



International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2022; 8(4): 53-57
© 2022 IJOS
www.orthopaper.com
Received: 09-07-2022
Accepted: 13-08-2022

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Management of upper limb diaphyseal and metaphyseal fractures (Humerus, Radius and Ulna) with application of extension cast

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DOI: <https://doi.org/10.22271/ortho.2022.v8.i4a.3242>

Abstract

To manage fracture either no operative or operative techniques is required. If the fracture is significantly displaced or angulated, a closed reduction should be done followed by a period of immobilization with casting or splinting is a basics of no operative approach. 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. To assess the efficacy and advantage of this treatment. The study included upper arm fracture patients. Fixed criterion was discouraged for a definite sample size and it was considered to take up as many cases as possible from trauma centre on every Wednesday in the entire period of data collection *i.e.*, from of September 2020 and May 2022. Forty-two newly diagnosed cases of the fracture of upper extremities whose radiological and clinical record were intact. 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

Introduction

In India, the healing therapies of fracture have become a major healthcare challenge in the recent years for general public (Saccone M *et al.*)^[1] Long-bone fractures are a typical complication of trauma. Humeral fracture comprises approximately 7-8% of all adult fractures in the western world (Court-Brown CM *et al.*, 2006 Matsunaga FT *et al* 2013)^[2, 3]. Adult humeral diaphysis fractures account for roughly 3% of all fractures and 20% of all humerus fractures (Ekholm R *et al.*)^[4]. To restore forearm functions, including supination and pronation, elbow and wrist movements, strength of handgrip, proper management of is very necessary (Droll KP *et al.*, 2007)^[5]. Long arm splints are applicable tools for elbow and proximal forearm injuries (Walthall J *et al.*, 2021)^[6]. This form of splinting can provide excellent immobilization and limit flexion and extension of the elbow and wrist flexion, forearm supination/pronation. The aim of this study is to evaluate results of "Management of Upper Limb Diaphyseal and Metaphyseal Fractures (Humerus, Radius and Ulna) with Application of Extension Cast in closed Humerus radius and ulna fractures in adults to assess the functional acceptance of the procedure. To assess the efficacy and advantage of this treatment.

Materials and method

The present study entitled "Management of Upper Limb Diaphyseal and Metaphyseal Fractures (Humerus, Radius and Ulna) with Application of Extension Cast" was undertaken in

Trauma Centre, Sir Sunderlal Hospital, Banaras Hindu University, and Varanasi. 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. Fixed criterion was discouraged for a definite sample size and it was considered to take up as many cases as possible from trauma centre on every Wednesday in the entire period of data collection *i.e.*, from of September 2020 and May 2022. 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 40 patients were chosen for the extension casting method.

The criteria for selection of the cases were as follows

Inclusion Criteria-Patients of all age groups, clinically diagnosed and proven by x-ray, Patients who were proved cases of Fracture of the upper limb diaphyseal and metaphyseal fractures, Patients who were diagnosed with recent fracture and Closed fracture (14 days or less), Patients who co-operated to give clear and detailed response to the questionnaire. Exclusion criteria-Individuals with segmental fracture of the humerus, radius and ulna, Patients suffered with open fracture and fracture with proximal or distal intra articular extension, Other exclusion criteria were polytrauma, floating elbow or shoulders, Pathological fracture,

compartment syndrome and patient with associated vascular disease.

The institutional ethical committee approved this study. The written informed consent document embodied in languages (Hindi/English) understandable to the participant was obtained from all the participants. A pre-designed questionnaire was administered to each individual to elicit information for various parameter. The sociodemographic data included the name, age, sex, area of residence, address, education, occupation. History of diabetes was also recorded for each and every case.

Results

The duration of the study was from June 2020 to April 2022. Forty-two patients fulfilled inclusion criteria of the study, of which 2 were lost to follow-up after casting. The remaining 40 patient were recruited for the extension casting method. Patients were treated by the extension casting method including 28 (70%) males and 12 (30%) females. The age of the patients ranged from 25 to 62 with a mean age of 41.45 ± 9.85 years. Out of these, 32 patients were treated on day of the injury while 8 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 40 patients 8 were found with diabetic history. 28 left extremity and 12 right extremities were treated with extension casting.

Table 1: Demographic data distribution in patients

Variables		Extension Casting (N =40)
Age	(Mean±SD)	41.45±9.85
Gender	Male (%)	28 (70.0%)
	Female (%)	12 (30.0%)
Diabetic	Yes (%)	8 (20.0%)
	No (%)	32 (80.0%)
Arm Side	Left (%)	28 (70.0%)
	Right (%)	12 (30.0%)
Type of fracture	Simple (%)	18 (45.0%)
	Intermediate (%)	17 (42.5%)
	Complex (%)	5 (12.5%)

Morphologically there were 18 simple transverse, 17 simple oblique and 5 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. Recovery with respect to other side after 1 year of treatment in patients showed in table 4. 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 92.5% (37/40).

Table 2: Distribution of recovery in patients with extension casting

Recovery	Extension Casting
< 75%	3 (7.5%)
75-89%	17 (42.5%)
	20 (50.0%)

Case 1



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

Case 2



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 1/3rd humerus treated in extension cast (showed union in 6 weeks) and range of motions

Discussion

Despite the fact that the long arm cast with the elbow extended is infrequently utilized, it has long been recognized for its benefits (Reynolds AW *et al.*)^[7]. The humerus is one of the long bones and radius ulna that can still be managed conservatively (Harkin FE *et al.*, 2017, Peeters PM *et al.*, 1987, Lehmann A *et al.*)^[8, 9, 10]. 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 (Zhang BS *et al.*, 2007)^[11]. In a study of 186 cases (Mahabier *et al.*)^[12] found that after operational and nonoperative treatment, consolidation time and complication rates were equal (Mahabier KC *et al.*, 2013)^[13]. The current study performed on 40 patients including 28 (70%) males and 12 (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 (Sarmiento A *et al.*, 2000)^[14] 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, Fjalestad et colleagues found that 38 percent of patients treated with this approach had substantial external rotation of the shoulder joint (Fjalestad T *et al.*, 2000)^[15]. 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 (Toivanen JA *et al.*, 2005)^[16]. In his famous work on closed fracture care, Sir John Charnley was critical of the sling, describing it as a deforming force" (Sahu RL *et al.*, 2015)^[17]. 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 (Westrick E *et al.*, 2017)^[18]. Non-union, deformity, and shoulder range of motion should be the focus of further research in the conservative care of humeral fractures. 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±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 (Prakash L *et al.*, 2022) ^[19].

The use of a lengthier cast allowed for more fracture immobilisation, 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. The cautious treatment may result in some loss of mobility in the shoulder and elbow (Kumar V *et al.*, 2013, Hackstock H *et al.*, 1988, Heineman DJ *et al.*, 2010) ^[20, 21, 22]. Surgical treatment of shaft fractures have been growing in the United States. Despite the benefits of conservative approaches. The cause of this increase is unknown. More emphasis should be placed on refining the conservative methods in situations where the change toward operational treatment is unexplainable (Schoch BS *et al.*, 2017) ^[23] 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 (Bleeker WA *et al.*, 1991, Pollock FH *et al.*, 1981) ^[24, 25]. 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.

Conclusion

It is simple to implement in resource-constrained environments

1. At the fracture site, the flexed forearm acts as a lever, creating rotational motion. Minimal rotation is caused by an extended forearm. This helps in faster union rates and better degree of range of motions at shoulder, elbow and forearm.
2. Patient compliance is high with the ultra light, lightly cushioned casts that are moulded across the deltoid, biceps, and triceps and applied with a precise cast index.
3. The range of motion in the wrist and shoulder, particularly external rotation, is unaffected. This is because shoulder range of motion can be started right away.
4. After removing the extension cast after 6 weeks, the range of motion is only affected in the elbow, however after 6 months, the range of motion progressively returns.
5. The general range of motion isn't affected much.
6. Edema of the hand does not occur when the limb is in a dependent position. This is due to the establishment of early shoulder and wrist range of motion. We didn't come across any cases of hand or forearm edema.

7. Extension cast allows gravity to work all the time which is especially beneficial for comminuted fractures. This reduces the chances of limb shortening.

Acknowledgement

Study was performed in trauma centre, institute of medical sciences, Banaras Hindu University, Varanasi, up. Study was approved by university ethical committee. There is No conflict of interest in this study. Not funded by any agency

Conflict of Interest

Not available

Financial Support

Not available

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How to Cite This Article

Singh CK, Samad R, Verma V, Yadav A, Sah A, Aggarwal P. Management of upper limb diaphyseal and metaphyseal fractures (Humerus, radius and ulna) with application of extension cast. *International Journal of Orthopaedics Sciences.* 2022;8(4):53-57.

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