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Surgical Management of Supracondylar Femoral Fracture with Locking Compression Plate

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Abstract

Background: The goal of fracture treatment is to obtain union of the fracture in the most compatible anatomical position which allows maximal functional restoration of the extremity. The increase in stability provided by Locking Compressive Plates (LCP) is most helpful to surgeons treating a fracture in poor-quality bone, and comminuted fracture.

Objective: To find out the Management of Surgical Supracondylar Femoral Fracture by locking compression Plate.

Materials & Methods: Prospective interventional (Quasi Experimental) study was conducted from June 2016 to February 2017 in the Dhaka Medical College Hospital. All patients of Supracondylar femur fracture treated by LCP implantation were included in the study.

Results: Total number of patients was 28. The mean age was 40.96 years ranging from 20 to 66 years. Shows, out of 28 cases, 24 (85.7%) cases were male and 4 (14.3%) were female. The male and female ratio is 6:1. An analysis of functional outcome of 28 cases of displaced distal femoral fractures, internally fixed using locking compression plates. The selected patients were evaluated thoroughly and after the relevant investigations, were taken for surgery. The fractures were classified as per the MULLER'S types and operated accordingly with ORIF with LCP. Early range of motion was then started. Weight bearing up to 6-12 week was not allowed. The full weight bearing deferred until 24 weeks or complete fracture union. The knee range of motion was excellent to very good, gait and weight bearing after complete union was satisfactory. This dissertation consists of 28 patients with supracondylar femoral fractures, treated with locking compression Plating. None of the patients were having bilateral fractures. There were males 20 and 8 females. 8 patients had associated fractures. There were 28 compound fractures (6 cases were grade 1, 14 cases were grade 2 and 8 cases were grade 3).

Conclusion: Complications associated with the plate were few and the functional outcome was excellent. Thus, many of the common complications of the conventional plating can possibly be avoided. We therefore recommend the use of locking plate, especially in elderly patients with osteoporotic bone and comminuted fracture.

Keywords: Locking Compressive Plates (LCP); Supracondylar Femur Fracture

Abbreviations: LCP: Locking Compressive Plates; ARDS: Acute Respiratory Distress Syndrome; DCS: Dynamic Condylar Screw.

Introduction

Supracondylar fracture of femur is common and it is account of 6% of all femoral fractures. In the last few decades, rapid

industrialization and the fast pace of life, have brought both comfort and catastrophe like road traffic accidents and crippling many young lives. Fractures of the lower end of femur are often difficult to treat and they are associated with many complications like acute respiratory distress syndrome ARDS), infections, malunion and nonunion causes high rate of morbidity and mortality [1]. In the early 1960s, there was a great reluctance towards operative management of these fractures because of high incidence of infection, non-union, malunion, inadequate fixation and lack of proper instruments, implants as well as antibiotics. Then, the traditional management of displaced supracondylar fracture of femur was along the principle of Johnes Charnley [2]. The incidence of distal femur fractures is approximately 37 per 1, 00, 000 person-years [3]. Distal femoral fractures mainly arise from two different injury mechanisms. They are often caused by high energy trauma mainly sustained in road traffic accidents. Open injuries with considerable comminution of condyles and metaphysis are frequently seen, as is low energy trauma, relating to elderly patients with severe osteoporosis frequently seen as periprosthetic fracture. Most surgeons agree that distal femur fractures need to be treated operatively to achieve optimal patient outcomes [4-6]. Although good internal fixation results have already been reported with these fractures over 30 years ago the number of revisions for non-union, loss of reduction and implant failure has been high [7]. The options for operative treatment are traditional plating techniques that require compression of the implant to the femoral shaft (blade plate, Dynamic Condylar Screw, non-locking condylar buttress plate), antegrade nailing fixation, retrograde nailing, sub muscular locked internal fixation and external fixation [4,5,8]. Most commonly used implant for the fixation of distal femur fractures are Fixed angle devices, usually in the form of Dynamic Condylar Screw (DCS) [9], system, which is a supracondylar plate combined with a lag screw. This two piece device is more forgiving and allows correction in the sagittal plane after the lag screw is inserted [10,11]. The LCP is a single beam construct where the strength of its fixation is equal to the sum of all screwbone interfaces rather than a single screw's axial stiffness or pullout resistance as seen in unlocked plates. Its unique biomechanical function is based on splinting rather than compression resulting in flexible stabilization, avoidance of stress shielding and induction of callus formation. Further when it is applied via a minimally invasive technique, it allows for prompt healing, lower rates of infection and reduced bone resorption as blood supply is preserved [11,12]. The implant offers multiple points of fixed-angle contact between the plate and screws in the distal part of femur, theoretically reducing the tendency for varus collapse that is seen with traditional lateral plates [5]. The DF-LCP is a further development from the LISS which was introduced in the mid to late 1990's. The main difference between the DF-LCP and the LISS is that the LISS utilizes an outrigger device for shaft holes, functioning essentially as a locking guide jig, which is attached to the distal part of the plate and guides the placement of the proximal locking screws. The shaft holes on the DF-LCP are oval allowing for the options of a compression screw or a locking screw. This leads to a more precise placement of the plate, as it is able to be compressed more closely to the bone [7,13,14]. The study is justified for the fact that it will be one of the solutions for the age old complications associated with the treatment of supracondylar fractures with traditional fixed angle plates and nails of, postoperative loss of reduction (varus collapse) and malalignment due to their inherent lack of rigidity and in some cases, eventual implant failure.

Materials and Methods

Materials & Methods: Prospective interventional (Quasi Experimental) study was conducted from June 2016 to February 2017 in the Dhaka Medical College Hospital. All patients of Supracondylar femur fracture treated by LCP implantation were included in the study. Purposive sampling according to availability of the patients and it had strictly considered the inclusion and exclusion criteria (Figure 1).

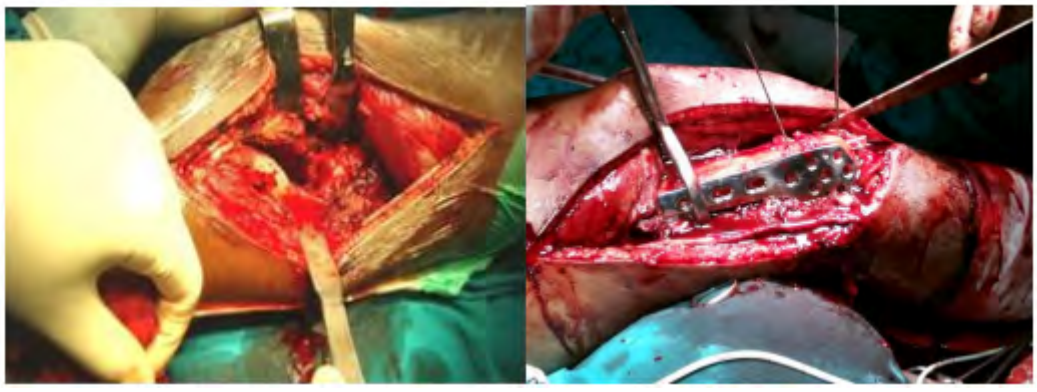

Figure 1: Picture showing skin incision and ixation with locking compression plate.

Selection Criteria

Inclusion Criteria

- All adult patients age over 18 years.
- Closed supracondylar fracture of femur (AO type 33-A1, 33-A2 & 33-A3).
- Fracture less than three weeks.

Exclusion Criteria

- Close T-Y condylar/ intra-articular fracture of femur(AO type 33-B & AO type 33-C)
- Open fractures
- Pathological fractures
- Multiple fractures patients
- Fractures with neurovascular deficit

Preoperative Investigation

- Hemogram
- Blood sugar level
- Blood urea level
- Serum creatinine level
- Serum electrolytes
- Blood group and Rh typing
- Bleeding time, clotting time and prothrombin time
- Chest X-ray postero-anterior view, electrocardiography, 2D Echo and other investigations done in patients as required during anaesthetic evaluation.

Surgical Technique for Fixing Distal Femur Fractures

Although Various Approaches Like

- Lateral-standard
- Minimally invasive lateral approach
- Medial Approach
- Antero-lateral approach is described. Most surgeons prefer to use the Lateral approach-standard.

Complications-Early

- Forceful maneuvers can induce iatrogenic fractures and complicate the fixation, especially in osteoporotic bones.
- Damage to collateral ligaments of knee and menisci.
- Damage to popliteal vessels, as it winds from medial to posterior compartment.
- Damage to collateral vessels (geniculate) and accompanying nerves.

Complications-Late

- Infection – following fixation of open fractures approach 20% and for closed fractures approaching 1%.
- Failure of Reduction, due to improper surgical technique, poor bone stock, poor patient compliance, poor surgical planning and execution.
- Nonunion, Malunion occurs with distal fragment in varus. The indications for a corrective osteotomy depend on the degree of malalignment and the severity of symptoms. Valgus and varus malalignment greater than 10° and / or rotational deformity greater than 15°, should be corrected [14-16].
- Knee stiffness postoperatively.

Post-Operative Care and Rehabilitation: Proper postoperative rehabilitation is essential to ensure the attainment and maintenance of satisfactory range of motion, strength and function of the knee joint. Rehabilitation should be custom made to the patient and the fracture type, and is easier, more comfortable and more assured with firm internal fixation. If fracture fixation is stable, then therapy can be started early. The most useful range of motion can be achieved, in the first few weeks of postoperative period.

Early Phase (1-3 Weeks): The primary goal is full range of motion, started on 2nd day, if fixation is stable, emphasizing extension, normal patella mobility, control of edema and pain. Quadriceps strengthening and hamstring stretching exercises are encouraged. Gentle hip and ankle mobilization exercises are continued.

Continuous passive motion-when started in 1st week has following Advantages;

- Improves early range of motion of knee.
- Decreases incidence of deep vein thrombosis and pulmonary embolus.
- Faster pain relief and shorter stay at hospital.
- Better results when used at a rate of 1 cycle per minute, with 40 degrees of maximum flexion for first 3 days.
- Continuous passive motion reverses collagen loss, improves cartilage nourishment, and prevents joint stiffness. Non – weight bearing with crutches or walker support can be initiated in 1st week, if fixation is stable. Sutures are removed between 10th - 12th postoperative days.

Data collection: Data were collected nonrandomized statistical basis using a structured questionnaire (research instrument) which contained all the variables of interest according to Neer's score. Demographic variables: Age, Sex, Occupation, Clinical variables, Side, Mechanism of injury, Fracture types, Interval between injury & fixation, Post-operative hospital stay, etc and Outcome variables: Complications, Final outcome score according to the NEER's score criteria).

Data collection Procedure: Data was collected with a pre-tested structured questionnaire containing history, clinical, laboratory investigations, pre-operative, per-operative, postoperative follow up findings complications and all other variables of interest. Data has been collected from the admitted patients at the Department of Orthopedic Surgery,

Dhaka Medical College Hospital and other private hospitals and clinics in Dhaka city.

Data Analysis: After data collection, the raw data was compiled and tabulated according to key of variables. All statistical analysis of different variables was analyzed with computer software using IBM SPSS Version 22.0 in Windows-10 with standard statistical methods and appropriate formula. Results were presented in table, chart and graph.

Results

Total number of patients was 28. The mean age was 40.96 years ranging from 20 to 66 years. Shows, out of 28 cases, 24 (85.7%) cases were male and 4 (14.3%) were female. The male and female ratio is 6:1. An analysis of functional outcome of 28 cases of displaced distal femoral fractures, internally fixed using locking compression plates, which was undertaken at the Department of orthopedics at DMCH, Bangladesh (Table 1, Figure 2).

Nature of Violence	No of Cases	Percentage (%)
RTA Injuries	20	71.4
Falls	8	28.6

Table 1: Nature of Violence.

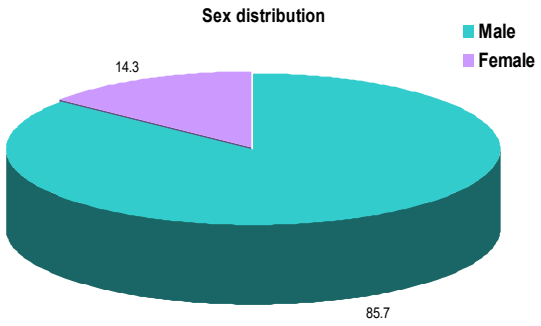

Figure 2: Pie diagram showing the sex distribution (n=28).

Below diagram shows the age distribution of the patients, most of the patients 9 (32.1%) patients were in age group of 20-30 years, 8 (28.6%) were in 31-40 years and 7 (25.0%) of them were in the age group of 51-60 years. The mean age was 40.96 and ranging from 20 – 66 years (Figure 3).

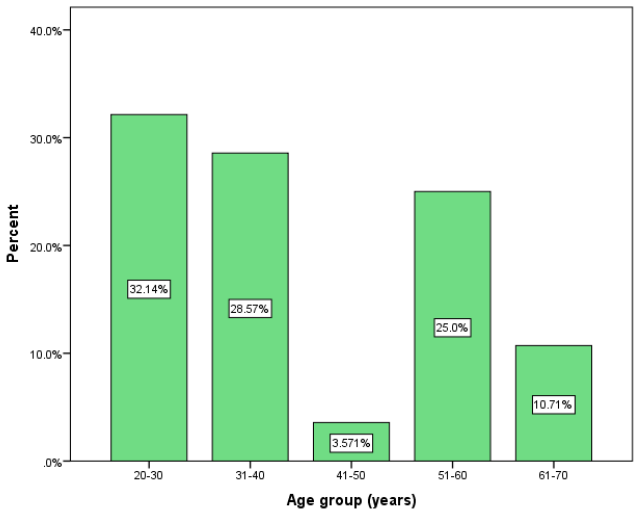

Figure 3: Bar diagram showing the age distribution (n=28).

Out of 28 patients, 15 (53.6%) were affected in their left side rest of them 13 (46.4%) on right side (Figure 4).

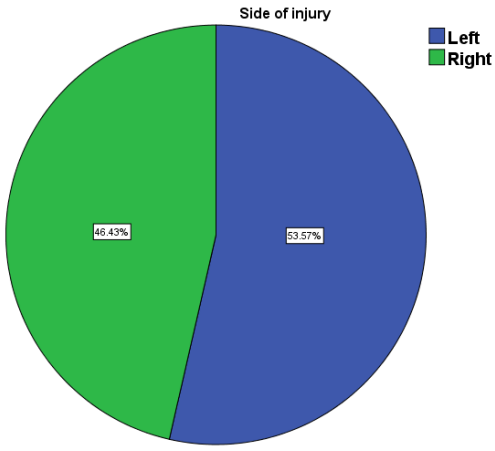

Figure 4: Pie diagram showing the side distribution of injured limb (n=28).

Here, we have found 14(50.0%) cases were AO Muller's Type A2, 8(28.6%) were AO Muller's Type A3 and another 6 (21.4%) fractures were AO Muller's Type A1 (Tables 2 & 3).

Type of fracture	Frequency	Percentage (%)
AO Muller's A1	6	21.4
AO Muller's A2	14	50.0
AO Muller's A3	8	28.6
AO Muller's B1	-	-
AO Muller's B2	-	-
AO Muller's B3	-	-
AO Muller's C1	-	-
AO Muller's C2	-	-
AO Muller's C3	-	-
Total	28	100.0

Table 2: Shows, distribution of the study patients by type of fracture (n =28).

S. No.	Fracture	No. of patients	Percentage (%)
1	Closed	8	71.4
2	Open	20	28.6

Table 3: Type of Fracture.

Most of the 16 (57.1%) patients were operated within 8-14 days of injury, 8 (28.6%) were by 7 days and 4 (14.3%) patients were operated within 15-18 days. Mean injury surgical interval time was 10.5±3.3 days (Table 4 & Figure 5).

Time interval between injury and fixation	Number of cases	Percentage
Within 7 days	8	28.6
8-14 days	16	57.1
15-21 days	4	14.3
Total	28	100.00

Table 4: Shows the distributions injury- surgical interval (n =28).

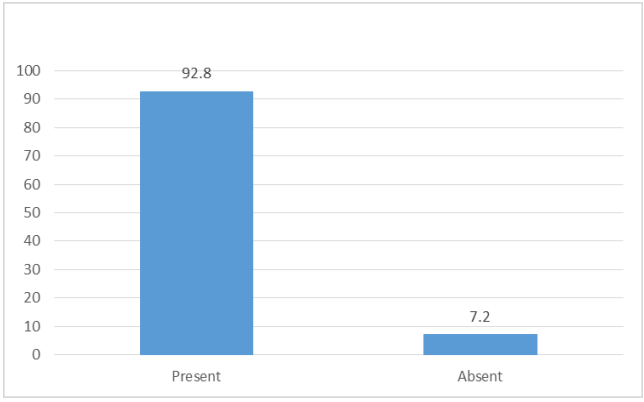

Figure 5: Physiotherapy.

Table 5 shows the time at which full the weight bear were achieved by the patients. 13 (46.4%) of them bearded full weight by 16-20 weeks, 8 (28.6%) were less than 16 weeks and 7 (25.0%) patients bearded full weight by the time of 20-24 weeks. Mean full weight bearing time was 17.29±2.07 weeks (Table 5).

Weight bearing time (weeks)	Number of cases	Percentage
< 16 weeks	8	28.6
16-20 weeks	13	46.4
20-24 weeks	7	25.0
Total	28	100.0

Table 5: Time at which full Weight bearing were achieved (n =28).

Knee flexion	Number of cases	Percentage
< 90 degree	2	7.1
91-119 degree	4	14.3
> 120 degree	22	78.6
Total	28	100.0

Table 6: Distribution of the study patients by knee flexion (n =28).

Table 6 shows the range of motion, 22 (78.6%) patients had knee flexion >1200 and 4 (14.3%) had within 91-1190 of

knee flexion. Only 2 (7.0%) patients had flexed their knee < 900 and the range of motion within 91-1190 were found in 4 (14.3%) of them. Mean knee flexion was 121.8±12.2 degrees (Table 6).

Result	Number of patient	Percentage
Satisfactory (Excellent & Good)	26	92.9
Unsatisfactory (Fair & Poor)	2	7.1
Total	28	100%

Table 7: Distribution of the results according to the final outcomes (n=28).

Confidence level of the final outcome: In this study, Confidence Interval (CI) was 70% to 100%, and we found the satisfactory result by 93% (Table 7, Figures 6&7).

Figure 6: Pre op and post op x-rays.

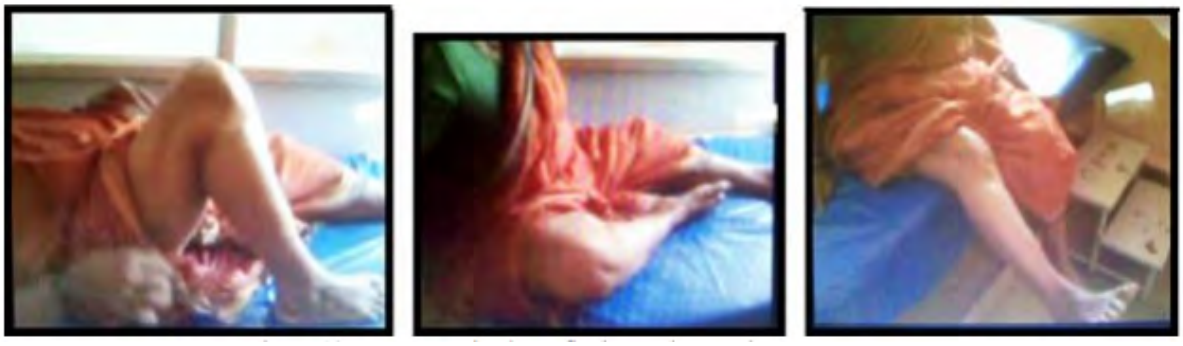

Figure 7: Post-operative knee flexion and extension movements.

Discussion

This study was carried out in DMCH from June 2016 to February 2017 with 28 fractured patients. All (n=28) patients were treated by minimal invasive plate osteosynthesis (MIPO) using distal femoral locking plate. Over all final outcome of surgical management of supracondylar femur fracture using distal femoral locking pate was assessed by NEER's Score. In this study, the mean age of patients was 40.96 years, ranging from 20-66 years. Almost similar findings were reported by Krettek, et al. Yeap, et al. where the average age of the patients were 40 years and 44 years respectively [17,18]. Total number of cases were 28, among them 24 (85.7%) patients were male and 4 (14.3%) patients were female. The male: female ratio is 6:1. In the study of Geel [19], male female ratio was 1: 1.5, Kregor, et al. [20], demonstrated in their study male-female was 1:1.07 and Vijayakumar, et al. [21], mentioned in their study male and female ratio was 5.7: 1. In our study 53.6% patients were affected on the left side and 46.4% patients were affected on the right side. This dissertation consists of 28 patients with supracondylar femoral fractures, treated with locking compression Plating. None of the patients were having bilateral fractures. There were males 20 and 8 females. 8 patients had associated fractures. There were 28 compound fractures (6 cases were grade 1, 14 cases were grade 2 and 8 cases were grade 3). Supracondylar fractures of the femur are always regarded with great concern because they are difficult to treat, cause a long absence from work. These facts have encouraged surgeons to resort to operative treatment with internal fixation. Successful treatment of intraarticular fractures, especially in weight bearing joint, requires restoration and maintenance of the congruence of the two articular surfaces. Distal femoral alignment is one of the treatment priorities. The femoral shaft is oriented 7° of valgus in relation to the knee joint [22-24]. Maintaining this alignment is critical to the function and durability of the limb [23], Coronal plane alignment has been shown to be the most difficult factor to control and the most crucial to overall outcome [23,25]. Malalignment in the axial and sagittal planes also affects knee kinematics and range of motion

[23,25] When comminution is present, supracondylar femoral fractures are especially prone to varus collapse [5,26]. Previous studies stated that open fractures are common in the setting of distal femur fractures (19%– 54%) [27]. The current study supports the reduced rate of fixation loss due to the utilization of locked plating and shows that additional lag screws do not influence varus collapse. Patients with greater loss of fixation tend to have a worse outcome. Open fractures were related to high-energy injury mechanism and a greater prevalence of infection. Therefore, the outcome of distal femoral fractures, similar to other major injuries, not only depends on bony reconstruction but also on soft tissue management. The locking compression plate (LCP) [28,29], system offers a number of advantages in fracture fixation combining angular stability through the use of locking screws with traditional fixation techniques. This study showed the mean injury-surgery interval was 10±3.3 days, it was similar to the study of Yeap, et al. and Ganesh BG, et al. illustrated their mean injury- surgery interval was 9.9 and 14 days respectively [18,30]. Almost similar findings were reported by Apivatthakakul, et al. [31], where average operative time was 94 minutes ranging from 60 to 162 minutes. Their average hospital stay was 13 days and mean post-operative hospital stay was 2.46±0.69 days. We found 1.00 cm limb length shortening in 7.1% patients in this study. Yeap, et al. and Gupta, et al. demonstrated that 18% and 5% patient developed limb length discrepancy in their study [18,32]. We did not found deep infection but only 7.1% patients developed superficial infection which was healed with regular dressing and use of antibiotics. It is similar to the study of Hoffman, et al. [33], found 7.2% and Gupta, et al. [32], and showed 5% of superficial surgical site infection in their study. All patients in this study were closed fractures and antibiotic coverage started one hour before operation and continued 2 weeks postoperatively. All patients were in close supervision in the postoperative period. Regarding the range of knee movement of 22 (78.6%) patients had wide range of knee flexion >1200 and 2 (7.1%) patients had mild restriction to flex their operated side of knee which was <900. The mean range of knee motion was 121.8± 12.2 degrees. In the study of Gupta, et al. and Geel, in their study showed average range of knee motion was 1040 and 109.50 respectively which were similar to this study [32,34]. We have observed 100% union rate, out of 28 patients within 24 weeks of follow up. Successful fracture union was defined as completed bridging callus in three cortices, together with painless full weight bearing Gunnaiah, et al. [35]. In the study of Kanabar, et al. [36], 11% non-union was found but Kregor, et al., Nayak, et al. and Gupta, et al. found 100% union rate, though found [32,37,38]. Regarding this study the average radiological union time was 17.75 weeks, 50% fracture has united in the range of 16 -18 weeks. Similar radiological bony union time was 18 weeks in the study of Yeap, et al. Canale & Beaty and Gupta, et al. [18,32,39]. Some of the authors showed in their study that the mean bony union time were 14, 15.72 and 13.8, weeks in Giannoudis, et al., Ganesh BG, et al. [40], Doshi, et al. respectively [24,41,42]. The average full weight bearing time in this study was 17.5 weeks ranging from 16 to 22 weeks. In the study of Kanabar, et al. and Chandrasekaran, et al. has showed the full weight bearing time was 17 weeks 16 weeks simultaneously [36,42]. In the final follow-up, according to The NEER's knee score criteria Neer, et al. [43], the satisfactory result (excellent and good) was 92.9%. Krettek, et al. [17], found 78.66% satisfactory results in their study. 85% satisfactory results were seen in the study of Doshi, et al. and Gupta, et al., showed 80.95% satisfactory results [32,41]. However the system is complex, requiring careful attention to biomechanical principles and good surgical technique.

The angular stability provided by LCP at the plate-screw interface, allows extra periosteal fixation of the plate to bone. By preserving periosteal blood supply to the bone it addresses the importance of the biological factors involved in fracture healing. The principles of flexible fixation are employed where the goal is for indirect healing with the formation of callus. Although the LCP system offers a number of advantages in fracture management, its successful use requires careful pre-operative planning, consideration of biomechanical principles, and the use of the appropriate plate and screws combined with good surgical technique. The principle of the locking compression plate (LCP) is represented by the combination of two completely different technologies and two opposed principles of osteosynthesis in one implant it combines the principles of conventional plate osteosynthesis for direct anatomical reduction with those of bridging plate osteosynthesis. Since the LCP can be used as a conventional plate using only dynamic compression, as a pure internal fixator using locking head screws, or as both combined, it provides the surgeon with multiple variations. It was attributed to the stable and study construct and the early range of motion achieved with LCP. Four of our patients had extension lag which persisted even after physiotherapy. We conclude that locking plates are a useful option in patients with osteoporotic bones and patients with poor bone stock. Locking plates when used in biological plating give stable and sturdy construct.

Conclusion

Complications associated with the plate were few and the functional outcome was excellent. Thus, many of the common complications of the conventional plating can possibly be avoided. We therefore recommend the use of locking plate, especially in elderly patients with osteoporotic bone and comminuted fracture.

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