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Complications of ilizarov ring fixator and their management

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Abstract
Background: Ilizarov ring fixation technique has its own advantages as well as associated complications. Present study was done retrospectively with an aim to evaluate and manage the intra operative and post operative complications of Ilizarov ring fixator (IRF). All the cases in this study included fractures of either tibia or femur.
Material and Methods: The study included 30 cases (31bone segments) that were operated upon with IRF, 24 over tibia, 5 over femur, 1had both over ipsilateral tibia and femur. All cases except one were males. 80 percent of patients were between age group of 16 to 45 years. IRF was applied from 3 to 12.5 months with average duration of 8.25 months. All complications were recorded and managed accordingly.
Results: There were a total of 97 complications in 30 patients (31 bone segments) with an average of 3.23 per patient, minimum number of complications being 2 and maximum 4. Pain and pin tract infection was present in all. Complications seen were more for tibia (average 3.28) than for femur (average 2.50).
Conclusion: Pain and pin tract infection were the most common complications. Most complications can be prevented by diligent post operative care. Complications if diagnosed early can be managed effectively. As such advantages of IRF outweigh the associated complications.

Keywords: Ilizarov, associated complications, IRF

Introduction
The mention of word Ilizarov brings into mind the new vistas this revolutionary technique has brought to the world of orthopaedics and traumatology. IRF combines the biological principles of tension stress affects with the development of a circular frame. This device has a wide range of applications in current orthopaedic practice like non union, skeletal defects, chronic refractory osteomyelitis, filling septic cavities, limb lengthening, joint contractures, angular and other limb deformity correction e.g. Genu varum.
Just like the two sides of a coin and just like any other surgical technique in the history of orthopaedics Ilizarov method too has its own advantages as well as associated complications. These can occur in intra operative, immediate post operative or late post operative period. Broadly they can arise: 1 during actual surgical procedure, 2 during distraction phase, 3 during consolidation phase, and 4 after removal of IRF. According to Parihar [1], most of the complications occur during distraction phase.
These can also be divided into bony and soft tissue complications especially in limb lengthening cases. Soft tissue complications arise because of inadequate accommodation of soft tissues as compared to the change in length of bone and rate of change in length e.g. normal growth at distal femur occurs at 50µm/day while limb lengthening occurs at 1000 µm/day, 20 times faster than natural growth [2]. Grossly complications can also be divided into local and systemic.
Wire related complications can be pin tract infection (commonest), loosening of wire, breaking of wire, skin tension and rarely acute neurovascular injury. Transient pain at wire site occurs in almost all cases at one time or other. Other complications of IRF can be muscle or joint contractures, joint luxations, axial deviation, neurological injuries, vascular injuries, premature or delayed consolidation, refracture, joint stiffness, reactivation of infection and premature

removal of apparatus etc. Sometimes loss of appetite, loss of weight and depression may occur. Most of the complications can be prevented by pre operative, intra operative and post operative care. Some inevitable complications that happen during course of treatment have to be managed by medical or surgical interventions.

Material and methods

A retrospective study was carried over 30 patients admitted in a tertiary care hospital of north India over a period of four years to evaluate the complications of IRF and their management. Patients having fractures of tibia or femur operated for IRF and with minimum follow up of 1 year were included in study. Patients having IRF done for deformity correction, limb length discrepancy and incomplete data were excluded from study. All the 30 patients (31 bone segments) were operated with IRF, 24 had tibia fractures, 5 femoral fractures and 1with ipsilateral tibia and femur fracture. Frames were assembled pre operatively. 28 cases (93.33%) were operated as a second surgery in the presence of persistent infection with implant in situ. IRF was applied to limb after removal of implant (if any) and wires inserted as determined by safe planes. Any bleeding occurring during surgery was managed at the earliest. Post operatively foot splintage with elastic strap was given to avoid equines deformity. Regular debridement was done and antibiotics given as per culture and sensitivity. Any offending wire causing bleeding was removed; equines deformity treated by Tendo Achilles (TA) lengthening or frame extension and continuous neurovascular assessment done. Connection bolts and nuts were checked regularly for tightness, wires cut and bent smoothly. Regular stretching exercises, psychotherapy, analgesics, sedation at night and radiography at regular periodic intervals were part of protocol. Medical treatment like antidepressants or appetizers was given and surgical intervention /plaster of Paris (POP) done wherever necessary. Results were graded as excellent, good, and fair and poor as per modified ASAMI (Association for the Study and Application of Methods of Ilizarov) classification based on radiological and clinical criteria [3].

Results

Total number (n) of patients was 30 and bone segments operated were 31. 80% (n 24) of patients were in their active life period (16-45 yrs age). 96.66% (n 29) were males, with only one female operated for IRF. Bone involved was femur 6.66 % (n 5), tibia 80 % (n 24) and both in 3.33% (n 1) cases. 70% (n 21) cases had right lower limb and remaining had left lower limb involved. Maximum number (63.33%, n 19) of fractures operated for IRF were in middle third of tibia. Only 2 (6.66%) cases had IRF as their first surgical procedure over the bone being observed. 10 (33.33%), 15 (50%), 2 (6.66 %) and 1(3.33%) had 1, 2, 3 and 4 previous surgeries respectively. Distraction osteogenesis was done in 28 (93.33%) and compression with bone grafting (BG) in 2 (6.66%) cases. Majority of the cases (64.28 %) had more than 6.0 cm bone gap with average bone gap being 7.35 cm. Most common complications with IRF were pin tract infection and pain that are known to occur universally.

Table 1: Showing wire related problems

Wire Related Problems	Number of cases	Percentage
Pin tract infection	30	100
Grade 1 skin inflammation	20	66.66
Grade 2 infection of adjacent soft tissue	5	16.66
Grade 3 infection of bone	5	16.66
Granulation tissue around wire	1	3.33
Pain	30	100
Mild pain	19	63.33
Moderate pain	7	23.33
Severe pain	4	13.33
Loosening of wire	2	6.66
Bleeding around wire	3	10.00

Table 2: Showing other complications

Other complications	Number of cases	Percentage	Treatment
Soft tissue contractures at ankle	2	6.66	1- additional half ring 1-additional half ring-TA lengthening- Triple arthrodesis
Soft tissue (ST) interposition	12	40.00	ST removal with compression with or without BG
Premature consolidation	None	-	-
Delayed consolidation	2	6.66	Bone grafting
Deformity of toes	3	10.00	POP
Clawing of toes	1	3.33	POP
Great toe drop	2	6.66	POP
Infection at regenerate site	5	16.66	3 – controlled, 2 – unwilling for further treatment hence amputation
Infection at docking site	1	3.33	Controlled with debridement and injectable antibiotics
Refracture of docking site	1	3.33	Compression with BG
Common peroneal nerve involvement	None	-	-
Uncontrolled bleeding	2	6.66	Wire removal and packing
Malalignment	3	10.00	Additional wire/pin insertion, arching

Frequency of Complications: Minimum number of complications was 2 and maximum 4, with average 3.23 complications per patient

Table 3: Showing frequency of complications

Number of complications	Number of cases (n)	Percentage (%)
2	3	10.00
3	17	56.66
4	10	33.33

Complications were found to be more frequent in tibia (2 to 4, average 3.28) than in femur (2 or 3, average 3.28).

Table 4: Showing frequency of complications according to bone involved

Bone involved	Total number of complications	Number of bone segments	Average
Femur	15	6	2.50
Tibia	82	25	3.28

Complications were found to be more frequent on left side than on right.

Table 5: Showing complications according to side involved

Side involved	Total number of complications	Number of cases	Average
Left	30	9	3.33
Right	67	21	3.19

Two patients had premature removal of IRF due to intolerance to pain. Two patients had regenerate infection and were unwilling to undergo further treatment; hence below knee amputation was done. Most of the cases needed plaster of Paris cast (above knee walking cast 2, patellar tendon bearing cast 19) for variable period of time after IRF removal. 1 had equinus deformity, for which TA lengthening was done but proved unsuccessful hence triple arthrodesis was done.

Range of motion (ROM) and limb length discrepancy (LLD): Majority of patients had reduced ROM (ankle affected more than knee). These patients had IRF rings applied near joint lines, leading to pain during joint movements; thus were reluctant for physiotherapy.

Table 6: Showing loss of range of motion (ROM)

Loss of ROM	Number of cases of ankle	Number of cases of knee
<15º	15 (53.47 %)	16 (57.14 %)
>15º	13 (46.42 %)	12 (42.85 %)

5 cases had < 1cm LLD while 8 had 1-3 cm LLD, shoe raise sufficed the purpose.

Table 7: Showing limb length discrepancy (LLD)

Limb length discrepancy (LLD)	Number of cases	Percentage
Same as before	15	53.57
0-1 cm	5	17.85
1-2 cm	4	14.28
2-3 cm	4	14.28

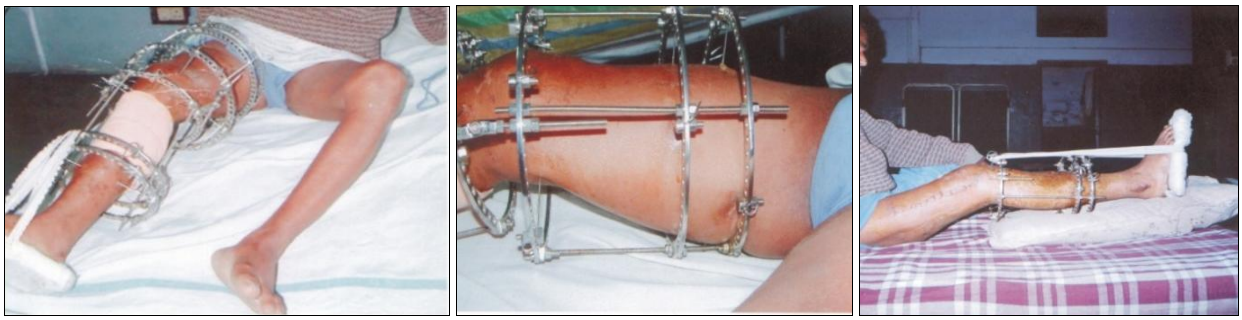
As per modified ASAMI classification 26.66 % (n 8), 30.00 % (n 9), 23.33 % (n 7), 20.00 % (n 6) had excellent, good, fair and poor results respectively. 86.66 % (n 26) patients were satisfied while 13.33 % (n 4) were not satisfied with final outcome of treatment with IRF.

Discussion

Complications have plagued limb lengthening techniques since Codivilla (1905) [4] introduced surgery for elongation of lower limb. Giorgio (1979) [5] reported his case series on 16 patients with epiphyseal traction method for limb lengthening in different etiologies like congenital in 7 cases, septic in 4 cases, trauma in 4 cases and bone cyst in one. He tried with Ilizarov apparatus both in femur and tibia. He could achieve lengthening a minimum of 3 cm to maximum of 10 cms in duration of four and a half to six and half months. The complications observed were separation of epiphysis and premature healing of fibular osteotomy.

Majority of the patients in this study, 28 (93.33%) had some kind of operative procedure performed on the bone under study and subsequently got infected thus creating discouraging milieu around the fracture site i.e. disuse osteoporosis, soft tissue dystrophy and persistent infection in the presence of implants. 15 patients (50%) had undergone two surgeries, 2 patients (6.66%) three surgeries and one patient (3.33%) a total of four surgical procedures previously over the bone under study. One patient was already treated by IRF and had achieved union at docking site. He suffered from refracture at docking site due to reactivation of infection. He was treated by IRF with technique of compression along with bone grafting. Majority of patients, 23 (76.66%) had undergone tubular fixation for treatment of fractures. Different other surgical procedures undergone by patients were compression plating, intramedullary nailing, tension band wiring, sequestrectomy, bone grafting, skin grafting, drilling, fasciotomy and decortications.

Most common complications with IRF were pin tract infection and pain that are known to occur universally. All patients in this study had pin tract infection. Wire skin interfaces should be cleaned daily with water. Similarly pain was present in all patients ranging from mild to severe intensity. 26 out of 30 patients had bearable pain, controlled with analgesics and psychotherapy, 4 patients had severe pain. In one patient, severe pain could be controlled by narcotics. Out of other three, one case complained of severe intolerable pain in right thigh due to Ilizarov ring impinging over right thigh (as seen in Figure 1). Patient could be relieved of his symptoms only after removal of IRF from thigh. Later on open reduction and internal fixation of right femur was done. One case complained of severe intolerable pain in left leg after application of IRF during consolidation phase. Hence premature removal of IRF was done and above knee walking POP cast given.



1 a **1 b** **1c**

Fig 1: IRF applied over right thigh and leg (1a), ring impinging over thigh caused severe intolerable pain (1b), hence IRF removed from thigh. Foot strap given to prevent equinus (1c).

There was no acute neurovascular injury, 3 patients had mild bleeding from few wires during distraction phase, which was controlled by stopping weight bearing over the limb. Two other patients had uncontrolled bleeding from the wires. While in one patient, removal of offending wire controlled the bleeding, in other patient, hemostasis could be achieved only after removal of offending wires, exploration and packing in operation theatre. Two patients had loosening of wires in distraction phase and were retensioned.

Most common of other complications was soft tissue interposition in 12 cases (40%). In all of these, union at docking site could be achieved after soft tissue removal, 8 of 12 required additional bone grafting. Malalignment at the docking site occurs because of malalignment of Ilizarov assembly and muscle contractures. In this study 3 cases had some kind of malalignment at the docking site. The axial deviation resulted from tilting of the middle bone segment in sagittal plane producing anterior or posterior angulation. In coronal plane, this tilting produced medial angulation at docking site and lateral angulation at distraction site. Malalignment was managed accordingly during soft tissue removal at docking site along with bone grafting, arching and additional olive wire insertion. In 2 cases, additional schanz cancellous pin was also inserted to improve the stability of frame (Figure 2).

Fig 2: Additional schanz pin insertion for correction of malalignment

Fig 3: Bleeding from wire, it necessitated wire removal

An elastic strap was used around the planter aspect of forefoot attached to frame to keep foot in neutral position. Yet non-compliance in two patients lead to equinus deformity of foot. To realign the plantar flexed ankle, case was managed by additional half ring. Equinus deformity in the other patient did not improve even after additional half ring over foot. In 3 patients, deformities of toes were observed. 2 patients had great toe drops and 1 patient had clawing of toes. All were corrected by POP cast after IRF removal. There was no premature consolidation. Two patients had delayed consolidation at regenerate site necessitating bone grafting. One patient had refracture of docking site and was managed by compression and bone grafting. Dagher *et al.* (1991) [6] used IRF in 25 cases of compound tibial fractures. One patient had refracture. Paley and Maar (2000) [7] reviewed 19 patients, ten patients required debridement of bone ends and one bone grafting of the docking site, at the end of transport.

Severe regenerate site infection occurred in 5 out of 30 patients (16.66%), threatening failure of treatment. In 3 patients, further distraction was stopped, regular and thorough debridement done and injectable antibiotics were given according to culture and sensitivity along with maintenance of good nutrition; infection was controlled. One of these 3 later on developed infection of bone graft at docking site, but that was also fully controlled; bony union along with soft tissue coverage was achieved. Other two patients with severe regenerate site infection were not willing to undergo further treatment with IRF; hence below knee amputation was done. Paley *et al.* (1989) [8] reported treatment of 25 tibial non-unions with IRF. In 3 patients infection persisted. Amputation was eventually required in one. Morandi *et al.* (1989) [9] reported 13 patients of infected non union treated by them. One had residual infection. Ring *et al.* (1999) [10] reported residual infection in 4 of their 10 patients of infected non-union tibia treated by IRF. One patient ultimately required a below knee amputation. David (2003) [11] reported 25 patients with complex non-union of tibia treated by IRF, 3 eventually required amputations, 2 for persistent infection and one for persistent pain.

Jones (1985) [12] reported that complications of lengthening of femur are more than that of lengthening of tibia particularly while using IRF in the treatment of residual poliomyelitis. Mosca and Mosely (1986) [13] reported an average of two complications per lengthening with Wagner technique, of which at least usually one was serious enough to prevent achieving the original goal of surgery.

Richard and Deborah *et al.* (1991) [14] reported a complication rate of 183% on 62 bone segments while correction of limb

deformities in children with IRF. Mark *et al.* [15] (1994) reported a total major complication rate of 72% in 110 patients with 120 bone segments lengthened by IRF (84), Wagner method (22) and Debastiani method (54). They reported bone healing complication rate of 72% for Wagner apparatus, 80% for Debastiani and 40% for IRF. Baruach [16] (1999) found an average of 2 complications per patient in treatment of non-union of long bones with IRF. Leunz *et al.* [17] (2000) reviewed 31 distal tibial fractures treated with IRF; complications included 9 pin treat infections, 1 skin necrosis, 1 osteomyelitis requiring arthrodesis, 1 malunion and 2 unsatisfactory reductions necessitating frame adjustments. Paley and Maar [7] (2000) retrospectively reviewed 19 patients of tibial bone defects treated with IRF. There were 22 minor complications, 16 major complication without residual squeals and 3 major complications with residual squeals. Chandra *et al.* [18] (2001) studied 48 cases of difficult non union tibia treated by IRF. Complications observed by them were wire breakage, pin tract infections, equinus deformity, transient common personal nerve palsy, refracture and amputation.

Blum AL *et al.* [19] had 13/50 cases of persistent pain while Vignes [20] *et al* had 17 cases of pin tract infection. R Bhardwaj *et al.* [21] reviewed 30 patients each (of infected non union) operated by IRF and rail fixator (RF). They reported pin tract infection as most common complication which was comparable in both groups. Pain was present in 25 cases of IRF and in 20 cases of RF. There were five cases of equinus foot, five cases of limb length discrepancy and one refracture at docking site.

Most of the patients, 19 (67.85%) were given PTB cast after removal of IRF so as to give more time for consolidation of bony union. 2 (7.14%) were given above knee walking POP. One of these 2 patients had premature removal of IRF due to intolerance to pain. Other patient was a child of 6 years age having fracture in proximal 1/3 of tibia. One patient had severe equinus deformity of both fore foot and hind foot, which could not be controlled by addition of half ring; hence TA lengthening was done after removal of IRF. But that also was unsuccessful, hence triple arthrodesis was performed.

As per the results are concerned about condition of adjacent joints, most of the patients were able to bear weight and could do physiotherapy. The persons who worsened after IRF application were having rings very close to the joints. The patients who had worsening of joint function during treatment, functions were restored to pre-operative status after removal of IRF with physiotherapy. Results were graded according to ASAMI criterion [3] (1995). Out of 30 patients, there were 8(26.66%) excellent, 9(30%) good, 7 (23.33%) fair and 6 (20%) poor results.

Ramesh *et al.* [22] (2004) evaluated 13 patients with distal femoral fractures. Functional outcome (using Neer's scoring criteria) revealed 10 cases with good or satisfactory outcome and 3 cases with poor or unsatisfactory results. Results of this study of 14 excellent, 6 good, and 5 fair and 5 poor compared well with the series in literature. Final outcome was not affected by number of previous surgical procedures. Excellent result was achieved in a patient, who had undergone maximum number of surgeries (4) previously.

Conclusion

In badly infected non-union where large segments of necrotic bone have to be resected and in cases where extensive soft tissue damage is there, IRF application is the best choice to save the limb, to achieve union and to restore the limb length. Many a complications of IRF can occur during intra-operative, immediately post-operative or late post-operative period. It is to be emphasized here that with IRF, the post-operative period is merely a temporal extension of the actual surgical procedure. It needs the same high level of care, monitoring and intervention that we apply during the actual surgery. Most complications of IRF can be prevented by diligent post-operative care and those that do occur can be treated successfully, if diagnosed early and managed accordingly. In this study, total number of complications did not affect the final results. As such advantages of Ilizarov ring fixator outweigh the associated complications. Patient's education for compliance for a very long time is must before deciding to go ahead with this procedure. Small sample size is a limitation of study and IRF use should be compared with use of rail fixator in such cases.

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Consent of Patients: Taken

Ethical committee approval: Taken

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