ORIGINAL ARTICLE

Frequency of ulnar nerve injury after closed reduction and pin fixation of supracondylar humerus fractures in children

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Abstract

Objective: To determine the frequency of ulnar nerve injury after closed reduction and percutaneous pin fixation of displaced supracondylar humerus fractures in children.

Study design: Descriptive case series.

Place and duration of study: Orthopedic Department, Lady Reading Hospital, Peshawar from 15th February 2017 to 14th August 2017.

Material and methods: All patients aged between 4 to 13 years having closed displaced supracondylar fractures of both genders were included in the study. After detailed history, physical examination and appropriate laboratory investigations; the patients were operated by closed reduction and percutaneous cross k-wires were passed. The patients were then assessed postoperatively and at follow up for sign and symptoms of ulnar nerve injury.

Results: A total of 146 patients were included in the study of which 103(70.5%) were males and 43(29.5%) were females. During closed reduction and percutaneous pin fixation of 146 supracondylar humeral fractures, there were only 3 cases of ulnar nerve injuries.

Conclusion: The frequency of Ulnar nerve injury during closed reduction and percutaneous pin fixation of supracondylar humeral fractures, with protective measure was 2.05% which is quite low as compared to most local and international study.

Keywords: Supracondylar humerus fracture, percutaneous pin fixation, ulnar nerve palsy.

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Introduction:

Supracondylar humeral fractures are the most common elbow fractures seen in children.[1] Two-thirds of children hospitalized because of an elbow injury have a supracondylar humeral fracture.[2]

Diagnosis of supracondylar humerus fracture is based on history, clinical examination and x-ray findings. Emergency treatment includes immediate reduction of the fracture (if displaced) and splintage. Emergency treatment has been recommended to avoid vascular compromise and compartment syndrome.[3] However, recent studies suggest that delay does not influence outcome.[4,5,6] Definitive treatment options include treatment with Traction, Closed Reduction and Splintage, Closed Reduction and Percutaneous Pin Fixation and Open Reduction Internal Fixation with Pins.[7]

Closed Reduction and Percutaneous Pin Fixation under Image Intensifier is the recommended and modern treatment of displaced supracondylar humerus fractures.[7] Closed Reduction and Percutaneous Pin fixation can be done either with two cross (one medial and one lateral) or two laterally placed pins.[8,9]

Cross pin fixation provides more stable configuration and the probability of deformity or loss of reduction is lower than isolated two lateral pin fixation. In two different studies, by Zenios et al and Zamzam et al, it was found that only a small

proportion (26%) of these fractures were rotationally stable with two lateral pins.[10,11]

Although cross pin fixation is a more stable configuration, it is associated with ulnar nerve injury during insertion of the medial pin, thus care should be taken to avoid iatrogenic ulnar nerve injury.[12] Complications of closed reduction and percutaneous pin fixation include ulnar nerve injury, pin tract infection, vascular compromise, elbow stiffness and loss of reduction. Iatrogenic ulnar nerve injury is a well known complication during insertion of the medial pin through medial epicondyle, with reported prevalence's of upto 10.6%13 and 15%14 Ulnar nerve injury results in numbness which involves the small finger and the ulnar half of the ring finger.[15] Sensory disturbance can be evaluated with use of tests of threshold sensibility (monofilament testing).[15] Changes in sensory conduction are more sensitive indicators of nerve injury and correlate more directly with findings on physical examination.[15]

Iatrogenic ulnar nerve injuries usually resolve, but there have been several reports of permanent iatrogenic ulnar nerve injuries.[16] Measures to protect ulnar nerve during placement of medial pin are smooth sharp pins should be used, the lateral pin should be placed first, the elbow should then be extended, the medial pin should be placed without hyperflexion of the elbow and the procedure should be done when swelling in the elbow has subsided.[17]

The current study is designed to determine the frequency of ulnar nerve injury in children with supracondylar humerus treated with pin fixation. The results of this study will be used to determine the current status of outcome of pin fixation in terms of ulnar nerve injury in our population and if found to be significantly high in our study than we will share these results with other orthopedic surgeon in general and also will suggest certain modifications in surgical technique and absolute follow up of the standards set for the insertion of pin for supracondylar humerus fractures, this will help our population to reduce the stress and other morbidity associated with ulnar nerve injuries.

Study design: Descriptive case series.

Material and Methods:
Study was conducted at Orthopedic Department, Lady Reading Hospital, Peshawar from 15th February 2017 to 14th August 2017. Sample size was 146 keeping frequency of ulnar nerve injury after percutaneous pin fixation as 10.6%13, 95% confidence interval and 5% margin of error using WHO sample size calculator. Sampling technique used was Non probability consecutive sampling. All children with age range 4 to 13 years having closed displaced supracondylar fractures in both genders were included in the study. Patients with supracondylar fractures already having ulnar nerve injury, detected by monofilament test, with severe swelling in the elbow post operatively detected by clinical examination, with presence of post-operative central nervous system injury detected by clinical examination in which the patient does not respond to verbal commands were excluded from the study. The diagnosis of displaced supracondylar humerus fractures was based on history of trauma and X- ray showing a break in the continuity of the distal humerus just above condyles. The purpose and benefits of the study was explained to the patient and a written informed consent was obtained. On OT day all the included children were subjected to closed reduction and cross pin fixation under general anesthesia, when the swelling, if present subsided and distal neurovascular status intact. In the operation theatre under general anesthesia, the fracture was first reduced in the frontal plane with fluoroscopic verification. The elbow was then flexed to correct the sagittal deformity. Percutaneous crossed pins were passed with measures described to protect the ulnar nerve. All the reduction procedures and pin fixations were conducted by experienced orthopedic surgeons having minimum of 5 years of experience. Post-operatively all the children were examined at 24th hour to detect ulnar nerve injury on the basis of positive monofilament test. Data was stored and analyzed in SPSS version 16. Mean+standard deviation were calculated

Table-1: Gender and Side distribution

Gender	Side		Total
	Right	Left	
Female	19 (13.0%)	24 (16.4%)	43 (29.4%)
Male	40 (27.4%)	63 (43.2%)	103 (70.6%)
Total	59 (40.4%)	87 (59.6%)	146 (100.0%)

Table-2: Total Number of Attempts, Ulnar Nerve Palsy and their percent injuries

Attempts	Injury		Total	% Injury within attempts
	No	Yes		
1	105	1	106 (72.6%)	1.0
2	27	1	28 (19.2%)	3.7
3	9	1	10 (6.8%)	11.1
4	2	0	2 (1.4%)	0
Total	143 (97.95%)	3 (2.05%)	146	

Chi-square test was applied in which P-value was 0.0031

Table-3: Number of Attempts in the two Age groups

Age groups	Attempts				Total
	1	2	3	4	
4 to 8 years	55	18	7	1	81
9 to 13 years	51	10	3	1	65
Total	106	28	10	2	146

Table-4: Stratification of ulnar nerve injury according to gender

Ulnar Nerve Injury	Male	Female	Total
Yes	3	0	3
No	100	43	143
Total	103	43	146

Chi-square test was applied in which P-value was 0.241

Table-5: Stratification of ulnar nerve injury according to age

Ulnar Nerve Injury	4 – 8 Years	9 – 13 Years	Total
Yes	2	1	3
No	79	64	143
Total	81	65	146

Chi-square test was applied in which P-value was 0.0031

for numerical variables like age. Frequencies/ Percentages were calculated for categorical variables like gender and ulnar nerve injury. Ulnar nerve injury was stratified among age, sex and number of attempts during insertion of medial pain to see the effect modifications. All results were presented in the form of tables and graphs.

Results:

A total of 146 patients were included in the study of which 103 (70.5%) were males and 43 (29.5%) were females (Table 2.1). Age range was 4 to 13 years, and the mean age was 8.28±2.56 years.

Of the 103 males, 40(38.8%) had right sided fractures while 63(61.2%) had fractures of the left side. Out of the 43 females, 19 had right sided fractures while 24 had fractures of the left side, thus 44.2% of the females had right side fracture and 55.8 % had left side fracture. (Table 1)

Left elbow was involved in 87(59.6%) patients and the right side was involved in 59(40.4%) patients. (Table 1)

The results of this study show that there were only 3(2.05%) cases of ulnar nerve palsies out of the 146 patients with closed reduction and percutaneous pin fixation of supracondylar humerus fractures. All the three patients were males; two of them had right distal humeral fractures while one of them had a fracture of the left humerus.

During the fixation of the supracondylar humerus fracture, the medial pin was fixed on the first attempt in maximum number of patients 106(72.6%). It was fixed in 28(19.2%) patients on the 2nd attempt and in 10(6.8%) patients on the 3rd attempt. In only 2 patients the medial wire was fixed in more than three attempt and these were the very difficult fractures with medial column instability. (Table 2)

There was one case of ulnar nerve palsy in the group who had medial pin fixed on the first attempt, one ulnar nerve palsy in the group with medial pin fixation on the 2nd attempt. Also one ulnar nerve palsy was in patients who had the medial pin fixed during three attempts. Interestingly, of the two patients in which the pin was fixed in more than three (i.e. 4) attempts, there was no case of ulnar nerve injury. (Table 2)

If we divide the patients into two groups according to age, there were 81(55.5%) patients with age range from 4 to 8 years and 65(44.5%) patients with ages between 9 and 13. Patients with ages between 4 and 8 years, the medial pin was fixed on the first attempt in maximum number

of patients 55(67.9%). It was fixed in 18(22.2%) patients on the 2nd attempt and in 7(8.6%) patients on the 3rd attempt. (Table 3)

Table 4 and 5 represent the stratification of ulnar nerve injury according to gender and age of the patient respectively. Chi square test was applied to find the association between ulnar nerve injury and gender and age of the patient.

Patients with ages from 9 to 13 years, the medial pin was fixed on the first attempt in maximum number of patients 51(78.5%). It was fixed in 10(15.4%) patients on the 2nd attempt and in 3(4.6%) patients on the 3rd attempt.

We also divided our 146 patients of our study into two further equal categories, the first group comprised of the first 73 patients and the second group contained the rest of the 73 patients (i.e. patients who came during the 2nd half of the study).

As pointed out above, the right side was involved in 59 children while the left distal humerus was fractured in 87 children. During closed reduction and percutaneous cross pin fixation of the 59 supracondylar humeral fractures involving the right side, the medial pin was placed on the 1st attempt in 44(74.6%) patients, on the 2nd attempt in 12(20.3%) patients and on the 3rd attempt in 3(5.1%) children. Out of the 87 children having left side supracondylar humerus fractures, medial pin fixation was done on the 1st attempt in 62(71.3%) patients, on the 2nd attempts in 16(18.4%) patients and in 7(8.0%) patients the medial pin was fixed on the 3rd attempt. In 2(2.3%) patients, 4 attempts were made to correctly place the medial pin in 2 patients, but luckily none of the two had ulnar nerve palsy.

Discussion:

The prevalence of supracondylar humerus fracture in children and the morbidity following its lack of treatment or maltreatment has been explained in detail. In my study 146 patients were included, 103 were males and 43 females. This is consistent with almost all the series cited except for one study by Farnsworth et al in which females have actually been more in number than males.[3]

Also the left side (the non dominant side) is more commonly involved as in most studies.[3,18]

The mean age of patients (8.28 years) in this study was higher than the mean age in other series, because we have excluded patients with supracondylar fractures less than 4 years in our study in order to properly comprehend ulnar nerve palsy. Age range was 4 to 13 years. In a very larger review of 503 patients by Elberl R et al, the median age of children with supracondylar humerus fractures was 6.5 years.[14] Naum et al reported median age of 5.4 years.[19] In a local series by Waseem et al the median age was 7.02 years.[20]

The frequency of ulnar nerve palsy during fixation of supracondylar humerus fractures with percutaneous pin fixation in our series is 2.05%. This is quite low as compared to frequency of ulnar nerve palsy in other studies, in which its frequency has been reported as high as 15%.[14] Elberl R et al 2012, in their large review of 503 patients treated with percutaneous cross pinning reported iatrogenic ulnar nerve palsy in 15% of children.[14] Sibinski et al 2010, in a series of 131 patients reported 6% post operative ulnar nerve injury with cross pinning.[21] We employed all the special protective measures to avoid ulnar nerve palsy in our study.

These protective measures were:

a) Usage of smooth pins to fix the fracture

b) The procedure was done when swelling of the elbow subsided, to minimize soft tissue damage and easily direct the pins into the bone (distal humerus)

c)The lateral pin was inserted first in order to hold the fracture reduced so that minimal attempts were made during insertion of the medial pin

d)Another precaution was that the elbow was extended to upto about 90° from full flexion, during the insertion of the medial pin . This allows the ulnar nerve to displace posteriorly and

minimize its chance of damage during medial pin fixation. So, all these protective measures were found to be very effective in preventing damage to the ulnar nerve during medial pin fixation of the supracondylar humerus fracture.

All the above mentioned protective measures were practiced in every patient, but the number of attempts during insertion of the medial pin was still different. Though, reduction and insertion of the lateral pin first minimized the attempts made during insertion of the medial pin, still there were some difficult fractures which needed further attempts. So majority (72.6%) of patients had the medial pin fixed at first attempt, 19.2% had it fixed on the 2nd attempt, 6.8% on the 3rd attempt while only 2(1.4%) patients required 4 attempts in order to correctly place the medial pin. There was one case of post-operative ulnar nerve palsy in each of the 1st three groups, i.e. one case of ulnar nerve palsy in the 106 cases in which the medial pin was inserted on the first attempt, one case of 28 patients with 2 attempts at the medial pin and also one case of post operative ulnar nerve palsy in the 10 patients who had their medial pin fixed on the 3rd attempt. The percent injury of each of these groups was found to be statistically significant (p value 0.005). % injury for the 1st attempt patients was 1%, for the 2nd attempt patients was 3.7% and for the patients with 3rd attempt, it was 11.1%. One interesting finding was that there were only two patients in which the fracture reduction and maintaining reduction was so difficult that 4 attempts were made in order to correctly place the medial pin with the fracture well reduced, and in these two patients no post operative ulnar nerve palsy was found. This seems to be only by chance as the sample size of this group was very small. Theoretically the chance of ulnar nerve injury with four attempts at the medial pin should be high.

The number of attempts needed to correctly place the medial pin between these two groups was different. In the 4 to 8 years group patients 67.9% of patients had the medial pin fixed at first attempt, 22.2% had it fixed on the 2nd attempt, 8.6 % on the 3rd attempt while In the 9 to 13 years of age patient group 78.5% of patients had the medial pin fixed at first attempt, 15.4% had it fixed on the 2nd attempt, 4.6% on the 3rd attempt. This shows that in younger patients, closed reduction and percutaneous pinning is slightly difficult than in older ones, as the number of patients in which medial pin was inserted on the 1st attempt is more in children above 9 years than in children below 9 years.

As all our surgeons were right handed, so we presumed that there may be difference in the side of the elbow operated. So, during closed reduction and percutaneous cross pin fixation of the 59 supracondylar humeral fractures involving the right side, the medial pin was placed on the 1st attempt in 44(74.6%) patients, on the 2nd attempt in 12(20.3%) patients and on the 3rd attempt in 3(5.1%) children. Of the 87 children having left side supracondylar humerus fractures, medial pin fixation was done on the 1st attempt in 62(71.3%) patients, on the 2nd attempts in 16(18.4%) patients and in 7(8.0%) patients the medial pin was fixed on the 3rd attempt. This showed no difference in reduction or fixation of the fracture whether the patient's left elbow is affected or the right one. And presumably no difference whether the surgeon is left handed or right handed.

Conclusion:
The frequency of Ulnar nerve palsy during closed reduction and percutaneous pin fixation of supracondylar humeral fractures, with protective measure was 2.05% in our study, which is quite low as compared to most local and international studies. So these measures, which are described in detail, should be followed in every case of percutaneous pin fixation of the humerus.

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Role and contribution of authors:
Dr. Aimal Sattar, collected the data, referenes and wrote the initial write up.

Dr. Wali Muhammad, collected the references and helped in introduction writing.

Dr. M Ayaz Khan, critically review the article and made the final changes

Dr Syed Dilbagh Ali Shah, helped in collecting the data and references and also helped in discussion writing.

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