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Review Article

Current Status of Ilizarov Method of External Fixators

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ABSTRACT

The Ilizarov method of external fixation was revolution in field of Orthopaedics. For the first time it introduced the concept of distraction histogenesis. This method was useful for fixation fracture, infected non-union, compound fractures, segmental fractures, polytrauma, segmental bone loss. The principle of controlled distraction at the fracture site stimulated not only the neovascularistion & new bone formation, but also regeneration of soft tissues & nerves. The wires were passed in each fracture fragment; the tension applied to the wire & was fixed to circular rings. The circular rings were connected to each other by threaded rods. Thus frame was constructed.

This was widely used in treatment of various types of fractures. But over a period of time, the popularity of this method of fixation gradually reduced & now that this technique is restricted to the injuries of tibia. Very rarely this method is used as mode of fixation to salvage the extremity.

Keywords: Ilizarov ext. Fixator, comminuted fractures, distraction histogenesis, Bone regenerate.

INTRODUCTION

Prof. Gravil Abramovich Ilizarov invented this method of External Fixators while treating casualties at Kurgan, Siberia around 1950. [(1)] There he witnessed the complications of the fractures such as- [(2)]

I Non healing wounds
II Infected Nonunion
III Osteomylitis
IV Malunions

He invented his idea of ring fixators which was based on simple concept of bicycle wheel with tensioned spokes. [(1,3)] Thus he devised the meticulous construct with tensioned wires connected to circular rings which behave as trampoline. With this, he was able to achieve bone healing, Realignment & Lengthening. For the first time he introduced the Principle of Distraction Histogenesis wherein he proved that not only the bone but also muscle, nerves & neovascularisation increases after controlled gradual distraction of the fractured fragments due to the effect of tension & stress.

In 1978, Prof. Ilizarov was awarded with Lenin Prize for Medicine. He was elected as Emeritus Professor & Inventor Emeritus of USSR & further achieved full

membership of Soviet Science Academy, a rare Honour for Doctor of Medicine. [4]

Standard frame:

The basic procedure of application of this type of fixator consists of

I 1.5 - 1.8 mm S.S. wires / bayonet wires.

II Wires, by applying tension of 90 - 130 kg, are fixed to circular rings.

III This tension applied to SS wires resists the Axial & Tensile deformation

IV Rings are interconnected with Threaded rods & bolts.

V Distraction or compression device is applied to the circular rings.

VI Angle of the two SS wire at same level should be between 90-120 degrees

Hybrid frame:

Instead of using SS wires or bayonet wires, Shanz pins are used.

Rest of the assembly is more or less same.

Latest addition to this technique is Computer navigation wherein the alignment of bone, deformity correction is guided by computerised control.

Principle of Distraction Histogenesis:

It is mechanical induction of new bone between the two adjacent bony surfaces which are gradually pulled apart. The biological bridge between these two adjacent surfaces, arises from the neovascularisation & spans the entire cross section of bony surfaces. The fibrovascular Interface is aligned parallel to the direction of distraction. When the mechanical & biological conditions are ideal, the new bone is formed, which is pure intra membranous ossification. [5,6]

Animal model studies were carried out in mature Canine tibia. Ring frame was applied & the corticotomy was performed to left tibia while right tibia was used as control. Distraction started on Day 7. Sequential changes were noted & analyzed from Day 0 (day of operation) to Day 77 after taking weekly X-rays, triphasic technetium scintigraphy, quantitative computerised tomography to measure the blood flow & new bone formation and was compared with the opposite side.

Earliest change was noted on Day 7 of distraction @ 1mm per day with the rhythm of 0.25mm four times a day. The changes noted in the study are as under [5]

Day 7 (Distraction): Fibrovascular network bridged the distraction gap.

No mineralisation.

Day 14:New bone was seen first time from entire cross section of the cut. bony surfaces, including periosteum, spongiosa,& cortex.

Day21:New bone had differentiated into micro-columns with max. diam. of 200 microns. The central zone of the interface remained fibrous

Interzone with traces of calcium & no HAP crystals. The fibrous zone persisted throughout the distraction averaging 3-4 mm.

Bone columns bridged across the fibrous interzones.

Day70: Osteogenic area had remodelled radiographically showing early cortex formation.

Day112: Osteogenic area contained lamellar bone with haversian system & hematopoeic marrow.

The cells within the fibrous interzone resembled fibroblasts, actively producing collagen matrix. As the collagen bundles consolidated, the same cells became incorporated into their own HAP matrix. The bone columns crossed the fibrous interzone to bridge osteogenic surfaces. This process closely resembled the process of intramembranous ossification.

The vascular studies revealed new afferent &efferent vessels on Day35. Increased blood flow was noted on technetium scintigraphy.

Bone mineral density studies revealed radiodense projections between Day14 & Day21. Before Day 14 distraction gap remained radiolucent. Quantitative CT

(QCT) revealed the new bone formation & its mineralization. QCT done on Day77 confirmed that osteogenic area was completely remodelled & mineralized circumferentially across the cortex. [5,7]

Mechanical factors which were accepted as ideal, were

Rate of distraction – 1 mm per day. Slower rate of distraction caused premature closure of the gap. [1,5]

Faster rate of distraction outstrip the advancing blood supply & inhibit mineralization.

Rhythm of distraction – 0.5 mm twice a day, 0.25 mm 4 times a day.

Latency which is the gap between Day of operation & Day of distraction is around 7 days.

Earlier the rate & quality of Bone regenerate was assessed by conventional X-rays taken at frequent intervals. This increased the total dose of radiation thereby increasing the risk of radiation hazards to the patients. Now real time ultra sound serves as a best substitute for X-rays.

Usually the bone is poorly visualised on ultrasound as cortex being tough does not allow ultrasound waves to pass. But the Bone regenerate does not have cortex & hence is better visualised on USG. Also the risk of the radiation hazards is reduced significantly.

Signs suggestive of hypotrophic regenerate are

i) Narrowing of regenerate on T.S.,

ii) Echolucent cavities within regenerate

If either signs are present one has to reduce the rate of distraction.

The quantitative assessment of the regenerate can also be done by Radionuclide studies. [5,7] Pyrophosphate estimation & technetium 99mc can assess about the increase in blood flow & bone formation. Dr. L. Celentano of Department of Nuclear Medicine Naples University has following observation. Use of technetium 99MPc can give quantitative information about bone regenerate. He used three phase method that provides information on following,

Status of blood flow in limb as a whole & in the regenerate bone segment.

Relationship between the blood flow & blood pool scan.

Metabolic uptake of the bone as related to those changes induced by surgery / fixator.

In all the cases examined in his studies there was marked increase in perfusion of the limb.

Advantages of Ilizarov Technique: [8]

Fixation of fractures, deformity correction can be done in same sittings.

Can be used in both closed & open factures.

Bone transport / Limb length discrepancy can be corrected.

Repeated surgeries can be avoided.

Distraction & minor adjustments in the alignment of bones does not require anaesthesia.

Serves as imp. modality in Infected Nonunions, & Polytrama.

Early ambulation of the patient.

Disadvantages:

Heavy frame becomes cumbersome especially in case of fracture of femur.

Pin tract infection is major cause of concern.

Long duration of treatment.

Improper assessment of fracture geometry may cause iatrogenic problems.

Application of pins may damage major vessels, results in catastrophy.

Distraction of the facture fragments reflexly cause soft tissue contractures.

Limitation for the bone regenerate.

Improper & haphazard distraction can result in fracture of the bone regenerate.

Inadequate mineralization of Bone regenerate. [9]

Few years back orthopaedic surgeon tried to use this technique in majority of the fractures. Over a period of time as we learnt about the complications, its use got

restricted. The wave with which this technique got popular in Orthopaedic fraternity, the reverse trend also attained with equally fast pace. The technique requires reasonable skill & expertise for a surgeon to perform well. Not only that, pre operative planning needs to be absolutely meticulous which is many times more than that done in other cases. To know the exact nature of deforming forces, CT & 3-D CT studies are almost necessary before one decides for its use. Then, it is possible to have proper entry & direction of the pins passed through the bony fragments so that the deforming forces get nullified. Thus it may not be improper to say that, its use should highly selective, done after critical evaluation of fracture geometry, & lastly done at expert hands. Since the distraction histogenesis increases neovascularity, this technique cannot be treated & used as method of choice in Ischemic peripheral vascular disease.

Nowadays this technique is predominantly restricted to the pathologies of Tibia for simple reason that tibia is almost subcutaneous bone. Thus injures to major vessels & nerves are less likely. The technique of fixation is much easier. Frame around thigh for fracture of femur is too heavy and cumbersome. Also the technique of fixation of femoral fracture with this frame requires more skill and precision so as to avoid the complications. The patient has to sleep in bed with limb elevated to at least 30-40 degrees. Half rings around the gluteal region are causes concern. Incidence of pin tract infection & other skin lesions reported is much higher than in other cases. Patient's compliance for such heavy frame is poor.

Also it has been noted that the acceptance of this frame is poor in cases of fratures of humerus, fore arm, foot and ankle because Light weight & user friendly frames of other type are available in such cases (JESS frame). [(10)] The Duration of the treatment is quite prolonged, time span averaging between 12 t0 15 months. Due to this, most of the patients are desperate to get rid of the frame. So much so that they are ready to accept the amputation of the limb rather than continuing with the frame. However in some cases wherein all other modalities of fixation seem to be incompatible, this technique serves as good alternative for salvage. But the functional deficit observed in such cases is remarkably significant. The long duration of treatment makes the patient more averse to this technique.

Poor Compliance of Patients:

The frames used are heavy & cumbersome

The cost of the frame & assembly is also high

Duration of treatment is prolonged. (Average time required is 12-15 months)

Pin tract infection is the main cause of concern

Phase of active distraction is quite painful

Associated soft tissue contracture call for vigorous physiotherapy

Associated Osteomylitis further prolong the results

There is great degree of variation in results from surgeon to surgeon

Residual significant deformity is always persists

Patient cannot really ambulate freely as claimed, especially with heavy frames.

Secondary joint stiffness is marked & refractory

Some minor adjustments in the frame are required at quite frequent intervals

This technique really tries the patience of both Surgeon & Patient.

CONCLUSION

Ilizarov technique is a great revolution in orthopaedics especially High velocity RTA, Polytrauma, Osteomylitis,

Deformity correction. It introduced totally new concept of distraction histogenesis to us. Its role in bone transport & bone regeneration is unmatched & uncomparable. Over a period of time its use was found to be restricted to few injuries. Meticulous study of fracture geometry is essential before application of ring fixator. Inadequate preoperative planning, incomplete study of fracture geometry and vectors of deforming forces, can lead to more complications rather than doing any good. Also it has been observed that the results of Ilizarov technique vary greatly from surgeon to surgeon. Hence like any other precision technique it has to be utilized after achieving meticulous training & good expertise.

ASSORTED IMAGES OF ILIZAROV TECHNIQUE DONE AT OUR CENTRE.

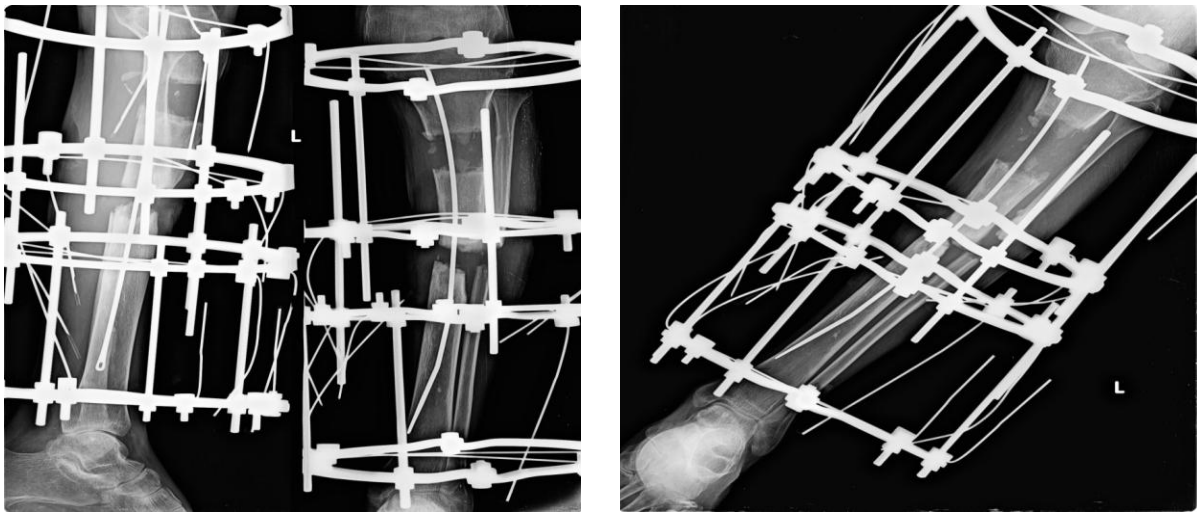

Fig 1&2 - bone transport

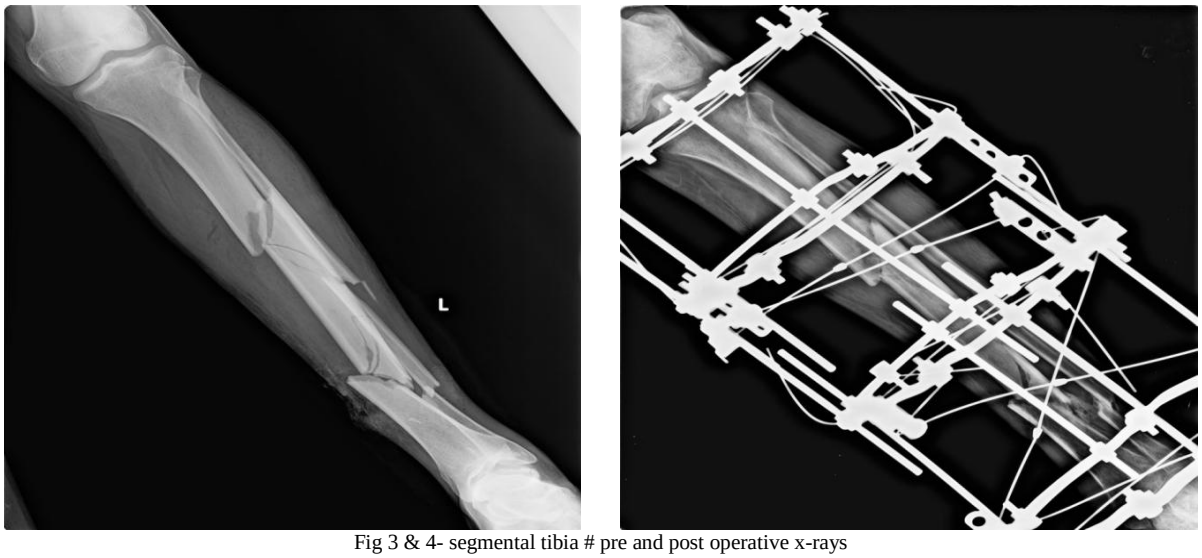

Fig 3 & 4- segmental tibia # pre and post operative x-rays


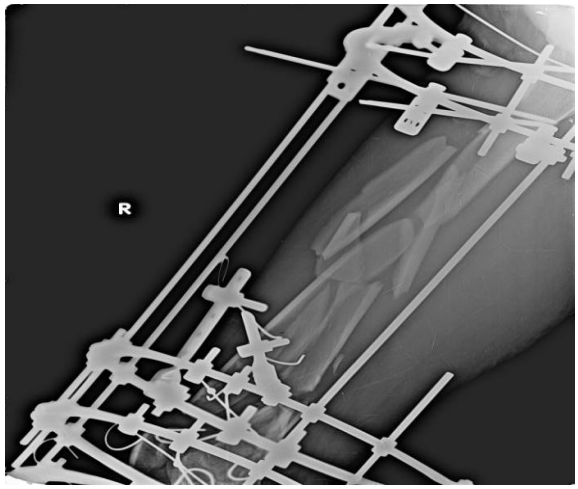

Fig 5 & 6 – comminuted femur # pre and post operative x-rays


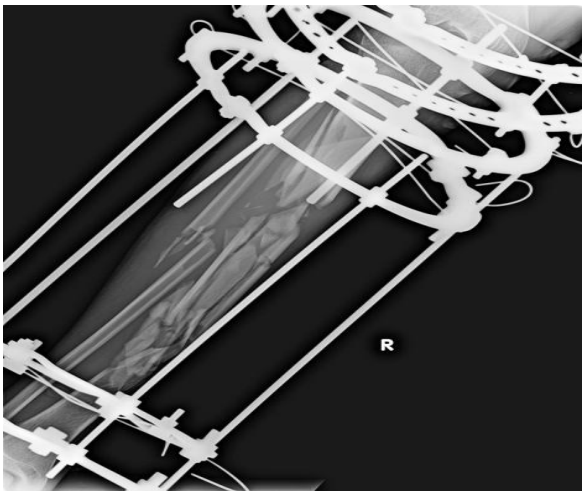

Fig 7 & 8- comminuted and segmental tibia # pre and post operative x-rays

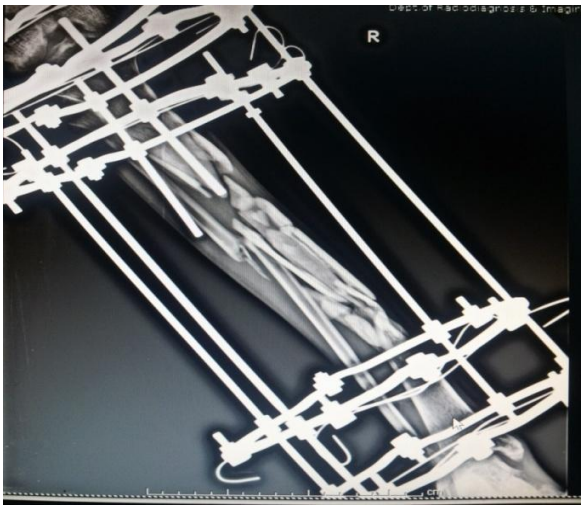
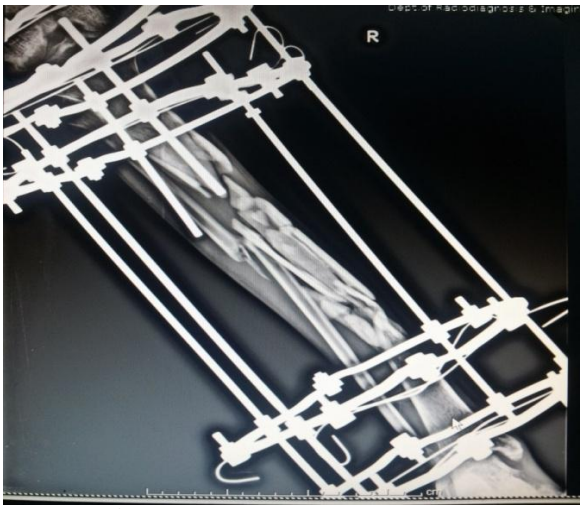

Fig 9 & 10- comminuted and segmental tibia # follow up x-rays


Fig 11& 12 - comminuted and segmental femur # follow up x-rays
Foot note #- fracture

REFERENCES

1. Research institute of Experimental & clinical orthopaedics & traumatology in kurgan- publication, kurgan,1986(F,E)
2. The principles of the Ilizarov method, Ilizarov G.A, Bull. Hosp.Joint Dis.1988; 48(1);1-11
3. Campbell's Text book of orthopaedics 11th edition chapter 51,page number 3131-3138
4. Golyankhovsky V; G A Ilizarov ; the magician from Kurgan.Bull Hosp. Joint Dis.1988;48(1): 12-16(E)
5. Biology of osteogenesis, Principles of illizarov fixation by ASAMI group, page 42.
6. Basic principles of Transosseous compression & distraction osteosynthesis (translated from Russian) by G A Ilizarov, Ortop.Travmatol.Protez 10;7-15,1975
7. Roentgenodensitometric & radioisotopic examination of reparative osteosynthesis in distraction osyteosynthesis - Syeshnikov,A A,Popkov,A.V, smotrova, L.A ; Ortop.travmatol.protez.1987;5:47
8. Textbook of Ilizarov surgical techniques bone correction & lengthening ,by Vladimir Golyakhovsky,Victor H Frankel first edition 2010, chapter 15,page 191
9. Textbook of Ilizarov surgical techniques bone correction & lengthening ,by Vladimir Golyakhovsky,Victor H Frankel first edition 2010, chapter 17,page 287
10. Trauma management by Joshis external stabilization system(JESS) by Dr B B Joshi first edition 2007 chapter 7 section I page number 225- 230.

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