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Original Article OPEN ACCESS

Supracondylar Humerus Fracture in Children: A Retrospective Study

Shorif Uz Zaman*[1], A.F.M. Julfikar[2], Md. Nazmul Islam Nissan[3]

Abstract

Introduction: *The most typical kind of distal humeral fracture in children is a supracondylar fracture of the humerus. Depending on the neurovascular injury and Gartland classification, the treatment options are either non-operative or surgical. Which Kirschner pin configuration—crossed pinning or lateral pinning—should be used is still up for debate.* ***Objective:*** *The purpose of our research was to compare the therapeutic outcomes of treating children with cross and lateral pinning for supracondylar humeral fractures.* ***Materials and Methods:*** *Retrospective analysis was done on 80 individuals under the age of 18, who underwent surgery between January 2021 and January 2023 for a supracondylar humeral fracture. For comparison, two treatment modalities—crossed pinning and lateral pinning—were examined.* ***Results:*** *In 66 cases (82.5%) crossed pinning was done, and in 14 patients (17.5%) lateral pinning. During the trauma, the average age was 6.83 years (2–14). When comparing the group treated crosswise to the group treated from the side, there was a substantial increase in the incidence ($p = 0.03$) of current complaints (53% vs. 33% of patients reported problems, respectively). The following parameters were analyzed: the presence of current neurological complications, the degree of satisfaction with the current function of the limb, the Baumann angle of the operated limb, the flexion deficit in the elbow joint of the operated limb, the Flynn criteria, and the Mayo Elbow Score. No significant differences were found between the types of fixation and any of these parameters.* ***Conclusions:*** *There is ongoing debate in the literature regarding the advantages of lateral or crossing pinning for children's supracondylar humeral fractures. Excellent clinical and functional outcomes are produced by both approaches.*

Key words: *Supracondylar fracture, Paediatric orthopaedics, Humerus fracture.*

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***1. Corresponding Author:**
Dr. Shorif Uz Zaman
Senior Consultant (Orthopaedics)
250 Beded General Hospital
Gopalganj, Bangladesh.
Mobile: 01712153478
Email: dr.shorifuzzaman@gmail.com

2. Dr. A.F.M. Julfikar
Senior Consultant (Orthopaedics)
250 Beded General Hospital
Gopalganj, Bangladesh.

3. Dr. Md. Nazmul Islam Nissan
Resident Surgeon(Orthopaedics)
Sheikh Sayera Khatun Medical College Hospital
Gopalgonj, Bangladesh.

Introduction:

The most common distal humerus fracture in children at the moment is the supracondylar fracture. It often happens between the ages of 5 and 7 and accounts for 60% of all elbow fractures and 16% of all pediatric fractures[1]. The literature reports that both boys and girls are equally distributed in the left side, where the bulk of cases occur[2,3]. Flexion and extension fractures can be classified into two categories based on the mechanism of damage. Up to 97% of instances are of the extension type, which is primarily caused by falling on an outstretched hand with the elbow fully extended[2,4]. When there is a suspicion of a supracondylar fracture, an AP (anterior-posterior) and lateral view x-ray should be performed. Because it can identify the type of fracture, this imaging modality is regarded as the "gold standard"[5]. Either operational or non-operative treatment is used in terms of management. Depending on Gartland's classification, one can choose. Broadly speaking, conservative care is typically used to treat undisplaced fractures (with a cast). Closed reduction and percutaneous pinning are used to treat displacement; ultimately, an open reduction may be necessary. Failure of closed reduction, limb vascular compromise, an open fracture, and suspicion of brain damage are among criteria for open reduction[5-8]. Between 5 and 19% of displaced fractures are associated with neurovascular problems. The anterior interosseous nerve, a branch of the median nerve, is the most often reported problem[8]. The brachial artery is the most usually affected vascular damage, and it can be diagnosed angiography or ultrasonography with Doppler mode in addition to a physical examination[9]. One of the rarest but most devastating consequences is compartment syndrome that results in Volkmann's ischemic contracture. A total loss of limb function is the outcome of this contracture[6]. Bone cortical continuity must be restored for appropriate bone union to occur, and this can ultimately result in the restoration of limb function that is physiological[10]. However, there is still space for debate over the ideal pin arrangement. These days, two main methods are employed: lateral pinning with two or three pins, and crossed pinning with two pins. Although the first one is thought to offer more mechanical stability, the addition of a medial pin is considered to increase the risk of ulnar nerve injury. Although the second one is thought to be less stable, it is thought to be safer in terms

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of the incidence of nerve injury[11-14]. There is no clear consensus on which of these two procedures is the gold standard despite several research comparing them in terms of surgical results[15-18].

Materials and Methods:

Eighty paediatric patients with supracondylar humerus fractures who had surgery between January 2021 and January 2023 were included in our study. A self-administered questionnaire was completed by caretakers, and patients were examined during a telephone visit after being searched in a hospital patient database. The patient's age of injury must have been under 18 years old, they must have undergone surgery under general anesthesia with closed repositioning and fracture stabilization by percutaneous Kirschner wire insertion, and they must not have had any prior elbow injuries. These were the inclusion criteria. Other diagnoses, the patient's age at the time of the accident, the use of an alternative fracture stabilization technique (such as open repositioning), and prior elbow injuries in the patient were all considered exclusion factors. A self-administered questionnaire about clinical information, fracture circumstances, perioperatively reported symptoms, recovery time, and an evaluation of their level of satisfaction with present limb function was filled out by the parents of the patients on the day of the study. The Visual Analogue Scale (VAS) was used to measure the respondents' present level of pain. Using a goniometer, the doctor examined the limb's mobility (limb axis, elbow joint extension, flexion, forearm supination, and pronation) and determined the operated limb's neurological status on the day of the evaluation. The Mayo Elbow Score, which takes into account the elbow joint's stability, range of motion, and capacity for performing fundamental everyday tasks, was used to evaluate the patients. In addition, patients were assessed using the Flynn evaluation criteria, which considered both mobility limitations and limb axis changes. Using the postoperative radiographs that were available, the Baumann angle was determined.To find relationships between individual characteristics, clinical data, and the insertion method (crosswise, from the side), statistical analysis was conducted. The statistical analysis was carried out using the SPSS 26.0 software version. A p-value of less than 0.05 was deemed statistically significant in the analysis.

Results:

The study comprised eighty patients with a history of supracondylar humerus fracture. When they were injured, the patients' ages ranged from 2 to 14 years old, with a mean of 6.83. In 40% of instances, the right limb was shattered. The dominant limb in 45.0% of the surgical patients was the fractured limb. Indicating a fall from over own height were 62.0% of the responders. The fracture mechanism in the remaining cases was a fall from their own height. In 83% of patients, crossed K-wires were implanted; in 17%, they were put from the side. The most often selected response (< 2 months) to the question about return to function was 35%. In 8.0% of cases, total loss of function was identified (Tab.I).

Table-I: Recovery time after a supracondylar fracture

Recovery time	<2 months	2-3 months	4-6 months	>6 months	Not fully functioning
Number of patients(%)	35	26	20	11	8

At the time of the study, the average VAS pain score was 0.2 (range: 0-10). 84% of the time, the response that was selected was 0.82% of participants expressed satisfaction, 15% moderate satisfaction, and 3% unhappiness with their present level of limb function. 16% of the participants experienced temporary nerve dysfunction as a result of the injury and surgical intervention; this most frequently affected the median nerve (8% of patients).

Table II: Nerve dysfunction in the course of supracondylar fracture and perioperative intervention

Disturbance of innervation originating from the nerve	Median nerve	Ulnar verve	Radial nerve
Number of patients(%)	8.0	5.0	3.0

After surgery, the disorders associated with selective innervation disappeared in all of the individuals. Volkmann's contracture followed fascial compartment syndrome in one patient as a result of the fracture. Due to the consequences of the fracture, the aforementioned patient had multiple forearm reconstruction procedures. The most frequent result in the Flynn criteria subcategories for axis change and mobility restriction was very good (81.25% and 75% of individuals, respectively) (Tab.III and Tab. IV).

Table III: Following treatment, assessment of elbow joint mobility in both operated and non-operated limbs using Flynn's criteria based on limb axis difference (n = 80).

Result	Very good (0-5)	Good (6-10)	Satisfactory (11-15)	Bad (>15)
Number of patients (%)	65 (81.25%)	13 (16.25%)	1 (1.25%)	1 (1.25%)

Table IV: The assessment of a range of motion (flexion-extension) in the operated and non-operated limb according to Flynn's criteria after the completion of treatment (n = 80).

Result	Very good (0-5)	Good (6-10)	Satisfactory (11-15)	Bad (>15)
Number of patients (%)	60 (75%)	15 (18.75%)	3 (3.75%)	2 (2.5%)

Cubitus varus was observed in 7 (8.75%) patients . The Baumann angle was 72.5 degrees on average. The Mayo Elbow Score turned out to be excellent in 94.7% of the operated patients and good in 4.0%. Patients with a satisfactory score represented only 1.3% of the sample. The kind of fixation was also examined in the patient group, comparing the cross and side approaches with respect to the frequency of current complaints. When comparing the group treated crosswise to the group treated from the side, there was a significant increase in the occurrence of current complaints (p = 0.03) (53% vs. 33% of patients reported

current complaints, respectively). A significant correlation was seen between the number of falls and the season. Trauma patients have more falls from over their own height in the summer. On the other hand, patients with trauma experience fractures from falls with a greater frequency during the spring than during other seasons. There were no relevant differences observed between the type of fixation and the following studied parameters: current VAS pain score, Baumann angle of the operated limb, flexion deficit in the elbow joint of the operated limb, presence of current neurological complications, satisfaction with the current function of the limb, Flynn criteria score, and Mayo Elbow Score. Additionally, there was no discernible difference between the patient's age at the time of the injury and the healing period, or between the patient's age at the time of the accident and the flexion deficit relative to the healthy limb. Gender did not significantly affect Baumann's angle, the suggested recovery time, postoperative neurological problems, or the difference in axis between the healthy and operated limbs.

Discussion:

In order to determine whether surgical approach was best, the retrospective study's data were analyzed and correlated. Specifically, the treatment of supracondylar humerus fractures in children was evaluated and compared using cross- and side-K-wire techniques. Regarding future limb function and patient satisfaction, it is unclear from the studies currently available which patient group will gain more from a specific K-wire design[19,20]. The K-wire cross approach has historically been linked to more neurological side effects, the most common of which is ulnar paresthesia[11].

On the other hand, the side K-wire approach is frequently linked to the fracture's instability[21]. Interestingly, some writers contend that it is impossible to prove the superiority of either approach[22,23]. Due to postoperative patient complaints, statistical analysis of the current study group reveals only one significant association favoring the cross K-wire surgical technique over the side K-wire surgical technique. It should be highlighted that the results may be skewed and that the surgeons' experiences with the two surgical procedures varied significantly because of the small number of study groups and the stark disparity in the two surgical techniques' popularity. According to a meta-analysis by Dekker et al., ulnar nerve injury is the most common type of iatrogenic intra and postoperative neurological consequence seen in humerus fractures, and it usually results in ulnar nerve palsy[11]. According to some sources, injuries to the median nerve are the most frequent[8]. The risk of injuring the median nerve should constantly be on the surgeon's mind. When palsy is identified early enough, ideally during the procedure, it helps to lessen long-term consequences. Kocher et al. compared the outcomes of the percutaneous cross K-wire approach versus the side K-wire technique in 52 patients, and neither group experienced iatrogenic nerve injury[19]. Krusche et al.'s study presents results that are comparable to those of the 36-patient group. The authors document just one instance of iatrogenic radial nerve damage, which resolved on its own without the need for medical assistance[24]. Of the 65 patients in the research group, Green et al. discovered one patient had a postoperative ulnar nerve injury, indicating a 1.5% iatrogenic injury rate[25]. According to our research, just one patient had Volkmann contracture, a serious consequence that was managed with revision procedures that only slightly improved limb function. On the day of the assessment, none of the patients had nerve damage. According to a meta-analysis by Mitchelson et al., contractures are usually regarded as some of the most frequent consequences of pediatric supracondylar fractures and affect 1.1% of patients. Nonetheless, Volkmann ischemic contracture is an uncommon but very challenging to manage side effect of supracondylar humerus fractures[26,27]. After surgery, all but one of the perioperative symptoms, which included transient nerve palsy, neurological symptoms of paraesthesia, and vascular issues that affected around 20% of patients, had either disappeared completely or significantly lessened. According to the authors, between 5 and 14% of patients manifest with neurological problems, while between 7 and 10% have vascular compromise[28-31]. The seasonality of injury following a fall has been observed to differ statistically significantly. There is statistical evidence that falls from one's own height are more common in the spring, while falls from heights above oneself are more common in the summer. Previous research on the seasonality of injury in upper limb fractures, particularly in supracondylar fractures, has shown that summer is the most common season for injuries[32-35]. Furthermore, associations were noted between the age of patients at the time of injury and the variations in the anatomical limb axis, indicating that younger children are more likely than older children to preserve the limb axis. The aforementioned results need to be carefully considered because the study groups had different proportions, and larger cohort studies ought to be conducted. In comparison to an injury of a similar nature in an older child, Auso-Peres et al.'s study demonstrated that a younger age at fracture allows a quicker and less complicated healing process[34].

In a study of 382 pediatric patients, Mitchelson et al. found that older children and those with bigger statures had more severe and complex injuries overall[26]. The authors point out that older children's rapid growth causes a decrease in bone mineral density, which increases the risk of complex fractures[36,37]. If the current study were expanded to a larger cohort of patients with statistically equivalent study groups, bias may be eliminated in subsequent research and, if broken down into smaller age-dependent subgroups, more associations might be found. A noteworthy constraint of the research is that the patients were enrolled freely and required to arrange their own transportation to the examination locations, so excluding certain individuals who lacked access to transportation from rural areas. The study's tertiary center focus means that it could not be entirely representative of the general population, which is another drawback.

Conclusion:

When a child's supracondylar humeral fracture is stabilized percutaneously, good results can be achieved. While perioperative disorders affecting the nerves in the limbs are not uncommon, the functional abnormalities are typically transient and resolve on their own in a matter of months. The functional examination of the upper limb is often more than adequate. Our study only showed statistical significance for the patients' current complaints when comparing the therapy outcomes to the K-wire introduction technique. Very good functional results are obtained with both pinning strategies. The study was constrained by the significant variations in group sizes, which might have affected the significance of the results. There should be additional research done with a larger or more representative sample of patients.

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