Research Article

Analysis of outcome of closed humeral diaphyseal fractures treated conservatively with functional brace

Jayant Jain[1*], Harshila Jain[2], V Shanmugam[3]

[1]Assistant Professor, [3]Professor and HOD, Department of Orthopedics, [2]Assistant Professor, Department of Ophthalmology, Sri Venkateshwara Medical College and Research Centre, Ariyur, Pondicherry-605102, INDIA.
Email: drjayanthj@rediffmail.com

Abstract

Background: Historically, humeral diaphyseal fractures have largely been treated conservatively, with high rate of union. The objective of study is to analyze the outcome of isolated humeral diaphyseal fractures treated by functional bracing. **Material and Methods:** This was a descriptive analytical study of closed isolated humeral diaphyseal fractures in ambulatory patients between 22 yrs and above. The affected arm was initially immobilized in U-slab for 2 wks before application of brace. Follow-ups were done at monthly interval for minimum of 6 months. Patients were assessed clinically and radiologically to see status of union, shortening, angulation or complications. **Results:** Twenty nine (96.66%) out of thirty fractures united with an average of 10.8 wks (range 9wks to 15 wks). There was no medial- lateral angulation in 50% patients. Apex lateral angulation was commoner than apex medial. As per Stewart and Hundley's criteria (1955), twenty four (80%) patients had excellent results, five (16.66%) had good results. Only one (13.33%) had poor result. **Conclusion:** Functional bracing gives high rate of union with acceptable deformity and good range of movement of adjacent joints.

Keywords: Humerus, Diaphyseal Fractures, Functional brace

[*]**Address for Correspondence:**
Dr. Jayant Jain, 302, Faculty Quarters S.V.M.C. and R.C., Ariyur, Pondicherry-605102, INDIA.
Email: drjayanthj@rediffmail.com
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INTRODUCTION

In recent years, with increase in civilization, industrialization and vehicular traffic, man has become more prone for injuries. Humeral shaft fractures represent approximately 1-5 % of all fractures.[1,2,3] The goals of management of diaphyseal fractures of humerus are to establish union and restore the patient's to their pre-injury level of function. The union should be rapid and should not be delayed due to technical errors of treatment. Functional cast bracing was first used in fracture of humerus by Sarmiento Augusto *et al*[4] Braces encourage the use of injured limb through the normal intermittent functions of daily living. Functional bracing is predicted on the belief that bone fragment contact, end to end is not required to obtain bony union and that rigid immobilization of joints above and below the fractures are detrimental to fracture healing. The main disadvantage of stiffness of joints and circulatory stagnation due to prolonged immobilization and disuse of limb can be avoided by functional bracing.

MATERIAL AND METHODS

A total of thirty four patients with closed diaphyseal fractures of humerus were treated with pre-fabricated functional brace. Four patients were lost to follow-up so this study consists of thirty patients. On admission detailed history of patients, mode of trauma, duration and any treatment taken were noted. Thorough general, systemic and local examination was done to check condition of skin over the fracture site, presence of wound and neuro-vascular status of the limb was determined. Roentgenograms Antero-posterior and Lateral view were taken to determine the type of fracture and degree of communition. Criteria for selection: The patients were selected for Functional brace application according to following criteria.

1. Closed fractures
2. Isolated humerus shaft fracture in that extremity
3. Ambulatory patients
4. Presence of reliability or co-operation on the part of patients.

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The affected arm was initially immobilized in a U-slab for two weeks to decrease edema and pain. Associated injuries were looked after and treated appropriately. After two weeks, when the initial pain and swelling subsided a pre-fabricated functional brace was applied with cuff and collar sling maintaining the elbow at 90°. The brace consists of a medial and a lateral shell and maintain the desired snugness of the brace. The proper fit of the arm was measured

a) From tip of acromion process to the lateral epicondyle in cms (l1) and 4cms were deducted to know appropriate length of lateral shell (L1), L1 = l1 – 4cm
b) From inferior border of axilla to medial epicondyle (l2) in cms and 2 cms were deducted to know the approximate length of medial shell (L2), L2 = l2 – 2cms

The brace is available in 3 sizes. Most appropriate size was fitted. Patients were carefully instructed to maintain a snug fit by adjusting Velcro straps. Too snug fit may cause swelling of distal arm and requires loosening of straps. The brace was born all the times. Patients were advised to remove cuff and collar sling for exercises. Patients were taught pendulum exercises and elbow extension exercises with active motion of hand. These movements were encouraged since beginning. Active shoulder flexion and abduction were forbidden at this stage to avoid angulatory deformity at fracture site. Patients were asked not to rest elbow on their laps or hard surfaces. Leaning on elbow may give apex lateral angulation at fracture site. Follow up: follow ups were done at monthly intervals for minimum of 6 months. Patients were assessed clinically and radiologically to see status of union, shortening, angulation or complications. When there was clinical and radiological evidence of union, active shoulder flexion and abduction were permitted, brace was discontinued and range of movements of shoulder and elbow were noted. Angular deformities like apex medial or apex lateral and anterior-posterior angulation were noted. Final assessment was done at minimum 6 months. Functional assessment was done according to "Stewart and Hundley (1955)" [5] criteria which assess result as follows **Excellent:** No pain and limitation of adjacent joint mobility less than 20° and angulation less than 10° **Good:** Pain after efforts or fatigue or limitation of mobility ranging between 20° to 40° and angular deformity greater than 10° **Poor:** Permanent pain or limitation of mobility greater than 40° or nonunion

OBSERVATIONS

In our study the youngest patient was 22 yrs and eldest patient was of 63 years. Majority of patients were of 3rd to 5th decade. Sex incidence: 73.33% of patients were male and 26.66% were female. Side injured: Right arm (66.66%) was more commonly involved compared to left arm (33.33%). **Mode of injury:** assault and road traffic accidents accounted for most of the cases and remaining were due to fall from height. **Level of fractures:** 56.66% had middle 1/3rd shaft fractures, 26.66% had distal 1/3rd shaft fracture and 16.66% were in proximal third of shaft of humerus. **Functional results**: As per Stewart and Hundley criteria patients were assessed clinically and radiologically, considering pain, function of limb, range of motion of shoulder and elbow, angulation at fracture site and union. 24 (80%) of patients had excellent results, 5 (16.66%) had good results. Only 1 (3.33%) had poor result. One patient with poor result underwent non-union for which percutaneous bone marrow infiltration was done at 4 months but fracture did not unite. Then open reduction and internal fixation with plating and bone grafting was done at 7 months and the fracture united.

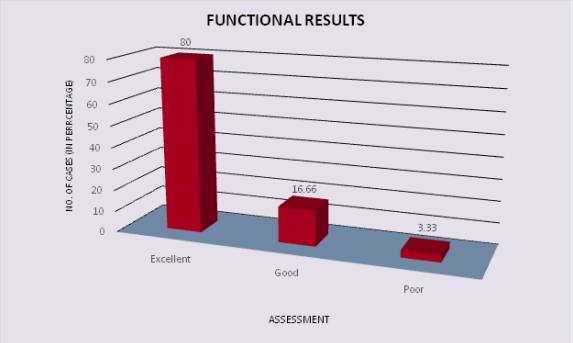

Figure 1

DISCUSSION

Trauma or injury to human body has been a challenging situation even to prehistoric man. Even earliest surgical test (1600BC) recommended reduction using traction followed by bandages made rigid by wax and resigns.[6] Apart from historic perspective, conservative treatment continues to be the mainstay of treatment for isolated humeral shaft fractures with good functional results.[7]

Because of multi-directional movement at gleno-humeral joint, deformity is well tolerated after union. Acceptable fracture alignment includes 20° of anterior bowing, 30° of varus angulation, 15° of mal-rotation and 3cms of shortening or bayonet opposition[8]. Nowadays there is general agreement that total immobilization of extremity is harmful for fracture healing[9] as well as for whole limb[10]. Latta *et al*[11] and Sarmiento *et al*[9] noted that controlled movement at fracture site is conductive for osteo-genesis. Sarmiento *et al* (2000) published a series of 627 patients with 97% union rates with high satisfaction rates with functional bracing[12,13.] Operative treatment is mainly indicated in specific circumstances including a) open fractures, b) associated neurovascular injury, c) proximal and distal articular extension, d) patients with multiple injuries (poly-trauma) e) floating elbow, f) progressive radial nerve deficits, g) associated soft tissue injury (unable to brace), g) pathological fractures and h) failed non-operative treatment[2,14,15]. Relative indications include obese patients, brachial plexus injuries (loss of muscular contraction with inability to maintain alignment) and non-compliant patients[4,12]. Union rate of fracture in our study was 96.66% (29 out of 30).

Table 1: Union in various series

Sr. No	Study	Union (in %)
1	Balfour G.W. *et al*. (1982) [16]	97.62%
2	Zagorski B.J. *et al*. (1988) [12]	98.24%
3	Osterman P.A.W. *et al*. (1993) [17]	98%
4	Sarmiento A. *et al*. (2000) [13]	97%
5	Kapil Mani K.C. *et al*. (2013) [18]	97.2%
6	Rutgers M. *et al*. (2006) [19]	90%
7	Present study	96.66%

Time taken for union in our study was 6-15 wks. Average 10.8 wks.

Table 2: Time taken for union in various series

Sr. No.	Study	Time for union (in weeks)	
		Range	Average
1	Balfour G.W. *et al*. (1982)	4-15 wks	7.5 wks
2	Zagorski B.J. *et al*. (1988)	5-20	10.6 wks
3	Osterman P.A.W. *et al*. (1993)	8-12	9.25 wks
4	Sarmiento A. *et al*. (2000)	5-19	9.5 wks
5	Kapil Mani K.C. *et al*. (2013)	7.5-19.3	12.16wks
6	Present study	6-15 wks	10.8wks

In our study there was no medial-lateral angulation in 50% patients. Apex lateral angulation was common (47.33%) than apex medial angulation (3.33%). Angulation more than 20% was found in only one (3.33%) patient.

Table 3: Medial-lateral angulation in various series

Sr. No	Study	Medial –lateral angulation >20°
1.	Klenerman L.*et al*. (1966) [8]	15.6%
2.	Balfour G.W. *et al*. (1982)	2.38%
3.	Zagorski B.J. *et al*. (1988)	2.3%
4.	Rangger christoph *et al*. (2000) [20]	0
5.	Sarmiento A. *et al*. (2000)	2%
6.	Present study	3.33%

In our study one patient (3.33%) had non-union and one (3.33%) had maceration of skin.

Table 4: Complications in various series

Sr. No.	Complications	Balfour G.W. *et al*. (1982)	Zagorski B.J. *et al*. (1988)	Sarmiento A. *et al*. (2000)	Present study
1.	Nonunion	1(2.38%)	3(1.76%)	16(3%)	1(3.33%)
2.	Refracture	3(7.14%)	2()1.17%	4(<1%)	--
3.	Maceration of skin	--	2(1.17%)	3(<1%)	1(3.33%)


Figure 1


Figure 2


Figure 3

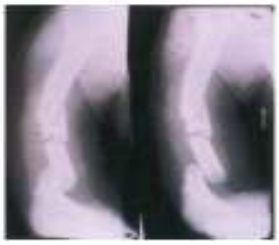
Figure 4


Figure 5


Figure 6


Figure 7


Figure 8


Figure 9


Figure 10

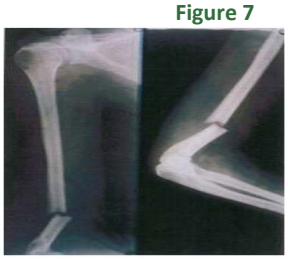
Figure 11


Figure 12

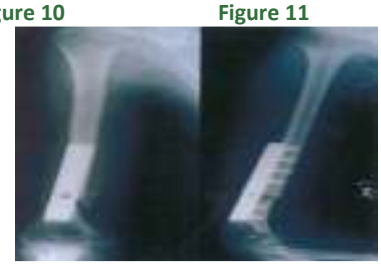
Figure 13

Legend

Figure 1: Initial skiagram showing displaced fracture shaft of humerus
Figure 2: Twelve wks post injury showing union with callus formation
Figure 3: Nine months post injury showing remodeling of fracture
Figure 4: Three level segmental fracture with longitudinal split (initial skiagram)
Figure 5: Union at 15 weeks
Figure 6: Forty-four weeks post-injury showing remodeling of fracture
Figure 7: Skiagram showing fracture middle third shaft humerus
Figure 8: At 6 months showing union
Figure 9: Skiagram in brace
Figure 10: Skiagram at 6 months showing union
Figure 11: Skiagram showing Fracture at lower third shaft humerus
Figure 12: skiagram 4 months post injury showing no signs of healing
Figure 13: Skiagram showing open reduction with plating with bone grafting

When compared to treatment of plaster cast, functional brace carries many advantages. Firstly, it can be removed for personal hygiene. Secondly, elbow movement are not restricted resulting in less elbow stiffness. Thirdly, due to less weight of pre-fabricated brace, it is patient friendly and causes no distraction at fracture site[21]. Operative treatment is mainly indicated in specific circumstances including open fractures, associated neuro-vascular injury, proximal and distal articular extension, patients with multiple injuries (poly-trauma), floating elbow, progressive radial nerve deficits, associated soft tissue injury (unable to brace), pathological fractures and failed non-operative treatment[2,14,15]. Relative indications include a) obese patients b) brachial plexus injuries (loss of

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muscular contraction with inability to maintain alignment) c) non-compliant patients[4,12] Recently, due to less patience for conservative treatment, intolerance for acceptable deformity, many orthopedic surgeons are increasingly considering surgical intervention in isolated humeral shaft fractures. Surprisingly, high complications rates have been reported with intra-medullary nails[22,23,24]. The complication rates reported were lower with plating to nailing [25, 26] but open reduction internal fixation causes a scar which may be troublesome esp. for young women. Furthermost, functional bracing does not require hospitalization and is cheap and cost-effective.

CONCLUSION

Functional bracing is safe, effective and economical and gives good functional outcome in cases of closed, humeral diaphyseal fractures.

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