

## Fracture Shaft of Humerus Treated with A Functional Brace

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### ABSTRACT

**Objectives:** To determine the clinical and radiographic outcome of patients treated with functional bracing for humeral shaft fractures.

**Study Design:** Descriptive case series

**Place and Duration:** Orthopaedic Surgery Unit, Mardan Medical Complex Teaching Hospital, Bacha Khan Medical College, Mardan, KPK from April 2012 to September 2013.

**Material and Methods:** Fifteen patients mean age 43 years (range 18 to 67 years) with fractures shaft of humerus meeting the inclusion and exclusion criteria were initially stabilized with plaster of paris U-slab for two weeks followed by the application of a functional brace. Clinical and radiographic evaluations were performed weekly for the first four weeks after the start of brace application, and then every two weeks. Functional evaluation was performed according to Hunter criteria. Radiographic evaluation was performed by taking the formation of healing tissue, anterior/posterior, lateral, and rotational angulations, and shortening into consideration.

**Results:** Majority (n=13, 86.6%) of the patients achieved union after a mean of 14 weeks (range 12 to 20 weeks). Two (13.3%) fractures failed to unite and were subsequently treated with surgery. Nine (69.2%) patients were evaluated functionally as excellent (G5) according to Hunter criteria while four (30.7%) evaluated as good (G3-G4). The mean varus-valgus angulation was 9 degrees while mean anterior posterior angulation was 10 degrees in patients who had union with functional bracing. One (7.6%) patient had shortening of 2 centimeter whose fracture was united with bracing.

**Conclusion:** Fractures shaft of humerus treated with a functional brace gave a high rate of union with excellent functional results.

**Key words:** Shaft of humerus, functional brace, outcome.

### INTRODUCTION

Fractures shaft of the humerus accounts for 1% to 3% of all fractures<sup>1, 2, 3</sup> and approximately 20% of all fractures involving the bone.<sup>4</sup> Radial nerve injury is a common complication of humeral shaft fractures, occurring in up to 18% of closed injuries.<sup>5</sup> Most commonly, radial nerve injuries are associated with middle one-third spiral humeral shaft fractures.<sup>6</sup> Fortunately, recovery can be expected with observation alone in 90% at 4 months after injury.<sup>5</sup> Treatment modalities of humeral shaft fractures have greatly evolved since their first description in ancient Egypt (Circa 1600 BC); however, fundamental management

principles have remained consistent throughout time.<sup>7</sup> There is no evidence available from randomized controlled trials to ascertain whether surgical intervention of humeral shaft fractures gives a better or worse outcome than no surgery.<sup>8</sup> Most closed fractures of the humeral shaft can be treated successfully with closed methods; union rates of more than 90% are often reported.<sup>9,10,11</sup> Multiple closed techniques are available, including the employment of traction, as well as the use of the hanging arm cast, coaptation splint, Velpeau dressing, abduction humeral/shoulder spica cast, or functional brace.<sup>9,10</sup> Sarmiento and colleagues first used the functional brace in 1977.<sup>11</sup> This device consists of anterior and posterior plastic shells that are held together with Velcro straps. The fracture is kept in position through soft-tissue compression, and the brace is tightened as the swelling decreases. Functional bracing renders a high rate of union and seems to be a safe method of treatment for the majority of closed humeral fractures.<sup>12</sup> This study was designed to evaluate

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the clinical and radiographic results of humeral shaft fractures treated with a functional brace.

**MATERIAL AND METHODS**

In this study a total of 15 patients of both gender and all ages with closed isolated fracture shaft of humerus presenting within a week or earlier after sustaining the injury were admitted through Orthopaedic Unit Out-Patient Department (OPD) and Accident And Emergency Department (A & E) of of Mardan Medical complex Teaching Hospital Bacha khan Medical College Mardan, KPK from April 2012 to September 2013. All patients with multiple fractures, bilateral humeral shaft fractures, pathological fractures, segmental fractures, intra-articular extension, open fractures, “floating elbow” with concomitant fractures of the humerus and both forearm bones, morbidly obese patients, patients with humeral shaft fractures and ipsilateral brachial plexus injuries and fractures with poor patient compliance like mental retardation and in those with neurological disorders like parkinsonism or epilepsy were excluded from the study.

The study protocol was approved by the Ethics Committee of the hospital and informed written consent was obtained from all the included subjects. Complete neurological examination of the extremity was done and X-ray humerus Antero posterior and lateral view was taken. All fifteen fractures were initially stabilized with the help of Plaster of Paris (Gypsona- BSN Medical 6”) U-slab under intravenous sedation with diluted Diazepam (Valium-Martin Dow) and Sosegan (Pentazocine HCl-Searle). Cotton wool is wrapped around the arm after giving the proper position to humerus, and elbow is brought to 90 degrees flexion. Slab is applied with a width of 6 inches an in 8-10 layers, to get hold of the shoulder and while the forearm is in neutral position.<sup>13</sup> Two weeks after the application of U-slab the acute pain and swelling subsided and functional brace was applied. Brace was applied to all the patients with the help of the measures taken from the intact arm, so as to leave the ante-cubital region open, and to allow flexion of the elbow up to 120°. Adhesive bands were arranged according to the swelling in the soft tissues and brace was used continuously. Braces manufactured from thermoplastic polyethylene extending in the medial aspect from a level of 2.5 cm below the axilla to a level of 1.3 cm over the medial epicondyl, and extending in the lateral aspect from immediately over the acromion to the lateral epicondyl of the humerus as described by

Sarmiento.<sup>11</sup> An arm sling was applied holding the elbow at 90 degrees of flexion. Patients were encouraged to do active and passive motion exercises for all joints of the fractured extremity. Arm neck sling was applied for the first two weeks continuously except for the periods that patient was exercising. Approximately one week after the application of the brace, pendulum exercises with the elbow in extension were begun. Clinical and radiographic evaluations were performed weekly for the first four weeks after the start of brace application, and then every two weeks. Functional brace application was terminated with the appearance of satisfactory healing tissue, disappearing of pathologic movement and pain in the fracture line. Patients with radial nerve palsy were followed with Nerve Conduction Study (NCS) and Electromyogram (EMG) taken after 6th week and repeated at 12<sup>th</sup> week if no recovery observed. Dynamized radial splint was applied to these patients immediately, and passive hand and wrist exercises were started.<sup>14</sup> Functional and radiographic evaluation was performed in the follow-up of the patients. Functional evaluation was performed according to Hunter criteria <sup>15</sup> by comparing to the intact side (Table 1). Radiographic evaluation was performed by taking the formation of healing tissue, anterior posterior, lateral, and rotational angulations, and shortening into consideration. Healing occurring in 16 to 24 weeks called delayed union, while healing not occurring till 24 weeks called a non union. <sup>14</sup> Acceptable alignment of humeral shaft fractures was considered to be 3 cm of shortening, 30° of varus/valgus angulation, and 20° of anterior/posterior angulation.<sup>16, 17</sup> All statistical analyses were performed using SPSS Version 15. Mean values calculated and data represented in tables where necessary.

**Table1:** Hunter Criteria

Grade	Description
<b>G1</b>	Complete absence of shoulder and elbow movements and complete impairment in daily activities
<b>G2</b>	Lesser degree of movement and important impairment in daily activities
<b>G3</b>	Small impairment in daily activities because of restricted movement
<b>G4</b>	Mild restriction in movement not affecting daily activities
<b>G5</b>	Full range of motion in shoulder and elbow

## RESULTS

Fifteen patients including 11(73.3%) males and 4(26.6%) females with mean age 43(range 18 to 67) years completed the study. Right humerus was fractured in 10(66.6%) patients while 5(33.3%) patients had fracture of the left humerus. Causes of fractures were road traffic accidents in 7(46.6%) patients, falling in 4(26.6 %) patients, physical assault in 2(13.3%) patients and sports injury in 2(13.3%) patients. The frequency and patterns of humeral shaft fractures are shown in Table 2. Majority (n=13, 86.6%) of the patients achieved union after a mean of 14 weeks (range 12 to 20 weeks).Two(13.3%) fractures failed to unite and were subsequently treated with plating and bone grafting. The two non union fractures were simple transverse fracture in middle third and an oblique fracture in the distal third of the humerus. Varus-valgus and posterior/anterior angulations were measured in patients that healing was obtained with functional brace in last control x-rays. The mean varus-valgus angulation was 9 degrees ( range 0-12 degrees) while mean anterior posterior angulation was 10 degrees( range 0-17 degrees) in patients who had union with functional bracing.

No rotational deformity was noted in any of the patients. None of these angulations were regarded to be important problems functionally and cosmetically. One (7.6%) patient had shortening of 2 centimeter whose fracture was united with bracing, full length could be obtained in all the remaining cases. Radial nerve palsy was reported in a middle third spiral fracture in only one (6.6%) patient and the nerve functions improved spontaneously after fourth month. Maceration developed in three (20%) patients related to the irritation of the skin by the brace. For these macerations, skincare and dermatologic agents were used without stopping the use of the brace. In the functional evaluation according to Hunter criteria following the healing of the fracture, there was mild restriction of motion in 4 patients (30.7%) that did not affect the daily activities (Hunter G3-G4), and full range of motion (Hunter G5) was seen in 9 (69.2%) patients. The most frequently seen functional losses were restriction in shoulder Abduction (average 30 degree loss) in 3(23 %) patient and restriction in external rotation (15 degree loss) in 1(7.6%) patient.

**Table 2:** Frequency and patterns of humeral shaft fractures

Level of fracture	Number of fractures	Transverse		Oblique		Spiral		Comminuted	
		No.	%	No.	%	No.	%	No.	%
Proximal 1/3	04	02	50%	01	25%	01	25%	00	00
Middle 1/3	08	04	50%	02	25%	01	12.5%	01	12.5%
Distal 1/3	03	01	33.3%	01	33.3%	01	33.3%	00	00
Total	15	07	46.6%	04	26.6%	03	20%	01	6.6%

## DISCUSSION

Functional bracing has been widely accepted as the gold standard for treating humeral shaft fractures conservatively.<sup>18</sup> We documented a union rate of 86.6% with functional humeral brace in our study. In the largest clinical analysis to date, Sarmiento reported on 922 patients treated with a functional brace for both closed and open humeral

shaft fractures, 98% of all closed injuries and 94% of all open fractures healed. He concluded that functional bracing for the treatment of fractures of the humeral shaft is associated with a high rate of union, particularly when used for closed fractures. The residual angular deformities are usually functionally and aesthetically acceptable.<sup>19</sup> Another study<sup>20</sup> reported a union rate of 77% (46

% union rates in the proximal third of humerus while 81% and 86% in the middle and distal third respectively).but the fracture brace in this study was applied immediately after injury while we applied functional brace two weeks after sustaining the fracture once acute pain and swelling subsided.

In our study functional evaluation following healing of the fracture was done according to the Hunter criteria and there was mild restriction of motion in 4 patients (30.7%) that did not affect the daily activities (Hunter G3-G4), and full range of motion (Hunter G5) was seen in 9 (69.2%) patients. Ozkurt and Altay achieved a union rate of 80% with a functional brace and reported functional outcome as excellent (G5) in 20% and good (G3- G4) in 80% of their patients according to Hunter criteria.<sup>14</sup> The sample size in the study was 30 with mean follow up period of 20 months (range 10 to 58 months )Another study assessed the radiographic and functional results using the scoring system of Kwasny et al. Radiographic and functional results were very good in 31 patients (81.6%) and good in seven patients (18.4%) and no complications were encountered pertaining to functional bracing.<sup>21</sup>

The most frequently seen functional losses in our study were restriction in shoulder abduction (average 30 degree loss) in 3(23 %) patient and restriction in external rotation (15 degree loss) in 1(7.6%) patient. Sarmiento<sup>19</sup> reported loss of shoulder motion exceeding 25 degrees in only 2% of his patients, while Fjalestad and Stromsoe reported loss of external rotation in 21(38%) of the fractures. Fracture consolidation in malrotation was seen frequently in their study, and a linear correlation between the clinical loss of external rotation and CT findings was indicated.<sup>22</sup> Rosenberg and Soudry treated 15 consecutive patients with humeral shaft fractures with a functional brace and followed for a mean of 30 months (range 12-57 months) and evaluated by Constant score and Oxford Shoulder Score. They concluded that although fracture union is usually achieved following functional bracing, the shoulder function in the injured limb may remain impaired.<sup>23</sup>

We documented non union in only two (13.3%) of our patients having a middle third transverse fracture and an oblique distal third fracture and both the patients were heavy smokers and could not gave up the smoking while using the fracture brace in spite of repeated instructions. Decomas and Kaye recognized the risk factors associated

with failure of treatment of humeral diaphyseal fractures after functional bracing as: obesity (37%); a history of cigarette smoking (53%); metabolic bone disease (32%); cardiovascular disease (37%); short oblique fractures (89%); open fractures (26%); and fractures of the proximal third of the diaphysis (68%).They recommend counseling these patients on the possible increased risk of nonunion from functional bracing and considering the option of operative fixation.<sup>24</sup> Union was achieved in 44 of 49 patients (90%) treated by Rutgers and Ring with no more than 15-degree loss of shoulder or elbow motion in any patient. Four of 14 proximal-third fractures (29%), one of 22 middle-third fractures (4%), and none of the 13 distal-third fractures failed to heal. They concluded proximal-third long oblique fractures may be at greater than average risk for nonunion after functional fracture bracing.<sup>25</sup>

Despite the strengths of our study, a few limitations deserve mention. Our sample size may not be large enough and follow up period was short. We therefore suggest larger case series with longer follow up period on this topic. As very little research data on this topic is available so far in this country, the need for more research cannot be over emphasized.

### CONCLUSION

Fractures shaft of humerus treated with a functional brace gave a high rate of union with excellent functional results. It maintains good alignment of the fragments and permits rapid and uninterrupted osteogenesis. The early introduction of functional activity to the entire extremity appears to provide a desirable physiological environment conducive to rapid healing and avoidance of loss of work power. It is easy to apply, adjust, bears no surgical risk, economically advantagous and the patient's acceptance of this method of treatment is high .As our results verified the efficacy of this treatment method, therefore functional bracing should be primarily considered in the treatment of humeral diaphyseal fractures because of low complications but very high success rates.

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