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RESEARCH ARTICLE

ASSESSMENT OF FUNCTIONAL OUTCOME OF DUAL PLATING FOR COMMUNUTED DISTAL FEMUR FRACTURE

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Abstract

Background-Distal femur fractures are commonly associated with severe metaphyseal comminution and significant soft tissue injury. Locking plating is one of the best and modern options for treating supracondylar femur fractures with relatively low failure rates. Single lateral plating of distal femur fractures was often found to have a relatively higher failure. A medial plating in addition to lateral plating reduces the chances of failure of fixation and prevents varus collapse. The purpose of this study is to Assessment of Functional Outcome of Dual Plating For Comminuted Distal Femur Fracture.

Materials and Methods-Following ethical approval, thirty patients with distal femur fractures were treated with dual plating between 1st January 2021 to 31st June 2022. The follow-up studies included clinical and radiographic examinations. All relevant outcomes were recorded during follow-up.

Result-All 30 patients were assessed by follow-ups. All follow-up fracture united by the end of study, but delayed union was observed in 5/30 patients. The average union time is 6.2 months (range, 5 to 8 months). The main complication in this study was found to be surgical site infection which occupied 6/30 cases.

Conclusion-In our study though there were complications and increase in operating time, the union rate is 100% with no varus collapse or malunion and functional range of movements were good in 40% of cases and excellent in 25% cases, so double plating is one of the better option to achieve bony union and better functional outcome in severely comminuted distal femur fractures.

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Introduction:-

Fractures within 15cm from articular surface of distal femur i.e., between articular surface and junction of metaphysis to femoral diaphysis are defined as distal femoral fractures which constitute around 5-6% of femoral fractures. These fractures are frequently associated with high velocity trauma, comminution, soft tissue injury, instability and articular surface extension. Anatomical reconstruction of articular surface, restoring rotational and axial alignment, stable fixation, early mobilization and functional rehabilitation are main goals of surgical treatment.

Lateral locking plates are now the choice of internal fixation and have replaced common blade plate in distal femur fractures. Retrograde nails were recently developed with more stability and better biomechanical performance for distal femur fractures not having much condylar comminution. Common association of distal femur fractures with

diabetes, open fractures and infection results in delayed fracture union, malunion and proximal implant failure commonly **varus collapse**.

Muscular forces acting on distal femur, weight bearing and gravity all affects fracture stabilization. When there is short distal fragment and metaphyseal comminution with defect in medial cortex, chances of varus collapse due to increased bending tendency caused by vertical load are common in internal fixation of distal femur fracture with single lateral locking plate alone. So additional support of distal femur fracture stabilization by using double-plating technique provides additional support and prevents complication like varus collapse and decreased incidence of non-union.



Single column plating in comminuted distal femur fracture is commonly associated with Non-union/Malunion, Varus collapse, Implant failure, Peri implant fracture.

Aims and objectives:-

1. To analyse the functional outcome of comminuted fracture distal femur treated with double distal femur LCP
2. To evaluate the effectiveness and pitfalls of treatment of comminuted fracture distal femur treated with double distal femur LCP in terms of range of motion, rate of union, complication rate and time of mobilization.
3. To assess the applicability of double distal femur LCP in comminuted fracture distal femur.

Materials and Methods:-

The proposed study was conducted in the department of orthopaedics, NSCB MEDICAL COLLAGE AND HOSPITAL after obtaining informed consent from study patients.

Study Period

1st Jan 2021 to 31st June 2022

Study Centre

Department of Orthopaedics N.S.C.B. Medical College & Hospital Jabalpur (M.P.)

Sample Size

A Total number of 30 patients were selected and followed up for 6-12 months after the intervention.

Inclusion Criteria

1. Age more than 16 years and less than 80 years
2. Patients with complete clinical records.
3. All comminuted intraarticular fracture distal femur AO type C
4. Patients with comminuted fracture distal femur (Muller type A2, A3 & type C2, C3 distal femur fractures)
5. Medically and surgically fit for surgery.
6. Capability to give informed consent.

Exclusion Criteria

1. Age less than 16 years and more than 80 years –
2. Compound grade II and III fractures
3. Muller type A1, type B1, B2, B3 and type C1 distal femur fractures.
4. Associated with Distal neurovascular deficit.
5. Systemic conditions such as osteoarthritis, malignancy, immunocompromised states.

Methodology:-**1. Pre-operative planning**

Patient will undergo a pre-operative evaluation

- Clinical examination - Palpation revealed abnormal mobility and crepitus. Distal vascularity was assessed by anterior & posterior tibial artery pulsations, capillary filling, pallor and paresthesia at tip of toes.
- Baseline investigations
- Radiograph – x-ray thigh with knee AP, lateral & oblique views, CT femur with knee with 3D reconstruction.
- Primarily immobilization of the fracture done with upper tibial pin traction with boehlerbraun splint
- Informed consent from the patient.
- Anesthesia – regional anesthesia

Operative Procedure:**Minimal invasive approach****Lateral fixation: Minimal invasive approach for distal femur**

Patient lying supine on the table with a bolster under the thigh so that the knee rests in approximately 30 degrees of flexion. Longitudinal incision is given over the lateral aspect of shaft of femur. Skin and subcutaneous tissue incised in line of skin incision. Lateral retinaculum is incised to expose joint capsule. At the proximal end of distal window, a

plane is developed between vastus lateralis anteriorly and lateral intermuscular septum posteriorly. Proximally subcutaneous fat is incised in the line of skin incision and then the deep fascia in longitudinal fashion. Distally knee joint capsule and synovium divided longitudinally to expose entire distal end of femur. Patella is retracted using retractor and all aspect of joint is visualised by flexion and extension at knee joint. Proximally vastus lateralis muscle is splitted in line of its fibre to give direct access to periosteum. Finally an epiperiosteal plane is developed between the two windows on lateral aspect of femur using a blunt dissector and plate is introduced.

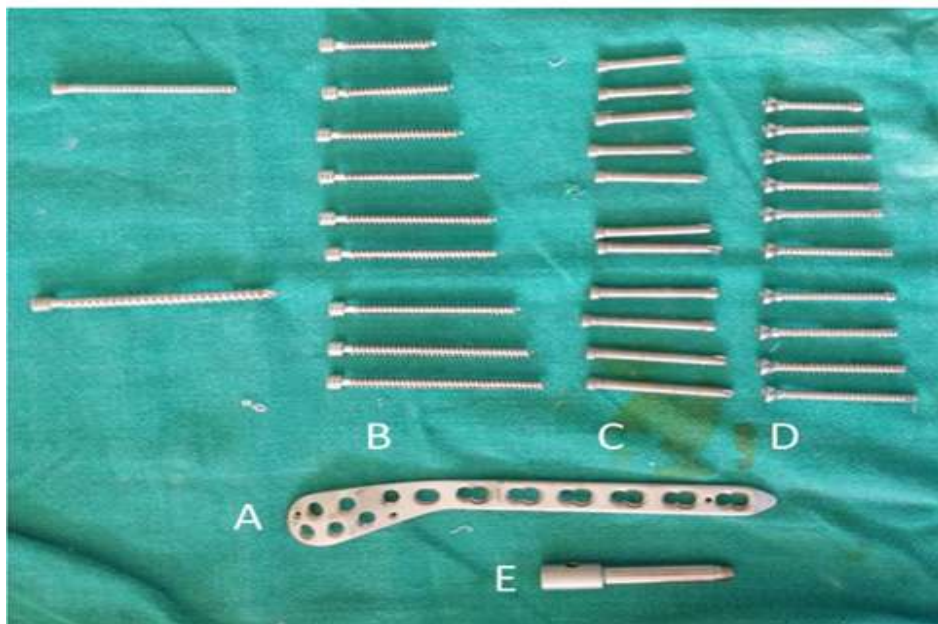
Medial fixation:



Medial fixation: Antero-medial approach

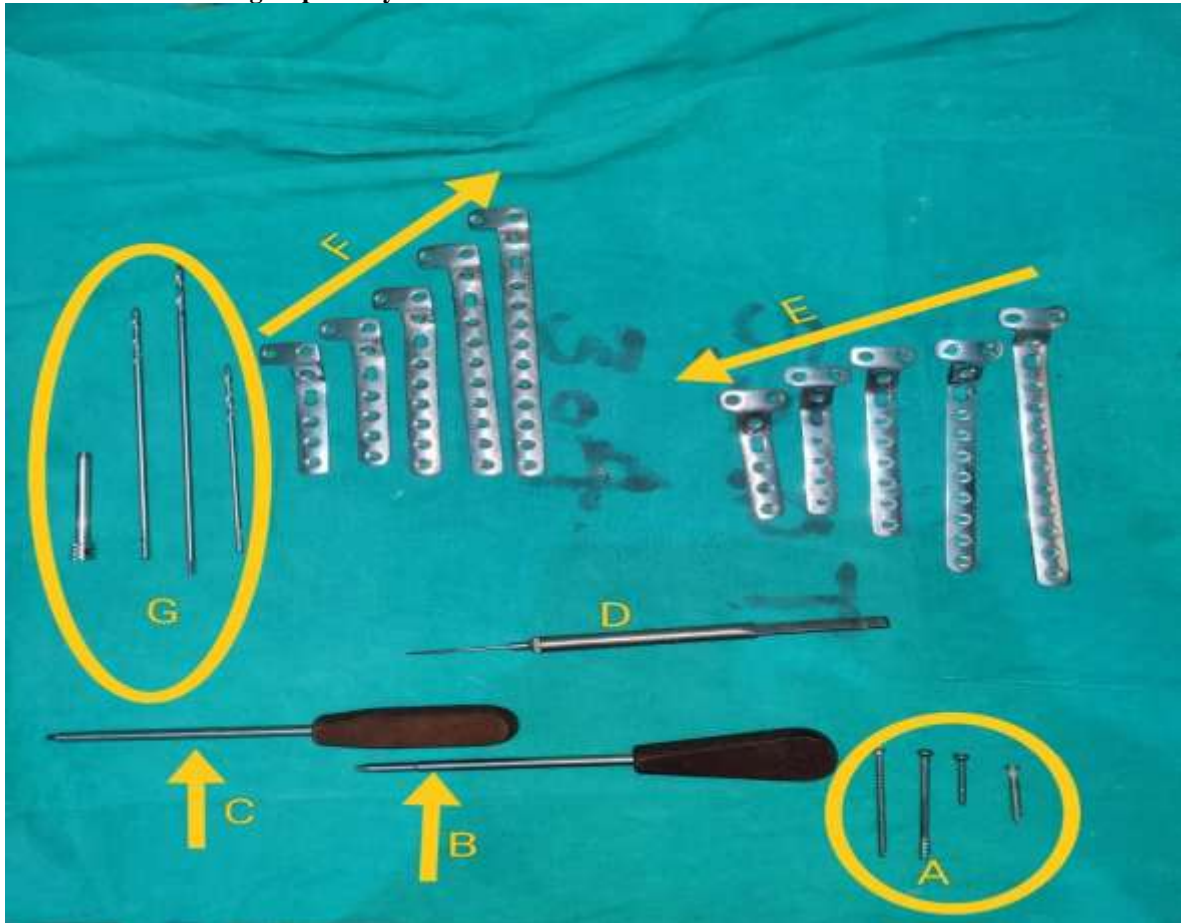
After lateral fixation, medial fixation through medial approach proceeded. An anteromedial incision from anterior margin of pes anserinus following the adductor canal, then fascial envelope surrounding the vastus medialis incised along the posterior margin of the muscle. Blunt dissection done to elevate the muscle off the periosteum and the intermuscular septum from adductor tubercle to intact proximal femur shaft. Distally vastus medialis tendinous insertion incised 2-3 cm wide into the medial capsule. Then the joint exposed through medial Para patellar arthrotomy now the medial plate is placed after reduction found satisfactory and fixed using screws with traverse portion placed distally. Thorough wound wash given and wound closed in layers.

Medial Side Locking Implant System

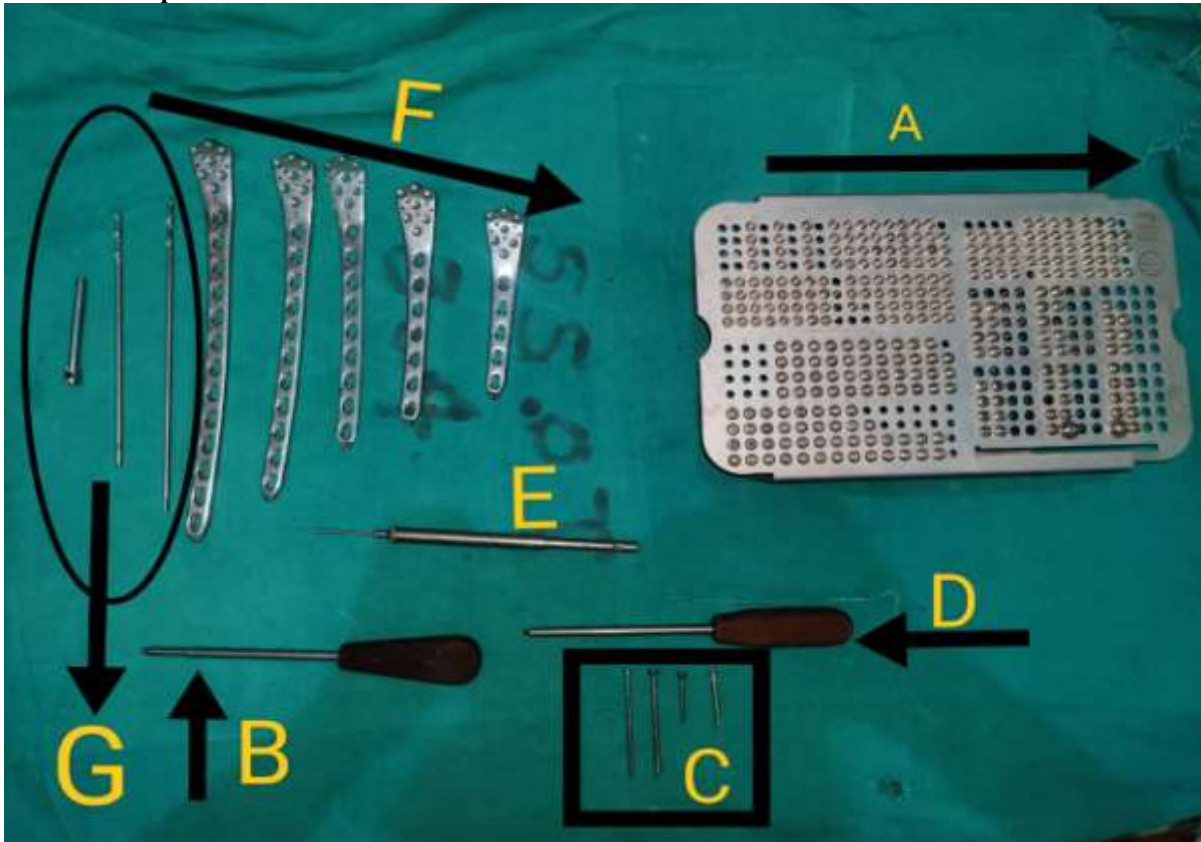


- A. LCP FOR MEDIAL SIDE OF DISTAL FEMUR
- B. 5MM CORTICAL LOCKING SCREWS
- C. 5MM CANCELLOUS LOCKING SCREWS
- D. 4.5MM CORTICAL SCREWS
- E. 5MM DRILL SLEEVE

Medial Side Non-Locking Implant System



1. 6.5mm Cannulated Cancellous Screw
2. 4.5mm Cortical Screws, 6.5mm 32mm Threaded Cancellous Screw, 6.5mm Cannulated Cancellous Screw Driver
3. 4.5mm Hexagonal Solid Screw Driver
4. Depth Gauge
5. T Butress Plate
6. L Butress Plate
7. 3.2mm Drill Bit, 5.0mm Cannulated Drill Bit

Lateral Side Implants

1. LOCKING SCREW SET
2. 4.5MM SCREW DRIVER
3. 4.5MM CORTICAL SCREW, 5.0MM LOCKING CORTICAL SCREW, 6.5MM CANCELLOUS SCREW, 6.5MM CANNULATED CANCELLOUS SCREW
4. 6.5MM CC SCREW DRIVER
5. DEPTH GAUGE
6. DISTAL FEMUR LOCKING COMPRESSION PLATE
7. 4.3MM DRILL BIT, 5.0MM LOCKING SLEEVE

Post Operative Protocol:

1. 1st check dress - 2nd Post op day
2. 2nd,3rd check dress – 5th,8th Post op day
3. Suture removal – 10-12th Post op day
4. continuous passive mobilization exercises with range of motion started at 30 degrees and then advanced on daily basis
5. Non weight-bearing using walker after 2 weeks.
6. Partial weight-bearing using underarm crutches after 6 weeks
7. Full weight-bearing after radiological evidence of bony union (minimum of 12 weeks postoperatively)

Follow-up:

Patients were advised to report for follow up at 4 weeks, 12weeks,24 weeks and at the end of one year. At every follow up a detailed clinical examination was done, patients were assessed subjectively for the symptoms like pain, swelling and restriction of joint movements. Patients were on physiotherapy in the form of active flexion & extension exercises without loading.

VAS score Activity:

The visual analog scale is a linear line, the left end of the line indicating no pain and the end of the right, indicating worst pain. There are 4 categories. A. None (0) - no pain B. Mild (1-3) - occasional pain at work. C. Moderate (4-6) – continue pain during work. D. Severe (7-10) – severe pain causes discontinuation of the work but resumed after rest.

The patient was advised to put the finger on the line where the pain is in relation to the two extremities of the scale. For those who can't understand the pain scale, pain assessment was done by asking the part of one rupee.

Knee Society Score:

Knee Society Score(KSS) scale, divided into two components. The first assesses the knee clinically through the physical examination (ClinicalKSS -"Knee Score"), and the second assesses the individual's functionality (FunctionalKSS - "Function Score"), while both attain a total of 100 points each. The objective of this separation was to make the scoring of the Clinical AKSS independent on the Functional AKSS, not being influenced by variables such as comorbidities and advanced age. The Clinical KSS evaluates pain, in a total of 50 points, stability, 25 points, and range of motion, 25 points. The maximum score of 100 points is reached when there is no pain, with good alignment of the knee in extension, and at least 125° of range of motion, without any anteroposterior or mediolateral instability. Deductions are made for flexion contracture, loss of extension and poor alignment. The Function AKSS evaluates the walking distance, totaling 50 points, and the act of climbing and descending stairs, 50 points. The maximum score of 100 points is attributed to the individual capable of walking unlimited distances without walking aids, and of climbing and descending stairs normally. Deductions are made for the use of canes, crutches or walking frame.

Knee Outcome Survey Activities of Daily Living Scale (ADLS).

Symptoms:

To what degree does each of the following symptoms affect your level of activity?

	I do not have the symptom	I have the symptom, but it does not affect my activity	The symptom affects my activity slightly	The symptom affects my activity moderately	The symptom affects my activity severely	The symptom prevents me from all daily activity
Pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stiffness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Swelling	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Giving way, buckling, or shifting of the knee	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weakness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Limping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Functional Limitations With Activities of Daily Living: How does your knee affect your ability to: (check one answer on each line):

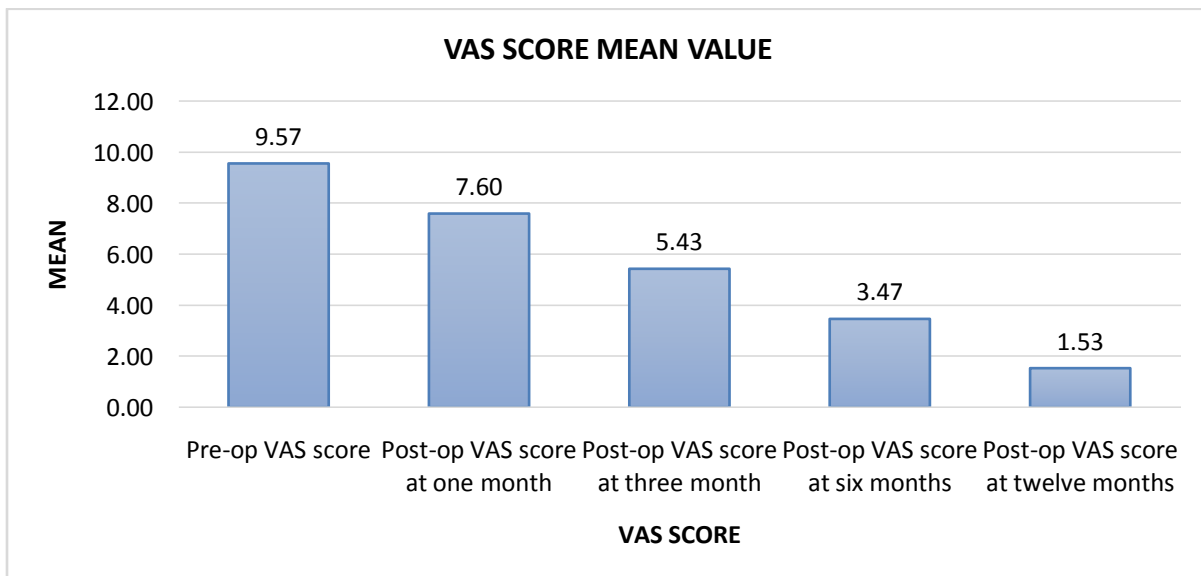
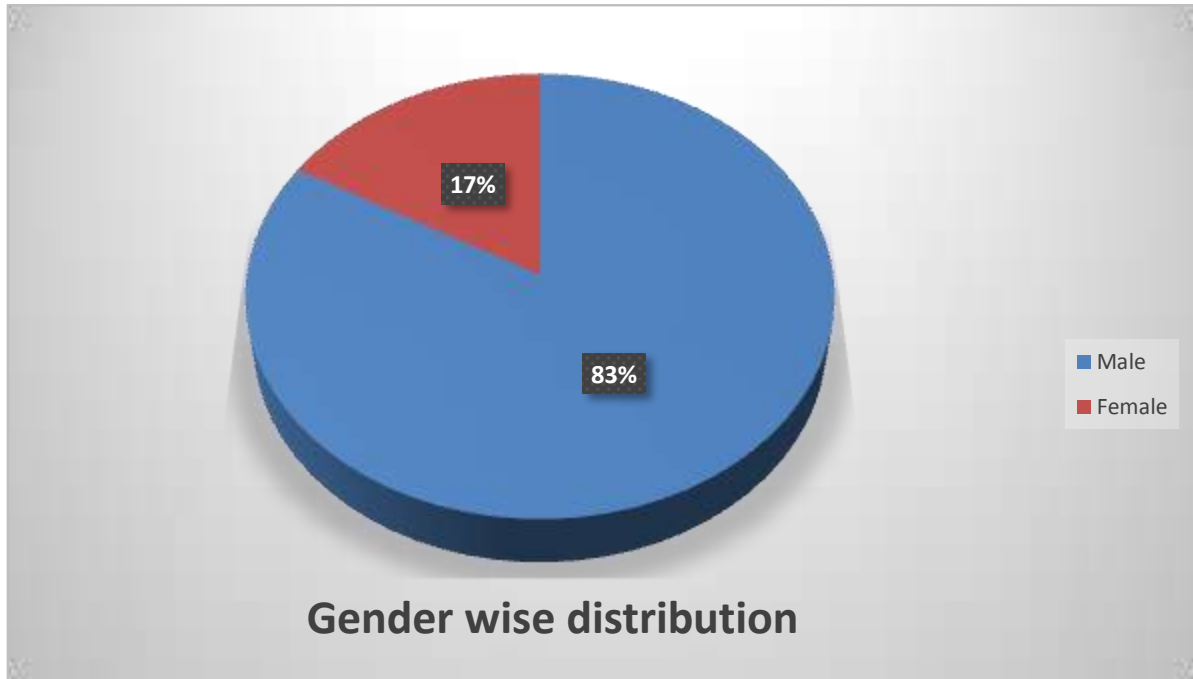
	Activity is not difficult	Activity is minimally difficult	Activity is somewhat difficult	Activity is fairly difficult	Activity is very difficult	I am unable to do the activity
<u>Walk</u>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Go up stairs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Go down stairs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stand	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Kneel on front of your knee	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Squat	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sit with your knee bent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rise from a chair	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Scoring:

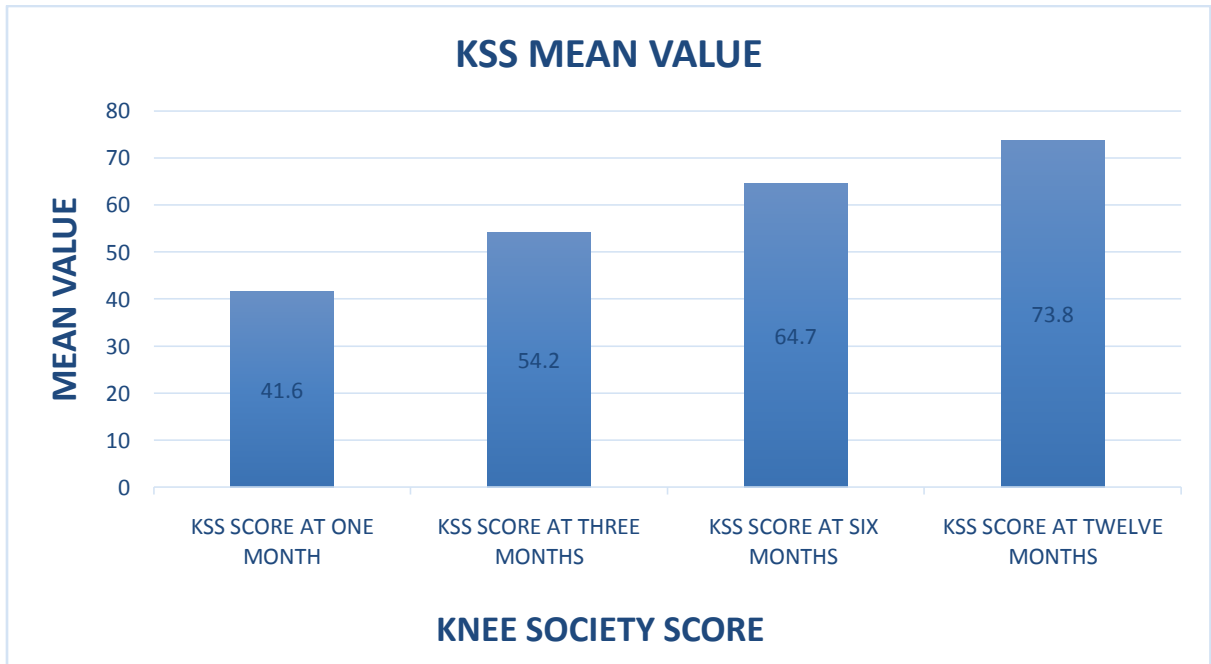
The first column is scored 5 points for each item, followed in successive columns by scores of 4, 3, 2, 1, and 0 for the last column. The total points from all items are summed, then divided by 70 and multiplied by 100 for the ADLS score.

Observations and Result:-

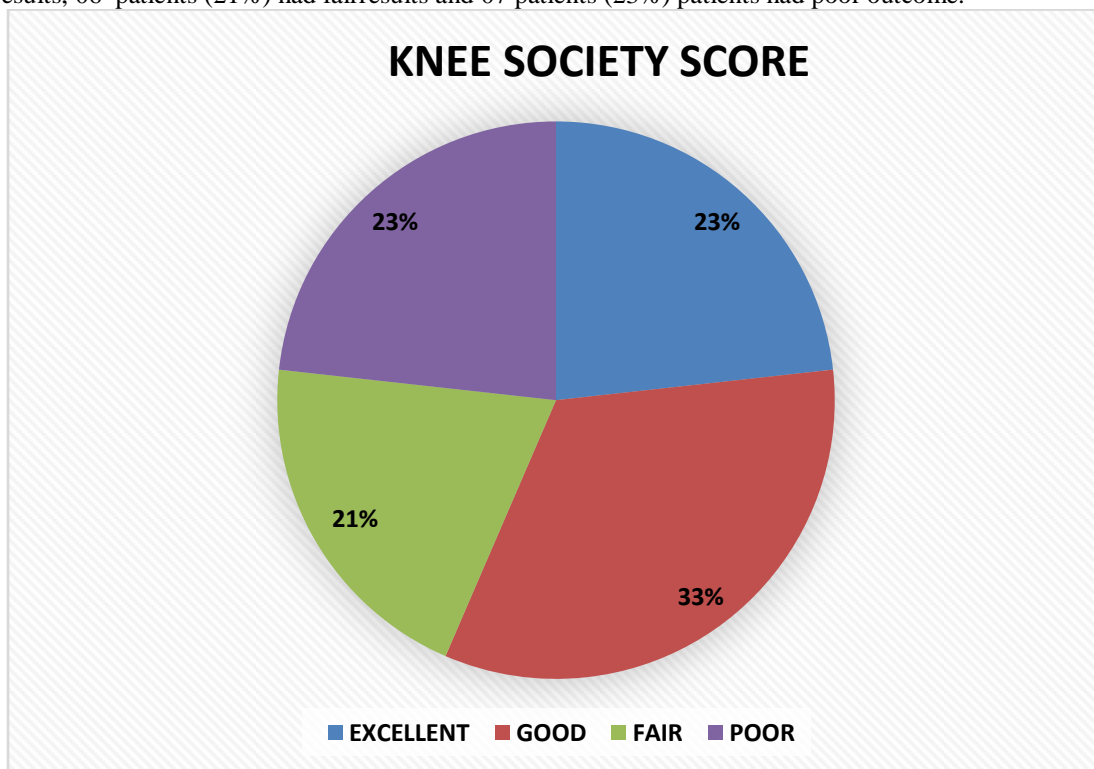
1. In our study conducted, the patients presented with age group ranging from 18 to 70 years of age (mean \pm SD age of 43.57 ± 15.18) with sex distribution of 83.3% male and 16.7% female.
2. After treatment follow ups shows improvement in mean VAS score up to 12 months of follow-up.
3. At the end of 12 months, the follow-up mean VAS score with SD was 1.53 ± 0.51 which was significantly low as compared with pre-op mean VAS score with SD 9.57 ± 0.50 .



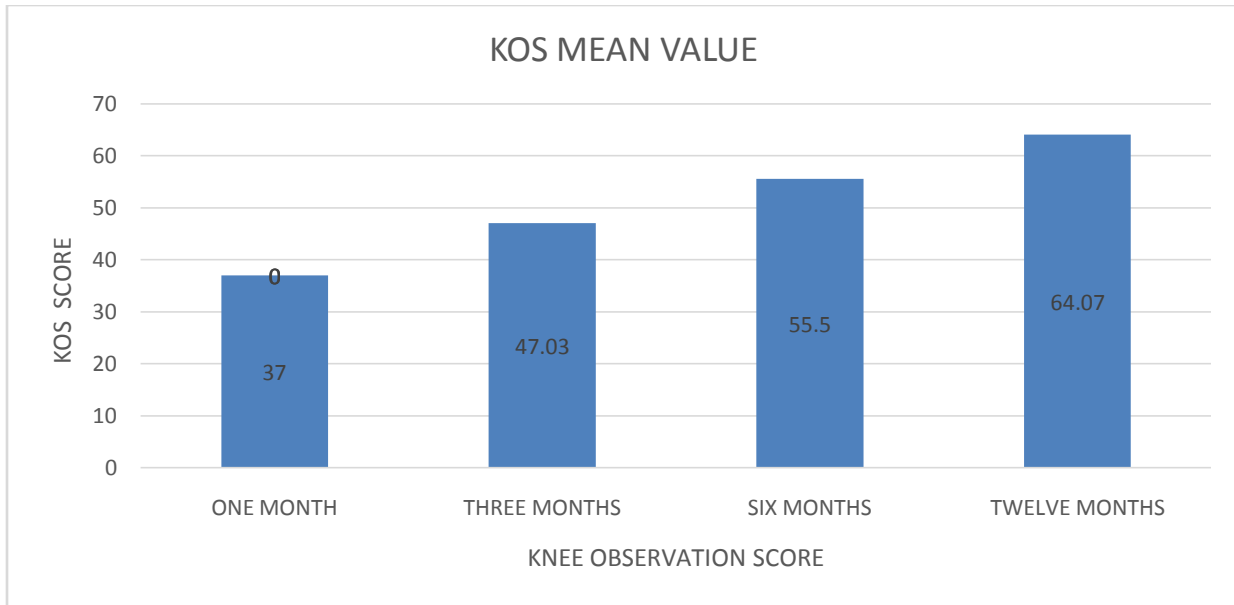
At the end of 12 months, the follow-up mean KSS score with SD was 73.80 ± 12.12 of the treating group which has been significantly improved as compared with the mean KSS score with SD 41.06 ± 6.01 at first follow up.



According to KSS score after 12 months of follow up 07 (23%) patients had excellent results, 10 patients (33%) had good results, 06 patients (21%) had fair results and 07 patients (23%) patients had poor outcome.



At the end of 12 months, the follow-up mean KOS score with SD was 64.70 ± 17.70 which has been significantly improved as compared with the mean KSS score with SD 37.00 ± 13.50 at first follow up.



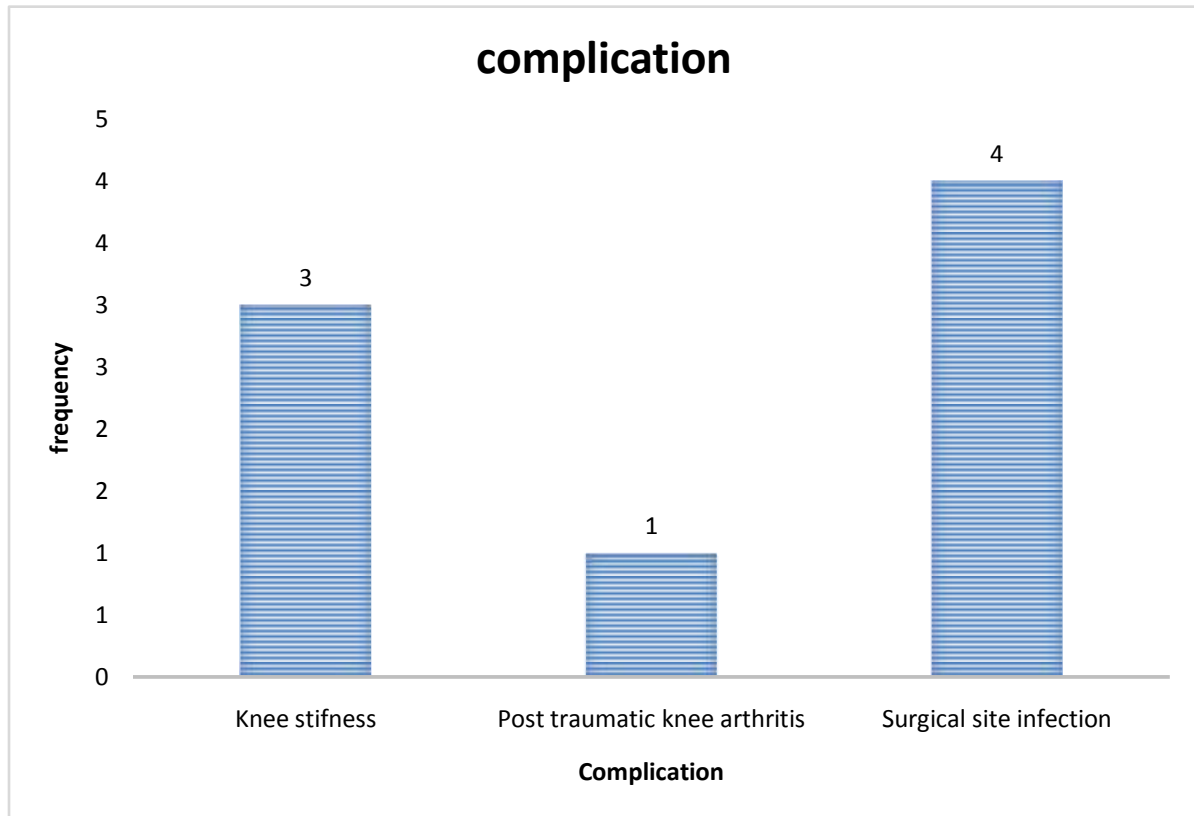
As per knee outcome survey nine patients (30.0%) had excellent outcome, seven patients (23.3%) had good outcome, six patients (20.0%) had fair outcome and eight patients (26.7%) had poor outcome.



Average healing time both clinically and radiologically varies from 18 weeks to 24 weeks in our study with a mean healing time of 21.3 weeks and 14 out of 30 cases healed both clinically and radiologically within 20 weeks.

Complications

In our study we found that surgical site infection was the most common complication 13.3%(4 out of 30 patients) followed by knee stiffness occurred in 10.0%(3 patients out of 30) and implant impingement occurred in 1 case (3.3%).



Discussion:-

Treatments of distal femoral fractures is a cumbersome subject. There have been changing principles towards surgical treatment for supra condylar fractures of femur. Close management of these fractures was the treatment of choice until 1970. This was mainly due to lack of proper techniques and appropriate implants. Conservative methods at any age may be complicated by knee stiffness, malunion and nonunion. Early surgical stabilization will facilitate care of the soft tissue, reduces bedridden period and the complexity of nursing care. In cases where fracture fragments in the medial side were severely comminuted or having massive bone defect, single lateral plate fixation may fail to stabilize fracture sites, resulting in knee varus deformity, breaking of plates and screws and nonunion. In cases involving single lateral plating, the rates of varus collapse and non-union were high but in our study the addition of medial plating has not yielded any case of varus deformity or malunion. In our study the average time taken per patient to complete the surgery is 135 minutes. Muller type A2 & C2 fractures comparatively had a better result compared to type A3 & C3 patients. In bicolumn fracture fixation of the distal femur fractures with comminution, the prognosis factors include age, method of treatment, intra articular involvement and timing of joint mobilization. For all these patient early rehabilitation, physiotherapy and aggressive postoperative protocol should be followed for better functional outcome.

Major factors responsible for poor outcome are:

1. Improper fixation may be due to complexity of fracture comminution
2. Elderly patient with less motivation to begin exercise and low osteogenic potential.
3. Delay in surgery causing increase in interval between injury and surgery
4. Open/closed fractures.

In 2018 Imam et al. did a prospective study on 16 patients with distal femoral fractures of Muller type C3. These patients were treated using dual plating and analyzed the outcomes including clinical and radiological outcomes and postoperative complications. Their results shown 68.75% of the studied patients had good-excellent functional outcome with 68.75% of patients having range of motion (90degree – 120degree) during follow-up. The mean time of radiological union in their study was 6.0 +3.5 months with a range of 3-14 months. There is no postoperative varus or valgus deformity in their study.

Our study also had a similar result with union rate of 100% and average healing time between 18-24 weeks both clinically and radiologically and a mean healing time of 21.3 weeks (5 months) with no cases of varus deformity or malunion. 66% of patients had good-excellent functional outcome in our study with 70% of patients having range of motion more than 90 degree.

Limitations

- 1) Our Study comprises of relatively small number of patients and not a strict random controlled trial design.
- 2) Repair of injured ligaments of knee joint not done during acute phase along with fracture fixation in our study.
- 3) Stainless steel plates are used in both medial and lateral sides due to economical constraints which limits the use of MRI for the evaluation of ligament injuries of the joint during follow-up.

Conclusion:-

Due to aging society, & enormous increase of high speed motor vehicle accidents, the number of distal femur comminuted fractures can be expected to increase in the coming decades. In this study, thirty cases of distal femur fractures who were treated with open reduction and internal fixation with dual plating were followed up and functional outcomes were analysed and discussed. From this sample study, we conclude that dual plating provides successful results for the treatment of both extra articular and intra articular unstable fractures of distal femur.

This method allows restoration of the anatomy, stable internal fixation, a decreased period of im-mobilisation and early return of knee function. This method, which is effective in anatomic realignment, allows early joint motion, owing to its fixation strength. Minimal invasive osteosynthesis approach provides both access with minimal surgical trauma on distal femur and fixation with a better adaptation to surrounding tissues.

In the subjects of our study, a successful anatomic alignment was acquired, regardless of the direction of fracture angulation. The patients who were young adults in majority, went back to their daily activities with 90% recovery.

In our study excellent to good results suggests that stabilizing the fracture with dual plating is an effective method to maintain the reduction till union and prevent collapse of the fracture fragments, even when the distal femur fracture is grossly comminuted intra-articular / unstable and or the bone is osteoporotic.

It is a simple and reproducible procedure that improves recovery from this common injury. The technique emphasis that dual plating has excellent functional outcome thus proving that it is the prime modality of treatment for distal femur fractures. The procedure is applicable for AO types A, B and C fractures of the distal femur, in young patients with a good bone stock as well as in elderly osteoporotic patients. In conclusion, we looked at Functional results of dual plating and found an improved range of movement and radiological outcome at eight, twelve and twenty four weeks follow up.

Thus, this study demonstrates that with the execution of good surgical techniques, including proper plate position, proper insertion of screws and avoidance of past pointing, and proper patient selection, a satisfactory functional and radiological outcome can be obtained for a great majority of patients with most of the distal femur fracture's (incl. Complex intra-articular) by using a dual plating fixation.

In our study though there were complications and increase in operating time, the union rate is 100% with no varus deformity or malunion and functional range of movements were good in 33% of cases and excellent in 23% cases, so double plating is one of the better option to achieve bony union and better functional outcome in severely comminuted distal femur fractures.

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