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Clinical and radiological outcomes of soft tissue surgery in stage III adult acquired flatfoot deformity: A prospective observational study

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Abstract

Background: Adult Acquired Flatfoot Deformity (AAFFD) is a progressive disorder primarily caused by posterior tibial tendon dysfunction, resulting in collapse of the medial longitudinal arch and hindfoot valgus, leading to impaired mobility and reduced quality of life. Surgical management varies by stage, especially for advanced deformities.

Objective: To evaluate the clinical and radiological outcomes of soft tissue surgical management without bony reconstruction in patients with stage III AAFFD.

Methods: This prospective observational study included 40 patients with stage III AAFFD treated by soft tissue procedures alone. Patients were assessed preoperatively and followed for 12 months postoperatively. Outcomes measured included the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score and radiographic parameters (Meary's angle, calcaneal pitch, talocalcaneal angle).

Results: The mean AOFAS score improved significantly from 52.4 ± 8.7 preoperatively to 85.7 ± 6.2 at 12 months ($p < 0.001$), indicating marked pain relief and functional improvement. Radiographic angles remained stable, demonstrating deformity arrest without significant correction. Complications were minimal, with two superficial infections managed successfully and no tendon transfer failures or neurovascular injuries.

Conclusion: Soft tissue surgical management without bony procedures provides effective pain relief and functional restoration while stabilizing deformity in stage III AAFFD patients, especially those unfit for or reluctant to undergo extensive surgery. This approach offers a safe, lower morbidity alternative with favorable short-term outcomes. Further studies are needed to determine long-term efficacy and compare with combined reconstructive techniques.

Keywords: Adult Acquired Flatfoot Deformity, Posterior Tibial Tendon Dysfunction, Soft Tissue Surgery, Flexor Digitorum Longus Transfer, AOFAS Score, Foot Deformity

Introduction

Adult Acquired Flat Foot Deformity (AAFFD) is a progressive condition marked by collapse of the medial longitudinal arch, hindfoot valgus, and forefoot abduction, resulting in impaired mobility and significant reduction of quality of life in affected adults. The primary etiology is dysfunction of the posterior tibial tendon (PTT), though contributions from attenuation of ligamentous structures, obesity, trauma, and systemic inflammatory diseases are increasingly recognized^[1].

Pathogenesis centers on progressive insufficiency of the PTT, leading to sequential structural alterations and joint malalignment. The most widely utilized classification is the Myerson modification of the Johnson and Strom system, which grades AAFFD into four stages based on the anatomical location and rigidity of the deformity: Stage I involves tenosynovitis of PTT without foot deformity; Stage II is characterized by flexible planovalgus deformity with PTT dysfunction; Stage III presents a rigid, uncorrectable flatfoot; and Stage IV includes ankle valgus due to deltoid ligament involvement. This staging system guides both prognosis and therapeutic planning^[2].

Management is stage-based, typically beginning with non-operative interventions such as orthotics, physiotherapy, activity modification, and weight loss, particularly in flexible and early-stage disease.

Advanced stages with rigid deformity or ankle involvement may require surgical procedures, ranging from tendon transfers and osteotomies to arthrodesis or ankle reconstruction depending on the degree of joint involvement and patient comorbidities. Optimal treatment involves tailoring the intervention to the specific stage, flexibility, and patient needs, aiming to restore alignment, function, and quality of life [3].

Surgical management of Adult Acquired Flat Foot Deformity is stage-specific and aligns with the Myerson modification of the Johnson and Strom classification. For Stage I, where pathology is limited to posterior tibial tendon tenosynovitis without fixed deformity, procedures involve tenosynovectomy, primary tendon repair, or tendon transfer, often combined with a medializing calcaneal osteotomy to support corrected alignment. In Stage II—characterized by flexible planovalgus deformity—soft tissue procedures such as flexor digitorum longus (FDL) tendon transfer to replace the dysfunctional posterior tibial tendon are frequently employed, along with bony reconstruction options including medial calcaneal osteotomy, lateral column lengthening, and spring ligament reconstruction to restore normal foot architecture and stabilize the medial column. For rigid deformity in Stage III, fusion procedures such as triple arthrodesis or isolated hindfoot (subtalar, talonavicular) fusions are preferred to achieve a stable, plantigrade foot, typically accompanied by gastrocnemius recession or Achilles tendon lengthening to address contractures. Stage IV disease, which demonstrates valgus tilting and involvement of the ankle joint, may necessitate more extensive intervention, including double or triple arthrodesis, ankle fusion or total ankle replacement, and deltoid ligament reconstruction; the choice is dictated by the rigidity and arthritic status of the ankle. Recovery and post-operative rehabilitation vary depending on procedure complexity but often require prolonged immobilization, gradual weight bearing, and extended physiotherapy [3, 4].

In certain patients with stage III and IV Adult Acquired Flat Foot Deformity, soft tissue procedures alone may be chosen when the rigid deformity is mild, the patient has significant medical comorbidities, or the risks of bony surgery are deemed excessive. These procedures may provide pain relief and functional improvement, but full anatomical correction is limited and malalignment may persist. Careful patient selection is essential, as long-term outcomes may include recurrence or progressive deformity [3].

The objective of this study is to assess the clinical outcomes of patients with stage III Adult Acquired Flat Foot Deformity who are managed without bony procedures, focusing on pain relief, functional improvement.

Materials and Methods

Study Design

This prospective observational study was conducted at a single tertiary care orthopedic hospital specializing in foot and ankle disorders. The study was conducted from March 2023 to September 2024, with each patient followed up for 12 months postoperatively.

Inclusion Criteria

- Age 18 years or older.
- Diagnosed with stage III Adult Acquired Flat Foot Deformity primarily due to posterior tibial tendon dysfunction.

- Presence of fixed or partially reducible deformity on clinical examination.
- Difficulty or inability to perform single-leg heel rise test.
- Radiographic confirmation of deformity via weight-bearing anteroposterior and lateral foot X-rays.
- Consent to undergo soft tissue surgical treatment without bony procedures.
- Willingness to comply with scheduled follow-ups and assessments.

Exclusion Criteria

- Flatfoot deformity secondary to systemic inflammatory arthropathies (e.g., rheumatoid arthritis).
- Neuropathic or neurologic foot conditions.
- Previous foot or ankle surgery.
- Acute traumatic flatfoot deformity.
- Significant medical comorbidities contraindicating surgery.
- Unwillingness or inability to adhere to follow-up protocol.

Clinical Evaluation

Preoperative and postoperative evaluations utilized the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score assessing pain (40 points), function (50 points), and alignment (10 points), with a maximum score of 100 indicating optimal clinical status.

The American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score is a combined clinician- and patient-reported outcome measure assessing pain (40 points), function (50 points), and alignment (10 points), with a total possible score of 100 points indicating optimal foot and ankle health. Pain is rated from none (40 points) to severe (0 points), function encompasses walking distance, gait abnormalities, range of motion, and stability, and alignment evaluates foot positioning. Scores above 90 are interpreted as excellent, 75-89 as good, 50-74 as fair, and below 50 as poor outcomes, providing a standardized framework to quantify clinical recovery after treatment [5].

Radiological Evaluation:⁴

Weight-bearing anteroposterior and lateral foot radiographs were obtained at baseline and follow-ups. Key parameters assessed included:

- **Talo-first metatarsal angle (Meary's angle):** Normal $\sim 0^\circ$; $>4^\circ$ indicates arch collapse.
- **Calcaneal pitch angle:** Normal 17° - 32° ; $<17^\circ$ indicates medial arch collapse.
- **Talocalcaneal angle (AP view):** Normal 25° - 40° ; increased values indicate hindfoot valgus.

Significant progression of deformity was defined as clinical deterioration with an AOFAS score drop >10 points and radiographic worsening evidenced by Meary's angle increase $>4^\circ$, calcaneal pitch decrease $<17^\circ$, talocalcaneal angle increase $>5^\circ$.

Surgical Technique

All surgeries were performed by experienced orthopaedic surgeons. Under spinal or epidural anesthesia with tourniquet, a medial or posteromedial incision exposed the posterior tibial tendon sheath. Teno-synovectomy removed inflamed synovium to restore tendon glide. The flexor

digitorum longus tendon was harvested via a separate incision, passed through a navicular bone tunnel, and secured with sutures or a tenodesis screw while the foot was held corrected to optimize tension. The incision was closed in layers.

Postoperative Protocol

- **Weeks 0-6:** Immobilization in below-knee plaster cast with foot in neutral position; non-weight-bearing.
- **Week 6:** Cast removal; clinical and radiological assessment; initiation of partial weight-bearing using a walking boot; ankle range-of-motion exercises started.
- **Weeks 6-12:** Gradual progression to full weight-bearing; physiotherapy emphasizing joint mobilization, muscle strengthening, and proprioceptive training using balance tools.
- **Months 3, 6, and 12:** Scheduled clinical and radiological assessments; AOFAS scoring; rehabilitation advanced with gait retraining and functional strengthening.

Outcomes Assessed and Complications

Outcomes included evaluation of pain, function, alignment (clinical and radiographic), and patient satisfaction measured by AOFAS score and radiological angles. Complications monitored were wound infection, delayed healing, tendon transfer failure, deformity progression, neurovascular injury, joint stiffness, and thromboembolic events.

Results

The study cohort consisted of 40 patients with Adult Acquired Flat Foot Deformity, with 28 (70%) cases being unilateral and 12 (30%) bilateral. The mean age was 54.3 years (range 38-68) with a female predominance of 65%. The average duration of symptoms before surgery was 18 months.

Intraoperative Parameters: The average surgical duration was 95 ± 15 minutes, and estimated blood loss averaged 85 ± 20 mL. No intraoperative complications such as nerve injury or tendon rupture were encountered, and all surgeries proceeded without conversion to bony procedures.

Table 1: Demography and intra op parameters

Parameter	Value
Number of patients	40
Unilateral involvement	28 (70%)
Bilateral involvement	12 (30%)
Mean age (years)	54.3 (range: 38-68)
Gender (female: male)	65%(26): 35%(14)
Average symptom duration	18 months
Mean surgical duration (min)	95 ± 15
Mean blood loss (mL)	85 ± 20

Clinical Outcomes: The mean American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score improved significantly from 52.4 ± 8.7 preoperatively to 85.7 ± 6.2 at 12 months postoperatively ($p < 0.001$).

Radiological Outcomes: Radiographic deformity angles including Meary's angle, calcaneal pitch, and talocalcaneal angle in weight-bearing radiographs remained largely unchanged at 12 months, indicating stable deformity without

significant correction. Specifically, Meary's angle was $17.2^\circ \pm 4.3^\circ$ preoperatively and $16.8^\circ \pm 3.9^\circ$ postoperatively; calcaneal pitch was $11.5^\circ \pm 3.2^\circ$ preoperatively and $12.1^\circ \pm 3.4^\circ$ postoperatively; talocalcaneal angle was $47.6^\circ \pm 5.1^\circ$ preoperatively and $46.8^\circ \pm 4.9^\circ$ postoperatively, demonstrating no significant radiographic improvement but stability of deformity. Only two patients exhibited progression of deformity on imaging at 12 months.

Complications: Two patients developed superficial wound infections managed successfully with antibiotics. No tendon transfer failures, neurovascular injuries, or revision surgeries occurred.

Table 2: Outcomes

Outcome	Preoperative Value	Postoperative Value (12 months)	Remarks
AOFAS Ankle-Hindfoot Score	52.4 ± 8.7	85.7 ± 6.2	Significant improvement ($p < 0.001$)
Meary's angle (degrees)	17.2 ± 4.3	16.8 ± 3.9	No significant change
Calcaneal pitch (degrees)	11.5 ± 3.2	12.1 ± 3.4	No significant change
Talocalcaneal angle (degrees)	47.6 ± 5.1	46.8 ± 4.9	No significant change
Deformity progression	N/A	2 patients (5%)	Radiographic progression
Complications	N/A	2 superficial infections	Resolved with antibiotics



Fig 1: Heel rise test





Fig 2: weight bearing Xrays



Fig 3: Intra op images- PTT tendon, FDL transfer



Fig 4: Post op image at 12 months

Discussion

This prospective observational study demonstrated that soft tissue surgical management alone in stage III Adult Acquired Flatfoot Deformity (AAFFD) patients leads to significant clinical improvement. The American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score increased significantly from a mean of 52.4 to 85.7 postoperatively, indicating substantial pain relief and functional restoration. Radiographic parameters such as Meary's angle, calcaneal pitch, and talocalcaneal angles remained stable, indicating deformity stabilization without structural correction within the 12-month follow-up period.

Comparison with Existing Literature

The clinical improvements align with literature supporting soft tissue procedures—such as flexor digitorum longus tendon transfer and tenosynovectomy as effective interventions to address posterior tibial tendon dysfunction in AAFFD [6]. While combined bony reconstructive surgeries offer greater anatomical correction, soft tissue surgery alone can provide functional gains and symptom relief, especially in patients with medical comorbidities or mild rigid deformities [7]. The limited radiographic improvement observed echoes previous findings indicating that functional outcomes are not always directly correlated with anatomical correction [8].

Clinical Implications of Soft Tissue Surgery Without Bony Procedures

Soft tissue surgery without osteotomies or fusions presents a valuable option for patients with contraindications to extensive surgery or where rigid deformity is mild. The functional success shown by heel rise test restoration demonstrates the importance of tendon function in symptom alleviation even when gross deformity persists. This supports a patient-centered, stage-based approach to AAFFD, emphasizing individualized treatment planning that balances risk, deformity severity, and functional goals [6].

Radiological Outcomes and Deformity Stability

The stable radiographic angles postoperatively highlight that soft tissue procedures contribute to halting deformity progression. Given progressive deformity adversely affects function and quality of life, stabilization alone is a clinically meaningful outcome in advanced AAFFD [9].

Complications and Safety Profile

The minimal complications observed—two superficial infections resolved with antibiotics and no tendon transfer failures or neurovascular injuries—highlight the relative safety of soft tissue surgery compared to more invasive bony reconstructions. This corroborates previous reports of lower morbidity for tendon transfer and tenosynovectomy procedures [9].

Limitations of the Study

The observational design, limited sample size, and short 12-month follow-up restrict the ability to generalize findings broadly or comment on long-term durability. The absence of a control group receiving combined bony and soft tissue procedures further limits direct comparative conclusions.

Directions for Future Research

Future randomized controlled trials with larger cohorts and extended follow-up are needed to clarify the long-term outcomes and indications for soft tissue versus combined surgical approaches. Research should also aim to refine patient selection criteria, optimize rehabilitation protocols, and explore the impact of deformity severity on treatment success.

Conclusion

Soft tissue surgical management without bony procedures offers a safe and effective treatment option for stage III Adult Acquired Flatfoot Deformity patients, particularly those unsuitable for or unwilling to undergo extensive reconstructive surgery. This approach provides significant pain relief, restores function, and stabilizes deformity radiographically over short-term follow-up. While it does not fully reverse anatomical deformities, the clinical improvements and low complication rates justify its consideration in carefully selected patients. Continued research will help refine treatment algorithms to optimize patient outcomes.

Ethical Standards

Institutional ethics committee approved the study. Informed consent was taken from all individual participants included in the study.

Conflict of Interest

The authors declare no potential conflict of interest in connection with the submitted article.

Each other certifies that he or she has no commercial associations that might pose a conflict of Interest in connection with the submitted article.

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