

Copyright: The author/s

This work is licensed under a CC BY-NC 4.0 license

(*) Corresponding author

Peer review method: Double-blind

Research article

DOI: <https://doi.org/10.20544/hisj.2026.646>

Received: 29.11.2025 • Accepted after revision: 26.08.2026 • Published: 29.10.2026



CLINICAL AND PATIENT REPORTED OUTCOMES FOLLOWING ILIZAROV TREATMENT OF SEVERE NEGLECTED CLUBFOOT: CASE SERIES

Ognen Sheshoski^{1*}

ORCID iD: <https://orcid.org/0009-0006-7468-833X>, ognen80@gmail.com

¹*Specialised hospital for orthopaedic surgery and traumatology “Sv. Erazmo” – Ohrid,
Republic of North Macedonia
University “St. Kliment Ohridski” – Bitola, Republic of North Macedonia*

Abstract

Severe residual and neglected rigid clubfoot deformities present significant reconstructive challenges in pediatric and adolescent orthopedics. We report two adolescent patients with severe rigid clubfoot deformity treated with gradual correction using an Ilizarov circular external fixator. This retrospective two-case series included two adolescent patients treated in 2022: a 13-year-old female with congenital bilateral clubfoot and a 17-year-old male with a residual clubfoot deformity associated with spastic cerebral palsy. Both underwent percutaneous Achilles tendon release and staged Ilizarov frame application followed by gradual closed manipulation. Clinical and radiographic correction, treatment duration, functional status, and recurrence during follow-up were assessed. Functional status was categorized using the ASAMI functional criteria, adapted from their original use in Ilizarov treatment of tibial nonunion. Plantigrade clinical and radiographic correction was achieved after 60 days of active manipulation in Case 1 and 50 days in Case 2. The frames were maintained in static fixation for 75 and 90 days, respectively, before removal. Case 1 received a Good and Case 2 an Excellent ASAMI functional grade at the one-year and three-year assessments. At the available one- and three-year postoperative examinations, both patients maintained plantigrade weight-bearing without documented recurrent equinus or varus deformity. In these two cases, gradual closed correction with an Ilizarov circular external fixator provided plantigrade alignment and preserved weight-bearing function without extensive bone resection. The findings are descriptive and cannot establish comparative efficacy or generalizability. Larger prospective studies using validated foot-specific and patient-reported outcome measures are needed.

Keywords: *Ilizarov method; neglected clubfoot; rigid equinovarus; closed manipulation; ASAMI criteria; adolescent orthopedics*

UN SDGs: *SDG 3: Good Health and Well-being; SDG 10: Reduced Inequalities*

Ethics and Consent

Written informed consent for this case report was obtained from the patients and their legal guardians. The patients and their guardians also provided consent for anesthesia, surgery, and eventual blood transfusion, and approved publication of the case report and the accompanying clinical and radiographic photographs. As both patients were minors at the time of treatment, consent was obtained from their legal guardians.

Introduction

Congenital talipesequinovarus, commonly known as clubfoot, is a congenital musculoskeletal deformity characterized by hindfootequinus and varus, forefoot adductus, and cavus. Early conservative management using serial manipulation and casting, including the Ponseti method, is highly effective in most infants; however, untreated, inadequately treated, or recurrent cases may progress to residual or neglected rigid deformity in late childhood and adolescence.

A plantigrade and functional foot is important for independent ambulation and participation in daily activities. Severe rigid deformity may impair gait and weight-bearing and may be associated with pain, functional limitation, and difficulty with footwear. These clinical considerations are relevant to the broader goals of maintaining health and physical function.

Problem Statement

Managing neglected rigid clubfoot deformity in adolescents is challenging because multiplanar deformity and contracted soft tissues may limit the effectiveness of isolated soft-tissue procedures. Extensive open corrective procedures, including posteromedial releases, tarsal osteotomies, or arthrodesis, may be associated with wound complications, stiffness, neurovascular risk and foot shortening. Gradual correction with circular external fixation offers a method for progressively addressing deformity while allowing adjustment of correction according to the soft-tissue response.

Objective

The objective of this retrospective two-case series was to describe the clinical course, clinical and radiographic correction, treatment duration, functional status, and available follow-up of two adolescent patients with severe neglected or residual rigid clubfoot deformity treated with gradual closed manipulation using an Ilizarov circular external fixator.

PREVIOUS RESEARCH

Management of neglected clubfoot has shifted from extensive surgical release and osteotomy toward gradual mechanical correction (Ilizarov, 1992). Open procedures, including posteromedial release and extensive tarsal osteotomies, may result in scarring, muscle weakness, stiffness, and residual deformity (Dobbs et al., 2006). In adolescents with established bony deformities, soft-tissue release alone may be insufficient and can place excessive tension on surrounding soft tissues and neurovascular structures (Ferreira et al., 2006).

The Ilizarov method enables controlled, progressive correction using circular external fixation and tensioned wires (Makhdoom et al., 2010). Circular frames can simultaneously

address equinus, varus, adductus, and cavus deformities, while percutaneous Achilles tendon release and gradual distraction facilitate soft-tissue lengthening with limited surgical exposure (Grill and Franke, 1987; Muhammed Z.A., 2023) providing a joint-preserving option for complex neglected clubfoot. Restoration of a functional, pain-free plantigrade foot can improve mobility, daily function, and quality of life.

GAP IN KNOWLEDGE

Despite established principles of distraction histogenesis, reports describing specific Ilizarov configurations for multiplanar closed correction of neglected clubfoot remain limited. Further evaluation of staged correction, soft-tissue edema management, and functional recovery using standardized measures such as the ASAMI score may help refine treatment protocols and improve patient outcomes.

METHODS

Study Design

This was a retrospective two-case series of adolescent patients treated for severe rigid clubfoot deformity at Specialized hospital for orthopedics surgery and traumatology “Sv. Erazmo” – Ohrid, North Macedonia during 2022. The purpose was descriptive; no statistical comparison or estimate of treatment efficacy was undertaken.

Participants

Case 1 was a 13-year-old female with congenital bilateral clubfoot. She had initially been treated in infancy with serial casting, followed by open Achilles tenoplasty and posteromedial soft-tissue release at age 3. A severe rigid residual deformity subsequently developed over approximately ten years, with marked gait impairment and functional limitation.

Case 2 was a 17-year-old male with a rigid residual clubfoot deformity associated with spastic cerebral palsy. He had undergone childhood conservative treatment including serial casting and Achilles tendon lengthening. At presentation, he had severe rigid equinus with moderate varus deformity.

Materials and Procedure

Treatment was performed using a standard Ilizarov circular external fixation system. The frame included appropriately sized circular rings, threaded connection and distraction/compression rods, articulated hinges, tensioned smooth and stopper Kirschner wires, and foot components anchored to the calcaneus and metatarsals.

Percutaneous Achilles tendon release and frame application were performed under spinal anesthesia using standard aseptic technique.

Operative Protocol for Case 1

The available operative description indicates treatment of the affected foot with an Ilizarov frame incorporating two tibial rings and independent foot sub-assemblies controlling the calcaneus and forefoot. A percutaneous subcutaneous Achilles tendon release was performed at four levels. Closed gradual manipulation began on postoperative day 5. Correction consisted of progressive lowering of the calcaneus to address equinus and lifting/eversion of the forefoot to address cavus and varus. Manipulation was temporarily paused when soft-tissue edema required recovery time. Standing radiographs were obtained approximately every four weeks. Plantigrade alignment was achieved after 60 days of active manipulation. The frame was then locked in static fixation for 75 days; minimal weight-bearing was permitted. After frame removal, rigid bracing was used for three weeks followed by targeted physical therapy. Although Case 1 had congenital bilateral clubfoot, only the left foot was treated and available for three-year follow up in the present procedure. Figure 1 depicts the treated left foot.

Operative Protocol for Case 2

A circular frame with two tibial rings was coupled to a foot frame anchored to the calcaneus and metatarsals using tensioned K-wires. A percutaneous Achilles tendon release was performed at three levels. A provisional K-wire was placed through the talar head to establish the biomechanical axis of rotation and was subsequently removed. Closed manipulation began on postoperative day 3, using distraction of the posterior heel section and compression of the anterior metatarsal section. Plantigrade clinical and radiographic correction was achieved after 50 days of active manipulation, followed by partial weight-bearing. The frame was maintained in static fixation for 90 days because of the underlying spastic cerebral palsy. After removal, a custom weight-bearing brace and physical therapy were prescribed.

CLINICAL AND FUNCTIONAL ASSESSMENT

Clinical and radiographic findings were reviewed retrospectively. Functional status was categorized using the ASAMI functional criteria. These criteria were originally developed for assessment of outcomes after Ilizarov treatment of tibial nonunion and therefore are not specific to clubfoot. They were used here as a descriptive measure of activity, pain, limp, joint motion, and related functional status in these two Ilizarov-treated cases. The assessment was performed by a specialist in physical medicine and rehabilitation at the one-year and three-year postoperative follow-up. No validated clubfoot-specific patient-reported outcome or quality-of-life instrument was administered.

RESULTS

Both patients completed active manipulation, static fixation, frame removal, and postoperative rehabilitation without documented major intraoperative or neurovascular complications. In both cases, plantigrade alignment and weight-bearing were achieved.

In Case 1, plantigrade alignment was achieved after 60 days of gradual closed manipulation. Static fixation continued for 75 days, giving a total frame duration of 135 days (4.5 months). In Case 2, active correction was completed in 50 days, followed by 90 days of static fixation, giving a total frame duration of 140 days (4.6 months).

At the available one- and three-year postoperative examinations, both patients maintained stable plantigrade weight-bearing without documented recurrence of equinus or varus deformity. These observations are descriptive and should not be interpreted as evidence of a general recurrence rate.

FUNCTIONAL ASSESSMENT

At the one-year and three-year functional assessment using the ASAMI criteria, Case 1 was categorized as Good and Case 2 as Excellent. Case 1 had plantigrade weight-bearing gait, minimal limitation in daily activities, mild residual joint stiffness, and no reported pain. Case 2 demonstrated plantigrade stance, pain relief, absence of sympathetic dystrophy, and return to daily functional activities. Because ASAMI was not developed specifically for clubfoot, these grades should be interpreted as descriptive rather than as a validated clubfoot-specific outcome measure.

Table 1. ASAMI Functional Scoring Criteria

Category	Clinical and functional criteria
Excellent	Ability to perform previous activities of daily living; no or mild pain; no limp; no soft-tissue sympathetic dystrophy; knee or ankle joint contracture <5°; loss of ankle or knee joint movement <15°.
Good	Almost all activities of daily living performed with minimal difficulty; no or mild pain; failure to meet one of the other Excellent criteria.
Fair	Most activities of daily living performed with minimal difficulty; no or mild pain; failure to meet two of the other Excellent criteria.
Poor	Severe restriction in activities of daily living; persistent pain; failure to meet criteria for Fair.

Table 2. Clinical Parameters, Treatment Timeline, and Outcomes

Parameter	Case 1	Case 2
Age / gender	13 years / female	17 years / male
Etiology	Congenital bilateral clubfoot; post-surgical residual deformity	Residual clubfoot associated with spastic cerebral palsy
Treated side	Left foot	Not applicable / as described in case report
Surgical intervention	Percutaneous Achilles release (4 levels) + Ilizarov frame	Percutaneous Achilles release (3 levels) + Ilizarov frame
Active manipulation	60 days	50 days
Static fixation	75 days (2.5 months)	90 days (3.0 months)
Total frame duration	135 days (4.5 months)	140 days (4.6 months)
ASAMI functional grade at 1 year	Good	Excellent
Recurrence at 1 year	None documented	None documented
Recurrence at 3 years	None documented	None documented
Follow-up available	1 and 3 years	1 and 3 years



Figure 1. Case 1 – left foot, preoperative and postoperative clinical/radiographic images. The panels show the preoperative deformity and postoperative correction at the stated follow-up.



Figure 2. Case 2 – preoperative and postoperative clinical/radiographic images. The panels show the preoperative deformity and postoperative correction at the stated follow-up.

DISCUSSION

These two cases illustrate the use of gradual closed manipulation with an Ilizarov circular external fixator for severe rigid residual or neglected clubfoot deformity in adolescents. In both patients, gradual correction was used to achieve plantigrade alignment while avoiding extensive bone resection.

The clinical findings suggest that closed gradual manipulation using the Ilizarov method can effectively correct severe neglected rigid clubfoot deformities in adolescents. Controlled

mechanical tension promotes distraction histogenesis and gradual elongation of contracted tendons, ligaments, joint capsules, and surrounding soft tissues while minimizing excessive surgical trauma (Ilizarov, 1992). In both cases, independent foot sub-assemblies allowed differential correction of the hind foot and forefoot. Percutaneous multi-level Achilles tendon release was important for relieving posterior equinus before distraction. Progressive correction over 50–60 days resulted in plantigrade feet capable of comfortable weight-bearing.

The treatment course differed between the two patients. Case 1 required 60 days of active correction and 75 days of static fixation, whereas Case 2 required 50 days of active correction and 90 days of static fixation. The longer static fixation in Case 2 was selected in the context of spastic cerebral palsy. These observations may be clinically useful when considering frame management, but they cannot establish that one protocol is superior to another.

The functional outcomes observed in these case series are consistent with published series describing external fixation for severe foot deformities (Nwet M. et al., 2023; Muhammed Z.A., 2023). In contrast to extensive tarsal osteotomies or triple arthrodesis, which may result in foot shortening, scarring, and risk of avascular necrosis, the Ilizarov technique preserves bone stock and joint articulation. Temporary distraction holds, as used in Case 1 for soft-tissue edema, demonstrate the flexibility of the method, while prolonged static fixation in Case 2 helped maintain correction in the presence of neuromuscular imbalance.

LIMITATIONS

The principal limitation is the sample size of two patients, which makes statistical analysis and generalization inappropriate. The cases also differed in etiology and clinical presentation. The ASAMI criteria were not developed specifically for clubfoot, and no validated foot-specific or patient-reported outcome measure was used. Finally, although one- and three-year follow-up examinations were available, longer follow-up into adulthood would be needed to evaluate late recurrence, joint preservation, and secondary degenerative changes.

In these cases, improvements in gait, weight-bearing, pain, and daily activity were observed clinically; however, no validated quality-of-life, psychological, or patient-reported outcome measure was administered. Therefore, broader psychosocial or well-being benefits should be regarded as possible implications rather than measured outcomes.

FUTURE RESEARCH

Future studies should include larger prospective multicenter cohorts to establish more robust evidence for Ilizarov correction of neglected adolescent clubfoot. Comparative studies of conventional Ilizarov frames and computer-assisted hexapod systems, such as the Taylor Spatial Frame, could evaluate differences in correction precision, treatment duration, and soft-tissue complications.

Objective biomechanical assessment using gait analysis and dynamic pedobarography could further quantify changes in foot loading, hind foot mechanics, and weight distribution following correction. Future longitudinal studies should also incorporate validated patient-reported outcome measures, such as EQ-5D, SF-36, or OAFQC, to evaluate pain, physical function, participation, and quality of life.

CONCLUSION

This study demonstrates that closed multiplanar manipulation with the Ilizarov circular external fixator, combined with percutaneous multi-level soft-tissue release, provides a joint-preserving reconstructive option for severe neglected rigid clubfoot in adolescents. Gradual correction based on distraction histogenesis achieved plantigrade alignment and functional weight-bearing while avoiding extensive bone resection, foot shortening, or aggressive open arthrodesis. Both patients achieved good-to-excellent functional outcomes according to ASAMI criteria, with no recurrence during the available follow-up.

Despite these encouraging findings, the small sample size limits generalization and supports the need for larger prospective studies. More importantly, the cases emphasize the value of early detection, timely evidence-based treatment, parental education, adherence to bracing, and long-term follow-up in preventing progression to severe neglected deformity. A coordinated screening and referral pathway involving neonatal, primary-care, orthopedic, rehabilitation, and family-based care may reduce avoidable disability associated with untreated or recurrent clubfoot.

This approach is consistent with SDG 3 (Good Health and Well-being) through early diagnosis, preservation of mobility, and prevention of functional disability. Coordinated multidisciplinary care and standardized referral and follow-up pathways also support SDG 17 (Partnerships for the Goals). Although psychosocial and quality-of-life outcomes were not directly measured in this study, restoration of a plantigrade, functional foot may have potential benefits for mobility, participation, and overall well-being. Future studies using validated patient-reported and psychosocial measures are needed to assess these effects objectively.

CONTRIBUTOR

The author contributed solely to the intellectual discourse that forms the foundation of this article, as well as its writing and editing, and assumes full responsibility for its content and interpretation.

COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments:

Not applicable.

Funding:

Not applicable.

AI Declaration:

Not applicable.

Statement of Human Rights:

All procedures performed in studies involving human participants were following the ethical standards of the institutional and national research committee and with the Declaration of Helsinki and its later amendments or comparable ethical standards.

Statement on the Welfare of Animals:

This article does not contain any studies with animals performed by any authors.

Informed Consent:

Informed consent was obtained from all individual participants included in the study.

Disclosure statement:

No potential conflict of interest was reported by the author.

PUBLISHER’S NOTE

Neutrality Statement on Jurisdictional Claims and Institutional Affiliations:

The publisher and the journal remain neutral regarding jurisdictional claims in published maps and institutional affiliations.

Disclaimer on External Links:

The publisher and the journal cannot be held responsible for the content of external websites or any broken or missing links within the article. Authors are solely responsible for ensuring the accuracy and functionality of all hyperlinks at the time of submission.

REFERENCES

1. Brand, R. A. "Clubfoot: Etiology and Treatment—Ignacio V. Ponseti, MD, 1914-." *Clin Orthop Relat Res* 467, no. 5 (2009): 1121–1123. <https://doi.org/10.1007/s11999-009-0719-8>.
2. Dobbs, M. B., R. Nunley, and P. L. Schoenecker. "Long-Term Follow-up of Patients with Clubfeet Treated with Extensive Soft-Tissue Release." *J Bone Joint Surg Am* 88, no. 5 (May 2006): 986–996. <https://doi.org/10.2106/JBJS.E.00114>.
3. Ferreira, R. C., M. T. Costa, G. G. Frizzo, and F. F. da Fonseca Filho. "Correction of Neglected Clubfoot Using the Ilizarov External Fixator." *Foot Ankle Int* 27, no. 4 (2006): 266–273. <https://doi.org/10.1177/107110070602700407>.
4. Grill, F., and J. Franke. "The Ilizarov Distractor for the Correction of Relapsed or Neglected Clubfoot." *J Bone Joint Surg Br* 69-B, no. 4 (1987): 593–597. <https://doi.org/10.1302/0301-620X.69B4.3611163>.
5. Herzenberg, J. E., C. Radler, and N. Bor. "Ponseti Versus Traditional Methods of Casting for Idiopathic Clubfoot." *J Pediatr Orthop* 22, no. 4 (2002): 517–521.
6. Ilizarov, G. A. *Transosseous Osteosynthesis: Theoretical and Clinical Aspects of the Regeneration and Growth of Tissue*. Berlin: Springer-Verlag, 1992.
7. Makhdoom, A., P. A. Qureshi, M. F. Jokhio, and K. A. Siddiqui. "Resistant Clubfoot Deformities Managed by Ilizarov Distraction Histogenesis." *Indian J Orthop* 46, no. 3 (2012): 326–332. <https://doi.org/10.4103/0019-5413.96385>.
8. Muhammed, Z. A. "The Use of the Ilizarov Method in the Correction of Neglected Clubfoot." *J Med Chem Sci* 6, no. 11 (2023): 2756–2766. <https://doi.org/10.26655/JMCHMSCI.2023.11.20>.
9. Nwet, M., R. Vignesh, W. Khaing, S. San, and Z. W. Ko. "Outcomes of Management of Severe Clubfoot among Children by Ilizarov External Fixator." *Malays Orthop J* 17, no. 3 (2023): 9–16. <https://doi.org/10.5704/MOJ.2311.003>.
10. Ponseti, I. V. *Congenital Clubfoot: Fundamentals of Treatment*. Oxford: Oxford University Press, 1996.
11. World Health Organization. *Global Action Plan on Physical Activity 2018–2030: More Active People for a Healthier World*. Geneva: WHO, 2018.