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Original Research Article

Presentation and treatment of pediatric supracondylar fractures of the distal humerus at Prince Rashid ibn Al-Hasan Military hospital

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ABSTRACT

Background: A supracondylar humerus fracture (SCH) is one of the common fractures that are seen in the pediatric age group, with the most common age (5-7) years as described in the literature. Objectives was to study the presentation and treatment of SCH fractures in children at Prince Rashid bin Al Hassan Military Hospital, Jordanian Royal Medical Services.
Methods: This study followed a retrospective design. Patients' ages (1-14) years who attended the emergency department of Prince Rashid Hospital and were diagnosed with SCH were included in this study. All these patients' data were statistically analyzed; descriptive analysis was performed for all variables. An association analysis used a chi-square test to find any association between the study variables and treatment modality variables.
Results: The commonest age is 5 and 2 years; the male gender is more affected by the SCH fracture, and the left upper extremity is more affected by this fracture. The commonest direction of fracture displacement is posteromedial, with a percentage of 72.1%. Only 21.3% of SCH fractures required conservative treatment. The results showed an association between treatment modality and both directions of displacement and fracture type.
Conclusions: A SCH fracture is one of the common fractures involving the pediatric age group that requires surgical intervention; 79.7% of cases require surgical intervention. Distal radius fracture is the most commonly associated injury with the SCH fracture. This study found an association between the treatment modality with both displacement direction and fracture type.

Keywords: Associated injuries, Closed reduction, Percutaneous pinning, Supracondylar fracture

INTRODUCTION

A supracondylar humerus fracture is one of the common fractures that are seen in the pediatric age group. The extension type is the most common, with common associated injuries, especially AIN palsy, vascular injuries, and distal radius fractures. 55% to 80% of all elbow fractures in children and up to two-thirds of pediatric elbow injuries necessitating hospitalization are humeral supracondylar fractures.[1] Supracondylar fractures typically originate from sports-related injuries or falls from a height. The estimated incidence is 177 per 100,000 people.[2]

Although they can happen at any age during childhood, they are most common between the ages of five and eight, with a median age of about six. Boys are 1.5 times more likely than girls to experience supracondylar fractures, typically occurring in the non-dominant arm.[3]

The supracondylar humerus fracture is often transverse or oblique and over the medial and lateral condyles. It is a rare fracture among adults but a common elbow fracture in children. It is often not displaced, so it can be treated conservatively using a splint. However, doctors may resort to surgery in cases of angled or displaced fractures, and they are treated effectively with high expected rates of full recovery in children. Treatment plans for some injuries may be complicated due to some complications, such as vascular injury, poor healing, or nerve injuries.[4]

Among the most prominent symptoms the affected child may complain of are pain and swelling above the elbow and loss of function of the affected upper limb. The limb pain may appear hours after the injury as a result of muscle ischemia, which may lead to the loss of muscle function; therefore, it is important to check the viability of the injured limb after detecting the fracture. The most prominent clinical parameters of this fracture's complication are the temperature of the extremities, whether it is cold or warm, the oxygen saturation of the affected limb, the presence of distal pulses, the time of capillary refilling, the presence of any open fracture wounds, and the evaluation of the peripheral nerves. If the distal pulses are not palpable, the Doppler ultrasound checks blood flow to the affected limb.[5]

This fracture may cause injury to the ulnar nerve. It may also cause injury to the anterior interosseous branch of the median nerve, the most commonly associated nerve injury. It may cause injury to the radial nerve. Wrinkling of the skin or the appearance of bruises in the skin in front of the distal humerus usually results in difficult reduction because the proximal part of the humerus may have penetrated the brachialis muscle and the subcutaneous layer of the skin.[5]

This research aims to study the presentation and treatment of supracondylar fractures of distal humerus in children at Prince Rashid bin Al Hassan Military Hospital, Jordanian Royal Medical Services. This is achieved through the following objectives: 1) Define the study's main variables, which are gender, age, weekend vacation, summer vacation, affected extremity, associated injuries, bone pathology, fracture type, anatomical site, mechanism of injury, direction of displacement, and modality of treatment; 2) Investigate and analyze all these variables descriptively in frequencies and percentages; 3) to investigate the association between the treatment modality variable and other variables.

METHODS

This study follows a retrospective research approach to study the presentation and treatment of supracondylar fractures of distal humerus in children at Prince Rashid bin Al Hassan Military Hospital, Jordanian Royal Medical Services. This study was conducted through the year 2022, from June to December. The study included all children, whose ages ranged from one year to 14 years, who attended the emergency department at Prince Rashid Hospital and were diagnosed with SCH fractures. Any patient over the age of 14 was excluded from the study because our institution considers paediatrics as any person under the age of 14 years.

Thus, the study sample included all children who fulfilled the inclusion criteria and attended the emergency department in the specified period of the study, and their number was 61 patients. Most of these patients were admitted for further surgical interventions, while the rest were treated conservatively.

The researchers collected the data from the paper medical files of the patients, and it was studied and analyzed. The data included personal data (gender, age, time of injury, school/weekend vacations), medical history (orthopaedic diseases), doctor's notes (affected limbs, Injury mechanism, type of fracture, associated injuries to bones/soft tissues, the direction of displacement, radiographs), treatment (conservative, surgical, operations notes).

After that, the data were analyzed statistically using version 25 of the SPSS program, where it was analyzed descriptively by finding frequencies and percentages for all variables such as (sex, age, time of injury, vacations, affected limbs, mechanism of injury, type of fracture, associated injuries, direction of displacement, modality of treatment). The association of the variable (treatment modality) was analyzed with all other variables, whether personal data or doctor's notes. The chi-square test was used to find an association between these variables so that the significance level of the test was compared with the alpha value (0.05); if it was less than the value of Alpha, it indicates that there is a statistically significant association between the variable and the treatment modality, and if it is greater, it indicates that there is no association.

RESULTS

According to the data collected from Prince Rashid Hospital, Jordanian Royal Medical Services, which were analyzed using SPSS version 25, the commonest age of presentation of SCH fracture is five years and two years with a percentage of 20% for both, followed by the age of 3 years with a percentage of 16%. The age of the presentation is shown in Figure 1.

The male gender is more affected by the mentioned fracture than the females, with a percentage of 70% of males compared to females. The gender distribution is shown in Figure 2.

The left upper extremity is more affected by supracondylar fracture than the Right, with a percentage of 54.1% for the left. The mechanism of injury for all patients was falling on the outstretched upper limb. Regarding the time of presentation, the results showed

that the majority of injuries occurred during school working days, in the middle of the week, where the percentage of injuries during the summer vacation period was 41% and during the weekend holidays, 44.3%, and this appears through Figure 3.

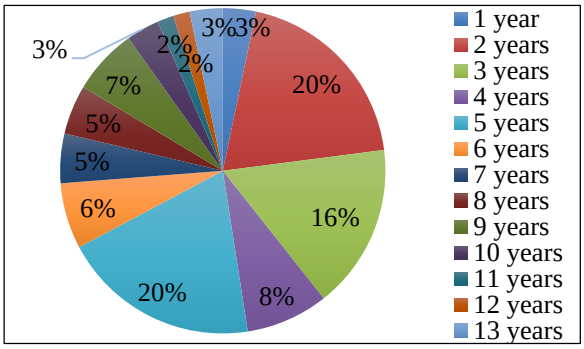

Figure 1: Age distribution.

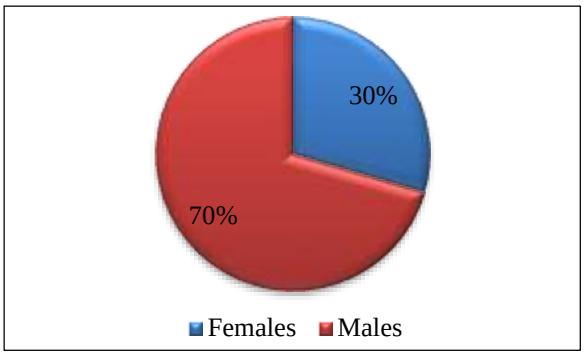

Figure 2: Gender distribution.

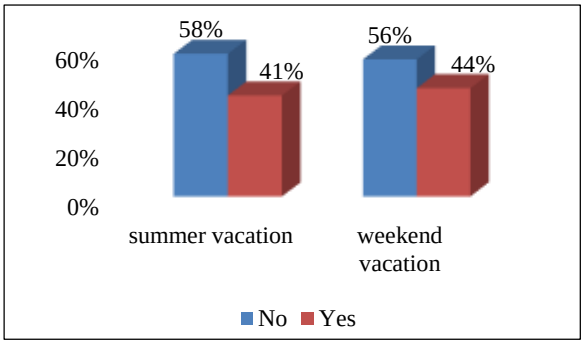

Figure 3: Vacations distributions.

The fracture anatomical site, type, direction of displacement, presence of brachialis sign, and associated bony and soft tissue injuries are all analyzed. Regarding the anatomical site, only 11.5% of the fracture line is high, while 8.2% of the fracture line is low in the supracondylar region (Figure 4).

The extension type is the most common, with a percentage of 96.7%, with extension type III being the most common, with a percentage of 49.2%, followed by extension type II, with a percentage of 29.5%; Figure 5 shows fracture type percentages.

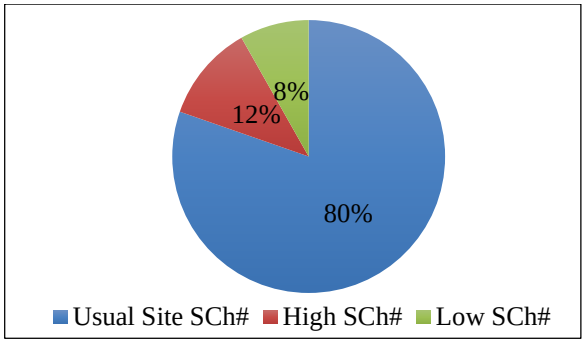

Figure 4: Fracture site.

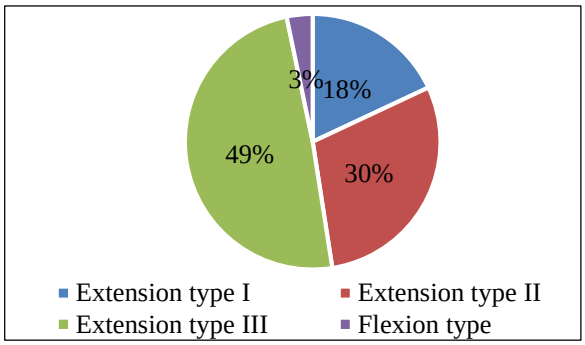

Figure 5: Fracture type.

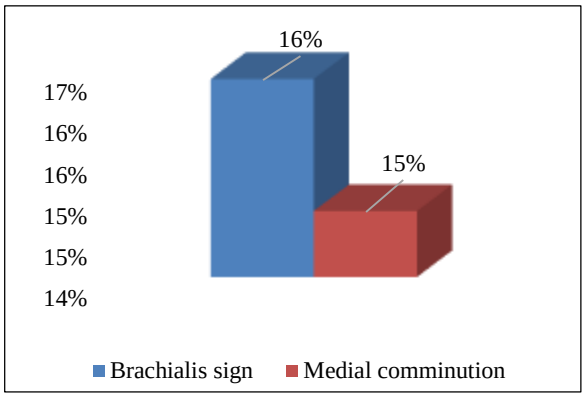

Figure 6: Brachialis sign and medial comminution.

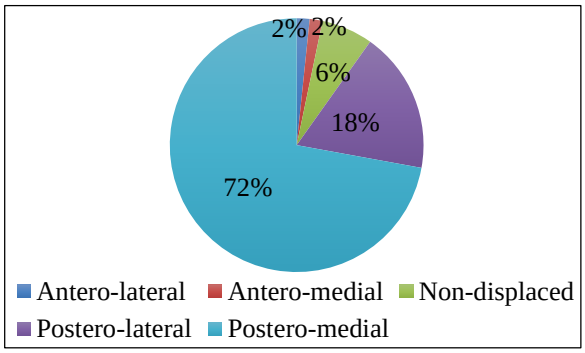

Figure 7: Direction of displacement.

The brachialis sign was seen only in 16.4% of all pediatric patients included in the study, while the medial

comminution was seen only in 14.8%. Figure 6 shows brachialis signs percentages and medial comminution.

The commonest direction of fracture displacement is posteromedial, with a percentage of 72.1%, followed by posterolateral, with a percentage of 18.0%; nondisplaced fracture is only seen in 6.5%. Figure 7 shows their percentage.

All patients who presented and were treated at Prince Rashid Hospital, Jordanian Royal Medical Services, had a normal bone at the fracture site without any underlying bone pathology. Open supracondylar fracture is only seen in 2 patients, with a percentage of 3.3%. The most common associated injury seen with a supracondylar fracture is associated with a distal radius fracture, which had been seen in 5 patients with a percentage of 8.2%. AIN palsy, weak pulse, and combined absent pulse with AIN palsy all had the same percentage of 1.6%, as shown in Figure 8.

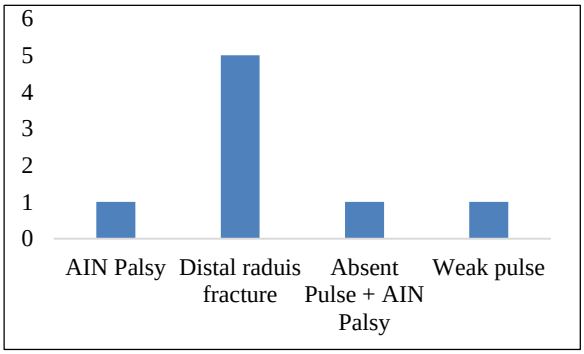

Figure 8: Associated injuries.

Fracture immobilization using a cast was the treatment modality used for 21.3% of the presented patients, as their fracture was amenable to the parameters of conservative treatment, while 70.5% underwent closed reduction and percutaneous pinning (CRPP) under general anaesthesia (GA), and 8.2% underwent Open Reduction and Percutaneous Pinning (ORPP) under GA. These percentages are shown in Figure 9.

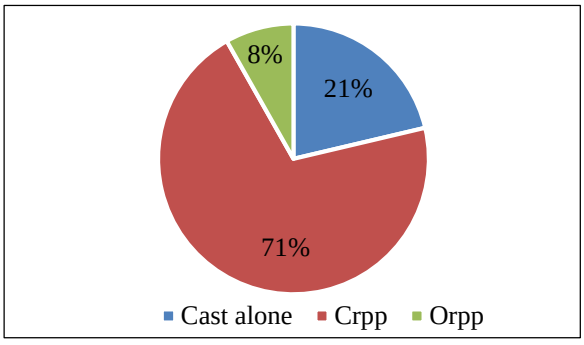

Figure 9: Treatment modality.

By using the chi-square test to investigate any association between all variables with the treatment modality variable, only there were significant associations between the treatment modality variable with both variables, the fracture type and the direction of the displacement, with a significance level of less than 0.05. In other words, treatment modality depends on the direction of displacement and the type of fracture. All the variables were analyzed using the Chi-Square test and showed no association between them and the variable of treatment options.

All fractures extension type I (18%) were treated using a cast, while all fractures flexion type (3.3%) were treated surgically by CRPP. Extension type III fractures were mostly treated by CRPP (41%), while the remaining were treated by ORPP (8.2%); as accepted, closed reduction is not achieved. Extension type II fractures were mostly treated by CRPP (26.2%), and the remaining percentage of extension type II fractures (3.3%) were treated by splinting. These percentages are shown in Figure 10.

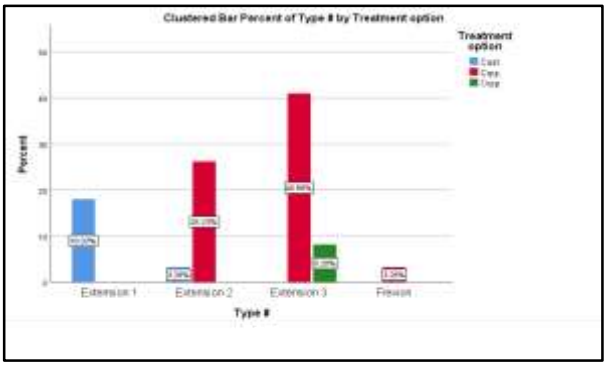

Figure 1: Fracture types of treatment modality.

All fractures that displaced anteromedially and anterolaterally were treated by CRPP (1.64% for each), and nondisplaced fractures were treated by casting (6.56%). Fractures that displaced posterolaterally were mostly treated surgically by CRPP (9.8%) and ORPP (6.56%), while only (1.64%) were treated by casting. Fractures that displaced posteromedially were mostly treated surgically by CRPP (57.38%) and ORPP (1.64%), while only (13.11%) were treated by casting.

DISCUSSION

According to the analyzed data collected from Prince Rashid ibn Al-Hasan Military Hospital, Jordanian Royal Medical Services, the male gender is more commonly involved in SCH with a percentage of 70.5%. The left upper extremity is more commonly affected.

The most commonly associated injury seen with a supracondylar fracture is a distal radius fracture, representing a percentage of 8.2%, whereas Muchow et al (2015) study reported that this associated injury is uncommon and occurs only in 5% of all SCH fractures.[6]

In this study, the percentages for AIN palsy, weak pulse, and combined absent pulse with AIN palsy were all recorded at 1.6%. This figure is notably lower than the reported range of changes in limb vascularity, which varied from 10% to 20% in the literature.[7,8]

The results imply that neural injuries, such as AIN palsy, are relatively uncommon within our study population when compared to the literature's findings, where they can be observed in 6.5% to 19% of cases involving displaced fractures. In contrast, non-displaced fractures seem to be exceptional in their association with such injuries.[9]

Only 21.3% of supracondylar humerus fractures required conservative treatment, while the majority (79.7%) required surgical interventions either by CRPP or ORPP. The brachialis sign was positive in 40% of cases that underwent open reduction and percutaneous pinning (ORPP). The chi-square test was used to find any association between the brachialis sign and treatment modality, and the results showed no association as the significance level was more than 0.05. Chi-square test results were also used to find any association between all variables with the treatment modality variable; only association between the treatment modality with both the fracture type and the direction of the displacement were found.

All fractures extension type I were treated using a cast, while all fractures flexion type were treated surgically by CRPP. Extension type III fractures were mostly treated by CRPP, while the remaining were treated by ORPP. As a result, achieving and maintaining an anatomical reduction of the fracture, with a focus on simulating the contralateral rotation of the humerus, appears to be the best course of action to prevent cubitus varus.[10] This is because, in a study by Moraleda et al, the incidence of cubitus varus in unreduced managed extension-type II fractures was reported to be as high as 26.1%.[11] In our study, most extension type II fractures were treated by CRPP because the Baumann angle did not fall within the accepted limits, and the anterior humeral line did not pass through the capitellum. This underscores the importance of precise reduction techniques to minimize the risk of cubitus varus, as supported by Moraleda et al's findings. The remaining percentage of extension type II fractures were treated by cast.

All fractures that displaced anteromedially and anterolaterally were treated by CRPP, and the nondisplaced fractures were treated by casting. Fractures that displaced posterolaterally were mostly treated surgically by CRPP and ORPP. Fractures that displaced posteromedially were mostly treated surgically by CRPP and ORPP.

For patients with associated injuries and those with distal radius fractures, the fractures were nondisplaced and treated conservatively using a cast. For the patient with an absent pulse at the time of presentation, at the initial evaluation of the patient's limb perfusion, the limb was warm and red, with a good capillary refill of the fingers with absent both radial and ulnar pulses on palpation, as the hospital was not supported by a vascular surgeon, the vascular surgeon on call at King Hussein Medical Center was consulted. He decided that the fracture should be reduced, and fixed by orthopedic team, then to reassess the limb vascularity and pulses. He preferred to transfer the patient to be operated at Royal Jordanian Rehabilitation Center, King Hussein Medical Centre, where he is available all the time and to be assessed by him after reduction and fixation. The patient was then transferred and operated on at the Royal Jordanian Rehabilitation Center, where the vascular surgeon on call assessed the patient postoperatively. He still had a pulseless, warm, pink limb with a good capillary refill; on Doppler ultra-sound assessment, both radial and ulnar pulses were tri-phasic. The decision was taken to put him on intravenous heparin therapy for three days. Badkoobehi et al mentioned in their study, in 2015, that any pulseless, well-perfused limb should undergo urgent operative reduction and fixation of the fracture and then reassess the vascular status.[12]

For the patient with a supracondylar humerus fracture with weak pulses, the patient underwent CRPP, and pulses were assessed intra-operatively and postoperatively and were normal in volume compared to the contralateral side.

The two patients with supracondylar humerus fractures with the features of AIN Palsy underwent CRPP, as their fracture was extension type III; during the follow-up period, the AIN function spontaneous recovery was seen at four months of follow-up.

The average follow-up of these patients was about 3 to 4 months; we will mention the commonest complications we observed during the follow-up period.

Pin migration was the most common complication seen in pediatric patients who were treated surgically; this is seen in 7 patients out of 48 patients who had been treated surgically (15%), but none of them required returning to the operating room to remove the migrated wire. In the s same context, Lindsay et al found that pin migration required surgical removal in the operating room represent 0.19% percentage of all cases.[13]

During this short follow-up period, no clear elbow deformity was identified clinically and radiologically, like cubitus varus or valgus. All fractures were healed clinically and radiologically during this short follow-up period with achieving functional elbow range of motion.

This study has some limitations. The study examining the presentation and treatment of SCH fractures in children at Prince Rashid bin Al Hassan Military Hospital, Jordanian Royal Medical Services, has several limitations. Firstly,

the study adopted a retrospective design, relying on historical data extracted from medical records. Such an approach inherently restricts the researcher's ability to control for variables, conduct in-depth assessments, or acquire supplementary data pertinent to the research query. This investigation was conducted exclusively at a single healthcare institution, limiting the generalizability of its findings. Different hospitals and regions might exhibit varying fracture patterns and treatment methodologies, making it challenging to apply the study's conclusions universally. Finally, the study focused on a specific region and population, the Prince Rashid Military Hospital. Fracture patterns and treatment practices may differ in other geographic regions or among different ethnic groups, further limiting the study's generalizability. Addressing these limitations in future research endeavours is essential to cultivating a more comprehensive understanding of supracondylar humerus fractures in children and enhancing the relevance of the findings to clinical practice.

CONCLUSION

A supracondylar humerus fracture is one of the common fractures involving the pediatric age group that requires surgical intervention; 79.7% of cases require surgical intervention. Distal radius fracture is the most commonly associated injury with the supracondylar fracture of the humerus. This study found associations between the treatment modality, with both, displacement direction, and fracture type.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee of the Jordanian Royal Medical Services under study ID: RMS 2-2023:20 dated February 19, 2023

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