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Comparative study of DCP versus locking plate in fracture shaft of radius and ulna

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Abstract

Background: Malunion and nonunion are more frequent because difficulty in reducing and keeping the reduction of bones in the presence of muscles that exert various deform forces over to the fractured bony fragments. Orthopedic surgeons often encounter diaphyseal radius and ulna fractures. Malunion and nonunion are most frequent complications because difficulty in reducing and keeping up the one reduction.

Objective: To compare the outcome of using dynamic compression plate versus locking compression plate in diaphyseal fractures of upper limb via bridge plating technique.

Methods: This randomized Controlled Trial study was carried out at Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh from July to December 2022. After taking ethical approval from board of studies, 100 patients who fulfill the inclusion and exclusion criteria was enrolled in the study from OPD and emergency. Informed consent was obtained from each patient. The non-probability purposive sampling technique was used in this study to include the patients. Patients were divided into two groups by using lottery method. In a group A, dynamic compression plate (DCP) was applied and its results were compared with group B, locking compression plate (LCP) was applied.

Results: Out of 100 patients 74% patients were males whereas 26% patients were females. The male to female ratio was 2.8:1. The mean age of the patients was 46.55 ± 15.03 years between 18-70 years. After 10 days, no patient in any group showed callus formation after 2 months, 32 in DCP group and 28 in LCP group showed callus formation after 2 months, 38 in DCP group and 42 in LCP group showed callus formation, after 3 months, 39 in DCP group and 44 in LCP group showed callus formation and after 6 months, 40 in DCP group and 46 in LCP group showed callus formation. Statistically there is significant difference was found between the callus formation, alignment and different complications post-operatively with DCP but LCP showed little better results than DCP.

Conclusion: LCP technique is more effective and feasible for the treatment of diaphyseal fractures of upper limb in comparison with DCP technique.

Keywords: Dynamic compression plate, Locking compression plate, Diaphyseal fractures upper limb

Introduction

Malunion and nonunion are more common in the presence of muscles exerting various deforming forces on the fractured bone fragments, as it is difficult to reduce and maintain the reduction. Orthopedic surgeons often struggle with femoral shaft fractures. Malunion and nonunion are the most common complications due to the difficulty in reducing and maintaining the reduction. Dynamic compression plates (DCPs) are metal plates that are typically used in orthopedics for internal fixation of bones after fracture. In general, open reduction and internal fixation is the best treatment for shaft fractures in adults, although open reduction is also possible ^[1]. Radius and ulna fractures are the most common upper limb fractures in adults ^[2]. The incidence is reported as follows ^[1]. The incidence may vary by age and sex, but is approximately 10 per 10,000 people per year ^[3]. Studies show a bi-modal distribution, with the highest incidence among young males aged 10 to 20 years (10:10,000)

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and females over age 60 years (5:10,000) [4, 5]. The majority of adult forearm fractures are typically treated with conventional bone setters. Conservative treatment of forearm fractures is associated with complications such as casting, compartment syndrome, malunion, and nonunion [6]. To put an end to this practice, it is essential for surgeons to understand the various options for surgical fixation and how they contribute to the effective treatment of forearm fractures [7]. Treatment with closed reduction and cast immobilization usually leads to poor functional outcomes due to prolonged bed rest, malunion, pseudoarthrosis, and joint stiffness. ORIF offers a variety of plate types that combine plates and screws. Dynamic compression plates (DCPs) have long been used as the highest quality internal fixation technique for diaphyseal long bone fractures [8]. Treatment of diaphyseal long bone fractures with ORIF is a generally accepted system. At various fracture sites, the use of connected plate fixation with locking compression plates (LCPs) has been shown to improve biomechanical and biological properties. Only very limited clinical information are accessible on bridging plate fixation utilizing LCPs for the treatment of diaphyseal long bone fractures [9]. Recently developed LCPs combine the properties of both locking plates (LPs) and DCPs. With their joined hole, an unlocked compression screw and a locking screw may be used [10]. Diaphyseal fractures of the radius and ulna are classified as articular fractures, so a slight deviation in the spatial orientation of both the radius and ulna minimizes the rotational frequency of the forearm, impairing hand positioning and functions. The preservation of inter-osseous space becomes necessary while treating fractures of the radius and ulna because it is necessary for successful pronation and supination to take place [6]. Therefore, to restore forearm functions, these fractures require adequate anatomical reduction and internal fixation [11]. LCPs have been shown to furnish a stronger fixation compared with DCPs in biomechanical studies [5]. LCPs may be utilizing a bridging plate procedure, permitting biological fixation for the management of comminuted fractures [10]. These benefits of LCP have been considered to accelerate fracture healing and reduce the problems of delayed union and nonunion [12]. However, LCPs have a few disadvantages, including troubles during removal and higher cost [13]. A predetermined number of studies compare LCPs and traditional plates and have reported similar outcomes with both implants in the management of diaphyseal long bone fractures. Despite the fact that LCPs have some theoretical advantages, the prevalence of the LCP over conventional plates remains to be proven [14, 15].

Material and Methods

This randomized Controlled Trial study was carried out at Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh from July to December 2022. After taking ethical approval from board of studies, 100 patients who fulfill the inclusion and exclusion criteria was enrolled in the study from OPD and emergency. All basic demographic information of patients was also noted. Patients were divided into two groups by using lottery method. In a group A, patient was managed with dynamic compression plate (DCP) and its results were compared with group B, in which patient was managed with locking compression plate (LCP). All surgeries were done by a surgical team. Then patients were shifted in ward and were discharged on 2nd postoperative day and were followed on 10th day, 1 month, 2-month, 3 month and 6 months

postoperatively. Success was labeled when there was complete callus formation after 6 months of operation on x-ray; alignment was also measured by using radiographs. Patients were assessed for weight bearing.

Patients were thoroughly examined in the emergency department for any associated injuries. Preoperative radiographs were taken to record the fracture geometry in two planes. Routine examinations were performed. To minimize the risk of infection, all patients received broad-spectrum antibiotics before surgery. Patients were prepared and surgery was performed under general or brical block anesthesia. The operated limb was prepared by painting and covering using routine antiseptic methods. An incision was then made above and below the fracture site without opening the fracture site and disturbing the fracture hematoma. The fracture was aligned and an appropriately sized DCP or LCP was forced over the bone to bridge the fracture and fixed with screws. Postoperatively, the limb was protected with a splint for 3–4 weeks and biological healing with callus formation and alignment of the upper limb diaphyseal fracture was evaluated with AP and lateral radiographs. The patient's ability to complications were evaluated at regular follow-up visits.

Results

Out of 100 patients 74% patients were males whereas 26% patients were females. The male to female ratio was 2.8:1. The mean age of the patients was 46.55 ± 15.03 years between 18-70 years. After 10 days, no patient in any group showed callus formation after 2 months, 32 in DCP group and 28 in LCP group showed callus formation after 2 months, 38 in DCP group and 42 in LCP group showed callus formation, after 3 months, 39 in DCP group and 44 in LCP group showed callus formation and after 6 months, 40 in DCP group and 46 in LCP group showed callus formation. There was insignificant difference observed on all follow-ups except at last follow-up. From 10 days till 3 months, all patients had proper alignment. After 6 months, 43 patients in DCP while 47 patients in LCP group showed proper alignment. The difference was insignificant on all follow-ups. After 10 days, no patients in both groups had infection, but after 1 month, 4 case in DCP group and 6 cases in LCP groups had infection. After 2 months, 4 case in DCP group and 8 cases in LCP groups had infection. After 3 months, 4 case in DCP group and 4 cases in LCP groups had infection. After 6 months, 8 case in DCP group and 10 cases in LCP groups had infection (Table-1).

Table 1: Comparison of outcome in both groups (n=100)

		Group		p-value
		DCP (n=50)	LCP (n=50)	
Callus formation after	10 Days	0	0	>0.999
	1 Month	32	28	0.2001
	2 Months	38	42	0.1570
	3 Months	39	44	0.0897
	6 Months	40	46	0.0408
Alignment after	10 Days	50	50	>0.999
	1 Month	50	50	>0.999
	2 Months	50	50	>0.999
	3 Months	50	50	>0.999
	6 Months	43	47	0.1570
Infection After	10 Days	0	0	>0.999
	1 Month	5	6	0.2786
	2 Months	4	8	0.1992
	3 Months	4	4	>0.999
	6 Months	8	10	0.2515

Table 2: Comparison of complication in both groups (n=100)

		Group		Total
		DCP	LCP	
Complications after 10 days	Implant Fracture	0	0	0
	Infection	0	0	0
	Mal-alignment	0	0	0
	Delayed union	0	0	0
	Non-union	0	0	0
	No	50	50	100
Complications after 1 month	Implant Fracture	0	0	NA
	Infection	5	6	0.5437
	Mal-alignment	0	0	NA
	Delayed union	0	0	NA
	Non-union	0	0	NA
	No	49	48	>0.999
Complications after 2 months	Implant Fracture	0	0	NA
	Infection	7	8	0.6693
	Mal-alignment	0	0	NA
	Delayed union	0	0	NA
	Non-union	0	0	NA
	No	47	46	>0.999
Complications after 3 months	Implant Fracture	0	0	NA
	Infection	7	6	0.6262
	Mal-alignment	0	0	NA
	Delayed union	0	0	NA
	Non-union	0	0	NA
	No	47	48	>0.999
Complications after 6 months	Implant Fracture	12	8	0.2160
	Infection	8	10	0.5029
	Mal-alignment	7	7	>0.999
	Delayed union	8	7	0.6942
	Non-union	7	6	0.6456
	No			

After 10 days, in both groups, no patient showed any post-operative complication, and the difference between both groups was insignificant. After 1 month, in infection was observed in 5 cases of DCP while 6 cases of LCP group and the difference between both groups were insignificant. After 2 months, in infection was observed in 7 cases of DCP while 8 cases of LCP group and the difference between both groups were insignificant. After 3 months, in infection was observed in 7 cases of DCP while 6 cases of LCP group and the difference between both groups was insignificant. After 6 months, implant failure was observed in 12 DCP cases while 8 LCP cases, in infection was observed in 8 cases of DCP while 10 cases of LCP group, mal-alignment was observed in 7 DCP and 7 LCP cases, delayed union in 8 DCP cases and 7 LCP cases while non-union was observed in 7 DCP cases and 6 LCP cases. The difference between both groups was insignificant (Table-2).

Discussion

The primary locking plates were displayed around last two decades for use in spinal and maxillofacial surgery [16, 17]. In the late 1980s and into the 1990s, experimentation with various sorts of internal fixation devices provoked the improvement of locking plates for fracture treatment [18, 19]. Both bones of the forearm fracture are one of the most common fractures in adults in the upper extremity. Conservative treatment is associated with mal-union, resulting in decreased rotation of the forearm and poor outcomes. The loss of rotation impairs upper-limb function and daily activities. For diaphyseal fractures of the forearm bones in adults, ORIF with dynamic compression plate (DCP) fixation has become the treatment of choice. The compression plating principle can be achieved by following the AO principles of

internal fixation, which are anatomical fixation, preservation of vascularity, mechanically stable fixation, and rapid mobilization of adjacent joints. To achieve good results, adherence to AO principles, strict asepsis, proper post-operative rehabilitation, and patient education are required. In North America for general orthopedic applications just in the last 6 or 7 years have been accessible [16, 20]. Displaced diaphyseal fractures of the forearm happen from high-energy trauma and may outcome in extreme loss of capacity except adequately treated. ORIF with DCP has been acknowledged as the best technique for treatment for these fractures [21]. In our study results the LCP group patients showed less complications in comparison with DCP group patients at different interval of months either that were related to alignment or callus formation. Statistically there is insignificant difference was found between the callus formation, alignment and different complications with study groups of the patients i.e. $p > 0.05$. But still LCP had a smaller number of complications as compared to DCP. Various researchers have noted union rates of 91-98% in A-type forearm fractures with DC plates which is accordance with our results [22, 23]. Some studies showed the strength of a system may be compromised, particularly in cases of low bone quality just like the circumstance in osteoporotic fractures. In this sense, the logical literature has demonstrated the achievement of the LCP framework with locking screws and the failure of the DCP framework [24-27]. In a progression of 40 patients of long bone diaphyseal fractures, Saikia et al., thought about LCPs and DCPs (22 patients in each group). Total patients achieved union, which happened at an average of 16 weeks in LCP group and 14 weeks in DCP group. One case of deferred association happened in the DCP gathering and 5 instance of osteomyelitis happened in LCP group. The

creators presumed that the LCP and LC-DCP gave comparative results ^[15]. Demirhan et al reasoned that the locking plate is altogether more steady than DCP and Ex-fix under torsional and bowing cyclic stacking in a dislodged break clavicle model. The mean initial stiffness (Nmm) for bending were 32.6 (LCP), 23.4 (DCP) and 20.6. Mean failure loads for bowing were 213.2 (LCP), 131.1 (DCP) and 102.7 ^[28]. In a study success rate of LCP (n=23) for treatment of long bone fracture was 15 (79%) while with DCP (n=6) was 4 (67%) cases. The difference was significant (p 0.003) ^[29]. Another study also reported that success rate of LCP (n=20) for management of long bone fracture was 10 (50%) while with DCP (n=20) was 5 (25%) cases. The difference was significant (p<0.05) ^[30]. CT Stevens et al demonstrated that in their study no neurological or vascular injury was seen previously or after operation, no infection and non-unions were seen. In LCP group mean time to bony union was 33 weeks (11-72, SD: 24), though in DC plate group it was 22 weeks (extend: 9-63, SD: 15.8) ^[31]. Saikia et al noted excellent function results of 36 patients (72%), satisfactory result in 7 patients (18%) and unacceptable result in 1% tolerant (3%) with no failure ^[32]. In Marya et al, reported the restricted contact dynamic compression plate for adult forearm fracture in 88% cases, good 7% cases, unsatisfactory 4% cases and failure in 1%. Verset et al concluded that locking screws had no statistically impact on the mechanical properties of LCP-plated bones in 4 point bending and torsion, contrasted to standard screws ^[33]. While in Raj demonstrated the normal age of patient in LCP group was 32.55±11.50 years from 18–64 years and in LC- DCP group, average age was 33.40±11.92 years between 18-60 years ^[30]. Leung et al, the mean age was 35 years ^[7] and Marya K et al where the mean age was 34 years ^[34]. The findings from Saika et al demonstrated that males established (70%) and female (30%) ^[32]. Manjappa et al reported 75% were male and 25% were females. While Marya K et al reported 24 patients were males in both group including 60% with male to female ratio being 1.5:126.

Conclusion

According to our study results we concluded that LCP is more effective and feasible for the treatment of diaphyseal fractures of upper limb in comparison with DCP when applied by bridge plating technique. Our study results showed statistically significant results between both the groups i.e. p value 0.001.

Conflict of Interest

Not available

Financial Support

Not available

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