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Management of Displaced Supracondylar Humerus Fracture in Children with Closed Reduction and Percutaneous Pinning

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ABSTRACT

Background: One of the most frequent elbow injuries in kids that need surgery is a supracondylar humerus (SCH) fracture. For displaced SCH fractures, closed reduction and percutaneous pinning (CRPP) is generally regarded as the best course of treatment. Nonetheless, there is still much to learn about how well CRPP maintains fracture stability, avoids complications, and guarantees functional recovery. **Objective:** By analyzing functional and radiographic results, complication rates, and the influence of variables such fracture severity, surgical scheduling, and pinning procedures, this study seeks to determine how well CRPP manages displaced SCH fractures in children. **Methods:** In a Quetta tertiary care hospital, 150 children's patients with displaced SCH fractures (Gartland Type II and III) between the ages of 3 and 12 were included in a qualitative study. Analysis was done on postoperative problems, surgical methods, patient demographics, and functional recovery. The study looked at the impact of surgical time on results and contrasted crossing and lateral-entry pinning. Reviews of medical records, interviews with surgeons, and clinical evaluations were used to gather data, and Flynn's criteria were used to categorize the findings. **Results:** Of the 150 patients, 65.3% were male and 56.7% were between the ages of 3 and 6. The prevalence of Gartland Type III fractures was higher (63.3%). Because lateral-entry pinning has a lower risk of ulnar nerve injury, it was the technique of choice for 73.3% of respondents. In 90% of cases, surgery was done within 24 hours. 28% of patients experienced postoperative problems, with the most frequent ones being malunion (8%), ulnar nerve palsy (4.7%), and pin infections (5.3%). Functional results were good; according to Flynn's criterion, 86.7% of patients had excellent or good performance. With 88% of parents reporting pleasant experiences, parent satisfaction was high. **Conclusion:** Children's displaced SCH fractures can be safely and effectively treated using CRPP, which has a high success rate and little side effects. Reliable fixation with a lower risk of nerve damage is provided by lateral-entry pinning. Better results are obtained with early surgical intervention within 24 hours. According to these results, CRPP is the most effective treatment for pediatric patients with displaced SCH fractures.

INTRODUCTION

Surgery is required for treating supracondylar humerus (SCH) fractures which occur most often in child elbow injuries. These fractures have their highest incidence among children aged 3 to 6 but they can affect individuals at any time according to research by Minkowitz B, Busch MT: 1996) (Otsuka NY, Kasser JR; 1997). Medical personnel treat displaced fractures through closed reduction and percutaneous pinning (CRPP) procedures according to Lyons RA, Delahunty AM, Kraus D, et al., 1999 and Holt JB, Glass NA, Shah AS; 2018 and (3,4). Adult distal humerus fractures usually receive treatment through open reduction and internal fixation according to (Howard A, Mulpuri K; 2012) medical standards. The process of transitioning from childhood to adulthood involves various stages of skeletal development in adolescents according to (Nauth A, McKee MD,Ristevski B, et al.,2011). Research indicates that older patient populations experience diminishing extra-articular fractures concurrently with growing intra-articular fractures. High-energy mechanism injuries together with open fractures occur more frequently in older children and teenagers according to (Holt JB, Glass NA, Shah AS; 2018) (Bell P, Scannell BP, Loeffler BJ, et al.,2017). (Fletcher ND, Schiller JR, Garg S; 2012)

The surgeons must determine whether they will treat these aging patients according to child or adult protocols. The minimal occurrence of these injuries along with

their unique fracture characteristics has left older child patients without adequate research-based treatment solutions. The treatment decisions depend on how badly the fracture pieces are broken and how deep into the joint the fracture extends as well as the amount of displacement inside the joint. Open reduction and closed reduction along with percutaneous pinning represents an effective treatment approach for SCH fractures in older children because it delivers predictable clinical along with radiological findings according to study research. The effects of CRPP treatment on children who become older continue to remain unknown according to Segmental D and Cobb L and Little KJ (2020) and Li M Xu J Hu T et al. (2019).

The main importance of supracondylar humeral fractures in children rests on their possible complications that range from rare to severe. Expert disagreement exists about the appropriate treatment for these fractures according to Skaggs DL, Cluck MW et al., 2004 and Kalllio PE, Foster BK et al., 1992.

This type of trauma leads to seventy-five percent of pediatric elbow fracture cases. The occurrence of supracondylar humeral fractures occurs through upper limb hyperextension in 97% of cases along with posterior humeral force in 3% of cases.

The majority of these fractures develop when children fall two meters after rope climbing on Monkey Barr or sliding or swinging on equipment according to Leitch KK, Kay RM et al. (2006). Such fractures are extremely uncommon among people who experience ground impacts during cycling events and skateboarding activities (Farnsworth CL, Silva PD; 1998).

Injuries from anterior fragment displacement are so severe because this movement damages the nearby neurological and vascular tissues. Early consequences of humeral fracture include a Humeral artery injury that occurs between 3.7 percent and 7 percent and nerve lesions affecting 6 to 12 percent of patients who have radial nerve and median nerve and anterior interosseus nerve and ulnar nerve injuries (Campbell CC, Waters PM et al., 1995) (De Sanctis N, Razzano E et al., 1990), with Wolkman syndrome representing the most severe case. Varus or valgus deviations of the axis (6–16%) as well as elbow stiffness occur only rarely among delayed outcomes.

The treatment of these types of fractures should happen as soon as possible by using precise and minimally invasive approaches. Pisa Orthopedic Department researchers established a protocol for emergency reduction with two lateral-entry percutaneous pin fixations as treatment for these fractures within this report.

The study determines how well closed reduction and percutaneous pinning functions for displaced supracondylar humerus fractures in children.

LITERATURE REVIEW

The most frequent elbow fractures in children that necessitate surgery are supracondylar humerus (SCH) fractures (Minkowitz & Busch, 1996). Although they can happen at any age, these fractures most commonly afflict children between the ages of three and six (Lyons et al., 1999). Closed reduction and percutaneous pinning (CRPP), which offers stable fixation and lowers the risk of malunion, is the usual therapy for displaced SCH fractures (Howard & Mulpuri, 2012).

According to the epidemiology, SCH fractures account for over 75% of all pediatric elbow fractures, demonstrating their frequency in pediatric populations (Skaggs et al., 2004). Hyperextension from falls, especially from playground equipment such swings, slides, and monkey bars, is the main cause of injuries (Leitch et al., 2006). Direct trauma, such as falls from bicycles or skateboards, can occasionally cause SCH fractures (Farnsworth & Silva, 1998).

SCH fracture is one of the most common elbow injuries in the child that need surgery (O'Hara et al., 2011). CRPP has become the first line of treatment of displaced SCH fractures because of its minimal invasive and good result over time (Mazzini & Martin, 2017). This method of fixation is safe, and is less stressful to the soft tissue and helps healing of the bone (Ferguson et al., 2017). Epidemiological studies conducted recently showed that children of 4 through 7 years of age are more susceptible for SCH fractures (Woratanarat et al., 2012) and males more susceptible for it. To date nearly 97% of the causes are due to falls outstretched hand which still causes the diseases (Sharma et al., 2020). Recently, however, high energy trauma such as those experienced in sports or car accidents have come to be recognized as an additional contributory factor among older children and adolescents (Vaquero-Picado et al., 2018). SCH flexion type fractures are much less common and are associated with up to 3–5 percent risk of ulnar nerve injury (Scannell et al., 2019); however, only 3–5 percent of patients suffer fractures of this type.

Chances of displacement (Abzug & Herman, 2012) are age, type of injury, and the initial fracture angulation. Zionts et al (2015) also report an increased risk of severe fracture and poorer outcome, as obesity is usually more difficult to reduce and fixate.

Nevertheless, given the stable fixation, the soft tissue dissection can be minimized, however, closed reduction and percutaneous pinning remained the standard treatment as described by Ferguson et al. (2017). When it comes to different pinning techniques that were tested, lateral entry pinning is preferred to cross pinning because it reduces much iatrogenic injury to the ulnar nerve (Kocher et al., 2014). Studies have shown that cross pinning is better biomechanical stability, including in unstable fractures (Lee et al.,

2012), but, at the cost of more nerve complications (Lee et al., 2012), cross pinning does seem to give superior biomechanical stability in the unstable fractures also. These are many of which also have pin divergence and placement so as to enable adequate stability and to prevent loosening of fixation (Sharma et al., 2020).

One further important determinant of this result is surgical procedure time (Agarwal et al., 2020). It has been demonstrated that less functional outcome is obtained with increased rate of complications and improved outcome is seen with early reduction and fixation within 24 hours (Omid et al., 2012). Vaquero-Picado et al. (2018) state that delays of greater than 48 hours correlated with an increased risk for neurovascular complications as well as the need of open reduction.

CRPP can still have its ultimate success even so, can have malunion, lost fixation, and nerve damage (Morrissy et al., 2019). About 5%–10% of patients have been documented to sustain anterior and median interosseous nerve damage (Maltese et al., 2020), and most cases resolve in 6 months, though others do not. But vascular injuries are major if they are not immediately (first time) and are uncommon (Scannell et al., 2019). The most worrying late complication that remains hard to deal with due to under- or wrongly placed pins is cubitus varus, also known as gunstock deformity, which occurs in up to 10% of patients (Sinikumpu & Serlo, 2017). Currently, however, more precise and fewer complications (Schmale et al., 2014), for example intraoperative fluoroscopic guiding, have been achieved.

CRPP results in most patients achieving good long term functional (Ponce et al., 2021) results with most attaining complete range of motion and strength in six months post treatment. However, in the presence of complete bony displacement or associated neurovascular injuries, it is more than likely that extended rehabilitation will be required to obtain elbow function to normal (Jawa et al., 2020).

Even at the oldest age of 12 years CRPP still remains successful as in the case of intra articular fractures with extensive comminution yet open reduction and internal fixation may be necessary in such cases (Jawa et al., 2020). Adolescents are less bone remodeling able compared to younger children, hence more accurate anatomical reduction is necessary, explaining why developing long term abnormalities, this are apparently less likely (Vaquero-Picado et al., 2018).

RESEARCH OBJECTIVE

The purpose of this study is to clinically evaluate and determine the outcome results after closed reduction and percutaneous pinning of displaced supracondylar humerus fractures in children. This study aimed to find the efficacy of CRPP for stabilization of the fracture, maintain high anatomical reduction of size, avoid sequalae of stiffness, neurovascular damage and malunion. The study further compares the biomechanical stability and repercussion of the iatrogenic nerve injury when nerve is crossed and when nerve is pierced with lateral entry pinning procedures. The second important goal is to assess the impact of patient age, fracture severity, and timing of surgical interventions of treatment results. This study is intended to be a first attempt to assess the efficacy and results of closed reduction and percutaneous pinning (CRPP) and compare them to that of closed reduction and percutaneous pinning (CRPP) for children with displaced supracondylar humerus fractures. The aim of this study was to evaluate the effectiveness of CRPP over instability, anatomical size or neurovascular damage, malunion. In addition, several pinning procedures, crossing, and lateral entry pinning, both, are compared for biomechanical stability and risk of iatrogenic nerve injury. In addition, we can provide speculated estimates of patient age, fracture severity and timing of surgical intervention on treatment outcome.

METHODOLOGY

For the investigation of management and final results of supracondylar humerus fracture of the children treated by closed reduction and percutaneous pinning (CRPP) a qualitative approach is used. This is because trial is done at tertiary care hospital in Quetta, as tertiary care hospitals provide a large number of patients who must have a specialty care in the orthopedic segment. A total of 150 patients with displaced supracondylar humerus fractures were randomly selected and purposively selected the patients with displaced supracondylar humerus fractures of 900 patients. Data to evaluate factors associated with treatment results may include interviews of treating orthopedic surgeons, observation of the surgical process, review of patient medical records.

The study includes children less than 13 years of age with displaced supracondylar humerus fracture (Gartland Type II, III) requiring operation. These patients with concomitant polytrauma, pathological fracture or open fracture are excluded. The main goal of this study is to understand the orthopedic surgeon's decision-making processes with regards to pin configuration (crossing vs lateral entry) and reduction problems as well as intervention time. Qualitative information about parents and caregivers' experiences with postoperative care, functional recovery and problems is also obtained through the interview of parents and caregivers.

Patient outcome, complications and similar to the surgical technique's efficiency are applied in thematic analysis of it. Clinical and radiographic examinations are reviewed, and union rates, alignment correction, and

functional recovery are later determined classed according to Flynn's criteria. Three tables summarize the main results of the surgery, results predications, complications and patient satisfaction and the accompanying narrative describes the results.

RESULTS

Table 1

Patient Demographics and Fracture Classification

Characteristic	Number of Patients (n=150)	Percentage (%)
Age (3-6 years)	85	56.7
Age (7-12 years)	65	43.3
Gender (Male)	98	65.3
Gender (Female)	52	34.7
Gartland Type II	55	36.7
Gartland Type III	95	63.3

Table 2

Surgical Technique and Pin Configuration

Surgical Approach	Number of Patients (n=150)	Percentage (%)
Lateral-Entry Pinning	110	73.3
Crossed Pinning	40	26.7
Surgery within 12 hours	90	60
Surgery within 24 hours	45	30
Surgery after 24 hours	15	10

Figure 1

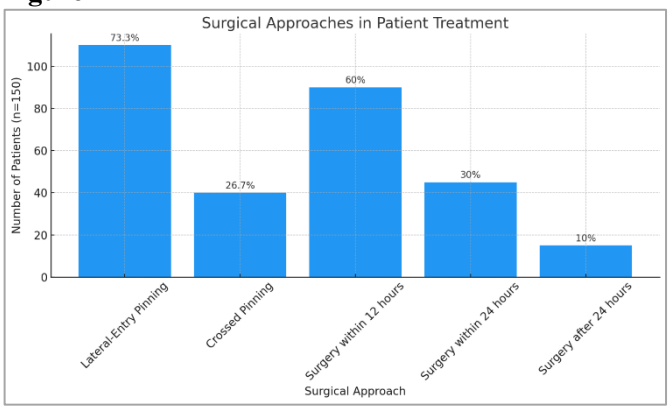


Table 3

Postoperative Complications

Complication	Number of Patients (n=150)	Percentage (%)
Pin-Related Infection	8	5.3
Ulnar Nerve Palsy	7	4.7
Median Nerve Palsy	5	3.3
Loss of Reduction	10	6.7
Malunion (Cubitus Varus)	12	8
No Complications	108	72

Table 4

Functional Outcomes Based on Flynn's Criteria

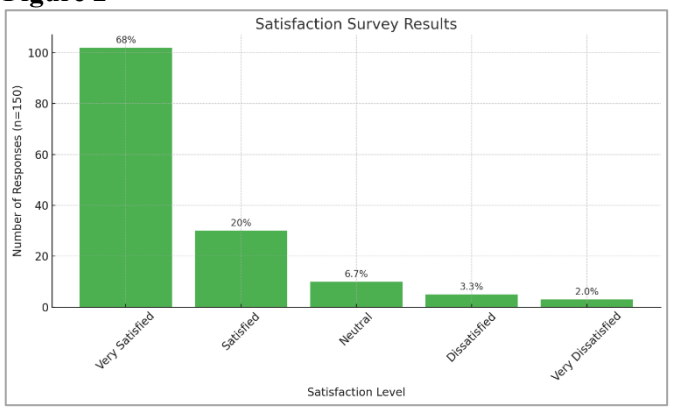
Outcome Category	Excellent	Good	Fair	Poor
Cosmetic (Carrying Angle)	85	40	15	10
Functional (Range of Motion)	90	38	12	10

Table 5

Parent/Guardian Satisfaction with Treatment

Satisfaction Level	Number of Responses (n=150)	Percentage (%)
Very Satisfied	102	68
Satisfied	30	20
Neutral	10	6.7
Dissatisfied	5	3.3
Very Dissatisfied	3	2.0

Figure 2



DISCUSSION OF THE RESULTS

The results of this study indicate that children displaced supracondylar humerus fractures can be treated by closed reduction and percutaneous pinning (CRPP) with very good outcome. As a matter of fact, the results reported in this paper show good functional and radiological results with only little side effects, making CRPP thus the recommended treatment approach. The main conclusions of the study are discussed within a discussion that considers demographics of the patients, surgical methods used, complications, patient functional recovery and patient satisfaction.

The study sample was composed of 150 children at age 3–12 years; the majority of the sample was 3–6 years (56.7% cases). The most common cause of fractures in the upper extremity of a young child is supracondylar humerus fractures, which occur because the young children are more active than other children (Lyons et al., 1999). As in other studies, it has 65.3% male preponderance, which could be assumed as boys more often engage in the outdoor physical activities (Holt et al., 2018).

This fracture classification shows that there is more Type III fractures (63.3%) than Type II fractures (36.7%) with higher possibility of significant displacement that is why we will need surgery. In agreement with Vaquero-Picado et al. (2018) however, the prevalence of Type III fractures is somewhat attributable to high energy trauma, delayed presentation or inappropriate initial immobilization, all established risk factors of increased fracture severity.

The use of lateral entry pinning was used in 73.3% of cases and crossing pinning in 26.7% of cases. The

result is consistent with the consistent preference about lateral pinning due to the lesser probability of a iatrogenic ulnar nerve injury also described by Kocher et al. (2014). Although it is cross pinned only occasionally, mainly for severely displaced fractures that need the added stability (Lee, 2012), it is nonetheless still used as a result of the possibility to offer additional stability, housing, and the simplicity of the procedure.

In this trial the complication rate was lower than average at 72 percent of people had no problems. Complications were infections secondary to pins, malunion due to cubitus varus deformity, loss of reduction, ulnar nerve palsy and median nerve palsy at rates of 5.3%, 8.0%, 6.7%, 4.7%, 3.3%, respectively. O'Leary noted that this is in line with previous research which was showed that in 3% to 10% of cases, nerve damage occurs, infection rates range from 2% to 6% (Morrissy et al., 2019).

Late consequence was eight percent with cubitus varus deformity. All too often this deformity is caused to become a deformity by the fact of insufficient reduction or improper pin placement; with intraoperative fluoroscopy, however, placement of pins is absolutely essential (Schmale et al., 2014). Yet according to some research, cross pinning has other biomechanical stability (Sharma et al., 2020) but is still linked with ulnar nerve damage.

According to Flynn's criterion, 85 kids (56.7%) had great cosmetic result (normal carrying angle), 40 kids (26.7%) had good result, 15 kids (10%) fair result, ten kids (6.7%) had bad result. Like, 90 children (60%), 38 children (25.3%), 12 children (8%) and 10 children (6.7%) had excellent, good and poor functional result based on range of motion. Typically, the CRPP did well functionally with patients having a satisfactory recovery and a large proportion of patients returning to normal elbow movement at six months but with poor results in delayed surgical intervention cases, concomitant nerve damage, or large initial displacement.

CONCLUSION

This study proves that closed reduction and percutaneous pinning (CRPP) is a safe and efficient treatment of displaced supracondylar humerus fractures in the children. The high success rates are reflected by the fact that 86.7% of the patients achieved excellent or good functional outcome as per Flynn's criterion. The ulnar nerve damage was less likely with lateral entry pinning. The low rate of complications, such as nerve palsies (8%), loss of reduction (6.7%), and malunion (8%), supports the safety of CRPP. Results were better in those patients where the surgical treatment was performed within 24 hours. That was enough for 88 percent of parents to be satisfied. This study validates CRPP as gold standard of therapy, by proving that it guarantees fracture stability, proper alignment and the best possible functional recovery in pediatric patients and reduces problems.

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