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RESEARCH ARTICLE

OUTCOME STUDY OF OPEN REDUCTION AND INTERNAL FIXATION WITH LCP IMPLANT IN LOWER LIMB: A PROSPECTIVE STUDY AT TERTIARY CARE CENTRE

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ABSTRACT

Introduction: 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, a comminuted bicondylar fracture.
Aims: To show efficacy and outcome of Locking Compression Plate (LCP) implantation in lower limb fractures (mainly in femur and tibia).
Study design: Prospective descriptive study.
Methodology: Study was conducted in Department of orthopedics, Government Medical College and Hospital, Akola (Maharashtra, India) from January 2013 to December 2013. All patients of lower limb fracture (femur and tibia) treated by LCP implantation were included in the study.
Result: Supracondylar femur fracture (38.4%) found to be most common fracture among lower limbs fractures. Majority of the cases 55 (70.5%) were injured due to road traffic accident (RTA). Majority of cases of distal femur fracture, distal tibia fracture, and proximal tibia fracture had shown excellent results.
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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INTRODUCTION

In the modern world with the increase in speed and number of fast moving vehicles there is great increase in number and severity of fractures. Fractures may be associated with multiple system injuries and polytrauma. When a bone is fractured, it loses its structural continuity. The loss of the structural continuity renders it mechanically useless because it is unable to bear any load. 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. Long term disability following a fracture is almost never the result of damage to the bone itself; it is the result of damage to the soft tissues and of stiffness of neighboring joints, (Singh *et al*., 2015). Locking plates are fracture fixation devices with threaded screw holes, which allow screws to thread to the plate and function as a fixed-angle device. These plates may have a mixture of holes that allow placement of both locking and traditional no locking screws (so called combi plates). The main biomechanical difference from conventional plates is that the latter require compression of the plate to the bone-plate interface, (Wade *et al*., 2007). With increasing axial loading cycles, the screws can begin to toggle, which decreases the friction force and leads to plate loosening. If this occurs prematurely, fracture instability will occur, leading to implant failure. Thus, the more difficult it is to achieve and maintain tight screw fixation (as for example, in metaphyseal and osteoporotic bone), the more difficult it is to maintain stability, (Fulkerson *et al*., 2006) Locking plates potentially provide increased stability in to a degree that a second plate is not required.

The increased stability is the result of the difference in the mechanics of conventional plate and locking plate fixation. Stability is maintained at the angular stable screw plate interface. Because the screws are locked to the plate, it is difficult for one screw to pull out or fail unless all adjacent screws fail, (Nayak *et al*., 2011). The increase in stability

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provided by locking plates is most helpful to surgeons treating a fracture in poor-quality bone, a comminuted bicondylar fracture for which a single plate may not provide adequate stability. (Egol *et al*., 2004) Some of the indication suggested for LCP are metaphyseal and intra-articular fractures, highly comminuted fractures, particularly those involving diaphyseal and metaphyseal bone, osteoporotic bone, proximal tibia and distal femur fractures, tumor surgery, open wedge osteotomy, secondary fractures after intramedullary nail etc. (Robert *et al*., 2006; Wade *et al*., 2007; Stoffel *et al*., 2003). The present study was conducted to show efficacy and outcome of Locking Compression Plate (LCP) implantation in lower limb fractures (mainly in femur and tibia).

MATERIALS AND METHODS

The present prospective descriptive study was conducted in Department of orthopedics, Government Medical College and Hospital, Akola (Maharashtra, India) from January 2013 to December 2013. All patients of lower limb fracture (femur and tibia) treated by LCP implantation were included in the study. All patients are evaluated clinically at the time of admission and first aid treatment was given. X-ray was done to assess the type of fractures and displacement and plan of the treatment. Patient was investigated completely for operative and anesthesia purpose. Any associated medical problems were taken care before patient is taken for operation. Cases with pathological fracture, history of long-term steroid therapy were excluded from the study. Preoperative counseling and informed consent of the patient and relatives regarding the treatment, operation and study was taken. Permission from ethical committee was taken prior to commencement of study. Operations were performed directly by a consultant orthopedic trauma surgeon or under their immediate supervision.

The LCP was used as a bridging construct across the diaphyseal—metaphyseal fracture. Where appropriate, articular fragments were anatomically reduced and rigidly fixed via separate small incisions. Splintage and immobilization was applied as per fixation achieved. After discharge from hospital patient was follow up after 2 weeks for suture removal and wound examination, then after six weeks patient was assessed clinically and radiologically. Thereafter patient was assessed every four weekly. Full weight bearing was permitted to patient based on radiological evidence of callus formation and clinical evaluation. For the assessment of outcome of distal femur fracture reduction was done according to Modified Mehrotra's Grading and Scoring system for the assessment of results of proximal tibia fracture reduction was done according to Modified Schatzker and Lambert (1982), (Schatzker *et al*., 1979). For assessment of results of distal tibia fracture reduction was done according to Olerud and Molander scoring system, (Port *et al*., 1996). Depending on the degree score the patients were divided into four groups: Poor: 0 %-30 %, Fair: 31 %-60 %, Good: 61 %-90 %, Excellent: 91 %-100 %.

RESULTS

Table 1 shows that 41-50 year age group was the most common age group (30.8%) followed by 31-40 years (26.9%). Supracondylar femur fracture (38.4%) found to be most common fracture among lower limbs fractures.

Table 1. Distribution of patients according to their age group and type of fracture

Age group	Supracondylar femur	Proximal tibia	Distal tibia	Total(%)
20-30	03	09	03	15(19.2)
31-40	06	06	09	21(26.9)
41-50	012	03	09	24(30.8)
>50	09	06	03	18(23.1)
Total(%)	30(38.4)	24(30.8)	24(30.8)	78(100)

Table 2. Base line data of patients

Sex	No. of cases (%)
Male	59(75.6)
Female	19(24.4)
Total	78(100)
Mode of trauma to patients	
RTA	55(70.5)
Fall at home	13(16.7)
Assault	05(06.4)
Others	05(06.4)
Total	78(100)

Out of 90 cases 76.70% were male and remaining patients were female. Majority of the cases 55 (70.5%) were injured due to road traffic accident (RTA) followed by 13 (16.66%) cases were of fall at home. (Table 2)

Table 3. Distribution of injury according to nature of fracture (Gustilo-Anderson classification) (Kim and Leopold, 2012)

Nature of fracture		No. of Cases	Percentage	
Closed		52	66.7%	
	Grade 1	05	06.4%	
Open	Grade 2	08	10.3%	25.6%
	Grade 3	07	08.9%	
Old un-united		06	06.7%	
Total		78	100	

Majority (66.66%) of cases was 'closed' in nature, total 25.6% were open in nature, and 06.7% of the cases were old un-united fracture. Most common type of fractured was observed was C2 type (40%), followed by C3 and A1 (both 20% each). In 80 % of cases direct reduction and in 20% cases LISS was done. 60% of cases were allowed full weight bearing by 12-16 weeks, 30% cases were allowed weight bearing by 17-20 weeks and 10% patient which was the case non union was allowed weight bearing with knee brace after 24 weeks. In complicated cases three cases (10%) were having superficial infection, non-union occurred in three cases where there was extensive bone loss. Shorting was also observed in 03 (10%) cases. Implant failure not observed in any case. 70% (21) of cases had ROM of 90 degree or more, 20% (6cases) had ROM <70 degree. 60% of cases had excellent results, 30% had fair results, and 10 % had poor result.

The case of poor result had non union at distal femur and shortening. (Table 6) Majority of fracture tibia were Schatzker Labart (1979) type- VI (37.5%), type-IV were (25%). All patients (24) get their range of motion more than 90 degree. There were 7 cases with superficial infections, two case developed shortening of 10mm and three cases that had developed varus deformity, these patients had started weight bearing from post operative days against medical advice. There

were satisfactory results in 87.5% patients of fracture tibia. (Table 5)

Table 4. Distribution of variable related to distal femur fracture and outcome of LCP implanted operative procedure (n=30)

Various variables	No. Of cases	Percentage
Fracture distal femur according to Muller AO classification (Ruedi *et al*., 2007)		
A1	06	20
A2	00	0
A3	03	10
C1	03	10
C2	12	40
C3	06	20
Total	30	100
Operative technique in fracture distal femur		
LISS	06	20
Direct reduction	24	80
Full weight bearing allowed (weeks)		
12-16	18	60
17-20	09	30
> 20	03	10
Complication in distal femur fracture (n=10)		
Superficial infection	03	10
Deep infection	01	3.3
Non union	03	10
Shortening	03	10
Implant failure	00	00
Range of movement at knee in fracture distal Femur		
90 degree or more	21	70
70 - 89 degree	03	10
Less than 70 degree	06	20
Evaluation of result of distal femur		
Excellent	18	53.33
Fair	09	33.33
Poor	03	13.33

Table 5. Distribution of variable related to fracture proximal tibia and outcome of LCP implanted operative procedure. (n=24)

Variables	No. of cases	Percentage
Distribution of proximal tibia fractures according to Schatzker Lambart types		
I	00	0.0
II	03	12.5
III	03	12.5
IV	06	25
V	03	12.5
VI	09	37.5
Total	24	100
Complication in distal femur fracture		
Superficial infection	07	29.17
Shortening	02	08.3
Varus deformity	03	12.5
Non-union	00	00
Range of movement at knee in proximal tibia fractures		
Complete	10	41.7
>120	09	37.5
90-119	05	20.83
Total	24	100
Evaluation of result (Schatzker Lambart's criteria) of proximal tibia fractures		
Excellent	07	29.2
Good	10	41.7
Fair	05	20.8
Failure	02	12.5
Total	24	100

Majority of the cases 12 (50%) were belongs to 43A1 type and followed by 43-A2 type in 06(25%) cases. Majority 19 cases (75%) fractures were of close type and 5 cases (25%) were of open types. Majority of the cases 15 (62.5%) started full weight bearing in 16-20 weeks. All the cases maintained initial reduction and showed minimal angulation in any plate (less than 5degree). None of the cases showed any collapse with no case showing shortening more than 10 mm. Majority of the cases (15) were belongs to excellent group, 09 cases from good group. (According to Olerud Molander score)

Table 6. Distribution of various variables related to distal tibial fracture and outcome of LCP implanted operative procedure

Various variables	No. Of cases	Percentage
AO classification for fracture distal tibia involved in study		
43-A1	12	50
43-A2	06	25
43-A3	03	12.5
43-C1	03	12.5
Total	24	100
Nature of distal tibia fractures		
Close fracture	19	79.2
Open fractures (all grade I*)	05	20.8
Full weight bearing allowed (weeks)		
10-15 weeks	07	29.2%
16-20 weeks	15	62.5%
21-25 weeks	02	08.3%

*Gustilo Anderson classification (Kim *et al*., 2012)

DISCUSSION

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 the present study higher age group peoples have more fracture probably due to osteoporotic changes. Among the various type lower limb fractures, supracondylar femur fracture was found most common type of fracture. Injuries was more commonly observed in males as compare to female. Road traffic accident was the most common cause of fracture observed in study. In the present study there were 30 cases of distal femur fracture. Most common type of fractured was observed was C2 type (40%), followed by C3 and A1 (both 20% each). Compound cases were managed initially by debridement and skeletal traction. These cases were operated after wound healing. Condylar butteress plate was used in 24 out of 30 cases. 06 cases in which LISS technique was used, distal femoral plate was applied. Post operative splintage of distal femoral fracture were applied in 06 cases out of 30 (100%), of which 1 case was continued splintage for more than 2 weeks, one patient had extensive bone loss and one patient had superficial infection.

Cases in which splintage were applied, mobilization started after 2 wks i.e. after suture removal. 24 cases in which splintage were not applied mobilization were started after 3-4 day. 60% of cases were allowed full weight bearing by 12-16 weeks. In complicated cases three cases (10%) were having superficial infection, non-union occurred in three cases where

there was extensive bone loss. Shorting was also observed in 03 (10%) cases. Implant failure not observed in any case. 70% of cases had ROM of 90 degree or more. 60% of cases had excellent results. Giles *et al* (1982) published a report of 26 patients of supracondylar-intercondylar fractures of the femur treated with a supracondylar plate and lag screw. 92% of patient had satisfactory results. There was no nonunion and no infection. Krettek and Tscherne, (1997) made a prospective study of displaced Muller type C2-C3 intraarticular fractures of distal femur, treated using an indirect plate fixation technique and a lateral parapatellar arthrotomy for the direct reduction of the Condylar block. Out of 8 patients, according to Neer's score there were 6 excellent and 2 unsatisfactory results. There was no infection or non union.

A comparison of published series of supracondylar femoral fractures and their treatment

In present study it was seen that the implant with locking head screw when used in difficult fractures like distal femur provides a good fixation. Even in osteoporotic bone the locking head implant provides a good anchorage also comparing the results in non osteoporotic patients even with conventional plates locking plate has better results in all subtype, more notably so in 3 and 4 part. We studied 24 patients of distal tibia fractures, majority of them 12 (50%) were of 43A1 type. Majority 19 cases (75%) of distal tibia fractures were of close type and 5 cases (25%) were open type. Majority of the cases 15 (62.5%) started full weight bearing in 16-20 weeks. Majority of the cases 15 were in excellent group, 09 cases being in good group (according to Olerud Molander score). All patients achieved union clinically and radiologically at the end of the study Francois *et al*. (2004) conducted a retrospective study on percutaneous plate fixation of fractures of the distal tibia, they observed no significant soft tissue problems occurred. All fractures healed within one year without malunion. Wang Cheng *et al*. (2011) conducted study to compare the results between two surgical options for distal tibia fracture, i.e. minimally invasive plate osteosynthesis (MIPO) vs. open reduction and internal fixation (ORIF). Thirty cases of distal tibia fracture (15 pairs of ORIF and MIPO) were submitted, no malunion occurred and one case of osteomyelitis developed in the ORIF group. In the ORIF group, ten cases were evaluated as excellent, three as good, one as fair and one as poor. In the MIPO group, ten cases were excellent and five good. Majority of fracture tibia were Schatzker Labart type- VI (37.5%). All patients (24) get their range of motion more than 90 degree. There were 7 cases with superficial infections, two case developed shortening of 10mm and three case which had developed varus deformity.

There were satisfactory results of fracture tibia according to schatzker lambart criteria in 87.5%. On final follow up in one case which had extensive communition there was shortening of 10mm and one case developed varus deformity due to very early weight bearing, the case was re-operated after a period of 13 months, plate was removed and high tibial osteotomy was done to correct the varus deformity. Kenneth *et al*. (2005) conducted a study on the treatment of complex tibial plateau fractures using LISS on 38 patients and observed that 36 out of 38 (95%) pt's fractures had united at 4 months after surgery with no loss of fixation or infection. Significant loss of knee range of motion was seen in 5 patients. Partenheimer *et al*. (2007) concluded that unilateral locked screw plating is a good alternative in treatment of problematic fractures of tibial plateaus that are associated with Soft Tissue Damage and metaphyseal communition. In the year 2008, Beck *et al*. (2008) were able to show that tibial LISS is a suitable implant for the treatment of proximal segmental tibia fractures with an acceptable rate of complications.

Conclusion

The results demonstrate several benefits of locking plate. More importantly, it is easy to use, it is biological in the sense that the blood circulation to the bone is not compromised, the plate does not need to be reconfigured and the angular screw fixation ensures fixed angle stabilization. Moreover, 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. Although the follow up period in our study was relatively short and it was not a randomized controlled study, also the locking plate is comparatively expensive, the number of second or more occasions of surgery is minimal. We therefore recommend the use of locking plate, especially in elderly patients with osteoporotic bone and comminuted fracture. Randomized studies will of course be needed in the future to validate the possible advantages associated with this method. Nevertheless, these new possibilities mean that preoperative planning and an understanding of the different biomechanical principles of osteosynthesis are essential if good clinical outcomes are to be achieved and maximum benefit is to be attained from the options offered by the LCP system**.**

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