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Close Reduction of Supracondylar Fracture of Humerus in Children by Gravity Method

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Author`s Contribution

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ABSTRACT

Objective: To evaluate the outcomes of employing a new technique, the gravity method, for the closed reduction of supracondylar humerus fractures (Gartland's type II and III) in pediatric patients treated at the Trauma Center of Aziz Bhatti Shaheed Hospital Gujrat.

Methodology: This descriptive cross-sectional study was conducted at Aziz Bhatti Shaheed Hospital's Trauma Center from August 2022 to April 2023. Children under 12 years old, presenting within 48 hours of injury with closed supracondylar humerus fractures (Gartland's Extension type II and III), were included. All patients underwent closed reduction and percutaneous pinning. Data analysis was performed using SPSS, employing means and standard deviations for quantitative variables, and frequency and percentage for qualitative variables.

Results: The mean age was 5.5 years (±1.5). Among 65 patients, there were 45 males and 20 females, with a male-to-female ratio of 1:0.4. The right humerus was affected in 28 patients (43%), while the left humerus was affected in 37 patients (57%). The gravity method successfully reduced 90% of fractures without the need for an assistant surgeon, resulting in a zero percent incidence of iatrogenic neurovascular injury. The average surgical duration was 20 minutes (ranging from 16 to 24 minutes), with an average of 7 images captured using the image intensifier. In cases where the gravity method failed, alternative closed reduction methods were employed for 10% of fractures; no open reduction was necessary.

Conclusion: The gravity method demonstrates safety and efficacy by providing accurate traction for reducing displaced supracondylar fractures without causing damage to the overlying skin or neurovascular structures around the elbow. Its applicability is particularly noteworthy in settings with a shortage of trained medical personnel and limited expertise in managing neurovascular complications.

Keywords: Close reduction, supracondylar fracture, gravity method

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Introduction

Supracondylar fractures are the most common humerus fractures in children, peaking between the ages of five and eight years.[1] They represent 55% to 80% of all elbow joint fractures in children and account for up to two-thirds of pediatric elbow injuries requiring hospitalization.[2] These fractures are primarily categorized into flexion and extension types based on distal segment displacement.[3] Extension type fractures are prevalent in 97% to 99% of cases and further classified into four Gartland types: Type I (undisplaced), Type II (displaced with intact posterior cortex), Type III (completely displaced posteromedially or posterolaterally), and Type IV (displaced and unstable with circumferential periosteal disruption).[4] Proper management is crucial as these fractures can lead to severe

complications such as neurovascular injury and compartment syndrome.

Currently, the gold standard for managing Type II and III fractures is closed reduction and percutaneous pinning (CRPP).[5,6] Immediate assessment of neurovascular status in the affected limb is essential, as 10% to 20% of displaced supracondylar fractures present alterations in neurovascular status.[1,7] Close reduction often restores perfusion, but there's a risk of secondary injury to the brachial artery and nerves during reduction maneuvers.[8] There's ongoing debate about the optimal and safe reduction technique. The standard closed reduction maneuver[1,3] for supracondylar fractures typically involves performing the procedure under general anesthesia with guidance from images obtained using a C-arm. Initially, traction is applied to the supinated forearm to disimpact the fracture and restore its length. Subsequently, any medial or lateral displacement and angulation are corrected. Following this step, pressure is applied over the tip of the olecranon as the elbow is flexed. The elbow is then maintained in a hyperflexed position with the forearm pronated to secure the reduction. Fixation is achieved using smooth 1.8 to 2.0 mm K-wires. In contrast, the Gravity Method[9] of close reduction for supracondylar fractures relies on Diwaker's constant, which posits that the weight of the child proximal to the fracture site (comprising the child's mass and gravitational force) generates the precise force needed to disimpact and reduce a supracondylar fracture. By hanging the child in flexion from the elbow, the supracondylar fracture recoils back, correcting all rotations and displacements through the child's weight. This method leverages a built-in safety mechanism in nature, ensuring accurate traction for reduction without causing damage to the antecubital skin, vessels, and nerves around the elbow. Despite being a common elbow fracture in children, the optimal management method remains controversial, and there is a lack of high-quality scientific data on the subject. Consequently, the aim of this study was to reevaluate the management philosophy of supracondylar fractures, specifically focusing on the novel approach of close reduction using the gravity method.

Methodology

After approval from Hospital Ethical Review Board the descriptive cross-sectional study conducted at Trauma Centre of Aziz Bhatti Shaheed Hospital Gujrat from August 2022 to April 2023. Patients under 12 years of age presented with closed supracondylar fractures of humerus (Gartland's Extension type II and III) within 48 hours of injury were included. Patients presented with indication of open reduction, presented with Associated neurovascular injury, with open fractures, after 5 days of injury, with multiple injuries or polytrauma were excluded. After taking written informed consent a detailed case history was obtained, and a thorough clinical examination was conducted. Temporary immobilization with a back slab was administered, and any other associated injuries were examined. X-rays of the elbow in anterior-posterior and lateral views were taken to classify the fracture. Patients underwent investigations to assess their fitness for anesthesia. All procedures were performed under general anesthesia.

The child was placed in supine position and general anesthesia given. The first step is dis- impaction by increasing deformity and side to side disengagement, The child was grasped by forearm with both hands. The position of forearm was irrelevant unless the fracture is unstable. The child is then hung by his own weight and the elbow is used as a fulcrum to lift him off the table by about 22.5 cm. The child was hung in this position for 45 to 120 seconds. This was the most important step of the procedure. The gravity uncoils tissues to correct all other displacements on their own. The elbow was then hyper flexed and the radial pulse was felt. Only when a supracondylar fracture was perfectly reduced the elbow flex fully. Reduction confirmed under C-Arm in AP and lateral views by evaluating the deformity in three planes (Antero-posterior translation, varus/ valgus, side to side shift, and rotation). In case of unacceptable reduction, the other methods of close reduction were used. The stabilization of fracture was done by per cutaneous pinning. Above elbow light back slab was given. The radial pulse was felt and the distal oxygenation checked by a pulse-oximeter. Distal neurovascular was accessed carefully again after patient coming out of anesthesia. The duration of the procedure and any complications during or after the intervention were recorded. All the data was recorded per operatively according to questionnaire.

Results

Mean age of children with closed supracondylar fractures of humerus was 5.50±1.48 years. The male to female ratio was 1:0.4 with 45 males and 20 female patients. The right humerus was involved in 28 (43%) while left humerus in 37(57%) of patients. Average duration of surgery was 20 min (16 to 24min). Average images taken from image intensifier were 7. Table. I

Table II showing that the 90 percent of fractures were reduced by gravity method with no assistant surgeon and with 0 percent iatrogenic neurovascular injury. About 10 percent of fractures were not reduced by gravity method. These Fractures were managed by other Conventional methods of close reduction. No fracture was indicated for an open reduction.

There was a potential association between age and the effectiveness of the gravity method in reducing fractures (p-0.065). Additionally, a significant association was observed between gender and the frequency of gravity method in reducing fractures (p-0.014). Table II

Table I: Descriptive of demographic variables (n=65)

Variables		Frequency	Percent
Gender	Male	45	69.2
	Female	20	30.8
	Total	65	100.0
Site of fracture	Right	28	43.1
	Left	37	56.9
	Total	65	100.0
Age (years)		5.50±1.48 years	
Duration of surgery mean (range)		20.0±2.59 minutes (16 to 24min).	

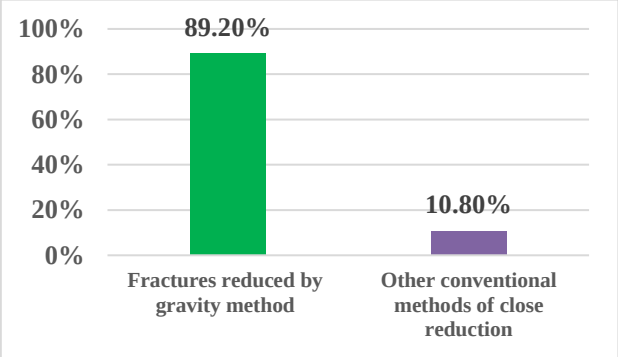

Figure 1. Frequency of fracture reduced by gravity method. (n=65)

Table II: Frequency of fracture reduced by gravity method according to age and gender (n=65)

Variables		Fracture reduced by gravity method			p-value
		Yes	No	Total	
Age group	**4-6 years**	44	3	47	
		67.7%	4.6%	72.3%	0.065
	7-9 years	14	4	18	
		21.5%	6.2%	27.7%	
Gender	**Male**	43	2	45	
		66.2%	3.1%	69.2%	0.014
	Female	15	5	20	
		23.1%	7.7%	30.8%	

Discussion

Supracondylar fractures of the humerus are highly prevalent among children, prompting extensive research into various management methods. Effectively managing displaced pediatric supracondylar fractures involves achieving and maintaining stable anatomical reduction until complete healing. Closed manipulation and fixation via percutaneous pinning represent the standard treatment for Gartland's type II and III supracondylar humerus fractures.[5,6] The common approach to closed reduction is universally performed using the traction-countertraction method.[1] However, complications such as reduced perfusion (0.3%) and absent radial pulse (3.2%) can arise, often necessitating immediate exploration and open reduction by experts, including vascular surgeons. Compartment syndrome may develop in 0.1 to 0.3% of cases, while neural injuries can occur in up to 19% of cases due to secondary injuries following close reduction and excessive manipulation.[1,5,6] These procedures often require surgical assistance, frequent use of an image intensifier, and expose both patient and surgeon to radiation.[15,16]

Another technique involves reducing fractures by inserting a K-wire subcutaneously through the posterior aspect of the humerus via the medullary canal. However, this method is associated with a high risk of nerve injury and wire migration.[14] Several other conventional techniques for close reduction are employed by different surgeons.[10-12] For instance, Mubarak and Davids used a method involving wrapping a bedsheet around the patient for countertraction provided by an anesthetist.[10] In a study by Tolo et al., an assistant applied countertraction by pushing against the patient's axilla while the surgeon applied traction.[11] In some methods, the receiver arm of the image intensifier is used as a table for the injured arm.[12] These methods, despite their usage, carry the aforementioned limitations and complications.[13]

Our study, led by Dr. Diwakar, utilized gravity as a natural force to disimpact and correct rotation, translation, and displacement, achieving a perfect reduction without iatrogenic neurovascular injury.[9] While we employed percutaneous pinning for fracture stabilization under general anesthesia, Dr. Diwakar advocates against using general anesthesia in children, suggesting that, with the proper application of this technique, K-wires or pins may be unnecessary to maintain reduction. Furthermore, the gravity-based method renders Gartland's classification irrelevant, proposing a new classification, The Diwakar Prakash classification, comprising nine fracture types. A

minimum of 50 such reductions is recommended to gain proficiency in achieving optimal reductions.

The findings from our study reveal an impressive 90% success rate in reducing supracondylar fractures through the use of this method, administered by a single surgeon. Notably, this success was achieved without encountering any procedure-related complications, such as skin issues or neurovascular complications. The significance lies in the method's ability to obviate the necessity for assistant surgeons and the involvement of specialized technical personnel like vascular surgeons. Furthermore, the method demonstrates advantages in terms of a shorter procedural duration and reduced C-arm imaging, thereby minimizing radiation hazards for both the patient and the surgeon. No more relevent studies found in the litrature to capre the findigs.

However, it's important to acknowledge a major limitation in our study the exclusive reliance on limited data collected from a single center's operating theatre. While this investigation represents a pioneering effort in exploring the novel pattern of reducing pediatric supracondylar fractures in Pakistan within a tertiary care hospital, the confined scope raises concerns about the generalizability of the results. To address this limitation and enhance the scientific validity of our findings, we emphasize the imperative need for multicenter studies involving a broader range of tertiary centers

Conclusion

Gravity method is a safe method by giving accurate traction to reduce the displaced supracondylar fracture without any damage to overlying skin and neurovascular structures at elbow and can be recommended in hospitals where there is scarcity of trained medical personals and less experts to deal with neurovascular complications. This study concludes that closed reduction of supracondylar fractures should be performed by gravity method to reduce radiation exposure, duration of surgery and to avoid iatrogenic neurovascular complications.

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