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Case Series

Radiographic evidence of medial longitudinal arch restoration following naviculocuneiform arthrodesis in progressive collapsing foot deformity: a retrospective case series

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ABSTRACT

The objective of this study was to demonstrate the corrective effect of naviculocuneiform (NC) arthrodesis on the medial longitudinal arch in collapsing foot deformity (CFD) and to establish radiographic criteria for its indication as a stand-alone or complementary surgical procedure. NC arthrodesis was performed in 17 patients diagnosed with CFD, with clinical and radiological follow-up conducted to evaluate correction of the medial longitudinal arch. Postoperative angular measurements were obtained at five weeks under weight-bearing conditions after removal of the short-leg cast. Statistically significant radiographic improvements ($p<0.05$) were observed in all parameters except for the calcaneal pitch angle ($p>0.05$). The mean preoperative Meary angle was 11.8°, with an average reduction of 10°, resulting in a postoperative mean of 1.9° ($p<0.05$). The preoperative talocalcaneal angle in the Saltzman view averaged 6.02° compared to 2.7° postoperatively ($p<0.05$). The talo–scaphoid coverage angle decreased from a mean of 34.5° preoperatively to 22.9° postoperatively ($p<0.05$), while the talo–scaphoid incongruence angle improved from 39.3° to 24.2° ($p<0.05$). Although the calcaneal pitch angle improved slightly (19.1° to 21.0°), the change was not statistically significant ($p>0.05$). NC arthrodesis proved to be an effective technique for correcting collapsing foot deformity, achieving significant restoration of medial arch alignment and stability with consistent improvements in key radiographic parameters.

Keywords: Collapsing foot deformity, Flatfoot, Adult acquired flatfoot, Naviculocuneiform arthrodesis, Midfoot arthrodesis

INTRODUCTION

Despite advances in understanding the natural history of collapsing foot deformity (CFD)—recognizing that the loss of muscular balance and joint dysfunction are key factors—the exact etiology remains nuclear.[1] Its treatment continues to challenge orthopedic surgeons. Historically, it has been described as a dysfunction of the posterior tibial tendon (PTT), which leads to collapse of the medial longitudinal arch, hindfoot valgus, forefoot abduction, and even verticalization of the talus.[2,3] The PTT primarily inserts into the navicular tuberosity, with multiple divisions extending to the cuneiforms and the bases of the second, third, and fourth metatarsals. This hypothesis supported the notion of Chopart joint dysfunction, which directed treatment toward the subtalar, talonavicular, and calcaneocuboid joints. However, the importance of the "spring ligament" as a stabilizer of the medial longitudinal arch has been demonstrated in several studies. Jennings and colleagues, in cadaveric studies, showed that dysfunction of this ligament leads to foot instability.[4]

Molloy et al demonstrated the importance of the NC joint as a static stabilizer of the medial longitudinal arch, as well

as the significance of the NC ligament as an extension of the PTT.[5]

The naviculocuneiform joint plays an important role in the kinematics of the medial longitudinal arch; its primary function is to provide a stable connection between the hindfoot and the midfoot.[6,7] However, NC arthrodesis is not a common procedure in the treatment of CFD.[6]

Approximately 85% of patients improve with conservative treatment based on rehabilitation, NSAIDs, and orthotic unloading; surgical intervention is reserved for those who do not improve.[8-10]

NC arthrodesis has emerged as a valuable surgical option in the treatment of CFD, particularly in cases of flexible deformity and instability of the medial column. The aim of this procedure is to restore the arch and stabilize the medial column of the foot while preserving motion in other joints.[5]

When correcting the varus component of the forefoot in CFD, fusion of the NC joint should be considered, especially when signs of arthritis, symptoms, and/or significant sagittal plane collapse are present.[11]

Recent studies have shown promising results for NC arthrodesis in the correction of flatfoot.[12] Steiner et al evaluated the combined subtalar (ST) and naviculocuneiform arthrodesis in patients with adult-acquired flatfoot with medial arch collapse. The results demonstrated a significant improvement in several radiographic parameters and a high fusion rate (94.1%), with good overall patient satisfaction.[13]

Separately, Ajis and Geary analyzed the surgical technique, fusion rates, and correction of planovalgus deformity through NC fusion. In their retrospective series of 33 feet, they found a fusion rate of 97% with significant improvements in radiographic angles and high patient satisfaction. Their study suggests that NC fusion is a safe and predictable procedure for correcting planovalgus deformity.[14]

The objective of this study is to determine the corrective power of NC arthrodesis and to demonstrate its importance in the treatment of CFD through a case series.

CASE SERIES

Study design

A retrospective case series was conducted. Seventeen patients (17 feet) who underwent surgery between March 2024 and March 2025 were selected from the Hospital de Ortopedia de la Cruz Roja Mexicana database in Mérida, Yucatán, Mexico. All patients presented with medial ankle pain, functional limitations, and hindfoot valgus deformity that did not respond to at least 6 months of conservative treatment, and they met the inclusion criteria.

Inclusion criteria

Patients with NC arthrodesis performed between March 2024 and March 2025 for CFD, with or without medializing calcaneal osteotomy (MCO), and who had a minimum postoperative follow-up of 6 months.

Exclusion criteria

Patients undergoing NC arthrodesis for causes other than CFD or those accompanied by subtalar arthrodesis were excluded.

Seventeen feet (17 patients) met the inclusion criteria. Patient age, comorbidities, tobacco use, and concomitant procedures were recorded. Fixation was performed using 4.0-mm screws in 94.12% of cases and a medial arthrodesis plate in 5.8%. All patients had pre- and postoperative radiographs in anteroposterior and lateral weight-bearing views, as well as a Saltzman projection. Measurements were made of the Meary angle, calcaneal pitch, talo–scaphoid coverage angle, talo–scaphoid incongruence angle, and tibio-calcaneal angle in the Saltzman view.

Bone consolidation was determined using clinical criteria (no pain on palpation or weight bearing) and radiographic criteria (obliteration of the joint line, formation of a bony bridge, or callus).

All patients were protected in a short-leg cast (plaster or fiberglass) until consolidation was achieved.

Selection method

Patient selection flowchart is shown in Figure 1.

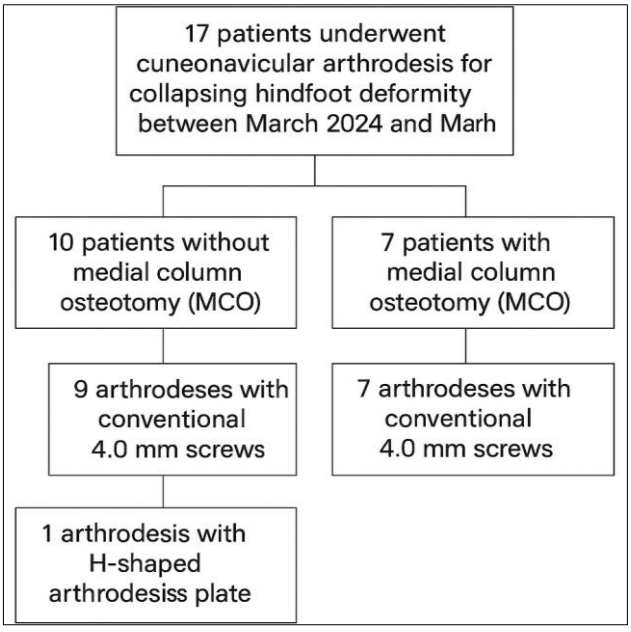

Figure 1: Patient selection flowchart.

Surgical technique

An either popliteal or regional block was administered as per the anesthesiologist's decision, with tourniquet inflation to 250 mmHg at the thigh. A dorsomedial incision was made centered over the NC joint (Figure 2a). The anterior tibial tendon was retracted dorsally and laterally. A subperiosteal dissection was performed to expose the NC joint, followed by a dorsal-medial capsular incision (Figure 2b).

A Hintermann retractor was used to distract the NC joint and expose the articular surfaces. Cartilage was removed from the joint surfaces using a combination of curved osteotomes and a sagittal saw with a blade. The subchondral bone surfaces were prepared with approximately 3-mm perforations using a 2.7-mm drill. An autograft or allograft, approximately 10×10 mm, was positioned in the joint (Figure 2c).

Instrumented reduction was achieved with Weber-type reduction clamps, maintaining dorsal flexion of the medial bar and plantar flexion of the lateral bar to recreate the double helical arch. Once a satisfactory reduction of the NC joint was obtained, it was maintained with a 1.6-mm Kirschner wire inserted from the medial cuneiform to the navicular.

Fluoroscopy was used to check the dorsoplantar and lateral positions with simulated support; once satisfactory positioning was confirmed, a 2.7-mm drill was used from the medial wedge toward the navicular, and a second 4.0-mm screw was placed in the navicular-medial-to-wedge direction. The wound was closed in layers using 2.0 Vycril for the subdermal layer and 3.0 nylon for the skin closure.

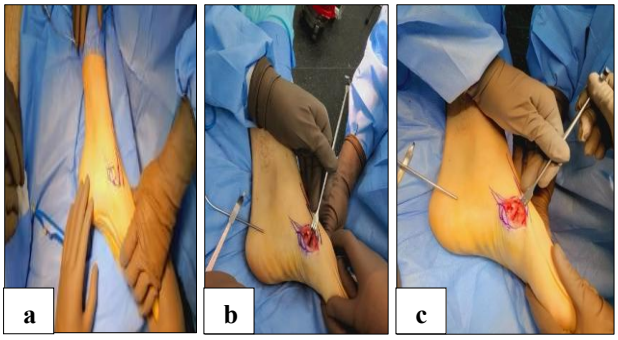

Figure 2: (a) Anatomical references and the dorsomedial incision, (b) exposure of the NC joint and (c) bone graft in position in the NC joint.

In cases requiring a medializing calcaneal osteotomy, a lateral oblique approach was used and a longitudinal osteotomy was performed through the calcaneal body with an oscillating saw until both cortices were breached.

Medial displacement was achieved under instrumentation and fixed with two 6.5-mm screws inserted from posterior to anterior under radiographic control.

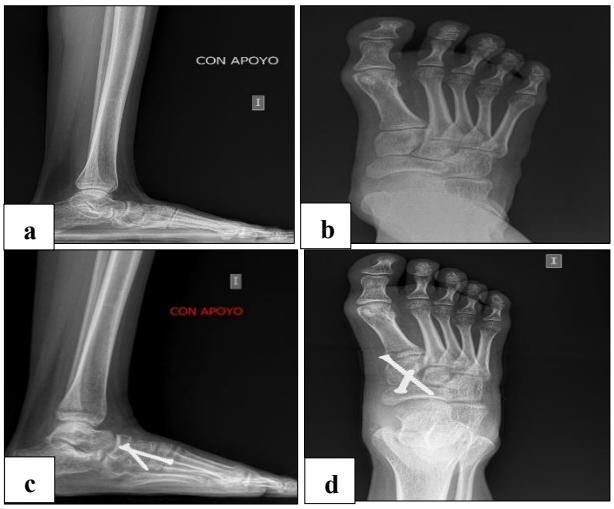

Figure 3: (a) Preoperative lateral weight-bearing radiograph of the foot, (b) preoperative dorsoplantar weight-bearing radiograph, (c) 4-week postoperative lateral weight-bearing radiograph and (d) 4-week postoperative dorsoplantar weight-bearing radiograph.

Statistical analysis

Statistical analysis was performed using statistical package for the social sciences (SPSS) version 25 (IBM Corp., Armonk, NY, USA). Seventeen cases were included in the study. The normality of the variables was assessed using the Shapiro-Wilk test. Since the data followed a normal distribution, continuous variables were expressed as means and standard deviations. To compare preoperative and postoperative values of the five variables analyzed (Meary angle, talo–scaphoid coverage angle, talo–scaphoid incongruence angle, talocalcaneal angle, and calcaneal pitch angle), the paired student's t-test was used. There were no missing data in the analysis. A level of significance of $p<0.05$ was considered, and results are presented with their 95% confidence intervals.

Seventeen patients were included in the study. The mean age was 43.9 years (range, 18 to 69 years). Of the 17 operated feet, eight (47%) were right and nine (53%) were left. Thirteen patients (76.47%) were female, and four (23.53%) were male. A medializing calcaneal osteotomy (MCO) was performed in seven patients (41.17%). Pre- and postoperative results of five key angles were analyzed to assess the corrective power of NC arthrodesis in various planes. Postoperative measurements were taken at 5 weeks with weight bearing after removal of the short-leg cast, showing statistically significant radiographic changes ($p<0.05$) in all parameters except for the calcaneal pitch angle ($p>0.05$) (Figures 3 a-d).

Considering the Meary angle as the key indicator for evaluating sagittal plane collapse, our results demonstrated a significant improvement. The preoperative mean was 11.8° with an average reduction of 10°, resulting in a

postoperative mean of 1.9° ($p<0.05$), confirming the corrective power of NC arthrodesis in the sagittal plane.

Regarding the talo–scaphoid coverage angle, which evaluates frontal plane collapse, a postoperative reduction was observed, indicating restoration of bony congruence. Preoperative values averaged 34.5° with an average decrease of 12° to a postoperative mean of 22.9° ($p<0.05$), thus improving the deformity in both the sagittal and frontal planes.

The talo–scaphoid incongruence angle measurements also demonstrated postoperative decreases, indicating improved articular stability. The preoperative mean was 39.3° with a postoperative mean of 24.2° ($p<0.05$).

In the Saltzman view, the talocalcaneal angle also improved, even though NC arthrodesis is not primarily focused on hindfoot correction; however, when accompanied by an MCO, good results were observed. Preoperative values were 6.02° versus 2.7° postoperatively ($p<0.05$) with 41.7% of cases having an MCO.

Although improvement was noted in the calcaneal pitch angle, suggesting a favorable adjustment of the heel alignment in the horizontal plane (thus implying subtalar alignment), the results were not statistically significant ($p>0.05$), with a preoperative mean of 19.1° versus 21.0° postoperative (Table 1).

Table 1: Radiographic angles.

Radiographic angles	Preoperative mean (°)	Postoperative mean (°)	P value
Lateral view			
Meary angle	11.8	1.9	<0.1
Calcaneal pitch	19.1	21.0	0.068
Dorsoplantar view			
Talo–Scaphoid incongruence angle	39.2	24.2	<0.1
Talo–Scaphoid coverage angle	34.5	22.9	<0.1
Saltzman projection			
Talocalcaneal angle	6.02	2.70	<0.1

Only one minor complication was observed—a delay in wound healing (5.8%).

Overall, the results demonstrate effective restoration of alignment and joint congruency in all three planes, mainly in the sagittal plane, supporting the effectiveness of NC arthrodesis as a treatment for CFD.

DISCUSSION

Cuneonavicular arthrodesis has proven to be an effective surgical tool in correcting collapsing midfoot deformities, particularly in patients with adult-acquired flatfoot, posterior tibial tendon dysfunction, or medial degenerative arthropathy. Our findings confirm that fixation of this joint not only provides structural stability but also results in significant angular correction, as evidenced by changes in key radiographic parameters.

In our case series, improvements were observed in Meary's angle, navicular height, and other indicators of the medial longitudinal arch, which aligns with previous studies supporting the biomechanical role of the medial column as a stabilizing axis for both the hindfoot and forefoot.[12,15] Fixation of the cuneonavicular complex enabled the restoration of sagittal midfoot alignment, promoting a more physiological load distribution during gait and a reduction in functional pain.

In contrast to more extensive procedures such as triple arthrodesis, this technique offers a more conservative alternative in selected patients, particularly when the deformity is confined to the medial plane without significant involvement of the subtalar joint. This selective approach allows for partial preservation of foot mobility, shorter rehabilitation periods, and a reduced risk of postoperative stiffness.

Reported complications for this procedure are generally rare and of low morbidity, as demonstrated by case studies reporting low rates of nonunion and surgical wound dehiscence.[14] In our series, no major adverse events were observed, further supporting the safety of this approach in properly selected patients.

It is worth emphasizing the importance of proper radiographic evaluation, especially using weight-bearing views, as they allow for accurate quantification of the deformity and objective assessment of postoperative correction. The literature underscores that weight-bearing imaging is essential to avoid underestimation of medial collapse and to guide surgical planning.[16]

One of the strengths of this study lies in the objectification of outcomes through pre- and postoperative radiographic measurements. Although the sample size is limited, the results are consistent and clinically significant. Future prospective studies with larger patient cohorts and long-term follow-up will be necessary to validate these findings and to further explore their functional impact at both biomechanical and quality-of-life levels.

Limitations

Nonetheless, we acknowledge certain limitations. First, the sample size was relatively small, and the study design was retrospective. Additionally, the absence of a comparison group involving other surgical techniques limits the ability to draw direct conclusions regarding the relative efficacy of different approaches. Future research, including prospective studies and randomized controlled trials, may provide stronger evidence.

CONCLUSION

Cuneonavicular arthrodesis represents a solid, safe, and effective surgical alternative for the treatment of collapsing midfoot pathology, particularly in patients with predominant medial deformity. Our results demonstrate that this technique not only provides structural stability but also achieves significant and reproducible angular correction, validated through weight-bearing radiographic measurements. This intervention allows for restoration of the foot's functional axis, improvement in gait biomechanics, and pain relief with a low complication rate.

The systematic integration of clinical and radiological criteria in patient selection, along with objective angular assessment, positions cuneonavicular arthrodesis as a high-value tool in the foot and ankle surgeon's armamentarium. As supporting evidence continues to grow, this procedure may become a cornerstone in the surgical reconstruction of the collapsed medial arch.

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