DOI: 10.14260/jemds/2015/647

ORIGINAL ARTICLE

SURGICAL MANAGEMENT OF CLOSED FRACTURES OF DISTAL END OF FEMUR OR PROXIMAL END OF TIBIA USING LOCKING COMPRESSION PLATE: A PROSPECTIVE STUDY

Shiva Naik R[1], Ganesh P. Subbaiah[2], Prabhanjan Kumar[3]

HOW TO CITE THIS ARTICLE:
Shiva Naik R, Ganesh P. Subbaiah, Prabhanjan Kumar. "Surgical Management of Closed Fractures of Distal End of Femur or Proximal End of Tibia using Locking Compression Plate: A Prospective Study". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 26, March 30; Page: 4479-4490,
DOI: 10.14260/jemds/2015/647

ABSTRACT: BACKGROUND: Fractures around knee are one of the commonest fractures encountered in high velocity trauma which are associated with high morbidity and mortality. Isolated fracture can itself lead to complications such as ARDS and pulmonary embolism. This necessitates early stablization of fractures. Internal fixation is the choice of treatment in fractures around knee and locking compression plate has shown to give one of the best results in terms of recovery, fracture union, return to work and the functional outcome. **OBJECTIVES**: To study the functional results of fracture lower end of femur or upper end of tibia treated by closed/open reduction and internal fixation with locking compression plate. **DESIGN:** A prospective study. **SETTING:** At Vims Government Hospital Bellary. **METHODS:** 20 cases of fracture around knee (10 cases with fracture lower end of femur and 10 cases with fracture upper end of tibia) were treated by closed/open reduction and internal fixation by locking compression plate between 1-07-2007 &31-07-2009 at our institution. The patients were evaluated clinically and radiologically for outcomes. All patients were followed up for an average of 12 months. Out-come was assessed using NEER'S Score. **RESULTS:** 19 fractures healed within an average duration of 13 to 16 weeks following surgery. There was nonunion with implant failure in 1 case (Tibal fracture-schatzker V), which was treated with second surgery using LRS and bone grafting. There was no instance of deep infection. Range of motion of knee & Hip was excellent to very good. Gait and weight bearing after complete union was satisfactory. **CONCLUSION:** Closed/open reduction and internal fixation of fracture lower end of femur or upper end of tibia using locking compression plate is one of the modalities of treatment especially in intraarticular fractures where the maintenance of articular congruity is crucial. Fixation with locking compression plate showed more effectiveness in severly osteopototic bones, shorter post- operative stay, faster recovery, earlier union rates and excellent functional outcome compared alternative procedures in other studies.

KEYWORDS: Supracondylar femur and tibial plateau fracture; Locking compression plate; closed reduction; LISS; MIPO; Early post-operative mobilization; weight bearing.

INTRODUCTION: In the last few decades, rapid industrialization and the fast pace of life have brought both comforts and catastrophe like road traffic accidents and crippling many young lives.

Fracture lower end of femur and upper end of tibia are often difficult to treat and they are associated with many complications.

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

DOI: 10.14260/jemds/2015/647

proper instruments, implant as well as antibiotics. Then, the traditional management of displaced fracture supracondylar of femur was along the principle of watson jones[1] & john charnley.[2]

This comprised of skeletal traction, manipulation of fracture and external immobilization in the form of casts and cast bracings. These methods however, met with problems like deformity, shortening, prolonged bed rest, knee stiffness, angulation, joint incongruity, malunion, quadriceps wasting, knee instability and post- traumatic osteoarthritis.

The trend of open reduction and internal fixation has become evident in the recent years with good results being obtained with the AO blade plate, dynamic condylar screw, intramedullary supracondylar nail & other implant system like locking compression plates.

Elderly patients with severe osteoporosis add further to the difficulties in management of fractures around knee which requires restoration of articular congruency for painless free movements of joint. Loss of stable fixation in osteoporotic bones is of great concern in such elderly patients. Locking compression plates with its innumerous advantage is of great use in such circumstances.

Locking compression plate has the advantage of combination of conventional compression plating and locked plating techniques which enhances the plate osteosynthesis. Anatomically precontoured built reduces soft tissue problems and acts as internal external fixator.

In addition, a Locking plate has got distinct advantages of unicortical fixation and least chance of plate back out as the screw gets locked to the plate. Further, Minimal soft tissue injury occurs when closed reduction is done and MIPO technique is used.

The purpose of this study is to evaluate the results of fracture lower end of femur or upper end of tibia, treated by close/open reduction and internal fixation using locking compression plate.

METHODOLOGY: In this study 20 patients with closed fracture around knee (10 cases with fracture lower end of femur and 10 cases with fracture upper end of tibia) were studied. All the cases were treated at VIMS combined government hospitals Bellary, between 1-07-2007 & 31-07-2009 at our institution and followed for a minimum of 6 months.

The method used for fracture fixation was closed or open reduction and internal fixation with locking compression plate. The duration of follow up ranged from 4 months to 24 months.

All the fractures in this series were post-traumatic. No pathological fracture was included in the study. Also supracondylar fractures in children were not considered. supracondylar fractures or upper tibial fractures treated conservatively and fixed with other fixation systems like AO blade plate and condylar buttress plate were not included.

The fallowing protocol was observed for patients with fracture lower end of femur or upper end of tibia on arrival:

1. General and systematic examination as well as local examination of the patient.
2. Thorough assessment of patient to rule out head/chest/abdominal/spinal or pelvic injury.
3. Evaluation of patients in terms of:
    a) Age.
    b) Sex.
    c) Mode of trauma.
    d) Period between injury and arrival.

DOI: 10.14260/jemds/2015/647

4. Musculo-skeletal examination of patient to rule out associated fractures.
5. Stabilization of patient with intravenous fluids, oxygen and blood transfusion as and when required.
6. Careful assessment of injured limb as regards to neurovascular status.
7. Primary immobilization of involoved limb in Thomas splint with a cotton pad below the distal fragment and transport of patient to the Department of Radio diagnosis in the same.
8. Radiological assessment; Anteroposterior and true lateral views of injured limb including complete knee joint and distal femur/proximal leg.
9. Thorough irrigation and lavage of associated compound injuries with hydrogen peroxide and normal saline followed by povidone iodine padded dressings.
10. Upper tibial skeletal pin traction with a steinmann or Derham pin drilled under local anesthesia followed by continuous traction given over Bohler-Braun splint for fracture lower end of femur and calcaneal skeletal traction with a Steinmann or Derham pin drilled under local anesthesia followed by continuous traction given over Bohler-Braun splint for fracture upper end of tibia.
11. Compound fractures were not considered in the study.
12. Injection ATS 1500 IU, Injection AGGS 20,000 IV, broad spectrum injectable antibiotics and analgesics were administered for compound injuries of other parts as and when required.

PATIENT SELECTION: Patients admitted to VIMS government hospital Bellary with fracture to end of femur or upper end of tibia with:

a) All types of fracture lower end of femur (Mullers type A, B & C) or lower end of tibia (Schatzker type I to 6) were included in the study
b) Only closed fractures were considered.
c) Pediatric patients and pathological fractures excluded.

Inclusion Criteria:

1. Those patients who are above the age of 20 yrs and managed surgically are included in the study.
2. Patients presenting with distal femoral and proximal tibial fractures with or without osteoporotic changes are included in the study.

Exclusion Criteria:

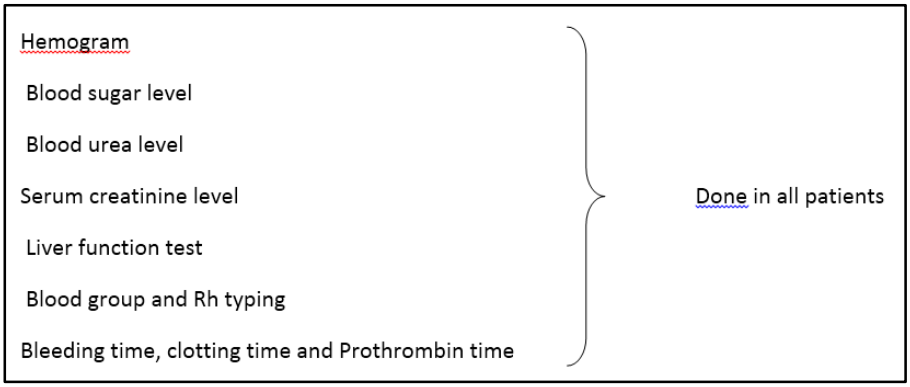
1. Patients with open distal femoral fractures.
2. Patients with open proximal tibial fractures.
3. Children with distal femoral fractures or proximal tibial fractures in whom, growth plate is still open.
4. Patient with pathological distal femoral/proximal tibial fractures other than osteoporosis.
5. Patients lost in follow – up.
6. Patients managed conservatively for other medical reasons.
7. Distal femoral/proximal tibial fractures with neurovascular compromise.

DOI: 10.14260/jemds/2015/647

Implant Used:

- The plate and screws arc manufactured from 316L stainless alloy with gundrilling technique
- The locking compression plates are available from 4 holed to 14 holed. With 4.5 mm thickness plate for lower end of femur and 4mm/4.5 mm thickness plate for upper end of tibia. Anatomically precontoured plate head with soft edges.
- Locking screws in the head of the plate for a secure support.
- The head of the locking screw is threaded which gets locked to the plate as it is tightened.
- LCP combi-holes in the plate shaft Intraoperative choice between angular stability and/or compression.

PREOPERATIVE INVESTIGATION:



Chest X-ray postern-anterior view, electrocardiography and other investigations done in patients as required during anaesthetic evaluation.

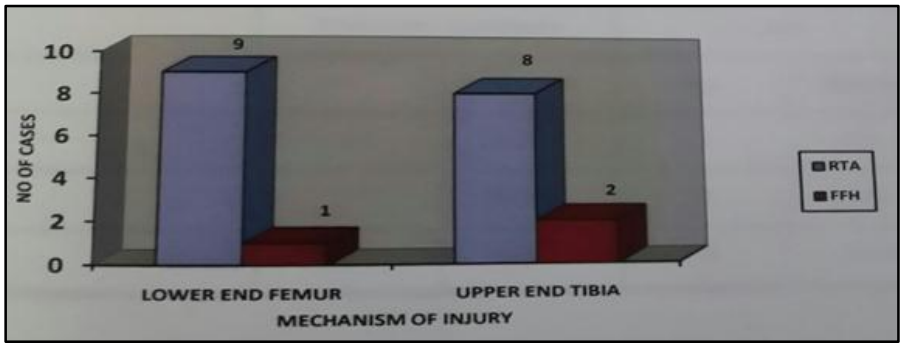
PREOPERATIVE PLANNING AND PREPARATION: Fractures were classified with the help of radiographs according to the AO-ASIF classification. Preoperative calculation was done on radiographs to ascertain the size of the plate, accurate size of locking, cortical and cancellous screws after subtraction of the magnification factor. The limb to be operated was shave and prepared a day before scheduled surgery. One gram of second third generation intravenous cephalosporin was injected previous night and early morning on the day of surgery.

RESULTS:

Mechanism	Lower end femur	Upper end tibia	Total
Road traffic accident	9	8	17
Fall from height	1	2	3

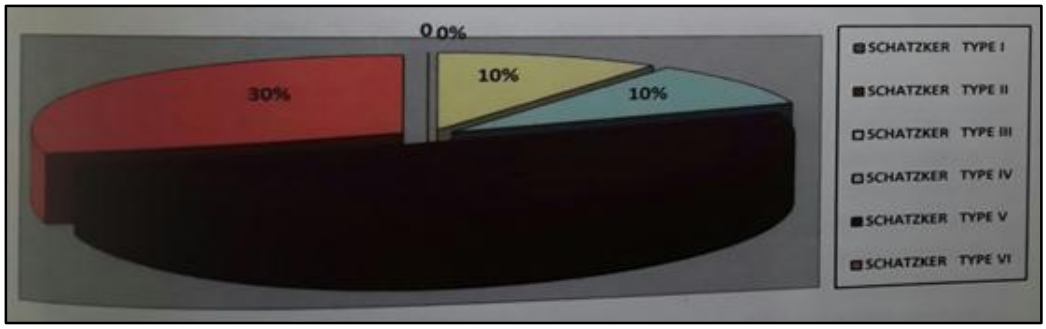
Table 1: Mechanism of Injury

DOI: 10.14260/jemds/2015/647



Fracture upper end tibia	No. of patients	Percent of upper end of tibia fracture
Schatzker type I	0	0
Schatzker type II	0	0
Schatzker type III	1	10
Schatzker type IV	1	10
Schatzker type V	5	50
Schatzker type VI	3	30

Table 2: Type of Fracture Upper End Tibia

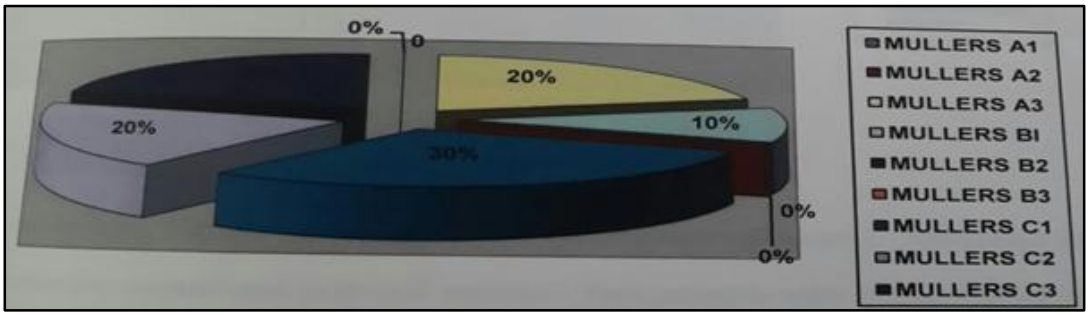


80% of cases were of schatzker type v and type VI fracture.

Supracondylar fracture	No. of patients	Percent of lower end of femur fracture
Mullers a1	Nil	Nil
Mullers a2	Nil	Nil
Mullers a3	2	20
Mullers b1	1	10
Mullers b2	Nil	Nil
Mullers b3	Nil	Nil
Mullers c1	3	30
Mullers c2	2	20
Mullers c3	2	20

Table 3: Type of Fracture Lower End of Femur

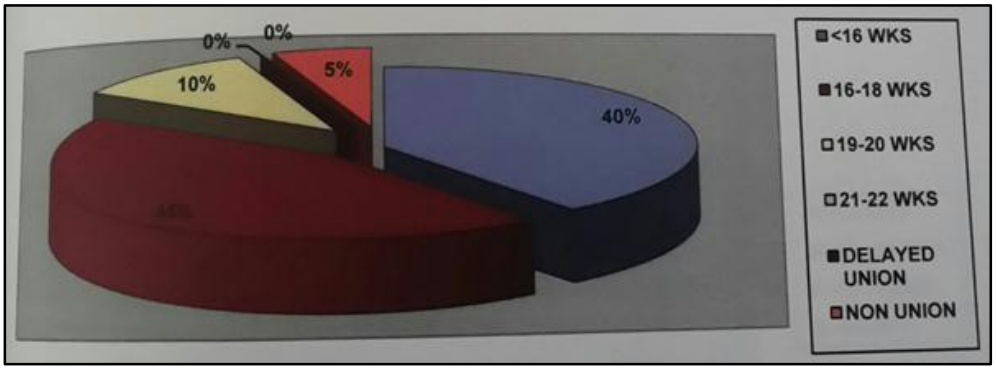
DOI: 10.14260/jemds/2015/647



Maximum number of cases was of mullers type c-70%.

Union (weeks)	No. of cases	Percentage
<16	8	40.00
16-18	9	45.00
19-20	2	10.00
21-22	Nil	Nil
Delayed union	Nil	Nil
Non union	1	5.00

Table 4: Radiological Union

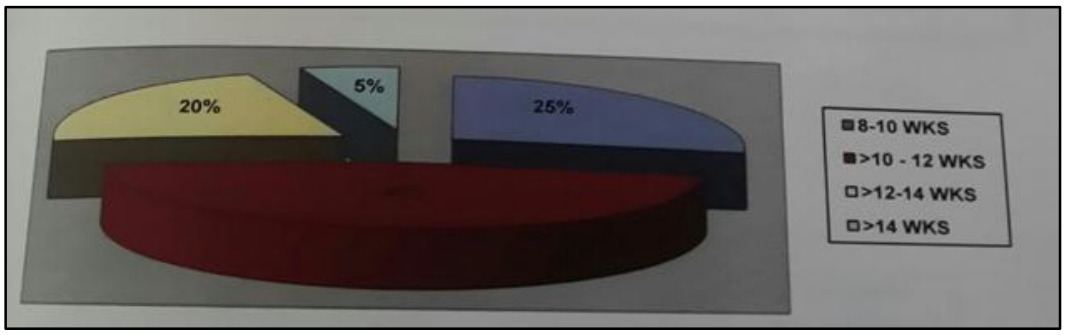


Of 20 patients, 17 patients (85%) showed radiological union within 18 weeks. One patient went for nonunion with implant failure. Broken plate was removed and treated with limb reconstruction system and bone grafting which united over 16 weeks following second procedure.

Achieved time (weeks)	No. of cases	Percentage
8-10	5	25.00
>10-12	9	45.00
>12-14	4	20.00
>14	1	5.00
Total	**19**	**95.00**

Table 5: Time at which full weight bearing achieved

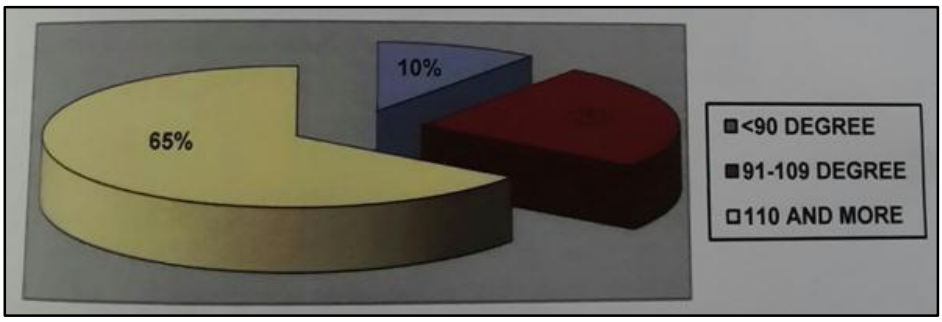
DOI: 10.14260/jemds/2015/647



One patient had implant failure on partial weight bearing. Who was treated with lrs and bone grafting. Patient achieved full weight bearing 16 weeks following second procedure.

Knee flexion (degrees)	No. of cases	Percentage
<90	2	10.00
91-109	5	25.00
110 and more	13	65.00

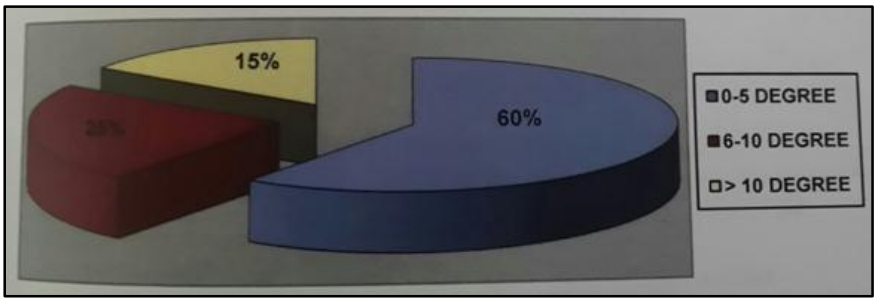
Table 6: Knee Flexion



Average flexion in this study was 105 degree with more than 65% patients having knee range of motion more than 110^0.

Extensor lag (degrees)	No. of cases	Percentage
0-5	12	60.00
6-10	5	25.00
>10	3	15.00

Table 7: Knee Extensor Lag

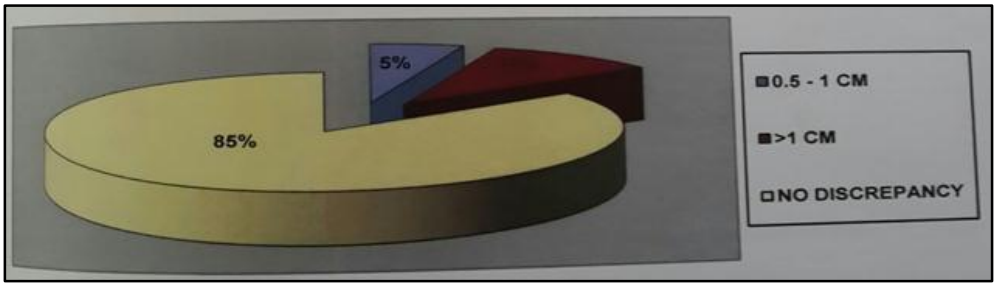


DOI: 10.14260/jemds/2015/647

Average extensor lag in this study was 5.60 degrees.

Shortening (cms)	No. of cases	Percentage
0.5-1cm	1	5
>1cm	2	10

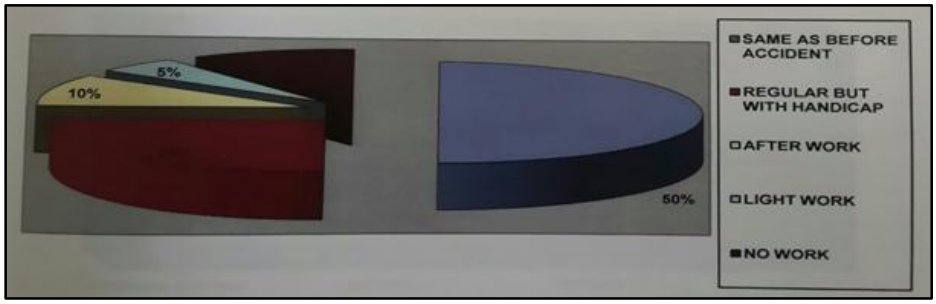
Table 8: Limb Length Discrepancy



Out of 20 patients, 3 had shortening 2 shortening of 15 mm and 1 shortening of 10mm.

	No. of cases	Percentage
Same as before accident	10	50
Regular but with handicap	5	25
Alter work	2	10
Light work	1	5
No work	2	10

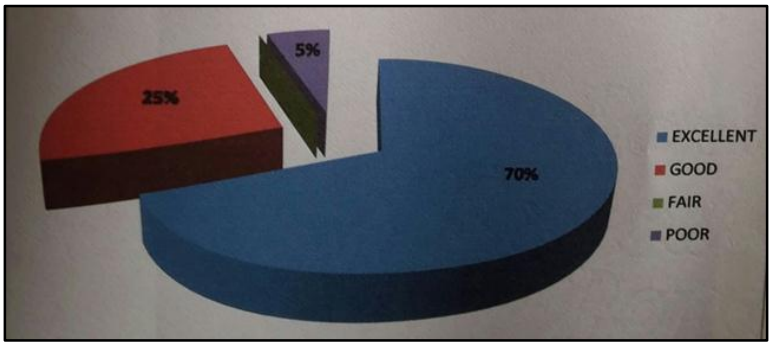
Table 9: Work Capacity



Grade	No. of cases	Percentage
Excellent	14	70%
Good	5	25%
Fair	0	-
Poor	1	5%

Table 10: Functional Results

DOI: 10.14260/jemds/2015/647



CASE 1: SCHATZKER TYPE VI#UPPER END LEFT TIBIA:

PRE OPERATIVE X RAY -AP AND LATERAL VIEW.

AP AND LATERAL VIEW

LATERAL VIEW- AFTER 4 MONTHS

DISCUSSION: In our study 20 fractures around knee were treated (10 cases were with fracture lower end of femur and 10 were with fracture upper end of tibia). Overall final outcome of the surgical management of fracture lower end of femur or upper end of tibia using locking compression plate was assessed in terms of regaining the lost knee function using NEER'S Score.

All 20 cases studied in our series were closed. 16 patients were males and 4 patients were females. The median age was 44 years ranging from 22-68 years. 17 of the fractures were caused by road traffic accidents and 3 were due to fall. 11 patients were with fracture on left Side and 9 on right side.

DOI: 10.14260/jemds/2015/647

FRACTURE UPPER END OF TIBIA: In a study on fracture upper end of tibia by Peter A. Cole[3] the mean age of the patients was 45 years (Range- 16-82 years). There were 22 female patients and 53 male patients. The mechanism of injury was a motor vehicle collision in 48 patients, a fall or twisting injury in 16 patients, gunshot injury in 6 patients, and other high-energy mechanisms in 5 patients.

In our study, of the 10 'upper end of Tibia' fractures, 8 were due to road traffic accident and 2 were due to fall from height. 1 was of Sehatzker type 111; 1 was of schatzker IV; 5 were of Schatzker type v and remaining 3 were of Schatzker type VI,

In a study by Peter A. Cole[3] Internal fixation using the LISS was performed at an average of 7.1 days (range: 0-29 days) after the injury. Twenty-two fractures were operated (within the first 24 hours. The implants used for the fractures in this series included 6 5-hole, 43 and 28 13-hole fixators. The mean number of locking screws used in the proximal articular segment was 4.9 (range: 3-7 screws), and the mean number of screws used in the distal segment was 4.8 (range: 2-6 screws). In 53patients, adjunctive implants were used for periarticular fixation, which included 6 plates (small-fragment plates), 1 K-wire, and articular lag screws in 49 fractures. Allograft bone grafting was performed in 9 cases of tibial plateau fractures, where voids from depressed plateau fracture fragments had to be filled and buttressed.

In our study for fixation of fracture upper end of tibia, the average injury surge- interval was 7 days. 7 to 9 holed plates were used in 60% of patients. The mean number of locking screws used in the proximal articular segment was 4 and the mean number of screws used in the distal segment was also 4, Similulating to the study by Peter A cote and colleagues. Additional cancellous screws were used in 2 cases.

Regarding associated injuries, one patient had undisplaced fracture patella which was treated conservatively.

The mean time for allowance of full weight bearing was 12.6 weeks after surgery in study by Cole. In our study, partial bearing was allowed at an average of 7 weeks and full weight bearing was allowed at an average of 10.2 weeks except for one case of united after second procedure and average took 42 weeks for full weight bearing.

9 out of 10 upper tibial fractures showed clinical and radiological union in average period of 16 weeks following surgery. 1 patient went for non-union due to implant breakage.

In 1 patient, plate breakage was encountered. Breakage in this case is mainly attributed to patient factor as patient did not come for follow up in the initial 3 and started walking before the clinical and radiological u procedure was done. Broken plate was removed and treated with limb reconstruction system and bone grafting. Fracture healed well 14 weeks after the second procedure.

Possible disadvantages of using the LISS include surgeon unfamiliarity with closed reduction techniques and fixator application. This methodology is unconventional, and the technique requires that a closed reduction be accomplished before implant application and fixation to the bone, although the closed reduction can be accomplished using any combination of manual traction, well-placed bumps, bone distractors, and approximation devices. (eg, "whirlybirds")[4]

Fluoroscopy should be used in a way to increase the field of view before screw Placement. It is recommended that strategic bumps be used during the case. These should rest with the apex just distal to the popliteal fossa, supporting the distal fragment, to help avoid relative anterior translation of the proximal fragment as a result of the pull of the quadriceps. For the same reason, more than 15° of knee flexion should be avoided.[3]

DOI: 10.14260/jemds/2015/647

Another possible disadvantage of percutaneous techniques in the distal lateral leg is the risk of injury to neurovascular stractures. Peter A. Cole[3] reported 1 neurologic injury in their study group. A single deep Peroneal nerve palsy would at first seem like an unusually low incidence, given the finding of a 27% (15% deep neurovascular bundle and 12% superficial peroneal nerve) Incidence reported by kregor et al[d] in an anatomical dissection study of cadaver legs implanted with 13- hole LISS fixators. 'Twenty-eight l3-hole fixators were used in the study by peter A. Cole[3] Thus, We believe the discrepancy may be explained by the open incision that we advocate for the placement of distal screws. There were no neurovascular injury reported in our series.

The LISS is akin to an internal fixator, which provides comparable stability to double-plating constructs biomechanical evaluation by Goesiing et a1.[5] Zlowodzki et al[6] have shown that the LISS fixator for treatment of distal femur fractures, which has similar material and design characteristics as the tibial LISS fixator, provides superior fixation in osteoporotic bone compared with the blade plate and retrograde IM nail. This series has demonstrated that its use prevents varus collapse in bicondylar tibial plateau fractures.

M. Ahmad et al[7] studied on biomechanics of locking compression plate. Consistent results were achieved in LCP constructs in which the plate was applied at or less than 2mm from the bone. When applied calm from the bone the LCP demonstrated significantly increased Plastic deformation during cyclical compression and required lower loads to induce construct failure.

Kenneth A. Egol et al[8] conducted a study on Biomechanics of Locked Plates and screws and showed that Locked plates and conventional plates rely on completely different mechanical principles to provide fractures fixation and they provide different biological environments for healing doing so. Locked plates may increasingly be indicated for indirect fracture reduction, diaphyseal/metaphyseal fractures in osteoporotic bone, bridging severely comminuted fractures, and the plating of fractures where anatomical constraints prevent plating on the tension side of the bone.

CONCLUSION:

1. Locking compression plate is a good fixation system for distal end femoral and proximal end tibia fractures, particularly intra-articular type.
2. The operative-time is lessened with decrease in blood loss.
3. Provides good angular stability by its triangular reconstruction principle.
4. It is of great use in elderly patients with severe osteoporotic bone.
5. Closed reduction and plate fixation by MIPO is soft tissue friendly approach in the treatment of fractures around knee preserving the blood supply to bone.
6. Even with open reduction, there is less soft tissue trauma and less post-operative stiffness.
7. Utmost care is required to avoid infection.
8. There is one non-union which was due to patient factor due to her early mobilization. But less delayed unions and rates of angular or rotational malunions.
9. Nona requirement of bone graft decreases the morbidity associated with donor site.
10. Early surgery, closed reduction, at least two screws in each fragment and early post-"Pert e knee mobilization are essential for good union and good knee range of motion.
11. There is no much difference in individual fracture type healing and weight bearing.

Thus, locking compression plate is the optimal tool for many fractures around knee. It provides rigid fixation in the region of femur, where a widening canal, thin cortices and frequently

DOI: 10.14260/jemds/2015/647

poor bone stock make fixation difficult. Surgical exposure for plate placement requires significantly less periosteal stripping and soft tissue exposure than that of other techniques by use of LISS. Orthopaedic surgeons experience with locking compression plating technique will find the locking compression plate a useful technique, but requires attention to prevent complications.

To conclude, Locking Compression Plate is an important armamentarium in treatment of fractures around knee especially when fracture is severely comminuted and in situations of osteoporosis. Further study in large number of patients is required to comment regarding disadvantages and complications.

BIBLIOGRAPHY:

1. Wilson JN. Watson Jone's: Fractures and joint injuries. 6th ed, pg. 1003-070, 1982.
2. Charnley John. The closed treatment of common fractures. 3rd ed, Pg. 197-204.
3. Cole, peter A.MD*; Zlowodzki, Michael MD; Kregor, philip j. MD. Treatment of proximal tibia fractures using the less invasive stabilization system: surgical Experience and Early clinical results in 77 fractures. Journal of orthopaedic trauma, Issue: volume 18(8), September 2004, pp 528-535.
4. BRETT D.CRIST et al Treatment of Acute Distal Femur Fractures; ORTHOPAEDICS 2008; 31: 681.
5. Goesling T, Frenk A, Appenzeller A,et al. LISS PLT: design, mechanical and biomechanical characteristics. Injury.2003; 34: A11-A15.
6. Zlowodzki M, Williamson RS, Cole PA, et al. Biomechanical evaluation of less Invasive stabilization system, angled blade plate, and rectrograde interamedullary nail for the internal fixation of distal femur fractures. J Orthop Trauma. 2004; 18: 494-502.
7. M. Ahmad; R. Nanda; A. S Bajwa; J. Candal-Couto; S. Green; and A.C. Hui; biomechanical testing of locking compression plates is distance between bone and implant significant? JBJS VOL 88-B, Issue-III, 401.
8. Egol, Kenneth A.MD; Kubiak, Erik N.MD; Fulkerson, Eric MD; Kummer, Frederick J. phD; Koval, Kenneth J. MD Biomechanics of Locked Plates and screws.

AUTHORS:

1. Shiva Naik R.
2. Ganesh P. Subbaiah
3. Prabhanjan Kumar

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Orthopaedics, VIMS, Bellary.
2. Senior Resident, Department of Orthopaedics, VIMS, Bellary.
3. Professor & HOD, Department of Orthopaedics, VIMS, Bellary.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Shiva Naik R,
#B/6, VIMS, Campus,
Cantonment, Bellary-583104.
E-mail: drshivanaik@rediffmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None

Date of Submission: 02/03/2015.
Date of Peer Review: 03/03/2015.
Date of Acceptance: 19/03/2015.
Date of Publishing: 27/03/2015.