Genij Ortopedii Tom 23, No 1, 2017

DOI 10.18019/1028-4427-2017-23-1-6-11

Role of the Ilizarov ring fixator in management of severely comminuted supracondylar & intercondylar fractures of the distal femur

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Introduction Supracondylar and intercondylar fractures of the distal femur are often attributed to high energy trauma. Treatment of such severely comminuted fractures is challenging. Poor overlying soft tissue, bone loss in the presence of severe comminution and intercondylar extension makes implant selection difficult. Unilateral knee spanning external fixators and hybrid fixators can lead to knee joint stiffness and the issue of bone loss is difficult to deal with them. Ilizarov ring fixator is reserved for severely comminuted fractures and injuries with poor overlying soft tissues. It can effectively manage the bone loss and facilitates limb length restoration, promotes early weight bearing and mobilization**. Aim** To study the role of the Ilizarov ring fixator in management of severely comminuted supracondylar and intercondylar fractures of the distal femur. **Material and Method** A total of 13 (all male patients) consecutive patients with severely comminuted supracondylar and intercondylar fractures of the distal femur were treated from December 2013 to March 2016. There was one case with A3 type, one with C1, five cases with C2 and six cases with C3 type as per AO/ASIF Classification. Gustilo-Anderson classification was used for compound fractures. Four cases of C3 type required limited open reduction. **Results** All patients completed one-year follow-up. Average fracture union time was 20 weeks. Pin-tract infection (n = 7) was a frequent complication. Patients with C3 Type of fracture had more restriction in knee flexion (n = 5). No case had limb length discrepancy more than 2.5 cm. No case of nonunion or premature fixator removal due to infection was noted in the series. **Conclusion** Ilizarov ring fixator can be considered as one of the reliable treatment options for severely comminuted distal femoral fractures with intra-articular extension.

Keywords: Ilizarov ring fixator, ligamentotaxis compression, distraction, femur, supracondylar fracture

INTRODUCTION

Supracondylar and intercondylar fractures of the distal femur are often attributed to high energy trauma. Strong deforming muscle forces, proximity to the knee joint and vicinity of vascular structures are some of the important factors to consider during their management [1].

Complications like angular deformity, malunion and joint incongruity make the conservative line of management obsolete [1].

Varieties of treatment modalities are available like a dynamic condylar screw, fixed angle blade plate, locking plates and even intramedullary nails [2]. Satisfactory outcomes can be obtained with these fixation devices, especially in extra-articular Type A or Type B supracondylar fractures as per AO/ASIF classification [2, 3]. But treatment of severely comminuted supracondylar fractures with intercondylar extension is challenging [1, 2, 4, 5]. In the presence of severe comminution and intercondylar extension, fracture reduction and fixation with conventional methods becomes difficult [1]. Intramedullary devices are also not suitable in such situation [2].

Factors like poor overlying soft tissues as in compound fractures, bone loss in the presence of severe comminution and intercondylar extension make even implant selection difficult [2].

Conventional unilateral knee spanning external fixators and hybrid fixators can be useful in such situations [3, 6] but they may cause problems of knee joint stiffness and the issue of bone loss is difficult to deal with them [2, 3].

This stimulated us to perform a study on the role of the Ilizarov ring fixator in the management of severely comminuted supracondylar and intercondylar fractures of the distal femur (C2 and C3 Type according to AO/ASIF Classification).

The Ilizarov ring fixator is reserved for severe comminuted factures and also injuries with poor overlying soft tissues [1, 2, 3, 5, 7] but it can also effectively manage the issues like bone loss, facilitates limb length restoration, early weight bearing and mobilization [2, 3, 5, 7].

MATERIAL AND METHODS

In this prospective study, a total of 13 cases of severely comminuted and intercondylar distal femur fractures were treated with the Ilizarov ring fixator at the department of orthopaedics of the Rural medical college

Yadkikar S.V., Yadkikar V.S., Das Somnath. Role of Ilizarov ring fixator in management of severely comminuted supracondylar & intercondylar fractures of distal femur. *Genij Ortopedii*. 2017. T. 23. No 1. pp. 6-11. DOI 10.18019/1028-4427-2017-23-1-6-11.

in Loni, India, from December 2013 to March 2016.

Approval from the institutional ethical committee was obtained for this study. Prior to it, a valid informed consent was taken from all patients.

All were male patients in the 4^{th} – 6^{th} decade of life (average age was 50 years). Eleven patients had injury due to road traffic accidents while two had assaults. Four patients had associated long bone injuries which were treated with open reduction and internal fixation during the same operation.

Fractures were classified by AO/ASIF classification (**Table 1**) and Gustilo-Anderson classification was used for compound fractures (**Fig. 1, 2**). Patients with associated vascular injuries IIIC Type of Gustilo-Anderson classification and patients not willing to participate in the study were excluded.

All the patients had a preoperative skeletal traction. Average duration between the admission and operation was 8 days. Among 13 patients, two had bone loss of 4 cm and 2 cm respectively.

All the patients were operated in the supine position on a traction table. Closed reduction was obtained by traction and counter traction under image intensifier control. The knee joint was kept in moderate flexion. Closed reduction was obtained in 9 cases while 4 cases with C3 Type required limited open reduction. In compound fractures, the wound was thoroughly irrigated with normal saline.

Assembly of construct Intercondylar compression was obtained with the help of two divergent olive wires that passed through the condyles from the anterolateral to posteromedial and from the anteromedial to posterolateral directions parallel to the knee joint (**Fig. 3**). A half-ring was attached to the wires and tensioning of the wires was done with a dynamometer. Distal to proximal progressive construct was made. In the proximal fragment near the trochanter, Schanz screws were used and they were connected to the Italian arch. Distal and proximal parts of the construct were connected with threaded rods. Depending upon the stability of the construct, additional rings were mounted near the fracture site.

In two patients with bone loss, corticotomy just below the lesser trochanter was performed with the help of low energy hammering and osteoclasis (**Fig. 4, 5**). Pin tract dressing was applied. Intravenous antibiotics were given for 5 days postoperatively and changed later to oral antibiotics. Active quadriceps strengthening and knee bending exercises were started as per pain tolerance from postoperative day 3 or 4. Compression distraction cycles at the fracture site and also distraction at the corticotomy site at the rate of 1mm/day divided by four times a day were initiated by a treating surgeon/nurse) on post-op day 7 as per fracture geometry.

Table 1

Number	Age in Years	Fracture type by AO/ASIF CLASSSIFICATION	Compound by Gustilo-Anderson classification	Reduction (Open/Closed)	Fracture union time (weeks)	Pin-tract infection	Limb length discrepancy (cm)	Range of knee motion (degrees)
1	42	C2	Grade II	Closed	20	-	1 cm	0 – 90
2	55	C2	Grade I	Closed	16	+	Nil	0 – 90
3	47	C3	Grade IIIB	Open	20	+	1cm	0 – 35
4	60	C3	Grade II	Closed	16	-	1.5 cm	0 – 20
5	49	C2	Grade I	Closed	16	+	Nil	0 – 100
6	47	A3	Grade I	Closed	12	-	Nil	0 – 110
7	51	C3	Grade II	Closed	16	-	Nil	0 – 20
8	47	C3	Grade IIIA	Open	20	+	2 .5 CM	0 – 40
9	53	C2	Grade II	Closed	20	+	NIL	0 – 75
10	50	C1	Grade I	Closed	12	-	NIL	0 – 100
11	63	C 3	Grade III B	Open	20	-	2 CM	0 – 45
12	59	C3	Grade III B	Open	20	+	1CM	0 – 30
13	60	C2	Grade II	Closed	16	+	NIL	0 – 100

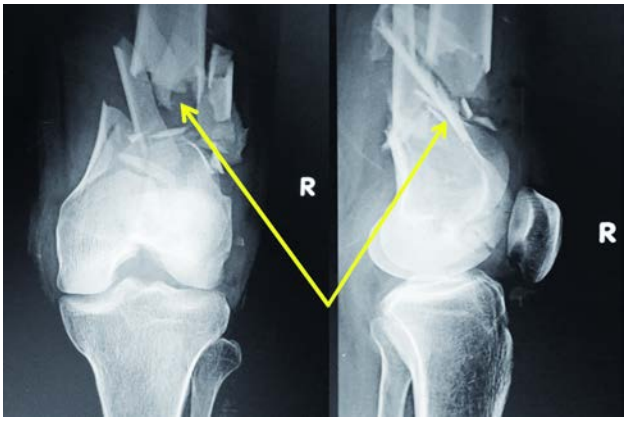

Fig. 1 Severely comminuted C 3 Type supracondylar fracture. Arrows pointing towards comminution and intra-articular extension in the lateral view

Fig. 2 Compound distal femur fracture

Fig. 3 Immediate post operative X-ray showing axial alignment following ligamentotaxis

Fig. 4 Intercondylar distal fracture with bone loss

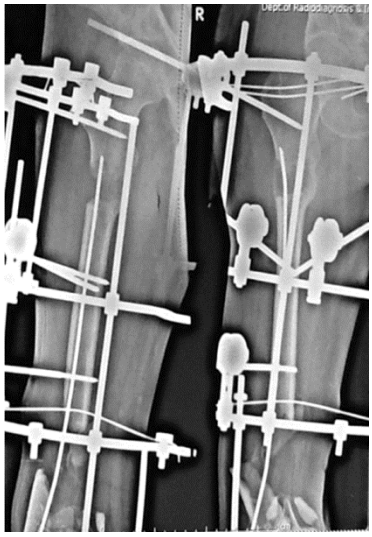

Fig. 5 Corticotomy and bone transport in a comminuted intercondylar fracture with bone loss

Approximate time required for distraction at the corticotomy site was 45 days. Non-weight bearing mobilization was initiated after 4 to 5 days postoperatively (**Fig. 6a**). It was continued for the next 4 weeks. Fracture healing was assessed clinically by absence of pain at the fracture site and radiographically by demonstration of the callus in both AP and lateral views (**Fig. 6b**). As per evidence of callus formation, partial and full weight-bearing was permitted. Frame was removed only after complete fracture union (**Fig. 7a, 7b**).

Average hospital stay was two months. The patients were reviewed at monthly intervals till frame was removed and then every three months till one year. Knee brace was used in 3 patients with severe comminution. Range of knee motion was measured with a goniometer. Leg length discrepancy was assessed by measuring the distance between the anterior iliac spine and medial malleolus on both sides.

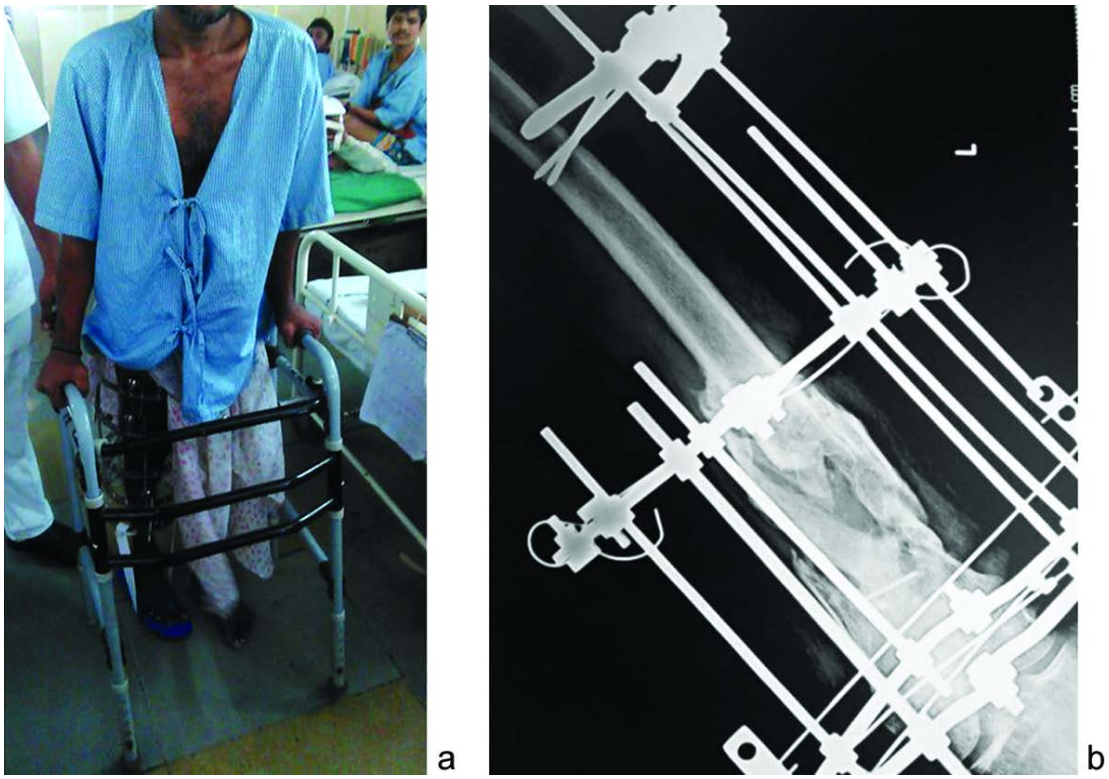

Fig. 6 Early mobilization (**a**); callus formation across fracture site (**b**)

Fig. 7 Fracture union (**a**); fracture as well as corticotomy union (**b**)

RESULTS

All patients were followed up for one year (Table 1). Average time for fracture union was 20 weeks. Fractures united in all the cases. Restricted knee flexion was frequently encountered in patients, especially with C3 Type of fractures (**Fig. 8**). In all the patients, knee extension was complete. Pin tract infection was noted in 7 patients. It was treated with daily pin tract dressing using betadine solution and intravenous antibiotics for 7 days. None of the patients required premature fixator removal due to infection. There were no cases of limb length discrepancy of more than 2.5cm.

Bone grafting was performed in none of the cases. One case showed valgus of the distal femur of 6 degrees while two cases showed varus deformity of 8 degrees. No patient required a secondary procedure due to loosening of the frame with loss of reduction. There were no cases with nonunion in our series.

Fig. 8 Limited knee flexion

DISCUSSION

Treatment of severely comminuted distal femur fractures, especially C2 and C3 fracture Type by AO/ASIF classification, is challenging [2]. Extensive comminution along with intercondylar extension makes fracture fixation with conventional implants like plates or intramedullary nails difficult [2].

Fixation with plates or dynamic condylar screws requires considerable amount of soft tissue exposure and periosteal stripping which can further devitalize bone fragments [2, 4, 8]. Though it can be done by a minimally invasive technique with intramedullary nails, intercondylar area comminution makes insertion of a nail difficult [2, 9, 10]. Poor soft tissue condition along with fracture comminution makes treatment even more complicated [1, 5].

Monolateral external fixators can be applied for such fractures but a knee spanning fixator needs to be applied sometimes in the presence of comminution and intercondylar extension that can lead to knee stiffness [2, 6].

Ilizarov ring fixator application for such fractures has certain advantages like a minimally invasive technique, versatile frame assembly which can be tailored as per fracture geometry [1, 2, 3] and facilitates bone transport, deformity correction, and correction of malalignment during the entire process of fracture healing. It provides better mechanical stability by three di-

mensional construct [2, 3, 5, 7]. Diverging olive wires provide stable fixation and compression of condyles [1, 2, 3]. Tensioned wires of small diameter for a better stability can be used even in the presence of osteoporotic bone [1]. In our series, we have used Schanz screws in the proximal femoral construct that are better tolerated by patients and are comparatively easy for fixation [2, 3, 12]. In the majority of cases (n=9), closed reduction with the help of ligamentotaxis was obtained but in several cases of C3 Type a limited open reduction was required due to severe comminution.

Frequent complications noted in our series were pin-tract infection and limited knee flexion.

Pin tract infection was controlled by local dressing and antibiotics. Limited knee flexion was seen more in C3 Type fractures [2, 3, 5, 11]. It is postulated that wires and pins in the femur pass through the quadriceps muscle, thereby acting as a checkrein to the movement of the knee while the fixator is applied [2, 3, 7]. To reduce this complication, we operated all the cases with moderate flexion of the knee which can stretch quadriceps mechanism [3]. The severity of soft tissue injury will also add to knee stiffness as well as the fracture pattern rather than technique [5].

Thus, from our observations and results it can be suggested that the Ilizarov ring fixator is versatile and can be tailored as per fracture geometry. Minimally invasive definitive treatment for severely comminuted distal femur fractures can provide early weight bearing, deformity correction by means of compression or distraction that is possible throughout treatment period. However, it is technically demanding, has a long learning curve and also has some disadvantages like a lengthy treatment span, heavy frame, and possible pin-tract infection [2, 3, 5].

CONCLUSION

The Ilizarov ring fixator can be considered as one of the reliable treatment options in severely comminuted distal femoral fractures with intra-articular extension.

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Received: 18.11.2016

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