OUTCOME OF MANAGEMENT OF SUPRACONDYLAR FRACTURES OF HUMERUS IN CHILDREN.

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Abstract

Background:

Supracondylar fracture of humerus in children is very common indeed. Every doctor has some idea of how to manage this injury. Often however, the treatment is inadequate or inappropriate and this occasionally leads to severe complications such as cubitus varus, elbow stiffness and ischaemic contracture formation following compartment syndrome. There are various treatment modalities i.e. casting, traction, percutaneous pinning and open reduction and internal fixation. The treatment modality chosen should be informed and aimed at optimum result.

Objective:

To study the causes, pattern and outcome of management of supracondylar fractures of humerus in children who were treated by the author at The Mombasa hospital between January 2002 to December 2006.

Design: A 5-year prospective study.

Setting: An urban and private practice set up mainly at The Mombasa Hospital Private Clinics, from January 2002 to December 2006.

Subjects: 68 children with supracondylar fractures of humerus (SCFH), aged between 1 and 15 years, were referred to the author from within the environs around Mombasa.

Intervention: Patients were managed conservatively or operatively depending upon the type of fracture. The non-operative approach consisted of application of a cast without any manipulation while the operations were manipulation under anaesthesia (MUA), closed reduction with Percutaneous pining (PCP) or open reduction and internal fixation with K-wires (ORIF). The limb would then be immobilised in a cast for two to six weeks.

Evaluations: Clinical evaluation for neurovascular injury before and after treatment, radiological assessment with plain X-ray films, assessment for duration of morbidity and for deformity if any.

Results: Sixty eight (68) children with SCFH met the inclusion criteria. The children were aged between 1 - 15 years. The peak age for this injury has been found to be between 5 – 7 years (56 %). Fifty nine percent (59%) were boys. According to the Gartland classification twenty six percent (26%) type I, twenty one percent (21%) type II and fifty three percent 53% were type III. Thirty two patients (47%) of patients had cast splintage while 36 (53%) were fixed with K-wires. The commonest complication was elbow stiffness which occurred in fifteen cases (22%).

Conclusion:

Supracondylar fracture of humerus being the most common fracture in children needs proper treatment to prevent complications such as compartment syndrome, neurovascular compromise (Volkman's), elbow stiffness and angulation (cubital varus).

Adequate radiological evaluation for classification is important in order to determine adequate treatment (this may not be easy due to difficulties in interpreting radiographs of a young child as a substantial portion of the elbow consists of unossified cartilage). Casting alone is adequate treatment for Gartland type I fractures, however, displaced fractures (Gartland type II, III) must be adequately reduced before casting, percutaneous pinning (PCP) or open reduction and internal

fixation (ORIF). When complications occur, they should be recognized and adequately treated to avoid permanent disability.

INTRODUCTION

Supracondylar fractures of humerus in children are extremely common. It has been estimated that they account for approximately 65% of all fractures and dislocations in children, constituting the most common paediatric elbow fracture (60%)[1.] The Supracondylar region of the humerus transforms from its tubular form to a flat, thin bone between the coronoid and olecranon fossae of the distal humerus. Consequently, the fracture line angles from an anterior distal point posteriorly and superiorly. The fracture typically remains extra-articular.

The mechanism of injury is commonly a fall on the outstretched hand with the elbow extended. The force is then applied directly to the distal humerus by the tip of the olecranon displacing the distal fragment posteriorly. These so called extension injuries may have the distal fragment angulated, rotated medially or laterally. The lateral rotation is the commoner of the two[2]. Uncommonly, direct force may be applied to the flexed elbow which displaces the distal fragment anteriorly. These are referred to as flexion injuries.

Gartland in 1959[3] classified extension fractures into three types: type I fractures are non-displaced; type II fractures are angulated but not translated in the saggital plane with hinging of the posterior cortex of the humerus; and type III fractures are posteriorly displaced with IIIA being posteromedial and type IIIB being posterolateral.

Improper management of these fractures may result in severe deformity such as cubitus varus, elbow stiffness and compartment syndrome and may even result in the loss of a limb through amputation. Various treatment modalities have evolved over several decades and are still in use depending upon the fracture configuration and the type and quality of facility the child is attending. These treatment modalities include traction, closed reduction and casting, closed reduction and pinning and open reduction with internal fixation.

The purpose of this study is to review the outcome of these modalities as used in management of supracondylar fracture of humerus in children in our setup while comparing the results with published literature.

MATERIALS AND METHODS

This Study was conducted in the author's private clinic at The Mombasa Hospital, Mombasa, Kenya from Jan 2002 to Dec 2006. The patients were mainly referrals from the various hospitals emergency departments and from other facilities within coast province. Data was collected in data sheets predesigned to collect information on all fracture cases attended to and treated. The data on supracondylar fracture of humerus in children was separated and analysed for this study. Children of both sexes, aged between 1 and 15 years, presenting from a few hours to two weeks of injury to the elbow were included in the study. Those children with history of previous manipulations and operations or those with open fractures more than one week old were excluded from the study.

Radiological assessment included anteroposterior (AP), lateral and oblique views of the elbow, as well as radiographs of the joints above and below the elbow. Comparison views of the unaffected elbow were occasionally done to assist in evaluating fracture displacement. Measurements of

Baumann's angle, the humerotrochlear angle, and the medial epicondylar epiphyseal angle (M.E.E), useful in evaluating the fracture displacement1, were not done.

Those children with incomplete fractures (Gartland type 1) but with only slight cortical irregularity or a minor greenstick fracture and minimal swelling had an Armsling applied for two to three weeks. Those children with Gartland type 1 but with significant swelling had a backslab applied for three weeks. Those children with Gartland type II had closed reduction done by manipulation under general anesthesia in emergency operation room and the elbow was immobilized in back slab at 90 - 100^0 of flexion with the forearm in pronation or supination depending on whether the distal fragment was in posteromedial or posterolateral displacement. Some of these children had percutenous pinning (PCP) and a few open reduction and internal fixation (ORIF). Those children with Gartland type IIIA or IIIB had closed PCP if reduction was successful or ORIF. Open reduction and internal fixation was done in those children with precarious or obvious insufficiency of the arterial supply (according to the radial pulse), displaced fractures with complete loss of bone contact or those with marked reduction of anterior angulation on lateral radiograph (usually 45^0) or obvious gross rotational deformity. Postoperative x-ray films of elbow (AP, LAT) were taken with a flexed elbow (Jone's view). Weekly follow up visits were advised for three to four weeks. The stitches were removed where applicable, after seven days. The back slab was removed after three weeks and the pins were removed a week later. The patients were followed up monthly thereafter, until they were discharged from follow-up. At each monthly visit the elbow was assessed for function and deformity if any. This was recorded in the data sheet.

RESULTS

Sixty-eight children with SCFH entered in the data sheet were analyzed for this study.

Figure 1 (below) shows the age distribution. Thirty-eight cases (56%) were aged between 5 and 7 years with a peak age of 6 years (20% of all cases). There were no fractures in children below 2 years.

AGE GROUPS	NO	%
2_3	8	12
4_5	17	25
6_7	22	32
8_9	10	15
10_11	6	9
12_13	5	7
14_15	0	0
TOTAL	68	100

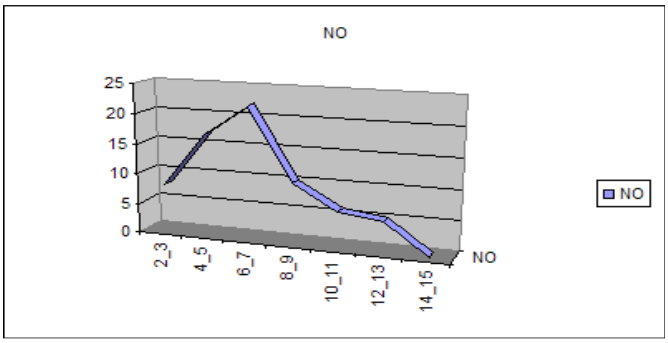


Figure 2 (below) shows the sex distribution within the age groups. Forty children (59%) were boys, giving a male to female ratio of 3:2. Between the 4th and 5th years of life, the girls were the majority to be quickly overtaken by boys. However, after the age of 8 years there is not much difference between the sexes.

AGE GROUPS	MALE	FEMALE	TOTAL NO.
2_3	5	3	8
4_5	7	10	17
6_7	16	6	22
8_9	5	5	10
10_11	4	2	6
12_13	3	2	5
14_15	0	0	0
TOTAL	40	28	68

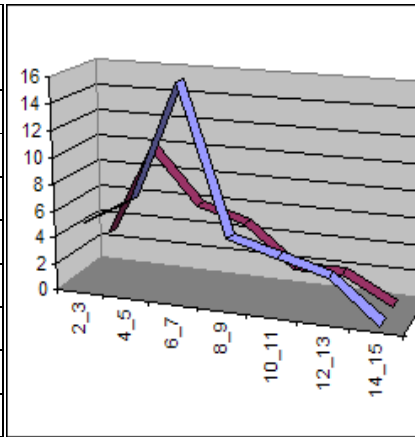
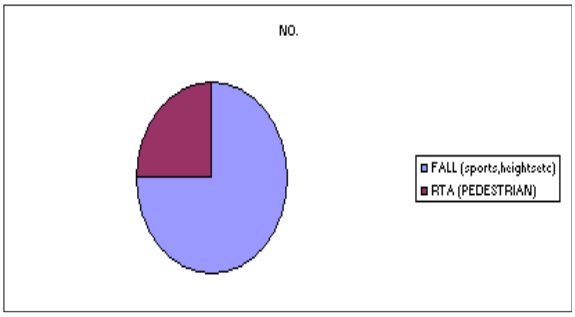


Figure 3 (Below) lists the causes of injury. Seventy five percent (75%) had history of a fall usually from height or on motion during play. Road traffic accident (mainly pedestrian) contributed the remainder. The fractures were also grouped as open or closed, so that sixty one (90%) of the fractures were closed.

CAUSE	NO.	%
FALL	51	75
RTA (PEDESTRIAN)	17	25
TOTAL	68	100



The fractures were further classified according to the Gartland classification as shown in **figures 4 (below**). Eighteen cases (26%) were type I, 14 (21%) were type II and the remaining 36(53%) were type III.

TYPES	NO.	%
Type I	18	26
Type II	14	21
Type III	36	53
Total	68	

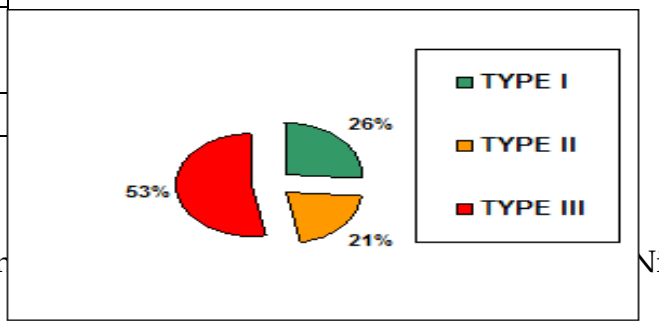


Figure 5 (below) shows the cor Nine of them (13%) had some other injuries, 7 of them being cases of road traffic accidents. Concurrent injuries after a fall were, therefore, rare.

Fracture elsewhere	3
Head injury	2
Facial injuries	2
Frictional burns	1
Multiple injuries	1
TOTAL	9

Figure 6 (below) shows the treatment modality employed as correlated with the fracture type.

	Backslab	MUA	PCP	ORIF	TOTAL
TYPE I	18	0	0	0	18
TYPE II	0	12	2	0	14
TYPE III	0	2	13	21	36
TOTAL	18	14	15	21	68
%	26	21	22	31	100

All the children with type I fractures were splinted with a back slab without any manipulation. Type II and III fractures required closed or open reduction under general anaesthesia. While most of the type II fractures (86%) required only a backslab after manipulation (MUA) the majority of type III fractures (94%) required PCP or ORIF with crossed K-wires. Twenty One of the sixty eight patients (31%) had ORIF with K-wires.

Figure 7 correlates the modality of treatment with the age of the patient. Note that no fixation with K-wires was required in children below 4 years while 13 of the 21 children (62%) aged between 8 and 13 years had ORIF.

AGE GROUP	Backslab	MUA	PCP	ORIF	TOTAL
2_3	5	2	1	0	8
4_5	6	5	4	2	17
6_7	5	4	7	6	22
8_9	2	1	2	5	10
10_11	0	1	1	4	6
12_13	0	1	0	4	5
14_15	0	0	0	0	0
TOTAL	18	14	15	21	68

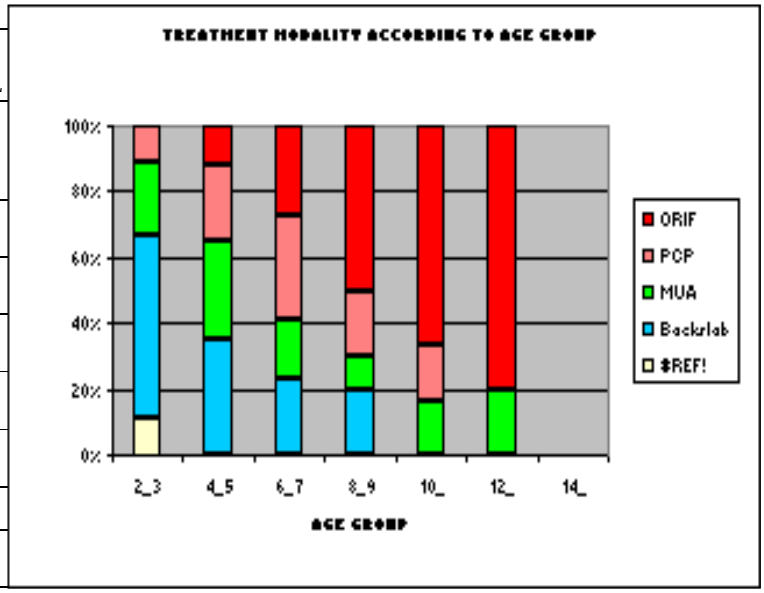


Figure 8 (below) shows the outcome after various modalities of treatment. All the type I fractures had excellent result as opposed to type II fractures which had 79% and type III fractures with 58%, excellent results. Nine percent of the type III fractures had poor results.

	TYPE I	**TYPE II**	**TYPE III**
EXCELLENT (%)	**100**	**79**	**58**
GOOD		**21**	**33**
POOR			**9**
TOTAL CASES	**18**	**14**	**36**

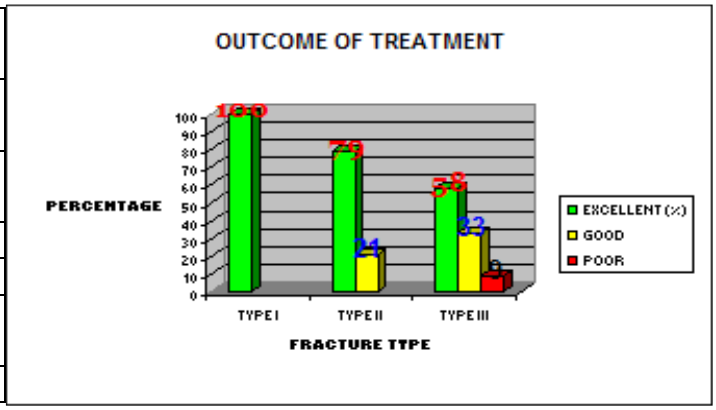
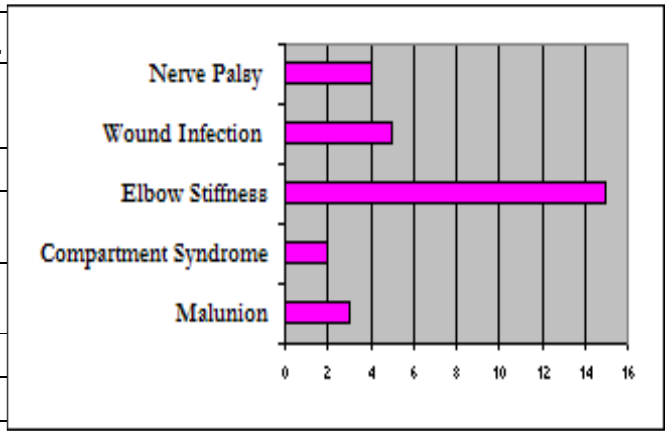


Figure 9 Below shows the complications encountered during the treatment of these fractures. There were 3 cases (2%) of malunion mainly cubitus varus, one each after MUA, PCP and ORIF. In this study 2 children developed compartment syndrome (pain, absent radial pulse, numbness and blistering) necessitating

Type	**Backslab**	**MUA**	**PCP**	**ORIF**	**TOTAL**
Malunion		1	1	1	3
CS*		2			2
Elbow Stiffness			6	9	15
Wound Infection			2	3	5
Nerve Palsy			2	2	4
TOTAL					29



*Compartment Syndrome

Five out of the 36 (14%) operated children developed some form of sepsis postoperatively. Three of these were pin related and two were over the incision **(figure 10)**.

All the infections were superficial and cleared up quickly. Four of the operated patients (11%) developed ulnar nerve palsy. Two were after PCP and the other two were after ORIF for open fractures.

Elbow stiffness occurred in 15 (22%) of the children under study. The severity of this stiffness and the outcome is shown in **figure 11 (below)**, which also shows the outcome of the patients who developed elbow stiffness after one year of follow up.

OUTCOME	NO.	%
Full recovery	9	60
Partial Recovery	4	27
significant deformity	2	13
	15	100

Nine out of 15 patients (60%) recovered full range of elbow movements within 3 months of continued physiotherapy. The remaining six cases required elbow manipulation and continued physiotherapy. Three completely recovered after that while two had extension deficit of more than 30° and one had her elbow stuck at about 90° of flexion (she had been casted for six weeks).

DISCUSSION

Supracondylar fracture of the humerus is common fractures of childhood. In this study, the peak age is 6 years. This compares well with reports published elsewhere. McRae reports a peak incidence at 8 years[2]. Kasser JR et al reported a peak of 6 to 7 years[5] while WendyA.H reported a peak incidence between the ages of 4 and 6 years[3]. In this study the majority of the patients were

boys (59%). Again this compares well with other published reports. Sex incidence in a study within an Asian population showed 74 % were males and 26 % females[6]. Between the ages of 4 to 5 years the incidence between the sexes is the same indicating that the behaviour of the girls and boys in this stage of life is the same. Later on the incidence on the boys increases drastically so that the ratio of male to female becomes 3:2 at the age of 6 years.

The commonest cause of injury is a fall onto an outstretched hand resulting into hyperextension injuries. This is the commonest type of injury as reported in many studies[7,8]. **This** study did not try to find out exactly how the child fell but recorded what the child was doing. Fifty one children (75%) fell down either from a height or while playing. The remaining 17 children were knocked down by a vehicle, motorcycle and other moving objects. Most of these children sustain other injuries. In this study 9 children (13%) had concurrent injuries. Wendy A.H et al reports associated injuries in 7-16% of their cases[5].

As indicated earlier this study did not group the fractures as hyperextension or flexion injuries. However, Gartland classification was used to classify these injuries. The results showed that 18 patients (26%) were type I, 14 patients (21%) were type II and 36 patients (53%) were type III. This compares well with other studies. In their study, Cekanauskas E. et al 70 % (63 patients) of their patients were Gartland type III, type II were 23 (25.5 %), while 04 patients (4.5 %) were type I fracture[9]. Type I fractures may appear to be much fewer than type III, but perhaps this may not be so. A lot of children with type I fractures will not be included in most studies including this one. The reason being that interpreting the radiographs of children's elbows is a challenge as a substantial portion of the elbow consists of unossified cartilage that is not radiographically visible.

This means that a lot of these fractures are not diagnosed and therefore, the children are not readily referred to a surgeon. The surgeons may also not classify correctly for the same reason.

Thirty two patients (47%) were treated by splintage with or without manipulation. The remaining 38 (53%) patients had manipulation followed by fixation with K-wires. Fifteen (22%) of these had percutaneous insertion of K-wires (PCP) while 21 (31%) had open reduction and internal fixation (ORIF). This compares well with the report of Celiker O. etal[6] where in their series of 142 patients only 60 (42%) were operated. Note that in that series 20 (14%) of their patients had traction followed by splintage, perhaps, reducing their operative cases.

The outcome of treatment was very good as expected in type I fractures. Only 79% of type II fractures had an excellent result while 58% of the type III fractures had an excellent result. An excellent result in this study meant lack of any complication.

The rate of compartmental syndrome is higher in those children whose displaced fractures are treated with closed manipulation and casting[10]. In this study, there were two vascular complications in those children treated with casts. These two girls developed compartment syndrome with loss of radial pulse, numbness, swelling and blistering around the elbow. The casts were removed and the limbs were supported by an armsling. In contrast there was no case of compartment pressure in those children treated operatively. In this study, the only other complication was a child who developed varus deformity after casting that required operative correction. Elbow stiffness is more common complication in case of ORIF[10, 11.] This causes prolonged morbidity and in some cases significant deformity. The rate of elbow stiffness in this study was 22% in those patients who were operated with 9 patients (60%) recovering fully while 4 (27%) had partial recovery. Two children had significant deformity due to elbow stiffness.

The other significant complication of ORIF encountered was neuropraxia of the ulnar nerve with 4 children developing ulna nerve palsy. The placement of the medial pin puts the ulna nerve at risk. This has lead to the promotion of the technique of placing two lateral pins[10]. All the pins were placed both medially and laterally (crossed). Two other patients developed cubitus varus despite pinning, indicating inadequate reduction especially of the medial displacement and internal rotation. Cubitus varus has been reported to be the most common complication following supracondylar fractures[10, 11]. Careful verification of reduction intraoperatively is therefore, important to avoid this complication.

CONCLUSION

Supracondylar fracture of humerus being the most common fracture in children needs proper treatment to prevent complications such as compartment syndrome, neurovascular compromise (Volkman's), elbow stiffness and angulation (cubital varus).

Adequate radiological evaluation for classification is important in order to determine adequate treatment (this may not be easy due to difficulties in interpreting radiographs of a young child as a substantial portion of the elbow consists of unossified cartilage). X-ray films, therefore, require to be studied carefully before a decision is made as to the modality of treatment. Casting alone is adequate treatment for Gartland type I supracondylar fractures, however, casting must be carefully done and monitored to avoid compartment syndrome. Displaced fractures (Gartland type II, III) must be adequately reduced before casting, percutaneous pinning (PCP) and during open reduction to avoid malunion. When complications occur, they should be recognized and adequately treated to avoid permanent deformity.

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