

General

Foot and Ankle Deformities in Fibular Hemimelia: Narrative Review

Fahad AlShayhan, MD¹^a

¹ Orthopedic Department, College of Medicine, King Saud University, Riyadh, Saudi Arabia

Keywords: Fibular hemimelia, Equinovalgus, Equinovarus, Tarsal coalition, Ball and socket

<https://doi.org/10.52965/001c.159358>

Orthopedic Reviews

Vol. 18, 2026

The foot and ankle deformities associated with fibular hemimelia are considered the most complex aspect of the disease. The goal of treatment at the end of treatment for fibular hemimelia is a plantigrade foot. The main scope of the treatment before the last decade was amputation, which was thought to be the only option to provide the best functional outcome. Over the last two decades, many procedures have been published with variable outcomes. This article provides a focused review of the foot and ankle aspects of fibular hemimelia, along with multiple surgical options described in the literature and their associated outcomes.

INTRODUCTION

Congenital fibular deficiency, also known as fibular hemimelia, is considered the most prevalent congenital defect of the long bones.¹ The incidence varies from 5.7 to 20 per 1 million live births.² Although it is rare, it remains one of the well-known pediatric orthopedic conditions.² Fibular hemimelia affects both limbs in 20% of cases and is often linked with congenital femoral deficiency.³ The clinical presentation of fibular hemimelia can range from mild fibular hypoplasia, which causes slight limb length discrepancy, to severe limb shortening with foot and ankle involvement.⁴ The foot and ankle deformities associated with fibular hemimelia can be quite diverse.⁵ Since the fibula plays a vital role in normal ankle joint development, its hypoplasia contributes to ankle abnormalities. The primary goal in treating fibular hemimelia is to maximize the patient's function. There is ongoing debate in the literature about how best to achieve this in severe cases—either through limb amputation with prosthetic fitting or through reconstruction to create a plantigrade foot. This review is the first to focus specifically on the foot and ankle aspects of fibular hemimelia, summarizing the current literature on treatment approaches and outcomes.

ETIOLOGY

As of now, the exact cause remains unknown, and there is no known genetic basis for congenital fibular deficiency. A family history of the condition is reported when the patient exhibits involvement of more than one limb. The mode of inheritance in these cases is autosomal dominant. One reported theory may explain that more than one limb is in-

involved when teratological factors, such as drug administration or radiation exposure, are present. In an animal model, a somatic gene mutation has been reported, though this has not been proven in humans.⁵

CLINICAL PRESENTATION

Patients with congenital fibular deficiency typically present to the clinic for the first time due to a significant limb-length discrepancy or foot and ankle deformities.¹ The more severe the disease and the visible deformity, the earlier they seek medical advice. When a patient with congenital fibular deficiency presents initially, they should undergo a thorough examination to identify any associated conditions with fibular hemimelia.⁴ The most common associated upper extremity conditions include ulnar hemimelia, amelia, or syndactyly of the fingers. Regarding the femur, conditions such as acetabular retroversion, acetabular dysplasia, hypoplasia of the lateral femoral condyle, coxa valga, or coxa vara may be present. In the knee, they might have a cruciate deficiency or genu valgus. Genu valgus is due to hypoplasia of the lateral condyle of the femur. In the leg, anteromedial tibial bowing and LLD are common. Ankle deformities associated with fibular hemimelia can include a ball-and-socket joint, ankle valgus deformity, ankle instability, or dislocation. Finally, in the foot, they might present with tarsal coalition, absent rays, hallux valgus, bracket first metatarsal, syndactyly of toes, or equinovalgus and equinovarus deformities.⁴⁻⁶

a Corresponding author: Falshayhan@ksu.edu.sa

PATHO-ANATOMY

The foot and ankle aspect of the disease is the most complex and challenging. The involvement can range from a normal foot, stable equinovalgus deformity with a full ankle range of motion, to dynamic ankle valgus instability, tarsal coalition with a fixed subtalar joint in valgus or varus, and absent central rays. The fibula provides strong lateral support to the ankle; however, it is not the only factor contributing to ankle valgus deformity. Patients were observed to have wedge-shaped distal tibial epiphyses, which likely contribute to the development of ankle valgus deformity. The degree of wedging can predict how severe the valgus deformity may become.⁷ The remnant of the fibula leaves a strong fibrous band that causes lateral tethering, which contributes to equinovalgus deformity. Soft tissues, including the Achilles and peroneal tendons, are considered deforming forces in the equinovalgus.⁵ The ball-and-socket ankle joint develops over time, resulting in a ball-shaped joint in the coronal plane and a flat joint in the sagittal plane.⁵ Many theories have been proposed to explain this development. One theory suggests that the loss of normal horizontal-axis rotation of the talus, caused by a coexisting subtalar coalition, leads to an adaptive ball-and-socket joint. Another theory proposes that the ball-and-socket configuration is part of the congenital disease, with deformity developing early in life.⁸ Tarsal coalition is most often found in the subtalar joint, particularly in the posterior facet, and usually results in hindfoot valgus and ankle instability. In some cases, the coalition fuses in an equinovarus position. The coalition can also occur in joints other than the subtalar, such as the calcaneocuboid or talonavicular joints.

CLASSIFICATIONS

Several classifications have been described in the literature for fibular hemimelia. Achterman and Kalamachi classification is primarily a descriptive classification that depends on fibula hypoplasia, which doesn't accurately reflect the severity of the disease in terms of leg length discrepancy or foot and ankle deformities (Table 1).⁹ The Birch classification divides fibular hemimelia patients into two main types: type 1, characterized by a preservable foot, defined as having three or more rays, and type 2, where the foot is non-preserved (less than three rays) (Table 2).⁶ His classification is guiding treatment, but doesn't reflect the exact deformity of the foot and ankle. Rather, he divided the classification based only on the number of rays. Paley classification divides the patients into four categories based on the ankle and subtalar deformity regardless of the amount of LLD: type 1 when the ankle is stable, type 2 dynamic ankle valgus, type 3 fixed equinovalgus deformity, and type 4 fixed equinovarus deformity (Table 3).⁵

IMAGING

The initial imaging modality for a patient with fibular hemimelia is plain radiography, specifically a standing long film from the pelvis to the ankle with the knee extended on the unaffected side, the patella facing forward, and a block placed under the affected side to balance the pelvis in the image. To further delineate the foot and ankle deformity, proper plain radiography, including Anteroposterior (AP) and lateral views of the foot and ankle, is required.

The role of Magnetic Resonance Imaging (MRI) is crucial for differentiating among the type 3 subtypes and localizing the coalition site. It has a role in confirming the cruciate deficiency at the knee level. It plays an important role in assessing the vasculature relative to the fibular anlage before surgical intervention.¹⁰

MANAGEMENT GOALS

The goals of treating patients with fibular hemimelia are to equalize both limbs at skeletal maturity and achieve a plantigrade foot. To have a plantigrade foot, through clinical examination and plain radiographs, determine the classification type and severity of fibular hemimelia.⁵

TIMING OF SURGICAL RECONSTRUCTION

The surgical reconstruction of the foot and ankle, as reported by Paley, is performed as early as 18 months of age, either alone or combined with the first lengthening at the same time.⁵ It was believed that doing a simultaneous SUPERankle procedure with tibia lengthening could increase the risk of ankle stiffness. However, Paley has attributed this complication to the dysplastic nature of the talus.⁵

SURGICAL OPTIONS

Historically, amputation was the preferred treatment for fibular hemimelia, especially in cases of significant leg length discrepancy and severe foot deformity. Over the past two decades, various techniques have been developed to achieve a plantigrade foot and improve outcomes after limb length equalization. One of the earliest reconstruction methods reported is gradual correction using the Ilizarov technique.¹¹ In the last decade, Paley introduced two surgical reconstruction approaches: Shortening Osteotomy Realignment Distal Tibia (SHORTT) and Systematic Utilitarian Procedure for Extremity Reconstruction of the ankle (SUPERankle), each designed for specific types of fibular hemimelia.⁵

SHORTT PROCEDURE

Shortening Osteotomy Realignment Distal Tibia (SHORTT) is a surgical procedure described by Paley for patients with fibular hemimelia, specifically those with a dynamic valgus deformity.⁵ It aims to correct the alignment of the distal

Table 1. Achterman and Kalamchi⁹ classification of fibular hemimelia:

Type	Description
IA	Proximal fibular epiphysis is distal to proximal tibia growth plate. The distal growth plate of the fibula is proximal to the dome of talus.
IB	Partial absence of the fibula proximally (30-50% of fibula length) with the presence distally without supporting the ankle.
II	Complete absence of the fibula with the presence of vestigial fragment.

Table 2. Birch classification⁶ and proposed treatment for fibular hemimelia:

Type	Treatment
Type 1 (Preservable foot):	
1A (< 6% inequality)	No treatment, orthosis or epiphysiodesis
1B (6-10% inequality)	Contralateral epiphysiodesis ± Lengthening
1C (11-30% inequality)	1 or 2 lengthenings ± epiphysiodesis or orthosis
1D (> 30% inequality)	>2 lengthenings or amputation or orthosis
Type 2 (Non-preservable foot):	
2A (Functional upper extremity)	Amputation
2B (Nonfunctional upper extremity)	Consider salvage

Table 3. Paley classification⁵ and proposed treatment for fibular hemimelia:

Type	Treatment
1 (Stable ankle)	Lengthening surgery
2 (Dynamic valgus)	SHORDT* with lengthening surgery
3 (Fixed equinovalgus deformity):	
3A Ankle type coalition	SUPERankle** with lengthening surgery
3B Subtalar type coalition	
3C Combined type	
4 (Fixed equinovarus deformity)	SUPERankle** with lengthening surgery

* SHORDT: Shortening Osteotomy Realignment Distal Tibia.

** SUPERankle: Systematic Utilitarian Procedure for Extremity Reconstruction of the ankle.

tibia with shortening, restoring fibular height, and lengthening the peroneal tendons

SUPERANKLE PROCEDURE

Systematic Utilitarian Procedure for Extremity Reconstruction of the ankle (SUPERankle) is a procedure described by Paley to realign and stabilize the ankle in severe cases of fibular hemimelia (Paley types 3 and 4).⁵ The procedure is started after applying a tourniquet by a posterolateral skin incision over the distal part of the tibia or at the level of the tibia bowing if present. Careful dissection and protection of the sural nerve should be carried out. Incise the fascia distally and open it retrograde. Exploration of the superficial peroneal nerve should be performed at this stage. Explore the peroneal tendons and lengthen the peroneus brevis only. In patients with a conjoined tendon, it appears as a peroneus brevis that attaches to the lateral aspect of the calcaneus; lengthening should be performed. If it is

the peroneus longus, release the sheath and allow anterior transposition of the tendon. At this point, dissection around the fibular anlage should begin at the distal end and proceed proximally. A separate proximal incision over the fibular neck should be performed. A transverse incision of the underlying fascia extending medially to the intermuscular septum all the way down. Under proper care, dissection and identification of the common peroneal nerve should be performed. The fibular anlage proximally will be found between the gastrocnemius and the peroneal tendons. Dissection around the anlage from the proximal and distal wounds should be carried out by making a tunnel in between them to ease the resection of the anlage. The anlage should be pulled proximally with care to avoid injury to the common peroneal nerve. Before proceeding with the osteotomy, perform a gastrocnemius recession at this stage. The posterior tibial nerve and artery should be decompressed from the calcaneus. Dissect the lateral wall of the calcaneus and elevate the extensor digitorum brevis muscle. Start the subtalar coalition osteotomy. It should be at the

level of the subtalar joint, starting at the posterior aspect and advancing anteriorly. The saw's direction must be 45 degrees, aiming caudally in the frontal plane. Provisional wires were inserted from the distal tibia metaphysis to the talus. Use a Hoffman to move the calcaneus medially and distally. After the realignment, insert two wires in retrograde fashion from the calcaneus, talus, through the distal tibia physis. To perform the tibia osteotomy, two distal guide wires are placed just proximal to the distal tibia physis in the coronal and sagittal planes parallel to the joint. The first osteotomy should be performed. The overlap is the amount of shortening that two guide wires should mark for the planned proximal osteotomy, perpendicular to the proximal tibia axis. After performing the osteotomy, the retrograde wires should be advanced through the osteotomy. Closure of the wound and insertion of the drain.⁵

Hazem et al. reported a modification in Paley type 3 patients, in which they used the distal remnant of the fibular anlage and preserved it to serve as a lateral malleolus, providing lateral support to the ankle and avoiding future recurrence.¹² A technique described by Exner called dome osteotomy of the distal tibia, which aims to correct the deformed distal tibia epiphysis by a metaphyseal osteotomy over the lateral aspect of the distal tibia following the same principle of Pamberton acetabuloplasty. Through this osteotomy, the lateral part of the epiphysis is depressed to equalize the mechanical stress on the talus. This procedure is described in addition to soft tissue releases.^{13,14} Abdulrazak et al. performed the bending osteotomy accompanied by soft tissue procedure in two fibular hemimelia patients, type 2 Achterman–Kalamchi.¹⁵

AMPUTATION VERSUS RECONSTRUCTION

Before the recent advances in managing fibular hemimelia, amputation was considered the best option for most patients with this condition. James et al. demonstrated better outcomes with amputation than with reconstruction in terms of functional outcomes, shorter hospital stays, and cost-effectiveness.¹⁶ Birch et al. showed comparable outcomes between patients who underwent amputation and those treated with reconstruction using the SUPERankle technique with lengthening, in terms of functional abilities, psychological well-being, and satisfaction.¹⁷ Aissam et al., in a meta-analysis using various surgical reconstruction methods, found that amputation patients experienced better results than those who underwent reconstruction.¹⁸ Calder et al. compared functional outcomes in fibular hemimelia type 2 according to the Achterman–Kalamchi classification, noting that short-term results favored amputation.¹⁹ Julio et al. reported on nine patients with fibular hemimelia types 1 and 2 Achterman–Kalamchi, all treated with Syme amputation, achieving satisfactory outcomes, although five of these patients among the 9.²⁰ Most literature recommends avoiding amputation for mild types of fibular hemimelia, specifically Paley types 1 and 2.⁵ When it involves more severe cases, such as Paley types 3 and 4, the decision becomes more controversial.⁵ The fact is, a plantigrade foot generally provides better functional results than

amputation.⁵ In cases where patients have upper limb involvement, belong to cultures where amputation is not accepted, or live in areas lacking access to prosthetic fitting and care, amputation is generally not recommended.⁵

It is believed that in fibular hemimelia patients who present with fewer than three toes, the best surgical option is amputation. The basis for this information is that two toes are considered non-functional in the foot.²¹ The function of the foot is independent of the number of toes. Even in some cases with two toes, their foot can be plantigrade and functional.^{5,22}

OUTCOME AND RECURRENCE

Outcome of gradual correction of foot and ankle deformities:

The role of gradual correction using the Ilizarov and Taylor Spatial Frame in treating foot and ankle deformities in fibular hemimelia has been described over the last few decades. The outcome was reported by Changulani et al. among fibular hemimelia patients of types 1 and 2, based on the Achterman–Kalamchi classification, equivalent to Paley type 2.²¹ In the mild form, the results are promising, with no signs of recurrence.²¹ Lazovic et al. suggested the Ilizarov method to gradually correct foot deformity and lengthen the tibia simultaneously in cases where a large amount of tibia shortening is expected. The recurrence is reported in two patients, which the authors attribute to the complexity of the foot deformity.²³ It is believed that gradual correction using Ilizarov of foot and ankle deformity in a fibular hemimelia patient has a high recurrence rate due to persistence of the posterolateral tether.²⁴ Arnold et al. compared the Ilizarov correction of foot and ankle deformity, accompanied with or without anlage resection. He found the recurrence is high if the anlage is preserved.²⁵ Maurozio et al. reported long-term outcomes in 32 patients with fibular hemimelia, classified as modified Dalmonte type 3, who underwent reconstruction using the Ilizarov method. The results showed good outcomes in 8 patients and satisfactory outcomes in 17 patients. Recurrence of equinus deformity was reported in 8 patients.¹¹

OUTCOME OF SUPERANKLE SURGERY

Paley reported comparable functional outcomes and gait analysis performance between patients who underwent the SUPERankle procedure and those who underwent amputation.⁵ Shadi et al. reported the midterm outcome of patients with Paley type 3c who underwent the SUPERankle procedure. SUPERankle achieved a plantigrade foot in all patients; however, a 40% recurrence rate was observed, requiring secondary surgeries.²² Hazem et al. reported the outcome of fibular hemimelia in 13 patients, including 10 patients with type 2 Achterman–Kalamchi, which is equivalent to types 3 and 4 in the Paley classification. The surgery performed is a SUPER ankle, in addition to preserving the lateral malleolus anlage remnant, which, once it ossifies, acts as the lateral malleolus. Short-term follow-up revealed good results, with no signs of recurrence or limitation in

ankle range of motion.¹² In sever form of the disease, Lazovic et al. found among 11 patients with type 3 Paley fibular hemimelia good results in 83% of patients when starting the reconstruction in the form of a SUPER ankle at the age of 2 years, followed by lengthening at the age of 4 years.²³ Hany et al. performed a new approach on 10 ankles in 8 patients. He made a zigzag posterolateral incision, which he thought would minimize the scar tether made by a straight lateral incision. In addition to coalition resection with realignment of the subtalar joint, he preserved the remnant of the distal fibular anlage, or he used an iliac bone graft to substitute the lateral malleolus. Short-term results have shown no signs of recurrence.²⁴

OTHER SURGERIES

Dimosthenis et al. reported the mid-term outcome of 7 patients with fibular hemimelia. Two of those patients experienced a recurrence of ankle valgus deformity, which was initially classified as type 2 according to the Achterman-Kalamchi classification. The surgeon performed tibia corrective osteotomy, achilles, and peroneal lengthening.²⁶ Tomas-Gil et al. reported the long-term outcomes of 3 patients with type 2 Achterman-Kalamchi, all of whom were asclassified to Paley type 3, who underwent calcaneal osteotomy, Achilles lengthening, and anlage resection. The results were satisfactory, with no signs of recurrence in the foot and ankle.²⁷ Kenichi et al. studied the long-term outcomes of 8 patients with fibular hemimelia, focusing mainly on the lengthening procedures. His cohort ranged from classes 1 and 2 of the Achterman-Kalamchi classification, with variable foot and ankle presentations. He performed posterior capsular release and fibular anlage resection in only two patients. Ankle valgus was reported at the final follow-up in 6 of 8 patients, underscoring the importance of achieving a plantigrade foot at the beginning to achieve the best results after lengthening.²⁸ Exner et al. in-

vestigated the long-term results of dome osteotomy in patients with Paley type 3C and 4. No signs of growth arrest were observed, resulting in a stable hindfoot. Recurrence of forefoot deformity occurred among two patients.¹⁴ Short-term results described by Abdulrazak et al. using bending osteotomy accompanied by soft tissue procedure for type 2 Achterman-Kalamchi demonstrated no signs of recurrence or growth arrest of the distal tibia physis.¹⁵

CONCLUSION

The literature lacks long-term follow-up for foot and ankle deformities in fibular hemimelia. The recurrence rate is high among complex foot deformities upon presentation. A plantigrade foot by the end of treatment, without any signs of recurrence, offers the best outcomes for patients with fibular hemimelia. Reconstruction of the foot and ankle in preservable feet is a valid option, according to current literature, and can yield results comparable to amputation. Preservable foot should not be judged solely on the number of toes, but rather on the function of the foot upon presentation.

DISCLOSURE

No conflict of interest.

FUNDING

No fund is provided.

Submitted: January 07, 2026 EDT. Accepted: March 05, 2026 EDT. Published: March 27, 2026 EDT.

REFERENCES

1. Rodriguez-Ramirez A, Thacker MM, Becerra LC, Riddle EC, MacKenzie WG. Limb length discrepancy and congenital limb anomalies in fibular hemimelia. *Journal of Pediatric Orthopaedics Part B*. 2010;19(5):436-440. doi:[10.1097/BPB.0b013e32832d5d7d](https://doi.org/10.1097/BPB.0b013e32832d5d7d)
2. Fordham LA, Applegate KE, Wilkes DC, Chung CJ. *Fibular Hemimelia: More Than Just An Absent Bone*. Vol 3. doi:[10.1055/s-2008-1080068](https://doi.org/10.1055/s-2008-1080068)
3. Tsai A, Kleinman PK, Laor T, Kasser JR. Lower-extremity growth patterns and skeletal maturation in children with unilateral fibular hemimelia. *Pediatr Radiol*. 2019;49(1):122-127. doi:[10.1007/s00247-018-4263-0](https://doi.org/10.1007/s00247-018-4263-0)
4. Hamdy RC, Makhdom AM, Saran N, Birch J. Congenital fibular deficiency. *Journal of the American Academy of Orthopaedic Surgeons*. 2014;22(4):246-255. doi:[10.5435/JAOS-22-04-246](https://doi.org/10.5435/JAOS-22-04-246)
5. Paley D. Surgical reconstruction for fibular hemimelia. *J Child Orthop*. 2016;10(6):557-583. doi:[10.1007/s11832-016-0790-0](https://doi.org/10.1007/s11832-016-0790-0)
6. Birch JG, Lincoln TL, Mack PW, Birch CM. Congenital fibular deficiency: A review of thirty years' experience at one institution and a proposed classification system based on clinical deformity. *Journal of Bone and Joint Surgery*. 2011;93(12):1144-1151. doi:[10.2106/JBJS.J.00683](https://doi.org/10.2106/JBJS.J.00683)
7. Choi I, Ho MD. Wedge-Shaped Distal Tibial Epiphysis in the Pathogenesis of Equinovalgus Deformity of the Foot and Ankle in Tibial Lengthening for Fibular Hemimelia SELECTED TOPICS SUBSCRIBED. 20. <https://oce-ovid-com.proxy3.library.mcgill.ca/article/01241398-200007000-00003/HTML#contributor->
8. Pistoia F, Ozonoff MB, Wintz P. *Skeletal Radiology Ball-and-Socket Ankle Joint*. Vol 16.; 1987. doi:[10.1007/BF00350538](https://doi.org/10.1007/BF00350538)
9. All CA, Froni K, Alfred. CONGENITAL DEFICIENCY OF THE FIBULA.
10. Fuller CB, Shannon CE, Paley D. Lengthening reconstruction surgery for fibular hemimelia: A review. *ChildrenMDPI*. 2021;8(6). doi:[10.3390/children8060467](https://doi.org/10.3390/children8060467)
11. Catagni MA, Radwan M, Lovisetti L, Guerreschi F, Elmoghazy NA. Limb lengthening and deformity correction by the Ilizarov technique in type III fibular hemimelia: An alternative to amputation. *Clin Orthop Relat Res*. 2011;469(4):1175-1180. doi:[10.1007/s11999-010-1635-7](https://doi.org/10.1007/s11999-010-1635-7)
12. El-Tayeby HM, Ahmed AARY. Ankle reconstruction in type II fibular hemimelia. *Strategies Trauma Limb Reconstr*. 2012;7(1):23-26. doi:[10.1007/s11751-012-0129-4](https://doi.org/10.1007/s11751-012-0129-4)
13. Exner GU. Bending osteotomy through the distal tibial physis in fibular hemimelia for stable reduction of the hindfoot. doi:[10.1097/01.bpb.0000043566.17315.ed](https://doi.org/10.1097/01.bpb.0000043566.17315.ed)
14. Exner GU, Maquieira GJ, Ramseier LE. Bending osteotomy through the distal tibial physis for stable reduction of the ankle joint in fibular hemimelia. Update at skeletal maturity. *J Pediatr Orthop B*. 2025;34(1):14-19. doi:[10.1097/BPB.0000000000001144](https://doi.org/10.1097/BPB.0000000000001144)
15. Sulaiman AR, Munajat I, Mohd EF. Ankle reconstruction and lengthening strategy in type II fibular hemimelia: a report of two cases. *Foot*. 2018;36:6-9. doi:[10.1016/j.foot.2018.01.001](https://doi.org/10.1016/j.foot.2018.01.001)
16. McCarthy JJ, Glancy GL, Chang FM, Eilert RE. Fibular Hemimelia: Comparison of Outcome Measurements After Amputation and Lengthening*. *The Journal of Bone and Joint Surgery-American Volume*. 2000;82(12):1732-1735. doi:[10.2106/00004623-200012000-00006](https://doi.org/10.2106/00004623-200012000-00006)
17. Birch JG, Paley D, Herzenberg JE, et al. Amputation Versus Staged Reconstruction for Severe Fibular Hemimelia Assessment of Psychosocial and Quality-of-Life Status and Physical Functioning in Childhood. *JBJS Open Access*. 2019;4(2). doi:[10.2106/JBJS.OA.18.00053](https://doi.org/10.2106/JBJS.OA.18.00053)
18. Elmherig A, Ahmed AF, Hegazy A, Herzenberg JE, Ibrahim T, Ibrahim T. Amputation Versus Limb Reconstruction for Fibula Hemimelia: A Meta-analysis. *Journal of Pediatric Orthopaedics*. 2020;40(8):425-430. doi:[10.1097/BPO.0000000000001510](https://doi.org/10.1097/BPO.0000000000001510)
19. Calder P, Shaw S, Roberts A, et al. A comparison of functional outcome between amputation and extension prosthesis in the treatment of congenital absence of the fibula with severe limb deformity. *J Child Orthop*. 2017;11(4):318-325. doi:[10.1302/1863-2548.11.160264](https://doi.org/10.1302/1863-2548.11.160264)

20. Avila J. Fibular Hemimelia: A Case Series of Nine Patients Treated with Syme Amputation. *Global Journal of Orthopedics Research*. 2022;4(1). doi:[10.33552/gjor.2022.04.000577](https://doi.org/10.33552/gjor.2022.04.000577)
21. Changulani M, Ali F, Mulgrew E, Day JB, Zenios M. Outcome of limb lengthening in fibular hemimelia and a functional foot. *J Child Orthop*. 2010;4(6):519-524. doi:[10.1007/s11832-010-0291-5](https://doi.org/10.1007/s11832-010-0291-5)
22. Shadi M, Janusz P, Kotwicki T. Correction of Ankle Malalignment in Severe Fibular Hemimelia. *Journal of Pediatric Orthopaedics*. 2025;45(4):e366-e377. doi:[10.1097/BPO.0000000000002876](https://doi.org/10.1097/BPO.0000000000002876)
23. Lazović M, Leonchuk SS, Ducić S, Imomov SA, Popkov DA. Limb lengthening and deformity correction in patients with severe fibular hemimelia: experience of the children's university hospital in Belgrade. *Genij Ortopedii*. 2024;30(1):38-45. doi:[10.18019/1028-4427-2024-30-1-38-45](https://doi.org/10.18019/1028-4427-2024-30-1-38-45)
24. Hefny H, Elmoatasem EHM, Mahran M, et al. Ankle Reconstruction in Fibular Hemimelia: New Approach. *HSS Journal*. 2017;13(2):178-185. doi:[10.1007/s11420-016-9524-6](https://doi.org/10.1007/s11420-016-9524-6)
25. Popkov A, Aranovich A, Popkov D. Prevention of recurrence of tibia and ankle deformities after bone lengthening in children with type II fibular hemimelia. *Int Orthop*. 2015;39(7):1365-1370. doi:[10.1007/s00264-015-2752-4](https://doi.org/10.1007/s00264-015-2752-4)
26. Alaseirlis DA, Korompilias AV, Beris AE, Soucacos PN. Residual malformations and leg length discrepancy after treatment of fibular hemimelia. *J Orthop Surg Res*. 2011;6(1). doi:[10.1186/1749-799X-6-51](https://doi.org/10.1186/1749-799X-6-51)
27. Tomás-Gil J, Valverde Belda D, Chismol-Abad J, Valverde-Mordt C. Complete fibular hemimelia: a long-term review of four cases. *Acta Orthop Belg*. 2002;68(3):265-271. <http://www.ncbi.nlm.nih.gov/pubmed/12152374>
28. Mishima K, Kitoh H, Iwata K, et al. Clinical results and complications of lower limb lengthening for fibular hemimelia. *Medicine (United States)*. 2016;95(21). doi:[10.1097/MD.0000000000003787](https://doi.org/10.1097/MD.0000000000003787)