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RESEARCH ARTICLE

DISTAL FEMUR FRACTURES TREATED WITH RETROGRADE FEMORAL NAIL

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Abstract

Objective: The aim of this study was to retrospectively review and evaluate the results of retrograde femoral nail for distal femur fractures with respect to range of knee flexion, early ambulation, and long term rehabilitation outcome including daily activities.

Materials and Methods: We reviewed 44 fractures of distal femur (AO classification type 33) in 43 patients treated by retrograde femoral nail at our Trauma Hospital between 2011 and 2017. Fractures consisted of type A1 (n=20), type A3 (n=17), type C1 (n=5), and type C2 (n=2). There were 37 closed (84%), seven open (16%), and four pathologic (9.1%) fractures. Mean age of patients was 43.8 years (range 16 to 83 year). The mechanism of injury was motor vehicle accident in 22 patients (51.2%), fall down in 12 patients (27.9%), and firearm injuries in 9 patients (20.9%). Associated fractures were seen in 14 patients (32.6%). Mean time to surgery was 7 days (range 2 to 15 days). Percutaneous technique was used in 39 (88.6%), and open technique used in 5 (11.4%) fractures. Functional outcome was assessed using the modified Hospital for Special Surgery knee scale. Relationship between clinical results and fracture type, surgical approach, and patient age were retrospectively reviewed.

Results: Thirty eight patients were followed (38/43 with 39 fractures) for a mean period of 24.8 months (range 16 to 58 months). Average operating time was 115 min ± 40 min. Four patients developed superficial infection, and one had deep infection, and 3 developed deep vein thrombosis. The mean time to union was 23 weeks (range 16 to 40 weeks). Delayed union was seen in four fractures (10.3%, more than 42 weeks). Five fractures (12.8%) required second surgery. The range of knee motion was normal in ten fractures (25.6%), 90°- 110° in 21 fractures (53.8%), 85° in five fractures (12.8%), and <85° in three fractures (7.7%). Using modified hospital for special surgery scale the results were excellent in 11 (28.2%), good in 14 (35.9%), moderate in 10 (25.6%), and poor in 4 (10.3%) fractures. There were five fractures with varus deformity (12.8%, 10°), two with posterior angulation (5.1%, 10°-15°), and two with loosening of distal and proximal locking screws, but no breakage of screws or nail failure.

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Conclusion: Retrograde femoral nail is good surgical option for distal femur fractures of type A and type C1, 2 AO classification.

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Introduction:-

The fractures of distal femur represent 7% of all the femoral fractures. They commonly occur in old people after fall down from body height because of osteoporosis, and in young due to high energy trauma e.g. motor vehicle accident (MVA) or firearm injuries.^(1,2, 3,4) These fractures need good alignment to restore the function of the lower limb, which can be achieved only by surgical treatment.^(1,2,5) To obtain satisfactory fracture fixation may be technically difficult, especially in severely comminuted fractures.⁽⁶⁾ There is inappropriate engagement of distal fragment in fractures treated with extra medullary devices like conventional plate, condylar blade plate, and dynamic condylar screw.^(2,7,8,9) Also technique of open reduction with soft tissue dissection and periosteal stripping to place the implant may disturb the fracture healing, leading to high rate of non-union and infection.^(10,11) The extra medullary devices have biomechanical drawbacks like stress-shielding and re-fracture.^(12,13)

Other methods including antegrade nailing, flexible intramedullary nailing, and external fixation allow minimal exposure of the fracture site but have lower axial and rotational stability compared to the retrograde nailing, so early movement of the limb might result in redisplacement.⁽¹⁴⁾ Leung et al. observed that in the very distal femur fractures the standard antegrade nails could not provide adequate control.⁽¹⁵⁾ In recent years two implants were specially designed for the distal femur and specially adapted for minimal invasive procedures with less compromise of local vascularity (biological plating): the LISS internal fixator and LCP for extra medullary, and retrograde nails for intramedullary fracture stabilization.^(16,17,18) Retrograde femoral nail (RFN) is intramedullary implant considered superior to extramedullary implants, both biologically and biomechanically. In a biomechanical comparative study, the stiffness of the intramedullary nail was superior to DCS or locking compression plate.⁽¹⁹⁾ In this study 44 distal femur fractures treated with RFN have been reviewed with regard to knee ROM, gait pattern, surgical approach, and complications. The incidence of distal femur fractures is constantly increasing as MVA and firearm injuries increase. These fractures may be associated with soft tissue injuries inside the knee joint, and to obtain good results the examination of the knee, the surgical procedure, and rehabilitation must be done properly. However, RFN is beneficial for the following: multiply-injured patients, multiple fractures including bilateral femur fractures, suspected or known spinal injuries, ipsilateral femoral neck and shaft fractures, peri-prosthetic fractures, ipsilateral tibia fractures, pregnancy and morbid obesity.^(20,21,22,23,24,25) Advantages of RFN include minimal soft tissue dissection, closed reduction technique, preservation of periosteal sleeve and fracture hematoma, adequate fixation and good control of distal fragment, shorter surgery time, minimal blood loss, minimal chance of infection, and early functional recovery, besides biomechanically is weight sharing device.⁽²⁶⁾ RFN is a good choice for the management of osteoporosis related fractures. Scheerlinck et al had good results for twelve elderly and osteoporotic patients treated with a femoral supracondylar nail.⁽²⁷⁾ Supracondylar fractures have tendency to shift into varus, with intramedullary device that maintains alignment of the femoral shaft with femoral condyles this tendency is reduced. The reduced bending movement results in less stress on the implant substantially and reduced failure of fixation in osteoporotic bone. The retrograde intramedullary nailing proved to be the most ideal technique to treat distal third femur fractures from thorough meta-analysis.⁽²⁸⁾ This retrospective study was conducted to evaluate the use of RFN for treatment of distal femur fractures.

Materials and Methods:-

In this study, 44 distal femur fractures in 43 patients were treated at our Trauma Hospital between 2011 and 2017. All fractures were surgically treated using RFN. The fractures included acute traumatic fractures, pathologic fractures, and non united fractures. Twenty-seven patients were males and 16 were females, with average age of 43.8 (16-83) year. The mechanism of trauma was MVA in 22 patients (51.2%, Table 1), simple fall down (FD) in 12 patients (27.9%), and firearm injuries in 9 patients (20.9%). One patient sustained bilateral fracture. Associated fractures were seen in 14 patients (32.6%). We classified the fractures according to AO system. They consisted of 20 type A1, 17 type A3, 5 type C1, and 2 type C2 fractures. There were seven open (16%) fractures; five due to GSW and two due to MVA, and four pathologic (9.1%) fractures as follows: metastasis from breast carcinoma (one pt.), secondary with occult primary (two pts.), and simple bone cyst (one pt. 16 Y.O.). There were two fractures followed conservative treatment with non union, and other two treated initially with other fixation devices one with DCS which had nonunion, and the other with external fixation which was exchanged to RFN. Surgery was performed on

the 2nd to 15th day following injury (mean time 7 days) under spinal anesthesia. Open approach was used in 5 fractures, and percutaneous approach in 39 fractures.

We used titanium retrograde femoral nail system (AesculapTargon RF®). Pre-operative evaluation was done on radiographs to determine nail length, diameter and lengths of interlocking bolts. Transpatellar approach was used, with mid-line incision from the inferior pole of patella to tibial tuberosity. The entry point for the nail is in the axis of the medullary canal and in the intercondylar notch, just anterior and lateral to the femoral attachment of the PCL, determined on image intensifier. Fifteen fractures were fixed using long version RFN with one locking proximal screw inserted in 12 fractures and 3 fractures were press fit proximally with no proximal screw.

Post-operatively, setting quadriceps and active or assisted bedside knee mobilization was started from the 2nd post-operative day. Toe touch weight bearing was started after 4-6 weeks, followed by full weight bearing from 10th week with the help of a walker as radiographic evidence of healing is noticed. Functional evaluation was done according to modified Hospital for Special Surgery knee rating scale (HSS). Relationship between clinical results and fracture type, surgical approach, and patient age were evaluated.

Results:-

Thirty eight patients were available for follow up (38/43 with 39fractures) for a mean period of 24.8months (range 16 to 58 months). The average operating time was 105min±25min, was longer for type C fractures than type A fractures, and for open approach than closed approach. Four patients developed superficial infection, and three developed deep vein thrombosis (DVT), all were treated conservatively. Seven patients (16, 3%) had anterior knee pain of mild to moderate severity which disappeared gradually with physiotherapy and weight bearing and ROM exercises. There were 4 patients (10.5%) with shortening of operated limb between 1 – 2.5 cm not affecting daily activities.

The mean time to union was 23 weeks (range 16 to 40 weeks). Delayed union (more than 42 weeks) was seen in four fractures (10.5%) and managed by dynamization. Five fractures (12.8%) required second surgery: one had deep infection treated with surgical debridement and IV antibiotics, two had loosening of proximal screws and backing out of distal bolt were removed after fractures became sticky (Fig.1), one underwent revision surgery and changing of the nail because of fracture redisplacement, and one patient had nail removed after union due to anterior knee pain not responding to conservative treatment. No breakage of screws or nail was seen. Functional outcome using modified HSS scale (Table 2) showed excellent results in 11(28.2%), good in 14(35.9%), moderate in 10(25.6%), and poor in 4(10.3%) fractures. Knee range of flexion (Table 3) was normal in ten fractures (25.6%), 90°- 110° in 21 fractures (53.8%), 85° in five fractures(12.8%), and <85° in three fractures (7.7%). There were five fractures with varus deformity (12.8%, 5°-10°) were tolerated and asymptomatic, and two with posterior angulation (5.1%, 10°-15°). Final knee flexion among fracture type and surgical approach showed almost similar result. Final knee arc was inversely correlated to patient age with patients younger than 55 years had very good knee ROM. Gait performance was satisfactory for isolated distal femur fractures, but less satisfactory for multiply injured patients. By the end of follow up period all fractures had united clinically and radiologically.

Discussion:-

The surgical treatment of distal femur fractures is challenging. The introduction of indirect fracture reduction techniques and less invasive approaches significantly reduced septic complications and nonunion rate, and provided specific biomechanical advantages. Seif Sawalha et al. in their series of 56 distal femur fractures in 54 elderly patients treated with RFN, concluded that RFN is good fixation method which allows immediate mobilization for elderly patients.⁽²⁹⁾ Arun K. N. et al. reported the results of 40 supracondylar and intercondylar fractures in 40 patients operated with RFN concluded that concept of biological fracture fixation is possible in these difficult and complex fractures with less operative time, minimal soft tissue stripping, minimal blood loss, decreased need for bone grafting and reasonably rigid fixation in osteoporotic bones. Post-operatively it helps in rapid mobilization and early functional rehabilitation.⁽³⁰⁾ Our study showed the same. Postoperative ROM in elderly patients was less compared to young due to preexisting conditions like osteoporosis, senile dementia, or osteoarthritis. There was no fatigue failure of the nail, while failure of distal interlocking screws and proximal screw was reported in 3 of the 43 patients, two had screws removed. Generally the closed surgical approach has some advantage over open approach, shorter duration of surgery, minimal soft tissue invasion, and less blood loss.

The significant advantage of retrograde nail is early weight bearing which cannot be recommended with plates. RFN provides reliable fracture healing and good functional results, even in the old age group, or in extreme osteoporosis. (13, 16, 31, 32, 33, 34, 35, 36) Thus excellent and satisfactory results, according to Neer's classification, are found in 72 % to 85% of geriatric collectives. (33, 35) In our study by the end of follow up period all fractures had united clinically and radiologically. El Kawy emphasized the advantage of early movement provided by IMN without decrease of mobility, though he observed in his collective a high rate (35 %) of postoperative mal-alignment. (13)

Handolin L et al. showed in their biomechanical study that IMN had higher construct stiffness and significantly lower micromotion at the fracture gap on cyclic axial compression compared to DCS or locked condylar plate. (1) So, early mobilization can be ensued with IMN. However, in the patient with osteoporotic bone and severe fracture comminution, it is very difficult to get adequate implant purchase. In the fixation of distal femur fracture, distal locking has a major effect on the implant purchase in osteoporotic bone. (37)

Several previous studies reported satisfactory results with RFN for fractures of distal femur. (1, 32, 38, 39)

In a series of 46 distal femur fractures in 44 patients the rate of union was 95% with a mean time to union was 17.5 weeks, however three patients lost reduction and two were re-operated. (1) In our study the mean union time was 23 weeks (16-40 weeks), and four fractures had delayed union (10.5%) of more than 42 weeks which were managed by dynamization. In a study by Gurkan et al. 16 distal femur fractures were treated with RFN, the mean union time was 25 weeks, and functional results were satisfactory using modified HSS scale; the knee ROM was 80° in 4 knees (24%) and below 80° in one knee (6%). (39) A survey of the literature found an average mobility of the knee joints operated with RFN for fractures of distal femur to be 104°, which is close to our results (Table 3). (35)

Bei et al. showed that many factors might affect restoration of function of knee joint following distal femur fracture like age, preoperative comorbidity, fracture pattern, reduction quality, whether or not continuous passive motion was used in rehabilitation, and postoperative complications. (40) However potential complications such as infection, knee septic arthritis, knee pain, and malunion might be seen following surgical treatment of distal femur fractures. Papadokostakis et al. in their meta-analysis reported the rate of infection as 1.1%, and knee septic arthritis as 0.18%, the rate of knee pain as 16.5%, and malunion rate as 5.2%. (31) The objective of this study was to assess clinical and functional outcomes of distal femur fracture stabilized with RFN. Our series was not consistent with that of Akib et al, which had a mean age of 63 years, against the mean age of 43.8 years. (41) MVA accounted for the majority in young population, and male patients, while simple fall down was the second most common mode in our series, while in a study conducted by Elsoe et al, they had a 61% incidence as a result of trivial trauma, this can be attributed to increased MVA in recent years. (42) Common complications encountered in our study were anterior knee pain and shortening. Less common complication was local symptoms at the distal bolt. We agree with Handolin et al, i.e. RFN is a reliable tool in treatment of distal femur fracture with a low complication rate. (1)

Conclusion:-

Retrograde intramedullary nailing using RFN is good technique for stabilization of distal femur fractures including supracondylar and intercondylar fractures. It provides a good anchorage to bone in the distal condylar segment where fracture fixation is potentially difficult because of wide canal, thin cortices, and frequently poor bone quality especially in osteoporotic patient. It is minimally invasive surgery with less soft tissue disruption and stable fracture fixation, which allows early mobilization and weight bearing with good results and low complication rates.

Table 1:- Mechanism of trauma (n=43).

Mechanism of trauma	Number of patients	Percentage (%)
MVA	22	51.2%
Simple FD	12	27.9%
Firearm injuries	9	20.9%

Table 2:- Functional outcome using modified HSS scale.

Outcome	fracturesof.No	Percentage (%)
Excellent	11	28.2%
Good	14	35.9%
Moderate	10	25.6%
Poor	4	10.3%

Table 3:- Range of knee flexion.

Range of active flexion	>110°	90°-110°	85°	85°<
No. of patients	10	21	5	3

**Fig. 1:-** Backing out of two distal locking screws with delayed union.**Fig. 2:-** Supracondylar fracture of right femur in 53 Y.O female with ipsilateral neckfemur fracture fixed with femoral neck plate and RFN.



Fig. 3:- Pathological fracture due to simple bone cyst in 16 YO female.



Fig. 4:- Fractures of both femurs in 35 YO male, left is segmental open type I fracture treated by long version RFN, right is supracondylar comminuted fracture treated by standard RFN with sound union.

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