JOINTS
JOURNAL ORTHOPAEDI AND TRAUMATOLOGY SURABAYA

JOINTS (Journal Orthopaedi and Traumatology Surabaya)
April 2023; 12(1): 36-42, DOI: 10.20473/joints.v12i1.2023.36-42
Received: 06 February 2023 / Revised: 01 March 2023
Accepted: 15 March 2023 / Published: 30 April 2023

Review Article

Closed Reduction Percutaneous Pinning Compared With Open Reduction Internal Fixation In Treating Supracondylar Fractures: A Systematic Review

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ABSTRACT

Background: Supracondylar fractures are one of the most frequent pediatric bone fractures. There are well-known treatments for this fracture. The most commonly used procedure is closed percutaneous reduction pinning, and open reduction internal fixation is for irreducible fractures. This study aims to evaluate and review those two procedures in treating a supracondylar humeral fracture in children by evaluating the clinical and functional outcomes.
Methods: Systematic review and meta-analysis (PRISMA) were conducted. Using Boolean operators, literature was searched through PubMed, Google Scholar, Science Direct, and Cochrane Library. The outcomes assessed by Flynn's criteria include functional aspects, cosmetic factors, and other outcomes.
Results: From 130 studies obtained, after a full-text review, four studies were included in the systematic review. The total sample size was around 268 patients with a mean age of 4-14. Male patients were higher than females. There is no significant difference in satisfactory outcomes measured by Flynn's Criteria.
Discussion: Flynn's criteria was found to be different in the result of the studies. Insignificant loss of carrying degree and Baumann's angle between two procedures. Some complications, like nerve injury, infection, and scar, were also seen after surgery.
Conclusion: The two approaches have an insignificant difference in their functional outcome. The choice of which procedure to perform relies on the surgeon's preference and the situation of the fractures.

Keywords: Supracondylar humeral fracture; Closed reduction percutaneous pinning; Open reduction internal fixation; Human and medicine

INTRODUCTION

Supracondylar fractures of the distal humerus are one of the most frequent types of pediatric bone fractures. Males are more likely to endure this injury than females. Extension-type is the common clinical presentation of these fractures injuries due to a fall onto an outstretched hand with the elbow extended.[1] Approximately 90% of all cases occur in children aged 5-7, and non-dominant arms are more frequently involved.[2] Gartland's classification is used to characterize the extension type of supracondylar fracture. There are three types of fractures: nondisplaced Type I fractures, intact posterior hinge Type II fractures, and complete displacement Type III fractures.[3]

Over this century, several discussions have been on the different therapeutic approaches for pediatric supracondylar humerus fractures. The two treatment approaches are surgical and conservative. When CRPP cannot reduce a fracture, ORIF is the preferable option.[4]

The preferred intervention course is CRPP due to its lower risk of infection, delayed bone union, fewer hospital charges, and certain disadvantages associated with open reduction. ORIF provides fracture reduction with good visualization supervision and decreases the chance of nerve injury like ulnar nerve but more often causes soft tissue injury, advanced infection risks, and the possibility of painful or unpleasant scarring. The final goal of these treatments is to prevent complications by ensuring a better functional and cosmetic aspect that is assessed clinically and radiologically.[4,5,6] Cubitus varus, Volksman's ischemia, malunion, and neurovascular injury are complications of supracondylar humerus fractures.[7]

This paper aims to evaluate the outcomes of treating supracondylar humerus fractures with CRPP and ORIF. We compared the outcomes of each surgery, specifically the clinical and functional results.

MATERIALS AND METHODS

Search Strategy

A systematic review was done following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[8] The two treatments for supracondylar humerus fractures, CRPP and ORIF, were compared in a comprehensive, peer-reviewed manuscript that was written in English. The Cochrane Library, PubMed, Google Scholar, Science Direct, and Boolean operators were used to conduct a literature search using the terms "Supracondylar Fractures," "CRPP," and "ORIF."

In this review, we used PRISMA guidelines. The formula diagram of PRISMA is shown in Figure 1 below. We found four journals for this review on inclusion criteria.

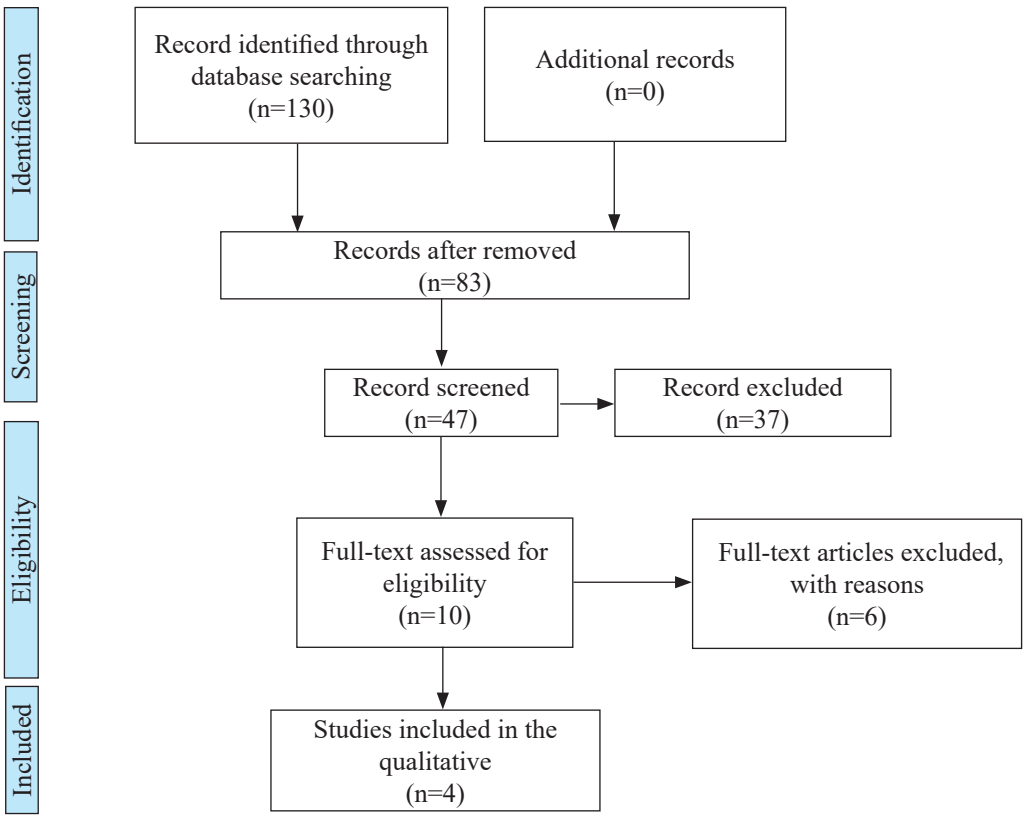

Figure 1. Flow diagram based on PRISMA Guideline describing the strategy for conducting this study.

Inclusion Criteria

The PICO approach was used to describe this investigation's inclusion and exclusion criteria. All English-language articles comparing CRPP versus ORIF for treating supracondylar humerus fracture were included in this analysis. Clinical, cosmetic, and functional results were assessed, as well as Flynn's Criteria for loss of ROM and carrying angle. The alternative outcome is Bauman's angle. Because just a few studies were comparing the two treatments, there were no restrictions on patient demographics. Excluded were studies that were not written in English.

Quality Evaluation

Each study's class of evidence was classified as I, II, III, or IV, corresponding to excellent quality RCT, moderate to bad quality RCT and cohort study, moderate to poor quality cohorts and case-control studies, and case series, respectively. The Oxford Center for Evidence-based Medicine produced criteria for assessing research quality and bias risk, the GRADE Working Group defined perspicacity, and the Agency for Healthcare Research and Quality sanctioned the study (AHRQ).

Table 1. List of included studies.

No.	Reference	Journal	Study Design	Level of Evidence
1.	Shrestha et al., 2016[9]	Journal of Society of Surgeons of Nepal	Prospective cohort	II
2.	Yaokreh et al., 2012[10]	Ortho & Trau: Surgery & Research	Retrospective cohort	II
3.	Bahadur et al., 2018[5]	Medical Journal of Pokhara Academy of Health and Science	Retrospective cohort	II
4.	Abousaleh et al., 2022[11]	Cureus Journal of Medical Science	Retrospective cohort	II

Table 2. Characteristics of patients of included studies.

No.	Reference	Total Sample Size	Mean Age (Age range in a year)	Male	Female	Study Comparison	Surgical Technique
1.	Shrestha et al., 2016[9]	63 CRPP = 37 ORIF = 26	CRPP = 7.29±2.3 ORIF = 8.11±2.02	N/A	N/A	CRPP vs. ORIF for Supracondylar humerus fracture	CRPP with two parallel or divergent lateral pins ORIF by posterior approach with crossed K-wires
2.	Yaokreh et al., 2012[10]	58 CRPP = 33 ORIF = 25	CRPP = 7.29 ORIF = 7	31	27	CRPP vs. ORIF for Supracondylar humerus fracture	CRPP - ORIF
3.	Bahadur et al., 2018[5]	87 CRPP = 54 ORIF = 33	CRPP = 7.8 ORIF = 7.9	59	28	CRPP vs. ORIF for Supracondylar humerus fracture	CRPP and ORIF were fixed with two cross-k-wires. CRPP was done under the guidance
4.	Abousaleh et al, 2022[11]	60 CRPP = 28 ORIF = 32	CRPP = 5.21±2.17 ORIF = 6.69±4.08	N/A	N/A	CRPP vs. ORIF for Supracondylar humerus fracture	CRPP - ORIF

Table 3. Summary of outcomes.

No.	Reference	Study Comparison	Follow up Duration (year)	Outcomes	Complications
1.	Shrestha et al., 2016[9]	CRPP vs. ORIF	Eight weeks	Radiological outcome using anterior humeral line and Baumann's angle, cosmetic and functional outcome using Flynn's Criteria	N/A
2.	Yaokreh et al., 2012[10]	CRPP vs. ORIF	Three months	Radiological outcome using Baumann's, functional using Flynn's Criteria	CRPP Iatrogenic nerve injuries = 2 Re-operation = 6 Cubitus varus = 2 ORIF Re-operation = 1 Cubitus varus = 1
3.	Bahadur et al., 2018[5]	CRPP vs. ORIF	One month	Functional outcome (loss of ROM) using Flynn's Criteria, Loss of carrying angle	CRPP Medial nerve injury = 6 Radial nerve injury = 1 Ulnar nerve injury = 3 Pin traction infection = 6 ORIF Radial nerve injury = 2 Pin tract infection = 3 Extensor lag (Corrective osteotomy) = 1
4.	Abousaleh et al., 2022[11]	CRPP vs. ORIF	3	Radiological outcome using Baumann's angle and anterior humeral line, cosmetic (loss of carrying angle) and functional outcome (loss of ROM in degrees) using Flynn's Criteria	CRPP Ulnar nerve injury = 1 Hypertrophic scar = 1 ORIF Ulnar nerve injury = 1

Table 4. Characteristics of the outcome of studies.

		Outcome Measure			
No	**References**	**Loss of Motion (Functional) by Flynn's**	**Loss of Carrying Angle (Cosmetic) by Flynn's**	**Baumann's Angle Change**	**Baumann's angle, at last, follows up**
1.	Shrestha et al., 2016[9]	Excellent/Good/Fair/Poor CRPP = 9/16/8/4 ORIF = 0/0/7/19	Excellent/Good/Fair/Poor CRPP = 31/6/0/0 ORIF = 20/4/2/0	CRPP =16.89±5.66◦ ORIF = 18.88±4.9◦	N/A
2.	Yaokreh et al., 2012[10]	Excellent/Good/Fair/Poor CRPP = 17/8/5/3 ORIF = 14/5/4/2	N/A	N/A	CRPP = 73.9±5.75◦ ORIF = 74.76±4.08◦
3.	Bahadur et al., 2018[5]	Excellent/Good/Fair/Poor CRPP = 45/6/3/9 ORIF = 26/4/2/1	All of the cases have less than 5 degrees	N/A	N/A
4.	Abousaleh et al., 2022[11]	Excellent/Good/Fair/Poor CRPP = 18/4/5/1 ORIF = 26/6/0/0	Excellent/Good/Fair/Poor CRPP = 21/4/2/1 ORIF = 28/3/1/0	CRPP = 8.21 ± 6.33 ORIF = 5.90 ± 4.39	N/A

RESULTS

The search approach was applied, and 130 studies were identified. Precisely 83 studies were removed due to duplication, while another 18 were disqualified based only on title screening. Nineteen papers were taken out of the running after the abstracts were reviewed. An analysis of the complete text led to the removal of six articles. The final evaluation resulted in the inclusion of four studies in this systematic review.

The included research's key characteristics and evidence level are depicted in Tables 1 and 2. As seen in Table 3, there were 268 patients from four research, 152 of whom had closed percutaneous reduction pinning, while the remaining 116 underwent open reduction internal fixation. A summary of the outcomes evaluated and the results from each study are reported in Tables 3 and 4, respectively.

DISCUSSION

Supracondylar humeral fractures, which occur above the condyle in the distal humerus, generally feature transverse or oblique fracture lines. Supracondylar fractures are one of the highest cases of bone fractures in children.[1]

Various treatment modalities are discussed in several studies. The most frequent treatment for supracondylar fractures of Gartland Types II and III is CRPP. The following management approach is ORIF.[5] Although ORIF can anatomically reduce the fracture, complications, including infection and stiffness from soft tissue damage, are possible.

Closed reduction percutaneous pinning (CRPP), such as being less invasive, faster, cheaper, safer, allowing for early mobility, and having fewer postoperative problems, were presented.[12] To use a transifier to evaluate an extension-type fracture, the patient will be placed next to the operating table with their upper arm lifted over the radiolucent table. Once reduced and repaired, the deformities are prevented from getting worse by percutaneous pinning. Open fractures, failed closed reductions, or vascular injury indicates that ORIF is required. The surgeon can see clearly through the incision, allowing accurate alignment to prevent deformities.[13] This systematic review compares the CRPP and ORIF approaches because there is still considerable debate on how to do so.

Flynn's criteria are used to evaluate the functional outcome with loss of motion degree and the cosmetic outcome with changes in carrying angle. Flynn's criteria are divided into two categories: satisfactory results and those not. Excellent, good, and fair were all considered satisfactory, but poor was regarded as unsatisfactory.[14] All four studies evaluated Flynn's criteria. Only three studies by Shrestha et al., Yaokreh and al, and Abousaleh et al. measured Baumann's angle as an additional outcome.

The functional outcome was excellent, good, fair, and poor, with 9 (24.3%), 16 (43.2%), 8 (21.6%), and 4 (10.8%) patients in the CRPP group, respectively. However, in ORIF patients, about seven patients (26.9%) had a fair functional outcome, while 19 patients (73.1%) had poor functional outcomes. This was a significant result (P=0.000).[9] In Abousaleh et al., loss of motion criteria, 96.4 percent of CRPP method patients had satisfactory results, and the others were unsatisfactory. Compared to CRPP, 100 percent of ORIF patients had a great functional outcome. There was a significant difference comparing the two groups' methods in this study (p = 0.038).[11]

Yaokreh et al., and Bahadur et al., found no significant difference between CRPP and ORIF. Yaokreh et al. achieved 90.9 % versus 92 % satisfaction; P = 0.8835.[10] In another study, Bahadur et al. found that the functional outcome in the CRPP group was 100 percent satisfactory. In contrast, the ORIF group had 97 % satisfactory outcomes, with 3% poor or unsatisfactory outcomes. There is no

significant difference in function between CRPP and ORIF.[5]

The two groups were compared by Flynn's criteria for loss of carrying angle. Thirty-one cases (83.7%) in the CRPP group had excellent outcomes, while the others (16.3%) had good outcomes. However, 20 (76.92%), 4 (15.38%), and 2 (7.69%) patients on the ORIF methods had excellent, good, and fair outcomes, respectively. In this study, neither group of patients had a poor cosmetic outcome. This outcome was not significant (P=0.23).[10] The loss of carrying angle was less than 5 degrees in all incidents, as demonstrated by Bahadur et al. However, in the Abousaleh et al. study, in the ORIF group, the loss of carrying angle was less (4.23 degrees) than in the CRPP group (5.51 degrees), with a statistically significant p = 0.023.[11]

According to Shrestha et al., the mean Bauman's angle for the CRPP and ORIF groups was 16.89 and 18.88 degrees, respectively. Between CRPP and ORIF, significant difference (P = 0.142). Yokrech J.B. et al. conducted a similar study on French youngsters, and the mean score of Baumann's angle was 73.9±5.75 and 74.76±4.08 in CRPP and ORIF groups, with a p-value of 0.5123.[10] The mean Bauman's angle shift post-surgery and post-union in the Abousaleh et al., the study was 8.21±6.33 and 5.90±4.39 in the CRPP and ORIF groups, respectively, with p = 0.343.[11]

Only three studies reported the incidence of complications following surgery. Yaokreh et al. reported two problems and ten events in the ORIF and CRPP groups. Complications were seen in both groups, according to Bahadur et al. While there were two nerve injuries and three infections following surgery in ORIF, there were eleven nerve injuries and six pin tract infections in CRPP. There are three (5%) cases of complications in the Abousaleh et al. study, two in the CRPP group and one in the ORIF group. Two ulnar nerve injuries occurred in each group, and hypertrophic scars occurred in the CRPP patients. Although the CRPP group experienced more issues than the ORIF group, the results are not statistically significant.[5,10,11]

CONCLUSION

Supracondylar humeral fractures on Gartland types II and III are often surgically treated. As opposed to ORIF, CRPP is the preferable course of therapy. Three out of four pieces of literature on functional outcomes showed that CRPP had more satisfactory results than ORIF. Still, only two pieces of literature significantly varied between the two groups. For the cosmetic outcomes, one study had a significant result that showed ORIF had a better outcome than CRPP. Although the CRPP group experienced more complications than the ORIF group, the results are not statistically significant. Which surgery is carried out will depend on the surgeon's preferences and the severity of the fractures. Additional research on a bigger population and an improved study design should be conducted to prove which approach provided more satisfying outcomes.

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