ORIGINAL ARTICLE

Smart Medical Journal

Smart Medical Journal (SMedJour) December 2024, Vol. 7, No.3, pp : 135-145
DOI: https://doi.org/10.13057/smj.v7i3.88653
E-ISSN: 2621-0916 | P-ISSN: 2621-1408

A 58-Years Old Women Underwent Triple Arthrodesis for Adult Acquired Flatfoot Deformity Grade IV with Posterior Tibial Tendon Insufficiency Post Failed Reconstruction: A Case Report

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Recived: 08/08/2024
Accepted: 17/01/2025
Published: 03/02/2025

ABSTRACT

Background: Adult acquired flatfoot (AAFD), formerly known as posterior tibial tendon dysfunction (PTTD), involves the gradual collapse of the foot arch, leading to ongoing deformity. The posterior tibial tendon, crucial for foot stability, is often implicated. A lack of comprehensive epidemiological data exists, but the condition is prevalent, especially among the elderly and those with chronic vascular diseases. Dysfunction of the posterior tibial tendon causes instability in the foot, leading to lateral displacement of forces and subsequent deformities. Triple arthrodesis is an effective treatment for correcting foot deformities, offering pain relief and stability, particularly in cases of arthrosis and neuromuscular diseases. This case report highlights a Grade IV AAFD with failed reconstructive surgery, contributing to the literature on surgical intervention outcomes.
Case report: We present the case of a 58-year-old woman with progressively worsening pain and discomfort in her left foot. The patient underwent a triple arthrodesis procedure for adult acquired flatfoot deformity grade IV with posterior tibial tendon insufficiency. the patient has a history of failed reconstructive surgery with medial displacement calcaneal osteotomy and flexor digitorum longus to posterior tibial tendon transfer. Physical examination findings revealed presence of surgical scars on the left pedis region consistent with prior interventions. There is evidence of hindfoot valgus and medial arch collapse, justifying the need for further surgical intervention in radiology finding.
Discussion: Stage IV acquired flatfoot deformity results from weakened deltoid ligament and Posterior Tibial Tendon Dysfunction (PTTD), leading to hindfoot valgus and abduction. Surgical options include medializing calcaneal osteotomy (MCO) and tendon transfers like flexor digitorum longus (FDL). Triple arthrodesis is preferred for rigid deformities, but whether to include the calcaneocuboid joint depends on examination findings. Exclusion may cause arthrodiastasis, with limited evidence of improved outcomes. Double arthrodesis has higher nonunion rates but doesn't impair correction.
Conclusion: Individuals with rigid foot deformities, triple arthrodesis, fusing the talonavicular, subtalar, and calcaneocuboid joints, improves pain relief and function. The decision to include the calcaneocuboid joint depends on its condition. Excluding it may cause unintended joint movement, but its distraction doesn't necessarily improve outcomes. After talonavicular fusion, calcaneocuboid joint motion is minimal. Double arthrodesis for rigid planovalgus deformity shows higher nonunion rates and lower patient scores compared to triple arthrodesis, but it doesn't impair deformity correction. This case contributes to the growing evidence supporting triple arthrodesis as a salvage procedure for advanced flatfoot deformities and serves as a valuable reference for managing similar challenging cases.

Keywords: *AAFD; Posterior tibial tendon; Triple arthrodesi*

INTRODUCTION

Adult acquired flatfoot (AAFD), formerly referred to as posterior tibial tendon dysfunction (PTTD), is a complex disorder marked by the gradual deterioration of the foot's arch on the inner side, resulting in persistent deformity of the foot and ankle[1]. The foot and ankle possess complex anatomy, including multiple components that are essential for stability and movement during walking and weight-bearing tasks. The posterior tibial tendon is a crucial factor in the development of adult acquired flatfoot among these structures. In addition to its function in plantar flexion, the posterior tibial tendon principally serves as the main inward rotator of the foot. The main point of attachment of the structure is the navicular tuberosity, with other lesser attachments to other bones in the tarsal and metatarsal regions[2].

Adult acquired flatfoot is a common orthopedic ailment, however there is a limited amount of extensive literature available on its epidemiology. Posterior tibial tendon issues are prevalent in the geriatric demographic, impacting around 10% of older people. Older persons may have a higher likelihood of experiencing more severe instances of adult acquired flatfoot due to variables such as the deterioration of muscle mass and bone structure. People who have chronic vascular illnesses, such as diabetes and hypertension, have a higher chance of getting adult acquired flatfoot.

The posterior tibial tendon is essential for maintaining correct walking patterns and foot functionality. The contraction of the tibialis posterior muscle causes the foot to turn inward and stabilizes the transverse tarsal joints, ensuring stability during push-off. When the posterior tibial tendon is insufficient, it leads to instability of the transverse tarsal joint and abduction of the forefoot. This instability enables the peroneus brevis muscle to exercise its action without any opposition. As a result, the front part of the foot and the joints in the middle of the foot move away from the body's midline, causing the force from the tendon in the heel bone to shift to the side. This sideways movement worsens the outward bending of the foot. The continuous stress on the static stabilizing ligaments leads to their gradual deterioration. The spring ligament is commonly impacted, and its dysfunction leads to the displacement of the talar head towards the medial and plantar side in respect to the navicular bone. Likewise, if the deltoid ligament fails, it causes the talus to be positioned in a valgus manner within the ankle mortise[4].

Triple arthrodesis is a highly effective treatment for foot abnormalities since it allows for correction in the coronal, sagittal, and axial planes. This surgery offers a dependable method for treating deformities and stabilizing the foot in patients with neuromuscular illnesses. It avoids the common problem of deformity recurrence that is typically seen with isolated soft tissue and periarticular procedures[6]. Triple arthrodesis is beneficial for both pain alleviation and correction of deformity in situations of arthrosis and deformity. The implementation and extensive acceptance of internal fixation techniques in foot procedures have significantly improved the procedure by allowing firm stabilization of many joints, eliminating the requirement for external hardware, and lowering the need for extended casting. Triple arthrodesis is currently used to treat a range of disorders, particularly as a last-resort operation for stiff and spastic problems in both children and adults. Furthermore, it is employed in the treatment of posttraumatic arthritic diseases, diabetic foot deformities, and inflexible adult cavovarus and planovalgus deformities[5].

This article describes case reports of adult patients with grade IV adult acquired flatfoot deformity and posterior tibial tendon insufficiency. These patients underwent unsuccessful repair using a surgical procedure involving medial displacement calcaneal osteotomy and flexor digitorum longus to posterior tibial tendon transfer. By presenting this case, we aim to provide insights into the challenges of managing advanced AAFD and offer a reference for optimizing surgical outcomes in similar cases.

CASE PRESENTATION

A 58-year-old woman presented in March 2024 with a three-year history of progressively worsening pain and deformity in her left foot. She reported significant difficulty standing for prolonged periods and performing daily activities. The patient had a history of failed reconstructive surgery with medial displacement calcaneal osteotomy and flexor digitorum longus to posterior tibial tendon transfer. However, the surgery failed to alleviate her symptoms, as she continued to experience pain and deformity progression, prompting further evaluation and management. The patient had no significant family history of foot deformities or related genetic conditions. Physical examination findings revealed pedis region.

Physical examination showed normal vital signs. Physical examination of the pedis region revealed postoperative scars from the surgery conducted in November 2022, as shown in Figure 1. On palpation, tenderness was noted in the dorsal region, but no signs of neurovascular disturbance were observed. Capillary refill time (CRT) was less than 2 seconds, and the ankle joint exhibited a full range of active motion.

The patient undergo x-ray examination before taking first surgery on 2022 as shown in Figure 3 and compared with the current pre surgery X-ray (Fig.2). The patient's clinical course is summarized in Table 1.

Table 1. Clinical Timeline of the Patient's Presentation and Management

Date	Event
November 2022	Underwent medial displacement calcaneal osteotomy and FDL to PTT transfer.
March 2024	a. Presented with persistent symptoms, including pain, deformity, and functional limitations. b. Radiographic evaluation revealed advanced deformity and progression of joint degeneration.
April 2024	Underwent triple arthrodesis as a salvage procedure.

Treatment and Outcome

The surgical approach are lateral approach and medial approach of ankle to expose talonavicular, subtalar, and calcaneocuboid joints (Fig.5). Internal fixation was performed using headless screws to ensure adequate alignment and stabilization (Tabel 2). The duration of the surgery was approximately 3 hours and no intraoperative complications were observed. Postoperative care included immobilization with a short leg cast for six weeks, followed by gradual weight-bearing with the assistance of a protective walking boot.

Adjustments to the patient’s treatment plan were made due to the failure of a prior reconstructive procedure, which included medial displacement calcaneal osteotomy and flexor digitorum longus (FDL) transfer to the posterior tibial tendon (PTT). Triple arthrodesis was chosen as a salvage procedure due to its efficacy in managing rigid deformities in advanced stages of adult-acquired flatfoot deformity (AAFD).

Patient-reported outcomes indicated significant improvements in pain relief and functional capacity. The patient reported mild soreness at the incision site during the early postoperative period, which resolved within six weeks. Adherence to postoperative protocols, including immobilization and gradual weight-bearing, was confirmed during follow-up visits. No adverse or unanticipated events, such as hardware complications or nonunion, were observed.

The intervention demonstrated high tolerability and effectiveness, resulting in the successful management of the patient’s symptoms and restoration of functional outcomes.

These results highlight the importance of tailored surgical strategies in addressing complex cases of AAFD.

Figure 1. Preoperative physical examination showing deformity of the left foot from superior (A), caudal (B), medial (C), and lateral (D) views, highlighting valgus alignment, collapsed medial arch, and surgical scars from previous interventions.

Figure 2. Preoperative X-rays showing the left foot in lateral (A) and anteroposterior (B) views, illustrating hindfoot valgus, medial arch collapse, and evidence of previous surgical intervention with internal fixation.

Figure 3. Preoperative X-rays from November 2022 showing the left foot in lateral (A) and anteroposterior (B) views, depicting hindfoot valgus, medial arch collapse, and initial deformity prior to the first surgical intervention.

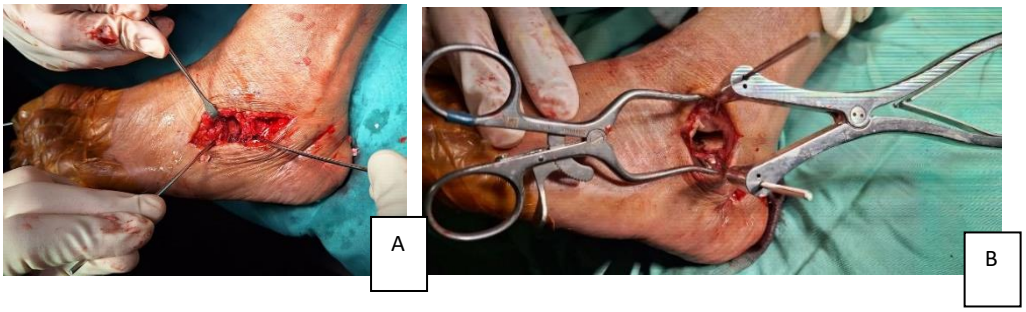

Figure 4. Intraoperative images demonstrating the lateral (A) and medial (B) approaches to the ankle, exposing the talonavicular, subtalar, and calcaneocuboid joints for arthrodesis.

Figure 5. Postoperative X-rays of the left foot in anteroposterior, lateral, and oblique views (A), demonstrating proper alignment and stabilization of the talonavicular, subtalar, and calcaneocuboid joints following triple arthrodesis with headless screw fixation.

RESULT

The classification of acquired flatfoot grading ranges from grade I to grade IV. During Stage I of the condition, patients commonly have tenosynovitis of the posterior tibial tendon without any collapse of the arch. As individuals progress to Stage II of adult acquired flatfoot, they will notice their foot collapsing and will struggle to do a single-leg heel raise. This stage can be further divided into two sub-stages. Stage IIa is characterized by the collapse of the foot with a deformity called hindfoot valgus, but there is no abduction of the midfoot. Stage IIb, on the other hand, is marked by the presence of midfoot abduction. In Stage III of adult-acquired flatfoot, patients have a permanent deformity characterized by the inward turning of the hindfoot and the outward turning of the forefoot. Stage IV deformity is characterized by ankle valgus, which occurs as a result of the deltoid ligament becoming weaker[4]. While there may be some differences in the recommended methods for treating flexible flatfoot, there is a general agreement that arthrodesis is the ideal treatment for resolving rigid flatfoot. Triple arthrodesis is specifically recommended for cases of stiff flatfoot. Furthermore, it is advised for cases of posttraumatic arthritis affecting the triple joint complex, spastic and paralytic disorders, loss of soft tissue limitations resulting in atraumatic subtalar dislocation, and severe tarsal coalitions.

Table 2. Classification of Adult-Acquired Flatfoot Deformity

Stage	Deformity	Operative Management
I	No deformity	Tenosynovectomy, tendon transfer, MDCO
IIa	Mild/moderate deformity, <30% talar head uncoverage	Tendon transfer, MDCO, Cotton osteotomy
IIb	Severe flexible deformity, >30% talar head uncoverage	Tendon transfer, MDCO, lateral column lengthening, Cotton osteotomy vs first TMT fusion, triple arthrodesis
III	Fixed deformity of the triple joint complex	Triple arthrodesis
IV	Foot deformity with ankle deformity (lateral talar tilt)	Correction of foot deformity, deltoid reconstruction, ankle arthrodesis vs arthroplasty
Va	Foot deformity is flexible	Correct foot deformity as outlined for IIb, correct ankle deformity as stage IV above
Vb	Foot deformity is rigid	Correct foot deformity as outlined for stage III, correct ankle deformity as stage IV above

DISCUSSION

The posterior tibial tendon (PTT) functions as a strong muscle that helps to flex the foot downward and rotate it inward. The structure moves towards the back and middle of the subtalar axis, exerting its impact on the transverse tarsal joints, specifically the talonavicular and calcaneocuboid joints[7]. During the early part of a typical walking cycle, the foot turns outward, causing the transverse tarsal joints to align parallel to each other. This alignment enables movement within the hindfoot. During midstance, the posterior tibial tendon (PTT) tightens, causing the foot to turn inward (inversion). This motion leads to the separation of the axis of the transverse tarsal joints, causing the hindfoot to become inflexible during the later part of the stance phase. The inflexible foot, aided by the movement of the posterior tibial tendon and the positioning of the transverse tarsal joints, allows the Achilles tendon to effectively assist in propulsion throughout the walking process[8].

Posterior Tibial Tendon Dysfunction (PTTD) is primarily attributed to a degenerative process. The degeneration of the tendon is frequently triggered by micro-mechanical stress caused by repetitive loading, ultimately culminating in tendon dysfunction[9]. When the posterior tibial tendon (PTT) loses its ability to function properly, the foot is subjected to the unopposed force exerted by the peroneus brevis muscle. This unchallenged motion results in increased hindfoot valgus and abduction. As the posterior tibial tendon dysfunction advances, the static stabilizers of the medial arch, specifically the spring ligament and interosseous talocalcaneal ligament, experience elongation. In addition, the direction of the gastrocnemius-soleus complex is changed, making the valgus deformity worse. Ankle instability and talar tilt can occur when the deltoid ligament fails in advanced stages[10].

Clinical Evaluation

Diagnosing flatfoot involves both clinical and radiographic assessments. Typically, patients with Adult Acquired Flatfoot Deformity (AAFD) are women in their sixth decade of life who may present with obesity[9]. Symptomatic flatfoot often correlates with a higher body mass index (BMI). Patients experiencing symptoms may report pain along the medial aspect of the foot, attributed to either tenosynovitis or deformity[11]. In advanced stages of AAFD, symptoms can extend to include lateral pain as well. This lateral discomfort is commonly linked to various factors such as talocalcaneal impingement at the angle of Gissane, fibular impingement against the calcaneus, subtalar arthritis, and peroneal tendonitis or tears caused by subfibular impingement[12]. Assessing the severity of AAFD can be aided by considering various factors such as the duration of symptoms, aggravating and alleviating factors, previously attempted therapies, and the patient's functional and employment status.

Assessing the flexibility of the foot and the strength and function of the PTT can be achieved through a single-limb heel raise test. During a normal heel raise, the hindfoot typically inverts. However, in cases of flatfoot, the PTT may not have the strength to adequately invert the foot and subtalar joint, preventing the proper locking of the transverse tarsal joints. Consequently, the foot may not function as a stable lever arm for raising the heel off the ground. This test can thus provide valuable insight into the integrity of the PTT and the stability of the foot's arch[9]. In less severe cases of flatfoot, performing a single-limb heel raise may elicit pain, but the patient might still demonstrate the ability to invert the hindfoot. Alternatively, the patient may manage to raise the heel using the Achilles tendon without observing hindfoot inversion. However, the pivotal indicator for posterior tibial tendon dysfunction (PTTD) is the inability to invert the heel. It's important to differentiate patients with severe arthritis, talonavicular or subtalar fusion, or Achilles tendon rupture from those with flatfoot based on thorough assessment, including history, physical examination, and imaging studies. Furthermore, it's essential for the examiner to prevent the patient from using their hands to push up from a surface during the single-limb heel raise test. Allowing the patient to use their hands in this manner can potentially lead to a false-negative result, undermining the accuracy of the assessment[9].

Examiner should evaluate the flexibility of the foot deformity. This involves testing whether the flatfoot deformity can be corrected through inversion at the subtalar joint and adduction at the talonavicular joint. This assessment provides valuable information about the degree of flexibility and potential for correction of the deformity. Indeed, in cases where an equinus contracture is present, the flexibility assessment may need to be performed with the foot in plantarflexion. This adjustment ensures that the evaluation comprehensively addresses any limitations in dorsiflexion range of motion caused by the contracture, providing a more accurate assessment of the foot's flexibility and deformity[13].

Evaluating the flexibility of the foot deformity is crucial. The examiner should assess whether the flatfoot deformity can be corrected through inversion at the subtalar joint and adduction at the talonavicular joint. This assessment helps determine the extent to which the deformity can be corrected passively, providing valuable insights into treatment planning and prognosis. Indeed, in the presence of an equinus contracture, it may be necessary to perform the flexibility assessment with the foot in plantarflexion. This adjustment ensures that any limitations in dorsiflexion range of motion caused by the contracture are adequately addressed. By assessing flexibility in plantarflexion, the examiner can obtain a more accurate understanding of the foot deformity's responsiveness to correction and tailor treatment accordingly[13].

Radiographic

Weightbearing radiographs of the foot and ankle are essential for evaluating foot deformities before surgery and for planning the surgical procedure. Quantifying the degree of deformity, aiding in treatment planning, and guiding surgical intervention can be achieved by measuring Meary's angle on both anteroposterior and lateral radiographs[5]. Measuring Meary's angle during surgery is crucial for confirming the effectiveness of the repair made. In addition, there are several other radiographic parameters that can assist in assessing foot deformity. The mentioned parameters include the talonavicular coverage angle, calcaneal pitch, talocalcaneal angle, and the cyma line. The cyma line represents the contour of the Chopart joint, and any variation from this line may suggest the presence of pes planus or cavus deformity. These measurements offer significant guidance during surgical procedures and guarantee the most effective repair of the deformity[14].

When analyzing ankle X-rays, it is important to thoroughly assess for any signs of valgus tilt of the talus. This may indicate a weakened deltoid ligament and perhaps signify the development of a stage IV flatfoot deformity. The Saltzman view, among other specialized views, is highly valuable for evaluating the positioning of the calcaneus in relation to the tibia. This view offers further understanding

of the alignment and stability of the ankle joint. These evaluations are crucial for precise diagnosis and treatment planning in individuals with flatfoot deformity[15].

Advanced imaging techniques, such as computed tomography (CT) scans, are essential for assessing different elements of flatfoot deformity. CT scans are quite valuable for examining joint degeneration, diagnosing tarsal coalitions, and detecting the growth of osseous cysts. If a weightbearing CT scan is accessible, it can reveal crucial information about the three-dimensional misalignment of the hindfoot and midfoot, providing a thorough picture of the deformity[16].

However, the use of magnetic resonance imaging (MRI) in stiff flatfoot deformity is relatively restricted. MRI scans are typically used in select cases, such as when there is a suspicion of deltoid ligament insufficiency that is not readily visible during a physical examination, or when a more thorough assessment of tibialis posterior tendon disease is needed[16].

Medializing Calcaneal Osteotomy

The medializing calcaneal osteotomy (MCO) is commonly used to treat hindfoot valgus. This procedure entails performing a surgical incision and repositioning of the calcaneus using a lateral approach. The posterior portion is moved inward and then fixed in its new location. This modification decreases strain on the ligaments and arch located on the inner side of the foot, while simultaneously readjusting the axis of movement of the Achilles tendon. As a result, it corrects the misalignment of the hindfoot towards the outer side and improves the inward movement of the foot[17,18].

PTT Insufficiency

Although surgical surgery is not the primary therapeutic option for stage I posterior tibial tendon (PTT) disorders such as tenosynovitis or tendinosis, it may be required for individuals who do not react favorably to conservative therapy and persistently suffer from symptoms. Possible soft tissue operations encompass tenosynovectomy, repair of the posterior tibial tendon (PTT), and tendon transplant. Some surgeons contend that relying just on soft tissue treatments may not be sufficient and propose augmenting them with a medial calcaneal osteotomy. However, the efficacy of this method has not been fully investigated for cases without deformity[19].

Tendon Transfer

Tendon transfers are frequently employed in the treatment of flatfoot abnormalities, with the flexor digitorum longus (FDL), flexor hallucis longus (FHL), and occasionally the peroneus brevis being popular choices. The FDL is commonly favored because of its close proximity to the posterior tibial tendon (PTT), which facilitates a more straightforward surgical approach. Moreover, its anatomical position is readily recognizable, and its role is seen less crucial in comparison to that of the big toe. Biomechanically, investigations have shown that the FHL is stronger than the FDL. However, there is a dearth of clinical evidence demonstrating the superiority of FHL in real-world situations[20].

Double / Triple Arthrodesis

For individuals with inflexible abnormalities of the foot, arthrodesis is generally advised. A study conducted on patients with chronic Adult-Acquired Flatfoot Deformity (AAFD) and inflexible deformities discovered that triple arthrodesis, which involves the fusion of the talonavicular, subtalar, and calcaneocuboid joints, led to improvements in pain alleviation, functional capacity, and overall clinical outcome scores[5,8]. Prior to undergoing surgery for flatfoot deformity, it is necessary to determine whether the calcaneocuboid joint should be included in the arthrodesis treatment. The decision is usually made by evaluating physical examination findings, such as sensitivity in the joint, and radiographic evidence of degenerative changes or partial dislocation. Excluding the calcaneocuboid joint from the fusion procedure might lead to inadvertent arthrodiastasis, which is the unintended occurrence of joint separation, while addressing forefoot abduction. Nevertheless, those with more severe degeneration in

this joint typically have reduced benefits from arthrodiastasis. While this phenomena can be seen on X-rays, there is no data indicating that the distraction of the calcaneocuboid joint leads to better results. Furthermore, following the fusion of the talonavicular joint, there is limited movement at the calcaneocuboid joint. A recent study discovered that persons who underwent double arthrodesis for inflexible planovalgus deformity had a greater rate of nonunion and lower patient outcome scores compared to those who underwent triple arthrodesis. Nevertheless, the utilization of double arthrodesis does not appear to have a detrimental effect on the radiographic correction of deformity[5].

Flatfoot Reconstruction

The complex nature of flatfoot repair raises the probability of difficulties related to each specific surgery, which may ultimately result in the overall failure of the reconstruction. Although problems may be visible on radiographs, it is only important to address them if the patient exhibits symptoms. Under correction is a frequent problem that often arises during flatfoot repair. This can happen when the deformity is not accurately recognized or when key components are not completely rectified[20].

The midterm results of combining FDL transfer with medial displacement calcaneal osteotomy show a failure rate of up to 7%. Instances of premature failure have been ascribed to the dislodgement of tendons from the navicular bone. Guyton et colleagues reported instances in which the reattachment of two tendons after pullout led to inadequate functioning, requiring subtalar fusion as a salvage procedure in one patient. A delayed failure, resulting from the rupture of a tendon transfer three months after surgery, resulted in the gradual collapse of the arch and loss of function. Hence, it is crucial to ensure the secure attachment of the tendon transfer to prevent any risk of dislodgement. It is advisable to use several, interrupted sutures to firmly attach the tendon back onto itself for secure fixation. Moreover, inserting a suture into the bone at the opening of the bony tunnel offers extra reinforcement. Tendon withdrawal can result in poor outcomes and may necessitate subsequent treatments[21].

CONCLUSION

Insufficient function of the posterior tibial tendon is the main cause of adult-acquired flatfoot deformity. Although the precise causes of AAFD are not fully comprehended, some variables include underlying medical disorders, diminished blood circulation to the region, genetic predisposition, foot structure, or prior damage. The diagnosis usually depends on the identification of particular clinical and radiological markers. The treatment approaches differ depending on the severity of the condition, as indicated by the flatfoot staging system. Typically, the first procedures used are non-surgical, such as medication, immobilization, bracing, and physical therapy. These approaches are successful in relieving symptoms during the early stages. In cases of stage II abnormalities, which are identified by a progressive misalignment of the hindfoot and deviation of the forefoot, different surgical approaches such as osteotomy, tendon transfer, or lengthening treatments might be taken into account. Surgical operations are performed to rectify abnormalities, with various techniques targeting specific components of the problem. Stage III, which involves a permanent deformity, generally requires fusion treatments such as double or triple arthrodesis. During stage IV, when the ankle joint is prominently affected and there is a lateral tilt of the talus bone, more advanced surgical techniques such as ligament reconstruction or joint fusion may be required, along with remedial measures for the hindfoot.

One of the strengths of this case is the systematic evaluation and individualized treatment strategy employed. Radiographic analysis and clinical assessments guided the decision to proceed with triple arthrodesis, which successfully addressed the patient's symptoms and deformity. Nonetheless, limitations include the lack of preoperative advanced imaging, such as MRI, which could have provided additional insights into soft tissue integrity. Furthermore, long-term outcomes, including functional scores and recurrence of symptoms, remain to be determined

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