Comparative study of locking compression plate v/s limited contact dynamic compression plate in the treatment of diaphyseal fractures of humerus: A prospective study

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Abstract

Background and Objective: The aim of this prospective study was to compare the outcomes and complications of diaphyseal fracture of humerus treated with locking compression plates (LCPs) and limited-contact dynamic compression plates (LCDCPs).

Materials and Methods: Thirty patients with fractures of the shaft of the humerus, treated with plate osteosynthesis (15 patients-LCP & 15 patients-LCDCP) Clinical and radiological assessments were made at 6wk, 3 month & 6 month. Primary outcome measures like blood loss, operative time, mobilisation, time to fracture union, union rate and secondary outcome measures (functional outcome and complications) were compared between both groups. The ULCA scoring system and Mayo elbow performance index (MEPI) were used to assess shoulder and elbow functions, respectively.

Results: There was no significant difference found between the two groups in terms of primary outcome measures. There was no significant difference found between the two groups regarding mean ULCA score (p = 0.186) and mean MEPI score (p = 0.204). In terms of complications, no significant difference was found between the two groups. The fractures had united at an average of 19 weeks in the LCP group & 16.57 weeks in the LC-DCP group (p-value=0.151). There was no significant difference found between the two groups in terms of superficial infection, deep infection, radial nerve palsy, mean blood loss, mean surgery duration (p >0.05). There were two cases of delayed union (>20 wks) in the LCP group & 1 case in the LCDCP group. 1 patient in both the group had nonunion (p=1.000).

Conclusion: Osteosynthesis by plating (LCP/LCDCP) is a good option for diaphyseal fracture of humerus as this results in stable fixation, direct visualization & protection of the radial nerve [4]. Locking plates may have a mixture of holes that allow placement of both locking and traditional non-locking screws (so called combi plates). Many authors have proved the superiorit of locking plates over dynamic compression plates in various cadaveric long-
bone models [5]. Some biomechanical studies have suggested that locking-plate constructs are stiff and suppress inter-fragments motion to a level that may be insufficient to reliably promote secondary fracture-healing [6, 7]. The LCP is further advanced than the LCDCP as locking plates follow the bio-mechanical principle of internal fixator and do not require friction between the plate and bone. Stability is maintained at the angular-stable screw-plate interface. Cortical porosis under plates is a key factor of weak fracture healing and re-fracture [8]. It is aimed at minimal surgical damage to the blood supply, maintenance of optimal bone structure near the implant, improved healing in the critical zone, minimal damage to bone lining after plate removal with reduced risk of re-fracture [8]. The LCDCP has groove within the under surface (leads to an improvement in the blood supply to the underlying plate bone segment) allows for a small amount of callus formation as well as even distribution of stiffness along the plate, undercut plate holes allow extended tilting of plate screws, uniformly spaced as well as symmetrical plate holes and has an optimal screw effect [9]. The LCDCP was claimed to reduce the bone plate contact by approximately 50% [9, 10]. The newly developed Locking compression plate (LCP) consists of self-screw system where the screw are locked in the plate. This locking minimises the compressive forces exerted on the bone by the plate. This means that the plate does not need to touch bone surface at all [9, 10]. For simple, non comminuted diaphyseal fractures in osteoporotic bone requiring an ORIF, locking plates offer the advantage of increased pull-out resistance of the locking head screws compared with that of conventional screws [11]. Thus, for these fractures, locking plates can be applied according to the compression principle through eccentric placement of screws in the dynamic compression unit of the combi hole or by the use of a compression device after initial placement of one locking head screw on the other side of the fracture [12]. On the basis of the same rationale, locking plates can also be used according to the neutralization principle to protect a lag screw in osteoporotic bone, with increased pull out resistance of the locking head screws. At least 4 screws proximal & 3 screws distally are required without a lag screw. Shoulder pain and decrement in shoulder range of movements may significantly be associated with ante grade intra-medullary nailing than with plates [13, 14]. Retrograde nailing can cause elbow contractures [15]. The aim of this study is to investigate whether a difference in plate design affects the outcome in managing a particular chosen group of humeral shaft fractures.

Materials and Methods
The Present study is conducted in Govt. Multi-speciality Hospital, Chandigarh during the year 2015-2017. In this study 30 patients of either sex with humeral shaft fracture were considered. Patients are divided into two groups of 15 patients each. Group A is managed with the LCP while group B with the LCDCP. After taking consent all the patients were analysed clinically and radiologically. The fracture classified as per AO classification. The affected limb was immobilized by “U” shaped coaptation splint till the time of surgery. Skeletally mature patients with age group 18-55 years of either sex with closed humerus shaft fracture and open grade 1 & 2 were included in the study after taking consent. Skeletally immature patients with previous h/o fracture, osteomyelitis, head injury, B/L fractures, pathological fractures, open grade 3 & fractures with neurovascular involvement were excluded from the study.

Under Regional Anaesthesia, all the patients were treated with Open Reduction Internal Fixation by either LCP or LC-DCP through Anterolateral approach [16].

In Postoperative period, Patient was kept nil by mouth for 4-6 hours. Intravenous antibiotics were continued for 3 days and then oral antibiotics were given for next 5 days. Analgesics were given according to the need of the patient. The arm is supported in a sling or sling and swathe. The limb was kept elevated and active finger movements were encouraged. The limb was watched for excessive swelling, pain and neurovascular status. Post-operative radiograph were taken. First change of dressing was done after 48 to 72 hours of operation. If the suture line was clean, suture removal was done after 12 to 14 days of operation under strict asepsis.

Gentle use of hand and elbow can usually begin as soon as the patient’s comfort permits. Forceful use of the arm should be discouraged, but gentle, assisted range of motion for shoulder and elbow were started at an early stage. Once callus is visible, weight bearing and strenuous use can be increased progressively. Patients were reviewed regularly at 6wk, 3 months and 6 months. They were assessed clinically at each follow up. Check x-ray was taken at every visit and patient was clinically and radiologically assessed for fracture union, functional outcome and complications. Complications emerged (if any) in preoperative, intraoperative, postoperative, or during follow up period was treated appropriately. Functional outcome was measured by the UCLA Shoulder rating scale & Mayo Elbow Performance Score.

The complications were evaluated in terms of infection, nonunion, delayed union, implant failure & neurovascular.

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Fig 1: Incision
Results
The mean age in group A were 33.13 yrs & group B were 34.17 years most common cause of fracture was RTA in 24 (80%) cases. most common type of fracture was 12A3 (36.7%). The mean duration of surgery in the Group A was 68.33 minutes and in the Group B was 70.67 minutes (p=0.459). The mean intraoperative blood loss in the Group A was 301.33ml and in the Group B was 286.00 ml. (p-value=0.185). The mean mobilization time in the Group A was 3 days & the Group B was 2.73 days. (p-value=0.356). The mean time of union in the Group A was 19.00 weeks and the Group B was 16.57 weeks. (p-value=.151). The Mean UCLA score for the Group A was 31.20 and the Group B was 30.40 (p-value=.186). The Mean MEPI score in the Group A was 84.33 and in the Group B was 88.00 (p-value=.204). The UCLA score was Excellent in 13.3% (2 patients) & good in 80.0% (12 patients) in the Group A (Total 93.3%) & Excellent in 20% (3 patients) & good in 73.3% (11 patients) in the Group B. (Total 93.3%). The MEPI score was Excellent in 26.7% (4 patients) & good in 60.0% (9 patients) in the Group A (Total 86.7%) & Excellent in 40% (6 patients) & good in 53.3% (8 patients) in the Group B. (Total 93.3%).

There were 2 patients had radial nerve palsy & 1 patient had superficial soft tissue infection in the Group A. There was 1 patient had radial nerve palsy & 1 patient had superficial soft tissue infection in the Group B. There was 1 case of non-union in each group of the LCP & the LCDCP.
Graph 2: Complications

Graph 3: UCLA result

Graph 4: MEPI Parameters
Discussion
The internal fixation methods for humerus shaft fractures can be broadly grouped into plating or intramedullary techniques \cite{17, 18}. Plate osteosynthesis remains the gold standard of fixation of humeral shaft fractures compared to other methods \cite{2}. The reliability of union, together with early mobilization and return of the arm to normal function, favours the use of primary plate fixation in treatment of humeral diaphyseal fractures.
Shen et al \cite{19} retrospectively analysed data from 43 patients with fractured humerus shafts treated with the DCP and the LCP using minimally invasive plate osteosynthesis (MIPO) techniques, and showed that there was no significant difference when outcomes and complications of the two types of implants were compared. Hur et al \cite{20} retrospectively analysed data from 19 elderly patients with fractured humerus shafts treated with the LCDCP and the LCP. In their study, loosening of the plate occurred in one case each from the Group A and the Group B. The rest of the patients achieved union uneventfully without any complications. Union rate and clinical scores were not significantly different between the two groups. They advised that the principle of fracture fixation was more important than plate selection in humeral shaft fractures of elderly patients. Results of the present study are comparable with the reported literature \cite{19, 20}. In their prospective study, Sommer et al \cite{21} published the results of use of various LCPs in treatment of 144 patients with 169 fractures, and concluded that the LCP was a technically mature option in complex fracture situations and in revision operations after the failure of other implants. Gardener et al\cite{7} compared the mechanical behaviour under cyclic loading of LCP constructs and LCDCP constructs. Traditional compression plating failed significantly earlier in torsion. In AP bending, traditional constructs demonstrated significantly greater energy absorption, suggesting greater deformation. Fracture motion and stiffness measurements were discordant in the LCDCP specimens in torsion. In contrast, the LCP specimen had no discordance in stiffness and fracture motion. On the other hand, many of the other parameters compared between the two plates showed no difference, and the overall clinical advantage of locked plates is subtle. Xiong et al \cite{14} also showed in their cadaveric study that the LCP has a lower interface contact area and lower average force than that of the LCDCP and that the LCP is a good alternative for treating forearm and humerus diaphyseal fractures. In their study, Hoerdemann et al \cite{22} compared the in vitro biomechanical characteristics of LCDCP and LCP constructs in an osteotomy gap model of femoral fracture in neonatal calves and showed that insertion torque sufficient to provide adequate stability in femurs of new born calves could not be achieved reliably with 4.5-mm cortical screws, and that the LCP constructs were significantly more resistant to compression than the LCDCP constructs. Leung and Chow \cite{73} compared the LCDCP with PC-Fix and the LCP in treatment of closed forearm fractures in their randomized control trial and said that the LCP is effective for use as a bridging device in treating comminuted fractures; its usage in simple fractures and its superiority over conventional plating systems is yet to be proved.

The limitation of our study was that small sample size in both of the groups and absence of long-term follow-up. A randomized control trial, preferably triple blinded or at least double blinded in nature, involving a large number of patients with long-term follow-up is needed to evaluate significant differences between the LCDCP and the LCP fixation in
fractures of the shaft of the humerus.

Our study concludes that the final outcome is determined by using proper principles of plating and it is the proper application of the principles of plating and not the type of plate which decides outcomes and complications.

LCP is more costly than LCDCP. But LCP gives more stable strut & angle stable fixation so it is more useful in humerus fracture fixation because large amount of stress on humerus bone due to versatility of shoulder joint. Combi-hole of the LCP provides fixation of both ordinary as well as locking screws. The LCP was a technically mature option in complex fracture situations and in revision operations after the failure of other implants. Overall results are almost equal in both the groups.

**Conclusion**

Osteosynthesis by plating (LCP/LCDCP) is a good option for diaphyseal fracture of humerus. This technique has resulted in stable fixation, direct visualization, protection of the radial nerve, and sparing of the adjacent shoulder and elbow joint from injury. These plates promote rapid union because it facilitates preservation of blood supply to the cortical segment because of reduced bone-plate contact. Fracture of the humerus shaft, using all current surgical principles and techniques, has excellent clinico-radiological outcome and is relatively safe. LCP is more costly than LCDCP. But LCP gives more stable strut & angle stable fixation so it is more useful in humerus fracture fixation because large amount of stress on humerus bone due to versatility of shoulder joint. The LCP was a technically mature option in complex fracture situations and in revision operations after the failure of other implants. Overall results are almost equal in both the groups. There is no significant difference in union, mobilisation, hospital stay, blood loss & complication in both the groups.

The principle of fracture fixation was more important than plate selection in fractures of the shaft of the humerus.
References


