



## Treatment of Diaphyseal and Metaphyseal Fractures of the Upper Limbs (Humerus, Radius, Ulna) Using Extension Casts

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### ABSTRACT

Fractures occur more often in the pediatric age group than in healthy adults. One reason for this is that children and adolescents are less skilled at-risk assessment. Humeral fracture comprises approximately 7-8% of all adult fractures in the western world. Adult humeral diaphysis fractures account for roughly 3% of all fractures and 20% of all humerus fractures. The aim of this study is to evaluate results of Management of Upper Limb Diaphysis and Metaphyseal Fractures (Humerus, Radius and Ulna) with Application of Extension Cast in closed fractures in adults to assess the functional acceptance of the procedure. The present study was carried out at Department of Orthopaedic Surgery BSMMU from June 2022 to July 2023. This Hospital-based study is conducted to manage diaphysis and metaphyseal fractures by applying extension cast to improve range of motion. The study included upper arm fracture patients. Forty-two newly diagnosed cases of the fracture of upper extremities whose radiological and clinical record were intact, constituted the study cases. So, the individual was registered as a "case" after clinical diagnosis was confirmed. During follow-up after casting two patients never showed up so only 60 patients were chosen for the extension casting method. Patients in extension casting group were followed up from 14 to 22 months, with an average of (17.34±2.61) months. The full-length cast was applied from 4 to 6 weeks with a mean of 5 weeks. All casts were converted to the above elbow cast

when the fracture became sticky. Radiological evidence of a fluffy callus appeared at an average of 35 days and bony union was achieved at a mean of (3.48±0.59) months. In current study after 1 year of treatment, the mean range of motion of all joints of affected limb became normal the mean VAS score after 6 weeks was 8 after 3 months the mean VAS score was 4 and after 6 months the mean was score was 1. Extension cast allows gravity to work all the time which is especially beneficial for comminuted fractures. This reduces the chances of limb shortening.

**Keywords:** Conservative Fracture Treatment, Extension Cast, Upper Limb Fracture.

### I. INTRODUCTION

Fractures occur more often in the pediatric age group than in healthy adults [1]. One reason for this is that children and adolescents are less skilled at-risk assessment [2,3]. Furthermore, bone is less stable—albeit much more elastic during skeletal development than in adulthood. These properties explain both the higher incidence and the more rapid healing of fractures in children and adolescents. The skeleton is a dynamically growing organ whose growth characteristics and reactions to trauma are well known [2-4]. Treatment of fractures in young patients demands precise knowledge of the radiographic anatomy and growth characteristics of healthy and damaged bones as well as the specific fracture dynamics in this age group [5]. Long-bone fractures are a typical



complication of trauma. Humeral fracture comprises approximately 7-8% of all adult fractures in the western world [6-8]. Adult humeral diaphysis fractures account for roughly 3% of all fractures and 20% of all humerus fractures [9]. To restore forearm functions, including supination and pronation, elbow and wrist movements, strength of handgrip, proper management of is very necessary [10]. Long arm splints are applicable tools for elbow and proximal forearm injuries [11]. This form of splinting can provide excellent immobilization and limit flexion and extension of the elbow and wrist flexion, forearm supination/pronation. The purpose of this study is to evaluate the treatment outcomes of upper limb metaphyseal and diaphyseal fractures (humerus, radius, ulna) with extended cast application for closed humerus, radius, and ulna fractures in adults. To evaluate the functional acceptability of the procedure. The long arm splint is an auxiliary device that can be applied to injuries of the elbow and proximal forearm. [11] This form of splint provides excellent immobilization, limiting elbow flexion and extension, wrist flexion, and forearm supination/pronation. The purpose of this study is to evaluate the functional and radiological results of conservative treatment with extended cast immobilization for diaphyseal and diaphyseal fractures of the upper limb (humerus, radius, ulna) and to evaluate the effectiveness and benefits of this treatment. Metaphyseal fractures are fractures affecting the metaphysis of a long bone. It can occur in both children and adults. Not all metaphyseal fractures penetrate the epiphysis. Even if the fracture extends to the epiphysis, it is not a Salter-Harris fracture. Due to the rich blood supply and low resistance to osteotomy, metaphyseal USO is thought to offer a better chance of bone healing than diaphyseal USO [11]. This is consistent with our findings.

## II. METHODS & MATERIALS

The present study was carried out at Department of Orthopaedic Surgery BSMMU from June 2022 to July 2023. This Hospital-based study is conducted to manage diaphysis and metaphyseal fractures by applying extension cast to improve range of motion. The study included upper arm fracture patients. Forty-two newly diagnosed cases of the fracture of upper extremities whose radiological and clinical record were intact, constituted the study cases. So, the individual was registered as a "case" after clinical diagnosis was confirmed. During follow-up after casting two patients never showed up so only 60 patients were chosen for the extension casting method.

## The selection criteria for the cases were as follows:

**Inclusion criteria-** Patients of all ages, patients with proven cases of diaphyseal and metaphyseal fractures of the upper limbs proven by clinical diagnosis and radiological examination, patients diagnosed with fresh or closed fractures (up to 14 days of age), patients who answered the questionnaire clearly and in detail with cooperation. **Exclusion criteria-** Subjects with partial fractures of the humerus, radius and ulna, patients with open fractures and fractures with proximal or distal intra-articular extension, further exclusion criteria included patients with polytrauma, floating elbow or shoulder, pathological fractures, compartment syndrome and associated vascular diseases.

The Institutional Ethics Committee approved the study. Written informed consent was obtained from all participants in a language (Bengali/English) that the participants could understand. A pre-designed questionnaire was administered to each participant to obtain information on various parameters. Socio-demographic data included name, age, sex, place of residence, address, education level, and occupation. Diabetes history was recorded for each individual case.

## Diagnosis and fracture types

Clinical examination is initially restricted to inspection. Testing for the primary signs of fracture (abnormal mobility, crepitation) would cause the child unnecessary pain and must therefore be dispensed with [4]. The periphery must be investigated for accompanying injuries (blood supply, sensation, and mobility). The workhorse of fracture diagnosis in pediatric traumatology remains conventional radiography [12]. In every case radiograph of the injured site including the neighboring joints are obtained in two projections. The images must be painstakingly analyzed and the fractures examined for signs of instability [13]. Some shaft fractures can be diagnosed reliably by sonography (compression fractures) [14]. Computed tomography and magnetic resonance imaging have no place in acute diagnosis [15-17].

## III. RESULTS

Total 60 patient were recruited for the extension casting method. Patients were treated by the extension casting method including 42 (70%) males and 18 (30%) females. The age of the patients ranged from 22 to 65 with a mean age of  $41.45 \pm 9.85$  years. Out of these, 48 patients were



treated on day of the injury while 12 patients had a delay in treatment ranging from 2 to 11 days due to various reasons. Table-1 show demographic, diabetic history, long arm extremity side,

morphological type of fracture. Out of 60 patients 12 were found with diabetic history. 42 left extremity and 18 right extremities were treated with extension casting.

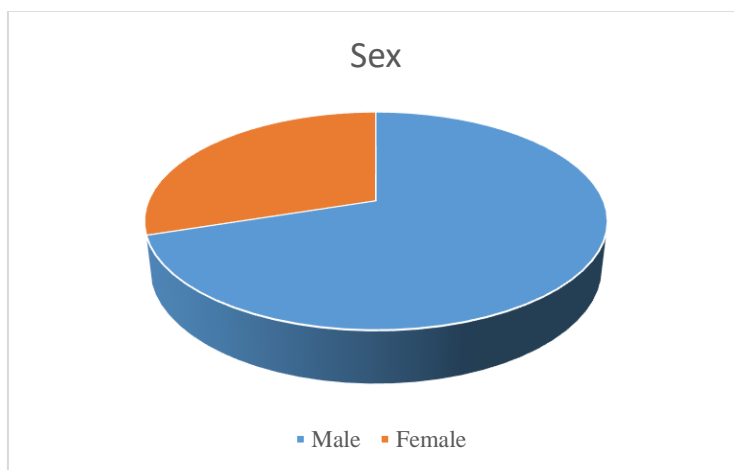


Fig-1: sex distribution of the study patients.

**Table 1: Demographic data distribution in patients (N=60)**

Variables	N	%
Age (Mean±SD)	41.45±9.85	
Gender		
Male (%)	42	70.0%
Female (%)	18	30.0%
Diabetic		
Yes (%)	12	20.0%
No (%)	48	80.0%
Arm Side		
Left (%)	42	70.0%
Right (%)	18	30.0%
Type of fracture		
Simple (%)	27	45.0%
Intermediate (%)	25	41.6%
Complex (%)	8	13.4%

Morphologically there were 27 simple transverse, 25 simple oblique and 8 comminuted fractures (Figure 3). Patients in extension casting group were followed up from 14 to 22 months, with an average of (17.34±2.61) months. The full-length cast was applied from 4 to 6 weeks with a mean of 5 weeks. All casts were converted to the above elbow cast when the fracture became sticky. Radiological evidence of a fluffy callus appeared at an average of 35 days and bony union was achieved at a mean of (3.48±0.59) months. There were no superficial wound infections in patients. Transient ulnar nerve paralysis developed in one patient (Flexion casting Group).

Nerve symptoms recovered completely within 3 months. In current study after 1 year of

treatment, the mean shoulder flexion was 1160, mean shoulder extension was 350, mean shoulder adduction was 240, and mean abduction was 1340. Mean elbow flexion was 1400, mean elbow extension was 1820, mean wrist flexion was 700, mean wrist extension was 650, mean ulnar deviation was 330, mean radial deviation was 180 the mean VAS score after 6 weeks was 8 after 3 months the mean VAS score was 4 and after 6 months the mean was score was 1. In this treatment procedure, twenty cases had results rated as excellent, seventeen cases were rated as good, and three case was rated as fair. The rate of excellent and good results was 91.6% (30/25).



Table 2: Distribution of recovery in patients with extension casting

Recovery	N	%
< 75%	5	8.3%
75-89%	25	41.6%
90-95%	30	50.0%

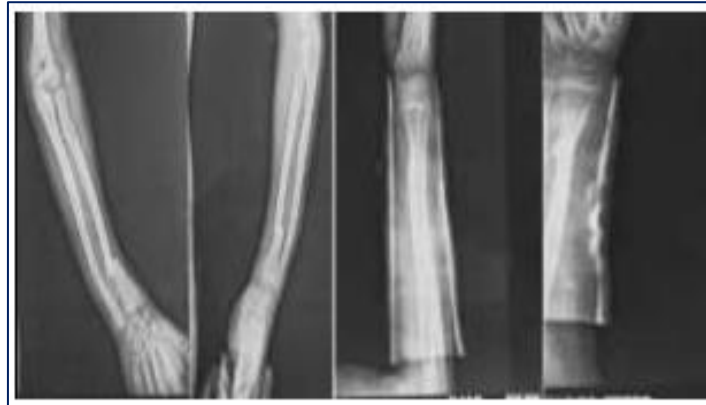


Fig 1: both bone forearm fracture treated with extension cast (after 4 weeks showed union)



Fig 2: Range of motion of elbow and fore-arm of case-1

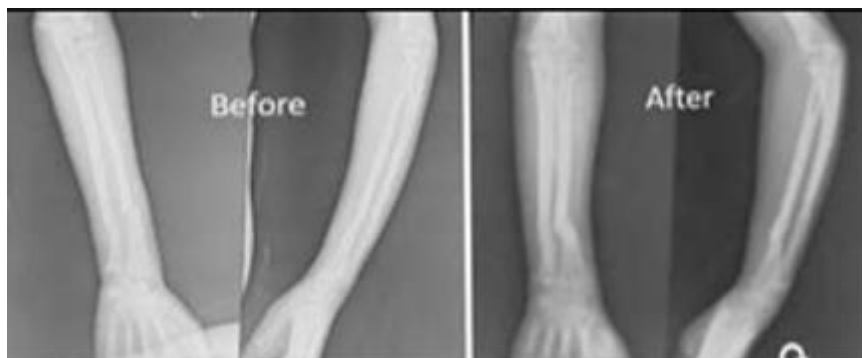


Fig 3: Both bones fore-arm fracture treated in extension cast after 6 weeks and range of motions of elbow and fore-arm



**Fig 4:** pictures showing comminuted distal 1/3<sup>rd</sup> humerus treated in extension cast (showed union in 6 weeks) and range of motions

#### IV. DISCUSSION

The primary goal of treatment is freedom from pain. Provisional immobilization of the injured limb even before diagnostic investigation provides pain relief and can be supported by medication (non-steroidal antirheumatics, opiates) [18-21]. Any painful manipulations, particularly reduction and correction of malalignment, must be carried out with the patient under anesthesia. Diaphyseal fractures heal by forming the periosteal and medullary callus, whereas metaphyseal fractures heal by forming the medullary callus. Bone healing in ovariectomized mice is accompanied by a decrease in the medullary callus formation both in the diaphysis and metaphysis. Despite the fact that the long arm cast with the elbow extended is infrequently utilized, it has long been recognized for its benefits [22]. The humerus is one of the long bones and radius ulna that can still be managed conservatively [23-25]. In a study of 252 cases, Zhang et al., reported that non-surgical treatment of humeral shaft fractures looked to produce outstanding results with a decreased risk of sequelae when compared to operational treatment [26]. In a study of 186 cases [27] found that after operational and nonoperative treatment, consolidation time and complication rates were equal [28]. The current study performed on 60 patients including 42 (70%) males and 18 (30%) females. Sarmiento et al., reported a 2.5 percent non-union rate with a healing duration of 9.5 weeks in a landmark study of 620 humerus fractures

treated with a functional brace [29] current study, the full-length cast was applied from 4 to 6 weeks with a mean of 5 weeks. At the moment, functional bracing is the most widely used and reproducible approach of treating humeral fractures. On CT examination, however, Fjalstead et colleagues found that 57 percent of patients treated with this approach had substantial external rotation of the shoulder joint [30]. Although the overall success of functional bracing is undeniable, Toivanen et al., found that when proximal shaft fractures are treated conservatively, they had a greater non-union rate [31]. Except in extremely restricted circumstances, according to chess, who developed the theory of indexed casts, elbow flexion is disruptive for both humerus and forearm alignment [32]. Non-union, deformity, and shoulder range of motion should be the focus of further research in the conservative care of humeral fractures. The most common sites for bone fractures are the wrist, ankle and hip. Treatment includes immobilising the bone with a plaster cast, or surgically inserting metal rods or plates to hold the bone pieces together. Some complicated fractures may need surgery and surgical traction. In the current study Radiological evidence of a fluffy callus appeared at an average of 35 days and bony union was achieved at a mean of  $(3.48 \pm 0.59)$  months with conservational method. Active muscular contractions are not continuous in any type of fracture immobilization. As a result, passive stretch and relaxation forces must be included while studying musculoskeletal fracture



biomechanics. Both the elbow and the shoulder joint are crossed by two muscles, triceps and biceps that work together. Both of these muscles are crucial in understanding the biomechanics of humeral fractures. Although the two muscles are comparable, the triceps contributes more biomechanically. Because the forearm has a longer lever arm, the extended casting position allows for better control of the distal fragment and better assessment of anatomic position [33]. The use of a lengthier cast allowed for more fracture immobilization, which resulted in good callus formation. The fact that the humerus is not a load-bearing limb means that deformation can be tolerated well with conservative therapy. More emphasis should be placed on refining the conservative methods in situations where the change toward operational treatment is unexplainable [34] in our study, no one had radial nerve palsy at the start. In humeral shaft fractures, the rate of early radial nerve injury ranges from 4% to 22%. Although there are differences in the literature regarding the order of rates and approaches, it is widely accepted that (a) nerve damage in a closed fracture is usually due to contusion, (b) nerve damage usually occurs in distal third humeral shaft fractures, and (c) early nerve exploration is not recommended except in open fractures because initial radial nerve damage resolves spontaneously in the majority of cases [35]. In current study after 1 year of treatment, the mean shoulder flexion was 1160, mean shoulder extension was 350, mean shoulder adduction was 240, mean abduction was 1340. Mean elbow flexion was 1400, mean elbow extension was 1820, mean wrist flexion was 700, mean wrist extension was 650, mean ulnar deviation was 330, mean radial deviation was 180 the mean VAS score after 6 weeks was 8 after 3 months the mean VAS score was 4 and after 6 months the mean was score was-1. The research reveals that extension casting is a safe and effective alternative that achieves similar benefits to a functional brace without limiting shoulder motion. It also has a lower rate of proximal shaft Malunion and non-union than other methods. Inflammation is thought to play an important, but different role in these two bone fracture types: diaphyseal fractures heal slowly through the formation of callus tissue, and metaphyseal trabecular bone heals faster, with no, or limited callus formation. In the treatment of diaphyseal fractures, the fixation techniques most commonly used are IM nailing, plating, and external fixation. Intramedullary nails are internal splints which are load sharing and allow early weight-bearing. External fixators are still the gold

standard in cases of severe soft-tissue problems. After setting, most fractures are immobilized with a cast, splint, or, occasionally, traction to reduce pain and help healing. In most cases, medication is limited to painkillers to reduce pain. In open fractures, antibiotics are given to prevent infection.

## V. CONCLUSION

At the break point, the bent forearm acts as a lever, creating a rotational motion. Straightening the forearm minimizes rotation, which promotes healing and increases range of motion in the shoulder, elbow and forearm. Patient compliance is high with an ultra-lightweight, lightly padded cast that is molded to the deltoid, biceps and triceps and has a precise cast index applied. Wrist and shoulder range of motion, especially external rotation, is unaffected. The range of motion of the shoulder begins immediately. Using an extension cast is particularly advantageous in the case of comminuted fractures, as gravity is always at work. This reduces the risk of shortening the limb.

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