

Role of Locked Compression Plate in Osteoporotic Humeral Shaft Nonunions: A Clinical Study

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What to Learn from this Article?

Locking Compression Plate is a very good option of fixation for osteoporotic shaft humerus nonunion

Abstract

Background: Osteoporotic humeral shaft nonunion is a challenge to modern implant design because of inadequate screw purchase in the bone. Locked compression plating (LCP) is the answer to this difficult condition. In this prospective study, we have tried to evaluate the role of LCP in management of osteoporotic humeral shaft nonunion in patients above 18 years of age.

Materials and Methods: We treated 14 such cases with mean age of 48 years. Open reduction and fixation with LCP along with cancellous bone grafting were done, and the cases were evaluated clinically and radiologically till union.

Results: All the fracture went on to the satisfactory union after an average of 21 weeks (14-32 weeks). Two patients had delayed union and required bone marrow injections. All the patients after union were able to perform their pre-injury work. Pain and limitation of motion improved remarkably.

Conclusion: LCP is a very effective procedure to achieve union in osteoporotic humeral shaft fractures in adult patients. We propose fixation with LCP as it provides additional stability at fracture site, led to high rate of union, with few complications.

Keywords: Osteoporosis, humeral shaft nonunion, locked compression plating.

Introduction

Humeral shaft fractures result from direct and indirect violence. Common mechanisms for humeral shaft fractures include fall on the outstretched hand, motor vehicle accidents, and direct load to the arm. Most of these fractures heal by conservative means or by surgical intervention. Few fractures fail to unite by 6-month time and they are labeled as nonunion. Humerus shaft nonunion is invariably associated with osteoporosis which further complicates the fracture. The major technical problem faced by the surgeon is the difficulty in obtaining secure fixation of an implant to osteoporotic bone. There is less cortical and cancellous bone for the screw threads to gain purchase so that the pullout strength of the implant is significantly reduced. Bone mineral density correlates linearly with the holding power of screws [1]. The load

transmitted at the bone implant interface can often exceed the reduced strain tolerance of osteoporotic bone. This may result in microfracture, resorption of the bone, and loosening of the implant, with secondary failure of fixation.

Although several surgical methods for the management of humeral shaft nonunion have been examined in the literature such as compression plating with bone grafting [2] intramedullary nailing [3] illizarov fixator [4], non-vascularized intramedullary fibular graft [5] but no single technique has proved its superiority over the other.

Very few studies have been published about the use of locking compression plate (LCP) in the management of a nonunion of humeral fractures [6-8].



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We conducted a prospective study at our institution to evaluate the clinical and radiographical results of LCP in the treatment of osteoporotic humeral shaft nonunion.

Materials and Methods

This prospective study was conducted at Jawaharlal Nehru Medical College, AMU Aligarh from January 2006-July 2008. The tool for data collection was a pre-designed data sheet to collect information on the cases. The questionnaire contained information on age, sex, residence, side involved, comorbid conditions, mechanism of injury, fracture location, initial treatment of the fracture, time from injury to definitive treatment, definitive treatment, time taken to unite, function, and complications. In this study, nonunion was defined as absence of radiographic signs of union and persistent pain on clinical examination 6 months after injury.

Inclusion criteria

- Patients more than 18 years of age
- Patients with osteoporotic humerus shaft nonunion.

Exclusion criteria

- Patients <18 years of age
- Patients with fresh fracture of humerus shaft
- Patients with infected/pathological humeral shaft fractures

Surgical technique

Treatment consisted of a standard Henry's anterolateral approach for proximal and middle-third humeral fractures while posterior triceps splitting approach for lower-third fractures. The radial nerve to be identified and protected for the duration of the procedure. Removal of any pre-existing implant followed by freshening of bone ends, reaming of medullary canal, reduction followed by stabilization of fracture by 4.5/5 mm locking compression plate, and autogenous cancellous bone grafting. A minimum of eight cortices of fixation above and below the fracture site were obtained in most fractures. Postoperatively, anteroposterior and lateral radiographs were done to assess alignment, loosening of devices, and later presence of bridging callus across the non-union site. Patients were placed in an arm sling primarily for comfort for 2 weeks. Gentle pendulum- and active-assisted shoulder and elbow range of motion were started at 2 weeks post-surgery followed by strengthening and passive range of motion exercises. Patients were reviewed at 2, 6, 12, and 16 weeks. The primary outcomes measured were time to union, function, and complications. Union was determined by radiographic evidence of cortical bone bridging at the nonunion site, stable hardware position on radiographs, as well as absence of pain with manual palpation of the non-union site. Function was assessed using the disability of the arm, shoulder, and hand (DASH) Score for 30 activities of daily living requiring full shoulder and elbow movement. Score range from 0 (no disability) to 100.

Results

We performed open reduction and internal fixation with locking compression plate and iliac crest bone grafting in osteoporotic humeral shaft nonunions in 14 consecutive patients with mean age of 48 years (range 20-60 years (Table 1).

There were 10 males and 4 females with an equal number of right and left arm affected (7 each). Mean age was 48 years (range 24-65 years). Delay in presentation ranged from 24 to 76 weeks (mean 35 weeks). The mechanism of injury was road-traffic accident in 7 patients, slipping onto ground in 6, and fall from height in one patient. All patients were in good health before the fracture and were doing their routine work.

Fracture types included 10 transverse, three short oblique, and one long oblique. None of the fractures was comminuted. All of the fractures were close. There were six proximal third, three middle-third, and five extra-articular distal-third humeral fractures. All the patients had osteoporosis as assessed by cortical index [9] (cortical index is the combined medial and lateral cortical thickness divided by the total width of the bone at that level). No pre-operative complication like radial nerve palsy was reported before management in any of the patients. None of the patients had undergone previous surgery. Nine patients had taken local treatment from quacks, five patients were treated in plaster splints for inadequate period. Preoperatively, all the patients complained of limitation of shoulder and elbow motion and were unable to use the affected limb properly. Average pre-operative DASH score was 89 (range 65-95). All the patients were followed for an average 12 months (range 6-18 months). There were two cases of superficial skin infection which healed with a course of antibiotics. There was no radial nerve palsy and hardware loosening. 12 patients showed evidence of complete healing as defined by radiographic evidence of at least three out of four bridging cortices within 24 weeks of the procedure (range 14-32 weeks) (Figs. 1-3). Two patients required additional bone marrow injections for delayed union with stable hardware position. Post-operative mean range of movement was 129° (range 100°-150°). At the final follow-up, the average DASH score was 24 (range 10-30).

Discussion

Non-union shaft of humerus was managed successfully by several authors using dynamic compression plates; [2] however, osteoporotic humerus shaft nonunion is difficult to manage because of presence of inadequate purchase of implant. Various methods have been employed to achieve union



Figure 1: X-ray anteroposterior and lateral views of humerus showing. (a) Atrophic nonunion. (b) Union achieved 5 months following fixation with locking compression plate and bone grafting.

Table 1: Patient profile

Patient No.	Age (years)	Sex	Time since injury (weeks)	Previous treatment	Post-operative complication	Time to union (weeks)	Additional procedures done to achieve union	Range of movement (degrees)	DASH score (preoperative)	DASH score (post-operative)
1	34	F	29	POP	Nil	20	Nil	150	89	15
2	24	M	45	No	Nil	18	Nil	135	75	10
3	65	M	24	POP	Superficial infection	22	Nil	110	72	25
4	58	M	24	No	Nil	16	Nil	145	95	20
5	64	M	39	No	Delayed union	28	Bone marrow injection	100	86	30
6	28	F	25	No	Nil	18	Nil	150	65	25
7	65	M	41	No	Nil	14	Nil	125	88	10
8	53	F	29	POP	Nil	14	Nil	145	75	18
9	38	M	76	No	Superficial infection	24	Nil	110	68	20
10	45	M	46	No	Nil	20	Nil	130	85	10
11	53	M	33	No	Delayed union	32	Bone marrow injection	100	70	15
12	54	F	25	POP	Nil	22	Nil	150	75	30
13	43	M	29	No	Nil	24	Nil	130	90	25
14	48	M	25	POP	Nil	18	Nil	125	75	10

DASH: Disability of the arm, shoulder, and hand, POP: Plaster of Paris



Figure 2: X-ray anteroposterior and lateral views of humerus showing. (a) Atrophic nonunion. (b) Union achieved 4 months following fixation with locking compression plate and bone grafting.

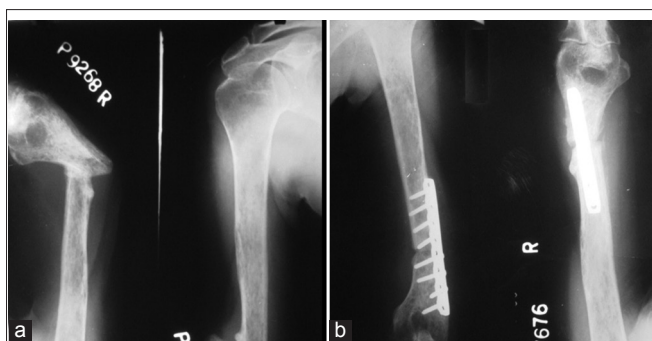


Figure 3: X-ray anteroposterior and lateral views of humerus showing. (a) Atrophic nonunion. (b) Union achieved 7 months following fixation with locking compression plate and bone grafting.

periosteal stripping of humerus and non-vascularized fibula has low healing rate. Intramedullary, rush pin with plating [11] and structural allograft with BMP-7 and mesenchymal stem cells [12] was advocated by few authors. Intramedullary, implants has high complication rate including rotator cuff injury and shoulder stiffness. Illizarov external fixators [4] have been used by several authors in management of humerus nonunion, especially in presence of infection, but they are associated with numerous complications such as pin tract infection, risk of neurovascular impalement by wires. In addition, the assembly is quite bulky and has high discomfort rate for the patient. Ring *et al.* used LCP in 24 patients with osteoporotic humerus shaft nonunion and achieved successful union in all the cases [6]. The average duration of nonunion of 9 months in our series (range: 6-19 months) was comparable to that of Ring *et al.* who had reported an average duration of 28 months (5-192 months). The mean age of our patients was 48 years in comparison with the mean age of 72 years in the study by Ring *et al.* Laboratory studies have also shown that locking plate constructs were superior to unlocked plate and screw constructs in osteoporotic diaphyseal humeral fracture models tested *in vitro* using cyclical torsional loading [13].

Within the present series, 14 patients of humeral shaft nonunion with osteoporosis underwent successful salvage with a standard protocol that included fixation with a locking compression plate, application of autogeneous bone graft, and optimization of associated patient comorbidities in the perioperative period. All 14 patients achieved clinical and radiographic union with good functional result. The strength of our study is that it was a prospective study that allowed comparison between the functional status in the pre-operative and post-operative periods. The

including double plating [10], plating with non-vascularize intramedullary fibula [5] but double plating entail extensive

drawbacks of the present study are the absence of a control group for comparison with the treatment group.

Clinical relevance

LCP is a very effective procedure to achieve union in osteoporotic humeral nonunion in adult patients. We propose fixation with LCP

and autologous bone grafting as it provides additional stability at fracture site, led to predictable high rate of union, and with fewer complications.

Clinical Message

LCP is a good option for fixation of osteoporotic humerus shaft nonunion.

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