Original Research Article

Study the Effectiveness of the Ilizarov Method in the Management of Fixed Flexion Deformities of the Knee Joint

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Abstract

Background: Fixed flexion deformity of the knee is a common and disabling problem, especially in India where poliomyelitis is still a great problem. Correction of severe deformities has been a challenge to orthopaedic surgeons over the years. The Ilizarov method of treatment has revolutionised the management of severe and complex deformities. **Aims:** To study the effectiveness of the Ilizarov method in the management of fixed flexion deformities of the knee joint and to identify the various associated complications.**Methodology:** It is a combined retrospective and prospective study of all the patients who underwent correction of fixed flexion deformities of the knee by the Ilizarov method. **Results:** 49 patients (59 knees) were included in the study. The age at primary surgery ranged from 4 to 24 years with an average of 16.5 years. The severity of the Fixed Flexion Deformity of the Knee ranged from 10° to 150°, with an average of 71°. The mean follow up after fixator removal was for 20 months ranging from 2 months to 6 years and 1 month. Deformity correction was done to neutral or 5-10 degrees of recurvatum. This was achieved in all but 2 knees. There was recurrence of less than 20° in 9 patients. 3 patients developed recurrence of the deformity more than 20° which precluded walking. Loss of terminal arc of motion was from 0% to 85.71% with a mean of 20.20%.There was Pin tract infection in 76%, posterior subluxation of tibia in 25.42%, stress fractures in 15.25%, and progressive equinus in 13.55%.**Conclusion:** In view of the immense advantages of the Ilizarov method, this should be the recommended method in the correction of severe fixed flexion deformities of the knee, correction of multiple and complex limb deformities and when other methods have failed, in spite of the associated complications.

Keywords: Ilizarov method, limb deformities, Complications.

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Introduction

It is estimated that in India there are about 10 million orthopaedically handicapped children and adults with limb deformities. Fixed flexion deformity of the knee is common and causes great disability. It increases the work load of the quadriceps during walking, and if associated with quadriceps weakness, results in a hand to knee gait. If severe, it often results in a non ambulant victim.Post polio residual paralysis (PPRP) is still a common cause of disabling FFD knee in our country . Other common causes are trauma, rheumatoid arthritis, infective arthritis, post burns contractures, congenital anomalies like multiple congenital contractures or the multiple pterygium syndrome and neuromuscular causes (cerebral palsy, meningomyelocoele).

There are many methods for managing flexion contracture of the knee including serial casting, bipolar traction, posterior soft tissue release, osteotomy, and femoral shortening. These have been used alone or in combination with various degrees of success depending on the severity of the deformity and its aetiology[1,2].Surgical therapy of fixed flexion deformity of the knee consists of tendon lengthening with or without capsular release as well as extension osteotomy of the distal femur. The former method often results in an incomplete correction in heavy contractures with a high risk of skin necroses and traction injury of the nerves following acute correction. Contracture correction by osteotomy can lead to secondary osseous deformity.The surgical correction of fixed and severe contracture requires extensive soft-tissue release which may create an unstable knee. The sudden stretching of posterior structures, namely the popliteal vessels, the tibial and common peroneal nerves can result in disastrous complications including thrombosis of the popliteal artery and nerve palsy. These may worsen the pre existent disability or even lead to gangrene of the limb resulting in amputation[3]Less serious contractures can be treated by noninvasive measures like plaster casts or dynamic orthoses. The fractioned changing of the cast or orthosis exerts a traction stimulation on the shortened tissues that leads at first to a stretching of these tissues and eventually to tissue growth. The force of the plaster casts or orthoses, however, is limited by the pressure tolerance of the skin. The Ilizarov technique is an improvement on conventional methods. It allows progressive correction of the most complex deformities of the knee, with simultaneous correction of associated foot deformities and limb lengthening. The principle of the Ilizarov method is the exertion of a continuous traction on bones and soft tissue that is increased in small

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measures, thus stimulating growth of all tissue types involved. The fixators used are distinguished by their gentleness concerning periosteal circulation and the soft tissues. The growth of bones and soft tissue during distraction treatment constitutes the principle of treatment for bone and tissue defects, marked joint contractures, and axial deviations. In severe flexion contractures of the knee joint, gradual correction can be achieved by a fixator instead of a cast, which eliminates the complications linked to casts or orthoses. The gradual and continuous correction according to the Ilizarov method not only induces a stretching but a real growth of the shortened soft tissues.

Materials and Methods

It is a combined retrospective and prospective study. All patients suffering from fixed flexion deformity of the knee, admitted in orthopaedic wards of between June 2006 and December 2007 who were operated upon by the Ilizarov External Fixation for the same were the subjects of the study in the prospective group.All patients suffering from fixed flexion deformity of the knee, admitted in the orthopaedic wards of before June 2006, who were operated upon by the Ilizarov External Fixation for the same were the subjects of the study in the retrospective group.

Inclusion Criteria: All patients with fixed flexion deformities of the knee joint who were treated by Ilizarov External Fixation.

Exclusion Criteria: All patients with fixed flexion deformities of the knee for whom other modalities of treatment was performed.

Radiological Evaluation

1. True antero- posterior radiographs of the affected knee joint, including the distal half of femur and the proximal half of tibia- to identify any associated varus or valgus deformity.
2. True lateral radiographs of the affected knee joint in maximum extension possible, including the distal half of femur and the proximal half of tibia- to know the amount of fixed flexion deformity of the knee and to identify any posterior subluxation of tibia.
3. Follow up radiographs were also taken similarly.

Routine laboratory evaluation was done for pre operative evaluation of all the patients AS Blood investigations, Urine routineAll patients were evaluated by a detailed history and clinical examination, to identify the aetiology, and their current status regarding ambulation, and the activities of daily living. An assessment of all the deformities was made along with a detailed neurological status, both sensory and motor. Muscle power was graded according to the MRC grading (Medical Research Council) from 0 to 5 (0= no contraction; 1= flicker of activity; 2= contractions and full movements with gravity eliminated; 3= contractions and full movements against gravity; 4= contractions against some resistance; 5= normal power)Careful pre operative counseling of patients and parents or guardian was done with a detailed explanation of the problem, the treatment options, surgery, duration of external fixation, post operative protocol and type of orthosis, to obtain maximum cooperation from them thereby favouring long term results. The radiographs were assessed with regards to the degree of fixed flexion deformity, presence of any associated varus or valgus deformities, and to identify any posterior subluxation of the tibia. The quality of bone and bone stock was assessed.Informed written consent was taken from all the patients and their parents or guardians.The procedure is performed under appropriate anaesthesia, using sterile precautions and antibiotic prophylaxis. Ilizarov wires are first passed through the femoral condyle, through the proximal tibia and through the distal tibia. For the R1 ring, one Ilizarov wire or a half pin is used. These are known as **reference wires** as they allow for the best (usually central) placement of the limb with respect to the apparatus. This placement is checked at the insertion of every wire from the first wire insertion and adjustments are made till we are satisfied that the limb is exactly as required in the centre or slightly anterior with respect to the centre of the rings. All wires are fixed to the rings with wire fixation bolts and tensioned[4-6].After attachment of at least one Ilizarov wire or half pin to each ring, a second set of Ilizarov wires or half pins are inserted and attached to the rings at angles as near to 90° as possible to the already placed wires, with due consideration to the neurovascular structures, so as to have at least two attachments from the bone to each ring. In case more stability is required, additional drop wires or half pins are inserted. The second proximal tibial wire is passed through the head of fibula to transfix it and to avoid damaging the common peroneal nerve. All the wires are parallel to the axes of the knee and ankle joints.

Post Operative Protocol

Radiological assessment using antero posterior and lateral radiographs of the knee with femur and tibia is made to see the FFD knee with the fixator and its components, to identify the position of the Ilizarov wires and shanz pins, and to identify the axes of the rings.Arthrodiastasis is started once the operative pain is minimal, usually between the 2nd and 5th days post operative, by distraction across fixed or locked hinges between R2 and R3and the posterior distraction rod. I.e. between all three rods connecting the femur and tibia which facilitates distraction of the whole tibia with respect to the femur. This is to separate the tibial condyles from the femoral condyles to avoid pressure-induced injury of the joint cartilage when correcting the FFD knee[5].After 5 to 10 days of arthrodiastasis, adequacy of the diastasis is confirmed by a lateral radiograph of the knee joint. Then the hinges are loosened and gradual distraction using the posterior distraction rod is performed daily in one to four installments. The rate of distraction was determined by the law of similar triangles as follows, aiming at of 1° per day at the knee joint, or based on patient tolerance.

Follow Up

Patients were followed up for a minimum period of 6 months after removal of the fixator. During each follow up, the patients were assessed clinically with regards to recurrence of deformity, ambulation status, activities of daily living and patient satisfaction. Radiological assessment was done to measure the deformity and to identify posterior translation of the tibia.The presence of any complications was also looked for.

Results

Forty nine patients with a total of fifty nine knees were included in the study. There were 27 males and 22 females. The age at primary surgery ranged from 4 to 24 years with an average of 16.5 years and a standard deviation of 5.395. The diagnosis was Post Polio Residual Paralysis (PPRP) in 38 patients, Polio like illness in 1 patient, Multiple Congenital Contractures (MCC) [Arthrogryposis Multiplex Congenita (AMC)] in 3 patients, meningomyelocoele in 2 patients, Proximal Focal Femoral Deficiency who developed FFD knee during femoral lengthening in 1 patient, Post Septic arthritis in 2 and Post Traumatic in 2 patients. The side involvement was as follows: left side only- 22, right side only- 17 and 10 patients had bilateral involvement.

Table 1: Recurrence of Deformity

Recurrence of Deformity	Number	Percentage
No Recurrence	46	77.96
<20°	8	13.56
>20°	3	5.08
Removal Before Complete Correction	2	3.38
Total Recurrences	13/59	22.03
Recurrences Who Required Repeat Surgery	4/59	6.77

Table 2: Pre operative and post operative gait pattern

Pre Operative Gait	Number	Post Operative Gait	Number
Non ambulant	2	Wheel Chair	2
Quadriped	17	B/L KAFO	11
		KAFO + AFO	4
		Wheelchair	2
Walking with support	20	KAFO	18
		Wheel Chair	1
		PWB with crutches	1
Hand to knee	10	KAFO	8
		AFO	2

10 patients had a hand to knee gait pre operatively. Ilizarov External Fixator was applied to sequentially correct FFD knee and shortening in 5, recurrence of FFD knee following recurvatum osteotomy in 2, recurrence of FFD with non union of recurvatum osteotomy site in 1, development of FFD knee during equinus correction by IEF and severe deformity in 1 patient. After fixator removal, 2 patients are walking with AFO only while the remaining 8 are walking with KAFO.

Table 3: Post operative loss of terminal arc of motion

Loss of terminal arc of motion	Number of knees	Percentage
no loss	13	22.03
<10°	22	37.28
11-20°	14	23.73
>21°	8	13.56
IEF reapplied	2	3.38
Total	**59**	**100**

The pre operative terminal arc of motion ranged from10° to 140° with an average of 67°. Following the correction of the deformity, the terminal arc of motion at latest follow up ranged from 10° to 120° with an average of 53.7°.There were no patients with an increase in terminal arc of motion. 13 patients had a terminal arc of motion equal to the pre operative values. The number of patients with a follow up terminal arc of motion that were within 10° of the pre operative values were 22, a loss of TAM of 11- 20° was seen in 14 patients. Another 8 patients had a loss of TAM of more than 20° with a maximum loss of 60° seen in 2 patients. Two patients were still on the Ilizarov External Fixator for recurrence of the deformity whose TAM at latest follow up was not included.

Table 4: Pre operative vs. post operative terminal arc of motion

Pre operative TAM	Number	Loss of TAM	Number
10-30°	8	no loss	3
		5°	2
		10°	2
		on ief	1
31- 70°	29	no loss	9
		<10°	10
		11-20°	7
		21-60°	2
		on ief	1
71-140°	22	no loss	1
		<10°	8
		11-20°	7
		21-60°	6

Similarly the loss of Terminal arc of motion for the four patients with excess arthrodiastasis ranged from 20% to 33.33% with a mean of 29.99% while the remaining patients without excess arthrodiastasis had a loss of TAM ranging from 0% to 85.71% with an average of 19.46%.

Table 5: Complications in present study

Complication	Number	Percentage
Pin Tract Infection	45	76
Wire Loosening	6	10.1
Cellulitis, Fever	4	6.77
Skin Necrosis	1	1.6
Septic Arthritis	0	0
Chronic Osteomyelitis	0	0
Posterior Subluxation Of Tibia	15	25.42
Stress Fractures	9	15.25
Progressive Equinus	8	13.55
Impingement Of Fixator On Skin	4	6.77
Excess Arthrodiastasis	4	6.77
Wire Cut Out	3	5.08
Knee Pain, Swelling	3	5.08
Decubitus Ulcers	2	3.38

External Rotation Deformity Of Knee	2	3.38
Neurapraxia	2	3.38
Gangrene Of Toes	2	3.38
Wire Breakage	1	1.6
Fracture After Ief Removal	1	1.6

Table 6: Pre operative, post operative and follow up FFD values compared in study

	Paired Differences		't' Value	'Df'	'p' Value
	Mean	Standard Deviation			
FFD Knee- pre op vs removal	69.579	29.011	18.422	58	<0.001
FFD knee- pre op vs follow up	65.254	29.804	16.817	58	<0.001
TAM- pre op vs follow up	13.983	13.123	8.184	58	<0.001

Statistical Analysis

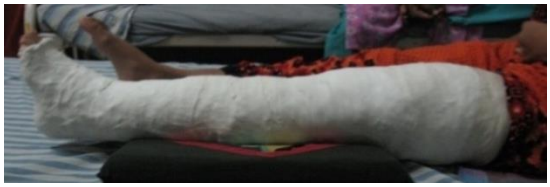
Statistical analysis was performed using the paired 't' test where the means of pre operative, post operative and follow up FFD values were compared and the difference was checked for significance. A similar procedure was done to compare pre operative FFD knee with follow up FFD and to compare pre operative TAM and follow up TAM. The 'p' values obtained are <0.001 which is less than 0.01, hence they are statistically significant.

PPRP LT LOWER LIMB WITH FFD KNEE 40° AND 8 CM SHORTENING

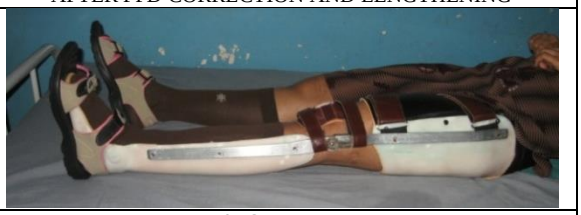
ROM- 40°- 150° TAM- 110°

DURING FFD CORRECTION

AFTER FFD CORRECTION AND LENGTHENING



AFTER IEF REMOVAL



KAFO FITMENT

TAM- 70°

Fig 1:Pictures related

Discussion

Fixed Flexion Deformities of the knee joint cause great disability and are impediments to efficient walking. Severe deformities may result in a quadriped gait or a non ambulant victim. The management of severe deformities has been a challenge over the years. The Ilizarov technique is an improvement on conventional methods. It allows progressive correction of the most complex deformities of the knee, with simultaneous correction of associated foot deformities and limb lengthening[2]. We compared our study with other similar studies and made the following observations.Damsin JP and Ghanem I used the Ilizarov technique for correction of severe flexion deformity of the knee in 11 patients (13 knees). There were six boys and five girls with a mean age at operation of 12 years (1.7 to 18.8). The flexion contracture exceeded 90° (90 to 150) in all. The diagnosis was congenital absence of the fibula in 1, popliteal angioma in 2, myelomeningocele in 2, myelomeningocele + quadriceps aplasia in 1, multiple pterygium syndrome in 1 (bil), complex knee malformation in 1 (bil), juvenile rheumatoid arthritis in 1, Poliomyelitis in 1 and electrical amputation of the leg in 1.Pathania et al, in their study used the Ilizarov method on 8 knees. The flexion contracture varied from 60 to 100 degrees. In their series, the diagnosis was below knee amputation in 3, post traumatic contracture in 2, post polio residual paralysis in 2, post tubercular contracture of knee in 1.In our study, we had 49 patients (59 knees) for whom the

Ilizarov method was used for deformity correction. There were 27 males and 22 females, the age at primary surgery ranged from 4 to 24 years with an average of 16.5 years. The severity of the Fixed Flexion Deformity of the Knee ranged from 10° to 150°, with an average of 71°. In our series, the commonest diagnosis was post polio residual paralysis in 38 patients, polio like illness in 1 patient, multiple congenital contractures in 3 patients, meningo-myelocoele in 2 patients, proximal focal femoral deficiency who developed FFD knee during femoral lengthening in 1 patient, post septic arthritis in 2 and post traumatic in 2 patients.Damsin and Ghanem in their study corrected the deformity by gradual distraction in 12 knees and by supracondylar recurvatum osteotomy in 1 patient. They corrected the deformity to an average of 6.5° (0-20°) followed by application of a POP cast followed later by a permanent KAFO. At the end of correction of the flexion deformity, five knees were arthrodesed, using femorotibial compression. Pathania et al corrected the FFD by gradual distraction in all of their 8 cases to 10-15° of flexion followed by application of KAFO. No knees were arthrodesed[7]In our study, we corrected the FFD knee by gradual distraction in the majority of patients (51 knees), by supracondylar recurvatum osteotomy in 7 patients and supracondylar corticotomy in 1 patient who underwent differential distraction to simultaneously correct FFD knee and achieve limb length equality. The deformity was corrected till complete correction 0° FFD followed by a consolidation period of 3-6 weeks. After removal of the fixator, an above knee POP cast was applied for a further 2-4 weeks before application of a KAFO. We did not perform knee arthrodesis for any of our patients.Damsin and Ghanem followed up their patients for an average of 4.1 years. Average fixation time was 3 ½ months (8 weeks to 1 year) and they had a recurrence of the deformity of 30° or less in 4 patients (30.76%), all of whom were operated. However, all their patients were able to walk with a KAFO. The complications in their series were mild varus in 1 (7.69%), 6 cases (46.15%) of posterior of subluxation of tibia, pin tract infection in 5 (38.46%), common peroneal nerve palsy in 1 (7.69%), and 4 fractures (30.76%). 5 patients had a mobile knee with a TAM of 5-50°.Pathania et al had a follow up of 1 year, had a recurrence in 4 patients (50%) all of whom were able to walk with orthotic support. Average fixation time was 14 to 22 weeks (Average: 18 weeks). There was posterior subluxation of tibia in 1 patient (12.5%) and pin tract infection in 75%[1]In our study, we had a follow up averaging 20 months. The duration of Ilizarov External Fixation averaged 7 months, with a range from 2- 24 months. There was recurrence in 13 patients (22.03%) of which 4 patients (6.77%) had to be operated upon. Of these, 9 patients were able to walk in spite of residual FFD. The complications noted were pin tract infection in 45 patients (76%), wire loosening in 6 (10.1%), cellulitis and fever in 4 (6.77%), skin necrosis in 1 (1.6%), fractures in 9 (15.25%), wire cut out or breakage in 4 (6.77%), decubitus ulcers in 2 (3.38%), posterior subluxation of tibia in 15 (25.42%), excess arthrodiastasis in 4 (6.77%), external rotation deformity at knee in 2 (3.38%), impingement of fixator on skin in 4 (6.77%), progressive equinus in 8(13.55%), gangrene of tips of toes in 2 (3.38%) and neurapraxia in 2 (3.38%). The post operative TAM ranged from 10° to 120° with an average of 53.7°. Theis et al reviewed complications from correction of lower limb deformities in 30 patients and pin tract infection was observed in all cases and all responded to oral antibiotics .[8] Ring in his study of 6 cases had pin track infection in 4 (66%) and all subsided with conservative treatment[9]Haung[10] reported on his series of ten patients with fixed flexion deformity of the knee. There was 80% recurrence in his study, and posterior subluxation of tibia in 30%. Jean Paul et al[10] had recurrence of 31% in 13 case studied . John Hertz et al[11] had recurrence in 13 cases (93%) out of 14 in his study . He attributed this to omission of osteotomy in case of severe deformities and not carrying out hamstring release pre-operatively. They noticed some rebound phenomenon in all cases on removal of fixator. Normal gait was possible in all patients with less than 30 degrees contracture. In our study, there were 49 patients and the recurrence rate was 22.03% with posterior subluxation of tibia in 25.42%.

Conflict of Interest: Nil Source of support:Nil

Conclusion

Ilizarov External Fixation is an excellent method of treatment of severe fixed flexion deformities of the knee. Failed previous surgeries, multiple deformities of the lower limb can be effectively treated with a single apparatus and limb lengthening can also be performed by this versatile technique. Non ambulant patients who have never walked in their lives can ambulate independently. The recurrence rates are acceptable.Complications such as pin tract infections, stress fractures, posterior subluxation of tibia and progressive equinus can be anticipated and prevented. These can also be effectively treated by the Ilizarov method. In view of the immense benefits of the Ilizarov method, this should be the recommended method in the correction of severe fixed flexion deformities of the knee, correction of multiple and complex limb deformities and when other methods have failed, in spite of the associated complications.

It is recommended for polio and post traumatic patients. It is very difficult and painful for patients with spasticity including cerebral palsy, meningomyelocoele, MCC etc. Recurrence rates and complications are higher in spastic patients. Hence, Ilizarov method is most useful in polio patients but benefits to usefulness in spastic patients has to be considered before venturing on Ilizarov method for spastic patients. It may be combined with open surgical procedures to improve results.

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