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Surgical Treatment of Relapsed Clubfoot Using the Ilizarov Method: Anatomical and Functional Outcomes—A Report of 16 Cases at the Order of Malta's Hospital Center

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Abstract

Introduction: Relapsed Congenital Talipes Equino Varus (CTEV) refers to clubfoot diagnosed after walking age. We refer to this entity as residual deformities of a previously treated clubfoot or a complete recurrence following treatment. For its treatment, several techniques have been used to improve the foot's functional outcome while remaining minimally invasive. Correction by distraction using the Ilizarov external fixator is a promising technique. This single-center study aims to evaluate the anatomical and functional outcomes of treatment by distraction and compression with the Ilizarov fixator in relapsed club feet. **Patients and Method:** We carried out a retrospective, single-center study over 5 years. In total 16 clubfeet in 14 patients, including 9 males and 5 females were retained for final analysis. The average age of the patients at the time of the intervention was 15.16 years. K-wires were placed using the original technique. The average duration of the fixator in our series was 4.27 months. The functional assessment of patients was based on pre-and post-operative evaluation of the Foot and ankle function according to the AOFAS score. **Results:** Anatomic assessment was done according to the Dimeglio classification. There was a significant improvement at post-operative period with an average score of 4.47 against 10.07 at pre-operative period. We obtained 43.8% good and very good functional outcomes according to the global AOFAS score increasing from 63.07 at pre-operative period to 77.88 at post-operative period. Two cases of reinterventions were recorded. **Conclusion:** Distraction with the Ilizarov external fixator occupies a place of choice in the management of relapsed club foot. A good mastery of the technique and

patient selection produce good functional outcomes.

Keywords

Clubfoot, Relapsed, Distraction, Ilizarov

1. Introduction

Relapsed Congenital Talipes Equino Varus (CTEV) refers to clubfoot diagnosed after walking age. We refer to this entity as residual deformities of a previously treated clubfoot or a complete recurrence following treatment.

Its treatment in developing countries is characterized by difficulties related to poverty, lack of awareness among populations regarding the benefit of early treatment and lack of appropriate medical resources, making it a challenge for any surgeon. Several techniques have been introduced to improve the foot's functional outcome while remaining minimally invasive. Correction by distraction using the Ilizarov external fixator is a promising technique. Also, fewer complications have been reported compared to other conventional methods.

Developed in 1951 by Gravil Abramovich Ilizarov, the use of this fixator in the management of clubfoot gained popularity in 1987 with Grill and Franke [1].

This single-center study aims to evaluate the anatomical and functional outcomes of treatment by distraction and compression with the Ilizarov fixator in relapsed club feet.

2. Patients and Method

2.1. Patients

We carried out a retrospective, single-center study over 5 years (February 2017 to April 2022). All patients who underwent surgery for relapsed clubfoot at the Dakar Order of Malta's Hospital Center (CHOM) using the Ilizarov fixator were included in the study. Not included in the study were:

- Patients lost to follow-up after surgery.
- Incomplete files.

In total 16 clubfeet in 14 patients, including 9 males and 5 females were retained for final analysis. The average age of the patients at the time of the intervention was 15.16 years with extremes of 8 and 30 years. The etiologies found were neurological (43.8%), idiopathic (31.2%) and traumatic (25%) (**Table 1**).

A complete plain radiographic assessment of the foot, including dorsoplantar and lateral views of the foot, as well as anteroposterior and lateral views of the ankle were carried out pre-operatively. In 9 patients, there was no talocalcaneal divergence. Only two patients had a good talocalcaneal divergence (**Table 2**). The average A/P view talocalcaneal angle was 10.89 degrees with extremes of 0˚ and 35˚.

Seven feet were previously treated (43.8%). This involved a Ponseti associated with an Achilles tendon tenotomy for 6 cases and a midtarsal osteotomy for 1 case.

Table 1. Etiologies of relapsed clubfeet.

Etiologies	Number (n = 16)	Percentage (n = 100)
Idiopathic	**5**	31.2%
Traumatic	**4**	25%
Poliomyelitis	**3**	18.8%
Cerebral palsy	**2**	12.5%
Arthrogryposis	**2**	12.5%
Total	**16**	100%

Table 2. A/P view talocalcaneal divergence.

Talocalcaneal divergence		
	Number	Percentage
Yes	2	18.20%
No	9	81.80%
Total	11	100 %

2.2. Operative Technique

The procedure was carried out under locoregional or general anesthesia depending on the patient's age.

Patients were installed in the supine position on an ordinary operating theatre table. A tourniquet was placed at the proximal thigh in case an osteotomy had to be done.

K-wires were placed using the original technique:

- 04 tibial wires, two of which were olive wires at two levels.
- 02 calcaneal K-wires including 01 olive wire.
- 01 or 02 metatarsal K-wires.

Two tibial rings connected by two rods were mounted on the previously tightened pins then a half ring on the hindfoot connecting the calcaneal pins and a half ring on the forefoot (**Figure 1** and **Figure 2**).

Two rods connected the tibia and forefoot on one hand and the other hand on the hindfoot. Two other rods mounted on holder posts or connecting plates connected the hindfoot to the forefoot mediolaterally.

Correction was done in chronological order by:

- First, a distraction on the medial rod between the hindfoot and forefoot to correct the adductus deformity, the coverage of the lateral portion of the talus and the curvature of the lateral border of the foot.
- Compression on the lateral rod between the hindfoot and forefoot to correct the hindfoot varus deformity.
- Finally, after having proceeded with an abduction of the calcaneo pedal block of 30˚, compression of the rod connecting the tibia to the forefoot to correct the equinus deformity and a distraction lowering the heel cup backward were

carried out.

Adjunctive procedures were equally carried out:

- Percutaneous tenotomy of the Achilles tendon was performed in 13 cases. This tenotomy was performed before the fixator was placed.
- Transfer of the tibialis posterior tendon using the Watkins technique in 1 case.
- Midtarsal dorsal closing wedge osteotomy in 1 case.

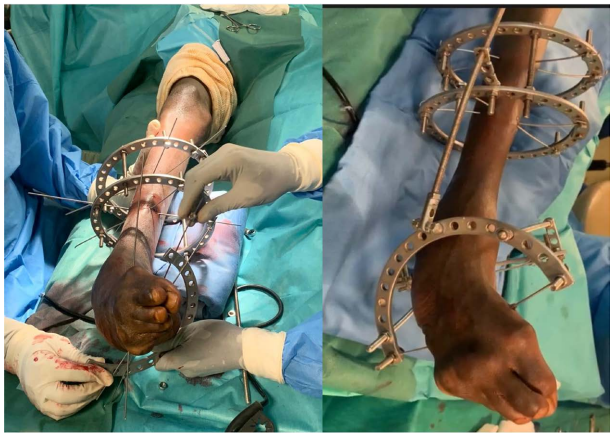


Figure 1. Assembling of rings and K-wires.

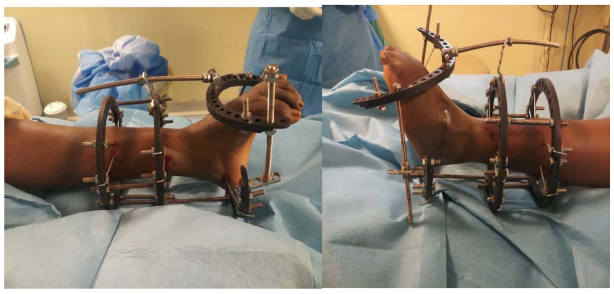


Figure 2. Final assembly.

2.3. Post-Operative Care

A medical treatment was initiated for post-operative pain management. It included an analgesic and an anti-inflammatory. Antibiotics and anticoagulants could be associated.

Plain X-rays of the foot and ankle were done the following day after the surgical intervention. Progressive correction was continued post-operatively by medial and posterior distraction and lateral and anterior compression. This correction continued and was performed at a rate of 1 mm per day by the patient or parents after an informed explanation from the physician.

The fixator was removed after satisfactory correction under anesthesia and a short leg cast was placed.

The average duration of the fixator in our series was 4.27 months (Min = 2, Max = 11). A short leg cast was placed on all patients after removal of the fixator. It was kept for an average duration of 48.6 days (Min = 30, Max = 72).

2.4. Outcome Assessment Tools

The mean follow up was 24.48 months.

The functional assessment of patients was based on pre-and post-operative evaluation:

- Foot and ankle function according to the AOFAS scale (The American Orthopedic Foot & Ankle Society) proposed by Kitaoka.
- Diméglio scale assessing anatomical outcomes.
- Subjective patient satisfaction rate.

Anteroposterior and lateral X-rays of the foot and ankle to evaluate for late-onset complications during follow-up such as:

- Tibiotalar and subtalar osteoarthritis.
- Neuroalgodystrophy.

3. Results

3.1. Anatomical Assessment

3.1.1. Diméglio Score

The average preoperative Diméglio score increased from 10.6 with extremes of 7 and 14 to 4.3 postoperatively with extremes of 0 to 8 (Figure 3).

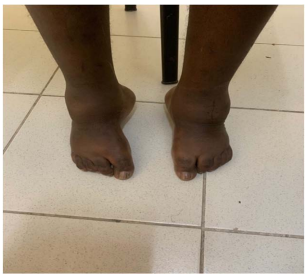
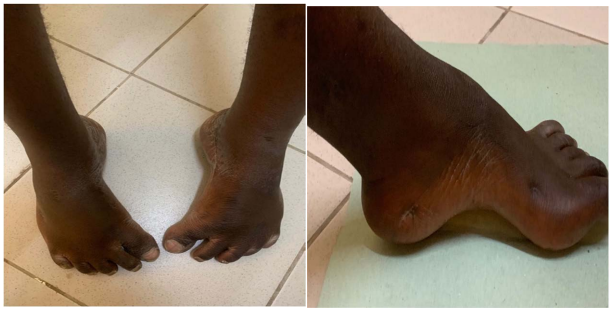


Figure 3. Good correction of a bilateral clubfoot after Ilizarov.

3.1.2. Residual Deformities (Figure 4)

After correction, forefoot adductus persisted in 8 cases, hindfoot varus in 5 cases and equinus in 5 cases. Table 3 provides more information on the residual deformations.



(a) (b)

Figure 4. Residual deformities post-Ilizarov: Adductus of the forefoot (a) and equinus and cavus (b).

Table 3. Residual deformities.

Deformities \ Divergence	YES	NO	Not calculated
ADDUCTUS (N: 8)	**1**	**6**	1
VARUS OF HINDFOOT (N: 5)	**1**	**3**	1
EQUINUS (N: 5)	**1**	**3**	1

3.2. Functional Outcomes according to the AOFAS Scale

- **Pain**

The average pain score increased from 35.63/40 [min = 20, max = 40] preoperatively to 37.5/40 [min = 30, max = 40] postoperatively.

- **Function**

The average functional score increased from 27.25/50 [min = 8, max = 37] preoperatively to 33.25/50 [min = 21, max = 43] postoperatively.

- **Alignment (weight bearing)**

Preoperatively, weight bearing was lateral in 14 cases and dorsal in 2 cases. The average score was 0.31. Postoperatively, all patients had a plantigrade bearing. There was total plantigrade bearing in 7 cases, while it was partial in 9 cases. The average alignment score was 7.19.

- **Total AOFAS**

We noted a significant overall improvement in all clinical components of the AOFAS score. The average total score increased from 63.19 preoperatively to 77.88 postoperatively. We obtained 43.8% very good and good results (Figure 5).

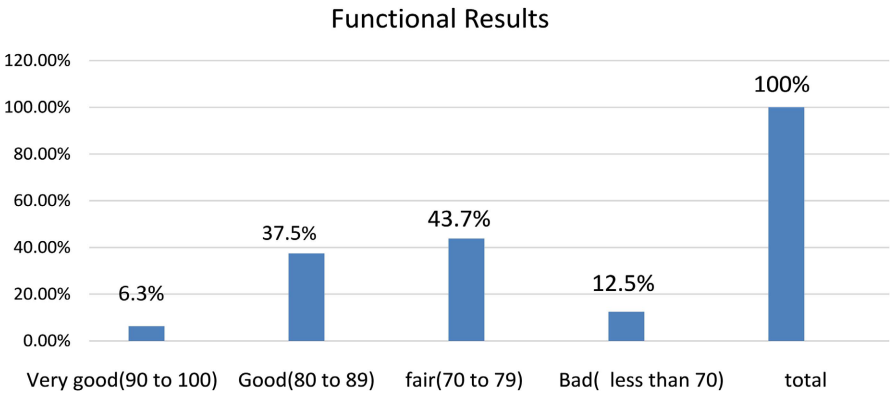


Figure 5. Functional results.

- **Correlational study**

Table 4 and Table 5 provide information on the correlation between the AOFAS score and etiology on one hand and the other hand between alignment and etiology. There was no significant difference between these parameters (Table 6).

3.3. Subjective Patient Satisfaction

In this series, 68.8% (11/16) of patients were satisfied or very satisfied with the surgical intervention.

Table 4. Functional score according to etiology.

Functional Score / Etiologies	Average	Min	Max
Idiopathic (n = 5)	79.20	70	92
Neurologic (n = 7)	77.71	61	88
Traumatic (n = 4)	76.50	65	83

Table 5. Alignment according to etiology.

Alignment / Etiologies	GOOD	AVERAGE	BAD
Idioathic (n: 5)	2	0	3
Neurologic (n: 7)	4	3	0
Traumatic (N: 4)	1	3	0

Table 6. Subjective patient satisfaction.

	Number (n = 16)	Percentage (n = 100)
Very Satisfied	**4**	25%
Satisfied	**7**	43.8%
Disappointed	**5**	31.2%
Unhappy	**0**	0%
Total	**16**	100%

3.4. Complications

Two cases of revision of the fixator for mispositioning of the metatarsal pins were reported. In one of the cases, the revision was carried out two months post-operatively, thereby extending the correction duration to 11 months. We noted a case of fixator intolerance leading to early removal of the fixator. At the last follow-up, 4 cases of ankle stiffness were observed. On the other hand, no cases of infection or skin necrosis were reported.

4. Discussion

Some limitations of the study include:

- The low number of cases in the series.
- The lack of certain preoperative information linked to the retrospective nature which was corrected by a retrospective interrogation.
- The poor quality of certain x-ray images does not allow the talocalcaneal divergence to be studied.

The anatomical assessment was done according to the Dimeglio scale with a clear improvement in the score at follow-up. It increased from 10.6 preoperatively to 4.3 postoperatively. The Ilizarov device allows gradual mechanical correction

of deformities in the three orthogonal planes, restoring good anatomy to the foot for painless plantigrade weight bearing [2]. It makes use of regeneration, bone plasticity and the ability of soft tissues to adapt to the new position to restore a normal configuration to the foot [3]. Thus, it results in good aesthetics and the possibility of wearing standard footwears, which ultimately improves the patient's quality of life. This correction is done without shortening the foot unlike other techniques, notably osteotomies [4].

Residual deformities were noted in some of our patients during assessment. Adductus of the forefoot persisted in 8 cases, varus of the hindfoot in 5 cases. Hani El-Mowafi [5] in his series of 28 club feet obtained 5 residual deformities. Karima A [6] found 4 residual varus, 2 equinus and one adductus for a series of 13 feet treated by double arthrodesis. Literature data shows that the most common residual deformity is forefoot adductus, although equinus and varus have been reported [3]. Our small sample size does not allow us to find a significant relationship between this result and some parameters, such as age at the time of surgery and talocalcaneal divergence. However, these deformities were observed more in patients with an absent talocalcaneal divergence and were more pronounced in older patients. Indeed, the limited range of motion at the ankle and foot in relapsed clubfeet due to multiple surgeries and significant retraction of the soft tissues in some etiologies makes distraction difficult. Many authors claim that the Ilizarov technique can be used with soft tissue distraction alone to correct clubfoot in children under 8 years. Beyond 8 years and in adults, soft tissue distraction must be associated with an osteotomy to preserve joint congruence [7].

Thus, associating the Ilizarov technique with osteotomies seems to be a good alternative in certain cases to reduce residual deformities and obtain perfect correction. Also, the persistent adductus after correction may be attributed to the mispositioning of the metatarsal pins while placing the fixator, frequently reported in literature [2] [4].

These residual deformities are most often the reason for secondary surgeries. Therefore, hindfoot varus can be corrected by subtalar arthrodesis [8] or by calcaneus osteotomy [9]. Management of forefoot adductus can be done using several procedures. It can be corrected by closing wedge osteotomy of the lateral aspect of the calcaneus (Lichblau technique) [10] or combined with resection and arthrodesis of the calcaneo-cuboid joint (Evans' technique) [11]. In paralytic club feet, a tibialis posterior tendon transfer may be sufficient to correct the forefoot adductus [12]. Finally, in the case of residual equinus, the first indication remains the release of the posterolateral subtalar joint capsule, the peroneal tendon sheath and the calcaneofibular ligament. If it persists, the next step will be a closing wedge osteotomy of the calcaneus, talus head resection, naviculectomy or distal tibia osteotomy [13].

As far as foot and ankle function is concerned, there was an improvement in all components of the AOFAS score at an average follow-up of 24.48 months. The average total score increased from 63.19 preoperatively to 77.88 postoperatively. We obtained 43.8% very good and good outcomes. These results are better than

those of Freedman *et al.* [4] who obtained 38.1% very good and good outcomes after treating 21 feet with a population similar to ours. On the other hand, they were lower than the results obtained by Bradish *et al.* [14] who managed 17 recurrent idiopathic clubfeet with 76.4% satisfactory corrections. The data in the literature vary according to the characteristics of the population, more precisely according to age and etiology but also according to the adjuvant procedures associated with distraction by Ilizarov [2]. As a matter of fact, results are better for idiopathic clubfeet and younger patients. Function is the component of the AOFAS score that was least improved postoperatively. This contributed to the significant number of fair results obtained with several cases of stiffness observed postoperatively. On the other hand, we had a good score as far as alignment (on the AOFAS score) is concerned with an average post-operative score of 7.19 compared to 0.31 pre-operatively. Plantigrade weight bearing was total in 7 patients (43.8%) and partial in 9 patients (56.2%). There was no correlation between etiology and degree of alignment.

Compared to other management techniques for relapsed clubfoot, distraction by Ilizarov often does not provide the best results. Its effectiveness lies in the choice of indications. Indeed, many authors [13] [15] agree that for correction, distraction by the Ilizarov fixator must be associated with a midfoot osteotomy.

In this series, 68.8% (11/16) of patients were satisfied or very satisfied with the surgical intervention. El-Mowafi [5] obtained 25% satisfaction rate (7/28). Wallander [3], on his part, obtained an 85.7% satisfaction rate (6/7) with a series of 7 patients. The clear improvement in weight bearing is the main source of satisfaction for our patients with the foot regaining anatomy closer to the norms. Aesthetics was the second aspect influencing the satisfaction rate of patients and parents. Five patients were disappointed with the final result. The persistence of residual deformities was the reason for dissatisfaction in three cases. In fact, in these patients, at least two deformities persisted. For the two other cases, it was however a patient with bilateral clubfoot secondary to cerebral palsy for whom the hoped-for gain in autonomy was not obtained postoperatively.

One of the advantages that the Ilizarov correction offers for foot deformities compared to other techniques is that it is the least invasive. As a result, it has fewer complications. The most frequent short-term complications reported in the literature [1] [2] [16] are infection at the pin orifices, soft tissue strain causing pain on the fixator, and pin mispositioning, particularly metatarsal pins. In our series, two revisions of the fixator were recorded and one case of pain on the fixator due to tension in the soft tissues during distraction. These revisions are generally driven by the complexity of the assembling in large deformations. Thus, in a logic of simplicity, Joshi, based on the principles of Ilizarov, developed a fixator that is less bulky and simpler to use with very good results [17].

5. Conclusion

Relapsed clubfoot represents a challenge for any surgeon, as its management is

complex. Distraction by Ilizarov is one of the alternatives and occupies a place of choice in the available therapeutic arsenal. It helps restore good anatomy to the foot for plantigrade and painless weight bearing. A good mastery of the technique and the right choice of patients make it possible to obtain good functional outcomes.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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