

Radiographic Analysis and Clinical Efficacy of Hindfoot Arthrodesis With versus Without Cotton Osteotomy in Stage III Adult Acquired Flatfoot Deformity

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Purpose

The purpose of this study was to evaluate the radiographic outcomes in patients who have undergone hindfoot arthrodesis for stage III adult acquired flatfoot deformity (AAFD) with and without a cotton osteotomy.

Literature Review

Forefoot varus develops as a result of longstanding adult acquired flatfoot deformity. This occurs with varying degrees of deformity and flexibility. Residual forefoot varus following hindfoot realignment in AAFD can lead to lateral column loading and a persistent pronatory moment in efforts to reestablish contact between the forefoot and the ground. This structural collapse is particularly concerning following hindfoot arthrodesis, where increased forces throughout the adjacent joints increases the risk for development of osteoarthritis, failure of the hindfoot fusion, and ultimately the possibility of further midfoot collapse or ankle valgus. (1)

Restoration of the “triangle of support” was first described by Cotton through the use of an opening wedge plantarflexory medial cuneiform osteotomy to provide stability to hindfoot arthrodesis. (2) This has been supported by multiple studies which have shown the osteotomy to restore medial arch height and improve forefoot loading. (6,7,8) The Cotton osteotomy may serve as a reasonable adjunct procedure to help avoid complications and poor outcomes associated with residual forefoot varus in patients undergoing hindfoot arthrodesis for stage III AAFD.

Forefoot varus is typically addressed intra-operatively by plantar rotation of the medial column relative to the talus. However, this maneuver alone is sometimes insufficient to address the full extent of forefoot varus and residual deformity persists. We are recommending hindfoot arthrodesis with medial cuneiform opening wedge osteotomy to address residual forefoot varus. Our hypothesis is that residual forefoot varus and the potential for further midfoot and ankle degeneration can be specifically addressed through the joint-sparing Cotton osteotomy, allowing the patient to maintain a flexible, accommodating, plantigrade foot. The aim of this study was to compare the radiographic outcomes in patients undergoing isolated hindfoot arthrodesis to patients undergoing hindfoot arthrodesis with adjunctive cotton osteotomy.

Methodology

Between 2015 and 2019 a consecutive series of 9 feet in 8 patients with stage III AAFD were included in the analysis. All patients in this study underwent hindfoot arthrodesis augmented with bone marrow aspirate, gastrocnemius recession, and a Cotton osteotomy. A second consecutive series between 2015 and 2018 consisting of 9 feet in 9 patients with stage III AAFD were included in the analysis. All patients in this group underwent hindfoot arthrodesis augmented with bone marrow aspirate and a gastrocnemius recession. A retrospective radiographic review was performed and the following measures were evaluated on standard weight-bearing radiographs including anterior-posterior and lateral views preoperatively, post-operatively at the initiation of full weightbearing and at 1 year post-operatively: Cuneiform Articulation Angle (CAA), Medial Arch Sag Angle (MASA), Meary’s angle, the AP talus-first metatarsal angle, the talocalcaneal angle, the calcaneal inclination, talar declination, MPE. Statistical analysis utilizing paired t-test to calculate p values where <0.05 was statistically significant.

Additionally radiographs were reviewed for evidence of union, hardware failure, and residual deformity. Chart review was performed in order to quantify rates of post-operative infection, return to activity, and use of assistive devices.

Results

At final follow-up the cotton osteotomy group showed statistically significant differences in the cuneiform articular angle (CAA) and talar tilt angle.

There were no complications identified in the Cotton osteotomy group. Six complications were noted in the control group without cotton osteotomy consisting of 4 patients that developed tibiotalar valgus, 1 patient with asymptomatic hardware failure, and 1 patient with posterior heel wound development.

Return to activity (RTA) for the cotton group was an average of 82.5 days (69-90 days) or 11.8 weeks which showed a reduction when compared to the control group at an average of 103.3 days (64 - 257 days) or 14.71 weeks. This finding was statistically significant.

All patients with cotton osteotomies returned to normal shoegear without bracing while 2 patients in the control group required bracing at final follow-up to address their underlying tibiotalar valgus.

Stable union was achieved at all arthrodesis and osteotomy sites for both cohorts.

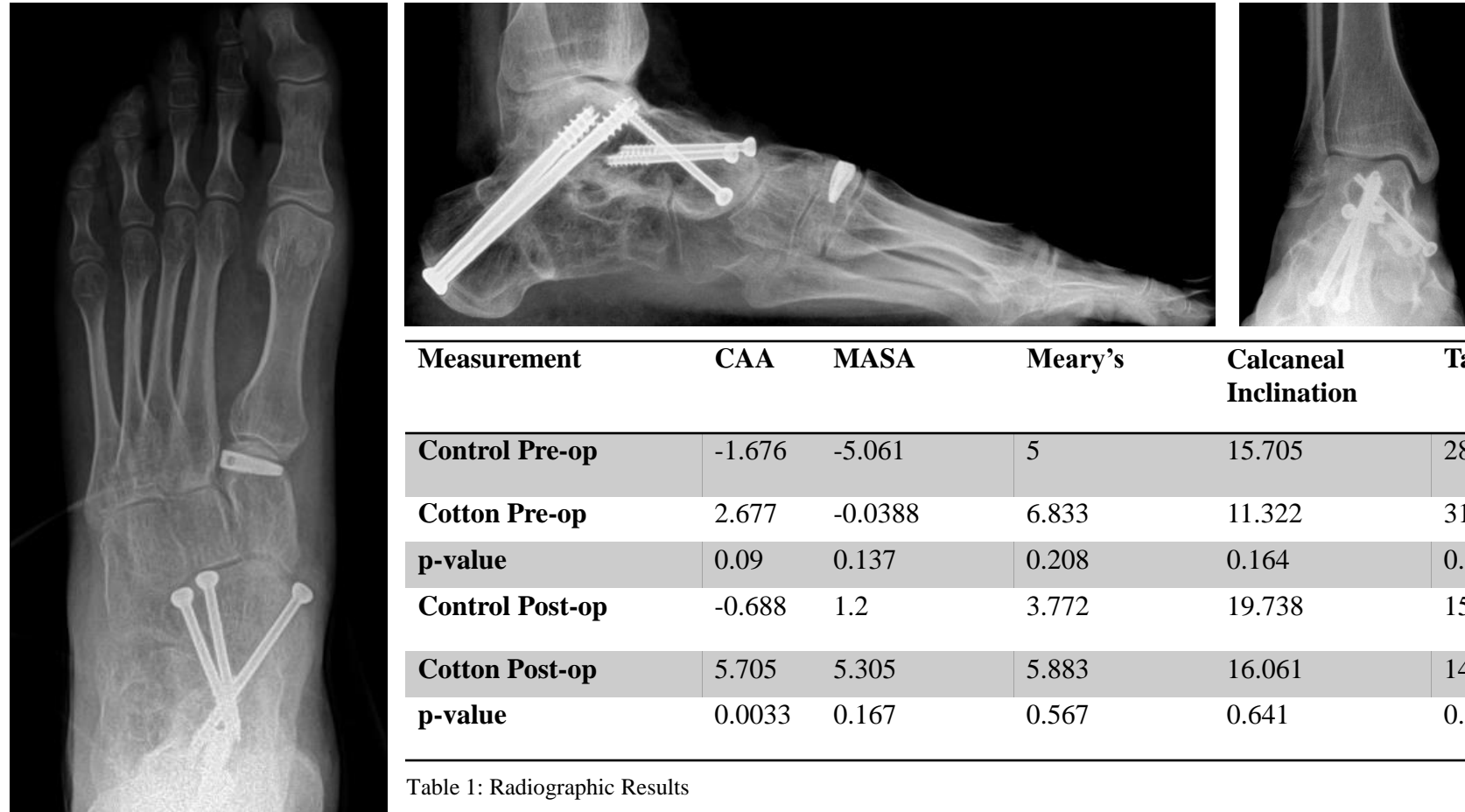
Figure 1 A-C: Pre-operative radiographs AP, Lateral, and Ankle Mortise



Figure 2 A-C: Intra-operative Radiographs AP, Lateral, Axial Calcaneal.



Figure 3 A-C: Post-operative radiographs AP, Lateral, Ankle Mortise



Measurement	CAA	MASA	Meary’s	Calcaneal Inclination	Talar Declination	Talar Tilt
Control Pre-op	-1.676	-5.061	5	15.705	28.344	3.07
Cotton Pre-op	2.677	-0.0388	6.833	11.322	31.4	0.903
p-value	0.09	0.137	0.208	0.164	0.625	0.254
Control Post-op	-0.688	1.2	3.772	19.738	15.566	5.988
Cotton Post-op	5.705	5.305	5.883	16.061	14.122	0.766
p-value	0.0033	0.167	0.567	0.641	0.653	0.008

Table 1: Radiographic Results

Analysis & Discussion

At final follow up, statistically significant differences were noted in the cuneiform articular angle (CAA) and talar tilt angle. The cotton osteotomy group showed a quicker return to pre-surgical activity level and a decreased incident of tibiotalar valgus. Rates of infection, nonunion, and the need for bracing was not significant between the two groups. Our study suggests that the Cotton osteotomy can address residual forefoot varus and potentially prevent further progression of ankle valgus in AAFD when used in combination with hindfoot arthrodesis.

Previously, literature regarding the use of the Cotton osteotomy in the correction of forefoot varus has been directed primarily towards the development and understanding of the correction achieved through varying osteotomy graft sizes. In a cadaveric study of 20 feet, Scott et al established a 1.9 degree increase in plantarflexion for each millimeter of bone graft used for displacement of the cotton osteotomy. Later, a retrospective cases series by Kunas et al established a decrease of 2.1 degrees in the cuneiform articulation angle (CAA) for every millimeter of bone graft used for the cotton osteotomy. Miniaci-Coxhead et al established that an increased Meary’s angle in the negative direction, both preoperatively and postoperatively, was associated with the development of postoperative ankle valgus in patients undergoing hindfoot arthrodesis.

Analysis & Discussion

While we did not find Meary’s angle to be statistically significant, similar to other findings, our study showed a positive correlation with preservation of the tibiotalar angle when the medial column angulations were corrected as shown by a positive increase in CAA. We believe our study demonstrates the potential for the cotton osteotomy to address forefoot varus and potentially prevent the development or progression of tibiotalar valgus through restoration of proper forefoot loading as described by Cotton.

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