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OUTCOME OF PATHOLOGICAL FRACTURES OF PAEDIATRIC FEMUR FOLLOWING CHRONIC OSTEOMYELITIS TREATED WITH ILIZAROV METHOD

Orthopaedics

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ABSTRACT

Background: Pathological fracture of the paediatric femur after chronic osteomyelitis presents a challenging situation. It is complicated by the need for radical debridement, often leaving a wide bone gap and instability that is difficult to be managed by the traditional methods. The Ilizarov method due to its versatility is a potential treatment option for this condition. **Materials and methods:** 19 children with pathological femur fractures following chronic Osteomyelitis were treated with Ilizarov methods. 3 children were excluded, and the final outcome was measured in 16 children. The mean age of the patients was 6.76±1.93 years, with 12 males (63.15%) and 7 females (36.84%). The Beit cure classification of childhood chronic osteomyelitis was used. The mean follow up after ring removal was 26.06±5.07 months. NEER's criteria was used to assess the radiological and functional outcomes. **Results:** With a mean union time of 10.94±3.93 weeks, 100% union was achieved in all of the 16 cases. The mean external fixator period was 14.25±4.94 weeks. The infection was fully eradicated in all of the cases, except 1 (6.25%) child diagnosed with tubercular osteomyelitis is still having the active infection. According to NEER's functional and anatomical grading, excellent results were found in 6 (37.5%) cases, satisfactory in 8 (50%), and unsatisfactory in 2 (12.5%) cases. Pin tract infection was found in 10 (62.5%) children, axial deformity after ring removal in one (6.25%), and knee stiffness in 2(12.5%) children. **Conclusion:** In children with pathological femur fractures caused by chronic osteomyelitis, the Ilizarov method can be a viable treatment option. It helps to eradicate infection, promotes fracture healing, and produces satisfactory to excellent results.

KEYWORDS

Ilizarov fixator, Paediatric Chronic Osteomyelitis.

INTRODUCTION:

Chronic osteomyelitis is far more common in developing countries than it is in industrialised countries[1,2] . Chronic osteomyelitis, in its severe form, is a leading cause of disability and sickness in these countries, putting a substantial strain on the limited health-care system.[2,3,4] In children, the condition is frequently caused by a lack of treatment or improper treatment of acute haematogenous osteomyelitis, a delay in the diagnosis or as a result of open injuries.[1,3] Acute osteomyelitis that progress to chronic osteomyelitis accounts for about 4.4% of children.[3] The long bones are most commonly affected, with the tibia and femur accounting for roughly 80% of all cases with the femur coming in second after the tibia.[2,3,1,4] In most cases, chronic osteomyelitis cannot be cured without surgery. However, opinions on the best treatment options for bone complications vary widely, and are frequently affected by surgical experience and resource availability.[4] Sequestrectomy and resection of damaged and diseased bone and soft tissues are the hall marks of the surgical management.[5] To attain this purpose, radical debridement is frequently required which leaves behind a large bone gap, limb instability and, invariably, non-union of the bone.[6,3] There are numerous traditional treatment options for managing bony and soft tissue defects . But the traditional treatment approaches have certain limitations and multiple challenges due to the unhealthy growing bone, poor soft tissue envelop, prolonged infection, and multiple surgeries.

Because of the difficulties encountered during skeletal stabilization in pathological fractures secondary to chronic osteomyelitis, an external fixator such as Ilizarov is a viable treatment option due to its limited surgical exposure, transosseous wire based fixation, three dimensional stability, compression at the fracture site, distraction osteogenesis, deformity correction and encouraging active use of the afflicted limb with active joint movement to restore its physiological function, which reduces the risk of disuse osteoporosis and soft tissue atrophy.[7,8,3,9,10]

Despite these benefits, the use of the Ilizarov method in such a setting has been scantily reported in the world literature. The objectives of our research was to use the clinco-radiological criteria to predict the union and functional outcome of the affected limb in children with pathological femoral fracture due to chronic osteomyelitis, treated with Ilizarov fixator.

MATERIALS AND METHOD:

From October 2015 to May 2022, this retrospective case series study was conducted in the department of Orthopaedics at Assam Medical College and Hospital, Dibrugarh, Assam, India. In this study, 19 paediatric patients were included. The patients were from various locations of North East India, the majority of whom had previously failed treatment. The patients were of 2 to 12 years of age with an average being 6.76 years, with 7 girls and 12 boys were treated with an Ilizarov external fixator for pathological femur fractures caused by chronic osteomyelitis.

Ethical Approval: was taken from the institutional ethical committee.

Inclusion criteria:

1) Child with pathological femur fracture secondary to chronic osteomyelitis.
2) Patients with paediatric age group between 2 to 12 years of age.
3) Minimum follow up period of 1 year after fixator removal.

Exclusion criteria:

1) Chronic osteomyelitis as a result of infected Osteosynthesis secondary to fracture fixations.
2) Concomitant skeletal or other systemic conditions.

Andrew J. Stevenson et al.[4] described the Beit cure classification of childhood chronic osteomyelitis, and all of our patients were identified as having type B4 of this classification.

Surgical steps:

A) Debridement:

The infected bone was exposed through the standard surgical approaches. Active sinus tracts were entirely excised, sclerotic bones were excised till paprika sign became positive and the closed medullary canal was opened in both directions. Tissues collected during surgical debridement were sent for culture sensitivity and pathological studies.

B) Ilizarov frame application:

Hybrid traditional type of frame assembly were used, where wires were used in the distal fragment and schanz screws proximally. Typically 3.5mm schanz pins, 1.5mm wires, 120 size paediatric Ilizarov rings were used, but for children with larger builds, adult Ilizarov components were used.

The ends of each bony segments were acutely docked, when not limited by the soft tissue scarring. Peripheral circulation was tested at the time of acute docking. In the distal fragment, one reference wire was placed parallel to the knee joint transversely under the control of IITV. The pre constructed Ilizarov ring fixator was mounted on this key

reference wire. Two rings distal to the fracture were tried to be accommodated, but if space was limited, a drop wire was used to hold the distal fragment to the distal most ring with a pair of male support posts. From distal to proximal, the entire construct was built in stages. Three to four schanz pins were used at a 30 degree angle in the posterolateral and anterolateral planes to secure the proximal fragment. If the distal fragment fixation was found, unstable, the knee was spanned with a proximal tibia ring.

Post-operative protocol and follow up:

Post-operative management:

Post-operative radiographs were taken on the second post-operative day or as per the patient's convenience. From second day after surgery, the rehabilitation protocol were followed and advised to mobilise as soon as possible with active and passive movements of all joints. Post-operatively empirical I.V. antibiotics were started and eventually modified to culture specific antibiotics. Intra-venous antibiotics were normally continued until the wound recovered and then switched to oral antibiotics for at least 6 weeks. If the wound healing process did not progress, periodic debridement was considered.

Follow up:

Patients were evaluated on an outpatient basis where clinical evaluations were done for wound infection, pin tract condition, local soft tissue problems, and other conditions. If necessary, the frame was adjusted to correct the mal-alignment, and the docking site was compressed to achieve appropriate compression. Routine ESR and CRP was advised to assess disease activity over the follow-up period. The fixator was kept in situ until the docking site had sufficiently consolidated. If the bridging callus showed in three out of four cortices in a true AP and lateral radiographs, the docking site was considered to be united. After an average of 14 days of dynamization, the ring removal was done and the final outcomes were evaluated using the NEER's criteria.[11]

Corticotomy and lengthening were not performed to avoid more trauma to the already diseased limb and risking an infected segmental fracture situation. Due to the immature physis, a high probability for spontaneously obtaining length and sometimes excessive spontaneous lengthening was there due to the hyperaemia of the physis in diseased condition. Hence, the lengthening part was left till the bony maturity of the child.

Statistical calculations of the data were done by Microsoft Excel 2013.

Fig1: pre-operative Radiograph and clinical image in a 4 years old child with pathological femur fracture following chronic osteomyelitis.

Fig2: Intra-operative images.

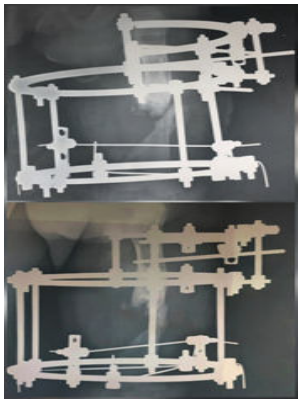

Fig3: Post-operative Radiographs.

RESULTS:

In this study, the mean follow-up period was 26.06± 5.07 months with a minimum of 17 months after ring removal. Out of the 19 children enrolled in the study one was lost in the follow-up and two cases had been removed from this study as they did not meet the inclusion criteria. The average age of the cases was 6.76± 1.93 years, with 12(63.15%) males and 7(36.84%) females. From pathological fractures to Ilizarov ring application, the average time was 13.94±5.02 months, with a maximum of 26 months and a minimum of 6 months. The average number of previous operative interventions was 3.05, with a maximum of 6 times in one case and a minimum of 1 in two cases, with the majority of them involving debridement and monolateral external fixation. At the time of presentation, 5 (26.31%) children had a discharging sinus with active clinical disease. The average blood loss during the surgery was 142.10±38.23 ml and the mean operative time was 57.21±11.94 minutes. Organisms were isolated from 63.15% of the cases, with staphylococcus aureus being the most common and was isolated from 83.33% of the culture positive patients. Additional organisms isolated include Pseudomonas aeuroginosa, Klebsiellapneumonae, Enterobacter cloacae, E. coli, and fungal hyphae with Mycobacterium Tuberculosis in one patient. Knee spanning was considered for 4(21.05%) patients, due to intra-articular involvement. Union rate of 100% achieved in all of our cases with a mean union time of 12.17±4.12 weeks. The total external fixator period was 14.25±4.94 weeks on average. The mean duration of the hospital stay was 17.05±2.69 days. The average knee flexion immediately after ring removal was 37.47±16.83 degrees, which was extremely low. In the follow up period after 1 year of ring removal, the average knee flexion was substantially increased, reaching 101±40.96 degrees. After one year following ring removal, the average shortening was 3.10±1.49cm, with a maximum of 6cm in one case as a result of extensive debridement and bone excision, and a minimum of 1cm in another case. Complete eradication of infection was achieved in almost all of the cases, except 1 (6.25%) child diagnosed with tubercular osteomyelitis. An excessive knee valgus deformity of 5 degrees was found in 6.25% of cases after ring removal, and two patients (12.5%) resulted with severe knee stiffness after final follow up. Ten cases (62.5%) complicated by pin tract infections [According to the Checketts-Otterburn[12] classification of pin tract infection, 7(70%) patients presented with grade1 pin tract infection and 3(30%) patients with grade2 pin tract infection]. Fortunately, no patients were required for pin removal or fixator discontinuation due to severe pin site infection. After one year following ring removal, the average final NEER's score was 81.5±21.91, with a maximum of 97 in one case and a minimum of 58 in another. According to the NEER's functional and anatomical grading, Excellent results were found in 6 (37.5%) cases, satisfactory in 8 (50%), and unsatisfactory in 2 (12.5%) cases.

Table-1

NEER's criteria for evaluation of results.[11]

Functional (70 units)	Anatomic (30 units)
Pain (20units) Unit value 1) No pain 20 2) Intermittent pain 16 3) With fatigue 12	Gross-Anatomy (15units) Unit Value 1) Thickening only 15 2) 5 degrees angulation or 0.5 Cm short 12 3) 10 degrees angulation or rotation, 2 Cm short 9

Functional (70 units)	Anatomic (30 units)
4) Restrict function 8 5) Constant at night 4-0 Function (20 units) 1) As before injury 20 2) Mild restriction 16 3) Restricted; stairs sideways 12 4) Cane or severe restriction 8 5) Crutches or brace 4-0 Motion (20 units) 1) Normal or 135 degrees 20 2) 100 degrees 16 3) 80 degrees 12 4) 60 degrees 8 5) 40 degrees 4 6) 20 degrees or less 0 Work (10 units) 1) As before injury 10 2) Regular but with handicap 8 3) Alter work 6 4) Light work 4 5) No work 2-0	4) 15 degrees angulation or rotation, 3 Cm short 6 5) Union but with greater deformity 3 6) Non-union or chronic infection 0 Roentgenogram (15 units) 1) Near normal 15 2) 5 degrees angulation or 0.5 Cm displacement 12 3) 10 degrees angulation or 1 Cm displacement 9 4) 15 degrees angulation or 2 Cm displacement 6 5) Union but with greater deformity 3 6)Non-union or chronic infection 0

DISCUSSION:

The primary goals of our treatment were to eliminate infection, accomplish union, and restore maximum function to the affected limb. We achieved 100% union rate in all of our cases with a mean union time of 12.17±4.12 weeks which is comparable to the 100% union rate with an average union time of 13.45 weeks (3.36 months) as described by Azad Yildirim et al.[13], 90.32% union rate by Karim Bakhsh et al.[14], 90% union rate by Vladimir Barbarossa et al.[7] and 95.45% by VuslatSema UNAL et al.[15]

In Ilizarov method, shorter surgical time, lesser soft tissue dissection and reduced blood loss provide further safety for paediatric patients as they are haemodynamically fragile.[14] In our study, the mean blood loss was 142.10±38.23ml , and the mean operative time was 57.21±11.94 minutes, which was quite relevant in terms of safety to the child when compared to a previous study's mean operative time of 116.50±20.13 minutes.[8] By improving the vascularity of the osteomyelitic focus, this method aids in the elimination of infection.[10,16]

Infection eradication rate of 93.75% has been achieved in all of our cases till final follow-up, which is comparable to the prior studies by Karim Bakhsh et al.[14], Karim Bakhs- Atiq Ur Rehman et al.[10], and Vladimir Barbarossa et al.[7], who reached 87.09%, 94%, and 100% infection eradication rates, respectively.

According to the NEER's functional and anatomical grading, 37.5% of cases achieved excellent results in this study, satisfactory in 50%, and unsatisfactory in 12.5% cases which is relatable to other studies such as Karim Bakhsh et al.[14] who acquired excellent results in 30% of their cases, and Vladimir Barbarossa et al.[7] obtained excellent results in 16.66% of their cases.

Although there is some debate on the age and sex distribution in chronic osteomyelitis in children, Andrew J. Stevension et al.[4] observed no significant differences in sex and age distribution in their study. However Karim Bakhsh's et al.[8] and Reiner Wirbel et al.[2] found male preponderance with an average age of 7 years in their study, which is consistent with the mean age of 6.76±1.93 years and male predominance in this study. In this research, the cases had an average number of previous operative interventions was 3.05, with the majority of them underwent debridement and monolateral external fixator application, and most of them presented to us with treatment failure. A culture positivity rate of 63.15% was found in the cases which is in line with the 63% culture positivity rate as described by BibekBanskota et al.[3], with staphylococcus Aureus being the most common and was found in 83.33% of culture positive cases in this study, which is also consistent with the previous studies.[15,2,17] Fungal hyphae and Mycobacterium tuberculosis were isolated from one case in a mixed infection with Staphylococcus Aureus. Pseudomonas aeruginosa, Klebsiellapneumoniae, Enterobacter cloacae, E. coli were among the other organisms found in the rest of the cases. Broad spectrum cephalosporin group of I.V. antibiotics was started as an empirical regime, followed by culture specific antibiotics until the wound condition was improved.

The mean external fixator period in this study was 14.25±4.94 weeks, which is close to the mean external fixator periods of 13 weeks and 5.3 months in the studies conducted by Reiner Wirbel et al.[2] and Gamal Ahmed Hosny et al.[18] respectively. In this study average knee range of motion was found to be 101±40.96 degrees after one year of post ring removal follow up and we agree with Karim Bakhsh et al.[10] who got 90 degrees of knee range of motion in their cases after 6 months of follow-up. The immediate post-ring removal knee range of motion was quite poor, with an average of 37.47±16.83 degrees, but it significantly improved after a year, indicating the importance of strict adherence to physiotherapy in the functional outcome. We spanned the knee in four cases, one of which had not yet had the ring been removed, so we measured the outcome in three out of the four.

The average knee bending in those three cases was found to be 96.33±3.21 degrees in the final follow-up which is lower than the overall mean knee bending of all 16 cases enrolled in the final follow-up, this could be attributed to the long term spanning of the knee, involvement of the intra-articular part of the knee joint, and involvement of the knee's extensor mechanism in the distal thigh.

In this study, the average shortening after 1 year follow-up was 3.10±1.49cm, which were managed by balancing the sole in the footwear. The lengthening was postponed until later since we did not want to jeopardise the union process of an already ailing bone. Poor quality osteogenesis in young children increases the risk of complications, such as fracture, as per Z. Pejin,[19] and parents' insistence on early lengthening should be resisted, especially as the range of techniques available increases with age.

Complications such as 5 degrees of excessive valgus deformity in the knee joint was found in 6.25% of cases, which was assumed to be attributed to the intra-articular involvement, physeal damage, and differential physis growth which is comparable to the past studies[10] . The most common complication in this study was Pin tract infection.

The limitation of the current study include a small sample size and a lack of comparison with alternative fixation methods. To reach a solid conclusion on the current fixation method, a multi-centric study with a large sample size and a number of comparison groups of different fixation methods should be conducted.

Fig4: Clinical images after 3 months of follow-up.

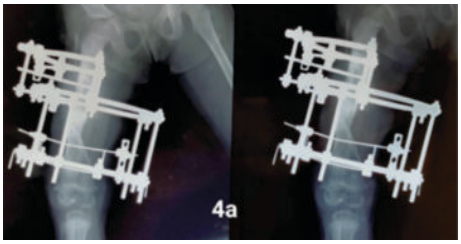

Fig5: Radiographs after 3 months of follow-up (union can be seen).

Fig6: Radiographs and clinical images after 17 months of follow-up.

Complications:

Fig7: Five centimetre shortening in a 3 years old child after complete treatment.

Table-2
Comparison of outcomes with previous studies.

Sl. No	Study	Number of patients	Type of fixation	Union time (weeks)	Union rate (%)	External fixator period (weeks)	Infection eradication rate (%)	Knee stiffness (%)	Functional outcome	
									Excellent (%)	Satisfactory/ Good (%)
1	Karim Bakhs-Faridullah et al.	31	Ilizarov external fixator		90.32	-	87.09	61.29	30	15
2	Karim Bakhsh-Hamidullah Khan et al.	30	Ilizarov external fixator		100	-	96.7	-	40	20
3	Vuslat Sema UNAL et al.	22	-		95.45	-		-		
4	Azad Yildirim et al.	11	Internal fixator	13.45 (3.36 months)	100		100			
5	Vladimir Barbarossa et al.	30	Ilizarov external fixator		90			-	16.66	33.33
6	Reiner Wirbel et al.	27				13		7.40		
7	Current study	16	Ilizarov external fixator	12.17 ±4.12	100	14.25 ±4.94	93.75	12.5	37.5	50

CONCLUSION:

In the modern orthopaedic armamentarium, the Ilizarov method has gained appeal in this condition throughout time as it promotes fracture healing, eliminates infection, and produces satisfactory to excellent results. The complications that occur are minor and can be treated with conservative measures. The active involvement and participation of the parents is a crucial aspect. The device should be adjusted by the parents on a daily basis and early post-operative mobilization and strict adherence to the physiotherapy are critical components of a successful Ilizarov treatment in children with pathological femur fractures following chronic osteomyelitis.

Conflict of interest: There is no conflict of interest.

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