

Preliminary Outcomes of Calcaneal Lengthening in Adolescent Flatfoot in Müller-Weiss Disease

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Abstract

Background: Müller-Weiss disease (MWD) remains a controversial painful foot condition without consensus on its pathogenesis or a gold standard treatment modality. The aim of the study was to evaluate the outcomes of calcaneal lengthening in adolescent patients with symptomatic MWD with flatfoot.

Methods: The study included 13 feet of 7 patients including 5 females and 2 males who were treated from March 2012 until June 2015 by calcaneal lengthening. The mean age was 15.6 years. The mean duration of symptoms was 13.5 months. The body mass index (BMI) averaged 28.9 kg/m² at presentation. The patients were followed up for a mean of 37.8 months.

Results: The osteotomy healed in all cases after a mean of 7.2 weeks. The second foot was operated on after an average of 11.5 months. The mean talometatarsal-I angle improved from 39.8 degrees preoperatively to 5.9 degrees. The mean preoperative calcaneal pitch angle of 7.5 degrees increased to an average of 17.8 degrees postoperatively. The mean American Orthopaedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot Score was improved from 61.9 preoperatively to 94.2 postoperatively. Four patients had occasional exertional pain. Four feet had mild residual forefoot abduction. Arthrodesis was not needed in any case by the last follow-up.

Conclusion: Early diagnosis of MWD with flatfoot was important and allowed for nonfusion treatment options. Calcaneal lengthening osteotomy in selected MWD cases achieved satisfactory outcomes with pain control, deformity correction, and improvement of the functional results.

Level of Evidence: Level IV, retrospective case series.

Keywords: Müller-Weiss disease, calcaneal lengthening, calcaneus osteotomy, flatfoot, foot deformities, planovalgus foot; tarsal navicular

Introduction

Müller-Weiss disease (MWD) is a rare, idiopathic, progressively deforming foot condition characterized by a comma-shaped tarsal navicular bone with compression and fragmentation of its lateral part presenting as mid- and hind-foot pain and may lead to flatfoot.^{10,16} The comma-shaped navicular bone is the hallmark radiographic sign of MWD.² Other reported associated findings in MWD include hind-foot varus, paradoxical pes planovarus, relative hypertrophy of the second metatarsal, and an index minus metatarsal formula.¹⁴ MWD is more frequently bilateral and demonstrates a female predominance.²³ A large multicenter study reported a mean age at diagnosis of 47.6 (range, 13-91) years.¹⁴ Despite early description of MWD, there is no consensus on its natural history, risk factors, pathophysiology, and treatment. Consequently, it is frequently underrecognized, misdiagnosed, and/or subject to mismanagement.^{2,4,9}

The goal of treatment is having a plantigrade, well-aligned foot with restoration of the medial column height and pain control. Despite appearing straightforward, achieving these goals in cases of MWD is often a difficult, complex, and risky endeavor.^{15,22} Because of the rarity of MWD, there is no available standard operative modality that is effective and safe for treating this disorder. Despite the reported variable operative modalities, none have reported the use of calcaneal lengthening to correct the associated flatfoot in adolescents.

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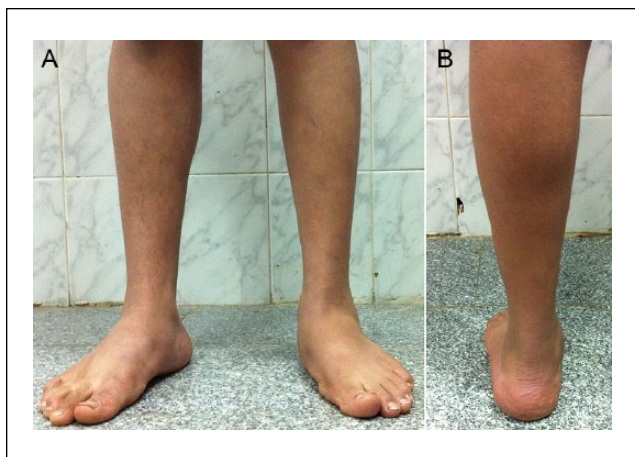


Figure 1. Clinical photos of patient with bilateral Müller-Weiss disease. (A) The left side shows flatfoot while the arch of the right side is still preserved. (B) The left heel is paradoxically neutral.

The purpose of this study was to evaluate the radiological and clinical results of calcaneal lengthening in adolescents with symptomatic MWD with flatfoot.

Methods

This prospective study was conducted following the approval of the Institutional Ethics Committee of the university. Inclusion criteria included adolescent patients having MWD with painful flatfoot with evidence of flexibility and failed conservative measures (insoles and physiotherapy) for at least 3 months. The exclusion criteria were MWD cases without flatfoot deformity, cases with arthritic changes, painful flatfoot for reasons other than MWD, and patients who were lost to follow-up for at least 2 years. The study included 13 feet of 7 patients who were treated by lateral calcaneal lengthening from March 2012 until June 2015. All cases were bilateral. However, 1 patient had a painless right side without flatfoot that was excluded from the study (Figure 1). The mean age at presentation was 15.6 (range, 14-17; SD, 0.98) years. Five patients were females and 2 were males. Duration of symptoms ranged from 7 to 24 (mean, 13.5; SD, 3.9) months. None had undergone surgery for correction of the deformity. The body mass index (BMI) averaged 28.9 (range, 26.2-34.4; SD, 2.89) kg/m² at presentation. The mean follow-up period was 37.8 (range, 24-64; SD, 11.83) months. The second foot was operated on after an average of 11.5 (range, 10-14; SD, 1.52) months.

Assessment of patients was done by local and systemic clinical evaluation, by weightbearing radiographs, and by CT scans. The patients had dorsomedial midfoot aching pain that was exacerbated by exertion. On examination, the patients showed collapse of the medial longitudinal arch and forefoot abduction with medial prominence of the

navicular and dorsomedial midfoot tenderness. The hindfoot was neutral in 7 feet and mild valgus in 6 feet. Flexibility was confirmed upon examination. However, the subtalar motion was painful with some restriction in all patients. The neurovascular assessment and the past history of the patients were unremarkable. Preoperative functional assessment was done using the American Orthopaedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot Scale.¹¹

On radiographic evaluation, all cases had the comma-shaped navicular with compression of its lateral part and relative hypertrophy of the second metatarsal with an index minus metatarsal formula. Anteroposterior radiographs were checked for talometatarsal-1 angle dorsoplantar (TMT1dp) (angle between axis of the talus and axis of the first metatarsal) and talocalcaneal angle dorsoplantar (TCA dp) (angle between axis of the talus and line tangent to the lateral edge of the calcaneus).¹ Lateral radiographs were assessed by calcaneal pitch angle (angle between horizontal axis and calcaneal inclination axis), the Meary-Tomeno (M-T) angle (angle between longitudinal axes of the talus and of the first metatarsal), and talocalcaneal angle lateral (TCA lat) (angle between longitudinal axis of the talus and calcaneal inclination axis).¹ Based on the staging of Maceira and Rochera,¹⁴ all cases were stage 4. None had tarsal coalition or osteoarthritis.

Preoperatively, the procedure details were explained to the patients and their families, including the possibility of arthrodesis if needed in the future. Informed consent was obtained from the parents or guardians of all patients included in the study.

Operative Technique

The operative technique was done for each foot using the calcaneal lengthening technique described by Mosca.¹⁷ Through a modified Ollier incision and after Z lengthening of the peroneus brevis tendon, the calcaneal osteotomy was performed between the anterior and middle facets and a trapezoid-shaped bicortical autogenous iliac crest graft was inserted. Percutaneous lengthening of an associated tight Achilles tendon was done in 9 cases. Before osteotomy distraction, Kirschner wires (K-wires) were used to stabilize the calcaneocuboid and the talonavicular joints to avoid possible subluxation with lengthening. The extent of correction was assessed both clinically and under fluoroscopy.

Postoperative Care

Patients were nonweightbearing in serial casts until radiographic union for at least 6 to 8 weeks (Figure 2). The K-wires were removed at 6 weeks. Then gradual weightbearing was allowed with a medial arch support for about 4 months, after which they could stop using it. Thereafter, follow-up was

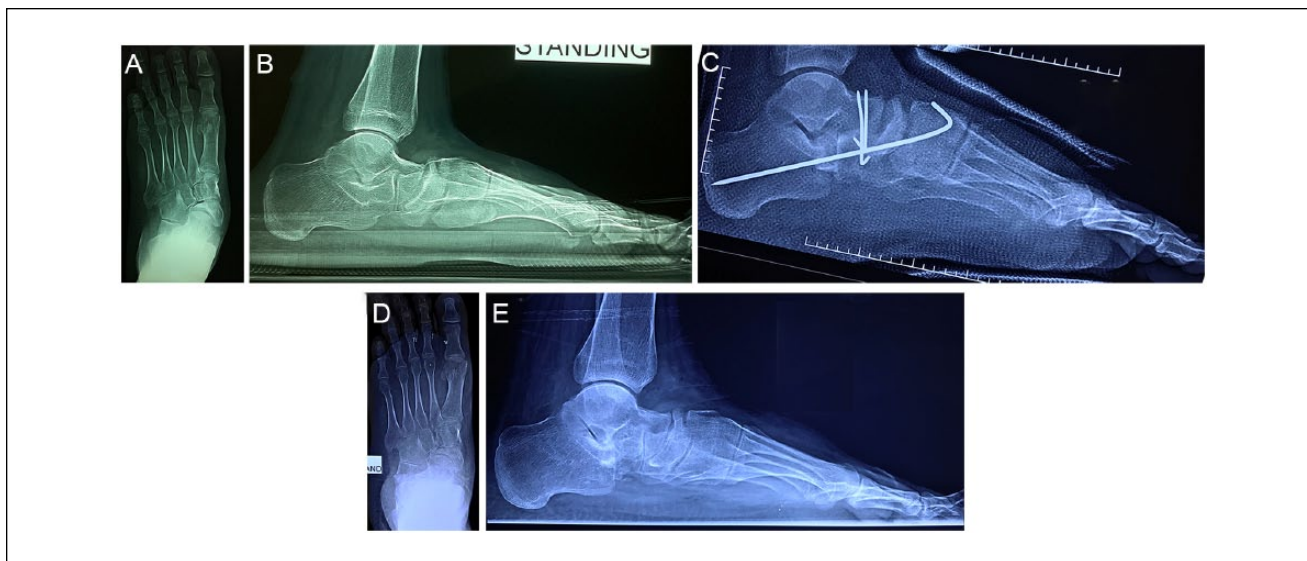


Figure 2. A case of Müller-Weiss disease. (A and B) Preoperative radiographs showing the comma-shaped navicular with abducted forefoot and foot arch collapse. (C) Postoperative lateral radiograph showing restoration of the arch and temporary fixation by K-wires. (D and E) Radiographs after 2 years showing persistence of deformity correction.

done every 6 months for 1 year, then annually with evaluation of the outcome both radiographically and clinically with the AOFAS Ankle-Hindfoot Scale.

Statistical Analysis

Statistical analysis was carried out using IBM SPSS Statistics for Windows version 22.0 (IBM Corp., Armonk, NY). Comparison of the mean preoperative and postoperative functional scores and radiographic parameters was executed by Wilcoxon signed rank test. The level of significance was set at $P < .05$.

Results

Osseous union occurred in all cases after a mean of 7.2 (range, 6-8; SD, 0.73) weeks. The TMT1dp angle improved from the preoperative mean of 39.8 (range, 35-46; SD, 3.94) degrees to a mean of 5.9 (range, 4-9; SD, 1.68) degrees. The mean preoperative calcaneal pitch angle was 7.5 (range, 5-11; SD, 1.98) degrees and increased to an average of 17.8 (range, 14-21; SD, 2.01) degrees postoperatively. The TCAdp angle changed from an average preoperative measure of 34 (range, 29-38; SD, 2.92) degrees to a postoperative average of 23.9 (range, 21-27; SD, 2.02) degrees. The mean preoperative versus postoperative TCAlat angles were 44.8 (range, 38-53; SD, 5.05) degrees and 29.5 (range, 23-39; SD, 5.64) degrees, respectively. The M-T angle improved from a plantar intersection with a range of 13 to 21 (mean, 17; SD, 2.52) degrees preoperatively to a postoperative range of 0 to 3 (mean, 0.85; SD, 0.99) degrees. These

postoperative radiographic values were significantly changed from the preoperative values ($P = .001$). The AOFAS Ankle-Hindfoot Score was significantly improved ($P = .001$) from the preoperative mean of 61.9 (range, 55-72; SD, 5.91) to a postoperative mean of 94.2 (range, 82-100; SD, 6.21). All patients were satisfied with their outcomes and asked for correction of the contralateral side (Figure 3). Four patients had occasional pain on exertion. Four feet had mild residual forefoot abduction with the TMT1dp angle ranging from 7 to 9 degrees. Delayed wound healing occurred in 3 cases without signs of infection and was managed by dressing changes. There was no reported deep infection, nonunion, joint subluxation, wire-related problem, or graft donor site complication. Arthrodesis was not needed in any case by the last follow-up.

Discussion

MWD remains a controversial painful foot condition.¹⁵ Several studies reported the occurrence of MWD in a middle-aged population.^{8,15,22} However, the largest series of MWD, by Maceira and Rochera,¹⁴ presented cases as early as 13 years old. The current study included a series of adolescents with a mean age of 15.6 years. The lack of another series of adolescent patients could be attributed to under-recognition or a low index of suspicion. Similarly, whereas pes planus deformity is considered a hallmark of MWD in its advanced stages or long-standing cases,^{8,12} the present study showed its presence in adolescents.

In the current study, despite the presence of flatfoot, paradoxically there was no excessive hindfoot valgus in



Figure 3. (A) Preoperative clinical photos of a bilateral case showing bilateral flatfoot without excessive rearfoot valgus. (B) Last follow-up photos after about 5 years showing correction of both feet. (C) She is fully active without any pain.

contrast to flexible flatfoot (FFF). The heel was neutral in 7 feet and mild valgus in 6 feet. Maceira and Rochera¹⁴ found that fixed rearfoot varus is a constant finding in MWD, and the cases that show flatfoot will have the paradoxical pes planus varus. The paradoxical heel varus deformity with the flatfoot deformity is considered a hallmark of MWD.^{4,21} However, different studies have reported variable hindfoot positions including slight heel varus,¹² without hindfoot varus,²³ neutral hindfoot,²⁰ and valgus hindfoot.⁷ In the present series, the medial foot prominence was formed by the navicular tuberosity, not by the talar head as in FFF.

The rationale of management in the current study was deformity correction to alleviate pain while preserving the joint motion. Correction of the flatfoot deformity improves the abnormal pressure distribution that was considered to be responsible for the patients' complaints.⁸ Moreover, calcaneal lengthening will theoretically result in distraction that may relieve pressure on the lateral part of the navicular. Lastly, if osteoarthritis developed and future arthrodesis is required, the current approach will not be an obstacle for that. Indeed, it will be easier to perform fusion for aligned joints than for deformed joints. The reason for using Mosca's technique with a trapezoid bone graft was

based on the observation that the center of rotation for the correction is near the center of the talar head (ie, closer to the talonavicular joint) and not simply in the medial cortex of the calcaneus. Thus, the osteotomy is actually a distraction wedge, not a simple opening wedge or plain distraction. The posterior calcaneus displacement osteotomy does not correct the malalignment but merely creates a compensating deformity.¹⁸ A large variety of operative methods have been presented in a limited number of published studies of small case series including triple arthrodesis (open²³ and arthroscopic¹³), talo-naviculo-cuneiform arthrodesis,^{5,22} talonavicular arthrodesis,⁶ and valgus wedge with a lateral displacement calcaneal osteotomy.¹² Because of these limited reports, and the considerably variable anatomy and characteristics of MWD, there is no consensus on the best treatment.^{15,16,19}

The outcome of the present study was satisfactory with a mean AOFAS Ankle-Hindfoot Score of 94.2. The postoperative AOFAS score reported by other studies with different treatment modalities varied from 79 to 90.9.^{3,6,12,13,22,23} However, comparing the results of the current study with those of other studies is difficult as the presented series included patients with a different age and

without osteoarthritis. This could partially explain the better results of this series in addition to using a joint-sparing treatment approach without any retained implants. Whereas none of the patients required arthrodesis by the last follow-up, this should be interpreted with caution because of the small series, young adolescents, and relatively short follow-up.

The strength of the study is its presentation of a homogeneous group of adolescents having MWD with flatfoot treated by a new treatment option that achieved satisfactory outcomes. On the other hand, it has several limitations, including a small number of cases, lack of a control group, and lack of long-term results. The known rarity of MWD could explain these weaknesses. Future multicenter larger studies with long-term follow-up are needed for better evaluation of different treatment methods.

Conclusion

In the current case series, the preliminary results of calcaneal lengthening osteotomy for adolescent flatfoot in MWD resulted in alleviated pain, deformity correction, and improvement of the function of patients.


Declaration of Conflicting Interests

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