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Long-Term Podiatric Functional Outcomes After Evans-Mosca Correction in Adolescents With Idiopathic Flexible Flatfoot: A Case Series

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Abstract

Introduction. Severe symptomatic idiopathic flexible flatfoot in adolescence may require surgical correction when conservative treatment fails. The Evans-Mosca procedure has been reported to provide satisfactory clinical and radiographic correction, but podiatric functional findings after surgery are less frequently described.

Case Presentation. This case series reports long-term podiatric findings in 14 adolescents, corresponding to 26 surgically treated feet, who had previously undergone treatment for idiopathic flexible flatfoot. The same cohort was previously described from orthopedic, clinical, and radiographic perspective.

Intervention. All patients underwent lateral column calcaneal lengthening according to the Evans-Mosca technique, associated with medial soft-tissue correction and Achilles tendon lengthening where indicated.

Outcome. At a mean follow-up of 7 years and 7 months, podiatric assessment showed no lower-limb length discrepancy, preserved ankle dorsiflexion, satisfactory subtalar mobility, physiological first-ray motion, positive Jack's and tip-toe tests, and plantigrade support on podoscopic examination. Static baropodometry showed balanced load distribution between left and right feet and physiological

rearfoot-forefoot distribution. Dynamic baropodometry showed similar plantar contact surfaces between feet and generally physiological gait-line progression. One case of functional hallux limitus was detected.

Conclusion. Evans-Mosca correction achieved satisfactory long-term functional outcomes in this series of 26 feet. Beyond the clinical and radiographic improvements already reported for this cohort, podiatric evaluation revealed preserved joint mobility, plantigrade support, balanced weight distribution, and physiological gait patterns in most patients. One case of functional hallux limitus was identified during dynamic testing.

Keywords: Flexible Flatfoot, Adolescent, Evans-Mosca Procedure, Podiatric Assessment, Baropodometry, Gait Line

Introduction

Idiopathic flexible flatfoot is common during skeletal growth and is usually asymptomatic. Most pediatric flexible flatfeet are managed through observation, education, footwear advice, exercises, orthoses, or rehabilitation, especially when symptoms are absent or mild. Conservative management remains the first-line treatment for symptomatic pediatric flexible flatfoot. Exercises and orthoses can improve pain, function, and arch development (Molina-García et al., 2024). Surgery is typically reserved for cases with persistent symptoms despite adequate conservative care (Sha et al., 2026).

When adolescent flexible flatfoot becomes painful and functionally limiting, surgical treatment may be considered. Available surgical options include subtalar arthroereisis, calcaneal osteotomy, and combined procedures, with the choice depending on age, flexibility, severity, symptoms, surgeon expertise, and anatomical presentation. Recent comparative literature confirms that there is still no single universally accepted operative approach for pediatric flexible flatfoot, and that different procedures may provide comparable long-term correction while differing in invasiveness, operative time, and recovery profile (Hu et al., 2025).

Lateral column calcaneal lengthening, originally described by Evans and later modified by Mosca, remains one of the joint-preserving procedures used for severe symptomatic flexible flatfoot. The procedure aims to correct hindfoot valgus, forefoot abduction, and collapse of the medial longitudinal arch while preserving motion of the subtalar and midtarsal joints. Recent open-access evidence still reports significant clinical and radiographic improvement after Evans osteotomy in young patients with flexible flatfoot, including improvements in quality-of-life measures and radiographic parameters (Yasin et al., 2025).

The orthopedic outcomes of the cohort described in this manuscript were previously reported by De Luna et al. (2021). That study included 14 adolescent patients and 26 surgically treated feet, with a mean follow-up of 7 years and 7 months. It documented statistically significant clinical and radiographic improvement after Evans-Mosca correction, including improvement in AOFAS, FADI, Meary's angle, and Costa-Bertani's angle, without significant midtarsal osteoarthritic changes. Those findings are treated in the present manuscript as previously published orthopedic context, not as new results.

The present case series has a narrower aim: to describe long-term podiatric functional findings after surgical correction. This focus is clinically relevant because gait analysis studies continue to show that pediatric flexible flatfoot can be associated with measurable dynamic alterations, and that clinical/radiographic assessment alone may not fully describe functional behavior during walking (Böhm et al., 2024). The present manuscript therefore reports podiatric, podoscopic, static baropodometric, and dynamic baropodometric findings collected after Evans-Mosca correction in adolescents with severe symptomatic idiopathic flexible flatfoot.

Case Presentation

This case series included 14 adolescent patients affected by severe symptomatic idiopathic flexible flatfoot. Eight patients were male and six were female. Mean age at surgery was 12.8 years, with a range from 11 to 14.6 years. Twelve patients underwent bilateral surgery and two underwent unilateral surgery, for a total of 26 treated feet. In all patients, surgery had been indicated because of persistent symptoms despite conservative treatment. The same cohort had already been described in a long-term orthopedic follow-up study by De Luna et al. (2021). The previous article reported the surgical technique, clinical scores, radiographic measurements, complications, and statistical analysis of the orthopedic outcomes. In the present manuscript, those data are cited only as previously published contextual information. The original contribution of this case series is the podiatric functional follow-up. Mean follow-up was 7 years and 7 months. (Table 1)

Table 1. Cohort and Previously Published Orthopedic Context.

Variable	Finding
Study design	Case series based on a secondary podiatric functional follow-up of a previously published cohort
Patients	14 adolescents
Treated feet	26 feet
Sex	8 male, 6 female
Mean age at surgery	12.8 years, range 11–14.6 years
Condition	Severe symptomatic idiopathic flexible flatfoot unresponsive to conservative treatment
Surgery	Evans-Mosca lateral column calcaneal lengthening
Associated procedures	Medial soft-tissue correction; Achilles tendon lengthening when indicated
Mean follow-up	7 years and 7 months
Previously published orthopedic outcomes	AOFAS Ankle-Hindfoot Scale, FADI, Yoo criteria, Meary's angle, Costa-Bertani's angle, complications
Previously reported statistical results	Significant improvement in clinical and radiographic outcomes, with $p < .01$ for the reported preoperative-to-follow-up comparisons
Present manuscript contribution	Long-term podiatric functional assessment, including clinical podiatric testing, podoscopy, static baropodometry, dynamic baropodometry, plantar support, load distribution, gait-line progression, and hallux function

Intervention

All patients underwent lateral column calcaneal lengthening according to the Evans-Mosca technique. The procedure included calcaneal lengthening with insertion of a tricortical iliac crest graft and fixation with wires. A medial soft-tissue procedure involving the tibialis posterior tendon and talonavicular capsule was associated. Achilles tendon lengthening was performed when indicated. The previously published orthopedic analysis reported statistically significant improvement in clinical and radiographic outcomes. AOFAS Ankle-Hindfoot Scale improved from 60.03 to 95.26, FADI improved from 71.41 to 97.44, Meary's angle improved from 25° to 1.38°, and Costa-Bertani's angle improved from 154.2° to 130.9°, with $p < .01$ for the reported preoperative-to-follow-up comparisons (De Luna et al., 2021). These results are not treated as new findings in the present manuscript.

Podiatric Assessment

The podiatric evaluation included morphometric tests, clinical functional tests, podoscopic examination, and static and dynamic baropodometric assessment. Morphometric and clinical testing assessed lower-limb length discrepancy, hip screening through FABER and FADIR tests, passive ankle dorsiflexion through the Silfverskiöld test, subtalar joint mobility, first-ray flexion-extension, medial arch behavior, hindfoot correction, and signs of residual forefoot abduction. Under weight-bearing conditions, Jack's test was used to assess reinforcement of the medial longitudinal arch. The tip-toe test was used to evaluate medial arch activation and correction of hindfoot valgus. The too-many-toes

test was used as a clinical indicator of residual forefoot abduction. Podoscopic examination evaluated plantar footprint morphology and the quality of plantigrade support. Static baropodometry assessed load distribution between left and right feet and rearfoot-forefoot load distribution. Dynamic baropodometry assessed plantar contact surface, angle relative to the walking axis, mean gait line, maximum-pressure gait line, and symmetry across the main stance phases. Because podiatric data were collected as follow-up functional findings and were available mainly as aggregate values, the present case series reports descriptive statistics only. Continuous variables are expressed as means and ranges when available. Categorical findings are reported as frequencies (Table 2).

Table 2. Clinical and Morphometric Podiatric Findings at Follow-Up.

Domain	Test or Parameter	Finding
Limb alignment	Lower-limb length discrepancy	Not detected in any patient
Hip screening	FABER test	Negative for pain
Hip screening	FADIR test	Negative for pain
Ankle dorsiflexion	Silfverskiöld test	Passive ankle dorsiflexion of at least 10° with the knee both extended and flexed
Subtalar mobility	Range of motion	Preserved in all surgically treated feet; mean 26°, range 21°–32°
First ray function	Flexion-extension	Physiological in all patients
First metatarsal position	Clinical observation	First metatarsal head positioned more dorsally than the lesser metatarsal heads, consistent with physiological morphology
Medial longitudinal arch	Jack's test	Positive functional response, with reinforcement of the medial longitudinal arch
Hindfoot correction	Tip-toe test	Positive, with reinforcement of the medial longitudinal arch and correction of hindfoot valgus
Forefoot abduction	Too-many-toes test	Overall satisfactory; mild residual visibility of fourth and fifth toes in selected patients
Plantar footprint	Podoscopic examination	Plantigrade foot and correct plantar support in all patients
Isthmus of plantar footprint	Podoscopic examination	Approximately one third of the anterior heel width, consistent with correct plantar support

Outcome

Clinical podiatric findings were favorable. Ankle dorsiflexion exceeded 10° in all cases, regardless of knee position. Subtalar joint mobility was preserved in all surgically treated feet, with a mean range of motion of 26° and a range from 21° to 32°. First-ray flexion-extension was physiological in all patients. Weight-bearing tests were also satisfactory. Jack's test showed reinforcement of the medial longitudinal arch. The tip-toe test showed both increased medial arch formation and correction of hindfoot valgus. The too-many-toes test showed overall good findings, although some patients showed mild residual visibility of the fourth and fifth toes. Podoscopic examination showed a plantigrade foot and correct plantar support in all patients, with the central isthmus of the footprint approximately one third of the anterior heel width. Static baropodometric assessment showed physiological load distribution between feet. Mean total load was 52% on the left foot and 48% on the right foot. Mean rearfoot-forefoot distribution was 53.25% for the rearfoot and 46.75% for the forefoot. Two patients showed mild rearfoot-forefoot imbalance without clinical relevance. In one patient, the left foot showed increased forefoot loading, with 53% forefoot and 47% rearfoot. In another patient, the right foot showed mild rearfoot overload, with 42% forefoot and 58% rearfoot. Dynamic baropodometric assessment showed similar plantar contact surfaces between the left and right feet. Mean contact surface was 124.5 cm^2 among left feet, with a range from 115 to 134 cm^2. Mean contact surface was 123.5 cm^2 among right feet, with a range from 107 to 140 cm^2. The mean angle relative to the walking axis was similar between feet, with an average variation of approximately 2°. The mean gait line began from the latero-central portion of the heel, progressed laterally, and ended at the first toe. The maximum-pressure gait line in the left feet

generally began from the latero-central heel, progressed laterally toward the forefoot, and transferred to the first metatarsal and first toe. Functional hallux limitus was detected in 1/26 feet, corresponding to 3.8%, during dynamic assessment, with incomplete load transmission to the first toe. In the right feet, the maximum-pressure gait line generally began centrally at the heel, progressed through the forefoot, and ended at the first toe. In two cases, the maximum-pressure gait line changed direction toward the third and fourth metatarsals before ending at the first toe; however, first metatarsal loading was preserved, and load transfer to the first toe was considered adequate. During kinematic assessment of plantar support, patients generally showed symmetry between feet across the main stance phases. The most evident differences concerned mean speed during stance-phase progression. Mean speed values were 222 mm/s in left feet and 335 mm/s in right feet during initial contact, 219 mm/s and 132 mm/s during loading response, 507 mm/s and 413 mm/s during midstance, and 263.8 mm/s and 285.2 mm/s during final contact, respectively (Table 3).

Table 3. Static, Dynamic, and Kinematic Baropodometric Findings at Follow-Up.

Domain	Parameter	Finding
Static baropodometry	Left-right load distribution	52% left foot / 48% right foot
Static baropodometry	Rearfoot-forefoot distribution	53.25% rearfoot / 46.75% forefoot
Static baropodometry	Mild imbalance cases	2 patients, without clinical relevance
Static baropodometry	Left forefoot overload example	53% forefoot / 47% rearfoot
Static baropodometry	Right rearfoot overload example	42% forefoot / 58% rearfoot
Dynamic baropodometry	Left plantar contact surface	Mean 124.5 cm^2, range 115–134 cm^2
Dynamic baropodometry	Right plantar contact surface	Mean 123.5 cm^2, range 107–140 cm^2
Dynamic baropodometry	Walking-axis angle	Similar between feet, with average variation of approximately 2°
Gait-line assessment	Mean gait line	Latero-central heel to first toe
Gait-line assessment	Maximum-pressure gait line	Generally transferred toward first metatarsal and first toe
Gait-line assessment	Functional hallux limitus	1 patient
Gait-line assessment	Directional changes in maximum-pressure gait line	2 cases, with preserved first metatarsal loading
Kinematic assessment	Initial contact mean speed	222 mm/s left feet / 335 mm/s right feet
Kinematic assessment	Loading response mean speed	219 mm/s left feet / 132 mm/s right feet
Kinematic assessment	Midstance mean speed	507 mm/s left feet / 413 mm/s right feet
Kinematic assessment	Final contact mean speed	263.8 mm/s left feet / 285.2 mm/s right feet
Overall interpretation	Static and dynamic plantar function	Generally physiological, with isolated functional alterations

Discussion

Functional outcomes were reassuring in this series. Joint mobility remained preserved, weight distribution was balanced, and most patients showed physiological gait patterns. These findings suggest that Evans-Mosca correction can maintain adequate foot function over time. To date, few studies have reported detailed podiatric functional data after Evans-Mosca correction. The previous orthopedic publication documented clinical and radiographic improvement in the same cohort. The present manuscript adds postoperative podiatric information on how the corrected foot behaved under static and dynamic loading. This distinction is clinically relevant, as pediatric flexible flatfoot is increasingly discussed as a functional condition, not only as a static morphological deformity. Recent gait-analysis literature highlights that dynamic assessment can provide clinically relevant information on walking mechanics, intervention planning, and follow-up in pediatric flatfoot (Böhm et al., 2024). Static baropodometry was reassuring in this series. Mean left-right load distribution remained close to physiological distribution, and mean rearfoot-forefoot distribution did not show a clinically relevant overload pattern. The two mild imbalances observed were minor and were not considered clinically significant. Dynamic findings were also favorable. Plantar contact surfaces were similar between left and

right feet, and the mean gait line progressed from the heel toward the first toe. The isolated case of functional hallux limitus remains clinically relevant. It shows that podiatric follow-up can identify specific dynamic dysfunctions that may remain hidden behind satisfactory clinical scores or radiographic correction. The two cases with directional changes of the maximum-pressure gait line also suggest that subtle compensatory strategies may persist after correction. These findings may inform podiatric surveillance, footwear advice, orthotic decision-making, rehabilitation, and sport-specific monitoring. The present findings fit within recent surgical literature showing that operative treatment can improve clinical and radiographic parameters in selected symptomatic pediatric or adolescent patients. A recent retrospective study on Evans osteotomy in young patients reported postoperative improvement in foot health and radiographic alignment, supporting the role of calcaneal lengthening when surgery is clinically indicated (Yasin et al., 2025). A recent comparative cohort study also confirmed that different surgical approaches for pediatric flexible flatfoot can provide meaningful correction, while treatment selection remains complex and procedure-dependent (Hu et al., 2025). This case series has limitations. The sample is small, with 14 patients and 26 treated feet. The same cohort had already been published from an orthopedic perspective; therefore, the present manuscript should be interpreted as a secondary podiatric functional follow-up, not as an independent surgical outcome study. The podiatric analysis is mainly descriptive because complete patient-level baropodometric data were not available for inferential statistical testing. There was no untreated control group and no comparison with alternative surgical procedures. Preoperative podiatric data were limited, so the present report mainly describes long-term follow-up status rather than quantified preoperative-to-postoperative podiatric change. Despite these limitations, the findings support the inclusion of podiatric functional assessment in long-term follow-up after adolescent flatfoot correction. Future prospective studies should collect standardized preoperative and postoperative podiatric variables, including plantar pressure parameters, center-of-pressure progression, first-ray function, hallux function, propulsion indices, sport participation, and patient-reported activity outcomes.

Conclusion

Evans-Mosca correction was associated with satisfactory podiatric functional outcomes at a mean follow-up of 7 years and 7 months in this adolescent case series. In addition to the previously reported clinical and radiographic improvements, podiatric evaluation showed preserved mobility, plantigrade support, balanced load distribution, and generally physiological gait-line progression. These findings support the functional validity of the procedure over time, while larger prospective studies with preoperative podiatric data are needed to confirm these results.

Patient Consent

No identifiable patient information, clinical photographs, radiographs, podoscopic images, or individual baropodometric images are included in this manuscript. The case series reports only anonymized and aggregated follow-up data. The availability and applicability of written informed consent for publication are being verified with the corresponding author of the previously published cohort before submission.

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References

- Böhm, H., Stebbins, J., Kothari, A., & Dussa, C. U. (2024). Dynamic gait analysis in paediatric flatfeet: Unveiling biomechanical insights for diagnosis and treatment. *Children*, 11(5), Article 604. https://doi.org/10.3390/children11050604
- De Luna, V., De Maio, F., Caterini, A., Marsiolo, M., Petrungaro, L., Ippolito, E., & Farsetti, P. (2021). Surgical treatment of severe idiopathic flexible flatfoot by Evans-Mosca technique in adolescent patients: A long-term follow-up study. *Advances in Orthopedics*, 2021, Article 8843091. https://doi.org/10.1155/2021/8843091
- Evans, D. (1975). Calcaneo-valgus deformity. The Journal of Bone and Joint Surgery. British Volume, 57-B(3), 270–278.
- Hu, X., Zhu, G., Liu, K., Mei, H., & Tan, Q. (2025). A retrospective cohort study comparing the therapeutic efficacy of three surgical interventions for pediatric flexible flatfoot. *Translational Pediatrics*, 14(3), 422–431. https://doi.org/10.21037/tp-23-610
- Molina-García, C., Banwell, G., Álvarez-Salvago, F., Reinoso-Cobo, A., Pujol-Fuentes, C., Medina-Luque, J., & Ramos-Petersen, L. (2024). Efficacy of functional re-education as a treatment for infantile flexible flatfoot: Systematic review. *Children*, 12(1), Article 8. https://doi.org/10.3390/children12010008
- Mosca, V. S. (1995). Calcaneal lengthening for valgus deformity of the hindfoot: Results in children who had severe, symptomatic flatfoot and skewfoot. *The Journal of Bone and Joint Surgery*, 77(4), 500–512.
- Mosca, V. S. (2010). Flexible flatfoot in children and adolescents. *Journal of Children's Orthopaedics*, 4(2), 107–121. https://doi.org/10.1007/s11832-010-0239-9
- Sha, R., Li, Z., Li, J., Zhang, J., Zhang, Y., Wang, Y., Li, Y., & CPAM-LRC Guideline Development Group. (2026). Treatment of pediatric flatfoot: A systematic review-based consensus and guidelines by CPAM-LRC. *Frontiers in Pediatrics.* https://doi.org/10.3389/fped.2026.1825355
- Yasin, M. S., Rayyan, H. A., Eid, M. K., Awamleh, N. A., Rahhal, S. O., Rawashdeh, R., Toubasi, A. A., Alqawasmi, M. S., Samarah, O. Q., Haddad, B. I., & Khanfar, A. (2025). Clinical and radiological outcomes of Evan's osteotomy in young patients with flexible flatfoot deformity: A retrospective investigation. *BMC Musculoskeletal Disorders*, 26, Article 755. https://doi.org/10.1186/s12891-025-08978-1