Orthopaedics

ANALYSIS OF OUTCOMES OF INTERNAL FIXATION OF DISTAL FEMORAL FRACTURES IN ADULTS USING DISTAL FEMORAL LOCKING PLATE AND DISTAL FEMORAL NAIL

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ABSTRACT **BACKGROUND:** Fractures of the distal part of the femur are difficult to treat and present considerable challenges in management. If fractures of the hip are excluded, 31% of femoral fractures involve the distal portion. The incidence of the fractures is highest in women older than 75 years and in adolescent boys and men of 15 to 24 years of age. **AIM:** The aim of our study is to compare the results of different modes of internal fixation of different type of distal femur fractures by Distal Femoral Nail & Distal Femoral Locked Plate. **MATERIALS AND METHODS:** The study was conducted in the department of orthopedics, R.G. Kar Medical College & Hospital; I.K.B. Sarani, Kolkata – 700004. The main source of patients was those adults presenting with distal femoral fractures attending either emergency or outdoor & also patients referred from peripheral hospitals. Distal femoral fractures of AO/OTA type A fractures (i.e. extra-articular supracondylar) & AO/OTA type C1 & C2 fractures (i.e. articular simple, metaphyseal simple type & articular simple & metaphyseal multifragmentary type respectively). **RESULTS:** Our study showed that the mean hospital stay for patients treated in two different groups included the day of admission of the patient to day of discharge. Day of injury might be the same as day of admission or somewhat before that. Average intra-operative blood loss and operating time for DFN were significantly low compared to the DFLP group. **CONCLUSION:** Distal Femoral Locking Plate can be used in type A and type C fractures and also in patients in older age group with significantly higher satisfactory outcome maintaining somewhat a balance between stability and rigidity of its fixation.

KEYWORDS : Distal Femoral Nail, Distal Femoral Locked Plate, Extra-articular Supracondylar, Metaphyseal Multifragmentary.

INTRODUCTION

Fractures of the distal femur are complex injuries that can be difficult to manage, although they are not as common as femoral shaft or hip fractures and account for about 7% of all femoral fractures. If fractures of the hip are excluded, 31% of femoral fractures involve the distal portion¹. These fractures often are unstable and comminuted and tend to occur in elderly or multiply injured patients. The incidence of the fractures is highest in women older than 75 years and in adolescent boys and men of 15 to 24 years of age. Various treatment options are available for the management of these injuries. Before 1970, when techniques and implants to provide stable fixation were not developed, most of these fractures were treated non-operatively, mainly with skeletal traction with unfavorable outcomes e.g. persistent angular deformity, knee joint incongruity, loss of knee motion and delayed mobilization, especially in patients with multiple injuries². In the 1970s, the AO principles and the use of the angled blade plate revolutionized the treatment of these injuries^{3,4}. Over the past three decades, it has been recognized that closed distal femur fractures are best treated by reduction and surgical stabilization by internal fixation. As with any other fracture treatment the goal of treatment is restoration of limb function. This could be achieved by rigid anatomic articular reduction, stable fixation of the articular component to the diaphyseal component, gentle tissue handling and early mobilization. The limiting factors which are not in the hand of the surgeon are osteoporosis, small distal fragments and amount of soft tissue damage. Hence these are becoming the area of further research and limiting factors in patient outcome.

Available implants for fixation of these fractures with the above-mentioned principles are – Fixed angle Blade Plate, Condylar Buttress Plate, Dynamic Condylar Screw, Cancellous Screws, Distal Femoral Locking Plate, Retrograde Interlocking Nail and Antegrade Interlocking nail^{4,5}, but each device would have its merits over the other depending on the personality of the fractures.

In this study, internal fixations were carried out with two most commonly used and popular types of implants, as practised in our institute viz. Distal Femoral Locking Plates and Distal Femoral Nails for different types of distal femoral fractures with an intention of comparing and analysing the results as well as the merits and demerits of each of them over the other, and an attempt to come to a conclusion whether any of those implants are superior to the others in treating distal femoral fractures.

AIMS AND OBJECTIVES

In developing country like India one should consider various factors in management of fracture both bone of lower limb like morbidity following treatment, duration of non weight bearing in affected limb, rate of union, cost involved etc.

In this situation, the aim of our study is to compare the results of different modes of internal fixation of different type of distal femur fractures by Distal Femoral Nail & Distal Femoral Locked Plate.

Specific objectives of this study are

a) **Pre-operative:** injury to surgery interval.

b) **Intra operative**

- time consumed for each operations with different types of implants (to the nearest 5 min),
- Blood loss (to the nearest 50 ml)

c) **Post operative: to compare**

- time taken for the radiological union
- radiological angulations in coronal or sagittal planes, if any
- limb length discrepancy & abnormal rotation, if any
- range of movements of ipsilateral knee at post-operative 6th month.
- loss of extension of ipsilateral knee, if any
- the average time to allow full weight bearing
- average time of hospital stay
- incidence of infection
- rates of complications arising during follow up
- functional outcome by Neer-Shelton-Grantham Scoring Scale at post operative 6th month.

MATERIALS AND METHODS

Study area: The study was conducted in the department of orthopedics, R.G. Kar Medical College & Hospital; I.K.B. Sarani, Kolkata - 700004

Study population: the main source of patients was those adults presenting with distal femoral fractures attending either emergency or outdoor & also patients referred from peripheral hospitals

Inclusion criteria: Distal femoral fractures of AO/OTA type A fractures (i.e. extra-articular supracondylar) & AO/OTA type C1 & C2 fractures (i.e. articular simple, metaphyseal simple type & articular

simple & metaphyseal multifragmentary type respectively)

Exclusion criteria

1] fracture's criteria

- AO/OTA type B fractures (condylar) & type C3 fractures (intra-articular multifragmentary type)
- open fractures
- pathological fractures
- fractures with co morbid features e.g. diabetes mellitus
- fractures with distal neurovascular deficit
- Having any associated major injury (head injury, intra abdominal injury, intra thoracic injury, any associated other long bone fracture)
- peri-prosthetic fractures

2] Patient's criteria

- skeletally immature patients
- patient's age > 70 years.

Study period: from January 2011 to August 2012

Sample size: a total of 63 cases were selected, 5 of which lost in the follow up. Hence, sample size consisted of 58 patients.

Emergency Room Checklist for Assessment of Injuries

Assessment of Soft Tissue Injury

Assessment of local wound, if present.

Assessment of peripheral nerve function (sensory function as well as motor function of the leg and foot).

Assessment of Blood Supply: If impairment in perfusion or vascular injury is clinically diagnosed, diagnostic assessment using USG-Doppler study &/or conventional angiography is indicated and was performed.

Assessment of Bony Injury

The anteroposterior (AP) and lateral X-ray of the knee with distal femur were performed, based on which fracture classification was done according to AO/OTA classifications.

3D-CT scan was performed in all patients to assess displacement of fragments, intra-articular involvement, degree of comminution, as well as detection of coronal plane fractures that are difficult to identify on plane films.

In addition, X-ray view of the proximal femur and the hip joint (AP and lateral) was done to rule out a multilevel femur fracture in all cases as part of the diagnostic protocol.

Sample design: cases to be treated with different implants are selected randomly.

Study design: prospective in nature

Study tools

- Distal Femoral Nail with two lateral to medial distal locking options, full instrumentation set
- Distal Femoral Locked Plates full instrumentation set
- Image intensifier
- Other general instruments for operation
- Radiolucent operation table

Study technique: The study was conducted after approved by the ethical committee of our institute before the subjects are recruited and recommended.

All the subjects under trial had written informed consent before starting the procedures.

The study was done after approval by the ethical committee of the Institute.

RESULTS & ANALYSIS

The fractures were classified according to AO/OTA classification. The average age of the patients in this series was 44 years. The male: female ratio was 1.4:1. The commonest mechanism of injury was found to be high energy injury (74.1% of all cases). The commonest fracture pattern was AO/OTA type A (57.6%; type A1:34%), type C2 comprised of 24% of all the fractures.

Our study showed that the mean hospital stay for patients treated in

two different groups included the day of admission of the patient to day of discharge. Day of injury might be the same as day of admission or somewhat before that. Average intra-operative blood loss and operating time for DFN were significantly low compared to the DFLP group.

It was found that angulations at the fracture site at the end of fracture healing were found to occur in two planes: coronal & sagittal. For fractures fixed with DFN, one type A1 fracture had 10° of valgus angulation & 2 type A2 fractures had 5° flexion & 10° extension whereas one type C1 fracture showed 10° extension and two type C2 fractures had 10° flexion and extension each. Only 1 patient treated with distal femoral locking plate showed 10° varus angulation.

The DFN group had significant lower knee ROM compared to DFLP group at post-operative 6th month of follow up. Pain and knee stiffness were the main concern contributing to high percentage of unsatisfactory to poor outcome in DFN group.

We found that the deep infections were seen mainly in the plating (DFLP) group, not with DFN. Delayed union occurred in 2 cases overall, both in type C2 fractures. Non-union occurred with DFLP group, one of them (DFLP treated) having fracture near the proximal edge of the plate and infected non-union. None of the patients in the DFN group had any deep infection.

In our study implant failure with non-union was found in 1 case of type C2 fracture treated with DFLP. 1 case of type A1 treated with DFLP had fracture near the proximal end of the plate. The latter case also had infected non-union & required debridement & application of local antibiotic-mixed cement beads at post operative 7th month. This case is still in follow up.

In average Neer Score in the two groups, one way ANOVA suggests significant difference in knee score (df = 57, p = 0.003). Bonferroini post hoc test suggests that significant better score in DFLP group than DFN (p = 0.003).

For type A fractures (type A1 + type A2 + type A3) and type C2 fractures separately, the comparisons of the different parameters were made, between the two groups.

Our study showed that in A type of fracture, significant difference is found by one way ANOVA in parameters like intraoperative blood loss (df = 33, p < 0.001), radiological union (df = 33, p = 0.001), full weight bearing (df = 33, p < 0.001), Lysholm knee score (df = 33, p = 0.045)

Bonferroini post hoc test suggests

Significant lower amount of intra-operative blood loss in DFN group compared to DFLP (p = 0.000) groups. No significant difference between DFN and DFLP (p = 0.306) groups regarding radiological union. No significant difference between DFN and DFLP (p = 0.153) regarding time to allow full weight bearing. We found significant higher average values of Neer score in DFLP group compared to the DFN group (p = 0.041). Significant lower value of average knee ROM in the DFN group compared to DFLP group (p = 0.001) at post-operative 6th months. No significant differences in the two groups regarding the parameters like injury to surgery time, mean operative time and average hospital stay.

We also found that in C2 type of fracture, significant difference is found by One way ANOVA in parameters like intra operative blood loss (df = 13, p < 0.001), operating time (df = 13, p = 0.029), knee score (df = 13, p = 0.019).

Bonferroini post hoc test suggests

Significant lower amount of intra-operative blood loss in DFN group compared to DFLP (p = 0.000) group. No significant difference between DFN and DFLP (p = 0.254) groups regarding operating time. Significant lower values of knee ROM at post-operative 6th month in the DFN group compared to DFLP group (p = 0.022). Significant higher average values of Lysholm score in DFLP group compared to the DFN group (p = 0.021). No significant differences between the two groups regarding the parameters like hospital stay, time to take radiological union and full weight bearing to be allowed.

DISCUSSION

Fractures of the distal femur are important injuries that frequently lead to permanent disability. The magnitude of the functional loss results

from the combination of injuries at the level of the distal femur, the articular cartilage and the surrounding soft tissues⁶. These fractures may encompass the femur shaft with limited effects on the knee, or they may occur at the level of the supracondylar metaphysis and remain as extra-articular. Often times the fracture is located at the supracondylar level, but it may extend inferiorly towards the articular surface with different degrees of comminution, as in supracondylar-intercondylar fractures⁷. Recently, the treatment of these fractures has evolved towards a balance between the mechanical stability of the fragments and the biological viability, observing the principles of the anatomic reduction of the articular surfaces and the restoration of the femur length, as well as of the articular alignment and rotation. Current fracture patterns veer towards complex comminuted types due to the prevalence of high speed vehicles. Improved healthcare results in a longer lifespan and subsequently presents us with more osteoporotic fractures which were previously treated using conservative methods⁸. The potential involvement of the articular surface of the knee may affect stability, knee flexion, and overall patient satisfaction. More favourable prognosis has been found for fractures without a gap, with mechanical stability, with less soft tissue damage, and with sufficient nutrition.

As per different literatures, the incidence of distal femur fractures is around 37/100,000 patients per year⁸⁶. In various studies, it is seen that 27% to 45% of the distal femur fractures occur as a result of minor trauma in osteoporotic bones. In our study also, there was a bimodal distribution of the ages of all the patients (17 patients in the age group of 18 – 29 years and 14 patients in the age group of 60 – 69 years) with mean age of 44 years. We found that a high energy mechanism of fracture was predominant (74.1%) and most of the males (28/34; 82.4%) had suffered from high energy injury (e.g. Road Traffic Accidents), a fact stated by Valles-Figueroa JFJ et al⁶². So far there are no reports distinguishing between the treatment choice according to the mechanism of fracture and the results gathered for analysis purposes⁶.

There was also no significant difference in mean hospital stay between the groups in our study⁹. The average values and ranges of days of hospital stay in the DFLP group was closer and higher compared to that for DFN group, as wound care in former groups had to be taken & we usually discharged those patients after suture removal at 15th post-operative day. EJ Yeap et al⁸ in their study showed that the average length of hospitalisation was 17.2 days with a range of 8 to 34 days. No relevant explanation was provided.

In our study, significantly lower mean blood loss was seen with internal fixation by DFN (overall and for type A & type C2 fractures separately) compared to DFLP. Less operative exposure, use of guide wire and zig, less requirement of opening the fracture site were usually required during fixation with DFN and even if open reduction was required, it could be achieved through a much smaller incision. There was, however, no significant difference in the operating time required in each of the two groups, although, mean operative time was lowest for DFN group. The concept of retrograde intramedullary nailing in distal femoral fractures was developed in an attempt to fix distal femur fracture type and to ensure the advantages of minimal invasive technique in contrast to plate osteosynthesis⁹. The short operative time and limited perioperative blood loss, in DFN are clear advantages which are of utmost importance in elderly patients¹⁰.

In our study, superficial infection rate was 12% of all cases; with DFLP & DFN these are 14.3%, 10.5% & 11.1 % respectively. Deep infection rates were 4.8%, 5.2% & 0% respectively. Removal of implant & thorough debridement & administration of IV antibiotics was the treatment given in both the cases which was preceded by radiological union of the fractures.

The average knee range of motion was significantly less in the DFN group for all types of fractures as well as for type A fractures separately, compared DFLP group. For type C2 fractures, average knee ROMs were also less by significant amounts in the DFN group compared to the other group.

In the older age group (60 – 69 years), only 2 cases (14%; both treated with DFLP) showed excellent results, 3 cases (21%) showed satisfactory results, 5 cases (35%) showed unsatisfactory results & remaining 4 cases (30%) showed poor results. This high percentage of unsatisfactory and poor results in this age group could be explained by use of a strict knee rating system in which less favourable results are

inherent in advanced age⁴³ and also predominance of pre-operative osteoporosis and knee osteoarthritis in this age group. Among the type C2 fractures, only 1 fracture showed excellent result, treated with DFLP; 4 fractures showed satisfactory results, 3 fractures showed unsatisfactory results and the remaining 6 fractures had poor results.

The effects of DFLP, and DFN on the type A and type C2 fractures were studied. As mentioned before, due to lack of number of the cases in the each subgroup in type C2 fractures, efficacy of neither of the implants could be documented from our study, although there was a trend of the result being significantly satisfactory with use of DFLP in these fractures. In type A fractures, DFLP also showed significantly better Neer score and ROM compared to DFN, although union and weight bearing occurred later in the former group compared to the latter. This also might be explained by the simultaneous presence of stability and rigidity of fixation with DFLP compared to DFN, especially in type A2 and A3 fractures, where supracondylar comminution is still a matter of concern and also the higher amount of satisfactory to excellent result in the DFLP group in older age (>60 years) compared to DFN. In spite of best of efforts, inadequate reduction and/or countersinking of the nail might cause loss of significant amount of flexion¹¹ with pain and stiffness. Long-term effects on the knee joint following nail entry through the intercondylar notch are not clear. Although we did not observe any significant deterioration of joint congruency or reduction in the thickness of the articular space based on X-ray evaluation, no conclusion can be reached since the number of cases was small and the duration of follow up relatively short. Moreover, it would be difficult to separate the effect of trauma from that of intercondylar nail entry. The benefits of maintaining good fracture alignment and early joint mobilisation with the use of supracondylar nailing may prove to be more important overall for the long-term integrity of the knee joint¹².

There are certain limitations of the study as well. A larger sample population needed to be studied to reduce the “type – II” or “beta” error of the study. A better method allocation of the implants should have been adopted. Randomization was not possible as we had to calculate outcomes of two different implants in such a small sample size. The patients could not be followed-up for a longer period. Trauma- surgery interval needed to be minimized as far as possible. The patient should have been sub-classified depending upon their age, sex, or else, age matched study should have been performed. The “type – I” error or the “alpha” error of the study could be further reduced by setting the “p” value significant at 1% or 0.5% level. Perimenopausal women or further aged patients did not have their bone density calculated by DEXA scan, an expensive investigation which would have made the study more productive in evaluating the results of these implants in documented osteoporotic cases.

CONCLUSION

As it is evident from the sections, “results” and Analysis” and “Discussion”, Distal Femoral Locking Plate can be used in type A and type C fractures and also in patients in older age group with significantly higher satisfactory outcome maintaining somewhat a balance between stability and rigidity of its fixation. Although Distal Femoral Nailing with two lateral to medial distal locking options has many advantages of minimally invasive procedures, it gives worse outcome in terms of pain and stiffness of the ipsilateral knee joint, especially with increased age of the patient and in intra-articular fractures. Furthermore, careful planning and evaluation of the pre-operative fracture type and fracture personality is required for selection of a suitable implant for internal fixation of the same.

Table: AO/OTA types of fractures

AO/OTA type of fractures	Number of patients
A1	20
A2	10
A3	4
Type A (total)	34
C1	10
C2	14
Type C (total)	24

Table: Incidence rate of infections in the two groups

Infection (n = 10)	DFLP	DFN	Incidence rate
Superficial	2(10.5%)	2(11.1%)	12%
Deep	1(5%)	0	5%

REFERENCE

1. Arneson TJ, Melton LJ 3rd, Lewallen DG, O'Fallon WM. Epidemiology of diaphyseal and distal femoral fractures in Rochester, Minnesota, 1965-1984. *Clin Orthop Relat Res*. 1998;234:188-94.
2. Healy WL, Brooker AF. Distal femoral fractures: comparison of open and closed methods of treatment. *Clin Orthop Relat Res* 1983;174:166-171.
3. Chiron HS, Tremoulet J, Casey P, et al. Fractures of the distal third of the femur treated by internal fixation. *Clin Orthop Relat Res* 1974;100:160-170.
4. Olerud S. Operative treatment of supracondylar-condylar fractures of the femur: technique and results in fifteen cases. *J Bone Joint Surg Am* 1972;54:1015–1032.
5. Kregor PJ, Stannard J, Zlowodzki M, Cole PA, Alonso J. Distal femoral fracture fixation utilizing the Less Invasive Stabilization System (L.I.S.S.): The technique and early results. *Injury* 2001; 32: SC 32-47.
6. Weight M, Collinge C: Early results of the less invasive stabilization system for mechanically unstable fractures of the distal femur (AO/OTA types A2, A3, C2 and C3). *J Orthop Trauma* 2004; 18: 503-8.
7. Schandelmaier P, Partenheimer A, Koenemann B, Grun OA, Krettek C. Distal Femoral Fractures and LISS Stabilization. *Injury* 2001; 32: SC 55-63.
8. EJ Yeap, AS Deepak, Distal Femoral Locking Compression Plate Fixation in Distal Femoral Fractures: Early Results. *Malaysian Orthopaedic Journal* 2007 Vol 1 No .1 108472; NV-OA4 pg12-17.
9. Moed BR, Watson JT. Retrograde nailing of the femoral shaft. *J Am Acad Orthop Surg*. 1999;7:209–216.
10. El-Kawy S, Ansara S, Moftah A, Shalaby H, Varughese V. Retrograde femoral nailing in elderly patients with supracondylar fracture of the femur; is it the answer for a clinical problem? *Int Orthop*. 2007; 31:83-86.
11. Ostrum RF, Agarwal A, Lakatos R, Poka A. Prospective comparison of retrograde and antegrade femoral intramedullary nailing. *J Orthop Trauma* 2000;14:496–501.
12. Saw A, Lau CP. *Journal of Orthopaedic Surgery* 2003; 11(2): 141–147.