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Study of Surgical Management of Supracondylar Femoral Fracture by Lockingcompression 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. The use of bone-implant constructs through interfragmentary compression may result in devascularisation of bone fragments and delayed fracture healing.*
Aims: 1. *to study the functional outcome for internal fixation of fractures of the distal end femur by locking compression plate.*
2.*To evaluate the effectiveness and complications of distal end femur fractures treated with locking compression plate based on rate of union, time till union, rate of infection, varus and valgus malalignment and fixation failures.*
Methods*: Study was conducted in Department of orthopaedics, Government Medical College & Hospital, Vijayawada, Andhra Pradesh, India from August 2013 to December 2015. All 30 patients of Supracondylar femur fracture treated by LCP implantation were included in the study.*
Results*: 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 – 8 week was not allowed. The full weight bearing deferred until 12 weeks or complete fracture union. The knee range of motion was excellent to very good, gait and weight bearing after complete union was satisfactory.*
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)[6], Supracondylar femur fracture[1,2,3]*

I. Introduction

The incidence of distal femur fractures is approximately 37 per 1, 00, 000 person-years[1]. 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[4,10,11]. 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.[2] 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.[4,10,12]

Most commonly used implant for the fixation of distal femur fractures are Fixed angle devices, usually in the form of Dynamic Condylar Screw (DCS)[17] 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.[7, 8]

The LCP is a single beam construct where the strength of its fixation is equal to the sum of all screw-bone 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.[8,9]

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.[10] 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.[2, 16,18]

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.

II. Methodology

In this study 30 patients with supracondylar fracture were studied. All the cases were treated at SMC Vijayawada, between 1 – 08 -2013 & 31- 12 -2015 at our institution and followed for a minimum of 6 months. The method used for fracture fixation was open reduction and internal fixation with locking compression plate. The duration of follow up ranged from 6months to 18 months.

Patient Selection

Inclusion Criteria:

1. Patients admitted to SMC VIJAYAWADA with fracture lower end of femur fixed with LCP
2. All skeletal mature patients(>18years)
3. Open distal femur fractures up to type I, II and III A
4. Patients willing to give consent
5. Patients presenting with distal femoral fractures with or without osteoporotic changes are included in the study.

Exclusion Criteria:

1. Patients with open distal femoral fractures Type IIIB & C
2. Patients with associated tibial plateau fractures
3. Children with distal femoral fractures or in whom, growth plate is still open or less than 18 years of age
4. Patient with pathological distal femoral other than osteoporosis
5. Patients lost in follow - up
6. Patients managed conservatively for other medical reasons.
7. Distal femoral fractures with neurovascular compromise
8. Nonunion and Delayed union.

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 otherinvestigations done in patients as required during anaesthetic evaluation.

Surgical Technique For Fixing Distal Femur Fractures

Although various approaches like

1. lateral-standard
2. minimally invasive lateral approach
3. medial Approach
4. Antero-lateralapproach is described. Most surgeons prefer to use the Lateral approach-standard.

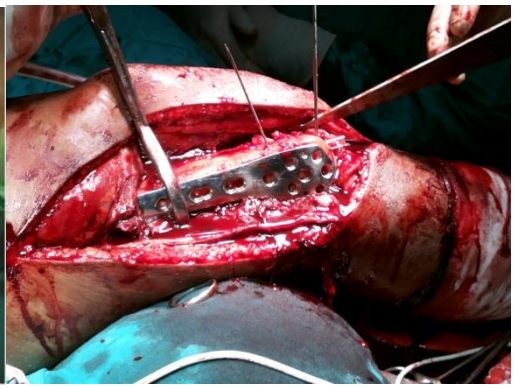



Fig1: picture showing skin incision Fig2: fixation with locking compression plate

Complications: Early

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

Complications: Late

1. Infection – following fixation of open fractures approach 20% and for closed fractures approaching 1%.
2. Failure of Reduction, due to improper surgical technique, poor bone stock, poor patient compliance, poor surgical planning and execution.
3. 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.[18,22,26]
4. Knee stiffness postoperatively.

Post-operative care andRehabilitation:

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

1. Improves early range of motion of knee.
2. Decreases incidence of deep vein thrombosis and pulmonary embolus.
3. Faster pain relief and shorter stay at hospital.
4. Better results when used at a rate of 1 cycle per minute, with 40 degrees of maximum flexion for first 3 days.
5. Continuous passive motion reverses collagen loss, improves cartilage nourishment, 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.

Late Phase (After 3weeks)

Continue isometric quadriceps setting exercises, Active and passive Range motion exercises. Seated knee extension procedures. Partial weight bearing is allowed after 3rd week. Full weight bearing is allowed after radiological evidence of healing. (6- 12 weeks). Patients with inter condylar fractures and A-0.types B and C fractures are not allowed full weight bearing for at least 12 weeks.

Scoring System

NEER'S FUNCTIONAL SCORING was used to assess the outcome of surgery, for adult distal femoral fractures[10]

It consists of: Functional (70 units) and Anatomic (30 units).

The results were evaluated by taking into consideration the following factors:

1. Pain – 20 points
2. Function – 20 points
3. Motion – 20 points
4. Work – 10 points
5. Gross Anatomy – 15 points
6. Roentgenograms – 15 points

Table 1: Neer's Score- Overall rating

Excellent	Above 85 units
Satisfactory	70-85 units
Unsatisfactory	55-69 units
Failure	Below 55 units

III. Results

This prospective study is an analysis of functional outcome of 30 cases of displaced distal femoral fractures, internally fixed using locking compression plates, which was undertaken at the Department of orthopedics at SMC, Vijayawada from August 2013 to December 2015.

In our study of the 30 patients, 22were males, 8 were females.

Nature Of Violence:

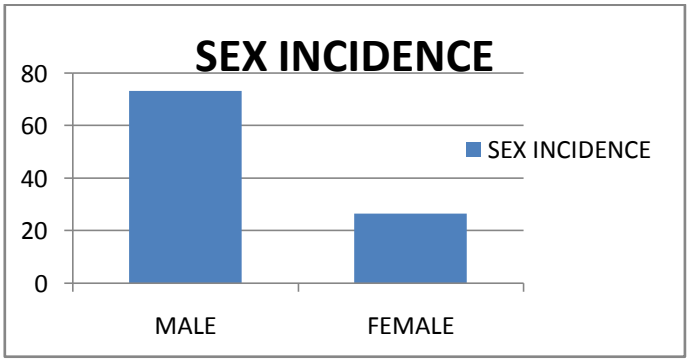
TABLE2: nature of violence

NATURE OF VIOLENCE	NO OF CASES	PERCENTAGE
RTA INJURIES	21	70%
FALLS	9	30%

Sex Distribution:

Table 3: sex distribution

S NO	SEX	NO OF PATIENTS	PERCENTAGE
1	MALE	22	73.3%
2	FEMALE	08	26.7%



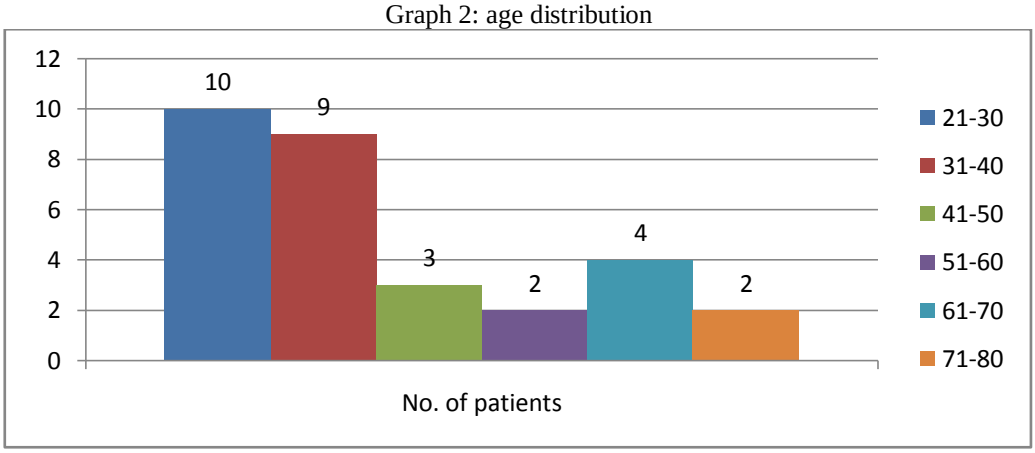
Graph1: sex incidence

Age Distribution:

Table 4: age distribution

Age	No. Of patients	%
21-30	10	33.3%
31-40	9	30%
41-50	3	10%
51-60	2	6.7%
61-70	4	13.3%
71-80	2	6.7%

Graph 2: age distribution



Side Of Fracture:

Table 5: SIDE OF AFFECTED LIMB

SIDE	NO OF PATIENTS	PERCENTAGE
RIGHT	21	70%
LEFT	9	30%

Fracture Classification:

Table6: fracture classification

S.No.	Fracture Classification (OTA)	No. of Patients	percentage
	Distal		
1	A1	2	6.7%
2	A2	3	10%
3	A3	5	16.7%
4	C1	8	26.7%
5	C2	7	23.3%
6	C3	5	16.7%

Type Of Fracture:

Table7: type of fracture

S.No.	Fracture	No.of Patients	Percentage
1	Closed	9	30
2	Open	21	70

Time Gap Between Injury And Surgery:

Table8: time gap between surgery and injury

TIME GAP IN DAYS	NO OF PATIENTS	PERCENTAGE
<3days	12	40%
4 –7 days	9	30%
8-14 days	7	23.3%

Above 15 days	2	6.7%

Physiotheerapy:

Table 9: physiotherapy

PHYSIOTHERAPY	NUMBER OF PATIENTS	PERCENTAGE
PRESENT	28	93.3%
ABSENT	2	6.7%

Time To Union:

Table 10: union time

UNION RATES (MONTHS)	NUMBER OF PATIENTS	PERCENTAGE
<3 MONTHS	7	23.3%
3-6 MONTHS	21	70%
6 MONTHS	2	6.7%

Movements Of Knee (Flexion In Degrees):

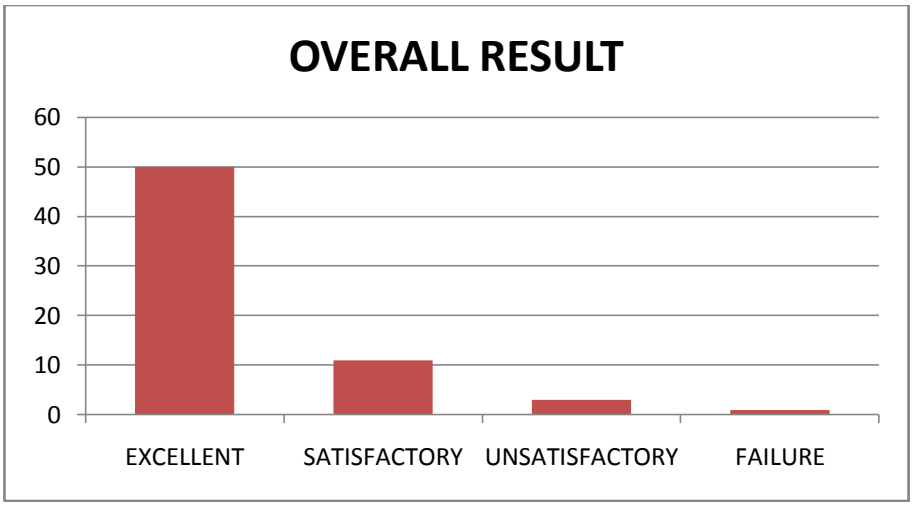
Table11: knee flexion

Knee Flexion(ROM)	Number of patients	Percentage
>135	2	6.7%
100- 135	22	73.3%
80-100	4	13.3%
60-80	2	6.7%

- **Neer's Score- Overall Scoring:**

Table12: overall result

	NO OF PATIENTS	PERCENTAGE
Excellent	15	50%
Satisfactory	11	36.7%
Unsatisfactory	03	10%
Failure	01	3.3%



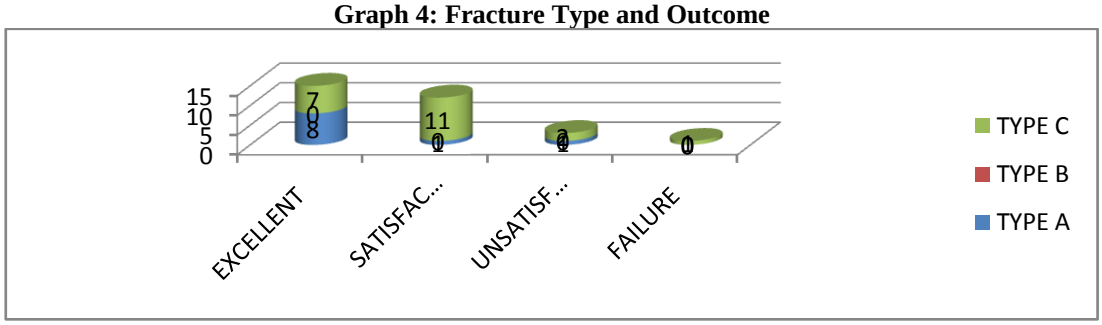
Graph3: neer's overall result diagram

- **Fracture Type Outcome Chart :**

Table 13: Fracture Type Outcome Chart

Outcome	excellent	satisfactory	Unsatisfactory	Failure
Type A	8	1	1	-
Type B	-	-	-	-
Type C	7	11	2	1

Graph 4: Fracture Type and Outcome



We can observe that all the excellent results were from Type A Fracture and satisfactory results were seen in Type A, B, C.

CASE1:

Fig3: pre op x-ray

Fig 4: post op x-ray

Fig5: post-operative knee range of movements flexion and extension movements

CASE2:

Figure 6: pre-operative x-ray showing fracture figure 7: post-operative x-ray

Figure 8: post-operative knee range of movements

CASE3:

Figure 9: pre op and post op x-rays

Figure 10: post-operative knee flexion and extension movements

IV. Discussion

This dissertation consists of 30 patients with supracondylar femoral fractures, treated with locking compression Plating. None of the patients were having bilateral fractures. There were males 22 and 8 females. 5 patients had associated fractures. There were 21 compound fractures (11 cases were grade 1, 6 cases were grade 2 and 4 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 [5,24,25]. Maintaining this alignment is critical to the function and durability of the limb [24].

Coronal plane alignment has been shown to be the most difficult factor to control and the most crucial to overall outcome[24,26].

Malalignment in the axial and sagittal planes also affects knee kinematics and range of motion [24,26]. When comminution is present, supracondylar femoral fractures are especially prone to varus collapse [7,10]. 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. Previous studies stated that open fractures are common in the setting of distal femur fractures (19%–54%) [21]. 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) [6,27] system offers a number of advantages in fracture fixation combining angular stability through the use of locking screws with traditional fixation techniques. 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.

In our study of 30 patients the mean age of the patients was 40.73 years and there were 22 males (73.3%) and females (26.7%).Most of the injuries were caused by road traffic accidents affecting mostly males. We had 21 (70%) RTA injuries and 9(30%) falls.

In our study of 30 patients belonging to AO type A and C of distal femur fractures, two belonged to A1, three to A2, five to A3, eight to C1, seven to C2 and five to C3 type fractures respectively. Majority of fractures belonged to type C fracture which was 66.7% and remaining 33.3% belonged to type A. This indicates that type C fractures occur more commonly than type A.

The average time interval between injury and surgery in our study was 6.1 days with a range 2-16 days. Delay in surgery is one of the factor contributing to unsatisfactory results. Of the 3 unsatisfactory cases was delayed up to 16 days due to late presentation to us, one up to 15 days due to social reasons.

Average duration of hospitalization in our study was 2.6 weeks (18.2 days), increased because of other associated injuries and the need for the strict postoperative physiotherapy which affected the course of treatment and rehabilitation. Post operatively physiotherapy in bed was started on the 2ndpost-operative day or according to the tolerance of patient and associated injuries. The patients were started with quadriceps strengthening exercises, knee and ankle mobilization exercises.

The average time to union was 3.83 months (15.36 weeks) with a range of 2-8 months (8-32 weeks) and a standard deviation of 1.482 in our study.We conclude that time to union in distal femur fractures are generally longer than usual fracture union due to high incidence of comminution and osteoporosis. Type C fractures took longer time to unite compare to type A.

Range of motionin our study the mean flexion was 111.3^0 (range 70^0 –150^0) **.**It was attributed to the stable and study construct and the early range of motion achieved with LCP. The average knee flexion in type C fractures was 105^0 compared to 122^0 in type A fractures, which shows that intra articular fractures lead to intra articular stiffness and decreased range of motion. 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.

V. Summary

This is a Prospective Study of 30 Patients of Distal femur Fracture treated surgically with locking compression Plate at SMC.22males and 8 were females, highest number of patients were in their 2nd decade (33.3%).Road traffic accident was the most common mode of injury (90%). There was not a single case with bilateral fractures.Most of the patients, reported within 1st week of injury to the hospital. 9 out of 30 patients had closed injury. AO Type C1 fracture was the most common fracture type 8out of 30 patients (26.7%).The shortest follow up period was 6 months and the longest follow up period was 16 months. The

average range of knee flexion achieved was about 111.3^0. Maximum gain in knee flexion was 140° and minimum gain about 70 ° .Average times to union was 3.83 months.Early complications were encountered in 3 patients and these were superficial wound infection, wound gaping, pin site infection. Late complications were observed like mal-union with varus in 2 patients, Plate breakage in 1 patient, knee stiffness in 1 patient. The average stay in hospital was about 2.6 weeks.Postoperative immobilization with knee brace was advised for severely comminuted fractures, for 3 weeks, although gentle physiotherapy exercises were started earlier.The LCP condylar plate is the treatment of choice in the management of distal Femoral Fractures especially Type A.Though Neer scores are lower in Type C Fractures, it still remains the implant of choice even in Type C fractures.

VI. Conclusion

- The LCP condylar plate[22,29,30] is the treatment of choice in the management of comminuted distal femoral fractures especially Type A fractures where we have found higher Neer scores. LCP also prevents compression of periosteal vessels. It may not completely solve the age old problems associated with any fracture like nonunion and malunion[28,29], but is a valuable technique in management of these fractures.
- However in type C fractures the outcome is poorer. But still LCP remains the implant of choice for type C fractures also, though there are complications like knee stiffness and extensor lag were encountered in a few cases.
- LCP show better results than Dynamic condylar screw and Angle Blade Plate[29,30].
- This is ideal to prevent Metaphyseal collapse and to maintain limb length in severelycomminuted fractures. This technique has a lesser chance of complications like plate or screw breakage, but careful selection of patients and strict adherence to the basic principles of fracture fixation will go a long way in reducing the complications of fracture fixation using locking compression plates.

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