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Dr. Amritpal Singh
Junior Resident, Department of Orthopaedics Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar, Punjab, India

Dr. Raj Kumar Aggarwal
Professor & Head, Department of Orthopaedics, Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar, Punjab, India

Dr. Rajan Sarad
Associate Professor, Department of Orthopaedics, Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar, Punjab, India

Corresponding Author:
Dr. Rajan Sarad
Associate Professor, Department of Orthopaedics, Sri Guru Ram Das Institute of Medical Sciences and Research, Sri Amritsar, Punjab, India

To study the outcome of retrograde nailing in distal one-third femoral shaft fractures

Dr. Amritpal Singh, Dr. Raj Kumar Aggarwal and Dr. Rajan Sarad

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Abstract
Objectives: With antegrade nailing, it is difficult to achieve perfect reduction of distal shaft femur fracture because of mismatch of size of medullary canal. Short juxta-articular segment is under the influence of deforming muscle forces and the large metaphyseal volume does not allow the intramedullary nail to have cortical contact that can aid in the reduction of the fracture. Distal femur fractures typically shorten and displace into recurvatum in the sagittal plane. In the coronal plane, the fractures have a tendency to displace or angulate according to the fracture morphology. This study was performed to assess the outcome of "Distal One-Third Shaft Femur Fracture" with Retrograde Intramedullary Interlocking Nail. Its intraoperative and postoperative complications and ease of surgery using retrograde intramedullary nailing. Using intraoperative time taken for completion of surgery and total number of C-Arm exposures.
Materials and Methods: The study will include 30 cases with distal one third shaft femur fractures, who will undergo surgery using retrograde nail. Patients will be followed up for a period of 6 months at 1st, 3rd and 6th month. Patients will be assessed on the basis of Demographic analysis, Mode of injury, Classification of fracture based on AO Classification, Duration of surgery, number of C-ARM exposures, Outcome of fracture, Sagittal/Coronal plane deformity, Limb Length Discrepancy/Rotational, alignment, Range of motion. Pain, functional outcome of knee using lysholm knee score and Complications observed.
Results: Two patients shows malalignment rest twenty patients had normal alignment. In our study radiological union was seen in 16(72.7%) patients and nonunion was observed in 6(27.3%) patients.
Conclusion: We strongly recommend the use of Retrograde Intramedullary Nail with multiple distal locking options in the patients with distal one-third femoral shaft fractures, keeping the distal end of the nail in subchondral bone.

Keywords: Retrograde intramedullary nailing, distal femur, fracture shaft femur, lysholm knee score

Introduction
Femoral shaft fractures are observed across all age groups and are attributable to a variety of mechanisms. There tends to be an age and gender-related bimodal distribution of fractures with injuries occurring most frequently in young males after high-energy trauma and in elderly females after fall. The mechanisms in young patients tend to be motor vehicle accidents, pedestrians struck by vehicles, or falls from height. Fractures secondary to low-energy trauma tend to occur more commonly in older female patients [1, 2].
Incidence of femoral shaft fracture varies from 1 to 9 % of all the fractures [3]. Distal femur fractures make up to 6% of all femoral fractures.[1] Distal one-third shaft femur is defined as infra-isthmus part of femur from where medullary canal begins to widen to the point where the bone flare up just above the femoral condyles [4].
Introduction of interlocking intramedullary nail in antegrade fashion was considered as gold standard, but every technique and implant have some limitations. Similarly, that occurred with antegrade nailing when the distal femoral fractures were considered. With antegrade nailing, it is difficult to achieve perfect reduction of distal shaft femur fracture because of mismatch of size of medullary canal [5]. Short juxta-articular segment is under the influence of deforming muscle forces and the large metaphyseal volume does not allow the intramedullary nail to have cortical contact that can aid in the reduction of the fracture. Distal femur fractures typically shorten and displace into recurvatum in the sagittal plane.

In the coronal plane, the fractures have a tendency to displace or angulate according to the fracture morphology [6-8]. This study was performed to assess the outcome of "Distal One-Third Shaft Femur Fracture" with Retrograde Intramedullary Interlocking Nail.

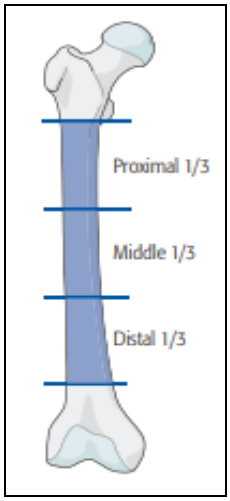


Fig 1: Anatomical Division of Femoral Shaft[4]

Methodology

This study included 30 cases with distal one third shaft femur fractures, who underwent surgery using retrograde intramedullary nail. Patients were followed up for a period of 6 months with follow-up at first month, third month and sixth month.

Inclusion Criteria

1. Age more than 18 years or with skeletal maturity.
2. As per AO classification type 32 with distal one third shaft femur fractures.
3. All closed distal one-third shaft femur fractures.
4. Open grade I and II fractures (Gustilo Anderson Classification)
5. Consent to participate in the study.

Exclusion Criteria

1. All supracondylar fractures, intra-articular fractures
2. Pathological fractures.
3. Refusal to provide informed consent.

All the analysis was done by an independent observer, a senior orthopaedic consultant not involved in conduct of study.

Patients were assessed on the following criteria

1. **Demographic Analysis:** Demographic analysis of the patient includes age and sex of patient.
2. **Mode of Injury**
3. **Classification of Fracture**: All the fractures were classified as per AO classification based on fracture pattern. All the open fractures were classified as per Gustilo-Anderson Classification.
4. **Duration of Surgery:** Duration of surgery was calculated from incision to the closure of wound using watch.
5. **Total Number of C-Arm Exposures Taken:** Before the start of each case exposures on the C-Arm were set to zero and reading of number of C-Arm exposures was noted at the completion of surgery.
6. **Outcome of Fracture: Union:** Union is defined as x-ray evidence of callus formation, atleast three out of four planes.
7. **Nonunion:** Non union is defined as no evidence of fracture healing both clinically and radiologically on three consecutive follow-up.
8. **Malunion:** Malunion is defined as >5º of angular deformity in either the coronal or sagittal plane, malrotation of atleast 10º or >1 cm of limb length discrepancy as compared with uninjured limb.
9. **Radiological Assessment**: Preoperative x-ray of the patient was taken. Type of fracture is assessed, planning of surgery is done. Immediate post-operative x-ray was taken, further x-rays were taken at first, third and sixth month follow-up and union was assessed. Long leg scanogram and lateral view of thigh with knee was taken at sixth month follow-up. On scanogram coronal plane assessment and limb length discrepancy was assessed. Scanogram was done in standing position with patella facing forward. A marker of 10 cm length is placed along the leg at the level of bone. The marker was taken as the reference scale for the further measurements. Sagittal plane assessment is done using x-ray lateral view of thigh with knee. All the measurements were done using the 'IMAGEMETER' Application.

A. Assessment of Frontal Plane Deformity

- **Assessment of Varus/Valgus:** Anatomical Lateral Distal Femoral Angle (aLDFA) of each side is calculated and compared, difference of more than 5 degree in either plane was considered as malalignment.

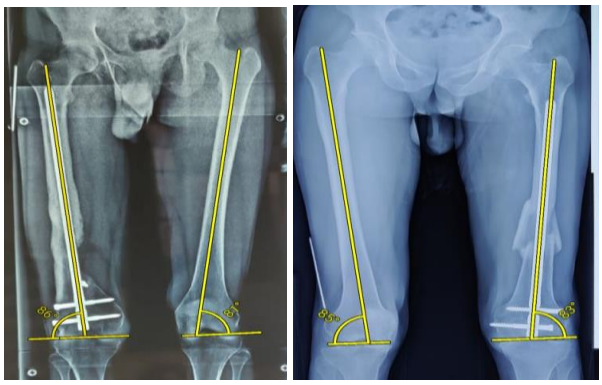


Fig 2: Assessment of Varus/Valgus

Limb Length Discrepancy: Taking the marker of known length as a reference, length of the limb was calculated using the anatomical axis of the femur. Length of the normal limb was measured and compared with the operated limb and limb length discrepancy was calculated.

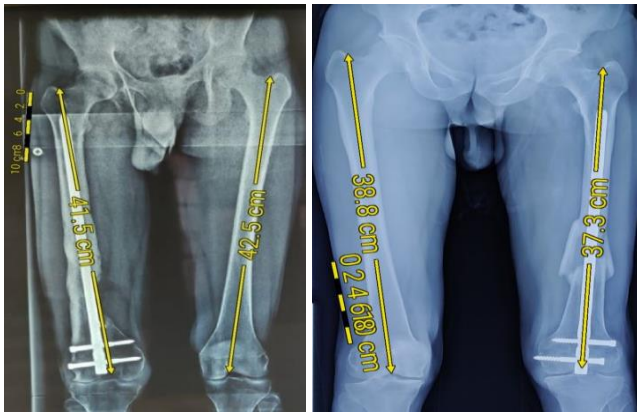


Fig 3: Measurement of Limb Length Discrepancy

Assessment of Procurvatum/Recurvatum: Sagittal plane deformity was calculated by measuring the angle between the posterior cortical lines of proximal and distal fragments on lateral view x-ray of thigh with knee.

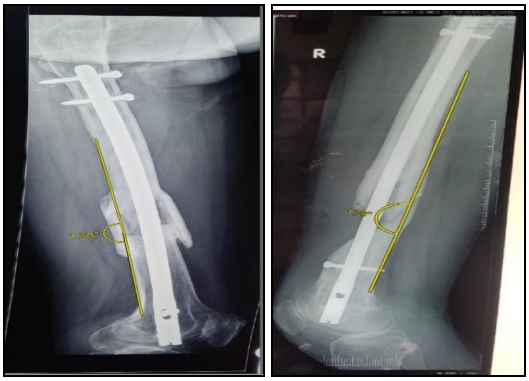


Fig 4: Assessment of Procurvatum/Recurvatum

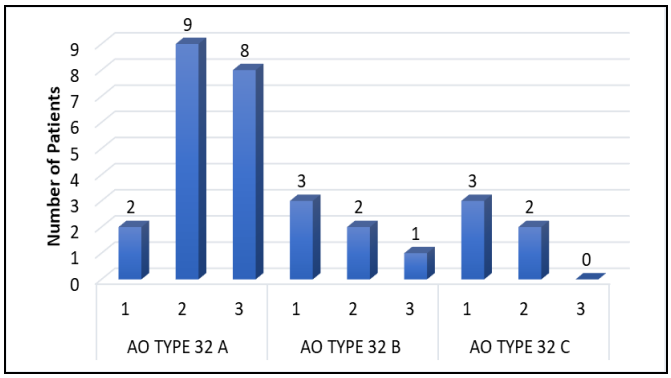
Clinical Assessment

- **Assessment of Rotational Deformity:** Rotation was clinically assessed by flexing the hip to 90º and evaluation of the amount of external and internal rotation was done. Then rotation of injured side is compared with the uninjured side [9].

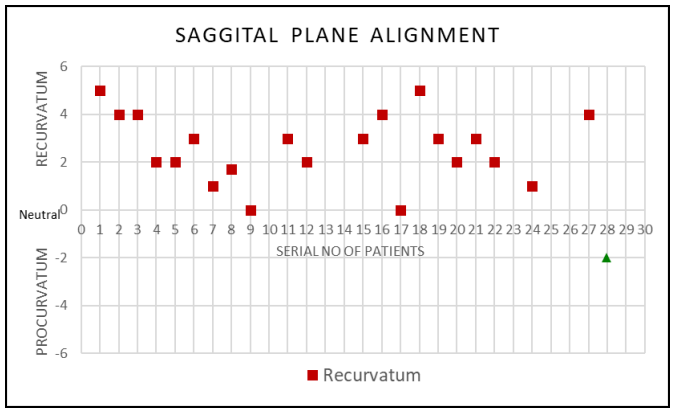
1. **Assessment of Range of Motion**: Range of motion is defined as degree of flexion from the fully extended limb. It was measured by using goniometer. Range of motion was assessed at first, third and sixth month.
2. **Assessment of Pain:** Pain was assessed using visual analogue scale at first, third and sixth month

Results

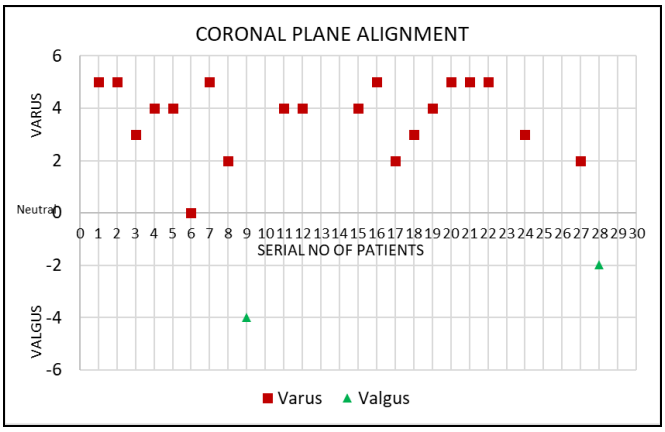
The present study was conducted in the Department of Orthopaedics, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar (Punjab). The study was approved by the Institutional Ethics Committee. 30 patients were enrolled in the study. Eight patients were lost to follow up (two patients died during follow up and six patients were lost due to COVID-19) who didn't arrived even for a single follow up. The findings of this study on remaining 22 patients in the form of observations are presented here. In our study, out of 30 patients, 22 (73.3%) were male and 8 (26.7%) were females with mean age of 44.97±17.39 years. Road Traffic Accident (RTA) was responsible for fractures in 25(83.3%) patients and fall was responsible for fractures in 5 (16.7%) patients. Surgery took ≤ 120 min in 24 patients and >120 min in 6 patients. Mean duration of surgery was 96.77±22.24 minutes. Mean Number of C-Arm exposures taken during surgery was 33.87±5.75. Two patients shows malalignment rest twenty patients had normal alignment. (Graph 2) Postoperative pain was classified as No Pain, Mild Pain, Moderate Pain and severe Pain according to visual analogue score. In our study, at the end of study at six months follow up 9 (40.9%) patients had no pain, 13 (59.1%) patients had mild pain and no patients had moderate or severe pain. (Graph 3) At 1 month mean range of motion was 87.3±15.3 degree and at three months follow up it was 100.5±15.6 and at six months follow up it was 110.0±15.7. At 6th month follow up functional status of the knee was assessed using Lysholm Knee Score. 9 patients had excellent, 6 had well and 7 had fair total score. No patients had poor outcome in our study as per Lysholm knee score. In our study radiological union was seen in 16(72.7%) patients and nonunion was observed in 6(27.3%) patients. (Graph 4)



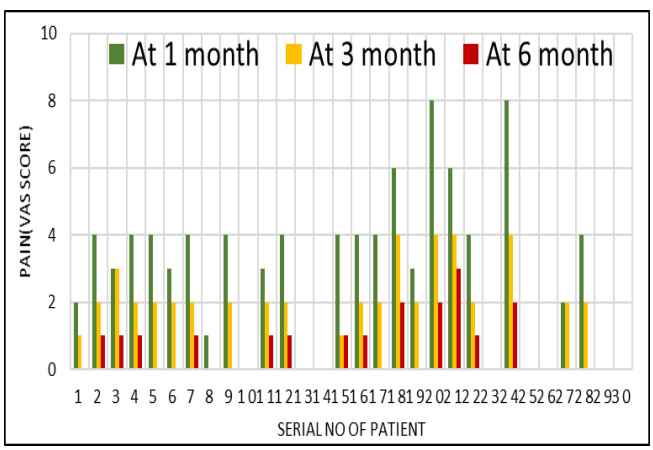
Graph 1: Distribution of Fractures as per AO Classification



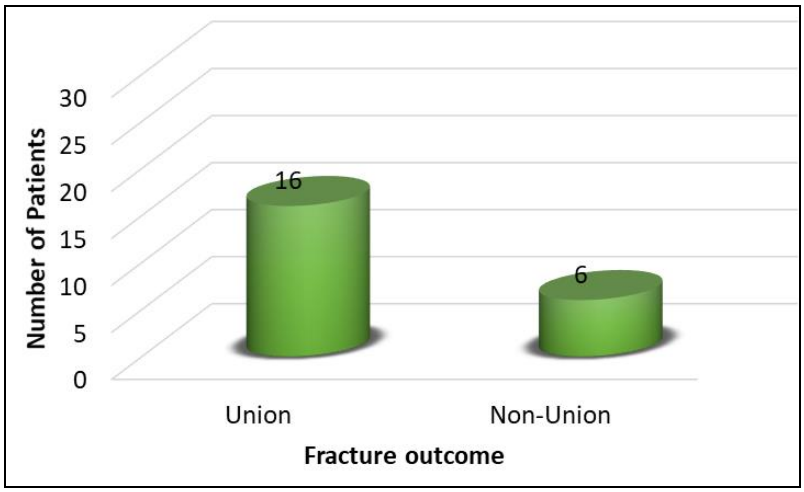
Graph 2: Scatter Diagram Showing Coronal/Sagittal Plane Alignment of Patients



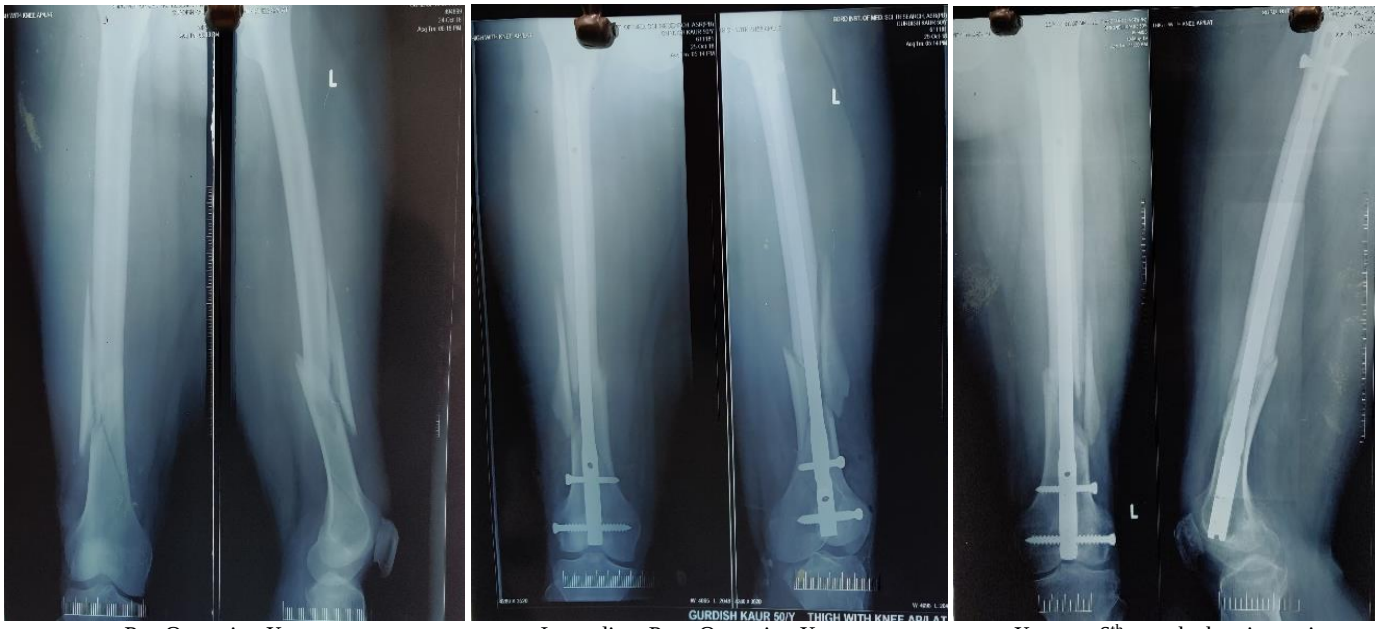
Graph 3: Distribution of Patients on the Basis of Pain at Each Follow Up



Graph 4: Distribution of patients on the basis of union



Graph 5: A 50 year old female with fracture left distal one third shaft femur. Fracture shows union at 6 months.



Pre-Operative X-ray | Immediate Post-Operative X-ray | X-ray at 6th month showing union

Discussion

Out of 30 patients, 8 patients lost in follow up (2 Patients died during follow up and 6 patients lost in follow up due to COVID 19 pandemic) and 22 patients were followed up for a period of 6 months. End result of all the cases have been summarized below. Patients were followed up regularly at first, third and sixth-month post operatively.

In our study 22 patients were male and 8 patients were female. The age of patients ranged from 19 to 75 years with the mean age of 44.97 year. Most common mode of injury is Road Side Accidents which accounted for fracture in 25(83.3%) and 5 patients with fall (16.7%). As per AO classification 19 patients had Type A, 6 patients had Type B, and 5 patients had type C fractures respectively.

Mean duration of surgery was 96.77±22.24 minutes with 24 cases done in less than 120 min only 6 cases took more than 120 min. Average C-Arm exposures taken were 33.87±5.75. We achieved mean degree of flexion of 87.3±15.3 at one month, 100.5±15.6 at three months and 110±15.7 at sixth month with mean Lysholm Knee Score of 89.6±10.76. The mean score for pain as per Visual Analogue Scale was 4.05 at one month, 2.23 at three months and 0.82 at sixth month.

Our study shows 6 non-unions (27.3%), 2 malunions (one shortening >1cm, One rotational deformity $>10^0$) and one patient developed infection.

Our study shows union rate of 72.7% which was less than Kim JW *et al*. They treated 22 patients with distal one-third shaft femur fractures with Retrograde Intramedullary Nail with 86.4% union rate with no malalignment. Mean age of their study group was 36.7 years. Different Retrograde Intramedullary Nails used by them were manufactured by Deputy Synthesis having helical blade for distal locking or Zimmer having multiple distal locking options. The cause for the decreased union rate in our study can be due to different design of implant used by us. We used retrograde intramedullary nail manufactured by Sharma orthopaedic India pvt. ltd. having two transverse locking options which control the distal fragment only in one plane causing instability at the fracture site that might have led to more nonunions in our study. Another reason can be the older age of patients in our study with mean age of 44.97years. Patients may have osteoporosis that might decrease the hold of nail in the medullary canal and also the hold of screws in distal femur. In some cases, nail was pushed beyond subchondral bone of intercondylar region that might have lead to the toggling of nail inside soft medullary canal leading to decreased stability at fracture site.

Fig 5: X-ray of 23 year old male showing nonunion. Nail was pushed beyond subchondral bone with 3 transverse distal locking screws in place.

In our study we found that the positioning of patient in retrograde nailing is quite easier as it does not require any traction table which saves the time for positioning of patient which is further advantage in polytrauma patient with head injury as it decreases the total anesthesia duration. In distal femur it easy to shift C-Arm from AP to lateral and vice versa saving time as compared to GT/Piriformis entry. It is easy to make entry from distal femur because of easy accessibility and better exposure to the entry site. In our experience the distal part of the fracture was easy to manipulate with nail. So reduction was easy and fast, decreasing the duration of surgery and total number of C-Arm exposures; decreasing total radiation exposure to the doctor and staff. This was evident in our study as total number of C-Arm exposures taken were less and also lesser duration of surgery which was comparative to study conducted by Gurkan V *et al.*

In our study major complication was nonunion. Six patients went into nonunion. All the patients were managed with plate augmentation at fracture site. Plate augmentation provides additional stability at the fracture site. All the fractures united within three months after the second procedure.

Conclusion

The present study entitled "To Study the Outcome of Retrograde Nail in Distal One-Third Femoral Shaft Fra ctures" was conducted in the department of Orthopaedics, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar (Punjab) from January 2019 to March 2020. The study was approved by the Institutional Ethics Committee. A total of 30 patients with distal one third femoral shaft fractures were enrolled in the study that underwent Retrograde Intramedullary Interlocking nailing. 8 patients were lost to follow up. Mean age of study population was 44.97±17.39 years. Post-operative assessment was done using x-ray taken at 1,3 and 6 months follow up to check the union and long leg scanogram was taken at sixth month and measurements were done. Radiological union occurred in 16 (72.7%) patients and nonunion was observed in 6 (27.3%) patients. There were 9 complications in our study group; 6 were due to nonunion, 2 malunion and one infection. We strongly recommend the use of Retrograde Intramedullary Nail with multiple distal locking options in the patients with distal one-third femoral shaft fractures, keeping the distal end of the nail in subchondral bone.

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