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Specialty study program

Department of Orthopedics and Traumatology

Outcomes of open vs. closed reduction with percutaneous pinning of completely displaced pediatric supracondylar fracture of humerus at Tikur Anbessa Specialized Hospital, a four-year retrospective study

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Addis Ababa, Ethiopia

Department of Orthopedics and traumatology

Investigator	Tefera Belay (MD, Orthopedics and trauma surgery resident)
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List of- Acronyms and Abbreviations

TASH: – Tikur Anbessa Specialized Hospital

SCHF: - Supracondylar humerus fracture

CRPP: -Closed Reduction and Percutaneous Pinning

ORIF: - Open Reduction and Internal Fixation

ORPP:-Open Reduction and Percutaneous Pinning

MD: -Medical doctor

MRN: – Medical Record Number

SPSS: -Statistical Package for service solution

TBS: -Traditional bone setter

COR: - crude odd ratio

AOR: - adjusted odd ratio

M-mean

SD- standard deviation

Abstract

Background:-Displaced supracondylar humerus fractures (SCHF) are common pediatric injuries. While Closed Reduction and Percutaneous Pinning (CRPP) is the first line treatment, Open Reduction and Percutaneous Pinning (ORPP) is required when closed reduction fails, and when intraoperative fluoroscopic imaging is not available. The comparative functional and cosmetic outcomes of these techniques within our context is not known, leading to variation in perception of surgical practice.

Objective: To compare functional and cosmetic outcomes between CRPP and ORPP for displaced SCHF (Gartland types III and IV) in children at TASH.

Methods: A retrospective cohort study will be conducted, reviewing medical records of all eligible children (<16 years) treated with CRPP or ORPP for displaced SCHF at TASH between May 1, 2021, and April 30, 2025. Data on patient demographics, fracture characteristics, and operative details will be collected. Functional and cosmetic outcomes will be assessed using Flynn criteria. Complications including nerve palsy, infection, and malunion will be recorded. Statistical analysis using SPSS version 27 (t-tests, chi-square, regression) will be performed to compare outcomes between the two groups.

Expected Outcomes: the study will provide crucial, localized evidence on the functional and cosmetic outcomes, and specific complications associated with CRPP and ORPP. The finding is expected to inform the development of an evidence based treatment protocol for displaced pediatric SCHF at TASH, aiming to optimize surgical decision making, improve patient outcomes and guide resource allocation.

Keywords: Supracondylar Humerus Fracture, Pediatric, CRPP, ORPP, Functional Outcomes, Tikur Anbessa Specialized Hospital, Ethiopia.

1. Introduction

1.1 Background of the study

Supracondylar humeral fractures are considered the most common elbow fracture in children (1,2,3). Gartland classification plays a fundamental role in decision-making regarding management and prognosis. Recent literatures recommend conservative management for non or minimally displaced fractures, whereas there seems to be a trend towards surgical treatment for all displaced fractures. The preferred treatment for displaced supracondylar fractures is closed reduction and percutaneous fixation with lateral pins (1,6).

These injuries occur most often in children between the ages of 3 and 8 years, with a peak incidence at 5-7 years, and a predilection for boys and the non-dominant arm (2,3,5). The vast majority (99%) are extension-type injuries, resulting from a fall onto an outstretched hand (2).

The management of these fractures is important due to the high risk of associated neurovascular complications. Nerve injuries, commonly median or ulnar nerves, are present in 5% to 14% of cases at initial presentation (2,7). vascular compromise is occurring in 7% to 10% of patients, which significantly increases the risk of devastating compartment syndrome (7). The primary goals of treatment are to achieve a stable anatomical reduction, enable full recovery of elbow function, maintain a satisfactory cosmetic appearance, and, most importantly, prevent neurovascular complications (4).

Surgical intervention is the standard of care for displaced pediatric supracondylar humeral fractures. Closed Reduction and Percutaneous Pinning (CRPP) is widely regarded as the standard surgical technique, favored for its minimally invasive nature, shorter operative time, shorter postoperative hospital stay and rapid healing (1,5). However, CRPP is not without limitations. The procedure can be compromised by inadequate closed reduction, often due to the entrapment of soft tissues like the brachialis muscle, joint capsule, or neurovascular bundle between the fracture fragments (2,5). This can lead to residual malrotation and medial displacement, resulting in complications such as cubitus varus deformity (2).

In cases where closed reduction fails or not feasible due to severe swelling, vascular injury, open fractures, or in areas with limited access to intraoperative imaging, Open Reduction and Percutaneous Pinning (ORPP) is the alternative. ORPP provides direct visualization of the fracture

site, allowing for anatomic reduction, release of entrapped structures, and direct assessment of neurovascular integrity. ORPP is more invasive, is associated with longer operative times, higher blood loss, and potentially a greater risk of stiffness and scarring (2,5).

The comparative functional and cosmetic outcomes of these two techniques particularly in Tikur Anbessa Specialized Hospital (TASH), remain inadequately characterized. A clear understanding of functional and cosmetic outcomes, and specific complications associated with each procedure is essential for optimizing surgical decision-making and improving patient care.

Therefore, this study aims to address this gap by evaluating and comparing the functional, cosmetic outcomes, and complication rates of CRPP versus ORPP for displaced supracondylar humerus fractures in children at TASH. The findings from this research will provide evidence based insights to guide surgeons at our institution in selecting the most appropriate surgical approach to maximize patient outcomes and minimize risks.

1.2 Statement of the Problem

The management of displaced pediatric supracondylar humerus fractures presents a significant challenge. The two primary surgical treatments, Closed Reduction Percutaneous Pinning (CRPP) and Open Reduction Percutaneous Pinning (ORPP) are both widely used but a clear consensus on their comparative effectiveness is lacking.

In the absence of local, evidence based data, the choice between CRPP and ORPP is often based on individual surgeon preference rather than robust outcomes specific to our patient population and resource setting. Consequently, a critical knowledge gap exists regarding which technique yields better functional results and fewer complications at our institution.

This study aims to address this gap by conducting a comparative analysis of functional and cosmetic outcomes between CRPP and ORPP for these fractures at TASH. The findings will provide essential evidence to inform local clinical practice and improve pediatric patient care.

1.3 Rationale of the Study

This study is justified by the persistent global debate and conflicting evidence regarding the optimal surgical management of displaced pediatric supracondylar humerus fractures, specifically between Closed Reduction Percutaneous Pinning (CRPP) and Open Reduction Percutaneous Pinning (ORPP). This research aims to directly address this gap by generating comprehensive, evidence-based comparison of functional and cosmetic outcomes for these procedures at TASH. The findings are essential to inform and standardize local clinical practice, directly enhance long-term pediatric patient outcomes, establish a foundational dataset for future research, and guide the optimal allocation of hospital resources like intraoperative fluoroscopic imaging, thereby representing a necessary step toward improving the overall quality of pediatric orthopedic care at our institution.

2.Literature review

Supracondylar humeral fractures (SCHF) are universally recognized as the most common elbow fracture in the pediatric population, with the Gartland classification system providing a fundamental framework for guiding management decisions and prognosticating outcomes (1,3,4). There are two studies conducted at Tikur Anbessa Specialized Hospital (TASH) which reveals predominance of pediatric elbow fractures. The first is one-year prospective study from 2005-2006 by Biruk et al., which focused exclusively on pediatric elbow fractures, 223 cases were assessed. This research found a strong male predominance (75.5%) and left-side involvement (66%), with the supracondylar fracture being the most common type, accounting for 69.1% of cases. A later, retrospective study by D. Admassie and B. Ayana et al. in 2013 analyzed 325 childhood limb fractures and dislocations. It confirmed a similar male predominance (78.2%) and also identified the supracondylar fracture of the humerus as the single most common specific fracture type (29.8%), followed by distal radial fractures. Together, these studies demonstrate that supracondylar humerus fractures are a leading pediatric orthopedic concern at TASH (3,4).

Concerning management of pediatric supracondylar fractures, there is a clear and established trend towards surgical intervention for all displaced fractures, with closed reduction and percutaneous pinning (CRPP) as the preferred initial treatment for many surgeons (2,5,18). The surgical debate primarily centers on the choice between two principal techniques: CRPP and ORPP. This decision necessitates a careful balance between the minimally invasive advantages of CRPP, which avoids a formal incision, and the direct visualization for achieving an anatomical reduction afforded by ORPP.

The consensus derived from many literature is that CRPP and ORPP yield statistically similar and largely successful functional and cosmetic outcomes in the majority of patients. This conclusion is supported by systematic reviews and meta-analyses that aggregate data from numerous primary studies. For instance, the systematic review and meta-analysis by Astawa et al. (2021) synthesized data from multiple comparative studies and concluded that ORIF offers functional and cosmetic outcomes comparable to CRPP, indicating no clear superiority of one technique over the other (15,21). PRISMA guided meta-analysis of four studies (n=268) also support similar finding with the above study, the study employed rigorous methodology to pool outcome data and determined the difference in functional outcomes between the two approaches to be statistically insignificant, thereby leaving the choice to surgeon preference and specific fracture circumstances (9). Further supporting this equivalence, more recent studies, including one by Wisnawan et

al. (2023) and a prospective study by Ali et al. (2025) which followed patients over time to assess outcomes both reported no significant difference in functional outcomes between the two surgical groups (11, 13).

Some comparative studies conclude that ORPP may be associated with marginally superior radiographic outcomes, especially in the accurate restoration of anatomical alignment. The primary advantages noted include a precise restoration of the carrying angle and a reduced incidence of malunion, such as cubitus varus. The methodology in these studies often involves precise postoperative radiographic measurements. For example, Tomori et al. (2018) conducted a retrospective case control study comparing CRPP to ORPP technique and found a significantly larger loss of carrying angle in the CRPP group. The outcome of this radiographic discrepancy was clinically meaningful; while functional outcomes assessed by Flynn's criteria were largely excellent or good in both cohorts, one patient in the CRPP group developed a cubitus varus deformity, leading the authors to recommend mini-ORPP to eliminate this risk (6). Similarly, a comparative study by Abousaleh et al.(2022) reported statistically significant differences favoring ORIF, with less loss of motion and a smaller mean loss of carrying angle (4.23° vs. 5.51°). The clinical outcome was that all patients in the ORIF group had satisfactory results according to Flynn's criteria, compared to 92.8% in the CRPP group, suggesting that superior radiographic alignment may translate to a higher rate of overall satisfactory outcomes (8). This trend was also observed by Keskin & Sen (2014) in their comparative evaluation, who found a statistically significant difference in carrying angle loss (2.96° in CRPP vs. 1.52° in ORPP), but both groups achieved excellent functional and cosmetic results (16).

Other studies with different result exist; an earlier prospective study by Ali et al. (2023) documented a significant difference in satisfactory outcomes, favoring ORIF (69.4% satisfactory, with 40.8% in the ORIF group vs. 28.6% in the CRPP group), leading the authors to propose ORIF as a valid first-line treatment option (14).

Despite the potential for enhanced radiographic alignment with ORPP, CRPP is consistently highlighted in the literature for its significant practical advantages which greatly contribute to its popularity as a first line treatment. These benefits are primarily rooted in its minimally invasive nature. The method of CRPP is associated with shorter operative times and reduced exposure to anesthetic agents, and avoiding visible scarring which is a concern in pediatric patients (7, 8). Furthermore, the outcome for the patient often includes a faster recovery, manifested as a shorter hospital stay (8,21). Perhaps most importantly, CRPP demonstrates a reduced risk profile for certain complications by avoiding soft tissue dissection, it minimizes related complications and, crucially, has been shown in comparative studies to have a lower need for follow-up surgery (10). Similar result in the comparative study from Hussein et al.(2018), which concluded that

CRPP is a safe, effective, and rapid method of fixation with less complications, including a minimized risk of compartment syndrome (17).

Conversely, the principal advantage of ORPP, as demonstrated in the studies discussing radiographic outcomes, is the ability to achieve an anatomical reduction under direct vision. This method is particularly valuable in specific clinical scenarios such as cases of failed closed reduction, suspected vascular injury, or open fractures (6, 8, 16). The disadvantages of the ORPP method are consistently noted across various studies. The inevitable surgical scar remains a persistent cosmetic concern. The open approach is a more involved procedure, requiring a longer duration of operation. Additionally, as an open procedure, it carries a theoretical, though often not statistically higher in reported studies risk of deep infection (7, 16).

A systematic review comparing primary open reduction to primary closed reduction for the management of totally displaced supracondylar humerus fractures, analyzed three papers composed of 207 patients, with 112 in the closed reduction group and 95 in the open reduction group. The review assessed functional, cosmetic, and radiological outcomes across four subcategories: excellent, good, fair, and poor. Results demonstrated a statistically significant overall advantage for open reduction in achieving excellent outcomes while the poor outcome subcategory significantly favored closed reduction. Although the good and fair subcategories did not reach statistical significance, there was a trend toward good results with closed reduction and fair results with open reduction. Cosmetic outcomes showed no significant differences between the groups. Regarding complications, no cases of compartment syndrome or vascular injuries were reported in either group. Ulnar nerve injuries occurred at an overall rate of 5.79%, with 4.2% in the open reduction group and 7.14% in the closed reduction group, but it was not statistically significant. The overall pin tract infection rate was 5.31%, with nearly equal incidence between groups, also lacking statistical significance. Wound issues were minimal, with only one reported superficial infection and no cases of problematic scarring or avascular necrosis of the trochlea (19).

A 19-year retrospective study done by Parikh et al. 490 pediatric supracondylar humerus fractures treated with percutaneous pinning reported an overall pin tract infection rate of 4.3% (21 patients), comprising 3.1% superficial and 1.2% deep infections. A key finding was that deep infections occurred exclusively with lateral-entry pin constructs (5 parallel, 1 crossed), despite the use of preoperative antibiotics and timely surgery. Superficial infections resolved with oral antibiotics and pin removal, while deep infections required operative irrigation, debridement, and prolonged intravenous antibiotics; all patients ultimately achieved excellent long-term functional outcomes (20).

A systemic review and meta-analysis was conducted by Bo Gou, et al, in Hubei University of Medicine, P. R. China, 2018, to compare the effectiveness and safety of open or closed reduction and percutaneous

pinning for pediatric displaced supracondylar humerus fractures. systematically compared the effectiveness and safety of closed reduction and percutaneous pinning (CRPP) versus open reduction and percutaneous pinning (ORPP) for pediatric displaced supracondylar humerus fractures. The study encompasses 502 patients, and the authors found no statistically significant differences between the two surgical approaches in critical radiographic outcomes (carrying angle and Bauman angle) or in overall complication rates. However, the study identified several advantages for the CRPP technique. Specifically, patients treated with CRPP experienced a shorter hospital stay, a reduced bone union time, and reported a higher satisfaction rate. The study concludes that while both methods are comparably safe and effective in achieving fracture reduction, CRPP offers superior perioperative efficiency and patient-reported outcomes, supporting its role as the preferred initial intervention when anatomically feasible (21,22).

In conclusion the current literatures present a clear and evidence based picture that both CRPP and ORPP are highly effective and successful treatment modalities for displaced pediatric supracondylar humerus fractures. The choice is not between a superior and an inferior technique but between two approaches with distinct benefit risk profiles. CRPP is generally favored for its minimally invasive nature, efficiency, shorter recovery, and lower rate of secondary procedures, making it an excellent first-line option for the majority of fractures in the presence of intraoperative fluoroscopic imaging. ORPP while more invasive, should be considered in cases where anatomical reduction is difficult to achieve through closed means and in areas where there is lack of C-ARM, as it may offer an advantage in achieving more precise radiographic alignment and potentially reducing the long-term risk of cubitus varus, at the cost of a surgical scar and longer operation time. Ultimately, the decision must be individualized, considering the specific fracture characteristics, the surgeon's expertise, and the presence of intraoperative imaging. This study at Tikur Anbessa Specialized Hospital aims to contribute vital local context and data to this ongoing global discussion, helping to refine these treatment principles within its specific patient population.

3. Objectives of the study

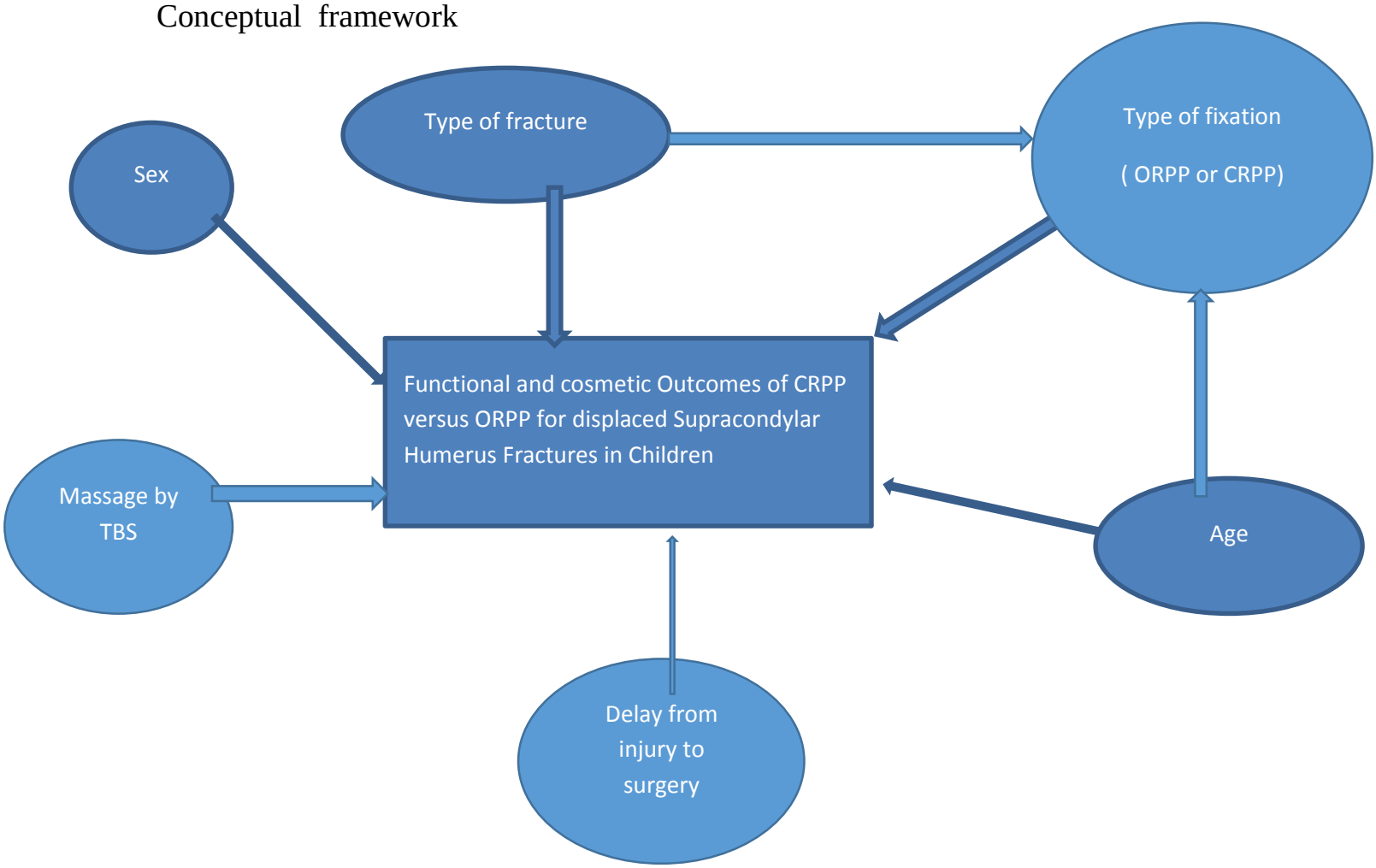
3.1 General objective

- To compare the functional and cosmetic outcomes between Closed Reduction Percutaneous Pinning (CRPP) and Open Reduction Percutaneous Pinning (ORPP) for the treatment of displaced supracondylar humerus fractures in children at Tikur Anbessa Specialized Hospital from May 1, 2021, to April 30, 2025.

3.2 Specific Objectives

- To evaluate and compare the range of motion (ROM) in the injured elbow between the two treatment groups.
- To evaluate and compare the cosmetic outcome in the injured elbow between the two treatment groups.
- To determine and compare the overall complication rates associated with CRPP and ORPP
- To analyze postoperative hospital-stay between the two surgical techniques.

Conceptual framework



4. Methods and Materials

4.1 Study setting and Period

This study will be a retrospective comparative analysis conducted at the Tikur Anbessa Specialized Hospital (TASH) Addis Ababa, Ethiopia. TASH is the largest tertiary teaching and referral hospital in the country, which makes it an ideal setting for studying the management of pediatric orthopedic injuries such as displaced supracondylar humerus fractures. The study will include all eligible pediatric patients who underwent surgical intervention either Closed Reduction and Percutaneous Pinning (CRPP) or Open Reduction and Percutaneous Pinning (ORPP) for this specific injury at TASH. The review period will span 48 months, from May 1, 2021, to April 30, 2025. This timeframe is selected to have better sample size for statistical comparison between the two treatment groups while providing a contemporary overview of the current practices and outcomes at the institution.

4.2 Study design

A retrospective cohort study design will be utilized.

4.3 Population

4.3.1 Source Population

It comprise all pediatric patients (aged <16 years) who presented with a displaced supracondylar humerus fracture (Gartland type III, and IV , flexion-type) and underwent surgical management with either Closed Reduction and Percutaneous Pinning (CRPP) or Open Reduction and Percutaneous Pinning (ORPP) at the Tikur Anbessa Specialized Hospital (TASH) in Addis Ababa, Ethiopia, from May 1, 2021, to April 30, 2025.

4.3.2 Study Population

It consists of all pediatric patients (aged <16 years) who were diagnosed with a displaced supracondylar humerus fracture (Gartland type III, and IV) and underwent surgical intervention with either Closed Reduction and Percutaneous Pinning (CRPP) or Open Reduction and Percutaneous Pinning (ORPP) at the Tikur Anbessa Specialized Hospital (TASH) between May 1, 2021, and April 30, 2025.

4.3.3 Study Unit

Each and every member of the sample who are selected from the sampling

4.4 Eligibility Criteria

4.4.1 Inclusion Criteria**: -**

To be eligible for inclusion in the study, patients must meet all of the following criteria:

- Age: <16 years old at the time of the fracture.
- Diagnosis: Radiographically confirmed, displaced supracondylar humerus fracture
- Treatment: Underwent surgical intervention with either Closed Reduction and Percutaneous Pinning (CRPP) or Open Reduction and Percutaneous Pinning (ORPP).
- Timing: Treated at TASH between May 1, 2021, and April 30, 2025
- Medical Records: Availability of a complete medical record including operative notes, pre-and post-operative radiographs, and discharge summary.

4.4.2 Exclusion Criteria: -

Patients will be excluded from the study based on the following criteria:

- Pathological Fractures: Fractures caused by underlying bone disease
- Open fractures and fracture with neurovascular injury
- Polytrauma Patients: Children with multiple major injuries that would significantly influence functional recovery or complication rates
- Incomplete Records: Patients with missing medical records, or insufficient data to classify the fracture type or surgical procedure.
- Lost to Follow-up: Patients who cannot be reached or whose families decline to participate.

4.5 Sample size determination and sampling procedures

- A convenience sample of all eligible patients from May 1, 2021, and April 30, 2025.

4.6 Study Variables

Dependent variable - Functional and cosmetic outcome of displaced supracondylar managed surgically

Independent variables - age

- sex

- type of fracture

- type of fixation

- massaged by TBS

4.7 Operational definitions and Measurements

- Functional outcome is defined as the recovery of elbow function, measured by a combination of objective range of motion (ROM) and patient/parent-reported outcome score.
- Flynn's Criteria**:** This is the most commonly used outcome measure for this specific fracture. It provides a composite rating based on cosmetic (carrying angle) and functional (loss of motion) factors.
    - Loss of Motion (Functional Factor): Measured using a standard long-arm goniometer. The total arc of flexion-extension of the injured elbow will be compared to the uninjured, contralateral elbow. The difference is recorded as "loss of motion in degrees."
    - Carrying Angle Change (Cosmetic Factor): The carrying angle of both elbows will be measured with a goniometer in full extension and supination. The difference between the injured and uninjured sides is recorded as change in carrying angle in degrees.
    - Grading: Based on the results, each elbow is graded as

    - Satisfactory: Excellent (0°-5° loss of motion/change in angle), Good (6°-10°)
    - Unsatisfactory: Fair (11°-15°), Poor (>15°)
- Complication Rate: Any undesirable event, directly or indirectly related to the fracture or the treatment method.
- Iatrogenic Nerve Palsy: Any new sensory or motor deficit in the ulnar, radial, or median nerve distribution identified post-operatively.
- Compartment Syndrome: A clinical diagnosis of increased pressure within the osteofascial compartment leading to impaired perfusion.
- Radiographic Outcome: The quality of fracture reduction and healing as assessed on standard anteroposterior (AP) and lateral radiographs.
- Baumann's Angle: On the AP view, the angle between the physeal line of the lateral condyle and the long axis of the humerus.

4.8 Data collection method, tool and procedures

Study Design: A retrospective comparative cohort study with convenient sampling.

Data Collection Method: The primary method of data collection will be a retrospective review of medical records supplemented by a structured interview and physical examination for collecting functional outcome data at follow-up.

Data Collection Tools:
Two primary tools will be used:

a) Data Abstraction Form (For retrospective chart review):
This is a structured, pre-piloted form created in Microsoft Excel to ensure consistent and complete data extraction. It will include the following sections:

- Patient Demographics: Unique study MRN, age at surgery, gender, affected side.

- Fracture Characteristics: Gartland classification (Type III, IV), neurovascular status at presentation (documenting any preoperative nerve palsies or pulselessness), associated injuries.

- Treatment Data:

    - Treatment group (CRPP vs. ORPP)
    - Number of K-wires used, configuration
    - Operative time (from incision to closure)

b) Structured Interview Questionnaire:

This will be a scripted questionnaire administered to the parents/guardians of the children. It will be designed to assess long-term functional outcomes and will include validated scoring systems:

- Demographic Verification: Confirm identity and consent.
- Subjective Questions:

    "Is your child experiencing any pain, numbness, or tingling in the elbow/ forearm?"
    "Have you noticed any difference in the appearance of the elbow compared to the other arm?"
    "Has your child returned to all their previous sports and activities?"
    "Overall, how satisfied are you with the outcome of the treatment?"

Data Collection Procedure:

Step 1: Identification of Eligible Cohort (Convenience Sampling)

- The hospital's electronic medical record (EMR) system and HMIS are used
- This will generate a list of all pediatric patients (<16 years old) treated for a displaced SCH fracture by CRPP or ORPP within the defined study period.

- Inclusion/Exclusion Criteria**:** This list will be manually screened by a research assistant (RA) to apply the inclusion/exclusion criteria.

Step 2: Data Abstraction from Medical Records

- A principal investigator will access the selected patient records.

- Using the pre-designed Data Abstraction Form, they will systematically extract all relevant pre-, intra-, and post-operative data.
- All data will be de-identified at the point of entry using a unique study ID.

Step 3: Conducting Structured Interviews

- For patients whose records indicate a healed fracture and who are beyond a minimum follow-up period (e.g., >6 months' post-op), contact information will be retrieved from the EMR.
- Parents/guardians will be contacted via telephone. The study will be explained, and verbal informed consent will be obtained.
- Structured Interview Questionnaire will be done.

4.9. Data quality control

A multi-faceted quality control protocol will be implemented throughout the study period. Prior to formal data collection, the data extraction questionnaire pretested on a cohort representing 5% of the sample size. The results of this pretest will be critically evaluated by the research team to identify and implement necessary amendments to the instrument's structure, including the content clarity, logical sequencing, and grammatical precision. During the active study period, from May 1, 2021, to April 30, 2025, the principal investigator will perform immediate checks on all collected data for completeness, accuracy, clarity, and internal consistency.

4.10 Data processing and analysis plan

This retrospective cohort study will analyze data from pediatric patients treated for displaced supracondylar fractures with either Closed Reduction Percutaneous Pinning (CRPP) or Open Reduction Percutaneous Pinning (ORPP) between May 1, 2021, and April 30, 2025. Data will be systematically extracted from electronic medical records (EMRs). Key variables to be collected will include patient demographics (age, sex), fracture characteristics (Gartland classification, neurovascular status on presentation), operative details and complication data (iatrogenic nerve palsy, infection, loss of reduction, re-operation). The primary functional outcome will be the final range of motion (ROM) at the elbow, measured in degrees of flexion and extension, and cosmetic

outcome which is change in carrying angle with a clinically significant difference defined as a loss of >10° compared to the unaffected limb.

The analysis begins with descriptive statistics. All continuous variables including patient age, time from injury to surgery, and postoperative hospital stay will be assessed for normality using appropriate tests and subsequently reported either as means with standard deviations (for normally distributed data) or as medians with interquartile ranges (for non-normally distributed data). Categorical variables, such as patient sex, mechanism of injury, affected side, treatment type (CRPP vs. ORPP), and the occurrence of specific complications, will be summarized as frequencies and percentages. For the initial comparative analysis, categorical outcomes including the dichotomized Flynn criteria (excellent/good vs. fair/poor for both functional and cosmetic outcomes) and overall complication rates will be compared between the CRPP and ORPP groups using either the Chi-square test or Fisher's exact test, based on expected cell counts. To rigorously assess the independent effect of the surgical technique (CRPP vs. ORPP) on outcomes while controlling for potential confounding variables, advanced multivariate regression modeling will be performed. Any variable demonstrating an association with the outcome at a univariate p-value of <0.25 will be considered a candidate for inclusion in the initial multivariate model to ensure no important confounders are prematurely excluded. For all inferential analyses, a two-sided p-value of <0.05 will be considered the threshold for statistical significance. All analyses will be performed using a validated statistical software package, SPSS version 27.0.

4.11 Ethical Considerations:

- The study protocol will be submitted for approval by the Institutional Review Board (IRB) before any data collection begins.
- For the retrospective chart review component, a request for informed consent will be sought due to the minimal risk nature of reviewing existing records.
- Verbal informed consent will be meticulously obtained on phone call from the parent/guardian and documented before proceeding. The consent script will explain the purpose of the study, the voluntary nature of participation, and the confidentiality of their responses.

4.12 Dissemination of results

The findings of the study will be submitted in both hard and soft copy to the department of orthopedics and trauma surgery, TASH. The result of the study will be presented to Tikur anbessa specialized hospital, TASH research coordinate office, to department of Orthopedics and Traumatology and also presented in front of audience as a graduation thesis and to other concerned bodies as per need. Through publication the research result will reach other concerned and interested bodies.

5. Result

5.1 Demographic Characteristics of the Study Sample

The characteristics of a study comparing the two surgical techniques: Closed Reduction Percutaneous Pinning (CRPP) and Open Reduction Percutaneous Pinning (ORPP), in a cohort of 65 pediatric patients. The analysis reveals no statistically significant differences between the two treatment groups across all measured parameters, indicating that the groups were well matched and comparable at the outset.

In terms of age, the overall sample had a mean age of 7.82±3.14 years. The ORPP group was slightly older on average 8.03 ± 2.8 years compared to the CRPP group 7.52 ± 3.56 years, but this difference was not statistically significant ($p = .525$).

Gender distribution also showed no significant disparity ($p = .322$). Males constituted the majority in both the overall sample (66.2%) and within each surgical group (59.3% in CRPP and 71.1% in ORPP). The side of the injury (right vs. left) was nearly evenly split in the total cohort (28:37) and was similar between the CRPP (13:14) and ORPP (15:23) groups, with no significant difference ($p = .486$).

A critical pre-operative factor, the time delay between the injury and the surgical procedure, was almost identical for both groups. The mean time was 5.96 ±2.45 days for CRPP and 6.67±2.40 days for ORPP, a non-significant difference ($p = .261$). Furthermore, a notably high proportion of patients (29.2%) had received prior massage treatment from a traditional bone setter (TBS), with nearly identical rates in the CRPP (29.6%) and ORPP (28.9%) groups ($p = .952$).

Finally, the mechanism of injury was consistent across groups. The vast majority of injuries in both the CRPP (77.8%) and ORPP (78.9%) groups were caused by "Falling on playground," with a smaller percentage from "Falling from height." This distribution was not significantly different ($p = .910$).

In conclusion, the comprehensive demographic analysis demonstrates that the 27 patients in the CRPP group and the 38 patients in the ORPP group were highly comparable in terms of age, gender, injury laterality, pre-surgical delay, exposure to traditional treatment, and injury mechanism. The absence of any statistically significant differences (all p-values > .05) suggests

that any variations observed in future outcome measures, such as functional recovery and complication rates can more reliably be attributed to the difference in surgical technique (CRPP vs. ORPP) rather than to underlying demographic or injury related confounding factors.

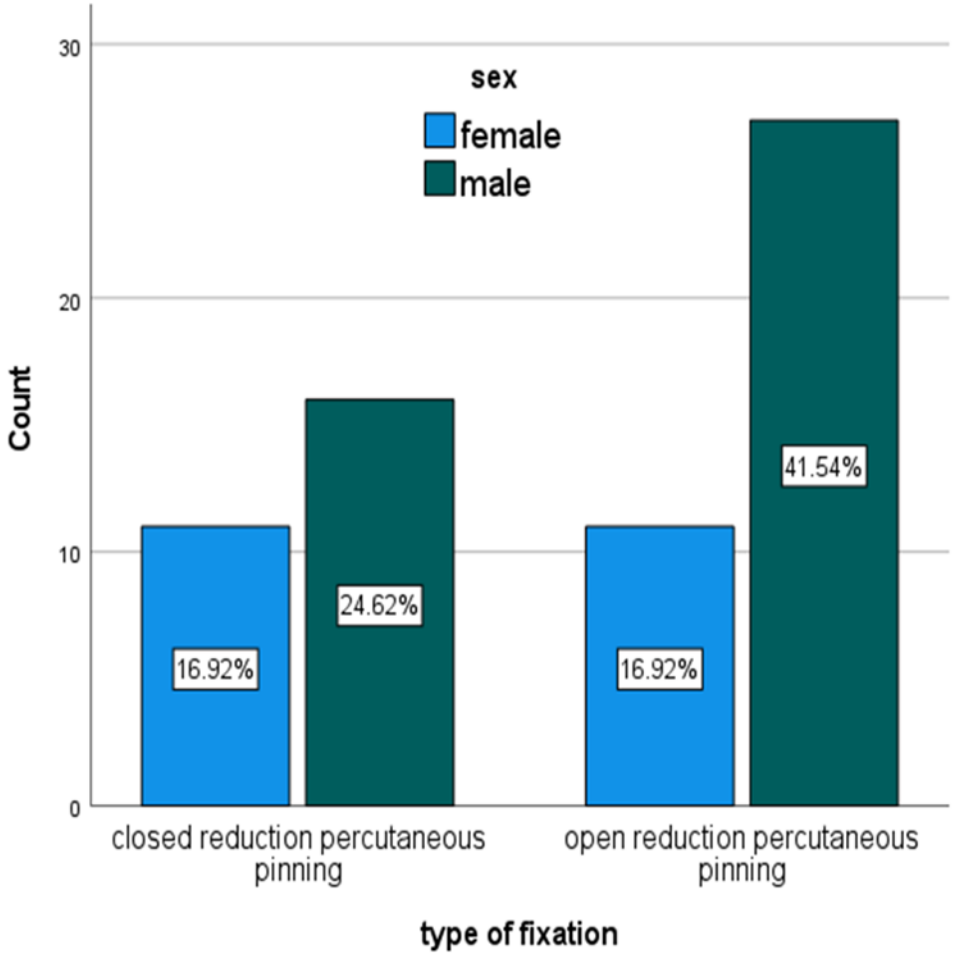


FIG. A bar chart dipicting gender distribution based on the type of fixation

Parameter	Overall sample (N = 65)	CRPP (n = 27)	ORPP (n = 38)	P-value (ORPP vs. CRPP)
Age (M ± SD)year		7.52±3.56	8.03±2.8	.525[a]
Age category in year				.334[a]
≤5	14(21.5)	8(29.6)	6(15.8)	
6-10	35(53.8)	12(44.4)	23(60.5)	
11-15	16(24.6)	7(25.9)	9(23.7)	
Gender				.322[b]
Female	22(33.8)	11(40.7)	11(28.9)	
Male	43(66.2)	16(59.3)	27(71.1)	
Side of injury (right: left)	28:37	13:14	15:23	.486[b]
Time between injury and surgery (M ± SD)	---	5.96±2.45	6.67±2.40	.261[a]
Massaged by TBS : No	46(70.8%)	19(70.4)	27((71.1)	.952[a]
Yes	19(29.2%)	8(29.5)	11(28.9)	
Mechanism of injury				.910a
Falling from height		6(22.2)	8(21.1)	
Falling on playground		21(77.8)	31(78.9)	

TABLE 1: Demographic data comparing CRPP and ORPP groups

M = mean; SD = standard deviation; CRPP = closed reduction with percutaneous pinning; ORPP = open reduction with percutaneous pinning; [a] = Mann-Whitney U test; [b]= chi-square test; * = statistically significant, TBS=traditional bone setter

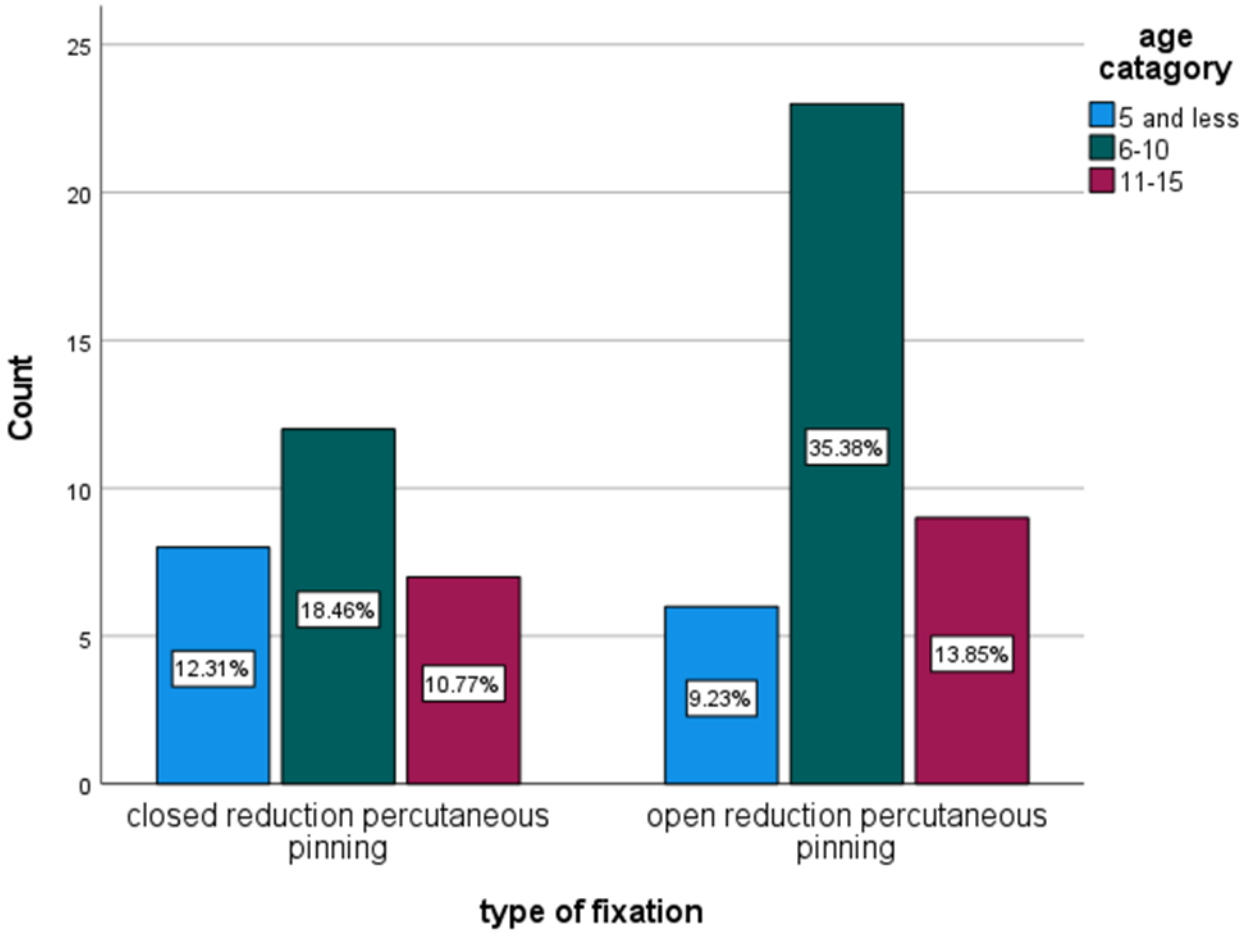


Fig. A bar chart showing age catagory based on the type of fixation

5.2 Comparative analysis of factors between CRPP and ORPP

	Overall sample	CRPP	ORPP	P-value
Parameters				
Change in Carrying angle post-union (degrees)				.975[a]
≤5 (excellent)	44(67.7)	18(66.7)	26(68.4)	
6-10 (good)	14(21.5)	6(22.2)	8(21.1)	
11-15 (fair)	3(4.6)	1(3.7)	2(5.3)	
>15 (poor)	4(6.2)	2(7.4)	2(5.3)	
Change in range of motion post-union(degrees)				.160[a]
≤5 (excellent)	37(56.9)	12(44.4)	25(65.8)	
6-10 (good)	19(29.2)	12(44.4)	7(18.4)	
11-15 (fair)	6(9.2)	2(7.4)	4(10.5)	
>15 (poor)	3(4.6)	1(3.7)	3(5.3)	
Functional outcome (based on Flynn criteria)				.590[a]
Satisfactory	56(86.2)	24(88.9)	32(84.2)	
Non-satisfactory	9(13.8)	3(11.1)	6(15.8)	
Cosmetic outcome (based on Flynn criteria)				.940[a]
Satisfactory	58(89.2)	24(88.9)	34(89.5%)	
Non-satisfactory	7(10.8)	3(11.1)	4(10.5)	
Pin site infection				.669[a]
Yes	6(9.2)	2(7.4)	4(10.5)	
No	59(90.8)	27(92.6)	34(89.5)	
Postop Hospital stay time (M ± SD) (days)		2.56±.75	3.82±1.1	<.001*
Vascular injury (cases)	0	0	0	-
Hypertrophic scar (cases)	0	0	0	-

Nerve injury	0	0	0	-

TABLE 2: Comparison of the clinical and cosmetic outcomes between CRPP and ORPP.

M = mean; SD = standard deviation; CRPP = closed reduction with percutaneous pinning; ORPP= open reduction with percutaneous pinning * = significant at the 0.05 level [a] = chi-square test

The data reveals that while both methods are highly effective and safe overall, with no major complications like nerve or vascular injuries in either group, there is one statistically significant difference in a practical measure of patient recovery.

The core findings demonstrate remarkable similarity between the two techniques across most measured parameters. For the critical outcomes of bone alignment (carrying angle change) and final patient function and appearance, there were no significant differences. The change in carrying angle post-healing was nearly identical between groups, with the vast majority of patients (67.7% overall) achieving an excellent result (5 degrees or less of change). Functional outcomes, rated by the Flynn criteria, were satisfactory in both groups (86.2% overall), with no statistical difference. Similarly, cosmetic outcomes were also highly satisfactory (89.2% overall) and equivalent between techniques. Minor complication rates further underscore their comparable safety profiles: pin site infections occurred at a low and statistically similar rate (~9% overall), and there were no cases of hypertrophic scarring.

However, the analysis identified one area where the two techniques diverge significantly: postoperative hospital stay. Patients who underwent ORPP had a notably longer average hospitalization (3.82 ± 1.1 days) compared to those who had CRPP (2.56 ± 0.75 days). The P-value of **<.001** for this measure is highly statistically significant, indicating this difference is very unlikely to be due to chance. This suggests that the less invasive CRPP procedure, which does not require a surgical incision to visualize the fracture, is associated with a shorter postoperative in-hospital stay, allowing for earlier discharge.

In conclusion, the expanded interpretation of this data indicates that both CRPP and ORPP are excellent surgical options for this injury, yielding similarly high rates of successful anatomical,

functional, and cosmetic results with low complication rates. The primary practical advantage of CRPP appears to be a shorter postoperative hospital stay, which can reduce healthcare costs and minimize family disruption. The choice of technique may therefore depend on specific fracture characteristics (whether it can be adequately reduced closed), surgeon expertise, availability of intraoperative imaging and the value placed on minimizing hospitalization time, given that both methods ultimately deliver equivalent final outcomes.

Result	Motion restriction (flexion and extension)	Changes in carrying angle (loss)
Excellent	0°–5°	0°–5°
Good	5°–10°	5°–10°
Fair	10°–15°	10°–15°
Poor	15°	15°

Table 3: Grading of outcome according to Flynn's criteria

5.3 Univariate and Multivariate analysis for factors affecting functional outcome

Variables	Functional outcome		COR(95%CI)	AOR(95%CI)	*P- value*
	Satisfactory	Non satisfactory			
Age group in years				--	
≤5	13(82.4)	1(17.6)			
6-10	32(91.4)	3(8.6)	1.219(.116,12.820)	1.244(.117,13.221)	.869
11-15	11(62.5)	5(37.5)	5.909(.597,81.08)	5.339(.528,54.018)	.129[a],.**156**[b]
Sex					
Male	37(66.1)	6(66.7)	1.027(.231,4.567)	--	.972[a]
Female	19(33.9)	3(33.3)			
Affected side of arm					
Right	25(44.6)	3(33.3)			
Left	31(55.4)	6(66.7)	1.613(.366,3.7.104)	--	.527[a]
Massaged by TBS				--	
No	40(87)	6(13)	.800(.178,3.594)	--	.771[a]
Yes	16(84.2)	3(15.8)			
Type of fixation				--	
CRPP	24(88.9)	3(11.1)	.667(.151,2.939)		.592[a]
ORPP	32(84.2)	6(15.8)			
Pin site infection				--	
Yes	4(66.7)	2(33.3)	3.714(.571,24.144)	2.610(.353,19.300)	.169[a],.347[b]
No	52(88.1)	7(11.9)			
Mechanism of injury				--	
Falling from height	11(78.6)	3(21.4)	2.045(.441,9.491)		. 361[a]

Falling on playground	45(88.2)	6(11.8)			
Time from injury to surgery in days (M±SD)	6.3±2.31	6.78±3.270	(-2.235,1.287)	--	.592[a]
Postop Hospital stay time (M ± SD) (days)	3.32±1.162	3.11±.928	(-.604,1.025)	_	.608[a]

M = mean; SD = standard deviation; CRPP = closed reduction with percutaneous pinning; ORPP= open reduction with percutaneous pinning, [a] =P value of univariate analysis. [b]=P value of multivariate regression analysis, COR= crude odds ratio, AOR= adjusted odd ratio, CI= confidence interval

TABLE 4: Univariate and Multivariate Logistic Regression Analysis of Factors Associated with Unsatisfactory Functional Outcome.

The results indicate most variables did not show statistically significant association with unsatisfactory functional outcome in the multivariate analysis, as evidenced by p-values > 0.05 and confidence intervals for adjusted odds ratios (AOR) that crossed the value 1. For instance, older children aged 11–15 years showed higher point estimate for the odds of unsatisfactory outcome (AOR: 5.339), but this was not statistically significant (p = 0.156). Similarly pin site infection was associated with increased odds of unsatisfactory outcome (AOR: 2.610), but again, this association was not statistically significant (p = 0.347). Variables such as sex, affected side, massage, fixation type, injury mechanism, and timing-related factors demonstrated no significant independent associations in the multivariate analysis. Overall, while certain factors like older age and pin site infection suggested a potential trend toward poorer functional results, no factor emerged as a statistically significant independent predictor of unsatisfactory functional outcome in this model.

5.4 Univariate and Multivariate analysis for factors affecting cosmetic outcome

Variables	Cosmetic outcome		COR(95%CI)	AOR(95%CI)	*P- value*
	Satisfactory	Non satisfactory			
Age group in years				--	
≤5	13(92.9)	1(7.1)			
6-10	31(88.6)	4(11.4)	1.677(.171,16.482)	--	.657[a]
11-15	14(89.2)	2(10.8)	1.857(.150,22.998)	--	.630[a]
Sex					
Male	40(93.0)	2(7.0)	.338(.068,1.667)	.207(.027,1.579)	.183[a],.**129**[b]
Female	18(81.8)	4(18.2)			
Affected side of arm				--	
Right	26(92.9)	2(7.1)			
Left	32(86.5)	5(13.5)	2.031(.364,11.338)		.419[a]
Massaged by TBS				--	
No	42(91.3)	4(8.7)		--	
Yes	16(84.2)	3(15.8)	1.969(.396,9.789)		.408[a]
Type of fixation				--	
CRPP	24(88.9)	3(11.1)	1.062(.218,5.087)		.940[a]
ORPP	34(89.5)	4(10.5)			
Pin site infection				--	
Yes	4(66.7)	2(33.3)			
No	54(91.5)	5(8.5)	.185(.027,1.274)	.148(.012,1.846)	.087[a],.**165**[b]
Mechanism of injury				--	
Falling from height	12(85.7)	2(14.3)	1.533(.264,8.9)		.634[a]
Falling on playground	46(90.2)	5(9.8)			

Time from injury to surgery (M±SD) days	6.16±2.3	8.14±3.024	$(-3.890, -0.86)$	1.609(1,033,2.479)	.041[a],.**036[b]***
Postop Hospital stay time (M ± SD) (days)	3.21±1.088	4±1.091	(-1.680,.094)	1.779(.825,3.836)	.079[a],.141[b]

[a] –P value of univariate analysis. [b]-P value of multivariate regression analysis, [b*]statistically significant p value

TABLE 5: Univariate and Multivariate Logistic Regression Analysis of Factors Associated with Unsatisfactory Cosmetic Outcome.

The primary factor significantly associated with an unsatisfactory cosmetic outcome following surgery was the time delay from injury to surgery. For each additional day of delay, the adjusted odds of an unsatisfactory outcome increased by approximately 61% (AOR=1.609, 95% CI: 1.033 to 2.479, p=0.036). The mean time to surgery was also significantly longer in the unsatisfactory group (8.14 days) compared to the satisfactory group (6.16 days). While not reaching statistical significance in the multivariate model, the presence of a pin site infection showed a strong concerning trend, substantially increasing the odds of a poor cosmetic result by over 85% in the univariate analysis (COR=0.185). Other demographic, clinical, and surgical variables including age, sex, affected side, use of traditional bone setting massage, type of fixation (CRPP vs. ORPP), and mechanism of injury demonstrated no statistically significant association with cosmetic outcome in this analysis. The length of postoperative hospital stay was longer in the unsatisfactory outcome group but was not a statistically significant predictor in the final adjusted model.

Parameter	CRPP (n=27)	ORPP (n=38)	P-value
Functional Outcome (Satisfactory)	24 (88.9%)	32 (84.2%)	0.590
Cosmetic Outcome (Satisfactory)	24 (88.9%)	34 (89.5%)	0.940
Change in Carrying Angle (Excellent)	18 (66.7%)	26 (68.4%)	0.975
Change in Range of Motion (Excellent)	12 (44.4%)	25 (65.8%)	0.160
Pin Site Infection	2 (7.4%)	4 (10.5%)	0.669
Major Complications (neurovascular injury)	0	0	-
Postoperative Hospital Stay (Days)	**2.56 ± 0.75**	**3.82 ± 1.1**	**<0.001***
Implication	Preferred minimally invasive method when intraoperative imaging (C-arm) is available.	An excellent, equivalent alternative when C-arm is not available.	

Table: overall summary of the comparative study of CRPP Vs. ORPP

6.DISCUSSION

The findings of the study contribute valuable data to the ongoing surgical debate regarding the proper management of displaced pediatric supracondylar humerus fractures. The results strongly align with the literature that both Closed Reduction Percutaneous Pinning (CRPP) and Open Reduction Percutaneous Pinning (ORPP) are safe and effective procedures with largely equivalent final functional and cosmetic outcomes.

The core finding of this study is that there were no statistically significant differences in satisfactory functional (CRPP: 88.9% vs. ORPP: 84.2%, p=0.590) and cosmetic (CRPP: 88.9% vs. ORPP: 89.5%, p=0.940) outcomes, directly supports the conclusions of major systematic reviews

and recent comparative studies. This echoes the meta-analysis by Astawa et al. (2021) and the PRISMA review, which found no clear superiority between techniques. The high rate of satisfactory outcomes in both groups (>84%) further reinforces that both methods, when performed competently, are excellent surgical choices. This equivalence extends to critical safety metrics, as this study reported no major neurovascular complications in either group, a finding consistent with the systematic review that reported no vascular injuries and comparable, low rates of nerve injury between techniques.

A notable point where this study's findings diverge from several in the literature is in the domain of radiographic alignment. Studies by Tomori et al. (2018), Abousaleh et al. (2022), and Keskin & Sen (2014) consistently reported that ORPP provided superior restoration and maintenance of the carrying angle (cosmetic outcome), with a lower incidence of malunion. In contrast, our study found no significant difference in the change in carrying angle post-union between the two groups (p=0.975), with nearly identical proportions achieving "excellent" alignment. This suggests that in this cohort and with the surgical expertise involved, the theoretical advantage of direct visualization in ORPP did not translate into a measurably better outcome than a well-executed closed reduction. This outcome aligns more closely with the meta-analysis by Bo Gou et al. (19), which found no significant difference in carrying angle between CRPP and ORPP.

This study identified one highly significant difference: postoperative hospital stay was markedly shorter for the CRPP group (2.56 days vs. 3.82 days, **p<0.001**). This finding is a robust confirmation of a key practical advantage for CRPP highlighted across the literature. The systematic review by Bo Gou et al. (19), specifically concluded that CRPP resulted in a shorter mean hospital stay. This outcome has direct implications for healthcare resource utilization, cost-effectiveness, and minimizing the psychosocial disruption for the child and family.

The overall low rate of minor complications in this study is consistent with the literature. The pin site infection rate was low (9.2% overall) and statistically similar between groups (p=0.669). This rate is slightly higher than the 4.3% reported by Parikh et al. and the 5.31% from the systematic review, which may reflect differences in postoperative care protocols or definitions. Importantly,

the study adds a significant local demographic insight: the very high rate of prior massage by traditional bone setters (TBS) (29.2%). While this did not emerge as a statistically significant predictor of poor outcome in the multivariate analysis, it is a critical community health finding that underscores the common treatment pathway before reaching a hospital.

The regression analyses yielded crucial findings that resonate with surgical principles. The most significant predictor of an unsatisfactory cosmetic outcome was a longer time delay from injury to surgery (AOR=1.609 per day, p=0.036). This strongly supports the established standard of care advocating for prompt surgical intervention in displaced fractures to reduce swelling and facilitate reduction. While the literature extensively compares techniques, this finding emphasizes that *timing* may be as critical as *technique* in optimizing cosmetic results. The trend suggesting older children (11-15 years) and those with pin site infections might be at higher risk for poorer outcomes, though not statistically significant here, warrants attention in larger studies.

7. Strength of the study

It is first study on this specific topic at TASH,

The use of primary data collected directly from parents and complementing parent reports with direct examination

8. Limitation of the study

A small sample reduces the statistical power

Some incomplete documentation on outpatient clinic follow-up

Retrospective Study Design:

9.Conclusion

This study's results powerfully affirm the global consensus that CRPP and ORPP are both effective for pediatric supracondylar fractures. It strengthens the evidence for CRPP as the preferred first-line technique when a satisfactory closed reduction is achievable, primarily due to its significant advantage in reducing hospital stay without compromising final alignment, function, or safety. The findings suggest that the purported radiographic superiority of ORPP may not be universal and may depend on surgical skill and specific fracture patterns.

Simultaneously, the study validates ORPP as an essential and equivalent alternative, particularly in settings where fluoroscopic imaging (C-arm) for closed reduction is unavailable or when closed reduction fails. The equivalent final outcomes support its use without concern for inferior results.

This reinforces that beyond the technical debate of CRPP vs. ORPP, healthcare systems must prioritize timely access to surgical care to optimize outcomes for all children.

The choice between CRPP and ORPP should be guided by fracture characteristics (reducibility), availability of intraoperative imaging and surgeon expertise.

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Annexes

Annex I: Information Sheet

My name is Dr. Tefera Belay, a final-year Orthopedics and Trauma surgery resident at Tikur Anbessa Specialized Hospital (TASH). I am conducting a research study comparing the functional and cosmetic outcomes of two surgical technique; Closed Reduction Percutaneous Pinning (CRPP) and Open Reduction Percutaneous Pinning (ORPP) for displaced supracondylar humerus fractures in children at TASH. Your child has been identified as a potential participant in this important study. Before you decide whether to participate, it is essential you understand the study's purpose and what it involves. This study will be conducted at TASH in Ethiopia, and participation is entirely voluntary. Your decision to participate or not will not impact your child's current or future care in any way, and there is no financial incentive for involvement. If you agree to take part, we will schedule a time for you to bring your child to TASH for a brief examination of their elbow's range of motion and to complete a questionnaire. All information collected from your child's medical records and from our interview will be kept confidential.

You are welcome to contact me, the Principal Investigator, if you have any questions.

Dr. Tefera Belay, +251-912690921 or +251-945193503,

Advisor: - Dr. Birhanu Ayana (MD, Associate Professor of Pediatric Orthopedic Surgery)

Coadvisor: - Dr. Bahiru (MD, consultant orthopedic and trauma surgeon), Dr. Samrawit Esayas (MD, consultant orthopedic and trauma surgeon)

The findings from this research will be available through future scientific publications and conference presentations. This study is sponsored by TASH.

Annex II:Informed Consent sheet

I confirm that the foregoing information regarding this study has been read to me, and I have had the opportunity to ask questions. All questions I have asked have been answered to my full satisfaction.

I understand that my participation is voluntary and that I may withdraw at any time without any penalty or loss of benefits to which I am otherwise entitled.

I hereby consent voluntarily to participate in this study.

_____ _____

Signature of Participant (Parent/Guardian) Date

_____ _____

Signature of Investigator Date

Annex III : From Patient Medical Records

Patient Unique ID: _____

Date of Chart Review: _____

A. Demographic & Pre-Operative Data

1. Date of Surgery: _____
2. Patient Age at Surgery: _____ years
3. Sex: Male / Female
4. Mechanism of Injury: Fall from height /Fall on playground / Road Traffic Accident/Other: _____
5. Affected Arm: Left / Right
6. Gartland Classification (from X-ray): Type III / Type IV
7. Neurovascular Status at Presentation:
    - Pulses: Palpable / Absent / Not documented
    - Capillary Refill: <2 sec />2 sec / Not documented
    - Nerve Palsy: None / Anterior Interosseous Nerve (AIN)/ Radial Nerve / Ulnar Nerve / Median Nerve / Not documented

B. Operative Data

8. **Surgical Technique:** Closed Reduction Percutaneous Pinning (CRPP) /Open Reduction Percutaneous Pinning (ORPP)

9. **Reason for Open Reduction (if ORPP):** Failed closed reduction /Vascular injury /Open fracture /lack of C-ARM/Other: _____

10. **Number of Pins Used: _____**

11. **Pin Configuration:** Lateral-only /Crossed (Medial & Lateral) /Other: _____

12. **Operative Time (from skin incision to closure): _____** minutes

13. **Documented Intra-Operative Complications:** None / Iatrogenic nerve injury (Specify: _____) / Vascular injury / Other: _____

C. Immediate Post-Operative & Inpatient Data (from discharge summary)

14. **Post-op Neurovascular Status:**

* Pulses: [ ] Palpable [ ] Absent [ ] Not documented

* Nerve Palsy: [ ] None [ ] AIN [ ] Radial [ ] Ulnar [ ] Median [ ] Not documente

15. **Other Inpatient Complications:** [ ] None [ ] Compartment Syndrome [ ] Superficia

Infection [ ] Deep Infection [ ] Pin site irritation [ ] Other: _____

16. **Length of Hospital Stay: _____** days

Annex IV: Structured Follow up Interview Questionnaire

Good morning/afternoon. My name is Tefera Belay; I am calling from Tikur Anbessa specialized Hospital's Orthopedic Department. We are conducting a follow-up study on children who had surgery for a broken elbow between May 2021 and April 2025. Your child, _____ was identified as part of this study. The call should take about 10 minutes. Your participation is voluntary and all information will be kept confidential. Would you be willing to participate?"

Patient Unique ID: _____

Date of Interview: _____

Interviewer Name: _____

A. Consent Verification & Current Status

1. "Have you previously provided consent for us to use your child's medical records for this study?" Yes / No
2. "How is your child's elbow doing now compared to before the injury?" Back to completely normal / Much better / A little better / Same / Worse

B. Functional Outcome Assessment (Flynn's Criteria - Parent Report)

3. "Is your child able to fully straighten their elbow so their arm is perfectly straight?"

   Yes, fully straight (No loss of extension)

   No, there is a slight bend (Loss of extension: _____ degrees)

4. "Is your child able to fully bend their elbow to touch their shoulder?"

   1. Yes, fully bent (No loss of flexion)
   2. No, it doesn't quite touch (Loss of flexion: _____ degrees)

5. When your child stands with their arms straight and palms facing forward, does the injured arm look different from the other arm at the elbow? For example, does it angle outwards or inwards more than the other one? (Assessing carrying angle)

   No, it looks the same as the other arm (No change in carrying angle)

   Yes, it looks slightly different (Change in carrying angle)

6. "Does your child have any pain in the elbow during daily activities or play?"

   No, never

   Occasionally, with heavy activity

   Frequently, limits activity

   Always, severe pain

C. Complication Screening

7. "Since the surgery and recovery, has your child experienced any numbness, tingling, or 'pins and needles' in the hand or fingers of the injured arm?" No / Yes (If yes, specify: _____)
8. "Has your child had any weakness in gripping or moving the hand or wrist?" No / Yes
9. "Did your child have any problems with the pin sites after surgery, like redness, drainage, or infection?" No / Yes
10. "Have you noticed any difference in the appearance of the elbow, like a bump or deformity?"

No /Yes

11. "Has your child required any additional treatment or surgery on the same elbow since the first operation?" No / Yes (If yes, specify: _____)

D. Overall Satisfaction

12. "Overall, how satisfied are you with the outcome of your child's surgery and their current level of function?"

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very Dissatisfied

Closing

"Thank you so much for your time and for sharing this important information. It will greatly help us improve care for future children. The results of this study will be published, and you can access them. If you have any concerns about your child's elbow, please follow up with the orthopedic clinic at TASH. Do you have any final questions for me?"

Annex V-Declaration sheet

I the undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress report to my advisor and coadvisor, seek the necessary advice and approval from my primary advisors in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name of the student: Tefera Belay (MD, Orthopedics and Traumatology Resident)

Signature: _____

Date: _____

Approval of the Primary Advisor

Name of the primary advisor: Dr. Birhanu Ayana (MD, Associate Professor of Pediatric orthopedic surgery)

Signature: _____

Date: _____