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Original Research Paper

Orthopaedics

EVALUATION OF RESULTS OF NON OPERATIVE TREATMENT OF FRACTURE SHAFT OF THE HUMERUS WITH A FUNCTIONAL BRACE

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ABSTRACT

Introduction: Fractures of the humeral shaft account for roughly 3% of all fractures due to fall on the outstretched hand, motor vehicle accidents and direct loads to the arm. The brace effectively compresses the bulky biceps and triceps muscle allowing early shoulder, elbow, wrist and hand motion with nonunion and radial nerve palsy in a significant percentage of humeral shaft fractures. This study intends to assess the results of non-operative treatment of fracture shaft of the humerus with a functional brace.

Materials and Methods: Prospective observational study was conducted in NMCTH, Birgunj among 50 patients from 16 years onwards of age who presented with fracture of humerus shaft. The patients with open fracture, floating elbow, bilateral humeral fracture, polytrauma, pathological fracture, additional injury of the extremities and patients with neurologic and psychiatric disorders were excluded from the study. The patients were treated with close reduction and immobilization in functional humeral cast brace and were followed up in outpatient department basis once a week for the first four weeks and every four weeks subsequently till fracture united. After removal of brace functional evaluation of results of upper limb was done according to Hunter's criteria.

RESULTS: Six patients out of 50 lost to follow up and was removed from final analysis . Out of 44 cases, mean age of patient was 34.77 year. Most of them 28(64%) were male. RTA was most common mode of injury 24(54%). Most of the patient 26(59%) had fracture on non dominant side. Majority of the fractures 24(55%) were in the middle 1/3rd. Thirty two cases (72%) attended the hospital within 24 hours of injury. Union was achieved in 41(93%) patients within a mean time of 11.48 weeks. One transverse and two comminuted fractures in middle and distal third of diaphysis did not unite and were treated surgically. According to Hunter's criteria of evaluation of results, 31(75.6%) of united fractures had excellent (G5) and 10(24.4%) had good (G4) results. Restriction of few degrees of terminal range of movements of shoulder abduction and external rotation present initially improved subsequently after physiotherapy. Mean varus angulation in 39 patients at the time of removal of brace was 7.05° and mean valgus angulation in four patients was 6.00°. Mean anterior angulation of 6.85° was present in 21 patients and mean posterior angulation of 7.11° was present in 20 patients at the time of removal of brace. Mean shortening of 6.5 mm was present in 36 patients. The various angulation deformities and shortening at the end of union did not cause functional and cosmetic effect.

Conclusion: Fracture shaft of humerus treated by close reduction and functional bracing has good functional outcomes.

KEYWORDS :

INTRODUCTION

Fractures of the humeral shaft account for roughly 3% of all fractures resulting from fall on the outstretched hand, motor vehicle accidents and direct loads to the arm. The commonest cause of injury is a motor vehicle accident especially in young adults[1]. While it is fall injury in elderly patients. Greater amounts of comminution and soft tissue injury results from higher energy injuries.[3,4]Most of these fractures can be treated non-operatively with a greater than 90% rate of union.[1,2]

Classically, humeral shaft fractures have been classified on the basis of various factors that mostly influence treatment such as location[1]: a) proximal 1/3rd b) middle 1/3rd c) distal 1/3rd. It indicates severity of force on the bone during injury.

On the basis of direction and character of fracture line[1] a) transverse b) oblique c) spiral d) comminuted e) segmental On the basis of fracture comminution to the external environment, open fractures by Gustilo and Anderson[5] a) grade 1 b) grade 2 c) grade 3A, grade 3B grade 3C.

This fracture is usually associated with skeletal and neurovascular injuries involving shoulder and elbow joints and radial, median, axillary, ulnar nerve and brachial artery and vein.

According to AO/ASIF, on the basis of fracture comminution it is classified as; type A-Simple fracture which is further classified as A1(spiral), A2(oblique) and A3(transverse) , type B(Wedge) which is further divided as B1(Spiral wedge), B2(bending wedge) and B3(fragmented wedge). Type C (complex comminuted) again subdivided into C1(Complex spiral) C2(complex segmental) C3(complex irregular).[1]

In contrast to the compressing forces in lower extremity fractures resulting from the body weight and ground reaction forces, reduction can be achieved easily in humeral shaft fractures owing to the effect of the muscle tissue surrounding the humerus, and consequently, conservative treatment can be possible most of the time [6,7] . It has been reported that higher rates of healing, lower rates of complications, and better functional results can be achieved as compared to surgical treatment.[9,10,11]

Application of surgery is accepted in general for fractures with vascular and nerve injury, patients with multiple fractures, bilateral humeral shaft fractures, comminuted segmental fractures, pathological fractures, open fractures, fractures that vascular and nerve complications develop during conservative treatment fractures with poor patient compliance like mental retardation and in those with neurological

disorders like parkinsonism or epilepsy. Humeral fractures in cases other than mentioned above can be successfully treated with conservative methods.[12,13,14,15,16]

Hanging cast, U splint, shoulder-trunk cast, Sarmiento cast, abduction device, shoulder fixing bandage(velpeau bandage) and skeletal traction are used methods of conservative traction. Movements of shoulders and elbow can be set free in early stages with brace treatment, and complications like stiffness in the elbow and shoulder joints, and subluxation of the shoulders as a result of atrophy of the deltoid muscle can be prevented.[17,18,19,20,21,22,23]

Functional bracing has essentially replaced all other methods of conservative treatment and has become the "gold standard" for non-operative treatment because of its ease of application, adjustability, allowance of shoulder and elbow motion, relatively low cost and reproducible results. Humeral functional bracing was initially popularized by Sarmiento in 1977[2,6]. It works on the principles of hydraulic effect of the brace by compressing the soft tissues circumferentially and maintains the fracture alignment. Active contraction of the muscles and beneficial effect of the gravity has been shown to be very effective for treating closed humeral shaft fractures. Union rates of 96% to 100% have been reported with this techniques. [6,7]

With the effect of gravity and weight of the limb, initial reduction can be achieved and this is maintained by functional brace. This stabilization of the fracture fragments allows active shoulder and elbow movements adjacent to the fracture. With the active contraction of the muscles around the fracture, physiologically controlled micromovement takes place, and blood flow and mineral deposition increases at the fracture site. These two factors together stimulate osteogenesis, and fracture healing occurs with external bridging callus.[29]

The humeral brace consists of two plastic sleeves and two adjustable Velcro Straps to hold the sleeves together. The sleeve extends medially from 2.5 centimeter below the axilla to 1.3 centimeter above the medial epicondyle of the humerus. Laterally, it extends from a point just below the acromion to slightly above the lateral epicondyle. During application of the sleeve, minor correction in the alignment of the fragments can be carried out. The sleeve must allow a complete range of motion of the shoulder and elbow. The Velcro straps permit removal of the splint for personal hygiene and for adjustment of the compression of the soft tissues as the edema subsides.[30] Guidelines for acceptable alignment for humeral shaft fractures were proposed by Klenerman, and they have been endorsed by several authors since then. Accordingly maximum of 3 cm of shortening, 20 degrees of anterior or posterior angulation and 30 degrees of varus angulation are acceptable.[31]

Although facilities for operative treatment are easily accessible in developed countries, these facilities are not available in most of peripheral areas in our country. Patients should wait for long time for surgery even in the centers that provide operative facilities because of overload of patients. So there is a prime importance of conservative treatment of humeral shaft fracture in the developing countries. Besides, the cost of operative treatment is quite high as compared to conservative treatment. Patients should undergo operation second time for the removal of implant in case of operative method. There is chance of infection, neurovascular injury, shoulder impingement, delayed union and nonunion in operative treatment.

A large number of patients came to our institute with humeral shaft fracture for treatment. The purpose of this study is to determine the functional outcome of diaphysealhumerus fracture in patients above 16 years of age treated conservatively by functional brace.

General Objectives

To evaluate the effectiveness of functional brace in fracture shaft of humerus in age 16 year onwards.

Specific Objectives

- To find out age, sex and side distribution.
- To measure the mean time for union.
- To evaluate the post functional bracing radiological parameters (AP angulation).
- To measure shortening of arm at the time of removal of brace
- To assess the varus/valgus angulation

METHODOLOGY

Type of Study

This was a prospective hospital based observational study carried out at National Medical College And Teaching Hospital, Birgunj, Nepal. A total of 50 cases with closed fracture shaft of humerus above 16 years of age who arrived within 14 days of injury during 1 year study period (July 2016 - June 2017) were included in the study.

EXCLUSION CRITERIA

1) Failure to obtain and maintain adequate closed reduction with residual shortening of more than 3cm, anter oposterior angulation of more than 20° and varus or valgus angulation of more than 30°.
2) Floating elbow
3) Open fracture
4) Polytrauma with multiple injuries, Spinal cord injury, head injury and lower extremity long bone fractures
5) Bilateral humeral fractures.
6) Segmental fracture of humerus
7) Pathological fracture
8) Neurovascular injury of the limb
9) Nerve injury occurring during the period of conservative management
10) Intra-articular extension of fracture into shoulder or elbow joint
11) Brachial plexus injury
12) Poor patient compliance like mental retardation and those with neurological disorders like parkinsonism or epilepsy.

Procedure

All the patients above 16 years of age with isolated arm trauma were attended in emergency or OPD. A proper history was taken and detailed examination of the patient was done alongwith vitals and general condition monitoring. Radiographs of the arm including shoulder and elbow joints, anteroposterior and lateral view were done to confirm the diagnosis and evaluation for fracture level, pattern and comminution.

The fracture was classified by AO/ASIF classification of long bone and all the patient with fracture shaft of humerus who had given an informed consent for participation in the study were included in the study.

Close Reduction Technique

Under the supervision of the faculty members, the fractures were reduced under analgesia by making the patient sit on the table. The weight of the limb and the effect of gravity help in reduction of the fracture. After reduction of fracture arm was immobilized in U slab with the elbow in 90 degrees of flexion and arm pouch was given. Minor correction was done if necessary after check x- ray. Patients were evaluated in the outpatient department after one week. After ruling out acute symptoms and swelling of arm prefabricated humeral cast brace was applied and fracture position was confirmed on check xrays. Varus or valgus and anterior or posterior angulation and shortening were measured and recorded. Collar and cuff sling was given.

Bracing technique

The humeral brace consists of two plastic sleeves and two adjustable Velcro straps to hold the sleeves together. The sleeve extended medially from 2.5 cm below the axilla to 1.3 cm above the medial epicondyle of the humerus. Laterally, it extended from a point just below the acromion to slightly above the lateral epicondyle. During application of the sleeve, minor correction in the aliment of the fragments was carried out. The shoulder and elbow joints were left free. It was ensured that the sleeve must allow a full range of motion of the shoulder and elbow. The Velcro straps permit removal of the splint for personal hygiene and for adjustment of the compression of the soft tissues as the edema subsides.

After applying the brace subsequently patients were followed in the outpatient department once a week for the first four weeks after application of brace and then once a month until clinical and radiological union occurred, At each visit, patient was examined clinically and radiologically for the progress of union, to check the position of the fragments, overriding, angulation, rotation of the fragments and callus formation. Shoulder, elbow and finger movements were checked and emphasized on every visit.

The patients were advised to sleep in head-up position with the purpose of preventing varus deformity that might develop particularly in transverse fractures. Active elevation and abduction of shoulder was not allowed, since it could lead to angular deformity. Patients were also advised not to lean with the elbow resting on the arm of a chair or table or their lap as leaning on the elbow of a fractured extremity during the early stages of healing to might aggravate varus angulation. Such angulation is more likely to occur in transverse fractures.

The brace was to be worn at all times, except during bathing. Patients were advised for the pendulum exercises immediately after the application till the removal of brace after union The collar and cuff sling was taken fill for a few minutes several times a day to permit combined active and passive exercises of the elbow and to regain full extension of the joint. Patients were also taught how to adjust the brace and tighten the Velcro straps Several times a day to accommodate the changes in the girth of the extremity that occurs as the swelling subsided.

Once full extension of the elbow was achieved, use of the collar and cuff sling was discontinued during walking but was used encouraged during recumbency. During the next four weeks, the frequency and intensity of exercises involving passive flexion of the shoulder and active flexion of the elbow was increased. Patients were instructed to perform active and passive extension of the wrist and fingers several times a day.

Follow Up

After application of functional cast brace patients were followed up in out-patient department basis once a week for the first four weeks and every four weeks subsequently till fracture united. After satisfactory clinical and radiographic healing, which generally occurred within eight to twelve weeks the brace was removed. After the removal of the brace, the functional evaluation of the limb was done with respect to the range of shoulder and elbow movements according to Hunter's criteria. Final varus-valgus angulation on anteroposterior radiograph, anteroposterior angulation on lateral radioqraph and Shortening was measured and recorded. Protocol of treatment for radial nerve palsy included splintage and observation. Dynamic Wrist drop splint was applied and continued in patients with radial nerve injury till it recovered.

HUNTER`S criteria for functional evalution[29]

G1: Complete absence of shoulder and elbow movements
G2: Lesser degree of movement and important impairment in daily activities
G3: Small impairment in daily activities because of restricted movement.
G4: Mild restriction in movement not effecting daily activities
G5: Full range of motion in shoulder and elbow.

The angulations i.e. varus or valgus and anterior or posterior and shortening recorded at the time of application of brace and after fracture union, and were compared.

RESULTS

A total of 44 patients were enrolled in the study. The mean age of the patient was 34.77 years with maximum patients 40(90%) were between 16 t0 45 years of age. The peak incidence of humeral fracture was between 31-45 year of age 24(54%) and higher in males 28(64%). RTA 24(54%) and fall from height 17(39%) were the major causes of fracture with left humerus26 (59%)involved more than right. Four out of 44 fractures in this study was associated with other skeletal injuries (2 were associated with head injuries, one with contralateral clavicle fracture and remaining one with contralateral elbow dislocation). The study revealed that all the patients except 2 arrived within48 hours of injury. 32(72%) attended the hospital within 24 hours of injury.

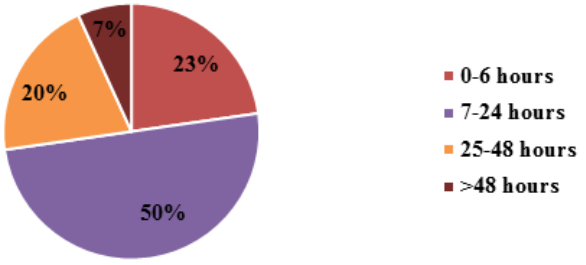

Figure 1: Distribution of cases according to time of arrival to hospital after injury

Four fractures were associated with radial nerve injury, 2 fractures each in middle 3rd and distal third of humerus, (one spiral and one oblique each) fracture.

Majority of the fractures 24(55%) were in the middle 1/3rd followed by 12(27%) in the distal 1/3rd and 8(18%) in the proximal 1/3rd. Transverse fractures were common 17(39%) followed by 10(23%) comminuted, 9(20%) oblique and 8(18%) spiral. Transverse fractures were more on the middle third and comminuted fractures were more on the distal third.

Majority of the fractures 28(63.6%) belong to type A (Simple fracture) and 10(22.7%) belongs to type B (Wedge fracture) and another 8(18.8%) belongs to type C (Complex comminuted).

Majority of the patients 40(91%) had varus angulation ranging from 4 to 16^0. Four (9%) had valgus angulation ranging from 5 to 15^0. After union, at the time of removal of brace, the mean varus and valgus angulation were decreased. Mean varus angulation was 7.05°(3-14°) and mean valgus angulation was 6.00° (4-9°). Three nonunion fractures were excluded from the study.22(50%) had anterior angulation ranging from 4-14°; 20(45.4%) had posterior angulation ranging from 4-14°. Mean anterior and posterior angulation were 8.31° and 8.21° respectively.

Forty one out of 44 patients had fracture union at 11.48±2.326 weeks with minimum of 7 weeks and maximum of 18 weeks except two who had delayed union occuring after 4th month. Spiral and oblique fractures united faster in comparison to transverse and comminuted fractures. The mean union time for type A fracture was 15.27 weeks, for type B 12.76 weeks

whereas type C complex fractures united within a meantime of 14.43 weeks. Type I fractures united late than type II and III. 36 patients had shortening of which (55.50%) patients had less than 0.5cm of shortening; 11(30.50%) had 0.51-1.00 cm of shortening. Mean shortening of 0.65±SD 0.904 cm was observed.

The most common lost range of motion was shoulder abduction and external rotation. There was normal or ≥ 25° restriction of abduction present in 93% of patients. Only 3 patients had more than 25° of restriction of abduction. 30 patients had restriction of abduction. All 41 patients had less than 20° restriction of flexion. Extension of less than 20° restriction was found in all patients. All 41 patients had less than 20° of internal rotation.One patient had more than 15° of restriction of elbow extension at the time of removal of brace after full union. Majority of patients had less than 15° of restriction which was functionally acceptable.

Radial nerve recovery occurred in all patients. First sign of recovery was wrist dorsiflexion which appeared with two patients in 6-10 weeks and in two in 11-15 weeks. Recovery of finger extension took in 16-20 weeks. All the four patients had recovery of normal (i.e grade 5 power) around 20 weeks.

In assessing the functions 10(24.40%) fractures had grade IV functions and 31(75.60%) fractures had V function. Rate of return to full function was fast in younger patients and slower and less complete in older. On subsequent follow ups most of the patients regained their full functions.

Three (7.31%) fractures underwent nonunion. Among three nonunions two were comminuted and one was transverse and two of them were in middle third and one in distal third.

DISCUSSION

Concepts in the management of trauma in orthopedics are very rapidly changing to keep pace with increasing severity and complexities of the fractures. The management of humeral shaft fracture is always a challenging problem, as they are frequently associated with multiple injuries, leading to complications like shortening, malunion, infection, delayed union and nonunion.

The classical method of treatment of humeral shaft fractures has been the use of U plaster slab followed by functional bracing. Functional bracing has been widely accepted as the gold standard for treating humeral shaft fractures conservatively. Encouraging-results have been obtained with this method despite some residual angulation, malrotation, and limb length inequality.

In our study,the mean age of the patient was 34.77 years. Ozkurt et al.[29] in their study mentioned the mean age of patients to be 34 years which was similar to various studies done by the several authors.The mean age of the patient was in between 3rd to 5th decades of life in those studies.

Our study included 64% male and 36% female similar to the study done by Ghadeer,Ozkurtet and Nasser et al.[29,40,42]

In our observation of 44 cases of humeral diaphyseal fractures, 20 (45.4%) cases were involved in RTA and 17(38.6%) had fall from height. 3 (6.8%) cases of humeral shaft fractures were from miscellaneous injuries like direct trauma to arm, throwing injuries similar to the study by Ozkurt et al.[29] Ghadeer et al.[42] and Faiz et al.[43] Non dominant arms were involved in 59% (26) i.e. the left side in right handed patients which was similar to other studies ranging from 57% - 61.5% of cases. [32,38,40]

Comparable to the findings of Ozkurtet al.[29], Rutgers et al.[37] and Pehlivan et al 9 %(4) of patients had associated skeletal injuries.Considering time of arrival after injury, 93% (41) of the patients arrived within 48 hours of injury similar to other studies where about 91% of the patients arrived within 48 hours of injury.

Radial nerve injury was encountered in 9% (4 cases) out of cases while the studies by Faiz et al.[43] ,Ekholam et al.[38] and Koch et al.[35] found 6.6%, 6%, and 7.4% patients had radial nerve injury in their respective studies.

In our study 54.5%(24) fractures were in the middle third followed by 27.2% (12) in distal third and 18.19% (8) fractures in the proximal third of shaft. Dameron TB et al.[31] found in 100 paients of humeral diaphyseal fracture 51% in middle third,23% in proximal third and 24% in distal third. Rosenberg et al.[36],Rutgers et al.[37],Nasser et al.[40],Kapil et al.[41],Jitendra et al.[45] and others authors have similar distribution pattern of humeral diaphyseal fractures.

According to AO classification of long bone fracture, 63.6% (28) were type A, 22.7% (10) were type B and 18.8%(8) were type C. Rosenberg et al.[36],in their study had 66% type A, 26.7% type B, 13.3% type C where asEkholm et al.[38] had 50% type A, 33% type B and 17% type C.

In our study of 44 humeral diaphyseal fractures; at the time of application of brace varus angulation deformity ranging from 5-17° (8.7°+/- 3.60 was present in 86.3%(38) of the cases while that of Valgus angulation was 5-15° (8.00° +/- 4.00) in 9.09% (4) of the patients. Anterior angulation of 5-14° (8.31° +/-3.35) was present in 22(50%) cases while posterior angulation of 4-12° (8.30°+/- 3.06) in 20(45.5%). In a study by Kapil et al.[41] 88% had mean varus angulation of 8.65°, 6% had mean valgus angulation of 7.44°, 48% had mean anterior angulation of 5.24° and 47% had mean posterior angulation of 5.35°.

After the fracture union in our study, 35 (85.3%) Patients had mean varusangulation of 7.05+/- 2.78, 4(9.7%) had mean valgus angulation of 6.00°+/- 3.00, 21(50%) had mean anterior angulation of 6.85°+/-2.532 and 20(45.4%) had mean posterior angulation of 7.15°+/- 2.63. In this study all the angulation deformities after application of brace either decreased or same as at the time of removal of brace similar to the study byKapilet al.[41], Faizet al.[43] and Ozkurt et al.[29]

Out of 44 patients 93.1%(41) united within 7-18 weeks with a mean of 12.5 weeks. In study done by Jitendra et al.[45] ,Wallny T et al.[12] ,Zagorski JB et al.[30] and Ekholam et al.[38] , the mean time of union was 10.3 weeks, 12.63 weeks, 10.6 weeks and 11.5 weeks respectively in more than 90% of cases. Similar to the studies by Faiz et al.[43],Sarmiento et al.[30]and Kapil et al.[41]the mean time of union was 10.6 weeks of oblique fracture,10.8 weeks for spiral fracture, 10.9 weeks for transverse fracture and 11.4 weeks for comminuted fractures.

According to Kapilet al.[41] and Faiz et al.[43] humeral diaphyseal fractures treated by nonoperative method had a mean shortening of 4.6mm while that in our study was 6.5mm

On evaluation of functional results of upper limb of these 41 fractures united patients, 4.8% (2) had restriction of terminal range of abduction 25° and 2 had restriction of adduction in terminal range of more than 10°. Terminal range of extension restriction of less than 10° was present in 87.8% of the cases. Restriction of terminal range of internal rotation up to 10° was present in 97.5% (40) patients; External rotation restriction of more than 15° was present in 7.3% (3) cases. Kapil et al.[41] on their final evaluation of shoulder and elbow functions after union of humeral shaft fracture treated by functional cast brace found ≥25° restriction of shoulder abduction In 60% of patients, ≤25° restriction of adduction in 88.6% of the Patients,

≤25° restriction of shoulder flexion in 65.7% of the Patients, ≤25° restriction of extension in 91% of the patients. External rotation of normal or ≤25° restriction was present in 80% of the patients and internal rotation of normal or ≤25°. Restriction was present in 88.7% of the patients. Normal or ≤10° restriction of elbow flexion and extension was present in 90% of the patients. According to Faizet al.[43] the most frequently seen functional loses were restriction in shoulder abduction; average 30° loss in 23% (three patients) and restriction in external rotation, 15° loss in one (6.7%) of the patients at the time of removal of functional brace after union.

Similar to Rutgers et al , pehlivan and Kapil study extension of elbow joint as compared to uninjured side, 29 had elbow extension <10°. 23 had restriction of elbow flexion of <10° and 2 patients had >15° restriction whereas these restricted joint movement subsequently improved with physiotherapy as observed during follow up.

Out of 41 cases of united fracture, shaft of humerus treated by cast brace 31(75.6%) had excellent (G5) results and 10(24.4%) had good (G4) results.Patients with excellent results had no complication and the range of movement was normal.Patients with good results initially had restriction of terminal degree of movements which recovered with physiotherapy similar to previous studies.[29,38,40]

Closed humeral shaft fractures had radial nerve injury in 4 cases. It was thought to be of type 1 injury according to Sunderland's classification[53] and neuropraxia according Seddon's classification[54]. In all cases nerve recovered within 7 weeks to six months. These findings were similar to the studies of Sarmiento et al.[30], Kapil et al.[41] and Faiz et al.[43]

CONCLUSION

This study concluded that fractures shaft of humerus treated with a functional brace gave a high rate of union with excellent functional outcomes.

Recommendations

- Fractures shaft of humerus treated with a functional brace is a safe procedure.
- The procedure is technically simple, time saving and low cost.
- Regular follow up is recommended to prevent any complications.

FUNCTIONAL BRACE APPLICATION

14TH WEEK FOLLOW UP XRAY

14TH WEEK FOLLOW UP XRAY

22ND WEEK FOLLOW UP XRAY

REFERENCES

1 Canale ST. Beaty JH, Andrew H, Crenshaw JR. Fracture of the humeral Shaft-Campbells Operative Orthopedics. Fracture of the humeral shaft. 11th ed. Philadelphia (USA): Mosby Elsevier Publisher, 2008;p:3389-8.
2 Sarmiento A, Waddell JP, Latta LL. Diaphyseal humeral fractures: treatment Options. Instr Course Lect 2002;51:257-69.
3 Chapman JR, Henly MB, Agel J, BencaPj. Randomized prospective study of the humeral shaft fracture fixation:Intramedullary nail versus plates. J Orthop Trauma 14;162-166.
4 lngman AM Waters DA. Locked intramedullary nailing of humeral shaft fractures:Implant design, surgical technique and the clinical results. J Bone Joint surg. Br 1994:70;701-7.
5 Gustilo RB. Anderson JT. Prevention of infection in the treatment of fractures of long bones. Retrospective and Prospective analysis. J Bone Joint Surg Am 1976;58:453-8.
6 Sarmiento A, Horowitch A, Aboulafia A. Functional' bracing for comminuted extra-articular fractures of the distal third of the humerus. J Bone Joint Surg Br 1990;72:283-7.
7 Balfour G, Mooney V, Ashby M. Diaphyseal fractures of the humerus treated with a ready made fracture brace. J Bone Joint Surg Am 1982;64;11-3.
8 Sarmiento A, Kinmann PB, Galvin EG, Schmitt RH, Philips JG. Functional bracing of fractures of shaft of the humerus. J Bone Joint Surg Am 1977;59: 596-601.
9 Ostermann PAW, Ekkemkamp A, Muhr G. Functional bracing of shaft fractures of the humerus. An analysis of 195 cases.Orthop Trans 1993-94; 17:937-44.
10 Sharma V Jain A' Gupta R, Tyagi A, Sethi P. Non operative treatment of fractures of the humeral shaft. A comparative study J Indian Med Assoc 1991;89;157-60.
11 Zagorsaki J, Latta L, Zych G, Finnieston A. Diaphyseal fractures of the humerus. Treatment with prefabricated braces. J Bone Joint Surg Am 1988;70:607-10.
12 Wallny T, Westermann K, Sagebiel C. Functional treatment of humeral shaft fractures: Indications and results, J Orthop Trauma 1997;11:283-7.
13 Claderone RR, Ghobadi F, Mcinerney V. Treatment of shoulder dislocation with ipsilateral humeral shaft fracture. Am J Orthop 1995;24:173-6.
14 Sarmiento A, Latta LL. Functional fracture bracing. J Am AcadOrthpsurg 1999;7:66-75.
15 Redmond BJ, Biermann JS, Blasier BB. Interlocking Intermedullary nailing of pathological fractures of the shaft of the humerus. J Bone Joint Surg(Am) 1996;78:891-6.
16 Tome J, Carsi B, Garca – Fernandez C. Treatment of pathologic fractures of the mumerus with Siedel nailing. ClincOrthopRelat Res 1998;350:51-5.
17 Thomsen NO, Mikkelsen JB, Svendsen RN. Interlocking nailing of humeral shaft fractures. J OrthopSci 1998;3:199-203.
18 Milne JS. The apparatus used by the Greeks and Romans in the setting of fractures and the reduction of dislocations (part 1). Interstate Med J. 1909;16:48-60.
19 Hippocrates. On Fractures.Withington ET, trans Cambridge, MA: Harbard University Press; 1984.
20 Rowlayin johns. Treatment of humeral shaft fracture. J orthop Trans 1942;12:189-206.
21 Seth M Fitchet. Aeroplane splint for certain fractures. JAMA 1955;82(14):1120-2.
22 Albert Cave. Stockinette for humeral shaft fractures in conservative management. J Lowa Orthopedics 1958;22:457-66.
23 Gilchrist P, Alen S, MJ Bell. Valpeau Shoulder bandage for humeral shaft fractures. J injury 1986;7:132-39.
24 Epps CH Jr, Grant RE. Fractures of the shaft of the humerus.In: Rockwwod CA Jr, Green DP, Bucholz RW, editors. Rockwood and Green's fractures in adults.3rd ed. Philadelphia; Lipincott Williams and Williams; 1991.
25 Ajmal MO, Sullivan M, McCabe J, Curtin W. Antegrade locked intramedullary nailing in humeral shaft fractures. Injury 2001;32:692-4.
26 Ghromley R K, Mro R J. Fractures of humerus. End results after treatment. Surg, gynecol and obst.1933; 60:730-6.
27 Huntere SG. The closed treatment of fractures of the humeral shaft.ClinOrthopRelat Res 1982;164:192-8.
28 J N Wilson, Watson Jones. Fractures and joint injuries.6th edition. B. l. Churchil Living Stone Pvt Ltd New Delhi 2002;1469-96.
29 Bullet Ozkurt, Murat Altay, CemNuriAktekin. The role of functional bracing in the treatment of humeral shaft fractures.ActaOrthopTraunatolTurc 2007;41(1):15-20.
30 Sarmiento A, Zagorski JB, Zych GA. Functional bracing for the treatment Of fractures of the humeral diaphysis. J Bone Joint Surg(Am) 2000;82:473-86.
31 Klenerman L. Fractures of the shaft of the humerus. J Bone Joint Surg 1996; 48B;105-11.
32 Thomas B Dameron, Stephen A Grubb. Humeral shaft fractures in adults. Southern Medical Journal 1981 ;12:1461-7.
33 PehlivanOzean. Functional treatment of the distal third humeral shaft fractures. Arch Orthop Trauma Surg 2002;122:390-5.
34 Gongol T, Mracek D. Functional therapy of diaphyseal fractures of the humerus. ActaChirOrthopTraumatolCech 2002;69(4):248-53.
35 Koch P, Gross D, Gerber C. The results of functional (Sarmiento) bracing of humeral shaft fractures. J Shoulder Elbow Surg 2002; 11:143-50.
36 Rosenberg N, Soudry M. Shoulder impairment following treatment of diaphyseal fractures of the humeral bone. ActaOrthop Trauma Surg 2006;126(7):437-40.
37 Rutgers M- Ring D. Treatment of diaphyseal fractures of the humerus using functional brace. J Orthop Trauma 2006;20:597-601.
38 Radford Ekholm, Jan Tidermark, Hans Tornkvist, JohanaAdami, Sari Ponzer. Outcome after closed functional treatment of humeral shaft fractures. J Orthop Trauma 2006;20(9):591-6.
39 Ring D, Chin K, Taghinia Ali. Nonunion after functional brace treatment of diaphyseal fractures. J Orthop Trauma 2007;62(5):1157-8.
40 Haider A Nasser, Ouday F Al Ali. Closed Diaphyseal humeral fractures in adults.A Comparision between conservative and operative treatment. Bas J Surg March 2010:16-23.

41 KC Kapilmani, DC GopalSagar, RijalLaxman, KC Govinda, ShresthaBinayaLal. Study on outcome of fracture shaft of the humerus treated nonoperatively with a functional brace. Eur J OrthopSurgTraumatol 2013;12-20.
42 Ghadeer H Majeed, Mahammed S. AHedani. Conservative treatment of closed fracture shaft humerus in adult patients. Al-Kindy Col Med J 2013;9:14-21.
43 Faaiz Ali, Zulfiqar Ali, AsmatUllah, KifayatUllah, Zakir Khan. Fracture shaft of humerur treated with a functional brace. Journal of Pakistan Orthopedic Association 2013;25(3):15-9.
44 Vipin Sharma, BhanuAwasthi, SM Mehta, RS Yadav, SudhirBabhulkar. Indian Journal of Clinical Practice. Vol.24, No 11, April 2014, 1068-73.
45 JitendraNath Pal, PrahasBiswas, Avik Roy, SunitHazra, SomnathMahato. Outcome of humeral shaft fractures treated by functional cast brace. Indian J. Orthop, 2015 July-Aug. 49(4): 408-417.
46 Browner BD, Levine AM, Jupiter JB, Trafton PG. Skeletal trauma. Philadelphia: Saunders; 1998
47 Hoppenfeld S, deBoer P. Surgical exposures in Orthopedics: the anatomical approach. Philadelphia: Lippincot Williams and Wilkins; 2003
48 Standring S, Ellis H, Healy JC, Johnson D, Williams A.Gray's Anatomy 39th edition pg901-906 Philadelphia: Elsevier Churchill Livingstone.
49 Carroll SE. A study of the nutrient foramina of the humeral diaphysis. J Bone Joint Surg Br 1963;45:176-81.
50 Meyer C, Alt V, Kraus R, Giebel G, Koebke J, Schnettler R. The arteries of the humerus and their relevance in fracture treatment.ZentrablChir 2005;130:562-7.
51 Guse TR, Ostrum RF. The surgical anatomy of the radial nerve around the humerus.ClinOrthopRelat Res: 1995;149-53.
52 Holstein A Lewis GM Fractures of the humerus with radial-nerve paralysis. J Bone Joint Surg Am 1963;45:1382-8.