International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2020; 6(3): 205-211

www.orthopaper.com
Received: 06-05-2020
Accepted: 08-06-2020

Dr. Maulik Patel
DNB Orthopaedics, Senior Resident, GMC Bhavnagar, Gujarat, India

Dr. Abhijeet Shinde
DNB Orthopaedics, Senior Resident, GMC Bhavnagar, Gujarat, India

Dr. Akshay Patel
MS Orthopaedics, Senior Resident, GMC Bhavnagar, Gujarat, India

Corresponding Author:
Dr. Maulik Patel
DNB Orthopaedics, Senior Resident, GMC Bhavnagar, Gujarat, India

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

Dr. Maulik Patel, Dr. Abhijeet Shinde and Dr. Akshay Patel

DOI: https://doi.org/10.22271/ortho.2020.v6.i3d.2200

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 sore ($p = 0.204$). 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, and sparing of the adjacent shoulder and elbow joint & rapid union because of reduced bone-plate contact. LCP is more costly than the LCDCP but LCP gives more stable strut & angle stable fixation so it is more useful in osteoporotic bones. Overall results are almost equal in both the groups. There is no significant difference in union, mobilization, 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.

Keywords: Locking compression plate, Limited contact dynamic compression plate, Fracture shaft of humerus, Dynamic compression

Introduction and Background

Incidence of shaft humerus fracture are representing approximately 3% of all fractures [1]. There is bimodal distribution with peaks primarily in young male patients, 21-30 years of age, and a larger peak in older females from 60-80 years of age [1]. Management of these fractures has been discussed in surgical texts for more than three millennia and has challenged medical practitioners since the beginning of recorded medical history. Plate osteosynthesis remains the standard of surgical treatment [2]. Plate fixation results in high union rates but requires extensive dissection and soft tissue stripping [3]. However open reduction and internal fixation (ORIF) with plating has advantages of 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 superiority of locking plates over dynamic compression plates in various cadaveric longbone models [5]. Some biomechanical studies have suggested that locking-plate constructs are stiff and suppress inter-fragmentary 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 tobone 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.[12,] 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.

Fig 1: Incision

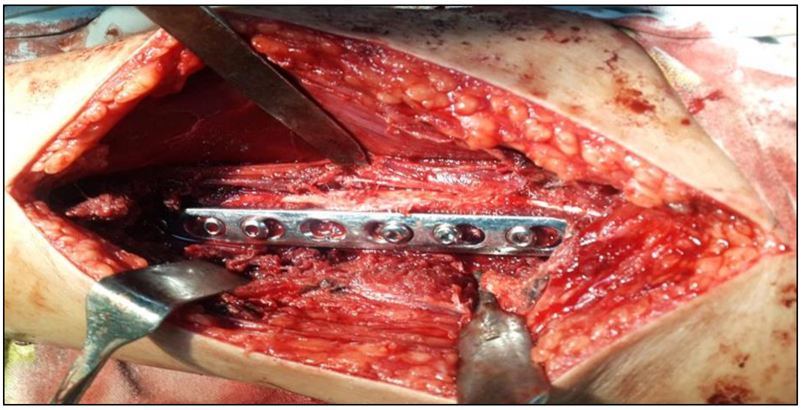


Fig 2: Fixation with plate

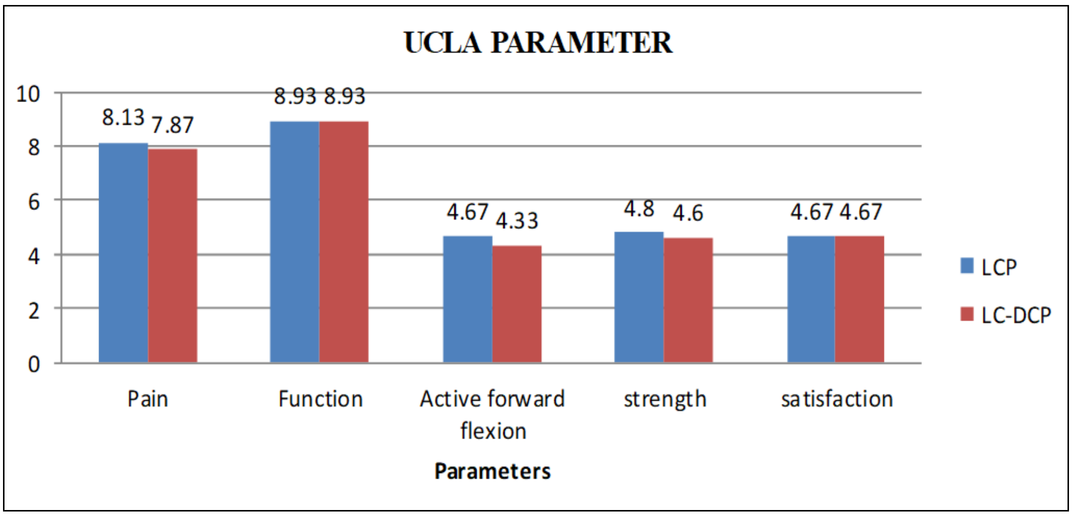
Fig 3: LCP

Fig 4: LC-DCP

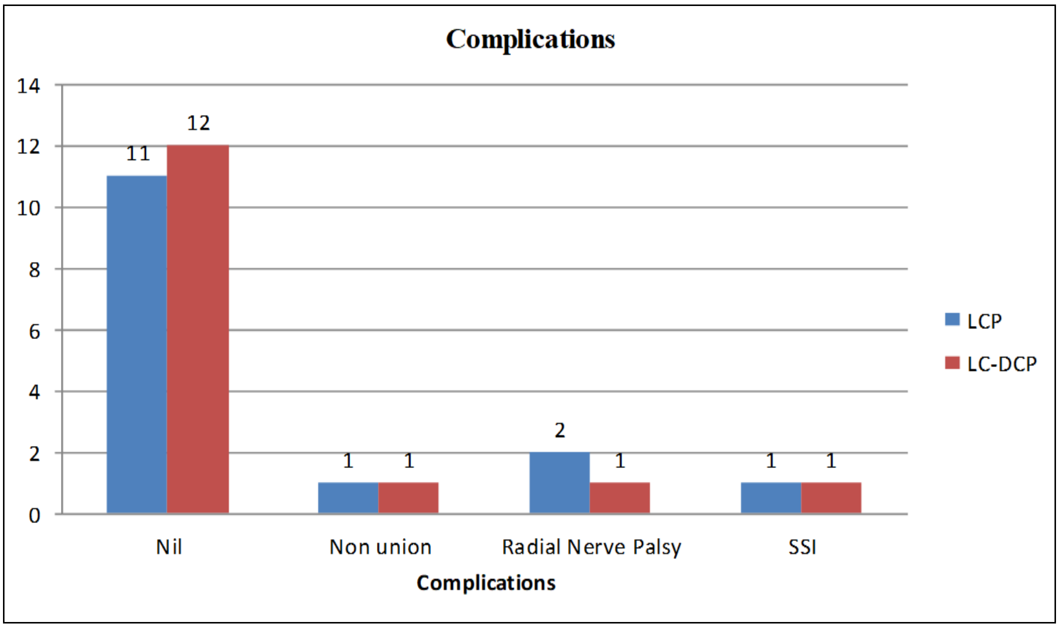
Results

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%).

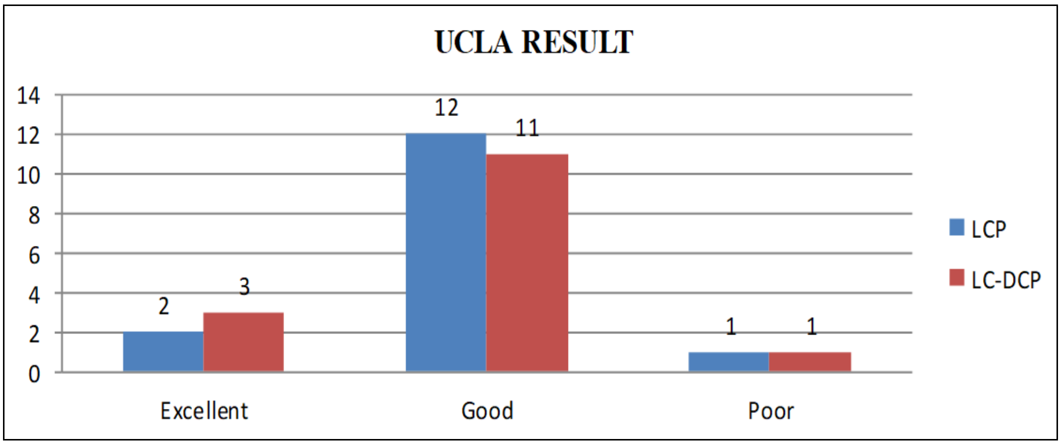
There were 2 patients had radial nerve palsy & 1 patient had superficial soft tissue infection in the Group A. There was 1 patient had radial nerve palsy & 1 patient had superficial soft tissue infection in the Group B. There was 1 case of non-union in each group of the LCP & the LCDCP.



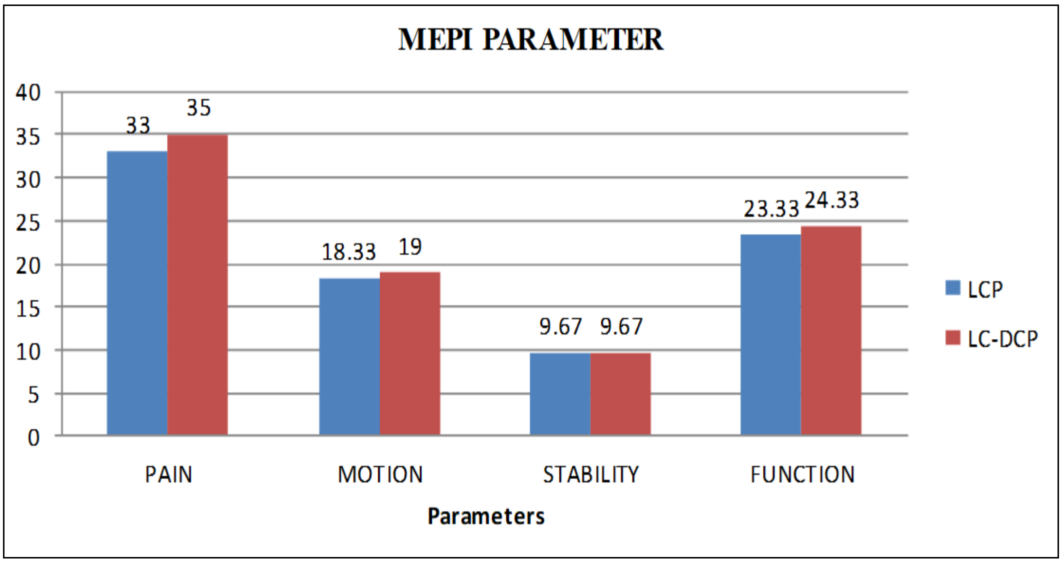
Graph 1: UCLA parameters



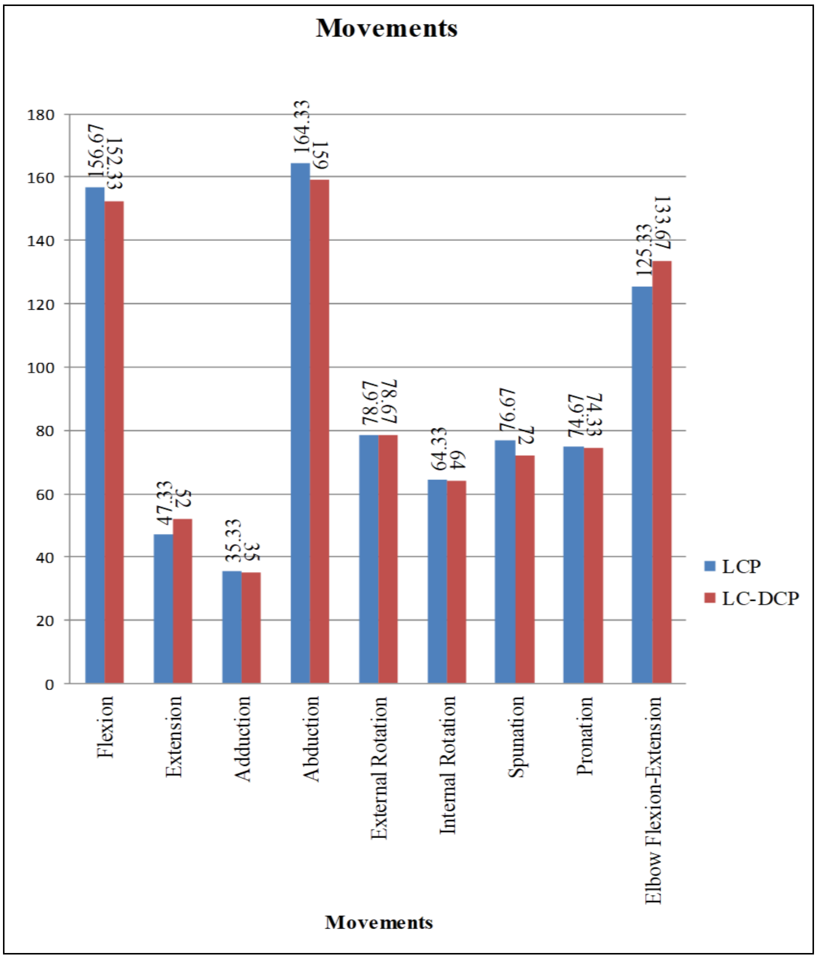
Graph 2: Complications



Graph 3: UCLA result



Graph 4: MEPI Parameters



Graph 5: Movements

Discussion

The internal fixation methods for humerus shaft fractures can be broadly grouped into plating or intramedullary techniques [17, 18]. Plate osteosynthesis remains the gold standard of fixation of humeral shaft fractures compared to other methods [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* [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* [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 [19, 20]. In their prospective study, Sommer *et al* [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*[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* [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* [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 [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.

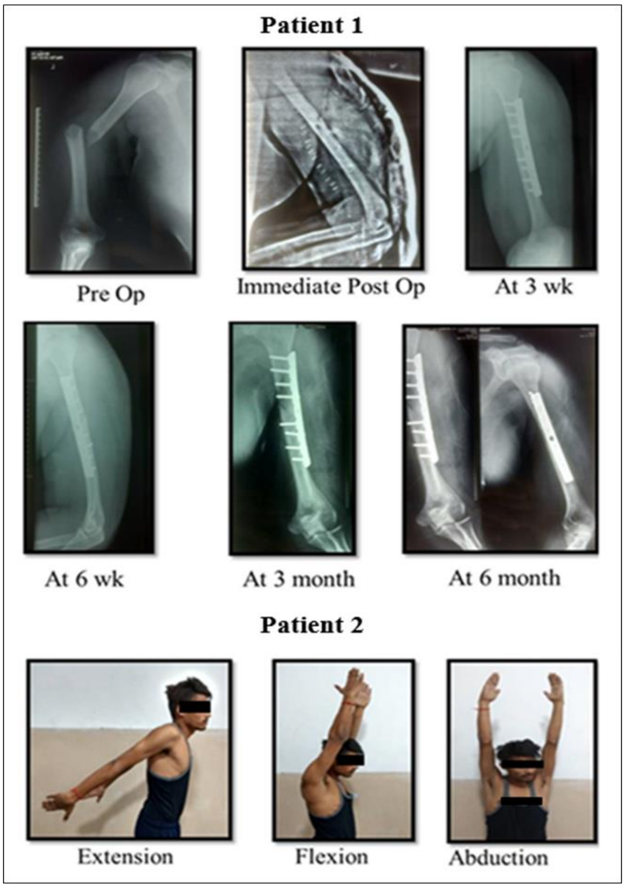


Fig 5: Patient no. 1

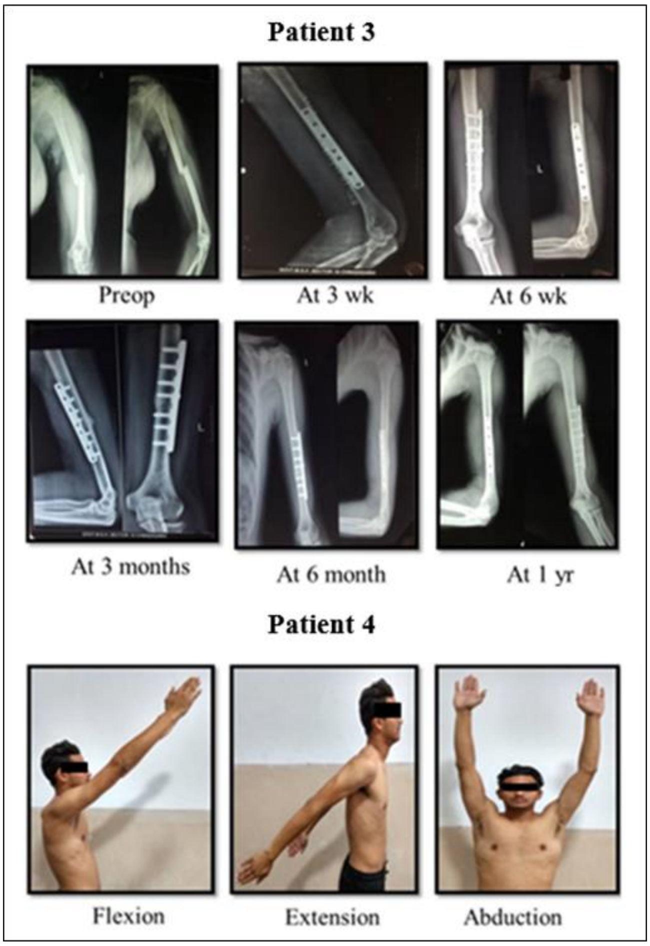


Fig 6: Patient no 2

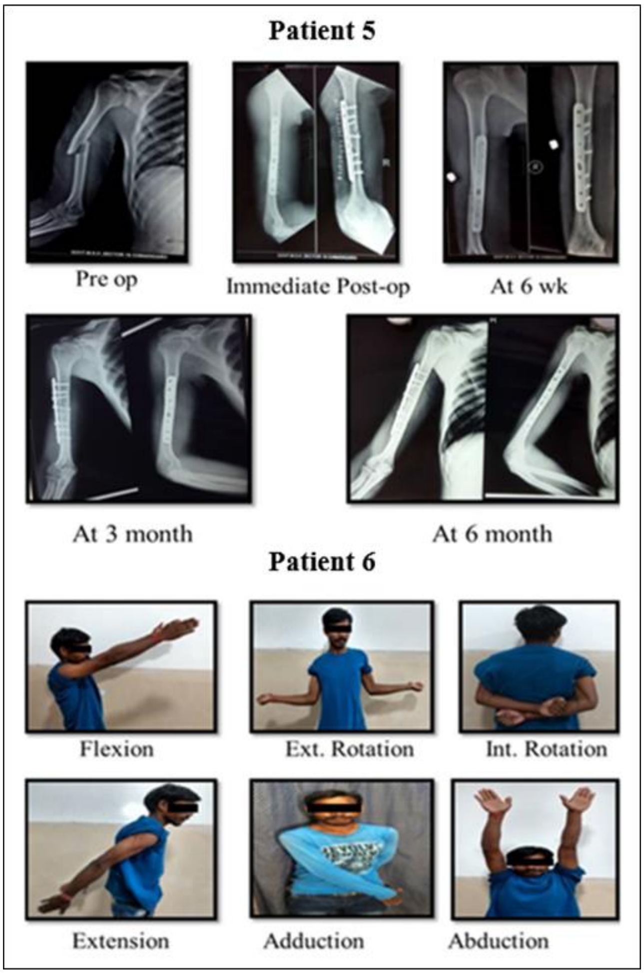


Fig 7: Patient no 3

References

1. Tytherleigh SG, Wallis N, McQueen MM. The epidemiology of humeral shaft fractures. J Bone Joint Surg. 1998; 80:249-53.
2. Spiguel AR, Steffner RJ. Humeral shaft fractures. Curr Rev Musculoskelet Med. 2012; 5:177-83.
3. Denies E, Nijs S, Sermon A, Broos P. Operative Treatment of Humeral Shaft Fractures. Comparison of Plating and Intramedullary Nailing. Acta Orthopaedica Belgica. 2010; 76:735-42.
4. Bell MJ, Beauchamp CG, Kellam JK, McMurtry RY. The results of plating humeral shaft factures in patients with multiple injuries: The sunny brook Experience. J Bone Joint Surg Br. 1985; 67:293-6.
5. Xiong Y, Zhao YF, Xing SX, Du QY, Sun HZ, Wang ZM *et al*. Comparison of interface contact profiles of a new minimum contact locking compression plate and the limited contact dynamic compression plate. Int Orthop. 2010; 34:715-8.
6. Fitzpatrick DC, Doornink J, Madey SM, Bottlang M. Relative stability of conventional and locked plating fixation in a model of the osteoporotic femoral diaphysis. Clin Biomech (Bristol, Avon). 2009; 24:203-9.
7. Gardner MJ, Nork SE, Huber P, Krieg JC. Stiffness modulation of locking plate constructs using near cortical slotted holes: a preliminary study. J Orthop Trauma. 2009; 23:281-7.
8. Jacobs RR, Rahn BA, Perren SM. Effects of plates on cortical bone perfusion. J Trauma. 1981; 21:91-5.
9. Perren SM. The concept of biological plating using the Limited contact dynamic compression plate (LC-DCP). Scientific background, design and application. Injury. 1991; 22:1-41.
10. McKee MD, Seiler JG, Jupiter JB. The application of the limited contact dynamic compression plate in the upper extremity: an analysis of 114 consecutive cases. Injury. 1995; 26:661-6.
11. Xiong Y, Zhao Y, Wang Z, Du Q, Chen W, Wang A. Comparison of a new minimum contact locking plate and the limited contact dynamic compression plate in an osteoporotic fracture model. Int Orthop. 2009; 33:1415-9.
12. Wagner M. General principles for the clinical use of the LCP. Injury. 2003; 34:B31-42.
13. Ouyang H, Xiong J, Xiang P, Cui Z, Chen L, Yu B. Plate versus intramedullary nail fixation in the treatment of humeral shaft fractures: an updated meta-analysis. J Shoulder Elbow Surg. 2013; 22:387-95.
14. Baltov A, Mihail R, Dian E. Complications after interlocking intramedullary nailing of humeral shaft fractures. Injury. 2014; 45:S9-S15.
15. Lin J, Inoue N, Valdevit A, Hang YS, Hou SM, Chao EY. Biomechanical comparison of antegrade and retrograde nailing of humeral shaft fracture. Clin Orthop 1998; 351:203-13.
16. The Humerus. In: Hoppenfeld S, De Boer P, Buckley R, editors. Exposures in Orthopaedics. 4th ed. Philadelphia: Lippincott Williams & Wilkins, 2009, 73-97.
17. Foster RJ, Dixon GL, Bach AW, Appleyard RW, Green TM. Internal fixations of fractures and nonunions of the humeral shaft. J Bone Joint Surg Am. 1985; 67:857-64.
18. Vander Griend RA, Tomasin J, Ward EF. Open reduction and internal fixation of humeral shaft fractures. J Bone Joint Surg Am. 1986; 68:430-3.
19. Shen L, Qin H, An Z, Zeng B, Yang F. Internal fixation of humeral shaft fractures using minimally invasive plating: comparative study of two implants (LCP V/s DCP). Eur J Orthop Surg Traumatol. 2013; 23:527-34.
20. Hur CY, Shon WY, Moon JG, Han SH, Hong JY, Chun SK. Comparison of LC-DCP versus LCP for Internal Fixation of Humeral Shaft Fractures in Elderly Patient. J Korean Fract Soc. 2007; 20:246-51.
21. Sommer C, Gautier E, Muller M, Helfet DL, Wagner M. First clinical results of locking compression plate (LCP). Injury. 2003; 34:B43-54.
22. Hoerdemann M, Ge´ ‘Det P, Ferguson SJ, Louis CS, Nuss K. *In vitro* comparison of LC-DCP- and LCP-constructs in the femur of newborn calves-a pilot study. BMC Vet Res. 2012; 8:139.