International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2019; 5(1): 288-291

www.orthopaper.com
Received: 01-11-2018
Accepted: 05-12-2018

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Nonunion of humeral shaft fractures following flexible intramedullary nail fixation

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DOI: https://doi.org/10.22271/ortho.2019.v5.i1f.51

Abstract
Introduction: The treatment of humeral shaft fractures ranges from conservative modalities to operative fixation, including plate osteosynthesis and intramedullary fixation. Nonunion is a complication of conservative and operative interventions but is more often associated with elastic nailing. This article discusses the successful outcomes for treatment of nonunion of humeral shaft fracture achieved by Locking Compression Plate (LCP) with autogenous bone grafting.
Methods: Fifteen cases of nonunion of humeral shaft fracture primarily treated with Elastic nail were included in this study. The study population comprised 12 males and 3 females with an average age of 31.2 years with minimum follow up of 12 months. Eleven fractures were defined as atrophic nonunion, and 4 as hypertrophic. All fractures were managed by open reduction and internal fixation with LCP and autogenous cancellous bone graft with mean follow-up period of 14 months.
Results: All cases showed union at subsequent follow-up with an average of 14 weeks (range 12-16 weeks). Complications included one patient with radial nerve neuropraxia which recovered spontaneously within 3 months of surgery, and a patient with superficial wound infection which was managed by debridement and antibiotics. At the final follow-up, shoulder and elbow functions of the operated limbs were satisfactory (4 Excellent, 11 Good results with an average ASES score of 46).
Conclusion: Fixation by LCP with cancellous bone graft is reliable and effective treatment for nonunion of humeral shaft fracture. The combined use of LCP and autogenous cancellous bone graft is able to achieve both rigid fixation and improve osteogenesis.

Keywords: humeral shaft fracture, nonunion, locking compression plate, flexible nails

Introduction
Although the majority of diaphyseal humeral fractures heal satisfactorily when treated non-operatively or operatively, nonunion is not a rare event. The prevalence of nonunion as a complication of both non-operative and operative treatment has been reported to be as high as 13% [1]. When nonunion does occur, it's likely to be related to the severity of the initial injury, open fracture, the transverse pattern of the fracture, soft tissue interposition or inadequate immobilization. Alongside these factors obesity, alcoholism, method of fixation, poor compliance of patients and infection may also contribute to the pathology [2, 3, 4]. Nonunion is often caused by distraction or excessive motion at the fracture site, and is thought to occur more commonly following nailing as compared to plating [1, 7, 17]. Excessive motion due to poor rotational control at the fracture site occurs when the intramedullary implant is not locked or, in the case of flexible nails, when the canal is not filled [17].
Nonunion of a diaphyseal fracture of the humerus can lead to a major functional problem. Numerous studies have been done outlining the various methods of treating humeral shaft nonunions [7, 11]. Nonunion after flexible nailing can be successfully treated by open reduction and internal fixation with plate and screws, reamed intramedullary interlocking nailing and external fixation [3, 4]. Different success rates and complications have been reported for these options. The objective of this study was to document and analyse the results of fixation of humerus diaphysis nonunion using a 4.5mm locking compression plate with at least seven cortices of fixation and utilization of autogenous bone grafting.

Material and Method

This study was conducted retrospectively at the Department of Orthopaedics, Dhiraj Hospital from July 2014 to January 2017. Fifteen consecutive patients with nonunion of the humeral diaphysis primarily treated with different types of flexible nailing (Enders's nail or Rush Pins) were included in this study after proper Ethical committee approval. All patients were thoroughly evaluated pre operatively by clinical, labortatory (Complete Blood Count, C - reactive protein and Erythrocyte Sedimentation Rate) and radiological methods with four different views (AP, Lateral & Two Oblique views) to find out the possible causes of non-union fracture and to rule out infection. In this study, nonunion was defined as absence of radiographic signs of union and persistent pain at fracture site on clinical examination at six months after the injury. (AO manual). All patients were included in the study after explaining the study and taking their written consent.

After administering General anesthesia, patient was kept in lateral decubitus position and prophylactic antibiotics were administered. Fracture was approached by a standard posterior triceps-splitting approach to the humerus, decision for which was based on operating surgeon's preference. The radial nerve was isolated and protected for the entire duration of the procedure. After removing the intramedullary flexible nails, the fracture site was cleared of fibrous tissue and pseudo-capsule, the medullary canal was reamed, decortications of the fracture site was done and the sclerosed fracture ends were freshened till visible punctate bleeding. After adequate reduction, a posterior 4.5mm narrow Locking Compressive Plate was fixed with minimum of seven cortices purchase proximal and distal the fracture site and autogenous cancellous bone graft (harvested from the ipsilateral iliac crest) was placed at fracture site.

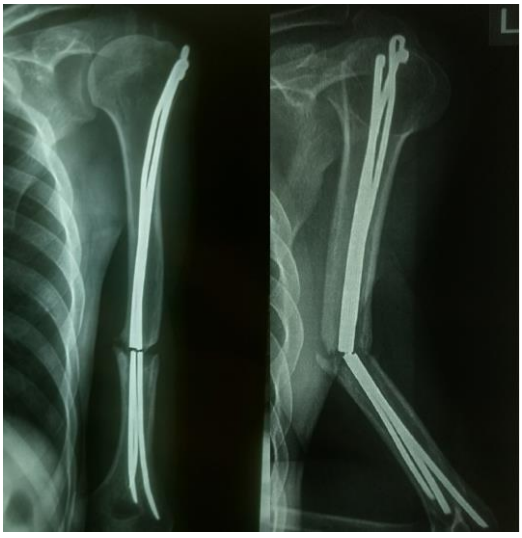

Fig 1: Pre-operative image

Postoperatively, limb was immobilised in U Slab for a period of 4 weeks. Post operatively antero-posterior and lateral radiographs were done to assess alignment, any complications, and later presence of bridging callus across the fracture site. Pendulum, circumduction and passive assisted shoulder range of motion were started at 5th week post-surgery followed by active exercises. Patients were reviewed at 1, 2, 3, 6, 9 and 12 months post operatively for radiological and clinical signs of union. The primary outcomes measured were duration for union, functional outcome and complications if any. Union was determined by radiographic evidence of cortical bone bridging at the fracture site, stable hardware position on radiographs, as well as absence of pain with manual palpation of the nonunion site. Function was assessed using the American Shoulder and Elbow Surgeons (ASES) Score for 13 activities of daily living requiring full shoulder and elbow movement. The maximum possible score is 52 points.

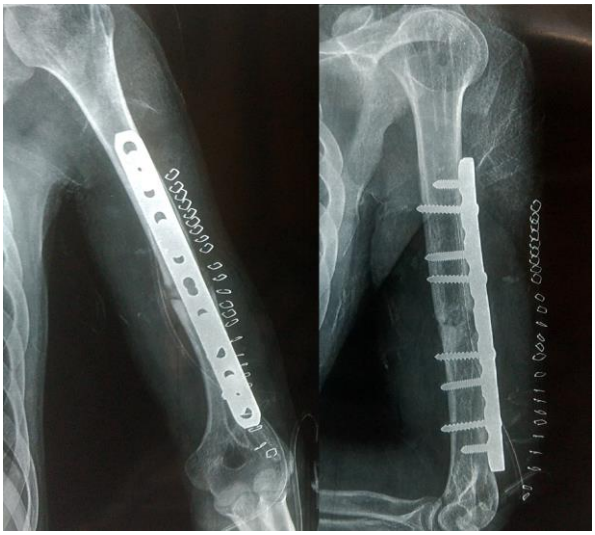

Fig 2: Post-Operative Image

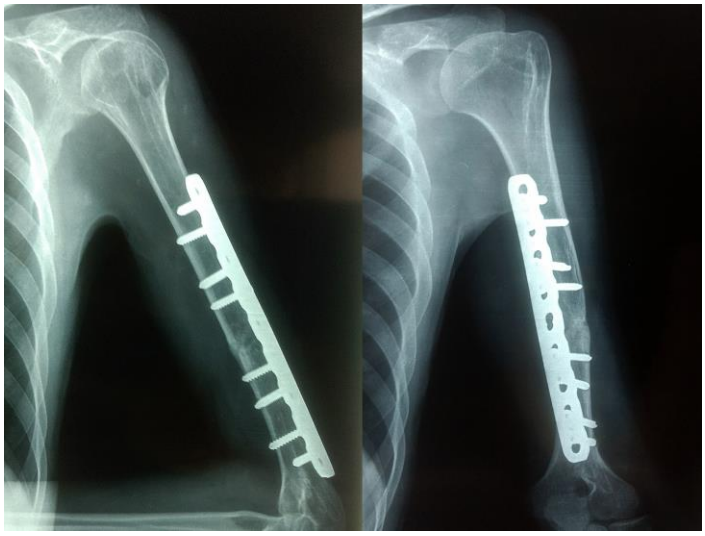

Fig 3: Final Follow-up Image

Observation and Results

A total of 15 patients, 12 male and 3 female with mean age of 31.2 years were followed up closely for a minimum of 12 months who were examined for various parameters. The causes of initial injury were road traffic accidents in 10 patients, fall from height in 4 patients and direct blunt injury in 1 patient; all primary injuries were closed. Out of 15 patients, 6 patients were chronic smokers and 2 had diabetes mellitus. We received patients at an average of 3.5 years after initial surgery. Right side was involved in 9 cases while left in 6 cases. None of cases had any clinical or laboratory evidence of infection. Radiographic evaluation showed 11 fractures to be atrophic and 4 were hypertrophic. Among the probable causes of non-union, distraction at fracture site was found in all patients and broken implants in 3 patients. Also, factors contributing to non-union like cigarette smoking was found in 6 patients and diabetes in 2 patients. Among them 12 patients were initially treated with multiple antegrade Ender's nail and 3 with multiple Rush pins. The mean operative time was 110

minutes (range 105 to 130 minutes). The average hospital stay was 13.5 days. The mean follow-up period was 14 months. Union occurred in all cases at an average time of 14 weeks postoperatively (range: 12 to 18 weeks). Atrophic non-unions had union at average time of 16 weeks postoperatively whereas those with hypertrophic non-union united earlier at average of 12 weeks post operatively. The overall complication rate was 13.3 %. One patient had superficial infection which needed wound debridement and resolved with appropriate antibiotics. Another patient had iatrogenic radial nerve injury (neuropraxia) which recovered completely within 3 months. There were no cases of Malunion or Non-union. All patients had satisfactory functional results with mean ASES score of 46 where 4 patients had Excellent result and 11 had good outcome. All patients had nearly normal shoulder and elbow range of movement, with satisfactory return to pre-injury activities and work, without any residual pain at the final follow-up visit.

Discussion

Various methods have been advocated for the management of humeral shaft fracture and have given good results [5-9]. Nevertheless, irrespective of whether fractures were managed conservatively or operatively, nonunion remained a problem. Humeral diaphyseal fracture has a natural tendency to heal well with a very low non-union rate when treated conservatively. With the advancements & innovations in treatment strategies like intramedullary nailing and locking plates, the non-union rates should have further reduced; but on the contrary, it has increased in recent decades. This may be attributed to various factors like poor selections of patients, unsuitable fracture geometry for the type of fixation, and substandard fracture fixation. The use of unlocked intramedullary nailing for humeral shaft fractures have reported high number of delayed union and nonunion, attributed mainly to the poor rotational control of the nails as well as distraction at fracture site [10, 13]. Locked intramedullary nailing has been propagated by some authors for managing non-union of humeral shaft fractures because of better rotational control of the nails, although this procedure has some disadvantages, such as difficulty in intra operative X-ray exposure, rotator cuff injury leading to shoulder stiffness and higher chances of neuro vascular injury during distal locking [10, 14]. The use of a Locking Compression Plating to fix a non united fracture of the humeral shaft could surpass the disadvantages of IM nailing. Compression plating with a 4.5mm LCP and autogenously bone grafting has been advocated as the gold standard with a reported success rate greater that 90 percent [5, 9] Healy *et al* used both single and dual-plate constructs with or without lag screws for treatment of humeral shaft non-unions and concluded that a stable plate fixation was the most reliable treatment for the same [15, 18].

The combined use of LCP and autogenous cancellous bone graft could achieve both rigid fixation (by LCP) and improve osteogenesis (by cancellous bone graft) [10]. Thus, the problems of non-union (either poor fixation in hypertrophic nonunion, or poor osteogenesis in atrophic nonunion) could be dealt with, and union could be achieved, as was shown in this series [10]. The results presented in this study also revealed a satisfactory functional outcome in all patients. The disadvantages of using a LCP are more soft tissue stripping and an increased incidence of iatrogenic radial-nerve palsy [12]. In a case of non-union to dissect the radial nerve is technically demanding and one should be meticulous. In our series, the incidence of superficial infection was 6.6%, which is comparable with other studies. The incidence of radial-nerve palsy was 6.6%, which is also comparable with other studies [13]. To avoid such soft-tissue injuries, it is important to dissect the soft tissue meticulously during surgery, especially in cases of nonunion of fractures of the distal third of the humeral shaft as nerve could be entrapped within the fibrous tissue [14, 18].

Conclusion

Elastic nails, which are more commonly linked to nonunion, have been shown to have many benefits, with good results attainable and even comparable with those seen with conservative modalities [13-16]. Distraction is a well-documented cause of non-union in cases treated with elastic nails. Flexible nails that do not adequately fill the canal may lead to hypertrophic nonunion because of excessive motion at the fracture site. When a nonunion occurs following elastic nail fixation, various authors recommend plate fixation with bone grafting of the fracture with predictable subsequent healing of the nonunion [5, 7, 9, 18].

In conclusion, results of this study indicate that our standard surgical procedure for treatment of nonunion of the humeral shaft, that includes removal of a previous flexible intramedullary nails, refreshing the fracture site, and fixation with a LCP and a supplemental autogenous cancellous bone graft, is effective and achieves high union rates in one procedure with few possible complications. Therefore, it is recommended for patients with nonunion of a humeral shaft fracture.

Conflict of Interest: The authors declare that they have no conflict of interest.

Funding: There is no funding source.

Ethical approval: This study was performed after Institutional Ethical committee approval.

Informed consent: Informed consent was obtained from all individual participants included in the study.

References

1. Marti RK, Verheyen CC, Besselaar PP. Humeral shaft nonunion: evaluation of uniform surgical repair in fifty-one patients. J Orthop Trauma. 2002; 16(2):108-115.
2. Foulk DA, Szabo RM. Diaphyseal humerus fracture: natural history and occurrence of nonunion. Orthopedics 1995; 18:333-5.
3. Healy WL, White GM, Mick CA, Brooker AF Jr, Weiland AJ. Nonunion of the humeral shaft. Clin Orthop 1987; 219:206-13.
4. Lin J, Hou SM, Han YS, Chao EYS. Treatment of humeral shaft fractures by retrograde nailing. Clin Orthop. 1997; 342:147-55.
5. Muller ME, Thomas RJ. Treatment of nonunion in fracture of long bone. Clin Orthop. 1979; 138:141-53.
6. Crolla RM, de Vries LS, Clevers GJ. Locked intramedullary nailing of humeral fracture. Injury 1993; 24:403-6.
7. Patel VR, Menon DK, Pool RD, Simonis RB. Nonunion of the humerus after failure of surgical treatment. Management using Ilizarov circular fixator. J Bone Joint Surg Br. 2000; 82:977-83.
8. Jupiter JB. Complex non-union of the humeral diaphysis. Treatment with a medial approach, an anterior plate, and

a vascularized fibular graft. J Bone Joint Surg Am 1990; 72:701-7.
9. Hornicek FJ, Zych GA, Hutson JJ, Malinin TI. Salvage of humeral nonunion with onlay bone plate allograft augmentation. Clin Orthop. 2001; 386:203.
10. Rosen H. The treatment of nonunions and pseudarthrosis of humeral shaft. Orthop Clin North Am. 1990; 21:725-42.
11. Foster RJ, Dixon GL Jr, Bach AW, Appleyard RW, Green TM. Internal fixation of fractures and nonunions of humeral shaft. J Bone Joint Surg Am. 1985; 67:857-64.
12. Pollock FH, Drake D, Bovill EG, Day L, Trafton PG. Treatment of radial neuropathy associated with fractures of the humerus. J Bone Joint Surg Am. 1981; 63:239-43.
13. Te Velde EA, van der Werken C. Plate osteosynthesis for pseudoarthrosis of humeral shaft. Injury. 2001; 32:621-4.
14. Laing PG. The arterial supply of the humerus. J Bone Joint Surg Am. 1956; 38:1105-16.
15. Robinson CM, Bell KM, Court-Brown CM, McQueen MM. Locked nailing of humeral shaft fractures. Experience in Edinburgh over a two-year period. J Bone Joint Surg Br. 1992; 74:558-62.
16. Watson-Jones R. Fracture and Joint Injuries, 6th edition. New York: Churchill Livingstone, 1982, 578.
17. McKee MD, Larsson S. Humeral shaft fractures. In: Bucholz RW, Court-Brown CM, Heckman JD, Tornetta P III, eds. Rockwood and Green's Fractures in Adults. 7th ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2010, 999-1038.
18. Healy WL, White GM, Mick CA, Brooker AF, Weiland AJ. Nonunion of the humeral shaft. Clin Orthop. 1987; 219:206-213.