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# Study of clinical and functional outcome of fractures of long bones with locking compression plates

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**Abstract**
The study was done to observe the role of locking compression plate as a fixation device in the management of fracture of long bones. Locking compression plate is an economical, safe and sound fixation system for the treatment of fracture of any part of the long bones. It is the implant of choice in case of pathological fractures comminuted fracture periarticular fractures, periprosthetic fractures and very wide or very narrow medullary canal in fractured bone. LCP is an alternative choice of implants for conventional plating and intramedullary nailing. It takes minimal time and less blood loss when used as a MIPO technique. The fixation of the long bone fracture by LCP allowed rapid mobilization and early weight bearing and does not interfere with functional use of limb during treatment or healing of fracture. A total of 40 patients were included in this study, but only 35 patients was evaluated and followed up at 1 week, 3 weeks, 6 weeks, 9 weeks, 12 weeks and 24 weeks.

**Keywords:** Study of clinical, fractures, locking compression plates

## Introduction
Long bones are like bricks of the building, any kind of derangement in the long bones either structural or functional, leads to deformity or disability in the body. The method of choice for treatment of long bone fractures should be such that it allows functional use of the limb after treatment, provide proper fixation, not interfere with healing, allowing early mobilization, no or minimal growth plate damage in children.

Conservative treatment of long bone fractures does not allow early mobilization. Bony union is not always the only goal to be achieved, the function of the limb is in fact the most important outcome measure. The slogan "Movement is life" was adopted by pioneers from AO group, who initially advocated surgery with rigid bone plates to permits early movement.

Various operative modalities like external fixation (conventional or locked plating) or internal fixation (intramedullary/extramedullary internal fixation).Intramedullary fixation either by locked or unlocked nailing is the treatment of choice for fractures of diaphysis of long bones specially for tibia and femur, while for diaphyseal fracture of long bones of upper limb are best treated by extramedullary internal fixation. Intramedullary internal fixation is not applicable in cases of intra-articular, multifragmentary, metaphyseal fractures, pre-existing bone deformity, shaft fractures in children, polytrauma patients, severe brain or thoracic injury. In extramedullary internal fixation the conventional plate have many demerits like; Damage to the soft tissue as well as blood supply to the bone, requires precontouring of the plate to match anatomy of the bone, requires open methods with direct reduction during fracture fixation. In case of Locked plate, simple locked plate is not technically feasible to be applied in transverse or short oblique type of fractures where compression is needed at fracture site. A newer concept of internal fixation; locking compression plate (LCP) was introduced to overcome the drawbacks of conventional and simple locked plating system. The unique design of these combination holes allows the system to be used both as a conventional compression plate and as a locked internal fixator; it also allows internal fixation with a combination of conventional and locking head screws.

This method of plate screw fixation means that the plate does not need to touch the bone at all, which is of particular advantage in so called minimal invasive percutaneous osteosynthesis (MIPO).

The locked internal fixator method has been based on scientific insights into Bone biology especially with reference to its blood supply. The basic locked internal fixation technique aims at flexible elastic fixation to initiate spontaneous healing, including its induction of callus formation.

**Benfits of LCP**

- Angular stable fixation of fragments regardless of bone quality.
- Reduced impairment of periosteal blood supply due to limited plate-bone contact.
- Good purchase, early and active mobilization in osteoporotic bone and in comminuted fracture.

**Material and Methods**

All the works were carried out in the Department of Orthopedics, Rajendra Institute of Medical Sciences Ranchi; during the period of JULY 2014 to May 2016.LCP plating was performed in 40 patients with fracture of long bones closed fractures of long bone (Femur, Tibia, Humerus, Radius and Ulna), Grade I and II open fractures, Pathological fractures, Delayed Union/Non Union/Malunion, Extension of fracture into joint, Multifragmentary shaft and metaphyseal fractures.

**Method**

After thorough clinical and radiological examination, the fractured limbs were kept in POP slab or on traction till surgery. After preoperative preparation all patients put for surgery. After exposing the bone, fracture was reduced by direct method and appropriate size and shape of plate was fixed, some extent of reduction or compression was also achieved by applying conventional screws through dynamic compression unit of LCP. After achieving the reduction locking screws were applied through locking unit of LCP. Minimum 3 screws/or 6 cortices were fixed in each side of the fracture. Finally the reduction, placement of plate and size of screws under image intensifier was assessed. Intravenous 3rd generation cephalosporin were administered routinely for 3 days. From the 2nd to 3rd postoperative day patients were encouraged to do exercises of the joints concerned. Fractures of humerus, radius and ulna were immobilized in above elbow slab. Range of motion exercise to the hand and wrist were begun 2nd day postoperatively. Progressive shoulder and elbow exercises were begun when comfort allowed.

Patients were followed up for clinical and radiological evaluation at interval of 3 weeks for a period of 12 weeks and at 24 weeks. A fracture was considered healed when an abundance of bridging or non-bridging primary callus was noted by X-ray and the patient could bear weight without pain at the fracture site.

**Observation**

A total of 40 patients were selected and operated upon, but only 35 patients could be evaluated and followed up at 1 week, 3 weeks, 6 weeks, 9 weeks, 12 weeks and 24 weeks. 5 cases were lost to follow up.

**Table 1:** Age Distribution

| Age (in yrs) | Total no | (%) |
|---|---|---|
| 10-20 | 4 | 11.43 |
| 21 -30 | 9 | 25.72 |
| 31-40 | 11 | 31.43 |
| 41 -50 | 5 | 14.28 |
| > 50 | 6 | 14.14 |

**Table 2:** Sex Distribution

| Sex | Total no | % |
|---|---|---|
| Male | 29 | 82.8 |
| Female | 06 | 17.2 |
| Total | 35 | 100 |

**Table 3:** Limb Injured

| Bone | Total no | % |
|---|---|---|
| Humerus (R/L) | 5/2 | 14.28/5.71 |
| radius(R/L) | 4/2 | 11.44/5.71 |
| ulna(R/L) | 2/2 | 5.71/5.71 |
| femur(R/L) | 3/3 | 8.57/8.57 |
| tibia(R/L) | 6/6 | 17.15/17.15 |
| Total | 35 | 100 |

**Table 4:** Side of Limb

| Side | Total no | (%) |
|---|---|---|
| Right | 20 | 57.14 |
| Left | 15 | 42.86 |
| Total | 35 | 100 |

**Table 5:** Associated Injuries

| Injury | Total no | Percentage |
|---|---|---|
| fibula | 9 | 25.72 |
| Radius | 2 | 5.71 |
| Metatarsal | 1 | 2.86 |
| Patella | 1 | 2.86 |
| Scalp | 2 | 5.71 |
| Total | 35 | 100 |

**Table 6:** Anatomic Location

| Site | Total no | Percentage |
|---|---|---|
| Proximal | 3 | 8.57 |
| Middle | 21 | 60.00 |
| Distal | 11 | 31.43 |
| Total | 35 | 100 |

**Table 7:** Extent of soft tissue damage

| Extent | PTS no | Percentage |
|---|---|---|
| Closed | 29 | 82.86 |
| Open type-I | 2 | 5.71 |
| Open type-II | 4 | 11.43 |
| Total | 35 | 100 |

**Table 8:** radiological union: callus formation Femur and tibia

| | Weeks | | | | |
|---|---|---|---|---|---|
| | 3rd | 6th | 9th | 12th | 24th |
| Visible callus | Nil | 4 | 12 | 17 | 18 |
| Moderate callus | Nil | 3 | 5 | 8 | Nil |
| Exuberant callus | Nil | Nil | 4 | 10 | 18 |
| Trabeculation | Nil | Nil | Nil | 3 | 16 |

**Table 9:** radiological union: callus formation Humerus, radius and ulna

| | Weeks | | | | |
|---|---|---|---|---|---|
| | 3rd | 6th | 9th | 12th | 24th |
| Visible callus | 8 | 14 | 15 | 17 | 17 |
| Moderate callus | Nil | 8 | 8 | 1 | Nil |
| Exuberant callus | Nil | Nil | 4 | 16 | 17 |
| Trabeculation | Nil | Nil | 10 | 14 | 17 |

**Table 10:** Clinical Union

| | Weeks | | | | |
|---|---|---|---|---|---|
| | 3rd | 6th | 9th | 12th | 24th |
| Humerus | Nil | 2 | 4 | 7 | 7 |
| Radius | Nil | 3 | 3 | 6 | 6 |
| Ulna | Nil | 1 | 1 | 3 | 4 |
| Femur | Nil | Nil | 2 | 5 | 6 |
| Tibia | Nil | Nil | 8 | 10 | 12 |

**Table 11:** Complications

| Complication | | Percentage |
|---|---|---|
| Superficial Infection | 3 | 8.57 |
| Delayed Union | 3 | 8.57 |
| Malunion | 2 | 5.71 |
| Shortening | 2 | 5.71 |
| Joint stiffness | 3 | 8.57 |

**Table 12:** Clinical and Radiological union with Functional Outcome at 24th weeks

| Result | | (%) |
|---|---|---|
| Excellent | 19 | 55 |
| Good | 11 | 30 |
| Fair | 2 | 5 |
| Poor | 3 | 10 |
| Total | 35 | 100 |

## Discussion

Fractures of long bones are common. Anatomical and functional restoration of the injured limb is the need of the hour. Various modalities are presently available for the treatment of these fractures. Numerous case series have reported the successful use of LCPs in a variety of clinical situations such as metaphyseal fractures, intra-articular fracture, fractures in osteoporotic bones as well as difficult non-union. The present study is an effort to observe the union of fractures of long bones by LCP fixation and to record pitfalls and sound a note of caution, where ever required.

In this study, age of the patients treated, was between 19 -70 years with mean age being 36.91 years. We have found male predominance, constituted 82.86% of total patients with a male: female ratio of 4.83: 1. Right sided limb (57.14%) involvement dominated over left. Probably the reason is that, right side is the dominant side in right handed people and is most active. Majority of the patients 20 (57.14%) had no associated injury. In our series fracture proximal, middle and distal third of shaft of long bones constituted 8.57%, 60% and 31.43% respectively. Experience of other authors also matches this finding.

Majority [29 (82.36)] of fractures were closed. We treated 2 (5.71%) Grade - I compound fractures and (11.43%) Grade – II compound fracture. In case of open fractures, thorough debridement of the wound and LCP fixation was done. Other authors have generally met higher percentage of compound fractures in their study.

In this study out of 35 patients, 10 (28.57%) was transverse, 4 (11.43%) was oblique and 3 (8.57%) was spiral fractures. It included Comminuted without butterfly fragment 11 (31.43%) and comminuted fracture with butterfly fragment 2 (5.71%). No fractures in our series were segmental or with bone loss. Open technique of fracture fixation was applied in 29 (82.86%) of our patients. There were 6 compound fractures which were fixed after thorough wound debridement and irrigation. 5 cases of non-union, out of these, 3 cases were initially treated conservatively, were later on fixed by LCP with cancellous bone graft. 1 case of non-union of the humerus initially treated with DCP (Loosening of screws) and 1 case of non-union of the femur, initially treated with distal femoral nail (Broken nail) later on both the cases were fixed by LCP with application of the cancellous bone graft after removal of failed implant. 6/12 cases of tibia fractures (17.14% of total cases) were fixed by LCP with the MIPO technique.

We encouraged active joint movement as soon as the pain was subsided or reduced to tolerable level. In all the cases of femur and tibia fractures, long leg POP slab were applied for 6 weeks. While all the cases of fracture upper limbs i.e. humerus, radius and ulna, were treated with above elbow POP slab till stitches removal.

For fracture union, we followed clinical criteria for the period between operation and full weight bearing without any external support for lower limb and for upper limb, full range of motion to the hand, wrist, elbow and shoulder joints, no local bony tenderness and radiologically healed fractures. Radiologic healing of fracture was defined as the presence of callus around most of the fractures circumference with a density similar to that of the adjacent cortical bone and trabecular pattern.

The union time in non-union ranged from 12-20 weeks with a mean of 15.25 weeks.

In our study on 10 cases of fore arm bone fractures treated by LCP and got solid callus at an average of 11.4 weeks (range 6 -24 weeks) while in cases of non-union average time for union was 12 weeks. 1 case of fracture ulna was united in 24 weeks. In case of femoral fracture, all the fractures healed at an average of 17.4 weeks except one case which unite after 35 weeks post operatively. In case of non-union which united around 20 weeks post operatively. All fractures united in this series without the need for any supplementary procedure. The average time for union in fresh cases was 16.4 weeks. 2 of the 4 open fractures and 1 of 2 non-unions in femur took more than 20 weeks to unite.

In case of tibia fractures all the fractures healed at an average period of 18.2 weeks post operatively accept one which was united after 35 weeks. The average time for union of fresh tibial fractures was 17.1 weeks while the non-unions united in an average of 17.7 weeks. Full weight bearing in cases of fracture tibia and femur was allowed in 14/40 cases within 12-16 weeks, 20/40 cases within 17-20 weeks and in 6/40 cases after 20 weeks.

Minimum follow-up was 12 months and average time to full weight bearing in the closed fracture (12 patients) was 18.1 weeks (range 8-32 weeks) and 19.3 weeks in the open fracture group (8 patients range 8-44 weeks). In open fracture group 4 fractures united within 6 months, 1 fracture between 6 to 12 months and 1 fracture united 12 months after surgery, there were 2 cases of non-union. In closed fracture group, 7 fractures united within 6 months, 3 fractures between 6 to 12 months and 2 after 12 months of surgery. 2 of the 20 patients required additional procedure to aid bone healing in the post-operative period. 3 of 20 patients required implant removal, for delayed implant breakdown in 2 cases and wound infection in 1 case. After removal if implants uneventful recovery occurred slowly in all 3 cases. There was 1 case of plate breakage at 32 weeks postoperative.

In our study, 25 (71.43%) patients were free from any complication with full range of movement at nearer joints, walking without the help of any external support. There was no case of deep infection. There were 3 (8.57%) cases of superficial infection, which responded to antibiotic treatment

and controlled completely. There was no any case of implant failure (plate breakage, screws loosening and screws breakage) and non-union. Out of 3 (8.57%) cases of delayed union found in their study, 1 case each was in Ulna, femur and tibia. 2 (5.71%) patients (1 femur and 1 humerus) had varus deformity 10-20%. Only 2 (5.71%) patients (1 fresh distal femoral fracture and 1 distal femoral non-union initially treated by DFN) had shortening of limb varying from 2.0 to 3.0 cm. We encountered 3 (8.57%) cases (2 distal femur fractures and 1 distal humerus) of joint stiffness. 20 -30° of terminal restriction of joint movement were initially occurred, which improved after physiotherapy.

Out of 5 cases of non-union (initially treated by other means), only one case presented with shortening of limb (Femur) while the rest 4 cases of non-union suffered no other complication. 2 refractures occurred after implant removal both were of simple transverse type and at the sites of the original fractures.

## Conclusion

The LCP is an effective bridging device for treating comminuted fractures but for treatment of simple fractures its superiority over conventional plating is yet to be proven.

2 cases had superficial wound infection which healed with antibiotics. Shortening was present in 1 case. In conclusion, if biomechanical principles are followed, LCP provides excellent fixation in difficult situations like comminuted fractures, osteoporotic fractures and periarticular fractures.

In this study, 19 (55%) patients showed excellent results, 11 (30%) showed good results, 2 (5%) showed fair and 3 (10%) showed poor results. In 85% of cases of present series final outcome was excellent or good. Our results based on clinical, radiological and functional outcome at 24$^{th}$ weeks of follow-up.

When we compared the observation of present series with observation of different authors in their international / national series on the fracture of long bones treated by locking compression plate, it was found that the rate of infection, malunion, non-union and failure of implants etc., were comparable. Since this fixation technique is simple, very effective (specially in comminuted fractures, osteoporotic fractures periarticular fractures etc.), economical and does not require different gadgets it is simple but needs good knowledge of preoperative planning and biomechanical scene.

In conclusion, locking compression plate is an economical, safe and sound fixation system for the treatment of fracture of any part of the long bones. The rate of union as well as range of motion makes it a good treatment option. It is the implant of choice in case of pathological fractures comminuted fracture periarticular fractures, periprosthetic fractures and very wide or very narrow medullary canal in fractured bone. LCP is an alternative choice of implants for conventional plating and intramedullary nailing. It takes minimal time and less blood loss when used as a MIPO technique. The fixation of the long bone fracture by LCP allowed rapid mobilization and early weight bearing and does not interfere with functional use of limb during treatment or healing of fracture.

So it can be said that, if preoperative planning and biomechanical principles are followed, LCP provide excellent fixation in difficult situations. Therefore it is the implant ready for use in any types of fractures of long bones at any time.

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