International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2017; 3(4): 709-713

www.orthopaper.com
Received: 22-08-2017
Accepted: 25-09-2017

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Comparision of locked compresion plate and limited contact dynamic compresion plate for internal fixation of both bone forearm

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DOI: https://doi.org/10.22271/ortho.2017.v3.i4j.99

Abstract
Background: The locking compression plate (LCP) is a newer modality for fracture fixation of both bone forearm fractures. The aim of the study is to compare this modality with the conventional Limited contact dynamic compression plate for Diaphyseal fractures of both bone forearm.
Materials and methods: It is a prospective type of comparative study involving 40 patients, 20 in each group. The functional outcome was assessed using the criteria of Anderson *et al*. The quality of reduction of the fractures was assessed using the criteria of Leung *et al*. The patient rated outcome was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire.
Results: The mean duration of surgery and the time for union were discovered to be less in LCP group as compared to LC-DCP though statistically insignificant. No significant differences were found between two groups with respect to functional outcomes (Anderson's criteria and DASH score)
Conclusion: LCP is an effective alternative treatment over LC-DCP in the management of these fracture but their superiority could not be certified. We conclude that surgical planning and technique for plate fixation is more important than the choice of implant.

Keywords: Limited Contact Dynamic Compression Plate (LC-DCP), Locking Compression Plate (LCP), Fractures both bones of forearm

Introduction
Forearm plays a cardinal role in the function of upper extremity. Fractures involving both bones of forearm have been acknowledged as articular fractures as even minor aberration in the spatial orientation of radius and ulna can appreciably debilitate the performance of hand [1-3]. Thus, the management of these fractures and their associated injuries deserve special attention as their treatment is not the same as the treatment of other diaphyseal fractures. Since radius and ulna articulate with one another at both distal and proximal end, the integrity of these joints is a further essential ingredient in achieving excellent long-term result after injury. It is essential to regain length, apposition, axial alignment and normal rotational alignment while treating diaphyseal fractures of the radius and the ulna to gain good range of pronation and supination. The chances for the occurrence of malunion and non-union are greater because of the difficulties in reducing and maintaining the reduction of two parallel bones in the presence of the pronating and supinating muscles, which have angulatory as well as rotatory influences [4]. Although open reduction and internal fixation with plate is commonly accustomed as a treatment of choice, the most efficacious implant remains unsettled [5]. The value of compression in obtaining rigid internal fixation had been noted by various authors [6-8]. Compression techniques have a lower incidence of non-union and are found to hasten rehabilitation, with less joint stiffness [9-14]. With conventional plating, the friction at plate bone interface lends stability at the expense of periosteal perfusion [15, 16]. Past few decades have introduced new implants in an effort towards biological plating which preserve vascularization more competently allowing early mobilization with a capably stable Fixation [17].

The limited contact dynamic compression plates (LC-DCP), developed in 1991, was said to reduce the bone-plate contact by approximately 50% to minimize the disruption of periosteal blood vessels beneath the plate. But the LC-DCP still relied on the plate-bone interface for stability and the problem of confluent contact areas was not completely resolved [15, 16]. Point contact fixator (PC Fix), was the first implant that did not confide on the plate bone interface for stability as it further diminished the contact area to mere point contacts of the plate with the bone [15]. Locking compression plate (LCP) was devised by combining the features of a LC-DCP and a PC-Fix. Theoretically, this allows for more rapid bone healing besides decreasing infection, bone resorption, delayed union/non-union and secondary loss of reduction [15, 16]. They can aid biological fixation by being placed in a bridge plate technique in a comminuted fractures and have been asserted to allow rapid bone healing thus abbreviating union complications [16, 18]. Hence, current study was organized to assess the supremacy of LCP over LC-DCP if any, in the management of diaphyseal fractures both bones forearm.

Materials and methods

In our study, 40 patients sustaining fractures of shaft of both bones of forearm stating inclusion and exclusion criteria were incorporated and ethical clearance was obtained from institutional ethics committee.

Inclusion criteria

Age 18-60 years

All closed fractures and open fractures up to Gustilo anderson grade 1, Polytrauma without any significant ipsilateral upper limb fractures. Patients fit for surgery.

Exclusion criteria

Significant concomitant ipsilateral upper extremity trauma, Pathological fractures, Patients not fit for surgery due to other medical conditions.

Surgery was performed within 1-7 days of admission. All surgeries were accomplished under general anesthesia or regional block. Preoperative and postoperative intravenous 3rd generation cephalosporins were given prophylactically. Duration of surgery was recorded in all cases to draw a comparison of the means between the groups. The patients were randomly assigned to either of the two groups after block randomization Surgical techniques as dictated by the AO/ASIF group were exercised. A volar henry approach was utilized to fix the fractures of radius at any level. Ulna was exposed through an incision over its subcutaneous border and its dorsal surface was plated. The bone with a transverse fractures or a less comminuted fractures was fixed first. Fixation was carried out with a 3.5 mm LCDCP OR LCP with a minimum of 3 Screws (6 cortices) on either side of fractures. A splint was applied for 2 weeks and wrist and elbow exercises were commenced immediately. Patients were discharged 3-7 days following surgery and were followed in opd at 2 weeks for suture removal, then 4 weeks, then monthly till minimum 6 months or fractures union and 3 monthly thereafter. AP and Lateral views of fracture were obtained. Osseous healing was designated radio logically as the presence of at least 3 of the 4 cortices with bridging callus formation and crossing trabeculae in AP and lateral radiographs. Absence of pain and tenderness at fracture site dictated the achievement of clinical healing. Fractures which healed in less than 6 months were classified as unions; those which required more than 6 months to unite but without any additional operative procedure were classified as delayed unions; and those which failed to unite without further operative intervention were classified as non unions. The functional outcome was assessed using the criteria of Anderson *et al*. The quality of reduction of the fractures was assessed using the criteria of Leung *et al*. The complications were evaluated in terms of infections (superficial or deep or chronic osteomyelitis), non-union, synostosis, implant loosening and secondary loss of reduction, implant breakage, refracture, fracture at the end of the plate, and fracture through the compression hole. The patient rated outcome was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, a 30-item questionnaire intended to assess the function and symptoms of patients with disorders of the upper limb.

Table 1: Anderson *et al*, criteria for assessment of functional outcome.

Result	Union	Flexion and extension at wrist joint	Supination and pronation
Excellent	Present	<10° loss	<25% loss
Satisfactory	Present	<20° loss	<50% loss
Unsatisfactory	Present	<30° loss	>50% loss
Failure	Non-union with or without loss of motion		

Results

In our study of 40 patients, LC-DCP group comprsied of 20 patients (12 males, 8 female) and LCP group comprised of remaining 20 patients (11 male, 9 female). Mean time to surgery was 5.2 ± 2.5 (Range 2-11) days in LC-DCP group and 4.9 ± 2.3 (Range 2-10) days in LCP group. High energy impact was the mechanism of injury in 70% cases in LC-DCP group while 66% in LCP group. The mean time required for LC-DCP fixation (80.2 ± 12.0 min) was calculate to be more than that of LC fixation (76.5 ± 12.0 min) although difference was statistically insignificant. Sixty five percent (n=13) of fractures in LCP group and 80 % (n=16) in those in LC-DCP were found to have anatomical reduction and rest had non-anatomical reduction. This difference was not significant. The amount of callus formed at the fracture site was assessed using the criteria of Leung *et al*. Fifty percent (*n*=10) of the forearms in the LCP group healed with radiological evidence of callus formation of which 20% (*n*=4) showed abundant callus formation, 20% (*n*=4) showed moderate callus, 10% (*n*=2) showed minimal callus and the rest 50% (*n*=10) had no callus formation. In the LC-DCP group, 60% (*n*=12) of the forearms did not show any callus formation, 20% (*n*=4) showed minimal callus, 20% (*n*=4) showed moderate callus while none had abundant callus. The two groups were found to differ significantly, when compared with respect to the number of forearms that healed with abundant or moderate callus and those that healed with minimal or no callus radio logically. One out of the ten anatomically reduced forearms (10%) fixed with LCP showed callus formation while none of the 12 anatomically reduced forearms fixed with LC-DCP showed any evidence of callus formation. Of the non anatomically reduced forearms, 90% (9 out of 10 forearms) of those fixed with LCP showed evidence of callus in comparison to 75% (3 out of 4 forearms) in the LC-DCP group. In both the LCP and the LC DCP groups, the difference between the cases that had been reduced anatomically and non-anatomically, with respect to the presence of callus, was found to be very significant. Two patient of LC-DCP group had delayed union, which ultimately united without any secondary procedure. The mean time of union for the forearms fixed with LCP was found to be 15.12 weeks (range 8–21 weeks) in comparison to 16.1 weeks (range 10–29 weeks) for the LC-DCP group. This difference was statistically not significant. The mean ranges of elbow, wrist joint and pronation–supination movements in the LCP group were 145.7, 146.5 and 145.4 respectively. While they were 142.4, 140.4 and 141°, respectively, for the LC-DCP group. The two groups were not significant with respect to these range of movements. In LC-DCP group, we had excellent outcome in 18 patients, satisfactory in one and unsatisfactory in one patient without any failure while in LCP group, we had excellent functional outcome in 18 patients and satisfactory outcome in 2, without any unsatisfactory or failure case. The grip strength of the involved side ranged from 80 to 100% of that of the contralateral side in the LCP group and from 70 to 100%, in the LC-DCP group. The two groups did not reveal any significant variation with respect to the grip strength. The DASH questionnaire was used to assess the outcome subjectively. The score was seen to be higher in patients who did not regain their full range of motions at the wrist and forearm. Overall, the patients were satisfied with the outcome in both the groups. Three patients (closed fractures) fixed with LC-DCP had superficial infection, which subsided uneventfully following antibiotic therapy. One patient belonging to the LCP group developed deep infection.

Table 2: Results according to Anderson criteria.

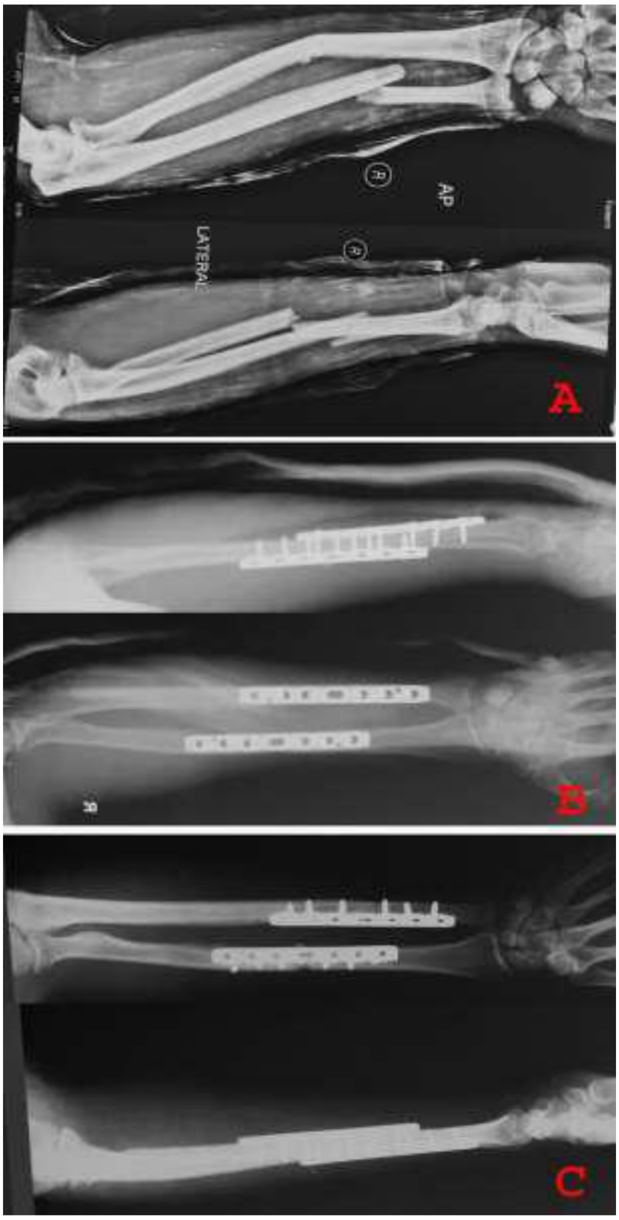
Group	Excellent	Satisfactory	Unsatisfactory
LC-DCP	18	01	01
LCP	18	02	00

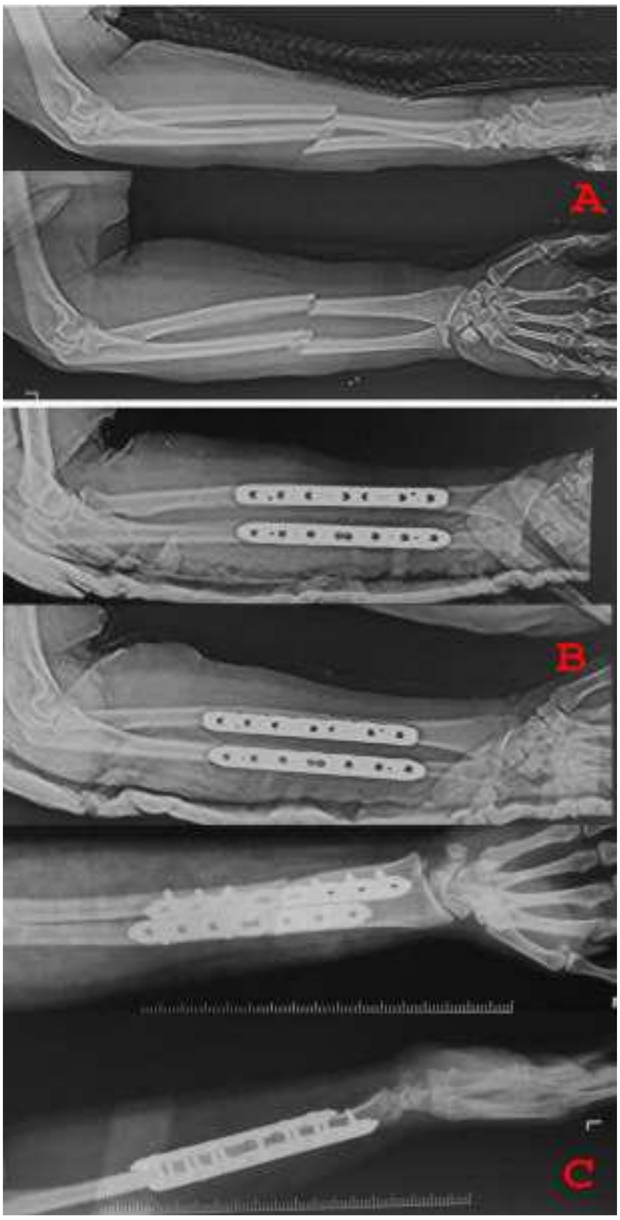
Discussion

Open reduction and plate fixation has been the standard treatment of adult diaphyseal forearm fractures [19]. But the most effective type of plate fixation for diaphyseal fractures of forearm bones has not been well defined [15]. Locked plates the "internal external fixators", does not rely on frictional force between the plate and the bone to achieve compression and provide absolute stability. Thus, the local blood supply under the plate to be preserved, thereby leading to superior bone healing and minimal complications. It has been proved to be valuable in situations like osteoporosis, comminuted fractures, complex intraarticulaar fractures or fractures in close proximity to the joints, upper extremity fractures [20, 21, 22]. Unperturbed bone perfusion reduces infection rate, bone resorption, delayed and nonunion. Currently established indications for their use include complex periarticular and intra articular fractures, osteotomies, periprosthetic fractures, failed fixations, union disturbances, osteoporosis etc, [20, 21] Atsunori *et al*. had stated that LCP is now considered to be superior to the conventional plating system in the treatment of forearm fractures [23]. But there is scarcity of information comparing LCP with conventional plating in the literature. Leung *et al*. in their randomized control trial (RCT) comparing LC-DCP with PC-Fix had found 100% union with a mean period of 17 and 18 weeks, respectively, for closed fractures [15]. In his another series of LCP, there was 100% union, with a mean of 20 weeks. The more recent study of Stevens *et al*. had 100% union rates in both LCP and DCP groups. They even found the consolidation time favoring the DCP [24]. Our study had a union rate of 100%, with one delayed union in the LC-DCP group and none in the LCP group. The authors propounded that it is the axial compression applied to the fracture line which dictates the time to union rather than the type of plate. In our research, the number of patients that had anatomic reduction with LC-DCP was greater than that with LCP as biological fixation with bridge plating was emphasized with LCP and consequently more callus was discerned with LCPs with either anatomic or non-anatomic reductions. This certainly underlines the biological nature of LCP plating Leung too proclaimed that with LCP the quality of reduction and stability control decide the type and speed of healing [15]. Egol *et al* also remarked that in a fractures with a wider gap and strain <10%, locked plates pretend to be an internal fixator contributing ample stability favoring secondary bone healing through enchondral ossification [16]. It also supports Wagner's view that the locked internal fixator technique allows but does not require precise reduction and that it gives priority to biology over mechanics. The locking screw into the plate ensures angular as well as axial stability, eliminates the possibility for the screw to toggle, slide or dislodge, and thus strongly reduces the risk of postoperative loss of reduction [25]. We could not bring out statistically significant difference in the other outcome parameters between the two groups treated with LCP and LC-DCP. Thus, the results of the present study are comparable with the reported literatures in terms of functional outcome and complication rates and are rather found to be superior in terms of union rates. Leung *et al*. had reported one refracture in both the groups after implant removal in his RCT comparing LC-DCP with PC-Fix. He also reported 2 refractures in his LCP series, where the plates were removed by 12 months and he recommended not to remove the implants within 18 months of fixation.

Conclusion

Locking compression plate is an effective treatment option for fractures of both bone forearm. Although the current study could not document its superiority over limited contact dynamic compression plate, locking plates can be used as an implant of choice as a bridging device in managing comminuted fractures. It is the proper application of the principles of plating and not the type of plate which decides the outcome. Further long-term multicentric study is required to prove behaviors of the implant.





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