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AO/OTA TYPE 33-C2 DISTAL FEMUR FRACTURES MANAGED WITH DISTAL FEMUR LOCKING PLATE. A FOLLOW-UP OF 40 CASES.

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KEYWORDS :

INTRODUCTION:

Fractures affecting the distal femur are very complex injuries that pose a challenge to every orthopaedic surgeon. These serious injuries have a potential to produce significant disability. Fractures of the distal femur accounted for 0.4% of all fractures. It involves about 7% of all femur fractures. [1, 2] It commonly occurs during high velocity trauma in younger group of patients and is frequently associated with other skeletal injuries. In contrast to this, elderly patients with severe osteopenia might sustain isolated distal femur fractures from trivial trauma.

The treatment of distal femoral fractures in the last decade or two; has evolved from non-operative, conservative treatment; to more aggressive, operative treatment. The aim was to achieve faster bone healing and to allow early, active mobilization of the patient and of the associated joints, thereby minimizing the side effects of joint stiffness and severe muscular atrophy encountered in the conservative treatments. [3, 4, 5] Distal Femur Locking Plate (DFLP) has given good results in AO/OTA type 33-A and type 33-B fractures; but for type C, the results are not as promising. The purpose of this study was to evaluate the clinical and functional outcome of AO/OTA type 33-C distal femur fractures treated with DFLP.

MATERIAL AND METHODS:

This is a retrospective study to access the functional outcome of patients suffering from AO/OTA type 33-C distal femur fracture and treated with DFLP at our institute from January 2014 - June 2017. Inclusion criteria were as follows: A) Patients with AO/OTA type 33-C distal femur fracture. B) Patients who were older than 18 years at the time of admission. C) Patients with minimum follow-up period of 3 years were selected for this study. Exclusion criteria were as follows: A) Patients with AO/OTA type 33-A and 33-B distal femur fracture. B) Patients who were less than 18 years at the time of admission. C) Patients with peri-prosthetic or pathologic fractures. D) Patients presenting with concomitant neuro-vascular injury. E) Patients who were not fit to undergo surgery.

As per the institution protocol and the ATLS guidelines; haemodynamic stabilisation of all patients was carried out, and injury to head, chest or abdomen ruled out and treated accordingly. If open fractures were encountered; thorough wash, sterile dressing, tetanus prophylaxis and antibiotics were given. Upper tibial skeletal traction was given in almost all patients with weights up to 3-5 kg applied depending on the weight and built of the patient, proximal displacement of the distal fracture segment. Plaster immobilisation in all patients in the form of high above-knee plaster slab was given. Standard Antero-posterior and lateral X-rays were done, Ultrasonography (FAST) was done in patients with high velocity trauma. CT-Scan of the affected knee was done in patients to identify intra-articular extensions of the fracture line. Patients were then classified as per AO Classification. All patients electively posted for surgery following anaesthetic clearance.

All surgeries were carried out at our tertiary care level 1 centre by either of the two senior surgeons in our unit. Patients were placed on a radiolucent table in supine position. A single or triple bolster was used as and when required. Lateral approach, Modified Swashbuckler approach or MIPO approach was used as deemed fit by the surgeon. Following satisfactory reduction, appropriate size DFLP was selected and slid in a distal to proximal direction over the lateral aspect of the bone. A minimum of 4 screws were fixed either side of the fracture. C-arm fluoroscopy image was taken to check the fixation. Following this thorough irrigation was carried out. Drain put whenever necessary. Closure was done in layers and pressure dressing was applied. Above knee brace was given.

In the immediate post-operative period, intravenous antibiotics were given to the patient for 1 day. Haemodynamic assessment of the patient was routinely carried out. 0.6mg subcutaneous Low Molecular Weight Heparin (LMWH) was given to prevent deep vein thrombosis. Drain was removed after 2 days. Sterile pressure dressing was carried out 6 hours after operation and was followed at 1st and 7th post-operative day. Depending on the healing response, sutures were removed on the 12th-14th post-operative day.

Patient was encouraged to perform ankle toe mobilization and isometric quadriceps contractions 6 hours after the surgery. In the early phase (1-3 Weeks) active range of motion exercises were started on the 2nd day, if fixation is stable, with emphasis on knee extension, normal patellar mobility, control of oedema and pain. Quadriceps strengthening and hamstring stretching exercises were encouraged. Gentle hip and ankle mobilization exercises were continued. In the late phase (after 3weeks), partial weight bearing was allowed. Full weight bearing was allowed after radiological evidence of healing. (6-12 weeks). All patients were followed up 2, 4, 8 and 24 weeks after surgery. Following that, they were advised to return for follow-up yearly. Neer's score and Knee Society score was calculated along with radiographic assessment regularly.

RESULTS:

The mean age of our study was 43.5 % with 33 (82.5%) males and 7(17.5%) females. Road traffic accident (RTA) was the most common

cause in 32 (82%) patients followed by fall down in 8 (20%). 22 (55%) patients suffered from close injuries whereas 18 (45%) patients suffered from open grade injuries. Open Grade (OG)-1 were encountered in 4 (10%) patients whereas OG-2 and 3 were encountered in 7(17.5%) each. AO/OTA type C1, C2, C3 were encountered in 15 (37.5%), 13 (32.5%) and 12 (30%) patients respectively. Lateral approach was used in 18(45%) patients whereas, Modified Swashbuckler and MIPO was used in 15(37.5%) and 7(17.5%) patients respectively.

There were 4 Cases (10%) of infection in the early post-operative period after distal femoral locking plate in our study. Infection was further divided as either deep or superficial. Deep infections were defined as those that required operative intervention. Superficial infections were defined as those that were treated only with local antibiotics and wound care. There were 2 cases of superficial infection which responded to injectable antibiotic and regular wound management. There were 2 cases of deep infection, which required debridement. Culture sensitivity was done in both the cases and injectable antibiotics were started accordingly. 2 (5%) patients suffered from late infection in our study; that occurred after 10-12 months of definitive fixation. In both these patients, implant removal and debridement was carried out. Complete union was achieved in both these cases. 6 patients (15%) suffered from knee stiffness. Aggressive physiotherapy followed by mobilization under general anaesthesia was done for these patients. None of these patients required any operative intervention. In 6(15%) patients union was achieved by 4 months, whereas union occurred at 5th and 6th month in 20(50%) and 11(27.5%) patients repectively. In 3 (7.5%) patients, union was achieved after 6 months. There were 3 cases (7.5%) of delayed union that healed eventually; without any surgical intervention. There were no cases of non-union, mal-union and broken implant in our study. Average union Rate was 5.42 months. Average time for bone union in close fractures was earlier (5.09 months) as compared to open fractures; averaging 5.52 months. In our study, 32.5% (13) patients required a secondary procedure. 3 patients (7.5%) required debridement for deep infection. 4 patients (10%) required bone cement removal and bone grafting and 3 patients (7.5%) required additional plating with bone-graft. In 1 patient; plate had to be removed due to impingement of the screws on the medial aspect after full bony union. In 2 patients; plate was removed due to infection after 10-12 months of definitive fixation. In both these case union was achieved.

In our study 25 patients (62.5%) have 101°-135°of knee flexion and 12 patients (30%) have 81°-100° knee flexion. Knee stiffness was defined as restriction of knee flexion up to 90°. Patients with AO type C1 (13 patients, 32.5%) had near normal flexion at final follow-up. 1 patient (2.5%) with AO type C2 had 61°-80° knee flexion. In patients suffering from AO type C3 fractures, 1 patient (2.5%) had 41°-60° knee flexion, whereas 1 patient (2.5%) had 61°-80° knee flexion.

In our study, Excellent outcome was reported in 17(42.5%) patients, whereas 20(50%) patients showed satisfactory outcome. 3 (7.5%) patients showed unsatisfactory outcome according to Neer's Scoring System.

In our study, of the total 18 open grade fractures; only 3 cases (7.5%) had excellent results; 12 cases (30%) had satisfactory outcome and 3 cases (7.5%) had unsatisfactory outcome. 14 cases (35%); of the 22 close fractures had excellent outcome and rest 8 cases (20%) had satisfactory outcome. All the cases with unsatisfactory outcome were in open fracture group. (Table 1)

Table 1. Results in open and closed injuries.

Type of Fracture		No. of patients	Excellent	Satisfactory	Un satisfactory	Failure
Open	Og1	4	3	1	0	0
	Og2	7	0	6	1	0
	Og3	7	0	5	2	0
	Total	18	3	12	3	0
Closed		22	14	8	0	0
Total		40	17	20	3	0

In our study, excellent results were obtained with lateral and swashbuckler approach in 6 patients (15%) each, whereas unsatisfactory outcome were maximum in Lateral approach (2 patients, 5%) followed by swashbuckler approach (1 patient, 2.5%). (Table 2)

Table 2. Results as per the Surgical Approach.

Surgical approach	Excellent	Satisfactory	Unsatisfactory	Failure
Lateral Approach	6	10	2	0
Swash Buckler Approach	6	6	1	0
MIPO	5	2	0	0
Lateral + Medial Approach	0	2	0	0
Total	17	20	3	0

In our study; AO type C1 had excellent functional outcome in 11 patients (27.5%) and satisfactory in 4 patients (10%). AO type C2 had 4 cases with excellent outcome (10%), 8 cases (20%) of satisfactory outcome and 1 case (2.5%) had unsatisfactory outcome. AO type C3 maximum unsatisfactory outcomes in 2 patients (5%). (Table 3)

Table 3. Results according to classification of fracture:

Type of Fracture	Number	Percentage	Excellent	Satis-factory	Unsatis-factory	Failure
C1	15	37.5%	11	4	0	0
C2	13	32.5%	4	8	1	0
C3	12	30%	2	8	2	0
Total	40	100%	17	20	3	0

DISCUSSION:

The principles and goal of treatment of complex intra-articular distal femur fractures are precise anatomical reduction and fixation of the articular surface, stabilization of the meta-diaphyseal component and restoration of femoral length and condylar rotation. ORIF is the most reliable method to ensure articular surface restoration. Coronal plane alignment has been shown to be the most difficult factor to control and the most crucial to overall outcome. Mal-alignment in the axial and sagittal planes also affects knee kinematics and range of motion. [6]

The distal femur locking plate system offers a number of advantages in fracture fixation; combining angular stability through the use of locking screws with traditional fixation techniques. However, the system is complex; requiring careful attention to biomechanical principles and good surgical technique. The angular stability provided by LCP at the plate-screw interface; allows extra periosteal fixation of the plate to bone. By preserving periosteal blood supply to the bone; it addresses the importance of the biological factors involved in fracture healing. The principles of flexible fixation are employed where the goal is for indirect healing with the formation of callus.

With DFLP, fracture union was achieved in all the cases, along with good ROM at knee joint (mean ROM being 114 degrees). Similar results were obtained by Rademakers et al., in their study on 67 patients and at 1-year follow-up mean knee range of motion of 111 degrees with excellent Neer's score. Study concluded that surgical treatment of mono and bicondylar femoral fractures shows good long-term result after open reduction and internal fixation and knee function increases through time, though the ROM does not increase after 1- year [7]. Similar results were produced by Indian authors on Indian patients by Virk JS et al., and Vishwanath C et al. [8,9] (Table 4)

Table 4. Comparative Analysis of our Study with other Published studies.

Name of Study	No. of patients	Mean follow-up (months)	Mean knee Flexion	Mean Union Rate (in weeks)	Result (Neer's Scoring System)			
					Excellent	Satisfactory	Unsatisfactory	Failure
Virk JS et al. [8]	25	24	109 degree	19	11	9	5	0
Vishwanath C et al. [9]	50	6	108 degree	18	19	20	8	3
Ahire R et al. [16]	60	12	92 degree	14.7	32	19	9	0
Our study	40	24	114 degree	22	17	20	3	0

The material of implant used in our study were stainless steel and titanium, with union being achieved with good amount of callus in both cases irrespective to the material of implant. In sharp contradiction to this, a study conducted by Henderson et al.; found less callus formed in

patients treated with stainless steel plates in comparison to titanium plates. [10] Most studies have achieved positive results with both types of implants and have not made a clear distinction regarding the nature of implant to be used for obtaining good results.

Average duration of union in all the cases was 5.42 months (21-22 weeks) in this series. In close fractures the average duration of union was 5.13 months (20-21 weeks) with no case in closed group requiring secondary bone grafting. For open fractures the average duration of union increased to 5.52 months (22-23 weeks) thus, making open fractures a risk factor for delayed union in such fractures. The same concern was voiced by Ricci et al.; in their study on open fractures; acting as a risk factor for longer duration of union. Besides this they also found diabetes, smoking and increased body mass index as independent risk factors affecting fracture union and out of surgeon's control. One risk factor within surgeon's control affecting fracture union and possible cause of failure was use of shorter plate length. Use of longer plates and the technique of spanning comminuted fractures can be detrimental in obtaining positive results and avoiding failure [11].

Complications related to slow healing including delayed union, non-union; are not infrequent and are ongoing problems in managing these fractures[10]. Earlier studies have shown reduced non-union rates for locked plating of distal femoral fractures compared to non-locking plates, but more recent studies found nonunion rates up to 20% [10,12]. In the current study, 7.5% of the fractures showed signs of delayed union. No cases of non-union were encountered in our study. Multiple reasons influence union rates that can be attributed to the coexisting patient morbidity, comminution at the fracture site and initial damage to the surrounding soft tissue. In a systemic review by Zlowodski et al. [13]; comparing traditional plating, intramedullary nails and locked plates, no observed differences were found between implants regarding the rate of non-union, infection, fixation failure or revision surgery. Infection was found in 4 cases (10%) in our study. There were 2 cases of superficial infection which responded to injectable antibiotic and regular wound management. There were 2 cases of deep infection, which required debridement. Culture sensitivity was done in both the cases and injectable antibiotics were started accordingly. 2 patients suffered from Late infection in my study; that occurred after 10-12 months of definitive fixation. In both these patients, implant removal and debridement was carried out. Complete union was achieved in both these cases. All the patients that developed infection had open fractures. Hoffmann et al also reported near similar rate of infection 8.1% in his study of which 1 was superficial and 7 were deep infections requiring secondary surgeries. All the patients that developed infection superficial or deep were from the open fracture group. [14] Knee Stiffness was the most common late complication present in my study; affecting 6 patients (15%). This untoward complication invariably results from damage to the quadriceps mechanism and joint surface; because of the initial trauma or surgical exposure for fixation or both. Quadriceps scarring with or without arthrofibrosis of the knee or patella-femoral joint are thought to restrict knee movement. These effects are greatly magnified by immobilization after fracture or internal fixation. Degenerative osteoarthritis of the knee also affects the knee movement. Mal-alignment of 10 degrees is likely to affect knee mechanics and gait. Increased varus or valgus may lead to overloading of the joint and subsequent arthrosis of the medial or lateral compartment, respectively. Flexion–extension, rotational deformity, or shortening may affect gait and comfort during activities of daily living. In early series using traditional plates and screws, problems with fixation failure, varus collapse, and malalignment for unstable injuries occurred commonly. In a study by Davison BL et.al, supracondylar femoral fractures are especially prone to varus collapse, when there is comminution at the fracture site. [15] In the present study also 3 patients of AO type C3 united with varus mal-alignment of 10° with DFLP. We recommend that in order to prevent varus collapse; comminuted fractures should be operated with parallel plating principle addressing both the lateral and medial column.

The outcome of distal femoral fractures, like other major injuries, not only depends on bony reconstruction but also on soft tissue management. Open wounds require thorough debridement and wash for prevention of complications and achievement of better knee functions. Special emphasis was given to all compound fractures in the study, all the compound fractures were treated with local application of vancomycin 2 gm in the inter-muscular planes after application of the plate. Despite that 10% patients had infection. Early stable internal fixation of the fracture with meticulous soft tissue handling and immediate immobilization of the knee joint; maximize the chance for an optimal outcome after a distal femur fracture.

Although the Distal femur locking plate system offers a number of advantages in fracture management, successful outcome requires; careful pre-operative planning, precise use of biomechanical principles, and the use of the appropriate plate and screws combined with good surgical technique.

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