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Different modalities of treatment in lower third femoral fracture including patients in all age group

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Abstract

The incidence of distal femur fracture is approximately 37 per 100,000 person per year. Typically distal femur fractures are caused by a high energy injury mechanism in young men or a low energy mechanism in elderly women. Managing these fractures can be a challenging task. Interlocking nail, supracondylar nail and nail-plate can be satisfactorily used for fixation of distal third femoral fractures while distal third femoral fracture with intraarticular extension can be treated with dynamic condylar screw. It provides rigid and strong fixation in this type of fracture. Thus permitting early mobilization of affected joint which is very essential for achieving better over all functional results post operatively.

Keyword: Fracture, Femur, Screw

Introduction

In past years number of road traffic accidents have alarmingly increased leading to an increase in number of trauma patients. This has lead to over all increase in high velocity traumatic injuries. The number of hospitalized patients of femoral fractures have been reported to 22-25% of total trauma patient admitted in orthopaedic wards & the incidence of distal third femoral fractures have also increased.

The incidence of distal femur fracture is approximately 37 per 100,000 person per year. Typically distal femur fractures are caused by a high energy injury mechanism in young men or a low energy mechanism in elderly women. Managing these fractures can be a challenging task.(1)

Distal femoral metaphyseal fractures are centered within an imaginary square based on distal articular surface, the side length of which is determined by width of condyles.(2)

Prior 1970s the majority of fractures of lower third of femur were treated non-operatively by skeletal traction & then cast bracing.(3) However, difficulties were often encountered including persistent angular deformity, knee joint incongruity, loss of knee motion & delayed mobilization.

The armamentaria of internal fixation devices available for these type of fractures is so vast that it leads to a confusing state for an orthopaedician to choose the proper implant. Various implants available today for internal fixation of these fracture are-

1. Supracondylar nail
2. Dynamic condylar screw
3. Cephalomedullary intenlocking nail
4. Intramedullary nail with derotation plate.
5. Angle blade plate.
6. Zicker nail
7. Enders nail
8. Supracondylar leaf locking plate.

Various prerequisites for internal fixation are:

1. Good general condition of the patient.
2. Availability of portable X-ray machine or IITV.
3. Adequate amount of blood.
4. Trained nursing staff & proper instrumentation.

The study was based on, use of various operative modalities like:

1. Supracondylar nail.
2. Interlocking nail.
3. Dynamic condylar screw.
4. Intramedullary nail supplemented with derotation plate.

This study was based upon AO classification of fracture distal third of femur. Evaluation was done according to criteria recommended by Neer.

The study was done at the department of Orthopaedics S.P. Medical College & associated group of hospitals, Bikaner under the able guidance of Dr. R.G Gupta, Professor & Head of the department of Orthopaedic. It is retrospective & prospective study.

Anatomy

The lower end of femur is anatomically and biomechanically a very complex structure, with its peculiarities, which are best suited to its function. It is heavily loaded and stressed during weight bearing. This end of femur, makes part in formation of knee joint which has one of the most complex ligament support. Fracture of lower end of femur particularly supracondylar fractures with intercondylar extension requires skillful surgical management to preserve near normal knee joint movements that actually each patient wants.

The lower end of femur is widely expanded and thus provides a good bearing surface for the transmission of the weight of the body to the top of the tibia. It consists of two prominent masses of bone, the condyles, which are partially covered by a large

articular surface. Anteriorly the two condyles are united and are continuous with the front of the shaft; posteriorly they are separated by a deep gap, the intercondylar fossa (intercondylar notch), and they project backwards considerably beyond the plane of the popliteal surface.

The lateral condyle is flattened on its lateral surface and is not so prominent as the medial condyle, but it is tauter and stronger, for it is placed more directly in line with the shaft and probably takes a greater share in the transmission of the weight to the tibia. The most prominent point on its lateral aspect is termed the lateral epicondyle, and the whole of this surface can be felt through the skin. A short groove, deeper in front than behind, separate the lateral epicondyle from the articular margin below and behind.

The medial surface of the condyle forms the lateral wall of the intercondylar fossa.

The medial condyle possesses a bulging, convex medial aspect, which can be palpated without difficulty. Its uppermost part is marked by a small projection, termed the adductor tubercle because it gives insertion to the tendon of the adductor magnus. The tubercle is an important bony landmark for the surgeon, and can be identified most readily when it is approached from above. It is, however, often a facet, rather than a tubercle. The most prominent point on the medial surface of the condyle is below and a little in front of the adductor tubercle and is termed the medial epicondyle. The lateral surface of the condyle is the roughened medial wall of the intercondylar fossa.

Mechanism of Injury: The mechanism of injury in most lower third femoral fracture is thought to be axial loading with varus/Valgus or rotational forces. In younger patients the injury is typically seen following high energy trauma related to motor vehicle or motorcycle accidents. In such patients there may be considerable fractures fragment displacement, comminution, open would and associated injuries. In elderly patients these fractures frequently occur following a minor slip and fall on flexed knee, leading to comminuted fractures through compromised osteoporotic bone. The deformities that result from supracondylar fracture femur are produced primarily by direction of initial fracture displacement and secondarily by pull of thigh muscle spasm and irritability in quadriceps and hamstrings visually leads to limb shortening and angulation at fracture site. The typical varus deformity is usually the result of pull of adductor muscles, contraction of gastrocnemius muscle often produces posterior angulation or displacement of distal fragment. In supracondylar fractures with intercondylar extension, muscle attachment to respective femoral condyles tends to produce splaying and rotational malalignment and contribute to joint incongruity. Anterior displacement or angulation seldom occurs in supracondylar fractures of the femur.

Aims & Objectives

1. Retrospective & prospective study of fracture distal third femur in terms of incidence, sex ratio & type of fracture.
2. To compare the results of various fixation methods of fracture lower one third of femur.
3. To evaluate different kinds of implant used for internal fixation of fracture lower third of femur.

Operative Procedures

1. Supracondylar nail
2. DCS
3. Cephalomedullary Interlocking nail
4. Intramedullary nail supplemented with derotation plate.

Indications

1. Open & closed distal third femoral fractures.
2. Displaced Intra articular fractures.
3. Irreducible fractures.
4. Most open fractures.
5. Severe ipsilateral limb injuries (e.g. patellar, tibial plateau fracture).

Contraindication for internal fixation

1. Active infection.
2. Severely contaminated open fracture
3. Patients with unstable multiple injuries

DCS: DCS is particularly useful in distal femoral fracture with comminution extending proximally into the femoral shaft. It is a two piece device so allows the degree of freedom in the sagittal plane, thereby minimizing fixation errors. But in low supracondylar fracture, the condylar screw may not provide as much rotational control of the distal fragment as the 95^0 condylar blade plate. Its shoulder is prominent and cause knee pain as iliotibial band slides over it. AO type C3 fracture are best treated with plating technique. Preferably at least 4 cm of intact medical cortex in medial femoral condyle should be there.

Review of Literature

In recent years with increasing motor vehicle accidents, there is high incidence of high velocity trauma particularly fracture shaft of femur in adult patients. In older person femur is more commonly fractured around hip joint due to trivial trauma. Among all femoral fractures 15% are in the distal third region. Datas on the incidence of fracture involving lower third femur are collected from hospital record and from various studies.

Shelton[4] et al. (1963-73) treated 15 supracondylar and low shaft femoral fractures using supracondylar plate and screws. There were 61.5 percent males and 38.5 percent females with an average age of 43 years. Falls and automobile accidents were the main causes. 15 percent were open fractures. Average follow-up was

18.3 months. All patients showed excellent anatomical restoration and satisfactory functional results except one (7.7%). He reported 15.4 percent clinically insignificant deformities.

Schatzker[5] et al. (1966-72) reviewed 90 supracondylar fractures but only 68 cases were analyzed. 26 were males and 42 females. Average age was 54.2 years (range 16-89 years). Automobile accidents and falls were the main cause. Fractures were grouped as supracondylar (47), unicondylar (8) and T or Y intercondylar(16). These were further subdivided into surgical and non-surgical groups. There were 5 open fractures in each group. Surgical group (32) were operated by AO supracondylar plate, lag screw alone, IM nail, Wright plate, K wires, Elliot plate and Rush pins. Average follow-up was 12 months (5 months, 3 years). In non-surgical group, patients were treated by one pin traction, two pin traction, skin traction, plaster cast and Robert Jones bandage etc. average follow-up was 13 months (15 months, 5 years).

Neer[6] et al (1967) treated 110 cases of supracondylar fractures (lower 3 inches), 59 percent were males and 41 percent were females between 23-86 years of age. 5 percent were bilateral fractures. Only 77 cases could be followed-up. He operated in 38 percent patients by using blade plate, Rush nails, plate and bolt and combination of wires bolts and screws. Conservative treatment was given in 62 percent patients like plaster and tractions. He classified the patients in 3 main groups.

Group I	Minimum displacement (stable)
Group II A	Condyles displaced medially
Group II B	Condyles displaced laterally
Group III	Conjoined supracondylar and shaft fractures.

Average follow-up was 5.6 years. Results were assessed according to numerical system (Neer, 1967).

In surgical cases, there were 31 percent excellent, 20.7 percent satisfactory and 49 percent failure while in conservative methods there were 41.7 percent excellent, 48.1 satisfactory and 11.3 percent failures.

He reported 12.8 percent post-operative infection, 10.4 percent thrombophlebitis (3 in surgical, 5 in non-surgical), psychoses 2 percent, delirium tremens in 4 percents [non-surgical cases] transient peroneal nerve palsy, 3.8 percent (2) in surgical group) 5.2 percent deaths (4) due to multiple injuries.

Muller[7] et al (1970) - described a classification which has been widely accepted. It is based on the location & pattern of the fracture and is useful in determining the treatment & prognosis of particular fracture. Considering all fracture within the trans epicondylar width of the knee distal femoral fractures are classified into 3 principle types. Each comprising 3 sub groups further:

Type A Extra articular fracture involving distal shaft only.

Group A1	Simple extra articular fracture.
Group A2	Metaphyseal wedge fracture.
Group A3	metaphysical complex fracture.

Type B are unicondylar fracture and involves the articular surface of only one condyle & do not cross mid line.

Group B1 -are lateral sagittal fracture with fracture line running upward & outward detaching the lateral condyle

Group B2 –are medial sagittal fractrue detaching the medial condyle. Group B3 - Fracture in coronal plane.

Type C - Complete articular T and Y condylar fracture and characterized by a disruption of articular surface and its complete separation from the diaphysis.

Group C1 - Simple T or Y fracture with no comminution.

Group C2 - Fracture has comminuted shaft with two principle articular fragments.

Group C3 Multi-fragmentory fracture with intraarticular comminution.

Muller favored operative treatment in form of blade-plate with vertical compression using two lag screw to add stability to the lower fragments.

Mooney[8] et al (1970) studied 150 patients of distal femur fractures treated by traction followed by cast brace. He divided into 2 groups. Study group included 150 patients treated by cast brace and control group included 50 patients treated by spica cast. Age and sex were equal in both groups. In study group 70 percent fractures were in distal third and 30 percent in middle third. 82 percent were closed fractures and 67% were comminuted. Mean traction time was 7.3 weeks, mean cast time was 7.2 weeks. Mean treatment time was 14.5 weeks without non-union or refracture. In control group 50 percent were of middle and distal third each 58 percent were closed fractures, 58 percent comminuted, mean traction time was 16 weeks, mean treatment time was 24.7 weeks while 12 percent had non-union or refractures. The study group had better knee motion, less period of morbidity and early ambulatory advantage.

Zickel[9] et al (1974-76) treated 17 cases using two curved nails which were introduced in retrograde manner and fixed with screws at the distal end. There were 70.6 percent males and 29.4 percent females. Post-operatively cast bracing was applied to 35.5 percent, long leg cast to 12 percent and cylindrical cast to 6 percent patients. Mean union time was 14 weeks. Satisfactory range of motion was in 82.3 percent except in three (17.7%). He reported 1 inch shortening in 12 percent, device penetration in 6 percent and superficial infection in 6 percents Daniel Borgen,[10] Sprague BL et al [1975] reported treatment of distal femoral (fractures with early weight bearing).

An elderly patients of stiff and osteoarthritis hip may predispose to a spiral fracture of the distal femur, as the rotational force of impact is exerted at a more distal level than the hip. Although fractures of the distal

femur can be treated by various methods but they felt that best option is intramedullary fixation with proximal and distal locking, because of the osteoporotic bone. In this case principle of intramedullary nailing with proximal and distal locking were applied by using a long-stem Charnley prosthesis achieving fixation of the implant with cement proximally and locking bolts distally.

Final Assessment: Evaluation of final result was done according Neer's criteria.

Assessment of End Results: Neer score will be used for evaluation of results[22]

Functional (70 units)

a.	Pain	20 units	No Pain Occasionally On effort Function - obstructing Continuous pain, night pain	20 16 12 8 4-0
b.	Function	20 units	As before the accident Easy restriction Middle restriction Stick assistance or strong handicap Supporting apparatus	20 16 12 8 4-0
c.	Range of Motion	20 units	Normally / 135^0 100^0 80^0 60^0 40^0 20^0 or less	20 16 12 8 4 0
d.	Work	10 units	As before the accident Able to work, but with handicap Change of profession Only easy activity possible Work – unable	0 8 6 4 2-0

Anatomical (30 units)

e.	Gross Anatomy	15 units	Only swelling 5^0 angulation or .5 cm shortening 10^0 angulation or 2 cm shortening 15^0 angulation or 3 cm shortening Union but with great deformity Non Union or chronic infections	15 12 9 6 3 0
f.	Roentgen	15 units	Almost normally 5^0 angulation or .5 cm shift 10^0 angulation or 1 cm shift 15^0 angulation or 2 cm shift Union but with great deformity or spreading of condyles osteoarthirits Non Union or chronic infections	15 12 9 6 3 0
	Results	> 85 units 70-84 units 55-69 units < 55 units	Excellent Satisfactory Un-satisfactory Failure	

Summary and Conclusion

100 cases of distal third femoral fracture operated with nail-plate fixation, dynamic condylar screw fixation, interlocking nail and supracondylar nail studied in this series. The average follow up was 24 weeks.

The relevant literature on the subject was reviewed thoroughly and results were compared with established series.

The youngest patient recorded in this study was l8 years old and oldest was 75 years old female. Average age for distal one-third femoral fractures was 37.5 years.

Majority of the cases in this series were male, 78 cases (78 %) while 22 cases (22%) were females.

In this series left side involvement was present in 56% cases while 43% cases had right side. Bilateral involvement was rare only in 1% case. Most of the cases in this series were due to RTA 79%, while 22% case had fall due to any reason. The incidence of associated injury in this study was 24% out of which 14% had lower limb injuries and rest 10% had injury of other body parts.

Majority of cases (84%) were closed while 16% cases were previously healed compound. Most common type of fracture in distal one third femur fracture was AO 33type A (75%) while 14% were type B and 11% were type C.

Average injury – surgery interval was 11.4 days for I/L nail group, 12.72days for s/c nail and 9.08 days for nail-plate fixation group while 16.28 days for DCS.

Average duration of hospital stay was maximum 12 days for DCS while I/L nail, s/c nail and nail-plate group had 10 days, 8 days ans 7 days respectively.

Average duration of full weight bearing was minimum for I/L nail 11 weeks while maximum for DCS 18 weeks.

Average time taken for clinicoradiological union was 16weeks each for I/L nail and sc nail, 18 weeks for DCS and 14 weeks for nail-plate fixation group.

The maximum follow up was 1.2 years and the minimum was 12 weeks. The average follow up was 24 weeks. Superficial infection was 16% in all four groups while there was 6 (24%) cases of deep infection overall. In none of the cases there was extrusion of the implant or breakage.

Non-uion was present in 20% cases of I/L nail (8%), DCS (8%) and nail-plate (4%) while none in s/c nail.

Shortening was found in 21cases (21%), in distal one third femur region. Maximum shortening observed in this study for distal fractures was 3 cm.5^0-15^0 Angulation was found maximum in 10 cases (40%) of DCS, while minimum in 4cases (16%) of nail-plate.

Less than 90^0 movement at knee joint was present in 9 cases (36%) of DCS while 3cases (12%) of s/c nail, 2cases (8%) of nail-plate and 1 case ((4%) of I/L nail showed this range of movement.

Highest incidence of pain was present in 7 cases (28%) of DCS while only 5 cases (20%) of s/c nail and 1 case (4%) each of I/L nail and nail-plate fixation.

Normal functional activity was present in 42% cases while rest 58% had mild to moderate restriction. In this study 45% cases led to normal working ability as before accidents while 42% cases had regular but handicapped. 45% cases had normal gross anatomical and radiological appearance while 55% cases had 5^0-15^0 angulation or 0.5 -3 cm shortening. Overall 78% Patients of distal one third femoral fracture had excellent to satisfactory results [I/L nail 22 cases (88%); DCS 14 cases (56%); s/c nail 19 cases (76%) and nail-plate 22 cases (88%)] while unsatisfactory and failure rate was 22% [I/L nail 3 cases (18%); DCS 11 (44%); s/c nail 6 cases (24%) and nail-plate 2 cases (8%)].

In view of above study it is concluded that interlocking nail, supracondylar nail and nail-plate can be satisfactorily used for fixation of distal third femoral fractures while distal third femoral fracture with intraarticular extension can be treated with dynamic condylar screw. It provides rigid and strong fixation in this type of fracture. Thus permitting early mobilization of affected joint which is very essential for achieving better over all functional results post operatively.

The results of various methods of internal fixation are assessed critically. Implant used were dynamic condylar screw with long plate; interlocking nail; kunctcher nail supplemented with six/seven hole narrow dynamic compression plate and supracondylar nail. As such there are many references available in literature about the DCS fixation with long plate or interlocking intramedullary nail for the distal femoral fractures. While scanning the literature available to us we did not find any documented study of using intramedullary nail with plate fixation for distal femoral fractures. Our study compares the results of nail-plate fixation with DCS, I/L nail and supracondylar nail.

In the present study out of 100 cases 25 each cases were subjected to these modalities of treatment for distal third femoral fractures. Simple K nail does not provide stable fixation because of rotational instability due to wide medullary canal. Therefore a need was felt to supplement intramedullary nail with six/seven holes, narrow dynamic compression plate with three screw proximal and three screw distal to the fracture site, which not only prevent the rotation but also give the additional stability to fracture site. In distal third femoral fracture k-nail usually occupies the anterior half of the medullary canal, therefore it always give a room for putting the screws at lower third femur even when intramedullary nail is lying inside the canal. To our surprise we did not find any difficulty in passing the screws and putting a plate through distal third femur.

Postoperatively patient was kept without immobilization, putting operated limb on a pillow and gradual knee mobilization exercises started as soon as

stiches removed. Final outcome of these 25 patients who were treated with nail and plate fixation, was better to the patients which was treated by dynamic condylar screw, interlocking nail and supra condylar nail.

Advantages of nail plate procedure over other methods at distal third femoral fracture are that in DCS procedure we require a long DCS plate and an extensive surgical incision used to be given reaching up to the knee joint. The knee joint, capsule and suprapatellar pouch is opened up during the operation which causes prolonged rehabitlation. Adhesion formation within the joint causes reduced knee joint movements postoperatively. The extramedullary location of the bulky implant near the knee joint also causes pain.

In intramedullary interlocking nail fixation usually three incisions are made at different sites and for interlocking the distal fragment, substantial radiation exposure is always there. In communited fracture partial weight bearing has to be delayed.

In supracondylar nail entry point has to be made within knee joint and sometimes protruded end of nail causes knee pain and decrease range of motion at knee joint.

Whereas in nail plate fixation the size of the incision remain same as that of the conventional intramedullary nailing and there is no hazard of radiation exposure and time taken for surgery is less comparative to other modalities of treatment. Good anatomical rigid fixation allows better rotational control, reduced chances of shortening due to impaction of fracture fragments. Postoperatively range of knee movements and toe touch partial weight bearing can be started early due to strong fixation.

This study therefore give a conclusive evidence that distal third femoral fracture can be treated by any of the modalities described above even though as far as the advantage is concerned pendulum swings in favour of nail plate fixation.

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