

Comminuted Supracondylar and Intercondylar Fractures of Distal Femur Managed by Ilizarov Method

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Abstract: Distal femur fractures are considerable challenge in management. Severe comminution, fracture extension into the knee joint and injury to quadriceps mechanism lead to unsatisfactory result in many cases regardless of the treatment. To determine the healing time and functional results of Ilizarov method for the treatment of comminuted supracondylar and intercondylar fractures of the distal femur. Duration: 4 years (April 2007 – March 2011). Prospective observational study. Fifty five patients with comminuted supracondylar and intercondylar fractures of the femur. All cases were followed by postoperative radiographs and clinical assessment. Patients were discharged upon demonstrating ability to bear partial weights and walking and in case of open fractures, wound healing or sufficiently healed wounds enabling patients to return to outpatient department for wound dressings. All patients were assessed in outpatient department weekly for one month and thereafter fortnightly till union or longer as required for rehabilitation to improve functional outcome. In all cases healing was assessed by clinical as well as radiological examination. Results revealed that There were 41 male and 14 female patients. Overall time to union was 14 to 38 weeks, mean 22, median 21, mode 19 and standard deviation was 4.7 weeks. Conclusions The Ilizarov fixator in the treatment of comminuted fractures of the distal femur was found to be safe and effective by providing stability and allowing early rehabilitation. Despite the achievement of union with satisfactory alignment, motion of the knee was uniformly limited in the patient pool.

Key words: Comminuted • Distal Femur Fractures • Ilizarov

INTRODUCTION

Supracondylar fractures of the femur occur mostly due to high-energy trauma and commonly encountered in any age group such as road traffic accident (RTA), firearm injury, fall from heights or other causes [1,2]. In aged patient causes of supracondylar fractures of femur may be due to low energy trauma such as osteoporotic bones [3]. Prior to 1970, majority of supracondylar fractures of the femur were treated conservatively. However, difficulties were often encountered such as persistent angularly deformity, knee joint incongruity, loss of knee motion and delayed mobilization [4,5].

However, in the past two decades as technology and implants have advanced most traumatologists have advocated some form of internal fixation in the management of distal femur fractures. Since supracondylar femur fractures occur due to high energy trauma they are normally contaminated and tend to be open type fractures, hence management of such injuries requires care of contaminated soft tissue, which has proven to be a major drawback in internal fixation [6].

Another concern of equal importance is illiteracy and ignorance among most of Pakistan's rural population. A sizable number of patients seek potters, bone setters and quacks for treatment of traumatic and non-traumatic

bone-related injuries which end up being harmed rather than cured. Consequently, patients with supracondylar fractures of femur report to public sector hospitals with well-established complication such as nonunion, malunion, limb shortening and superadded infections. Management options at this stage become difficult, complicated and limited. The main option available and practiced for these conditions is the Ilizarov method and it has proven to be an effective treatment modality for post-traumatic, comminuted, non-union, mal-union and contamination of supracondylar femur fracture cases, when other treatment options have failed [7].

The Ilizarov apparatus allows for gradual mechanical correction of any deformity in three dimensions including rotation, translation and angulations [8]. This system also attends dimensional correction, shortening, widening and lengthening and soft tissue defects [9].

The Ilizarov technique is a procedure used for the reconstruction of such defects, limb deformities and infections. Fractures once considered untreatable, or treatable only by means of amputation are now correctable by use of modern orthopedic surgical techniques known as the Ilizarov method [10]. The Ilizarov external fixator is best indicated for supracondylar comminuted or contaminated or open femur fractures by virtue of its advantages by allowing early weight bearing [11].

Our initial experience of managing such patients with Ilizarov technique has been quite encouraging. We intend to study its utility and establish efficacy in different respects such as bone union, correction of malformation and deformities, post-operative complications and rehabilitation issues in the supracondylar fractures of femur. The alternative options available and practiced thus far for the treatment of such conditions have not yielded better results.

MATERIALS AND METHODS

In this study 55 supracondylar and intercondylar comminuted femur fractures cases were managed from April 2007 to March 2011 (Type C2 and C3 closed or open supra and inter condylar femur fracture according to AO classification. Type IIIA and IIIB open supra and inter condylar femur fracture according to Gustillo classification).

All cases were followed with immediate postoperative radiographs and clinical assessment. They were discharged upon displaying evidence of being able to bear weights and walking. In cases of open fractures,

complete wound healing or wounds that had sufficiently healed enabling patients to visit the outpatient department for wound re-dressing. Patients were assessed in outpatient department weekly for one month and fortnightly thereafter till union or longer as necessary for rehabilitation to improve functional outcome.

In all cases healing was assessed by clinical as well as radiological examination. All fractures were labeled united upon resolution of tenderness and absence of movements at fracture site with obliterated and invisible fracture lines or there was sufficient callus formation around fracture.

Mean, median, mode, frequency, percentage and standard deviation were calculated by SPSS version 17.0 for all the variables.

Operative Procedure: After complete pre-operative work-up including assessment at pre-anesthetic clinic, arrangements for Ilizarov external fixator operation were made. Normally epidural anesthesia is administered to all the patients. All patients were operated on traction table under image intensifier. After draping, the construct was preassembled according to the fracture configuration. Fractures were reduced and smooth wires were inserted percutaneously under image intensifier to maintain the position of fracture during Ilizarov external fixation. The first transverse wire was passed through the femoral condyles and movements of flexion and extension at knee joint were assessed for earlier, easier and better rehabilitation of the knee joint to prevent stiffness. If wire moved with the knee joint movement then skin and fascia were released at the level of entry and exit of the wire to provide free movement of quadriceps muscle. During wire insertion, the wires were first gently pushed up to the bone through the skin and then drilled with pneumatic power drill. The wires came out through opposite cortex were hammered gently to push through soft tissues.

Then a ring was fastened followed by tensioning the wire either with wire tensioner or manually with spanners and the other two wires or 6mm half pins with rancho cube system were passed at least 45° to the first wire depending on the site and size of the distal condylar fragment. 1.8mm Olive tip wires were used for compression of intra articular or longitudinal fracture line to maintain the joint congruity. The 2nd half pin was applied proximal to the fracture site and fastened with the half ring with rancho cube system. Then other half pins were applied with rings and arches proximal to previous constructs respectively and fastened with rancho cube system. At times drop wires had to be used and they were attached with the help

of multiple holes plates. All the rings were larger by two-finger breadths around the thigh, knee and tibia. The wire sites were washed with hydrogen peroxide, pyodine, normal saline and dressed with pyodine soaked gauze pieces.

Post-Operative Management: Upon return from Operation Theater, epidural analgesia (10 ml solution composed of 0.5% Abocain/Bupicain, 2mL + normal saline, 8mL) was administered every 6 to 8 hours through epidural catheter for 2-3 days followed by administration of oral analgesics. Rehabilitation through patient mobilization and weight bearing and walking was determined based on the status of wound healing, patient's general health and confidence level.

Parenteral antibiotics, 2nd generation cephalosporin was prescribed for 2-3 days in closed supra condylar femoral fractures. 3rd generation cephalosporin alone or in combination with aminoglycosides depending on status of the wound were administered as best guess antibiotics in open cases. Laboratory samples were taken for gram stain, culture and sensitivity analysis at time of first debridement and antibiotics were prescribed based on the sensitivity reports.

Diagnostic x-rays were taken the following 2nd or 3rd day and adjustments made as required. Patients were examined for daily washing of fixator, cleaning and care of pins and pinholes and mobilization of joints and exercises.

At every follow-up visit in the outpatient department, fixators were checked thoroughly – and every nut and bolt tightened, wire tensioned as needed, pins sites cleaned with pyodine solution and hydrogen peroxide and washed thoroughly with normal saline. If there was any deep pin tract infection or pin loosening the patient were readmitted for drawing of laboratory sample for culture and sensitivity analysis. Adjustment or relocation of the pins was done along with surgical toilet of wounds as necessary. Patients were initiated on antibiotics based on available laboratory culture and sensitivity reports and adjusted accordingly based on test findings done later.

Radiographs were taken every 3rd week. Fixators were dynamized on callus formation and removed without anesthesia or in a few cases under anesthesia after 3-4 weeks of dynamization. Prior to removing of the fixator, the interconnecting threaded rods between the proximal and distal constructs were removed and union assessed. If there was tenderness and movement at the fracture site, the interconnecting rods were put back and fixator left in situ for another 3-4 weeks. All patients were then reviewed monthly for 3 months and their functional status

assessed. Patients were placed on exercise and rehabilitation programs and advised accordingly. Further review was warranted in cases where additional rehabilitation or care was deemed necessary.

RESULTS

Fifty-five comminuted supra and intercondylar femur fracture cases were treated. Injuries included 23 (41.81%) closed fractures and 32 (58.18%) open fractures (Table 1).

Out of 32 open fractures, there were 18 (56.3%) GIIIA and 14 (43.8%) GIIIB supra and intercondylar femur fractures (Graph 1). According to AO classification for 23 closed fractures, there were 11 (47.8%) C2 and 12 (52.2%) were C3 fractures (Graph 2).

In respect of mode of injury in the 55 cases, majority were due to road traffic accident (RTA) 34 (61.8%), 9 (16.3%) fall from height, 10 (18.1%) gunshot injury and 2 (4.9%) due to trauma (Sharp weapon) (Graph 3).

Ages ranged between 17 and 60 years with mean age being 32.80, median 33.50, mode 28 and standard deviation was 10.8 years. There were 41 male and 14 female patients. Male to female ratio was 3:1.

In this study open fracture union time was 17 to 29.7 weeks and for closed fractures between 14.3 to 38.4 weeks. The overall union time was 14 to 38 weeks with mean of 22, median 21, mode 19 and standard deviation 4.7 weeks (Table 2).

The partial weight bearing and walking ranged between 1 to 21 days with mean of 3.3 days, median 1.5 and mode 1 with standard deviation 3.98. Full weight bearing and walking ranged between 1 to 35 days with mean 9.3 median 7, mode 7 and standard deviation 8.6 (Table 3).

Almost all patients had pin site inflammation and superficial pin tract infection, 25 (45.4%) patients had pin site over granulation, 22 (40%) patients had pin loosening, 3 (5.45%) patients had pin breakage, 1 (1.81%) patient had deep pin tract infection during follow-up in outpatient department, knee joint stiffness developed in 37 (67.2%), 10 (18.1%) patients had quadriceps wasting, 28 (50.9%) patients had pain during walking, 5 (9%) patients had delayed union, 2 (3.63%) patients had muscle sagging and 1 (02.5%) patient had malunion (Table 4).

Removal of Ilizarov external fixators ranged between 14 to 38 weeks with a mean of 22, median 21, mode 19 and standard deviation 4.6.

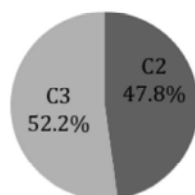
Functional outcome was assessed according to Neer Scoring System (Strength, reaching and stability) [12]. All 55 patients on final examination were assessed and

Fracture Grades - Gustillo Classification

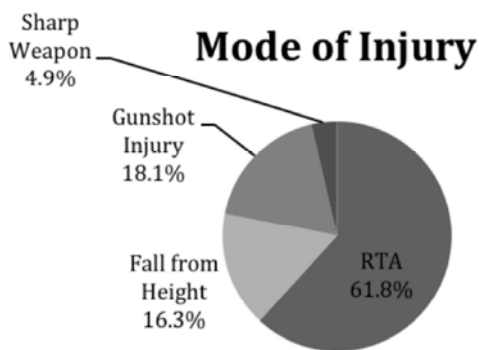


Graph 1: GIIIA and GIIIB supra and intercondylar femur fractures

Fracture Configuration - AO Classification



Graph 2: AO classification for 23 closed fractures



Graph 3: Missing

Table 1: Type of Fracture

S. No	Type	No. of Patients	%
1	Close	23	41.8
2	Open	32	58.2

Table 2: Union Time for Open and Closed Fractures

Union Time		Union Time				
For Open		For Closed				
Fracture (weeks)	Fracture (weeks)	Mean	Median	Mode	SD	
17-29.7	14.30-38.4	22	21	19	4.7	

Table 3: Weight Bearing

Weight Bearing in Days	Range	Mean	Median	Mode	SD
Partial	1-7	3.3	1.5	1	3.98
Full	1-35	9.3	7	7	8.6

Table 4: Complications with Treatment

S. #	Complications	No. of Patients	%
1	Pin Site Inflammation	55	100
2	Pin site Overgranulation	25	45.4
3	Pin Loosening	22	40
4	Pin Breakage	3	5.5
5	Deep Pin Tract Infection	1	1.8
6	Knee Joint Stiffness	37	67
7	Quadriceps Wasting	10	18.1
8	Pain while Walking	28	50.9
9	Delayed Union	5	9
10	Muscle Sagging	2	3.6
11	Malunion	1	1.8

Table 5: Functional Outcome

Quality	No. of Patients
Excellent	8 (14.5%)
Good	29 (52.7%)
Fair	14 (25.5%)
Poor	4 (7.3%)

their final functional results were as follows: 8 (14.5%) excellent, 29 (52.7%) good, 14 (25.5%) fair and 4 (7.3%) poor (Table 5).

DISCUSSION

The Ilizarov external ring fixator has considerable advantages: low blood loss, minimal surgical exposure, no additional periosteal stripping with possibly quicker healing of the fracture and greater mechanical stability than with a monolateral external fixator [13,14].

In this study patient ages ranged between 17 and 60 years with mean age of 32.8 years, median 33.5, Mode 28 and Standard deviation 10.8 years. Male preponderance was evident with 41 males and 14 females with a ratio of 3:1.

Ramesh *et al.* [15] of India in his study involving 15 cases also demonstrated a higher proportion of males to females with supracondylar fractures between the ages of 21 to 54 years, 12 (80%) were male and only 3 (20%) females.

The most common mode of injury in 55 patients of supra and intercondylar femur fractures treated with Ilizarov external fixator method was road traffic accident

(RTA), 34 (61.8%). RTA is one of the leading epidemiological concerns in developed and as well as developing countries.

Other causes of injury mentioned in this study include the following: 10 (18.1%) due to firearms, fall from heights 9 (16.3%) and 2 (3.6%) due to injury from sharp weapons. This fairly high incidence of firearm injuries can be attributed to rising terrorism, lawlessness and communal conflicts among local tribes in Pakistan.

In L.J Ramesh's study all injuries were due to RTAs, in M. Arazi's [16] study 11 out of 14 cases were due to RTA and only 3 fell from height and in Ahmed M. Abdel [17] study, 20 cases 13 (65%) were due to RTA, 5 (25%) due to firearm injury and 1 (5%) due to fall from height.

In this study the 55 supra and intercondylar femoral fracture cases were divided into open and closed fractures. The open fracture cases were 32 (58.18%) which were further sub-divided according to Gustillo classification system with 18 (56.25%) as GIIIA and 14 (43.75%) as GIIIB type.

Patients with C2 and C3 configuration according to AO classification included in this study were 11 (47.8%) with C2 and 12 (52.2%) with C3 type fractures. Pankaj Kumar *et al.* [18] in his study of 20 cases had Gustillo GIIIB open distal femur fractures. 14 had C3 and 6 had C2 fracture according to the AO classification. Ramesh *et al.* [18] in his study involving 15 cases had open fractures of C3 configuration only. Four patients were type GII, 6 GIIIA and 3 GIIIB according to Gustillo classification system. Arazi *et al.* [19] in his study of 14 cases had 10 closed and 4 open fractures of three types, GII and 1 type GIIIA according to Gustillo classification system. According to AO classification Arazi *et al.* [19] had 3 cases of A3, 2 of C2 and 9 cases of C3. In a similar study of Ahmed M. Abdel [20] had 20 open fractures around the knee joint with 19 type GII and 1 type GIIIA.

In this study union time varied from 17 weeks to 29.7 weeks for open fractures and 14.3 to 38.4 weeks for closed fractures. Overall union time per statistical analysis was Mean 22, Median 21, Mode 19 and Standard Deviation was 4.7 weeks. In L.J Ramesh's [18] study of 14 cases union time ranged from 19 to 47 weeks with an average of 19 weeks. Similarly, Arazi *et al.* [19] and Ahmed M. Abdel [20] in their studies reported union time between 10 to 24 and 11 to 18 weeks respectively.

Weight bearing ability after stabilization with external fixator was compatible to partial weight bearing at 4 days \pm 3 days in this and others studies. However, full weight bearing in this study varied from 6 days to 35 days (1 to 4.5 weeks), whereas in other studies on management

of supracondylar femur fracture treated by Ilizarov [17] External Fixator did not include time period for full weight bearing with the exception of L.J Ramesh's [18] study where full weight bearing varied between 14 and 42 days (2 to 6 weeks). Upon reviewing literature on the management of open fractures through unilateral tubular external fixators, it is apparent that weight bearing occurs at a much later period compared to circular fixators and this is also the known limitation of the unilateral fixator system.

In this study all patients developed pin track infection, 25 (45.4%) patients had pin site over granulation, 22 (40%) had pin loosening, 3 (5.5%) had pin breakage and 1 (1.8%) had deep pin tract infection. Literature demonstrates that these complications are comparable with other studies. 5 (33%) of L.J Ramesh's [18] patients developed pin tract infection, but failed to mention number of pins that were infected. Pankaj Kumar *et al.* [21] and Arazi *et al.* [19] of Turkey of Nepal in their studies reported infections in 21% of cases involved in their studies respectively. Cases in other studies were managed with appropriate antibiotics (Enteral or parenteral), adequate washing and application of antiseptic dressings as needed. However, none of the cases in this study required removal or reinsertion of pins.

Shortening of limb was observed in 9 patients (16.4%). In patients with C2 fractures the shortening varied from 1 to 1.5cm, whereas patients with C3 type fracture had shortening of 1 to 2.5cm. Upon comparing complications of shortening in this study with other studies, Pankaj Kumar *et al.* [21] reported shortening of 1 to 2.5cm with C2 type fractures and 4cm in type C3 cases, while Arazi *et al.* [19] observed shortening of 2.5cm in C3 fracture cases only.

One patient in this study had malunion with rotational element of 20°. However, patient refused correction of his rotational deformity and was excluded from study. None of the study participants with supracondylar fracture of femur with ring fixators complained of complications of malunion.

The range of movement at knee joint in this study varied from 35° to 110°. In other reported studies, the most disabling complication was loss of knee movements [19]. Whereas, range of movement in L.J Ramesh's [18] study was 40° to 90°, in Pankaj Kumar's study on C2 type fractures 110 \pm 10° and C3 fractures 73° \pm 36° and in M. Arazi's [19] study 05°. Ahmed M. Abdel *et al.* [20] has shown loss of flexion of last 15° in one patient, 20° in another and 30° in third patient. None of authors reported actual, mean, median, mode or standard deviation.

The successful outcome of results, both clinical and radiological in gross anatomy may be attributed to the added facility of traction table and image intensifier that were used with almost all the patients. The functional outcome was determined by applying Neer, Grantham and Shelton's functional and anatomical rating system to evaluate results at the final evaluation. The 100 point scale included a score of 70 points for functional evaluation (pain 20 points, function 20, range of movement 20 and working status 10 points) and 30 points for anatomical evaluation (Gross anatomy 15 and radiography 15 points).

The results were labeled as excellent when score was >85, good 70-84, fair 55-69 and poor <55.

All patients were assessed and rated based on the aforementioned criteria at the final evaluation with the following final functional outcome results: 8 (14.54%) excellent, 29 (52.7%) good, 14 (25.5%) fair and 4 (7.3%) poor. L. J Ramesh [18] and M. Arazi [19] also used this scoring system to analyze overall functional outcome. LJ Ramesh [18] labeled 10 cases as excellent and good while outcome of 3 patients were rated as fair or poor. M. Arazi [19] rated 2 patients as excellent, 7 as good, 3 fair and 2 patients as poor.

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