Original Article

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Humerus Shaft Infected Nonunion treated with Compression Plating and Bone Grafting after complete Asepsis

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Abstract:

Background: *Infected nonunions remain one of the most challenging surgeries, the protocol is to eliminate the infection, remove hardware if any, debridement and a second surgery for fixation. The purpose of this study was to evaluate a retrospective assessment of the clinical, radiological as well as functional outcomes following treatment with compression plating and bone grafting.*

Material and Method: *A total of 29 patients were reviewed between 2011 to 2015 of septic shaft humerus non-unions. The mean follow up was of about 1.5 years. A total of 21 males and 8 females were a part of the study. All the fractures were treated using the principles of compression plating with 4.5 mm plates and autologous bone grafting after a thorough meticulous surgical debridement along with antibiotic coverage. Functional evaluation was done by using the Disabilities of Shoulder, Arm and Hand criteria along with haematological and radiographic evaluation by taking anteroposterior and lateral views at regular monthly intervals to assess the rate of union and recurrence of any infection.*

Result: *Union was achieved in all 29 patients with a mean age of 42 years. The average time to union was 17.5 weeks. There were no intraoperative complications. The average period of non-union was about 20.46 months, comprising of patients who were either surgically treated before or received no specific treatment at all. Most of the cases were either compound road traffic accidents or post operative infections. Functional evaluation was satisfactory in 24 of the patients. There were three patients who had preoperative radial nerve palsy treated later with tendon transfer procedures. Fibular grafting was done in three cases due to extensive bone loss.*

Conclusion: *Infected nonunions treated in a staged protocol, controls the infection and achieves union of the bone with satisfactory functional outcome for the patient.*

Keywords: *Humerus Shaft Infected Nonunion, Compression Plating, Osteosynthesis, Bone Grafting.*

Introduction

Humerus shaft non-union is an infrequent but debilitating condition ranging from 1-10%, the non-union can be both septic and aseptic [1]. Although Humerus shaft fractures can be treated conservatively with hanging cast or brace, with a satisfactory outcome, however conservatively treated humerus shaft fractures may result in nonunions [2-5].

Infected non-unions are a great challenge to an orthopaedic surgeon, the causes range from open fractures, infection after internal fixation, chronic osteomyelitis with pathological fractures and inadequate surgical debridement of infected bone[6]. The infection not only causes delayed fracture healing but also makes the fracture site unstable. Although they can be treated in a single stage procedure with definitive fixation, the ideal method is to completely eliminate the infection along with stabilization of fracture fragments and then provide definitive fixation. Humerus non-union if treated with an optimal strategy, give a satisfactory functional outcome due to its tolerance of less than anatomical reduction, shortening less than 3cm, rotation less than <30 degrees and angulation up to 20 degrees [7].

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Material And Methods

A total of 29 patients were included in the study which were operated between January 2011 to January 2014, follow up of these patients continued till October 2015

Approval from the institutional review board and informed consent were obtained from all patients. 21 males and 8 females were included in the study, the mean age for the study was 42 yrs (range 22 – 79yrs). All 29 patients were evaluated at our clinic and diagnosed with infected nonunion according to both clinical presentation and radiographic findings.

Nonunion was defined as the persistence of a fracture line on at least three of four cortices on orthogonal radiographs by 3-6 months after the injury as documented at the time of patient evaluation. The cases were identified after undertaking a thorough history with regard to the mode of trauma and the treatment received was recorded. Patient selection was done meticulously and pathological conditions of the bone were ruled out based on the clinical history, metabolic workup and radiographic assessment. Infection was determined prior to the operation based on the C-reactive protein and erythrocyte sedimentation rate.

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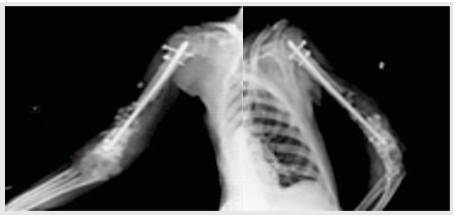

Figure 1a: A/P and Lateral Radiographs of a right infected non-union humerus treated outside with an intramedullary nail in situ.

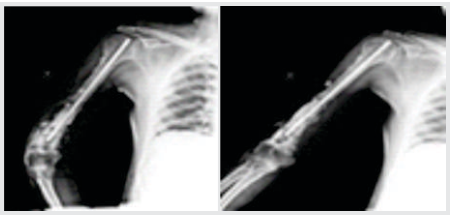

Figure 1b: A/P and Lateral radiographs after 1 month follow up following removal of intramedullary nail and insertion of an antibiotic impregnated nail.

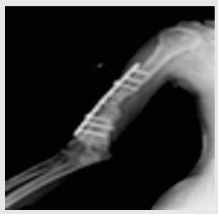

Figure 1c: A/P Radiograph of after 1yr following removal of antibiotic impregnated intramedullary nail followed by definitive fixation with a locking compression plate using fibular graft.

Charts were reviewed and the following data recorded: age, gender, mechanism of injury, whether or not the initial fracture was closed (n=21) or compound (n=8), whether the patient was an active smoker, co morbidities, number of prior procedures on the fracture and the index procedure performed.

Our study included patients with shaft humerus infected non-union, who were previously operated outside (n=26) as well as our own hospital (n=3), 11 patients had been operated with dynamic compression plate (DCP), out of which two had broken implants, 15 had been operated with intramedullary nail fixation including one case which was fixed using intramedullary k wires three had been treated conservatively with cast application. Prior to surgery neurovascular deficits were assessed in all patients, three patients had preoperative radial nerve palsy.

In cases of compound fractures, thorough debridement was done along with the closure of the exposed fracture site with skin graft or flap if required, done by our plastic surgeon.

Exclusion Criteria

The exclusion criteria included pathological fractures, fractures with intra-articular component, and children below the age of 18 years.

We assessed the results based in terms of time of union, pain, range of movement along with the ability to perform daily activities based on the DASH (disabilities of arm, shoulder and hand) score. Follow up check xrays were performed every month for six months, then every three months. Union was assessed by taking anteroposterior and lateral views with union of minimum three cortices.

Full length anterior posterior (AP) and lateral radiographs were taken preoperatively as well as on follow-ups.

Operative Procedure

All surgeries were performed by an experienced hand and upper limb specialist. The operative procedure comprised of two stages.

The First stage comprised of thorough debridement. All Patients received regional anaesthesia in the form of interscalene or supraclavicular block.

The surgical approach varied depending upon the fracture site as well as if any associated neurovascular deficit was present. Mainly two approaches were used Anterolateral and posterior approach. The anterolateral approach was mainly used for proximal humerus nonunions and the posterior approach for midshaft and distal shaft humerus nonunions. Preoperative antibiotics were given. Standard sterile prep and drape was performed. The nonunion site was approached normally through the prior incision if an index procedure was performed and was thoroughly debrided.

Once the fracture site was exposed, the previous implant was removed. The infected tissue was collected and sent for culture and sensitivity. Thorough debridement was done using normal saline, betadine and hydrogen peroxide with recanalization and reaming of the medullary cavity. The non-union site was then freshened, avascular fibrous tissue excised and shingling of the bony ends performed in order to achieve healthy bone elicited by the paprika sign. Once the debridement is complete, Antibiotic impregnated beads were inserted at the site of infection, comprising of vancomycin and cephalosporins in order to provide a broad spectrum coverage against common infectious

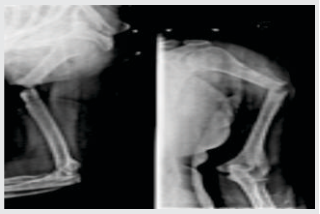

Figure 2a: Radiograph A/P and Lateral of an Outside Operated Left humerus shaft Infected nonunion.

Figure 2b: Radiograph A/P and Lateral Eliciting postoperative fixation with compression Plate.

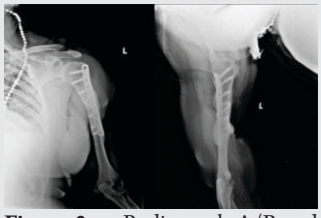

Figure 2c: Radiograph A/P and Lateral of an operated left humerus shaft Infected nonunion after 1 year of follow up.

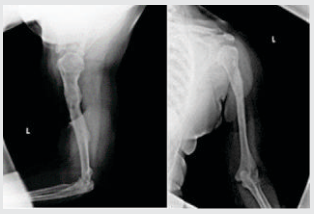

Figure 2d: Post operative Radiograph A/P and Lateral following removal of the implant after 1.5 years.

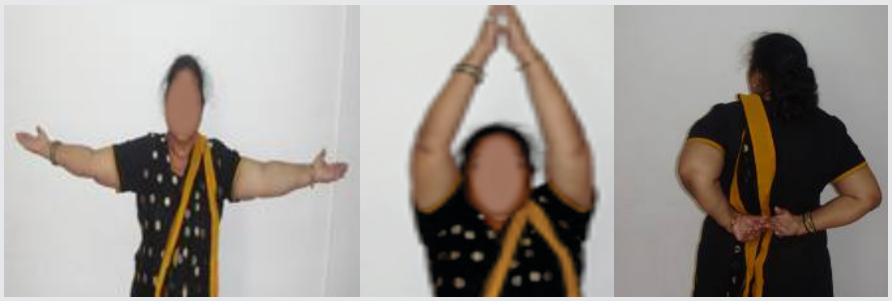

Figure 2e: Range of Motion of the left shoulder in flexion, abduction and external Rotation after 1 year of follow up.

pathogens.

Following debridement the fracture site was either intially stabilised by either unilateral external fixator (n=2), antibiotic impregnated nails (n=4), simple U splints (n=21) or an illizarov external fixator (n=2). The choice of stabilization was based on the infection, bone loss as well as on the soft tissue condition. U splints alone were primarily given in cases where the infection was mild and the average time interval between debridement and definitive fixation was of few days. Unilateral External fixator was used in cases where due to soft tissue loss, plastic surgery was required in the form of split thickness skin graft (STSG) or Flap along with stabilization of the fracture fragment, however in cases of severe infection illizarov was used till the period when the infection reduced and the fracture fragments could be fixed using plate for better convenience of the patient. In cases where the soft tissue coverage was adequate, and infection in the medullary cavity would take little longer to get controlled, antibiotic impregnated nail was used along with a U splint.

At the second stage, after freshening the non-union site, the fracture site was reduced and stabilised with k wires and bone holding clamps. When needed, Steinman pins were placed in each of the fragments as joysticks to aid reduction. Fine tuning of the fracture reduction was carried out under image intensifier guidance.

The apposition of fracture fragments was achieved by compressing the proximal and distal segments and held using bone holding clamps on either side. Although we did not use a tourniquet the dissection was done very meticulously in order to reduce blood loss, vitals were monitored regularly and blood was reserved prior to the surgery. Corticocancellous bone graft was harvested from the iliac crest or the tibial crest and placed at the site of non-union in all the cases. Three cases due to extensive bone loss, required fibula as a graft in order to maintain the length and provide adequate graft for bony union. (Figure 1 a-c)

Once the bony ends were compressed, we used a 4.5mm locking compression plate (LCP) or DCP placed along the tension surface at the fracture site and the plate fixed temporarily using k wires. The apposition and the placement of the plate was confirmed using intraoperative fluoroscopy. The decision for the usage of LCP or DCP was based on the quality of bone as well on the infection. In cases of osteopenic bones due to age or infection LCP plates were used providing angular as well as mechanical stability, DCP plates were used mainly for good quality bones.

We achieved compression of the fracture segments by either using the AO compression device along with compression plates or with the use of cortical screws passed through the conventional hole of the plate at the fracture ends on either fracture segments. Locking screws were then later placed on both sides of the fracture segments and a minimum of six to eight cortices were engaged.

Post- operatively, antibiotics were continued for 72 hours. Wound drain was removed after 48hours.

Postoperatively, a standardized physiotherapy regimen was conducted for all patients with passive and active assisted range of motion started from the third day comprising of pendulum exercises, shoulder flexion, shoulder walk up, internal and external rotation assisted exercises under the supervision of a professional physiotherapist. (Figure 2 a-e)

On regular monthly follow up, complete neurovascular examination along with movement at both the elbow and shoulder joints were checked, with regular radiographic images.

Results

In the period under study 29 followed patients were evaluated with an average period of 1.5 yrs of follow up. The average duration of non-union was 20.4 months. The main cause of humerus shaft fractures was either due to road traffic accidents (n=16) or domestic falls (n=13).

The Average Active range of motion achieved was 140 to 160 Degrees of shoulder flexion and abduction, Internal rotation of 50-70 Degrees , External rotation of 50 -60 Degrees, Adduction 30-40 Degrees, and extension 50-60 Degrees in 24 patients. Range of motion at the elbow was complete. In five cases, two operated with an illizarov external fixator and three with fibular graft due to bone loss, the average range of motion was 90-100 Degrees during Flexion and Abduction, 10-20 degrees Adduction, upto 10 degrees Extension, 20-30 Degrees Internal Rotation and upto 20 Degree of External Rotation at the shoulder with a preoperative fixed flexion deformity at the elbow

between 10-20 degrees with further flexion upto 100 Degrees. The range of motion in such patients was sufficient to perform daily activities.

A total of three patients had radial nerve palsy prior to surgery elicited by inability to dorsiflex the wrist along with weakness of the triceps and extensor muscles of the forearm, during such cases the radial nerve was explored, following which tendon transfer procedures were performed, the procedure comprised of transfer of pronater teres to extensor carpi radialis brevis or transfer of flexor carpi ulnaris to extensor digitorum. In these three patients all movements at the shoulder were complete only shoulder abduction and flexion were slightly reduced upto 120-130 Degrees.

Analysis of our result revealed an average overall union rate of 17.5 weeks with bone grafting done in all the patients. The average DASH score in 24 patients at 6 months,1 year and 1.5 year followup improved from 32.6,18.3 to 4.6, however in five patients with fixed flexion deformity, it was 63.2,48.6 to 27.4. All patients had difficulty in lifting heavy weights.

Complication

Four patients required repeat debridements due to recurrence of infection. Five cases had preoperative fixed flexion deformity due to soft tissue contracture, which did not improve post operatively.

Discussion

Nonunion of the humerus although has a low incidence, it is a great challenge in terms of treatment for both the orthopaedic surgeon and the patient.

Lower-level ("district") hospitals that initially treat a large number of injured patients are not equipped to handle the increased number and severity of injuries often caused by road traffic accidents [8]. If treatment is received it is delayed due to lack of experience of the operating surgeon, improper debridement or due to inadequate operating facilities. Inadequate debridement leaves nonviable or infected tissue secluded from the microcirculation, resulting in recurrence of infection despite local and systemic antibiotic delivery. This in turn facilitates biofilm formation, which protects the pathogens from antibiotics and host defence mechanisms [9]

The Limitations of this study relate to its retrospective nature, Majority of the patients had prior surgeries and differing degrees of injury severity. In the patients with a history of an open fracture, we cannot definitively state what the exact Gustilo classifications were because almost all were initially treated outside and we did not have access to the prior operative reports in most cases.

Infected non-union are commonly delineated by either sinus tract, active discharge or resultant scarring and poor cicatrisation of the surrounding soft tissue around the fracture site due to history of multiple surgical procedures. Based on routine C reactive protein and ESR values chronic infections can be detected due to their persistent elevation, but it is difficult to diagnose low grade or subclinical infections, due to lack of sensitivity and specificity [10-11]

Although there are various protocols followed in terms of treatment, at our institute we followed a simple methodological two stage protocol.

Once the infection was treated, the non-union could then be fixed with compression plating and bone grafting. Compression plating with LCP maintains the fracture line due to its provision of angular stability, Its use has been demonstrated particularly in cases of osteoporotic as well as infected bones [12]. In cases of DCP, dynamic compression is achieved either by eccentric screw placement or by the use of an AO tensioning device, with proved results of achieving high rates of union along with correction of axis misalignments, and stimulation of osteogenesis (shingling, grafting) in a single procedure [13-14] . Following compression plating with bone graft, union was achieved.

In comparison to our results, various authors have used separate modalities for achieving union, In a study by Gualdrini G et al, Eight patients with infected nonunions of the humerus were treated surgically by debridement with an external fixator, consolidation occurred in all of the patients after an average of 5.5 months. Long-term follow-up was obtained after a mean of 18 months (minimum 14, maximum 35) however there was postoperative paralysis of the radial nerve in two of the cases. [15]

Haidukewych GJ et al demonstrated 15 cases of infected humerus non-unions of which ten nonunions were treated with surgery using plates and external fixators along with bone graft, only seven healed. Three patients treated with functional brace did not unite,one was lost to follow up and one had resection arthroplasty. At final followup, 12 of 14 patients had minimal or no pain and two patients had moderate pain, both with ununited fractures. Complications included one seroma and two cases of posttraumatic elbow stiffness for which the patients required capsular release. [16]

A study conducted by Ayman A Bassiony et al included eight infected non-union of humerus diaphysis treated by Orthofix external fixator. Bone union was achieved in all cases. The mean time to union was 4.5 months (range 2 to 8). Radial nerve palsy developed in one patient who recovered spontaneously. No patient required an additional bone grafting procedure [17].

Illizarov exfix has proven to be an effective method of treatment of non-union along with results proving its

efficiency of achieving union particularly in cases of infection, Manish kiran and rabi jee achieved union in all 19 patients of diaphyseal non-union of the humerus with 6 infected cases [18], However illizarov exfix is associated with the disadvantage of prolong application as well as pin tract infection [19].

A similar two stage protocol was followed by Chen et al in a study comprising of Fourteen patients with infected humerus nonunion complicated by sinus discharge, in the first stage the author performed complete debridement followed by a second stage of bone grafting and external fixation. The length of time to achieve bony union ranged from 3.5 to 8 months, All the fractures achieved bony union, Not only was the infection eradicated and osseous union achieved, but also the limb function and joint motion was preserved [20].

There have been studies eliciting the use of a single stage treatment in the treatment of infected non-unions, Harpal Singh Selhi et al demonstrated the use of reinforced antibiotic impregnated cement rod in the treatment of infected non-unions although the study comprised of long bones in general ,union was achieved in 14 cases out of 16. Another similar study by Raghuram Thonse and Janet Conway also showed bony union in 17 out of 20 patients. Dror Paley and John E. Herzenberg demonstrated the use of antibiotic cement rods for intramedullary infections, the study showed complete elimination of infection in all nine cases. Taking these results in to consideration, antibiotic cement rod can also be considered a significant method of treatment [21-23].

Comparing to various other studies, it appears with external fixation method used as a definitive treatment there were still few cases with persistent non-union. Single stage procedures also had 8-10% cases of persistent nonunions along with problems of cement debonding, requirement of exchange nailing as well as breaking of the intramedullary rod in situ .However with the two stage protocol of the present study with compression plating and bone grafting, all bones had united. Plate fixation with bone grafting tends to achieve a union rate of >90%, however it requires meticulous soft tissue dissection along with the risk of damage to the radial nerve, which can be avoided by a surgeon with experience.

Conclusion

Nonunions treated in staged procedure, with debridment and stabilization followed by definitive fixation provide adequate conditions for a stable union with good functional results.

Clinical Relevence

An organized and a methodological approach during treatment tend to improve the functional outcome of the patient along with saving the patients time, money and improving social conditions.

References

Vidyadhara S, Vamsi K, Rao SK, Gnanadoss JJ, Pandian S. Use of intramedullary fibular strut graft: a novel adjunct to plating in the treatment of osteoporotic humeral shaft nonunion. International Orthopaedics. 2009;33(4):1009-1014.

2. Bohler L (1965) Conservative treatment of fresh closed fractures of humerus. J Trauma 5:464–468

3. Sarmiento A, Zagorski JB, Zych DO, Latta LL, Capps CA (2000)Functional bracing for the treatment of fractures of humeral diaphysis. J Bone Joint Surg Am 82:478–486

4. Koch PP, Gross DF, Gerber C (2002) The results of functional (Sarmiento) bracing of humeral shaft fractures. J Shoulder Elbow Surg 11:143–150

5. Foulk DA, Szabo RM (1995) Diaphyseal humeral fractures; natural history and occurrence of nonunion. Orthopaedics 18:333–335

6. Patzakis MJ, Zalavras CG. Chronic posttraumatic osteomyelitis and infected nonunion of the tibia: current management concepts. J Am Acad Orthop Surg. 2005;13:417–427.

7. Papasoulis E, Drosos GI, Ververidis AN et al (2010) Functional bracing of humeral shaft fractures. A review of clinical studies. Injury 41:e21–e27

8. Zirkle, L. G., Jr. (2008). "Injuries in developing countries--how can we help? The role of orthopaedic surgeons." Clin Orthop Relat Res 466(10): 2443-2450.

9. Schmidt AH, Swiontkowski MF. Pathophysiology of infections after internal fixation of fractures. J Am Acad Orthop Surg. 2000;8:285–291.

10. Bourguignat A, Ferard G, Jenny JY, et al. Diagnostic value of C-reactiveprotein and transthyretin in bone infections of the lower limb. Clin Chim Acta. 1996;255:27–38.

11. Wright EH, Khan U. Serum complement-reactive protein (CRP) trends following local and free-tissue reconstructions for traumatic injuries or chronic wounds of the lower limb. J Plast Reconstr Aesthet Surg. 2010; 63:1519–1522.

12. Ring D, Kloen P, Kadizielski J, Helfet D, Jupiter JB. Locking compression plates for osteoporotic nonunions of the diaphyseal humerus. Clin Orthop Relat Res. 2004;425:50–54.

13. Lin CL, Fang CK, Chiu FY, Chen CM, Chen TH. Revision with dynamic compression plate and cancellous bone graft for aseptic nonunion after surgical treatment of humeral shaft fracture. J Trauma 2009;67:1393-6.

14. Hsu TL, Chiu FY, Chen CM, Chen TH. Treatment of nonunion of humeral shaft fracture with dynamic compression plate and cancellous bone graft. J Chin Med Assoc. 2005;68:73–6

15. Gualdrini G, Pascarella R, Colozza A, Stagni C. Infected non union of the humerus. Chir Organi Mov. 2000;85:251–5

16. Haidukewych, G. J. and J. W. Sperling (2003). "Results of treatment of infected humeral nonunions: the Mayo Clinic experience." Clin Orthop Relat Res(414): 25-30

17. Bassiony AA, Almoatasem AM, Abdelhady AM, Assal MK, Fayad TA. Infected non-union of the humerus after failure of surgical treatment: Management using the Orthofix external fixator. Ann Acad Med Singapore. 2009;38:1090–4

18. Kiran, M. and R. Jee (2010). "Ilizarov's method for treatment of nonunion of diaphyseal fractures of the humerus." Indian J Orthop 44(4): 444-447

19. Patel VR, Menon DK, Pool RD, Simonis RB. Nonunion of the humerus after failure of surgical treatment. Management using the Ilizarov circular fixator. J Bone Joint Surg Br 2000;82:977-83

20. Chen C. Y., Ueng S. W. N., Shih C. H. Staged management of infected humeral nonunion. Journal of Trauma. 1997;43(5):793–798

21. Selhi HS, Mahindra P, Yamin M, Jain D, De Long WG Jr, Singh J. Outcome in patients with an infected nonunion of the long bones treated with a reinforced antibiotic bone cement rod. J Orthop Trauma.2012;26:184–188

22. Thonse R, Conway J. Antibiotic cement-coated interlocking nail for the treatment of infected nonunions and segmental bone defects. J Orthop Trauma. 2007;21:258–268

23. Paley D, Herzenberg JE. Intramedullary infections treated with antibiotic cement rods: preliminary results in nine cases. J Orthop Trauma. 2002;16:723–729

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