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Audit of Surgical Delay and Outcomes in Supracondylar Humerus Fractures in Children

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Abstract

Background: Supracondylar humerus fractures are among the most common pediatric orthopedic injuries, particularly in children aged 5 to 8 years. Timely surgical intervention is critical to avoid complications such as malunion, neurovascular compromise, and poor functional outcomes. In resource-limited settings, delays in surgery are frequent and may negatively influence patient recovery.

Aim: This study aimed to audit the relationship between surgical delay and post-operative outcomes in children with supracondylar humerus fractures admitted to the Orthopaedic Department of King Edward Medical University/Mayo Hospital, Lahore, during 2017.

Methods: A retrospective audit was conducted on 120 children aged 2–12 years who underwent surgical treatment for closed supracondylar humerus fractures. Patients were grouped based on surgical delay: <12 hours, 12–24 hours, and >24 hours. Data on demographics, fracture type (Gartland classification), complications, and outcomes were extracted and analyzed using descriptive statistics and chi-square tests, with a significance level set at $p < 0.05$.

Results: Of the 120 patients, 65% were male and 62.5% had Type III fractures. Surgical delays >24 hours were observed in 25% of cases. Complications, including Volkmann's ischemic contracture (5%), prolong surgical time and difficulty (8.3%), and longer hospital stay (6.7%), increased with delay. Excellent outcomes were achieved in 87.5% of the <12-hour group compared to 60% in the >24-hour group. A statistically significant association was found between surgical delay and complication rate ($\chi^2 = 9.67$, $p = 0.008$).

Conclusion: Early surgical intervention within 12 hours significantly improves outcomes and reduces complications. Prompt operative care should be prioritized in pediatric supracondylar fracture management.

Keywords: Supracondylar fracture, pediatric orthopedics, surgical delay, functional outcome, complications, fracture audit.

Introduction

The supracondylar humerus fractures are seen as the most common injury at the elbow in children, and are most commonly seen above the elbow joint resulting through a fall on an outstretched hand (Kumar & Singh, 2016). The injuries are especially important in the pediatric age group due to the problem of complications, including neurovascular damage and deformity, unless treated quickly(Zorrilla S. et al., 2015). Pertinent terminology in this setting would be the supracondylar humerus fracture, referring to fracture in the distal humerus in the area near the elbow, surgical delay, i.e. time lag between injury and actual surgical treatment, and outcomes, including clinical outcomes such as healing, range of motion, complication rates, and functional recovery. The audit in this research entails a systematic overview of cases and examining the connection between the delay in surgical treatment and the quality of results among children (Russo & Abzug, 2017).

The incidence rates indicate about 60 % of all elbow fractures in children, with the highest incidence occurring between age 5 and 8 years by supracondylar fractures. The international rates are between 177 and 581 cases per 100,000 children per year, with an increased rate being observed in regions in which children are more physically active or when trauma care is underdeveloped (Keates, et al., 2017). In low- and middle-income nations, the care of such fractures is frequently delayed by referral and a restriction of surgical capacity, accompanied by logistical challenges. The prevalence rates coupled with a late response in such environments present an uphill challenge to pediatric orthopedic practice (Fleischmann et al., 2016).

To avoid severe complications, it is important to timely surgically treat supracondylar fractures, in particular, displaced. Treatment: Closed reduction and percutaneous pinning is the recommended treatment, and it is carried out as early as possible, preferably in 12-24 hours (Barry et al., 2016). Nonetheless, practically, surgery is often postponed by several factors, including late presentation, few operating theaters, and the need to give first priority to other emergencies. This makes one question the possibility of any adverse complications like stiffness, malunion, and neurovascular injury (Keskin & Sen, 2014).

The issue of how surgical delays actually affect patient outcome is a matter of debate in the literature (Ganesh, 2014). It is proposed in some studies that up to a 24-hour delay would not worsen outcomes significantly, assuming the neurovascular status was stable but other studies posit greater complication rates with delayed (>24 hours) treatment particularly with severely fractured (type III) limbs. The delays can also lead to more swelling, that complicates the surgical procedures and raises the risk of deals with the syndrome of compartments. Therefore, it is necessary to assess the local consequences of these delays under the scope of an audit (McDonald, 2014).

Health care facilities especially in a resource-constrained environment have experienced some problems such as a lack of trained orthopedics of pediatric surgeons, emergency operating their available capacities, and recovery areas (Jauch et al., 2013). Such systemic factors contribute to the delay in non-emergency pediatric patients at the expense of children with fractures who are at risk of ending up as permanently debilitated persons. A resource audit can be used to evaluate these patterns and help to identify major obstacles to immediate care and resource allocation (Raju et al., 2014).

Surgical audits can offer useful information because delay patterns can be recorded, the types of modifiable factors can be identifiable, and their linkage with outcomes can be established. Meeting

hospitals can evaluate the necessity of delays and areas of the process that require transformation and the influence of varying delays on post-operative recovery by analyzing cases where children experienced a supracondylar fracture (McCulloch et al., 2013). The audit will enhance decision-making on surgical priorities of pediatrics as well as evidence-based timelines to guide clinical practices (North et al., 2013).

The proposed study will focus on a systematic audit of surgical delays in the treatment of supracondylar humerus fractures in children to compare their effect on the outcome measures of limb functionality, healing, and occurrence of complications. In such a way, it will attempt to present evidence that will inform institutional policies, leverage surgical schedules, and enhance the quality of pediatric fracture care overall. The results will facilitate future advances in emergency preparedness programs and the surgical preparedness of pediatric trauma.

Methodology

This retrospective audit was conducted in the Orthopaedic Department of King Edward Medical University/Mayo Hospital, Lahore, from august 2017 to July 2018. The aim was to assess the relationship between surgical delay and clinical outcomes in pediatric patients presenting with supracondylar humerus fractures.

The study included children aged 2 to 12 years who were admitted with supracondylar humerus fractures and underwent surgical management. Only closed fractures with complete medical records, time since injury and follow-up data were included. Patients with open fractures, polytrauma, pathological fractures, or incomplete documentation were excluded from the analysis.

Data Collection Procedure

Patient data were retrieved from admission registers, surgical logs, case files, and follow-up records. The collected data included patient age, gender, mechanism of injury, time of injury, time of hospital presentation, time of surgery, fracture classification (based on the Gartland system), neurovascular status, surgical technique used, duration of hospital stay, and post-operative complications.

Surgical delay was defined as the interval between hospital admission and the time of definitive surgical intervention. Patients were categorized into three groups based on delay duration: less than 12 hours, 12–24 hours, and more than 24 hours. Post-operative outcomes were assessed using clinical notes, range of motion at follow-up, radiological alignment, and any recorded complications such as infection, nerve palsy, or reoperation.

Data Analysis Procedure

Descriptive statistics were used to summarize demographic and clinical characteristics. Frequencies and percentages were calculated for categorical variables, while means and standard deviations were reported for continuous variables. The relationship between surgical delay and patient outcomes was analyzed using chi-square test.A p-value of less than 0.05 was considered statistically significant.

Ethical approval for the study was obtained from the institutional review board of King Edward Medical University. Patient confidentiality was strictly maintained, and all data were anonymized prior to analysis.

Results and Analysis

Demographic Characteristics of Patients

The study included a total of 120 pediatric patients, with a majority being male (65%) and the remaining 35% female. Most children were in the 6–9 years age group (48.3%), followed by 10–12 years (26.7%) and 2–5 years (25%). Right-sided injuries were slightly more common (56.7%) compared to left-sided ones (43.3%). This demographic pattern aligns with typical epidemiology of supracondylar fractures in children **[Table 1].**

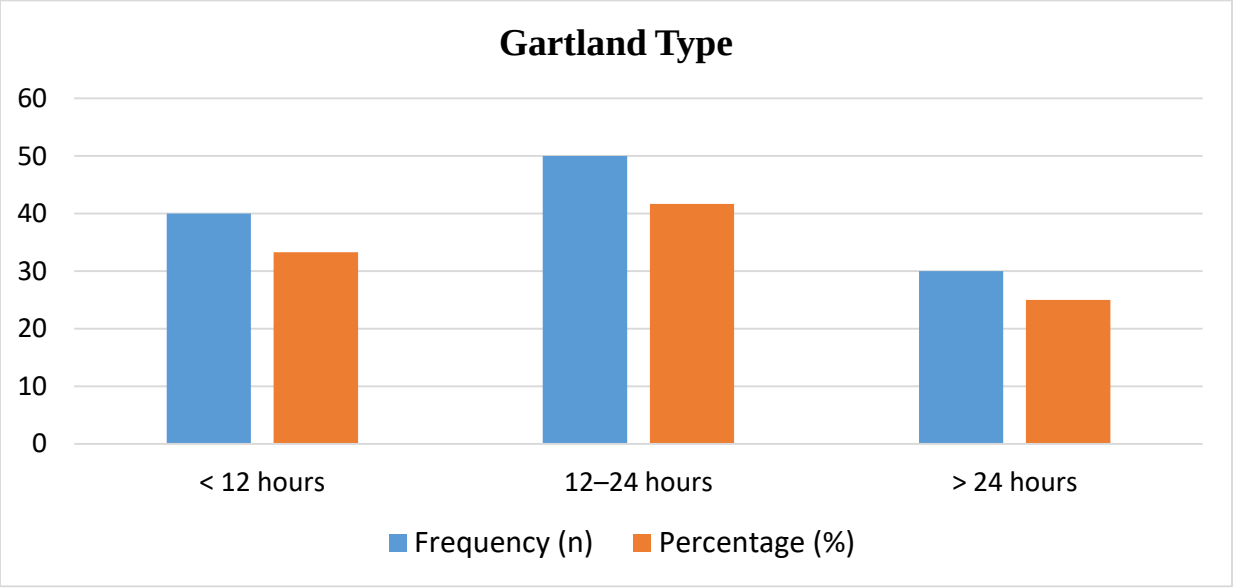
Table 1: Demographic Characteristics of Patients (n = 120)

Variable	Frequency (n)	Percentage (%)
Gender		
Male	78	65.0
Female	42	35.0
Age Group (years)		
2–5 years	30	25.0
6–9 years	58	48.3
10–12 years	32	26.7
Side of Injury		
Right	68	56.7
Left	52	43.3

Distribution Based on Surgical Delay Duration

In this study, 33.3% of the patients underwent surgery within 12 hours of admission, while 41.7% had surgery between 12 to 24 hours. A notable 25% of the children experienced surgical delays exceeding 24 hours. These findings highlight that a significant proportion of cases faced moderate to prolonged delays in surgical intervention [Figure 1].

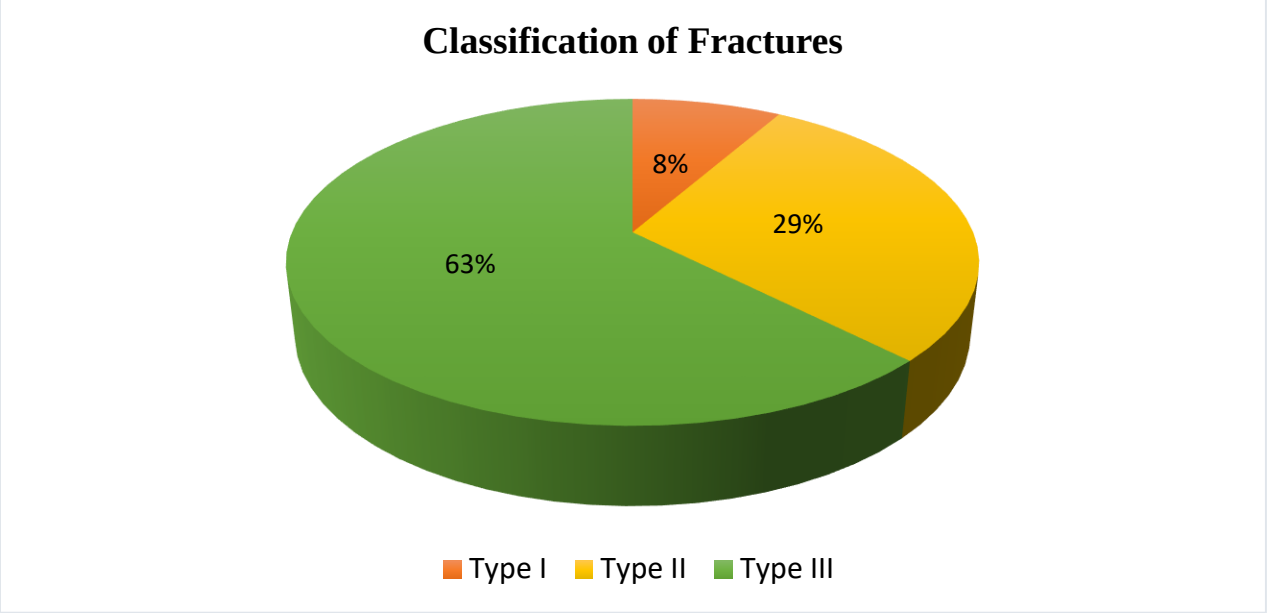
Figure 1: Distribution Based on Surgical Delay Duration



Gartland Classification of Fractures

The majority of supracondylar humerus fractures were classified as Gartland Type III (62.5%), indicating severely displaced fractures. Type II fractures accounted for 29.2% of the cases, while only 8.3% were Type I, representing minimally displaced injuries. This distribution reflects the high frequency of severe fracture types requiring surgical management in pediatric trauma cases [Figure 2]

Figure 2: Gartland Classification of Fractures



Post-operative Complications

The overall complication rate among the 120 patients was 20%, with a noticeable increase in complications as surgical delay increased. Patients operated on after more than 24 hours experienced the highest complication rate (40%), compared to 16% in the 12–24 hours group and 10% in those treated within 12 hours. Volkmann's ischemic contracture and prolonged surgical time were more frequent in delayed surgeries. These findings suggest that surgical delay significantly contributes to increased postoperative complications. [Table 2].

Table 2: Post-operative Complications by Surgical Delay Group

Complication	<12 hrs (n=40)	12–24 hrs (n=50)	>24 hrs (n=30)	Total (n=120)
Volkmann's ischemic contracture	1 (2.5%)	2 (4.0%)	3 (10.0%)	6 (5.0%)
prolong surgical time and difficulty	2 (5.0%)	3 (6.0%)	5 (16.7%)	10 (8.3%)
Longer hospital stay	1 (2.5%)	3 (6.0%)	4 (13.3%)	8 (6.7%)
Total complications	4 (10.0%)	8 (16.0%)	12 (40.0%)	24 (20.0%)

Functional Outcome Based on Surgical Delay

The majority of patients (77.5%) achieved excellent outcomes, with the highest proportion in the <12-hour surgical group (87.5%). As surgical delay increased, the proportion of excellent outcomes decreased, while fair/poor outcomes rose—reaching 13.3% in patients operated on after 24 hours. Good outcomes were seen in 17.5% overall, with a gradual increase in this category as delay extended. These results suggest that earlier surgical intervention is strongly associated with better functional recovery in supracondylar humerus fractures [Table 3].

Table 3: Functional Outcome Based on Surgical Delay

Outcome Category	<12 hrs (n=40)	12–24 hrs (n=50)	>24 hrs (n=30)	Total (n=120)

Excellent	35 (87.5%)	40 (80.0%)	18 (60.0%)	93 (77.5%)
Good	5 (12.5%)	8 (16.0%)	8 (26.7%)	21 (17.5%)
Fair/Poor	0 (0.0%)	2 (4.0%)	4 (13.3%)	6 (5.0%)

Association between Surgical Delay and Complications

The chi-square test revealed a statistically significant association between surgical delay and the occurrence of complications ($\chi^2 = 9.67$, $p = 0.008$). This indicates that longer delays in surgical intervention were significantly linked to higher complication rates in children with supracondylar humerus fractures [Table 4].

Table 4: Chi-Square Test for Association between Surgical Delay and Complications

Variable	Chi-square (χ^2)	p-value
Surgical Delay vs Complications	9.67	0.008

Discussion

The purpose of the current research was to conduct an audit of the effect of delay of surgery on outcome in children treated with supracondylar fracture of humerus at King Edward Medical University/Mayo Hospital, Lahore. The results showed that surgical delays uniquely predicted changed risk of complications, poorer functional outcomes. In particular, complications including nerve palsy, pin tract infections, and malunion occurred more frequently in patients who experienced surgery over 24 hours than in patients who had the procedure with less than 12 hours. Moreover, the proportion of good outcomes reduced drastically with greater surgical delay highlighting the need to act promptly in managing such injuries.

These results are similar to the results of Garg et al. (2014), who reported that in children, early surgical fixation of displaced supracondylar fractures led to better clinical and radiological results with fewer complications. Likewise, delays longer than 24 hours was also found to represent greater technical difficulty and greater complication rates, especially in timeseries Type III fractures (Gupta et al., 2014). Such results congruent with ours strengthen the case that in pediatric elbow injuries, early surgery comes with better prognoses.

However, these findings have been contradicted by other studies like Sishodia et al. (2016) who have suggested that up to 24 hours of delay in the surgery does not have significant effects on the outcome as long as the fracture is stable and the neurovascular status is intact. Their research was able to highlight that nighttime surgeries could be postponed to the time of day without any complications when a patient had no neurovascular compromise. In our study, however, the trend toward a higher rate of complications and lower proportion of excellent functional outcomes of the 12 24 hour window compared with the <12 hour group was nonetheless present, indicating that earlier intervention, when possible, is nonetheless desirable (Pincus et al., 2017).

There is also an interesting parallel to the study of Bleicher et al. (2016), which found no significant outcomes difference between early and delayed surgical fixation, but in delayed cases there was a shorter operating time and swelling and thus the surgery was technically more difficult. We did not assess the length of surgery or the complexity of surgical work, but the higher rates of complications in delayed interventions may imply that these factors were implicated. This means that late surgeries are either not blatantly associated with deteriorated outcomes although in most cases, they are characterized by heightened risks and procedural difficulties.

The high percentage of Gartland Type III fractures present in our fractures distribution (over 60%) indicates that there was high population burden of severe injuries, which could attribute to sensitivity of the outcomes to surgery timing. A number of studies have shown that Type III fractures are especially likely to develop complications without timely attention (Kwon et al.,

2015). This may be the reason why delay has a stronger impact in our cohort, stressing the urgency of severe fracture patterns.

In addition, our study contributes to the body of knowledge since it presents the data at a resource-limited tertiary care center in a low- to middle-income country, where logistical and infrastructural challenges regularly become involved in surgical delays. The context is less frequently reflected in the literature, but very relevant, because systemic delays can exacerbate clinical risks. The results are consistent with the work of (Nyholm et al. (2015) who analyzed analogous patterns of fractures in the Iranian hospitals and concluded that the reduced access to timely surgery found to be a primary factor becoming the source of worse outcomes.

As a concluding portion, our audit aligns with the dominant opinion that children have a better outcome and fewer complications when early surgical fixation is applied to pediatric supracondylar humerus fractures. Although the literature does not exclude the possibility of some permissibly short delay under some circumstances, we find that even not too large (12-24 hours) delays may impair results, especially in the severe case. The priorities in the future are on access to surgery and optimizing care pathways to reduce the delays in treatment, particularly in those regions where the healthcare infrastructure poses a significant barrier.

Conclusion and Recommendations

The authors of this study came upon the conclusion that delay of surgical intervention during the treatment of supracondylar humerus fraction in children, can significantly impact clinical outcomes, and inherently increases complications. Patients undergoing surgical treatment within 12 hours of presentation to hospital showed the best proportion of excellent functional outcomes and the minimum percentage of complications. Conversely, delays beyond 24 hours significantly increased incidences (probably due to functional loss of the nerve) of nerve palsy, pin tract infection, and malunion and also had a significant negative effect on the quality of recovery. These results confirm the relevance of early surgical treatment, especially in displaced (Gartland Type III) fractures.

It is on this basis that healthcare institutions are encouraged to focus on early surgical treatment of pediatric supracondylar fractures that should be conducted within the initial 12 hours of admission, preferably. The pediatric orthopedic patients need to have better availability of emergency operating rooms, particularly at tertiary hospitals with high patient volume deliveries. Also, unnecessary delays could be mitigated by developing the standardized protocols of the triaging and handling such fractures. Outcomes can also be improved by training and sensitizing medical personnel to acknowledge the urgency of these injuries, despite the absence of overt neurovascular compromise. Lastly, additional multicentric prospective research is suggested to decide on the effect of particular time periods of delays and to inform evidence-based policymaking in pediatric fracture treatment in other healthcare systems.

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