

Research Article

OUTCOME ANALYSIS OF OPERATIVE PAEDIATRIC SUPRACONDYLAR HUMERUS FRACTURES: A RADIOGRAPHIC AND FUNCTIONAL ASSESSMENT

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Abstract: Introduction: Supracondylar humerus (SCH) fractures following trauma account for 18% of all paediatric fractures and 60% of elbow fractures in children. Management is usually decided on the Gartland classification and presenting clinical signs, with closed reduction and percutaneous pinning (CRPP) being the most preferred methodology. CRPP technique may vary according to the fracture pattern and surgeon preference, including varied K-wire configuration. This study aims to evaluate the radiological parameters following two different CRPP configurations for fixation of SCH fractures in paediatric patients and assess the functional modulus to co-relate the effect of radiological parameters on the functional outcome and the influence of fixation configuration on clinical outcome. **Materials and methods:** This prospective observational study includes 60 children aged 5-14 years fulfilling the inclusion criteria; presenting at a teaching tertiary care centre and diagnosed with SCH fracture following trauma. They were managed by a single senior Orthopaedic surgeon and subject to pre-operative clinical and radiological investigation, following which they were operated for CRPP, the configuration determined according to the fracture pattern. They were then divided into two equal groups comprising 30 patients each, according to the K-wire fixation configuration – three lateral pins (Group A) and two lateral pins with one medial pin (Group B). All were subject to the same post-operative and follow-up protocol. Radiographic analysis (including Baumann angle, lateral capitello-humeral angle (LCHA) and anterior humeral line alignment) and the functional assessment was done using QuickDASH score, Mayo elbow score and Flynn criteria, at a single 3-month follow-up. Statistical analysis was done for group comparison of functional outcome using Mayo elbow score and Flynn criteria using the Chi-square test with p value < 0.05 considered statistically significant. **Results:** The study cohort included 42 males (70%) and 18 females (30%) with mean age of 8.5 years. 48 cases (80%) were classified as Gartland type II whereas 12 cases (20%) as Gartland type III. All cases were operated for CRPP by the same surgeon, without tourniquet under fluoroscopy guidance; with a minimally invasive approach for the medial pin. No intra-operative or post-operative complications were recorded. For Group A, the radiological assessment showed restored anterior humeral line, mean Baumann angle $73.5^{\circ} \pm 5^{\circ}$ and mean LCHA $44^{\circ} \pm 3^{\circ}$. The mean QuickDASH score was 0.22 ± 0.15 (22% \pm 15%), mean Mayo elbow score 90 ± 5 and 26 cases (87%) falling in excellent category whereas 4 cases (13%) falling in good category of the Flynn criteria. For Group B, the radiological assessment showed restored anterior humeral line, mean Baumann angle $75.5^{\circ} \pm 4^{\circ}$ and mean LCHA $45^{\circ} \pm 2^{\circ}$. The mean QuickDASH score was 0.18 ± 0.10 (18% \pm 10%), mean Mayo elbow score 90 ± 5 and 28 cases (93%) falling in excellent category whereas 2 cases (7%) falling in good category of the Flynn criteria. Though the radiological and functional outcome were marginally better for Group B (two lateral and one medial pin), the statistical difference in functional outcome of both groups was statistically insignificant ($p > 0.05$) using both Flynn criteria and Mayo elbow score. However, there is a statistically significant ($p < 0.05$) correlation between the restoration of radiological parameters and the functional outcome of each of the two groups. **Discussion:** Restoration of radiological parameters is paramount to achieve a positive functional outcome. Both techniques of CRPP have a suitable result pertaining the restoration of radiological findings and functional outcome of SCH fractures in paediatric population. Though there is no statistically significant difference in the functional results, though a medial pin was associated with a better radiological and functional outcome with lesser risk of rotational displacement and improved fracture site stability; but one needs to be careful and prevent iatrogenic ulnar nerve injury. **Conclusion:** Closed reduction and percutaneous pinning is a cost-effective and time proven procedure for the treatment of paediatric supracondylar humerus fractures. Both pinning techniques, three lateral pins and two lateral pins with a medial pin are statistically comparable and satisfactory with adequate restoration of radiographic characteristics important to achieve an optimal functional outcome.

Keywords: Supracondylar, humerus fracture, paediatric trauma, Gartland type, elbow, K wiring

INTRODUCTION

Supracondylar humerus (SCH) fractures following trauma account for 18% of all paediatric fractures and 60% of elbow fractures in children¹. Management is usually decided on the Gartland classification and presenting clinical signs, with closed reduction and percutaneous pinning (CRPP) being the most preferred methodology². CRPP technique may vary according to

the fracture pattern and surgeon preference, including varied configurations of K-wire fixation³. This study aims to evaluate radiological parameters following two different CRPP configurations for fixation of SCH fractures in paediatric patients and assess the functional modulus to co-relate the effect of radiological parameters on the functional outcome and the influence of fixation configuration on clinical outcome.

MATERIALS AND METHODS

This prospective observational study was conducted between 2025-26 after obtaining approval from the Institutional Ethics Committee (IEC). 60 children aged 5-14 years fulfilling the inclusion criteria; presenting at a teaching tertiary care centre and diagnosed with SCH fracture following trauma were included for the purpose of this study.

Inclusion criteria –

- Paediatric group (<18 years of age)
- Gartland type II or III, satisfying surgical criteria
- Either of the two K-wire configurations - three lateral pins and two lateral pins with one medial pin
- Consenting legal guardians
- Fit for surgery

Exclusion criteria –

- Open fractures
- Bilateral SCH fractures
- Neurological or vascular deficit
- Gartland type I / conservatively managed SCH fractures

- Concomitant lateral condyle fracture or comminution
- Non consenting and unfit patients
- Lost follow-up

They were managed by a single senior Orthopaedic surgeon and subject to pre-operative radiological investigation, including a antero-posterior (AP) and lateral (dead view) plain projection. The degree of displacement was determined as an alteration of the Baumann angle in coronal plane and distortion of the anterior humeral line in sagittal plane⁴. Based on the fracture pattern, patients were managed by CRPP either using three lateral pins or two lateral and a medial pin under fluoroscopy guidance; and post-operative above elbow slab applied. Neurological and vascular normalcy was confirmed post-operatively and any complications were ruled out. All cases were subject to similar post-operative protocol of obtaining a plain AP-lateral radiograph, IV antibiotics and discharge the next day, followed by regular visits and K-wire removal 45 days post-operatively.

SUMMARY OF STUDY VARIABLES		
Gender	Males	42 (70%)
	Females	18 (30%)
	Total	60
Side	Right	36 (60%)
	Left	24 (40%)
Gartland classification	Type II	48 (80%)
	Type III	12 (20%)

For the purpose of this study, 60 patients were divided into two equal groups comprising 30 patients each, according to the K-wire fixation configuration – three lateral pins (Group A) and two lateral pins with one medial pin (Group B). All patients were assessed at a single follow-up at 3-months and findings were recorded. Radiographic analysis was done by obtaining plain radiographs with AP and lateral views to assess the Baumann angle, lateral capitello-humeral angle (LCHA) and anterior humeral line alignment. The functional assessment was performed and recorded using QuickDASH score, Mayo elbow score and the Flynn criteria. Once the data was recorded for all cases, statistical analysis was performed for group comparison of functional outcome on Mayo elbow score and Flynn criteria and to establish relation of radiographic parameters with functional outcome, using the Chi-square test, with *p value* < 0.05 considered statistically significant.

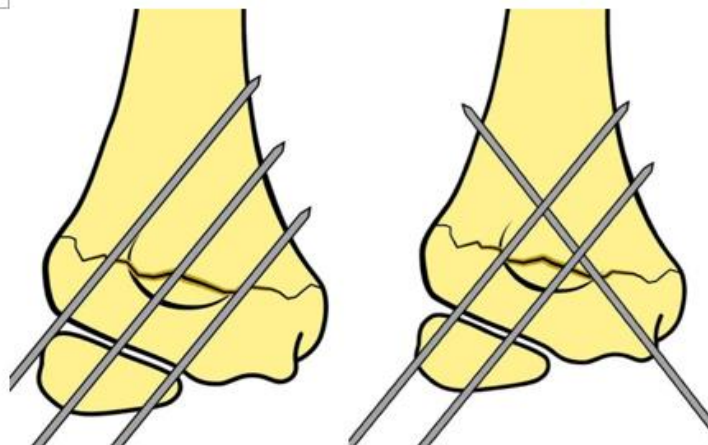


Figure 1: K-wire fixation configuration for Group A and Group B⁶

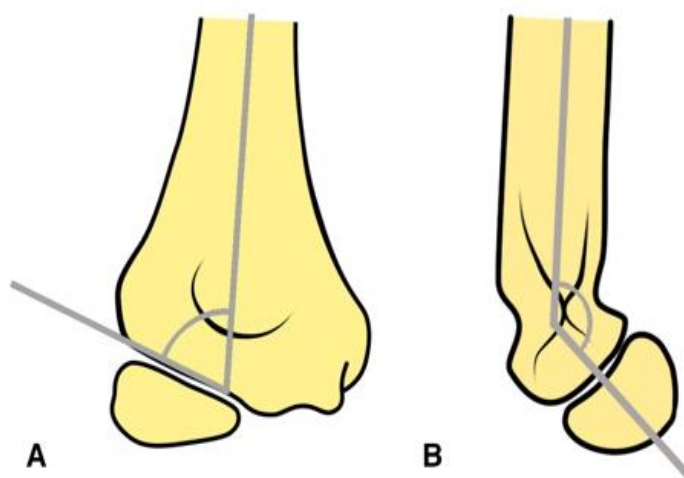


Figure 2: A – Baumann angle, B – Lateral capitello-humeral angle (LCHA) ⁶

RESULTS

The study cohort included 60 patients in total, who presented to a teaching tertiary care hospital following trauma. These included 42 males (70%) and 18 females (30%) with a mean age of 8.5 years with range 5-14 years, showcasing male pre-dominance. All the cases were subject to Gartland classification based on the AP and lateral plain radiograph of the elbow based on which 48 cases (80%) were classified as type II whereas 12 cases (20%) as type III. Of the 60 patients, 36 patients (60%) were affected on the right side and 24 patients (40%) on the left side. All the cases were operated for CRPP by the same surgeon, without tourniquet under fluoroscopy guidance; with a minimally invasive approach for the medial pin. Mean duration of surgery for Group A was 35±5 minutes whereas it was 45±5 minutes for Group B. No intra-operative or post-operative complications were recorded.

RESULTS		
	Group A (Three lateral pins)	Group B (Two lateral and one medial pin)
RADIOLOGICAL ASSESSMENT		
1. Anterior humeral line	Restored (passes through middle third of capitellum)	Restored (passes through middle third of capitellum)
2. Baumann angle	73.5°±5°	75.5°±4°
3. Lateral capitello-humeral angle (LCHA)	44°±3°	45°±2°
FUNCTIONAL ASSESSMENT		
1. Mean QuickDASH score	0.22 ± 0.15 (22%±15%)	0.18 ± 0.10 (18%±10%)
2. Mean Mayo elbow score (<i>p</i> > 0.05)	90±5	90±5

3. Flynn criteria ($p > 0.05$)	Excellent	26 cases (87%)	28 cases (93%)
	Good	4 cases (13%)	2 cases (7%)

For Group A, the radiological assessment illustrated a restored anterior humeral line, mean Baumann angle $73.5^{\circ} \pm 5^{\circ}$ and mean LCHA $44^{\circ} \pm 3^{\circ}$. The mean QuickDASH score was 0.22 ± 0.15 ($22\% \pm 15\%$), mean Mayo elbow score 90 ± 5 with 26 cases (87%) falling in excellent category whereas 4 cases (13%) falling in good category of the Flynn criteria. For Group B, the radiological assessment illustrated a restored anterior humeral line, mean Baumann angle $75.5^{\circ} \pm 4^{\circ}$ and mean LCHA $45^{\circ} \pm 2^{\circ}$. The mean QuickDASH score was 0.18 ± 0.10 ($18\% \pm 10\%$), mean Mayo elbow score 90 ± 5 with 28 cases (93%) falling in excellent category whereas 2 cases (7%) falling in good category of the Flynn criteria.

Though the radiological and functional assessment were marginally better for Group B (two lateral and one medial pin), the statistical difference in functional outcome of both groups was statistically insignificant ($p > 0.05$) using both Mayo elbow score and Flynn criteria.

However, a statistically significant ($p < 0.05$) correlation was established between the restoration of radiological parameters and the functional outcome, for each of the two groups.

DISCUSSION

Supracondylar humerus fractures are the most prevalent paediatric fractures and standardized measures of functional assessment and prognostic factors remain poorly defined. Moreover, corresponding evaluation of radiological and functional parameters, though seldom done, is of value since anatomical restoration forms the basis of physiological mobility.

Our study assesses functionality not only subjectively using the QuickDASH score, but also takes account of objectively assessed criteria by employing the Mayo elbow score and Flynn's criteria. Radiological assessment included the measurement and restoration of anterior humeral line, Baumann's angle and LCHA. The functionality was further correlated with radiological parameters by executing a statistical analysis using the Chi-square test. The analysis revealed and established that there exists a strong and statistically significant relation ($p < 0.05$) between the restoration of radiological parameters and the functional outcome of each of the two groups⁵. Hence, intra-operative focus should remain on acceptable and accurate restoration of anatomy to achieve adequate post-operative functionality.

However, there exists no statistically significant relation ($p > 0.05$) in the functional outcome of the two different configurations of CRPP and both the techniques have a suitable result, with the configuration with a medial pin having a slightly longer duration of surgery. Yet, it was observed that a minimally invasive medial pin was associated with a better radiological and functional outcome with lesser risk of rotational displacement and improved fracture site stability; but one needs to be careful and prevent iatrogenic ulnar nerve injury⁶.

The authors acknowledge the limitations of this study in form of a small sample size, only a single mid-term follow-up and only two fixation configurations with a strict exclusion criterion. They further advocate a cohort study comparing all different methods⁷ of SCH fracture fixation with a long-term follow-up and inclusion of other factors like age and open methods of fixation affecting the functional outcome⁸.

CONCLUSION

Closed reduction and percutaneous pinning is a cost-effective and time proven procedure for the treatment of paediatric supracondylar humerus fractures. Anatomical restoration evident by radiographic assessment has a statistically significant ($p < 0.05$) effect on the functional outcome. Both pinning techniques, three lateral pins and two lateral pins with a medial pin are statistically comparable and satisfactory with adequate restoration of radiographic characteristics and achieve an optimal functional outcome. Potential for bone remodelling at a younger age may contribute towards a positive functional outcome but careful and accurate anatomical reconstruction, as evident by radiological assessment, holds preliminary importance in the management of supracondylar humerus fractures in children.

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