Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Orthopaedics Surgery

Journal homepage: https://www.ijos.co.in/

Original Research Article

Ilizarov ring fixator as a definitive management of fracture long bones of lower limb

Prashant Upadhyaya[1], **Divyam Pandey**[1]*, **Abhishek Shukla**[1], **SA Mustafa Johar**[1]

[1]*Dept. of Orthopaedics, Index Medical College, Hospital and Research Centre, Indore, Madhya Pradesh, India*

ARTICLE INFO

Article history:
Received 25-05-2024
Accepted 04-07-2024
Available online 04-09-2024

Keywords:
Ilizarov
Definative treatment
Long bone fracture

ABSTRACT

Background: We conducted a study evaluating the clinical and radiologic results of the fracture long bones using an Ilizarov Ring fixator as definitive treatment.
Materials and Methods: Clinical, observational, descriptive, prospective and longitudinal study. Fifty patients were included, 31 males (62%) and 19 females (38%), whose age was 43.60 ± 14.37 years; the time elapsed from the accident to admission in the Emergency Room was 1-16 hours, with a mean of 5.1 ± 3.35 hours. 8 patients (16%) had a Gustilo Anderson grade I open fracture, and 29 patients (58%) a Gustilo Anderson grade II fracture and 13 patients (26%) had a Gustilo Anderson Grade III**.** They were also classified according to the AO classification, with the following resulting groups: 13 (26%) patients were A3, 15 (30%) were B3, 10(20%) B1, 9 (18%) were B2, and 3(6%) were A2. The dynamization of the fixator was done at a mean of 10.5 ± 1 weeks.
Results: Forty-six patients had healing at 24 ± 3 weeks; Gustilo I fractures healed at 21± 3 weeks; Gustilo II fractures at 24 ± 3 weeks, Gustilo III fractures at 27± 3 weeks with a P value of 0.48. In 4 patients (8%), due to absence of healing, the external fixator was exchanged for an intramedullary nail with a bone graft.
Conclusions: This fixator is safe in properly selected patients, since the few complications that occurred are similar to other reports using different internal fixation methods. Early application of the Ilizarov fixator constitutes an excellent management of open long bone fractures, especially types II, IIIA and IIIB, due to good functional and radiological results. Despite the technical difficulties and some complications (which are mostly minor) IEF may be the preferred method in open long bone fractures, especially types II and III.

1. Introduction

The industrialization of society, crowded highways and with the increment of highspeed vehicles in developing countries such as India where the industrial safety norms are ignored and the traffic management is poor, the cases of compound fractures and fractures with impending compartment syndrome has increased. The mechanism of the injury contributes to a high rate of complications and it also tends to cause severe soft tissue damage. The long period of morbidity, pain, infection and ultimately functional impairment have a serious impact on individual, country in terms of patient care, loss of productivity, time and lowered quality of life.[1] Despite its frequency, the ideal management of open fractures remains controversial. Modern day management of this injury has focused on thorough debridement and immediate bony stabilization with tissue cover to enable early mobilization and restoration of optimum function.[2] Close reduction and intramedullary nailing saves extra osseous blood supply, doesn't disturb fracture hematoma and maintains soft tissue envelope, allows early weight bearing,[3,4] but it

* *Corresponding author*.
E-mail address: pandeydivyam@gmail.com (D. Pandey).

https://doi.org/10.18231/j.ijos.2024.040

compromises the intramedullary blood supply and in open fractures increases the risk of infection.[3,5] Open reduction internal fixation with plating is the usual treatment for such fractures. However, these plates, especially when placed under thin or damaged soft tissue, may compromise wound healing[6] and also in developing countries such as India, where the patients present late to the hospitals and adequate facilities (in terms of manpower and theatre facilities) are not always available, the situation is different.[2] In our hospital, as in most centres in the less developed regions, open fractures have been traditionally managed by external fixators. The high rate of failure associated with this management protocol made us to look to the Ilizarov external fixator (IEF) as an alternative.[2] The IEF is a minimally invasive method which permits effective wound management, early weight bearing and bone lengthening. This study looks at the role of early IEF as definitive management in open fractures in a developing country.[5]

The study was undertaken to see if the patient can be treated with single surgery of primary external fixation with Ilizarov technique so as to reduce hospitalization stay and early return to work.[1] The key components of approach were aggressive debridement; primary Ilizarov fixation and soft tissue coverage.[1] Other advantages of this technique are that adjustments during and after surgery are possible, also it allows early weight bearing.[6] The most important disadvantages of the method are patient's psychological trauma during the follow up, patient compliance modifications are needed, and external fixation devices are more difficult to learn compared to other methods of fixation.[3,7] Ilizarov has revolutionized the management of Compound comminuted fractures which are more susceptible to the infection by allowing more union rates and early mobilization of the extremity and other advantages which include wound management, deformity correction and limb lengthening, among others. The tensioned wire circular fixator has proved valuable in subacute and acute treatment of fractures.[3]

The aim of current study was to evaluate treatment of open comminuted fracture by ilizarov external fixator; its effective, availability, outcomes and complications.[3]

2. Materials and Methods

This study was conducted between June 2022 and November 2023 at a tertiary Centre in 50 patients with Compound Comminuted fracture. All patients admitted either via Emergency or Out Patient Department were included in this study. Informed consent was taken from all patients. Inclusion criteria were patient age more than 20 years, both sexes, all Compound fracture including severely comminuted fractures. Exclusion criteria were pathological fracture and patient lost for follow up. All patients were evaluated for musculoskeletal and neurological injuries. Time period between trauma and surgery varied from 8 hours to 5 days. Most of the cases were operated in regional anaesthesia. Aim of our treatment to study & evaluate functional and radiological outcome of ilizarov external ring fixator as a definitive treatment modality (as a minimal exposure technique) by assessing radiological status, pain, range of motion and muscle power.

Aim of our treatment for articular fractures is anatomical restoration of joint surface and absolute stability at the fracture site. At the metaphyseal region we need relative stability.

Objectives of our study are to propose minimally invasive, easy and safe technique of managing fractures in long bones and to assess the benefits of application of ilizarov external ring fixator as the definitive procedure in term of operative time and soft tissue dissection.

3. Observations and Results

Table 1: Distribution of study participants according to gender

Gender	Frequency (N =50)	Percentage (%)
Male	31	62
Female	19	38

Table 1 shows the distribution of study participants according to gender. Out of total, 62%(31) were males and 38%(19) were female.

Table 2: Distribution of study participants according to age

Age (in years)	Frequency (N =50)	Percentage (%)
21-40	27	54
41-60	13	26
>60	10	20
Total	50	100
Mean ± SD	43.60 ± 14.37	

Table 2 shows the age distribution of study participants. In our study, we found that around half (54%) of study participants were in the age group of 21- 40 years. Around one-fourth (26%) of study participants were from 41-60 years of age group. Study participants who were elderly (>60 years) comprised 20% of total study participants. Mean age of study participants was found to be 43.60 years with standard deviation of 14.37 years.

Table 3: Distribution of study participants according to the site of fracture

Site of Fracture	Frequency (N =50)	Percentage (%)
Tibia	29	58
Femur	21	42

Table 3 represents the distribution of study participants according tothe site offracture with which they presented.

In our study, we found that 58% (29) of fractures were of Tibia which were followed by Femur fractures (42%

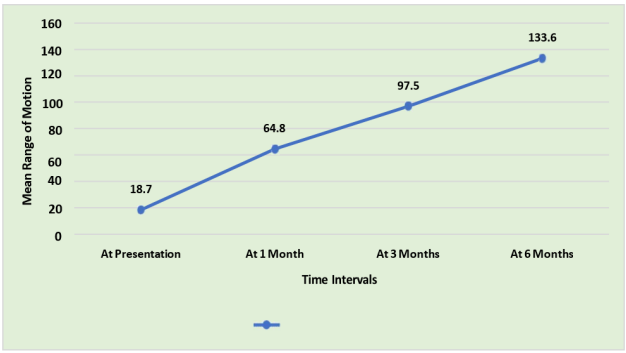
Table 4: Distribution of study participants according to fracture status at the end of 6months

Fracture status	Frequency (n)	Percentage (%)
Union	41	82
Non-union	04	08
Malunion	05	10
Total	50	100

Table 4 shows the distribution of study participants according to fracture status at the end of 6 months of follow-up. It was seen in our study that 82% of study participants had union while 10% were found to have malunion and 8% as non-union.

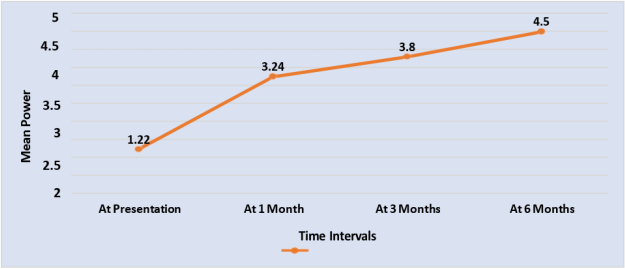
Table 5 shows the descriptive statistics for various parameters that were found in our study. Mean time of presentation (in hours) from the time of injury was found to be 2.30 hours with standard deviation of 1.26 hours. When assessed for range of motion in study participants, the average in our study was found out to be 18.70 degrees with standard deviation of 14.35 degrees. Pain assessment was done using visual analogue scale (VAS) and it was found to be 6.18 for all study participants at the time of presentation.

Table 5 shows the mean VAS scores obtained at different time intervals in the study. It can be seen from the figure that mean VAS scores show a declining trend and keep going down as study progressed. Mean VAS score at the time of presentation was 6.18 while at 24 hours, mean VAS score was 4.94. At 6 months follow-up, the mean VAS score was 0.78.



Graph 1: Graph showing Mean Range of Motionat different time intervals

Graph 1 shows the distribution of mean range of motion that was observed among study participants at different time interval during follow-up. At the time of presentation, mean range of motion was observed to be 18.7 while it increased to 64.8 at 1 month follow-up. At 6 months follow- up, the mean range of motion was found to be 133.6.



Graph 2: Graph showing Mean power at different time intervals

Graph 2 shows the line diagram which shows obtained mean power at different time intervals in the study duration. It can be seen from the graph that mean power scores increased throughout the follow-up period. At presentation, mean power was found to be 1.22 and it increased to 3.24 at 1 month follow-up. At 3-month follow-up, mean score for power was 3.8 and at 6-month follow-up, it was found to be 4.5.

Table 6 shows the comparison between mean VAS score at different time intervals in between two age groups – those whose age was below 40 years and those whose age was more than or equal to 40 years. Being a continuous data, normality was checked using Shiparo-Wilk test and distribution was found to be non-parametric. Mann Whitney U test has been used to compare mean score between these two age groups. At the time of presentation, mean score was 5.91 in <40-year age group while it was 6.42 in ≥ 40 years age group, and the difference was not statistically significant ($p = 0.16$). At 24 hours, mean VAS scores in these two groups were 4.79 and 5.07 respectively and the difference between the two was not statistically significant ($p = 0.25$). Mean VAS scores at 1 month, 3 months and 6 months in the age group of <40 years were 2.21, 1.29 and 0.62 respectively while in the age group of ≥ 40 years, the scores were 2.53, 1.53 and 0.92 at 1, 3 and 6 months respectively. The difference between the two groups was found to be statistically insignificant ($p > 0.05$).

Table 7 shows the comparison between mean power obtained at different follow- ups during the study between two age groups – one less than 40 years and another ≥ 40 years. Being a continuous data, normality was checked using Shiparo-Wilk test and distribution was found to be non-parametric. Mann Whitney U test has been used to compare mean score between these two age groups. The difference between the scores in both the age groups was not found to be statistically significant at any of the follow-up interval ($p > 0.05$). However, mean power showed increasing score throughout the follow-up period in both the age-groups.

Table 8 shows the comparison between mean range of motion obtained at different follow-ups during the study

Table 5: Descriptive statistics for different characteristics

Characteristics	Mean	Standard Deviation	SE of Mean
Time of presentation (in hours)	2.30	1.26	0.17
VAS at presentation	6.18	1.45	0.20
VAS at 24 hours	4.94	1.09	0.15
VAS at 1 month	2.38	1.42	0.20
VAS at 3 months	1.42	1.07	0.15
VAS at 6 months	0.78	0.86	0.12
Range of motion at presentation	18.70	14.35	2.02
Range at 1 month	64.80	43.82	6.19
Range at 3 months	97.50	40.29	5.69
Range at 6 months	133.60	41.21	5.82
Power at presentation	1.22	1.03	0.14
Power at 1 month	3.24	0.79	0.11
Power at 3 months	3.80	0.83	0.12
Power at 6 months	4.50	0.90	0.12

Table 6: Comparison between VAS score at different intervals based on age

VAS Score	Age (in years)		p value*
	<40(Mean ± SD)	≥ 40 (Mean ± SD)	
At Presentation	5.91 ± 1.01	6.42 ± 1.74	0.16
At 24 hours	4.79 ± 0.83	5.07 ± 1.29	0.25
At 1 Month	2.21 ± 1.14	2.53 ± 1.65	0.27
At 3 Months	1.29 ± 0.85	1.53 ± 1.24	0.43
At 6 Months	0.62 ± 0.64	0.92 ± 1.01	0.42

* p value < 0.05 significant; Mann Whitney U test used

Table 7: Comparison between power at different intervals based on age

Power	Age (in years)		p value*
	<40(Mean ± SD)	≥ 40 (Mean ± SD)	
At Presentation	1.37 ± 0.82	1.07 ± 1.19	0.17
At 1 Month	3.29 ± 0.62	3.19 ± 0.93	0.76
At 3 Months	4.00 ± 0.78	3.61 ± 0.85	0.10
At 6 Months	4.54 ± 0.97	4.46 ± 0.85	0.50

* p value < 0.05 significant; Mann Whitney U test used

Table 8: Comparison between range of motion at different intervals based on age

Range of Motion	Age (in years)		p value*
	<40(Mean ± SD)	≥ 40 (Mean ± SD)	
At Presentation	18.75 ± 12.44	18.65 ± 16.15	0.77
At 1 Month	65.62 ± 41.86	64.03 ± 46.36	0.89
At 3 Months	107.91 ± 32.73	87.88 ± 44.68	0.19
At 6 Months	147.29 ± 33.45	120.96 ± 44.24	0.04

* p value < 0.05 significant; Mann Whitney U test used

between two age groups – one less than 40 years and another ≥ 40 years. It being also a continuous data, normality was checked using Shiparo-Wilk test and distribution was found to be non-normal. Mann Whitney U test has been used to compare mean score between these two age groups. At baseline i.e. at the time of presentation, mean range of motion was found to be 18.75 and 18.65 in <40 years and ≥ 40 years age group respectively and the difference was not statistically significant (p = 0.77).

At 1 month, mean range of motion was found to be 64.03 in ≥ 40 years age group while it was 65.62 in < 40 years age group. However, the difference was not statistically significant (p = 0.89). Mean range of motion at 3 and 6 months was found to be 107.91 and 147.29 in the age group of < 40 years. Similarly, mean range of motion in the age group of ≥ 40 years at these intervals were found to be 87.88 and 120.96 respectively. The difference between the two was not statistically significant at 3-month time- interval (p = 0.19) but was statistically significant at 6 months (p=0.04).

4. Discussion

Tucker et al reported 100% union of 26 tibial fracture in 22 patients treated primarily with Ilizarov external fixator. The average time to union was 25.6 weeks. In our study the average time to radiological union was 20.76 weeks.[8]

Management of unstable open and closed fractures using the Ilizarov method. The acceptable goals for open diaphyseal comminuted tibial fractures remains the prevention of infection; keeping of normal length, rotation and alignment of the extremity; minimizing further damage to soft tissue and bone; preserving the remaining circulation and providing a mechanical environment which stimulates periosteal and endosteal responses which induce bone healing.[8]

George K Dendrinos et al[9] states that Ilizarov is an ideal method of treatment for these fractures when extensive dissection is there.

Treatment of open tibial fractures with primary suture and Ilizarov fixation. Shtarker et al. reported a good result after primary suturing and Ilizarov fixation in the treatment of open diaphyseal comminuted tibial fractures.[10]

Whatson J, Tracy et al[11] states that Ilizarov is an ideal method of treatment for these fractures when extensive dissection is there.

Treatment of type II and III open tibial fractures with Ilizarov external fixation.[12] The time to achieve union with Ilizarov varies in different studies, since different authors have used measures of union. Bone union reported by Inan et al. in 19 weeks in all type IIIA diaphyseal tibial fractures and the time to union was less than in the nailing group.

The time to union in our patients is comparable to that of Tucker who used the same criteria as we did for defining union. The union time in type IIIB patients without bone loss is not significantly different from that in type IIIA.

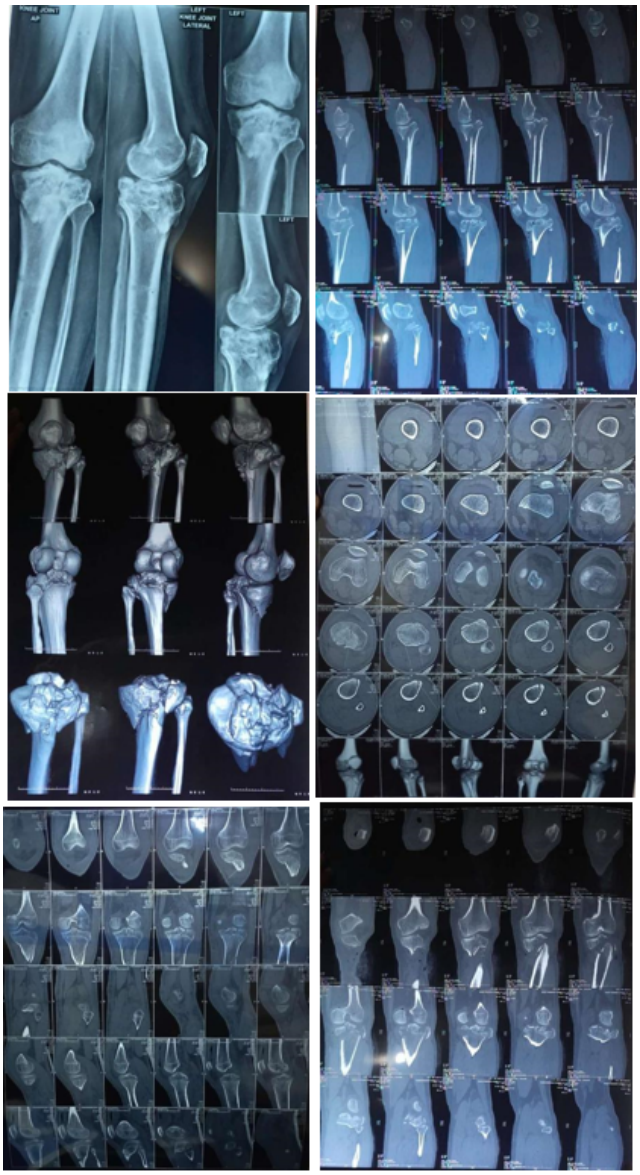


Figure 1: Case 1: Preop x-ray and CT scan

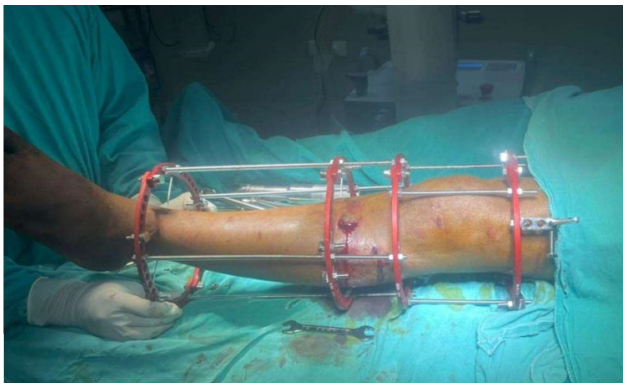


Figure 2: Case 1: Intra op

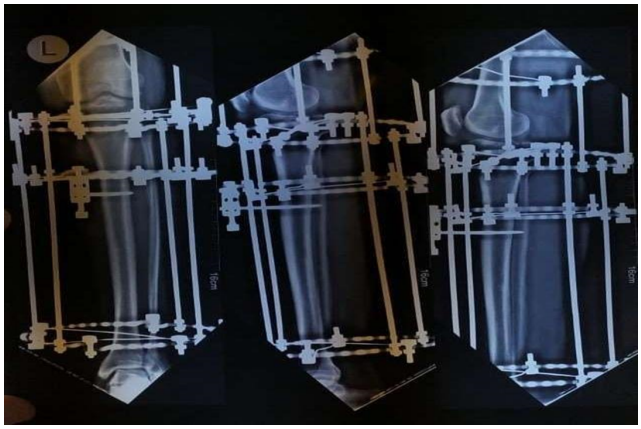


Figure 3: Case 1: Immediate post op

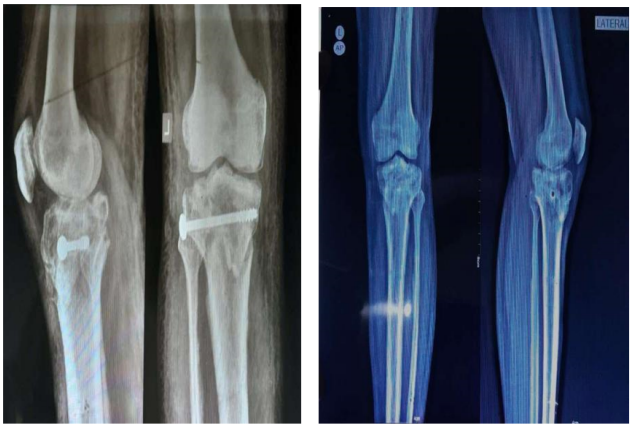


Figure 6: Case 1: After removal

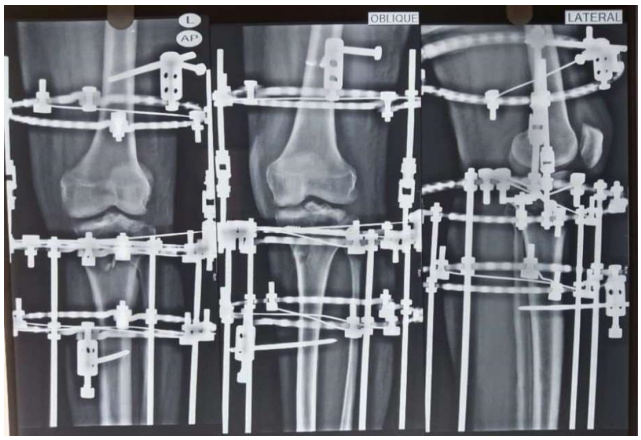


Figure 4: Case 1: Follow up

Figure 7: Case 1: Full extension after removal

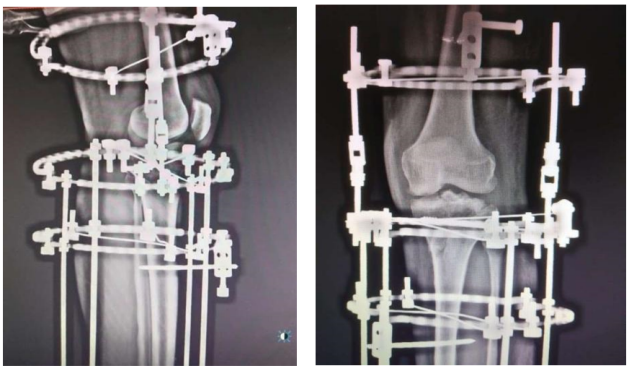


Figure 5: Case 1: **Case 1**:Follow up

Figure 8: Case 1: 120 degree flexion after removal

Figure 9: Case 1: Full weight bearing after removal

Figure 10: Case 2: Pre-op

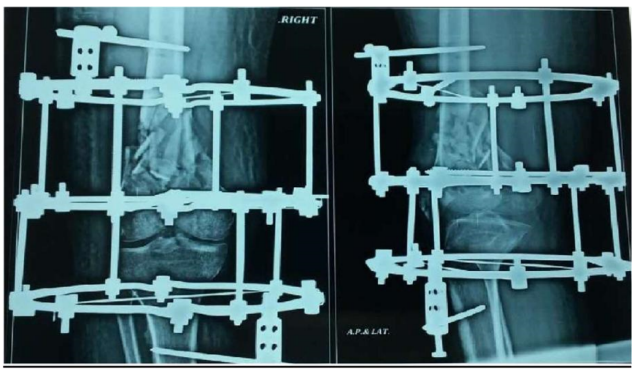


Figure 11: Case 2: Immediate post-op

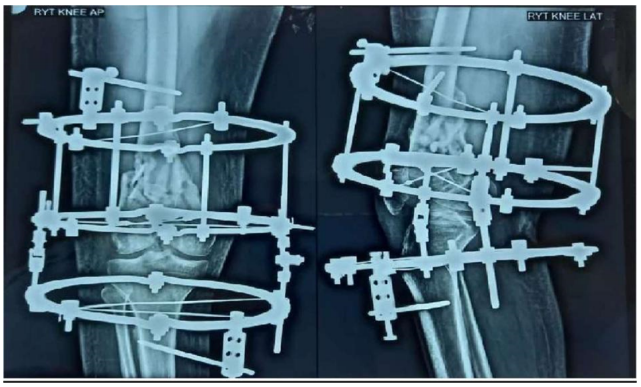


Figure 12: Case 2: Follow up

Figure 13: Case 2: Clinical picture

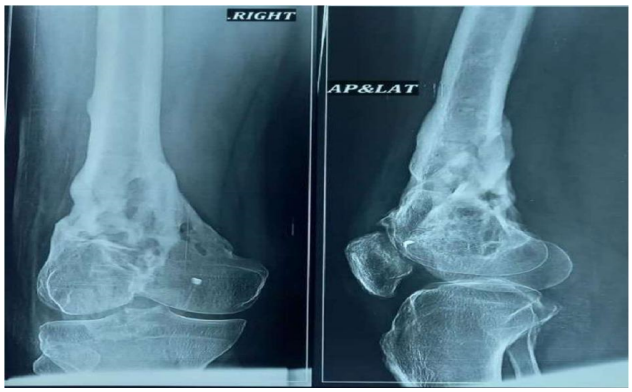


Figure 14: Case 2: After removal

Figure 15: Case 2: A, B): Full extension after removal

However, when fractures with bone loss are also included the difference in union time when compared with type IIIA fractures becomes significant. This may be related to the severity of trauma which leads to soft tissue damage and loss of blood supply to the bone. A significant difference between types IIIA and IIIB was found in time to union.

Ilizarov external fixator for open fractures of the tibial shaft.[13] IEF provides a safe and effective treatment modality for open tibial fractures. The hallmark of the method is the high union rate. Hosny and Fadel achieved union in all 34 open tibial fractures managed by IEF.

Complex tibial plateau fractures treated with ilizarov circular fixator.[14]

Management of high energy tibial fractures using the Ilizarov apparatus. Sidharthan et al. achieved union in all the 42 high energy tibial fractures managed with IEF and advocated the use of IEF in high energy tibial fractures since the device provides an early and definitive management of these fractures.[15]

24 patients were studied (19 males, 5 females) with segmental tibial fracture treated with ilizarov. Excellent bone result was obtained in 20 and good result in 4 patients. Functional results were excellent in 19 and good in 5patients. In our study excellent bone result was obtained in 38 and good results in 8 patients. Functional results were excellent in 39 and good in 7 patients.[16]

Treatment of tibial plateau schatzker type VI fracture with iilizarov technique using ring external fixators across the knee.[17]

Foster et al studied 40 patients (19 open and 21 closed). Time from injury to application of Ilizarov frame was 0-35 day and mean time for union was 187 days, which was comparable to our study.[18]

All the following studies shows better results with external fixator.

Evaluation of Tibial Plateau Fractures treated with Ilizarov Fixation[19]

Studies which show that Ilizarov is better treatment option compared to open reduction internal fixation.

External versus internal fixation for bicondylar tibial plateau fractures: systematic review and meta-analysis.[20]

Satish Nesari et al[21] concluded that Ilizarov circular fixation is an ideal method for fracture when extensive dissection and internal fixation are contradicted due to trauma to soft tissue, deficiency of bone stock, and comminuted fracture.

Outcomes following the treatment of bicondylar tibial plateau fractures with fine wire circular frame external fixation compared to open reduction and internal fixation.[22]

Comparison of postoperative outcomes between open reduction and internal fixation and Ilizarov for Schatzker Type V and Type VI fractures.[23]

5. Conclusion

Ilizarov apparatus involves non-invasive operation, provides 360degree stability, respects the vascularity of fracture fragments. It allows early joint mobilization and early weight bearing stimulus which aids compressive effects on the fracture callus. It improves and increases venous and lymphatic return preventing swelling and disuse osteopenia. It also reduces risk of infection. Early application of Ilizarov ring fixator is an excellent option for fracture long bones as a definitive surgery especially with damaged soft tissue as well as in closed complex fractures due to good functional and radiological results. Despite the technical difficulties and some complications (mostly minor) we concluded that complex fracture of the long bones can be effectively managed with use of ilizarov external fixator as a single staged procedure.

6. Sources of Funding

None.

7. Conflict of Interest

None.

References

1. Irfan SK, Sujai S, Junied HKM, Chethan MH, Ganesh H, Swamy MKS. Evaluation of the functional outcome in open tibial fractures managed with an Ilizarov fixator as a primary and definitive treatment modality. *Int J Orthop Sci*. 2017;3(2):436–40.
2. Wani N, Baba A, Kangoo K, Mir M. Role of early Ilizarov ring fixator inthe definitive management of type II, IIIA and IIIB open tibial shaft fractures. *Int Orthop*. 2011;35(6):915–23.
3. Saied HZ, Mahmoud WS, Arafa KS. Treatment of Open Comminuted Diaphyseal Fracture of the Tibia by Ilizarov. *Egypt J Hosp Med*. 2019;77(6):5965–72.

4. Foote CJ, Guyatt GH, Vignesh KN, Mundi R, Chaudhry H, Heels-Ansdell D, et al. Which Surgical Treatment for Open Tibial Shaft Fractures Results in the Fewest Reoperations? A Network Meta-analysis. *Clin Orthop Relat Res*. 2015;473(7):2179–92.
5. Bhandari M, Guyatt G, Tornetta P, Schemitsch EH, Swiontkowski M, Sanders D, et al. Randomized trial of reamed and unreamed intramedullary nailing of tibial shaft fractures. *J Bone Joint Surg Am*. 2008;90(12):2567–78.
6. Upadhyaya P, Sharma J, Mandloi A. Evaluation of tibial condyle fractures treated with primary Ilizarov with a modified technique. *Indian J Orthop Surg*. 2022;8(2):154–61.
7. Bilal D, Sami S, Erdem Ö, Umut Y, Serda D, Yavuz S. A new application technique of circular fixator for the treatment of open tibial fractures: circular fixator-hinge technique. *Ulus Travma Acil Cerrahi Derg*. 2013;19(6):543–7.
8. Tucker H, Kendra JC, Kinnebrew TE. Management of unstable open and closed tibial fractures using the Ilizarov method. *Clin Orthop Relat Res*. 1992;280(280):125–35.
9. Dendrinos GK, Kontos S, Dalas KD. Treatment of high energy tibial Plateau Fractures Using Ilizarovcircular fixator. *J Bone Joint Surg Br*. 2009;91:426–33.
10. Shtarker H, David R, Stolero J, Grimberg B, Soundry M. Treatment of open tibial fractures withprimary suture and Ilizarov fixation. *Clin Orthop Relat Res*. 1997;335:268–74.
11. Watson JT, Coufal C. Treatment of complex lateral plateau fractures using Ilizarov techniques. *Clin Orthop Relat Res*. 1998;353:97–106.
12. Inan M, Tuncel M, Karaoğlu S, Halici M. Treatment of type II and III open tibial fractures withIlizarov external fixation. *Acta Orthop Traumatol Turc*. 2002;36(5):390–6.
13. Hosny G, Fadel M. Ilizarov external fixator for open fractures of the tibial shaft. *Int*. 2003;27(5):303–6.
14. Barbary HE, Ghani HA, Misbah H, Salem K. Complex tibial plateau fractures treated with ilizarovcircular fixator. *Int Orthop*. 2005;29(3):182–5.
15. Sidharthan S, Sujith A, Rathod AK, Pathak RH. Management of high energy tibial fractures usingthe Ilizarov apparatus. *Internet J Orthop Surg*. 2005;3(1):1–6.
16. Ozturkmen Y, Karamehmetoglu M, Karadeniz H, Azboy I, Caniklioglu M. Acute treatment of segmentaltibial fracture with the ilizarov method. *Injury*. 2009;40:321–327.
17. Ranatunga IR, Thirumal M. Treatment of tibial plateau schatzker type VI fracture with iilizarov technique using ring external fixators across the knee: A retrospective review. *Malaysian Orthop J*. 2010;3(2):34–9.
18. Foster PA, Barton SB, Jones SC, Morrison RJ, Britten S. The treatment of complex tibial shaft fractureby the Ilizarov method. *J Bone Joint Surg Br*. 2012;94(12):1678–83.
19. Reddy SR, Kumar YC, Shah HM, Golla DK. Evaluation of Tibial Plateau Fractures Treated withIlizarov Fixation. *J Clin Diagn Res*. 2014;8(11):5–7.
20. Metcalfe D, Hickson CJ, Mckee L, Griffin XL. External versus internal fixation for bicondylartibial plateau fractures: systematic review and meta-analysis. *J Orthop Traumatol*. 2015;16(4):275–85.
21. Nesari S, Wali P, Pasha M. Treatment of tibial fractures by Ilizarov technique: A longitudinal study. *IJSS journal of surgery*. 2015;1(6):6–9.
22. Boutefnouchet T, Lakdawala AS. Outcomes following the treatment of bicondylartibial plateau fractures with fine wire circular frame external fixation compared to open reduction and internalfixation. *J Orthop*. 2016;13(3):193–9.
23. Tahir M, Kumar S, Shaikh SA, Jamali AR. Comparison of postoperative outcomes between open reduction and internal fixation and Ilizarov for Schatzker Type V and Type VI fractures. *Cureus*. 2019;11(6):e490.

Author biography

Prashant Upadhyaya, Associate Professor https://orcid.org/0000-0001-9195-013X

Divyam Pandey, PG Resident 3rd Year https://orcid.org/0009-0007-6510-9524

Abhishek Shukla, PG Resident 3rd Year https://orcid.org/0009-0005-9732-9578

SA Mustafa Johar, Professor and HOD https://orcid.org/0009-0006-8795-4246

Cite this article: Upadhyaya P, Pandey D, Shukla A, Johar SAM. Ilizarov ring fixator as a definitive management of fracture long bones of lower limb. *Indian J Orthop Surg* 2024;10(3):256-264.