may be reported at meetings or in medical journals; your name will not be used in the report.

I have read the foregoing information or it has been translated to me in a language I understand. I have had opportunity to ask questions about it and answers given me are to my satisfaction.

I consent voluntarily to participate as a subject in this study and understand that I have the right to withdraw from the study at any time without it affecting my treatment at the clinic.

Date ……

Signature ……

APPENDIX THREE

ETHICAL CLEARANCE FORM