RESEARCH ARTICLE

Retrospective study of correction of rigid adult clubfoot or equinovarus deformity using Ilizarov technique, outcomes in Pakistan

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Abstract

Objective: To assess the outcomes of correction of adult equinovarus clubfoot with Ilizarov technique.

Method: The retrospective study was conducted from December 2023 to January 2025 at the Department of Orthopaedic Surgery, Liaquat National Hospital and Medical College, Karachi, and comprised data from 2015 to 2025 of adults with rigid equinovarus deformity who were treated with the Ilizarov construct of 2 tibial full-rings, one half-ring for forefoot and hindfoot, and tendo-Achilles lengthening for gradual correction. Outcomes were assessed using American Orthopaedic Foot and Ankle Society score and Reinker-Carpenter scale, preoperatively and 12 months post-surgery. Data was analysed using SPSS 22.

Results: Of the 38 patients with mean age 23.7±6.2 years, 26(68.4%) were male and 12(31.6%) were female. There were 29(76.3%) unilateral and 9(23.7%) bilateral cases. There were 10(21.3%) cases of congenital neglected clubfoot, 22(46.8%) cases of recurrent/resistant clubfoot, 4(8.5%) cases of neuromuscular/spinal pathology, 3(6.4%) cases of post-polio deformity, 7(14.9%) cases of posttraumatic deformity, and 1(2.1%) case of hemimelia. Mean frame duration was 16.3±5.1 weeks, and follow-up time was 28.5±12.2 months. At frame removal, Reinker-Carpenter score was excellent in 6(12.8%) cases, good in 30(63.7%), fair in 8(17%), and poor in 3(6.5%). There was 1(2.1%) case of supination deformities and 5(%) of claw foot requiring adjunct surgery, and 1(2.1%) case of acute posterior-tibial-nerve palsy with treatment abandonment. Mean American Orthopaedic Foot and Ankle Society score increased from 29.6±19.2 to 81.4±12.3 postoperatively.

Conclusion: Ilizarov fixator with tendo-Achilles lengthening allowed controlled correction of rigid clubfoot deformity with minimal complications. Ankle-foot-orthosis could minimise any residual deformitiy. Ankle stiffness was commonplace.

Key Words: Ilizarov, Rigid clubfoot, Equinovarus deformity.

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Introduction

In skeletally mature individuals, the equinovarus deformity of the foot, which is also known as clubfoot, is rigid and inflexible. It is a difficult problem to manage as bony distortions and soft tissue stiffness are major hurdles in acquiring a functional plantigrade, painless foot. Such deformity is associated with several aetiologies, such as congenital disorders, posttraumatic, neuromuscular disorders, and burns.[1] In congenital clubfoot disorders, like congenital talipes equinovarus (clubfoot), arthrogryposis and myelomeningocele, 90% of children benefit from the conventional Ponsetti technique.[2] Neurological causes, like brain trauma, cerebrovascular accidents and spinal column injuries can lead to persistent equinovarus feet, while other causes include sequelae of compartment syndrome or knee dislocation.[1] Patients usually have difficulty ambulating, wearing shoes or corrective braces, and develop painful callosities over the dorsolateral aspect of the foot and ankle.[2] Non-surgical treatment to reverse deformity includes stretching exercises, dynamic splint, casting, and sometimes botulinum toxins injections as an antispasmodic. However, such treatment modalities usually do not lead to satisfactory results in rigid clubfoot, especially in adults.[3]

Various surgical techniques exist to correct this inflexible equinovarus deformity, such as soft tissue releases, tendon lengthening, tendon transfers, soft tissue manipulations with internal fixation, Ilizarov frame, osteotomies and arthrodesis, which can be used via an ala carte approach. However, acute corrective surgery for these stiff deformities involves extensive soft tissue dissection and releases, which can result in skin flap necrosis, wound dehiscence, secondary infections, and, more commonly, neurovascular damage.[4] This is

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explained by the fact that the medial column in such feet is considerably shortened, and neurovascular structures are contracted, limiting the correction of equinovarus deformity. Therefore, such patients are prone to prior soft tissue treatment failures during childhood, leading to the recurrence of the equinovarus deformity that persists into adulthood.[4] Such recurrent or neglected deformities are severe and rigid, with poor soft tissue or skin coverage and underlying bony distortions.

The Ilizarov frame application, when combined with minimal soft tissue releases, is an effective treatment to gradually correct clubfoot deformities in neglected and relapsed cases in the adult population.[5]

The current study was planned to evaluate the clinical and functional outcome of the Ilizarov technique in rigid equinovarus deformity or clubfoot in the adult population.

Materials and Methods

The retrospective, observational study was conducted from December 2023 to January 2025at the Department of Orthopaedic Surgery, Liaquat National Hospital and Medical College, Karachi, and comprised data from 2015 to 2025. After approval from the institutional ethics committee, data was retrieved for all adults patients with rigid equinovarus deformity who were treated with the Ilizarov construct of 2 tibial full-rings, one half-ring for forefoot and hindfoot, and tendo-Achilles lengthening for gradual correction. Informed consent had been obtained from each patient at the time or procedure. Medical records, operative notes and outpatient notes were reviewed to extract data on clinical course, operative details, and outcomes. Patients who had not provided informed consent or had incomplete records were excluded.

Regarding the surgical technique, Ilizarov frame application was performed in the supine position. After aseptic preparation, a ring fixator was first applied on the tibia with three Shanz pins of 4.5mm thickness. The hindfoot frame was applied with a half-ring, one Shanz pin of 4.5mm thickness, and two wires of 1.8mm for the calcaneum. A half-ring was applied to the metatarsal bones of the forefoot with three wires of 1.8mm. The tibial, hindfoot and forefoot rings were connected by two anterior and two posterior motor-assembly rods for angular correction of equinus in the coronal plane. Two universal side-hinges were assembled on the collateral sides of the ankle to allow varus correction. The forefoot and hindfoot rings were connected via distracting rods to correct cavus deformity (Figure 1). Achilles tendon lengthening or percutaneous toe-flexor tenotomy was also done under tourniquet control as an adjunct soft tissue procedure when deemed necessary.

All patients were mobilised with full-weight bearings and crutches from the first post-surgery day using custom-made shoes due to the forefoot and hindfoot ring. Active and passive physiotherapy of the toes was advised. The deformity was corrected at 1mm per day from the first postoperative day. The wound was assessed, and the dressing was changed every 24 hours. The patients were followed up every two weeks to ensure proper mobilisation and physiotherapy compliance. Gradual correction continued for 8-12 weeks. The operated foot's lateral and anterior-posterior weight-bearing X-rays were done every four weeks. Following clinical correction of the foot, a plantigrade posture was achieved, and the frame was continued for three weeks before removal (Figure 2). After frame removal, a short below-the-knee cast was applied for four weeks after which the patient was allowed to bear weight with monthly follow-ups.

The outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) score[6] by comparing baseline values with postoperative scores at 12 months follow-up. The score included three assessment parameters of ankle and foot: pain, function and alignment. Function incorporated an additional seven sub-parameters. The score was calculated out of a total of 100 points. The Reinker-Carpenter grade scale[7] was also retrieved from the 1-year follow-up data.

Data was analysed using SPSS 22. Quantitative parameters were expressed as mean +/- standard deviation, while qualitative variables were expressed as frequencies and percentages. Differences in the mean values were compared using paired t-test with 95% confidence interval (CI). $P<0.05$ was taken as significant.

Results

Of the 38 patients with mean age 23.7±6.2 years, 26(68.4%) were male and 12(31.6%) were female. There were 29(76.3%) unilateral and 9(23.7%) bilateral cases.

Table-1: Patient demographics and coutcomes.

Total patients	**38(100%)**
Males	26(68.4%)
Females	12(31.6%)
Mean Age	23.7 ± 6.2 years
Community Ambulant without support	17(44.7%)
Ambulant with walker/crutch support	12(31.6%)
Home ambulant with support	9(23.7%)

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Unilateral foot	29 (76.3%)
Bilateral feet	9 (23.7%)
Total feet	47 (100%)(29+9*2)
Causes:(out of 47 feet)	
Congenital Neglected Clubfoot	10(21.3%)
Recurrent/Resistant Clubfoot	22(46.8%)
Neuromuscular/Spinal	4(8.5%)
Post-Polio Deformity	3(6.4%)
Post-traumatic Deformity	7(14.9%)
Hemimelia	1(2.1%)
Mean Duration of Correction	12.4 ± 3.3 weeks
Mean Duration of Total Frame	16.3 ± 5.1 weeks
Mean Followup Time	28.5 ±12.2 months
Tendo-Achilles Lengthening	n=44 (93.6%)
Percutaneous FHL/FDL tenotomy	5(10.6%)
Results	
AOFAS Preoperative score	29.6 ± 19.2
AOFAS 12 months Postoperative score	81.4 ± 12.3 (p=0.0035)*
Reinker Carpenter Scale	
Excellent	6 (12.8%)
Good	30 (63.7%)
Fair	8 (17.0%)
Poor	3 (6.5%)
Total Complications (out of 47 feet)	19 feet (40.4%)
clawing of toes	5(10.6%)
residual supination deformity	1 (2.1%)
posterior tibial nerve neuropraxia - reversible	4(8.4%)
posterior tibial nerve inury - irreversible	1(2.1%)
residual Hallux Valgus	2(4.2%)
superficial pin track infection	5(10.6%)
Wound Dehiscence	1(2.1%)
AFO bracing	11(23.5%)

FHL: Flexor hallucis longus, FDL: Flexor digitorum longus, AOFAS: American Orthopaedic Foot and Ankle Society, AFO: Ankle foot orthosis.

There were 10(21.3%) cases of congenital neglected clubfoot, 22(46.8%) cases of recurrent/resistant clubfoot, 4(8.5%) cases of neuromuscular/spinal pathology, 3(6.4%) cases of post-polio deformity, 7(14.9%) cases of posttraumatic deformity, and 1(2.1%) case of hemimelia. The average duration of the Ilizarov apparatus was 12.4±3.3 weeks, and the total frame time before removal was an average of 16.3±5.1 weeks. Tendo-Achilles lengthening was done in 44(93.6%) feet, and percutaneous release of Flexor hallucis longus/Flexor digitorum longus (FHL/FDL) was done in 5(10.6%) feet with claw toes.

Preoperatively, 17(44.7%) patients were in community ambulant without support, 12(31.6%) needed walkers or crutches for ambulation, and 9(23.7%) were home ambulant only. The mean AOFAS score increased from 29.6±19.2 at baseline to 81.4±12.3 postoperatively (p=0.0035). The average improvement in AOFAS score was 48.4±5.9 (p<0.05). At frame removal, Reinker-Carpenter score was excellent in 6(12.8%) cases, good in 30(63.7%), fair in 8(17%) and poor in 3(6.5%). Excellent and good categories 36(76.5%) were deemed satisfactory, while fair and poor results 11(23.5%) were considered unsatisfactory, and were further managed with an ankle foot orthosis (AFO) brace.

Complications occurred in 19(40.4%) feet. There were 5(10.6%) patients with clawing of toes that required percutaneous tenotomy of FHL/FDL; 1(2.1%) foot with residual supination deformity was corrected with supra-malleolar osteotomy. There were 5(10.6%) feet that experienced transient neuropraxia of the posterior tibial

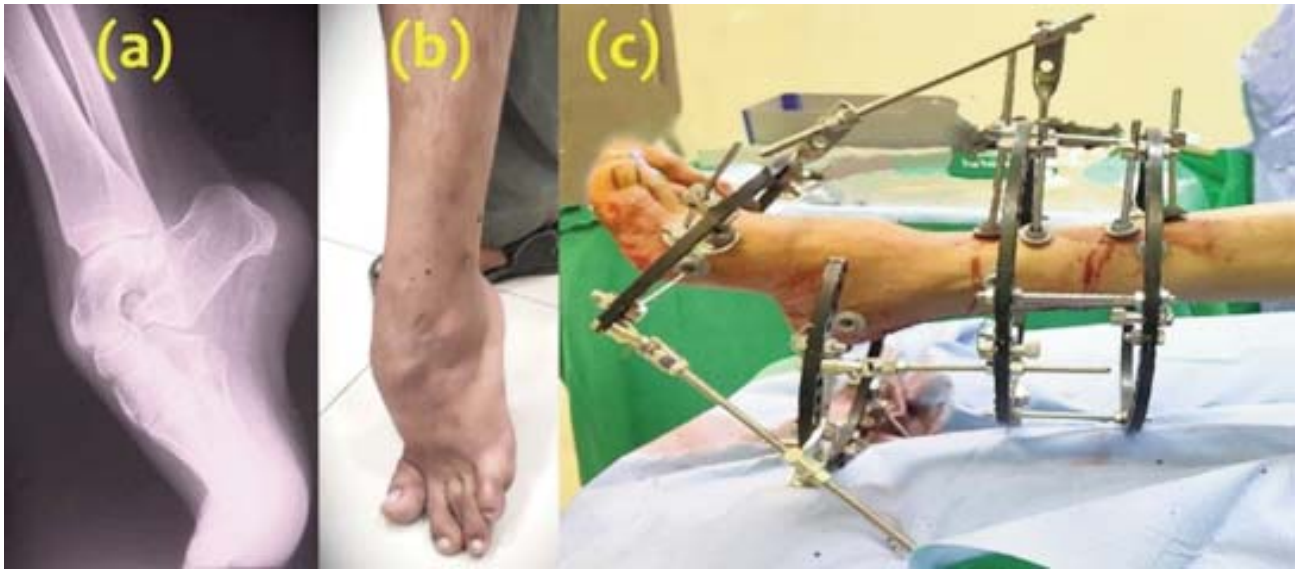

Figure-1: (a)Preoperative X-ray showing equinus deformity with high cavus arches; (b) Clinical deformity showing equinus prominent talar head, toe contractures, and weight-bearing on forefoot; (c) Intraoperative picture of Ilizarov construct with two tibia rings, one forefoot half-ring and a hindfoot half-ring.

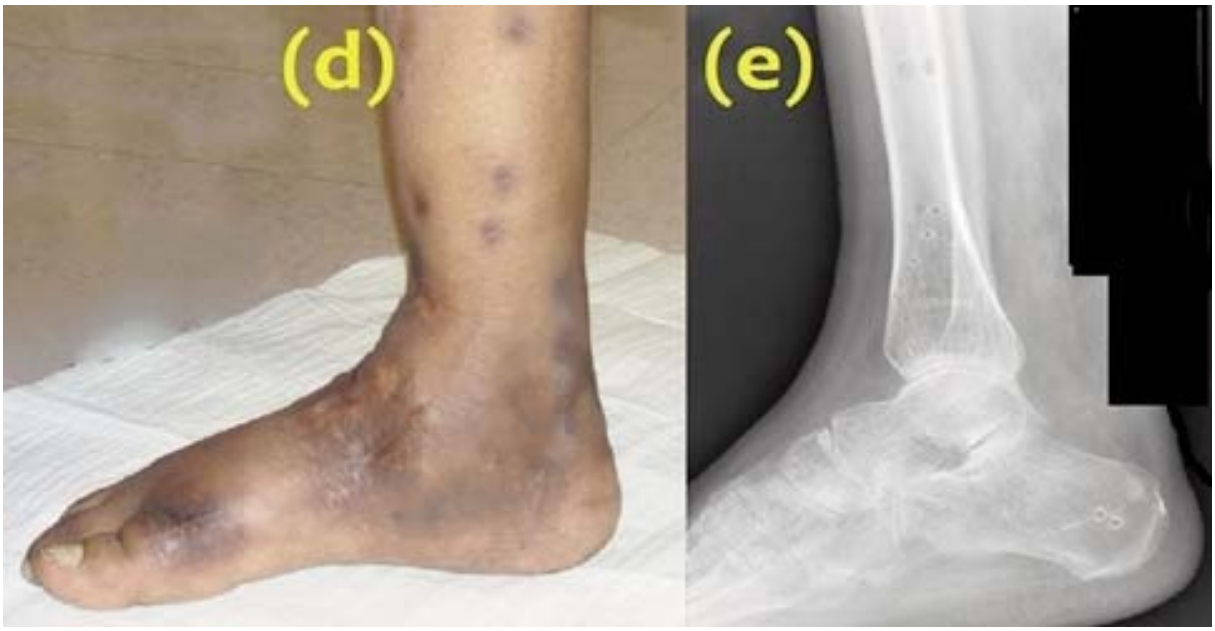

Figure-2: (d) One-year postoperative clinical picture, showing plantigrade foot with no equinus; (e) Postoperative Xray showing bony alignment.

nerve distribution, and a short correction pause of four weeks was allowed for nerve recovery. Among these feet, 1(2.1%) re-experienced progressive neuropraxia for which the correction was partially reversed, and the procedure was abandoned. This patient had presented with previous surgical failures and a severe deformity, with a preoperative AOFAS score of 16. There were 2(4.2%) patients who experienced residual hallux valgus, and were managed conservatively with toe spacers and a hallux brace. There were 5(10.6%) patients who experienced superficial pin track infection that was cleared with oral antibiotics and wound hygiene. Further, 1(2.1%) foot developed a surgical-site infection (SSI) with dehiscence at the tendon-Achilles lengthening site, and was treated with intravenous (IV) antibiotics and debridement. At subsequent follow-ups, the patient had healed uneventfully and was ambulating with an AFO brace at the final follow-up. None of the patients were wheelchair or homebound at the final follow-up. There were 10(26.3%) patients and 11(23.4%) feet with Reinker Carpenter grades fair and poor) who were using AFO for mild residual deformity or foot weight balancing.

Discussion

Rigid equinovarus deformity in adults is complicated due to previous failures of standard procedures, like soft tissue releases, tendon lengthening or transfer in childhood, or neglect in patients who have not received any treatment for their equinovarus foot. This resistant deformity is challenging to correct and is well-known to have frequent complications.[8] In either case and regardless of the aetiology of the development of rigid equinovarus in adults, the debate is between acute correction versus slow, gradual correction using an external frame. Acute correction's most notorious complication is the compromise of the surrounding tissue envelope, skin, wound complications, and even neurovascular impairment.[9] Complications like SSIs and delayed wound healing have been reported in up to 27% of acute surgical correction cases.[10] However, such studies show the fallout of acute correction with soft tissue procedures, but do not address the associated bony deformity in the adult population.

The Ilizarov frame application allows the benefit of performing a gradual bony correction with minimal soft tissue correction.[11] Hence, it stabilises the soft tissue and the bony elements. Using the Ilizarov method, ankle joint stiffness is documented. In one study, 12 patients achieved complete plantigrade correction, but the residual ankle range of motion was only 10 degrees on average.[12] In the current study, similar outcomes were achieved with residual ankle stiffness in most patients, and the mean ankle joint movement was <20 degrees in 27 feet (Reiter Carpenter grade: good). Only 6 patients (Reiter Carpenter grade: excellent) had 31 degrees of range of motion at the ankle joint at the final follow-up. Hence, patients who are planning for treatment with Ilizarov should be counselled that they will not achieve joint mobility from this process; rather, the target will be to achieve a plantigrade foot that is brace-able for independent walking.

In the current series, only one patient experienced significant tarsal tunnel compression symptoms / posterior tibial nerve palsy that required stopping correction and immediate removal of the Ilizarov frame. This patient previously had multiple failed soft tissue releases and triple arthrodesis. Tarsal tunnel syndrome is relatively uncommon because the Ilizarov method exerts minimal correction and stretching at the level of the tethered posteromedial structures.[13] In the current series, an open tendo-Achilles lengthening during the index procedure was a key factor. Since the Ilizarov frame can exert sustained large/long mechanical forefoot lever forces, there is always a risk of midfoot fracture from these transmitted forces.[14] An open tendo-Achilles lengthening significantly decreases the chances of midfoot fracture by allowing further mobility of the hindfoot, and there were no fractures in the current series. Furthermore, tendo-Achilles lengthening also prevents the recurrence of equinus deformity after frame removal.[15]

Overall, the current study experienced a few complications. Nine feet developed superficial pin tract infections that were effectively treated with per-oral antibiotics and local pin track dressing care. This complication rate is in line with a previous study.[16] he current study experienced up to 10.6% toe clawing, which matched earlier reports.[17,18]. Toe clawing release can also be performed at the time of frame removal. This is an anticipated sequela of equinus correction since extrinsic flexor contracture is inherently present with any equinus deformity.[19] Naveen et al. showed a 78% residual toe clawing sequelae after equinovarus deformity correction.[20] In the current study, one patient had treatment abandonment due to recurrent posterior tibial nerve palsy.

The current study has some limitations, including the inherent flaws of a retrospective study, the relatively small sample, and the lack of long-term follow-up. Also, the sample size was not statistically calculated. The various causes of the deformity and the wide range of adult age may contribute to the lack of uniformity, and should be investigated further. Moreover, the question remains as to whether or not functional improvement differs by an active or sedentary lifestyle. Also, only one type of external fixator system was used, the Ilizarov method, which requires a manual adjustment programme. Newer techniques, like Taylor-Spatial-Frame,[21] can be used in the future, but this requires a complex and expensive computer-based adjustment programme.

Larger, multicentre, prospective studies should investigate different subgroups of ageing patients, such as by aetiology, to define the multiple aspects of the treatment modality.

Conclusion

Using a multiaxial Ilizarov external fixator to treat rigid equinovarus deformities allowed for complete deformity correction to achieve a plantigrade foot while keeping soft tissue releases to a minimum. The modality provided gradual controlled correction while keeping the patient ambulatory, reducing the risk of neurovascular and soft tissue compromise.

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AUTHORS' CONTRIBUTIONS:
TKR: Methodology, data compiling, analysis, formatting and abstract writing.
MKR: Data collection, results and conclusion.
MAP: Data collection, analysis and methodology.
SA: Literature search, introduction, methodology and data compiling.
SMS: Data collection, Methodology and drafting.
SSN: Result compilation, data analysis, literature search and methodology.