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Analysis of management of supracondylar femur fracture by locking compression plate

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Abstract
Background: Supracondylar fractures of femur present a huge surgical challenge. The introduction of locking compression plate (LCP) has brought a remarkable change in the management of supracondylar fractures of distal femur.
Aim: The aim of this study was to evaluate the rate of union, functional outcome and complications of these fractures treated with open reduction and internal fixation with a locking compression plate.
Materials and method: The present study was conducted in the Department of Orthopedics, RIMS, Ranchi during June 2014 to December 2015. A 40 adult patients with closed supracondylar fractures of distal femur (Muller Type-A) and treated by locking compression plate were included in this study. Variables of each patients were recorded and analyzed with respect to age, sex, fracture type, mode of injury, limb involvement, associated injuries, timing and duration of operation, duration of hospital stay in days, follow up, complications and final outcomes. Patients were evaluated both clinically as well as radiologically at 6 weeks interval for first 6 months, then every 3 months for next 6 months and then at every 6 months.
Results: The mean age of patients was 27.50 yrs. Out of 40 patients, 26 (65%) were male and 14 (35%) were female. The right femur was involved in 22 (55%) patients, and left in 16 (40%) patients while both femur was involved in only 2 (5%) patients. Clinical union was seen at 12.65 weeks (10-30 weeks) in all cases. Radiologically bridging callus was seen at 12th post-operative week and complete radiological union at a mean time of 25.73 weeks (20 - 40 weeks). 34 (85%) patients had excellent, 4 (10%) patients had good outcome and 2 (5%) patients had failure in the final result.
Conclusion: Locking compression plate fixation is a safe procedure for supracondylar fractures of distal femur with an excellent functional outcome, early clinical and radiological union and it can be done on a routine basis with a minimum risk of complications.

Keywords: Supracondylar femur fracture (Muller Type-A), Locking compression plates

1. Introduction
The femur is the largest tubular bone in the body connecting between tibia and pelvic bone. It is surrounded by the largest mass of muscles, having three portions as proximal, middle and distal third. The distal femur (supracondylar and intercondylar) comprises the distal 10 to 15 cms of the femur [1]. The supracondylar area is defined as the zone between the femoral condyles and the junction of the metaphysis with the femoral diaphysis [2]. Femur is almost cylindrical in most of its length and bowed with a forward convexity [3]. It is narrowest in the mid shaft, expands a little as it is traced upward and widens appreciably near the lower end of the bone [4]. Supracondylar fracture is known as Muller's type - A subgroup of extra-articular fractures of distal femoral fractures [5].
Distal femoral fractures account for about 7% of all femoral fracture [6]. These fractures have got wide variety of fracture patterns and they are commonly associated with injuries such as open wounds, ligament disruption and fractures of acetabulum, femoral neck and shaft, tibia, patella etc. These serious injuries have the potential to produce significant long-term disability especially when they are associated with extensive articular cartilage damage, marked bone comminution, and severe soft tissue injury [7].
Supracondylar fractures of femur is a catastrophic event with an age and gender-related bimodal distribution and occur most frequently in young men after high energy trauma and in elderly

women after a low-energy fall [1, 4]. The most common causes of such severe trauma are road traffic accidents (RTA), falls from height and gunshot injuries. The incidence is on the rise because of increasing vehicular accidents and rapid urbanization.

The management of supracondylar femoral fractures has seen a paradigm shift from non-operative measures in 1960 to biological fixation and evolution of modern implants as well as specific techniques in current times [8]. Several method of treatment of is now available; the choice of a particular method being determined by the type, location, degree of comminution, age of the patient, surgeon's expertise and the availability of implants and instruments. The surgical goals of treatment are anatomic reduction of the fracture, restoration of limb alignment, length, and rotation, bone grafting for extensive bone loss and stable fixation that allows for early mobilization. Metaphyseal comminution is a challenge to conventional plate fixation. Among the operative managements, locking compression plate gives one of the best clinical results especially in highly comminuted and osteoporotic fractures where intramedullary fixation cannot be applied due to very short distal fragment [9-11].

Locking compression plates allows both locking and compression screw fixation of the femur shaft. The pull-out strength of locking screws is substantially higher than that of conventional screws, and it is difficult for one screw to pull out or fail unless all adjacent screws do so. This enables a better hold in osteoporotic bones. The preservation of osseous viability using indirect reduction methods has led to an increase in fracture union rates without the need for supplemental bone grafting procedures. These plates are designed to apply in minimally invasive fashion to preserve local biology and avoid problems with fracture healing and infection. These locking plates forms a fixed angle construct and enables placement of the plate without any contact to the bone [12-15]. Despite the advances in techniques and the improvements in surgical implants, treatment of supracondylar femoral fractures remains a challenge in many situations.

The purpose of this study was to evaluate the rate of union, functional outcome and complications of these fractures treated with open reduction and internal fixation with a locking compression plate.

2. Materials and Methods

This prospective study was conducted in the Department of Orthopedics, Rajendra Institute of Medical Sciences (RIMS), Ranchi, Jharkhand, for a period of one and half years from June 2014 to December 2015. 40 patients with supracondylar femur fractures, aged between 21 to 70 years, irrespective of sex, were subjected to locking compression plate fixation after obtaining written informed consent. The fractures were classified according to the Muller and AO/OTA classification and type - A fractures were considered in this study.

2.1 Exclusion Criteria for subjects: Patients less than 18 years of age and had sustained compound fractures of distal femur, closed distal femur fractures of (AO/OTA) – B and C types, pathological fractures other than those due to senile osteoporosis, pregnant patients, patients who had sustained peri-prosthetic fractures and patients who were unfit for surgery were excluded from the study.

The clinical diagnosis was confirmed by routine antero-posterior and lateral radiographs of femur with knee and hip. X-rays were assessed for comminution, involvement of joint, displacement and extension of fracture to the shaft. CT scan was done in selected cases to establish the nature of fracture, commination and any intercondylar extension. After getting all pre-operative evaluation and fitness for surgery patient were operated with locking compression plate (LCP). Patients were treated with appropriate antibiotics, analgesics & anti-inflammatory medications pre & post operatively.

2.2 Operative and Surgical Technique

Patients were positioned in supine position, slightly tilting the affected limb in lateral position with a sandbag beneath the ipsilateral buttock. After scrubbing the affected limb skin was prepared by povidone iodine (10% v/v) solution and spirit, and the operating field from the buttock to the knee was draped. Fracture site was approached through a postero-lateral incision. After skin incision vastus lateralis muscle was separated from intermuscular septum and fracture site was exposed. Both the fracture fragments were reduced in anatomical position through open method.

The appropriate chosen sized plate was placed into position and stabilized with bone clamp or reduction forceps. Then stable fixation was achieved by insertion of variable numbers of locking and conventional screws which was inserted after drilling the bone through the plate and bone surface by motorized power drill or hand-drill. The skin wounds were closed over a negative suction drain after thorough washing with copious amount of sterile saline solution and sterile dressings applied over the limb. The operated limb was kept elevated with both the hip and knee partially flexed (10 to 15 degree).Drain was removed after 48 hrs. and Skin sutures were removed on twelfth post-operative day and patients were discharged.

Patients were evaluated post-operatively by clinical & radiological assessment. Patients were assessed for wound healing complications, time for union, weight bearing and ambulation. Quadriceps and hamstring exercises were started on 1st post-operative day followed by active and active assisted range of motion exercises of the knee. Graded weight bearing was allowed depending on X-ray and clinical assessments.

Post-operatively, patients were evaluated both clinically as well as radiologically at 6 weeks interval for first 6 months, then every 3 months for next 6 months, then at every 6 months. In each visit, Radiological assessment of union and fracture callus quality was done in addition to functional limb assessment by modified Sanders criteria.

3. Results

The present study was conducted in the department of orthopedics of Rajendra Institute of Medical Sciences, Ranchi during the June 2014 to Dec. 2015. The treatment modalities, rate of union, functional outcome and complications of treatment in 40 adult patients with closed supracondylar fractures of distal femur (Muller Type-A) were analyzed. Out of 40 patients, 26 (65%) were male and 14 (35%) were female. The maximum age of the patient in this study was 68 years and minimum being 18 years, with mean age of 27.50 years (Table-1).

The mode of fracture was presented in table-2. The majority of patients were from RTA (70%) followed fall (30%). The cases of sports or industrial accidents were not reported in this period. The involvement of right femur was in 22 (55%) patients, left femur was in 16 (40%) patients and both femurs were involved in only 2 (5%) patients. The average length of hospitalization was 30 days with a range of 10 to 40 days. The average number of days from injury to surgery was 13 days with a range of 8 to 28 days. The operative time ranged from 60 minutes to 90 minutes with average of 76 minute. There were no intraoperative and immediate post-operative complications.

Two case of superficial infection was managed by antibiotics and local wound dressing. The average range of flexion obtained postoperatively was 111 degree with a range of 70 – 150 degree. Patients were followed up from 01 to 18 months.

Successful fracture union was defined as complete bridging callus in three cortices, together with painless full weight bearing. Clinical union was comprehended at 12.65 weeks (10-30 weeks) in all cases. While Radiologically bridging callus was appeared at 12th post-operative week and complete radiological union was seen at an average time 25.73 weeks (20 - 40 weeks) (Table-3).

Based on the assessment parameters (Modified Sanders criteria) used for the final result, 34 (85%) patients had excellent outcome, 4 (10%) patients had good outcome and 2 (5%) patients had failure (Table- 4).

Table 1: Showing age and sex distribution of the patients

Age range (yrs.)	Male		Female		Total	
	No.	%	No.	%	No.	%
<20	02	7.69	01	7.14	03	7.5
21-30	14	53.84	03	21.43	17	42.5
31-40	04	15.38	02	14.28	06	15
41-50	01	3.85	00	00	01	2.5
51-60	02	7.69	03	21.43	05	12.5
>60	03	11.54	05	35.71	08	20
Total	26	100	14	100	40	100

Table 2: Showing Mode of Injury

Mode of injury	No. of patient (N=40)	Percentage (%)
RTA	28	70
Fall	12	30

Table 3: Showing time to Union (in weeks)

Mode of Assessment of Union	Duration to Union(in Weeks)	Mean duration to Union(in Weeks)
Clinical	10-30	12.65
Radiological	20-40	25.73

Table 4: Showing final outcome

Outcome	Number of patient (N=40)	Percentage (%)
Excellent	34	85
Good	4	10
Failure	2	5

4. Discussion

Supracondylar fracture of femur, historically have been difficult to treat. These fractures often are unstable and comminuted and have a potential for long term disability. The review of literature showed the application of various different implants and techniques in the management of these fractures, the uses of these devices requires a certain amount of bone stock present, which limits their uses in some fracture types. The standard buttress plate, even though, can be used in comminuted fractures, often ends with various deformity [16, 17]. Biomechanical studies revealed gross loosening because of toggle at screw-plate interface. Advance in mechanization and acceleration of travel have resulted in increased incidence of such comminuted, unstable fractures. Increasing geriatric population and osteoporosis has added to the problem [18].

Locking compression plate acts as load bearing device, stabilizing fracture fragments and ensuring early bony union. The LCP is a single beam construct where strength of its fixation is equal to the sum of all screw bone interfaces rather than a single screw's axial stiffness and pull out resistance as in unlocked plates. It acts as an 'internal fixator' and functions by splinting the fracture rather than compression and hence allows a flexible stabilization, avoidance of stress shielding and induction of callus formation [19]. Vascular compromise was minimal due to the fact that the plate does need to be in contact with the bone.

The findings of the present study was based on 40 adult patients of supracondylar fractures (Muller's type A) of femur those were subjected to open reduction and internal fixation (ORIF) using locking compression plate in the Department of Orthopedics, Rajendra Institute of Medical Sciences (RIMS), Ranchi, Jharkhand.

Among 40 patients, 26 (65%) were male and 14 (35%) were female. The maximum age of the patient in this study was 68 years and minimum being 18 years, with mean age of 27.50 years. In present study the majority (about 43%) patients were in the age group of 21 to 30 years. Similar observation was reported by Arneson TJ, Melton LJ- (1988) [20] and Mahesh D V *et al* [21] Shriharsha RV& Sapna M (2015) [22].

The cause of fracture was RTA in 28 (70%) patients and fall in 12 (30%) patients. Similar observation was reported by other authors [21-26].

The present study showed that the right femur was involved in majority patients (55%) followed by left femur (40%) and both femur in a 5% patients only. These findings are commensurate with findings of Abhijit Sarkar and Sachlang Debbarma (2016) [26]. In the present study the average length of hospitalization was 30 days with a range of 10 to 40 days. Similar observation was reported by various other researchers that the average length of hospitalization was 30 days with a range of 20 to 40 days. The mean duration of hospitalization for all patients was 18.77 days (range, 14 – 29 days) [23]. The average number of days from injury to surgery was 9 days with a range of 3 to 15 days [21].

The average number of days from injury to surgery was 13 days with a range of 8 to 28 days. Majority (87.50%) were operated in 8–14 days following injury. Similar findings also reported by Bipul *et al* (2016) [27] and Rajaiah D *et al* (2016) [25].

The average operating time in the present study was 76 minutes (60 -90 minuets) which was much lesser than that of reported by the Ej Yeap *et al* [10] was 119.2 minutes (80-180 min),Yu X *et al* [28] was 126 minutes (48-248 min),Panchal P *et al* (2016) [24] Average time duration of surgery was 124 min., and Average time duration of surgery was 110 minutes by Rajaiah D *et al*. (2016) [25].

Clinical union was seen at a mean time of 12.65 weeks (10 -30 weeks) in all cases. Similar observation was made by Weight *et al* [29] that clinical union mean time was 12 weeks (8-26 weeks) and Bae SH *et al* [30] reported mean time to union was 14.3 weeks.

In the present study the radiologically bridging callus was seen in 12 - 16 post-operative week and mean time to complete radiological union was 23.68 weeks (20 - 36 weeks). While Yu X *et al* [28] reported mean time to complete radiological union was 20.6 weeks and Ej Yeap *et al* [10] reported 18 weeks (6-36 weeks).

One of the most common complications of supracondylar femoral fractures is knee stiffness. The average post-operative active range of motion as reported by Seinsheimer *et al* [31] was 91 degrees. The average range of motion in our series is 111 degree with range of 70 to 150 degrees. There were no intraoperative and immediate post-operative complications. We had two cases (5%) of superficial infection which was managed by antibiotics and local wound dressing. Neer *et al* [32] has reported 20% infection rate.

Based on the assessment parameters (Modified Sanders criteria)

used for analysis of final outcome, in majority 34 (85%) patients had excellent outcome, 4 (10%) patients had good outcome and only 2 (5%) patients had failure. Similar observation was observed by Bae SH *et al* [30] that excellent to good outcome in 17 patients (81%), fair in 3 (14.2%) and failure in only 1 (4.7%) patients, while Su Qi *et al* [33] reported excellent in 22 (50%), good in 18 (41%) and fair in 4 (9%) patients and reported overall satisfactory result of 90% using the Sanders criteria.

Fig 1: Pre-operative X- Ray

Fig 2: Just post-operative X ray

Fig 3: 12 week follow up knee flexion is only up to 80 degree

Fig 4: 12 week follow up knee full extension of knee

Fig 5: Preoperative X Ray

Fig 6: Just post-operative X ray

Fig 7: 12weeks follow up showing full range of motion of knee joint

4. Conclusion

Locking compression plate acts as an extra-medullary load bearing device, stabilizing fracture fragments and ensuring early bony union. The locked plate-screw system produces a rigid screw-bone fixation which prevents malrotation or shortening. Further, randomized controlled studies are required in different situations to know the usefulness of this implant.

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