COMPARATIVE STUDY OF INTERNAL FIXATION OF DISTAL FEMORAL FRACTURES IN ADULTS USING DYNAMIC CONDYLAR SCREW AND DISTAL FEMORAL NAIL

Orthopaedics

Dr. Anindya Basu	Assistant Professor, Department of Orthopaedics, Kolkata Medical College, Kolkata, WB.
Dr. Imran Khan*	Senior Resident, Department of Orthopaedics, Kolkata Medical College, Kolkata, WB. *Corresponding Author
Dr. Debarshi Jana	IPGMER and SSKM Hospital, Kolkata, WB

ABSTRACT

BACKGROUND: Distal femoral fractures are uncommon, usually complex and account for about 7% of all femoral fractures. These fractures often are unstable and comminuted and tend to occur in elderly or multiply injured patients. The incidence is highest in women older than 75 years and in adolescent boys and men 15-24 years. **AIM:** To compare the results of different modes of internal fixation of different type of distal femur fractures by Distal Femoral Nail and Dynamic Condylar Screw. **MATERIALS AND METHODS:** The study was conducted in the department of orthopaedics, R.G. Kar Medical College & Hospital; 1, 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:** Most of the patients were operated on an average of 6.5th day from injury. Average intra-operative blood loss and operating time for DFN were significantly low compared to the other group. The average duration of hospital stay was 14.7 days overall. No groups showed significant higher duration of the same. **CONCLUSION:** Dynamic condylar Screws give results in treating pure supracondylar or complete intraarticular fractures, although with less satisfactory outcomes especially in the latter.

KEYWORDS

Distal Femoral Fracture, Distal Femoral Nail, Dynamic Condylar Screw.

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 fixation⁶. 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 nail⁵, 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. Dynamic Condylar Screws 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 and Dynamic Condylar Screw.

Specific objectives of this study are:

- a) Pre-operative: injury to surgery interval.
- b) Intra operative:
 - i. time consumed for each operations with different types of implants (to the nearest 5 min),
 - ii. Blood loss (to the nearest 50 ml)
- c) Post operative: to compare
 - i. time taken for the radiological union
 - ii. radiological angulations in coronal or sagittal planes, if any
 - iii. limb length discrepancy & abnormal rotation, if any
 - iv. range of movements of ipsilateral knee at post-operative 6th month.
 - v. loss of extension of ipsilateral knee, if any
 - vi. the average time to allow full weight bearing
 - vii. average time of hospital stay
 - viii. incidence of infection
 - ix. rates of complications arising during follow up
 - x. 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 orthopaedics, R.G. Kar Medical College & Hospital; 1, 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 --
 - a. AO/OTA type B fractures (condylar) & type C3 fractures (intra-articular multifragmentary type)

- b. open fractures
 - c. pathological fractures
 - d. fractures with co morbid features e.g. diabetes mellitus
 - e. fractures with distal neurovascular deficit
 - f. Having any associated major injury (head injury, intra abdominal injury, intra thoracic injury, any associated other long bone fracture)
 - g. peri-prosthetic fractures
- 2] Patient's criteria –
- a. skeletally immature patients
 - b. 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:

- a) Dynamic Condylar Screw full instrumentation set
- b) Distal Femoral Nail with two lateral to medial distal locking options, full instrumentation set
- c) Image intensifier
- d) Other general instruments for operation
- e) 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.

We found 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 DCS 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. Out of the fractures fixed with DCS, one type A1 & one type C1 fracture showed 5° & 10° valgus angulations.

The DFN group had significant lower knee ROM compared to DCS 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

Our study showed that deep infections were seen mainly in the plating (DCS) group, not with DFN. Delayed union occurred in 2 cases overall, both in type C2 fractures. Non-union occurred with DCS group. None of the patients in the DFN group had any deep infection.

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 no significant difference in score between DFN and DCS groups (p = 0.577).

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.

It was found 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 DCS (p = 0.000) group. Significant earlier values in weeks for radiological union of fracture in the DFN group compared to DCS group (p = 0.001). Significant delayed allowance of full weight bearing in the DCS group compared to DFN group (p = 0.000). 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 DCS (p = 0.000) group. Significant lower operating time in minutes in the DFN group compared to DCS group (p = 0.028). No significant difference between DFN and DCS (p = 0.340) groups regarding knee ROM. No significant difference of the Lysholm score between DFN and DCS (p = 0.480). 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 al⁹. 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 study. The average values and ranges of days of hospital stay in the DCS 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 DCS. 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 osteosynthesis¹⁰. The short operative time and limited perioperative blood loss, in DFN are clear advantages which are of utmost importance in elderly patients¹¹.

Shortening was seen in type A2, type A3 & type C2 fractures, i.e. fractures with supracondylar comminution. Reduction was performed by ligamentotaxis alone using manual traction or a trans-tibial wire or by direct manipulation at the fracture site and corroborated with the limb length of the normal side intraoperatively. None of the shortening was > 1.5 cm. Siliski et al.¹² reported that 15 of 52 patients in their series of distal femur fractures treated with plate fixation had limb shortening of 1 to 3 cm. Shortening was intentional in 11 patients to allow impaction for better bone healing. In our study, we aimed to restore original bone length. One patient, treated with DFN had 1.5 cm femur shortening which was most likely due to less stability of fixation while performing interlocking of the nail. Other patients had shortening ≤ 1 cm that did not interfere with their gait. Intentional fracture impaction was not necessary in any case. In fact, it was avoided in cases of osteoporotic bones.

Loosening of distal bolts in osteoporotic bone is a major problem and is subject to various attempts to improve the purchase of the distal screws/bolts^{13,14}. In the current series, there was only one case with type C2 fracture fixed with DFN with this surgical complication. Singh et al¹⁵ reported that 10 of 26 distal screws of T2 nails disengaged within 10 weeks in patients aged an average of 78 years. The implant removal for this patient in our study was performed at 14 months because of pain complaints when bending the knee due to distal locking bolts. During nail removal, second degree retropatellar lesions of the cartilage were obvious indicating an insufficient countersinking of the nail within the intercondylar notch. There were no signs of associated synovial metallosis.

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

Dynamic condylar Screws give results in treating pure supracondylar or complete intraarticular fractures, although with less satisfactory outcomes especially in the latter. 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: Fractures were classified by AO/OTA classification. The number of different types of fractures was as follows:

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: Implant distribution in different types of fractures

AO/OTA type of fractures	DCS	DFN
A1	8	6
A2	2	4
A3	1	1
Type A (total)	11	11
C1	5	4
C2	5	3
Type C (total)	10	7

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