CHAPTER **6**

TALONAVICULAR JOINT ARTHRODESIS FOR COLLAPSED PES VALGUS: A Retrospective Review of 51 Cases

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INTRODUCTION

The painful pes planovalgus foot type includes a range of deformities. Causes for the symptomatic pes valgus deformity include posterior tibial tendon dysfunction, subluxation of the talus, triceps surae or isolated gastrocnemius equinus, traumatic tendon rupture, ligament laxity, and various neuromuscular imbalances. Detailed discussion of the anatomy and physiology of the symptomatic pes planovalgus deformity has been described in the scientific literature. Collapsing pes valgus deformity includes the loss of medial arch height, forefoot abduction, hindfoot valgus and, most importantly, pain, discomfort, and functional weight bearing limitations.

A variety of joint-sparing, arthrodesis, and combination procedures have been described for the treatment of the painful pes valgus deformity that warrants surgical intervention. Of particular note, some authors have indicated the need for further research regarding the usefulness of isolated talonavicular (TN) arthrodesis in this setting. In the current retrospective study, the authors assessed the effectiveness of an isolated TN arthrodesis for the surgical management of the painful collapsing pes valgus deformity in both pediatric and adult patients.

PATIENTS AND METHODS

A retrospective chart review was completed by one of the authors (CM) for all patients treated by the senior author (CC), between May 1998 and December 2006. All patients undergoing talonavicular arthrodesis for reasons other than flexible pes valgus deformity were excluded. Patients having other medial column stabilization or lateral column lengthening procedures in addition to a TN fusion were also excluded from this study. Patients within this study are referred to as having an isolated TN fusion, regardless if they underwent an additional soft tissue release (gastrocnemius recession or Achilles tendon lengthening) or forefoot correction because they underwent an isolated hindfoot fusion.

As part of the routine preoperative assessment, patients were asked to rate their pain on a categorical (0-10) Likert scale, where 0 represented no pain and 10 represented the worst pain that the patient could imagine. Postoperatively, patients were contacted by telephone interview and again asked to rate their level of pain using the same scale. A follow-up objective, clinical evaluation was not performed, beyond the information that already existed in the medical record. At the time of the follow-up interview, we also asked the patient if they were, satisfied or dissatisfied with the outcome of their foot surgery.

In addition to the subjective assessment of pain, a number of radiographic variables were measured on the pre- and postoperative weight-bearing radiographs. Specifically, the radiographic analyses involved pre- and postoperative radiographs that were present in the medical record up to the time of the last follow-up evaluation, including the last set of preoperative radiographs and the final set of postoperative radiographs. Postoperative osseous union was determined by the radiographic presence of trabeculation across the TN joint on all 3 standard radiographs (anteroposterior, lateral, and medial oblique). On the lateral radiograph talar dome height, calcaneal inclination angle, and talar-first metatarsal angle were measured preoperatively and at various times during the postoperative period. On the dorsoplantar (DP) radiograph the talocalcaneal angle, cuboid abduction angle, and percentage of talar head uncovering were compared preoperatively and at various times during the postoperative period.

The operative intervention was carried out using a combination of a mid-calf pneumatic tourniquet and 0.25% bupivacaine with epinephrine (1:200,000) for hemostasis. A 5-cm medially placed, linear incision was made from the tip of the medial malleolus to the navicular-medial cuneiform joint. A linear incision was made through the capsular layer and all soft tissue and

ligamentous attachments were dissected off the TN joint. The tibialis posterior tendon was preserved, except for one case involving a complete rupture in which the tendon was excised from its insertion. Degeneration of the posterior tibialis tendon was not routinely evaluated or repaired. A small joint distractor was placed dorsally over the TN joint to allow for contoured joint resection without obscuring visualization. Joint resection was accomplished with rongeurs, curettes and power burs.

The joint was fixated with 1 of 3 techniques: 1) 2 4.0-mm partially-threaded cancellous screws in a distal-to-proximal orientation, 2) a 2-hole one-third tubular plate fixated with 2 4.0-mm fully-threaded cancellous screws oriented eccentrically for compression, or 3) a 4-hole titanium locking H-plate. If present, ankle equinus was addressed in a variety of different ways. For patients with isolated gastrocnemius equinus, a gastrocnemius lengthening as described by Vulpius and Stoffel was performed through a posteromedial incision with the patient supine and the leg externally rotated. For patients with gastrosoleal equinus, an open tendoAchillis lengthening (TAL) was performed through a medial incision creating a sagittal plane Z-lengthening.

In all of the cases, the foot was initially placed in a compressive dressing with a posterior splint in a neutral position following the operation. In the postoperative phase, initial wound inspection was performed 7 to 10 days following the operation. The patient was placed in a permanent dressing consisting of either a posterior splint or a hard Jones compression dressing and remained non-weight bearing for 6-8 weeks. Protected weight bearing was initiated 6-8 weeks postoperatively, and full weight bearing in regular shoe gear routinely began 10-12 weeks postoperatively.

The data were collected from the medical records and the follow-up patient interviews, and stored on a personal computer running Microsoft Excel 2002 SP-2 (Microsoft, Redmond, WA). The data were inspected with an emphasis put on the data type and distribution. Descriptive analyses, and repeated measures analysis of variance (ANOVA) were performed. The statistical analyses were performed by Dr. Jeffery S. Kane Ph.D., using a personal computer using STATA software, version 8.0(Stata, College Station, TX).

RESULTS

Review of the medical records revealed 68 patients that underwent TN fusion for a variety of disorders. After excluding patients that did not meet the inclusion criteria, records for 62 feet in 52 patients were retained for further review. Preoperative diagnoses of those included were painful collapsed pes valgus deformity, tibialis posterior tendon dysfunction, tibialis posterior tendon rupture, and failed previous subtalar joint implant. Only 41 of 52 patients completed the postoperative follow-up interview; 2 patients were deceased of unrelated causes, and we were unable to contact the remaining 9 patients. Overall, 41 patients (51 feet) were followed for a minimum of 11 months and the mean follow-up duration was 43.3 (range 11-113) months. There were 15 men and 26 women with a mean age of 47 (range 9-72) years at the time of surgery. Gastrocnemius recession was performed in 19 legs and open tendoAchillis lengthening in 13. Bone graft in the form of either allogeneic or autogenous bone was used in 10 patients (6 and 4, respectively). No orthobiologic bone graft substitutes or internal bone stimulators were utilized. One patient required the use of external bone growth stimulation for a period of 4 and 5 months post-operatively for bilateral delayed unions.

Table 1

PAIN MEASUREMENTS

Mean Preoperative	Mean Postoperative	*P**
7.6 ±	1.9 ±	< 0.001

*Repeated measures analysis of variance (ANOVA).

In regard to the categorical measurement of pain, the mean pain level before surgery was 7.6 ± and improved postoperatively to 1.9 ± and this change was statistically significant ($P < 0.001$) (Table 1). In regard to the binary, subjective outcome of overall satisfaction with the results of the TN fusion surgery, 90% (36/40) of the patients stated that they were satisfied with the surgery and would undergo the procedure again. Three patients were not satisfied with the outcome of the surgery, and indicated that they would not repeat the foot surgery. One of these was a woman with rheumatoid arthritis and experienced substantial postoperative pain and abnormal motion involving her knees and lumbosacral spine. The other 2 were men who described transfer of pain to the lateral aspect of their foot and, of these patients, one was a worker's compensation patient who, at last follow-up, was participating in a pain management program.

In regard to the radiographic variables that were assessed, all of them demonstrated statistically significant changes between the pre- and postoperative periods (Table 2). Overall, 100% (51/51) of the operated feet went on to

Table 2

RADIOGRAPHIC MEASUREMENTS.

Variable	Mean Preoperative	Mean Postoperative	*P**
Talar dome height (cm)	7.1 ±	7.8 ±	< 0.001
Calcaneal inclination angle (degrees)	10.7 ±	19.2 ±	< 0.001
O0l./;pTalar-first metatarsal angle (degrees)	12.5 ±	1.5 ±	< 0.001
Talocalcaneal angle (degrees)	22.3 ±	10.9 ±	< 0.001
Cuboid abduction angle (degrees)	28.1 ±	5.6 ±	< 0.001
Percent talar head uncovering (%)	39.57 ±	0.9 ±	< 0.001

*Repeated measures analysis of variance (ANOVA).

display radiographic osseous union, 2 of which displayed delayed unions (failure to demonstrate progressive radiographic changes consistent with arthrodesis after the 3-month postoperative interval). External bone stimulators were utilized in both delayed unions at the 14th postoperative week for a length of 4 and 5 months. Upon comparison of the pre- and postoperative DP radiographs, the repeated measures ANOVA of the percentage of talar head uncovering improved from a mean percentage of 39.57 ± to 0.9 ± ($P < 0.001$). The calcaneocuboid abduction angle improved from 28.1° ± to 5.6° ± ($P < 0.001$), Kite's angle improved from 22.3° to 10.9° ± ($P < .001$), and the talar-first metatarsal declination angle decreased postoperatively from 12.5o ± down to 1.5° ± ($P < 0.001$). Upon comparison of the pre- and postoperative lateral radiographs, the calcaneal inclination angle increased from 10.7° ± to 19.2° ± ($P < 0.001$), and the change in talar dome height increased from 7.1 ± cm to 7.8 ± cm ($P < 0.001$).

DISCUSSION

The most immediate concern with any selected hindfoot arthrodesis is the limitation or elimination of motion, and the creation of additional stresses at adjacent joints. It has been demonstrated, however, that if the foot is placed in a well-aligned position, additional stresses and the development of adjacent arthritis can be minimized, perhaps even eliminated. This has also been seen in patients with asymptomatic tarsal coalitions, and has been described by Yu et al as follows: "These occult conditions have remained silent for a lifetime…The reason for the lack of symptoms in this group of patients is that the foot is in a neutral position or the patient has experienced a developmental arthrodesis over time and has maintained relatively normal alignment of the foot." In the patients described in this investigation, the decision to undergo TN joint fusion was based on the presence of recalcitrant symptomatology, severe malposition, and joint instability. In essence, the goal of the procedure was to create a stable, well-positioned foot.

A recent study examined the current approach to treating acquired pes valgus deformity among 104 academic foot and ankle surgeons. A hypothetical 62 year-old male with a symptomatic pes valgus deformity and posterior tibialis tendon dysfunction was, by means of questionnaire, presented for consideration. Specifically, with conservative measures having failed, the choice of proposed operative treatment was surveyed. Ninety-seven percent of the surgeons selected some form of osseous procedure, but only 12% of respondents chose isolated rearfoot arthrodesis procedures. A trend toward joint preservation was supported by the fact that 39% of those questioned, selected the combination of medial displacement calcaneal osteotomy (MDCO) with posterior tibial tendon (PTT) augmentation. Only 1.92% (2/104) of the surgeons responding to the questionnaire indicated that they would have performed an isolated TN arthrodesis.

The majority of published reports regarding isolated TN arthrodesis deal with adults and associated rheumatoid arthritis. As regards the arthritic TN joint, various articles have shown the effectiveness of arthrodesis at this level. Generally arthrodesis of an isolated, unstable, nonarthritic joint for the treatment of pes valgus is well accepted (i.e., subtalar joint and medial column procedures); however, this is not the case for isolated TN joint fusion. One extensive literature review summarized the surgical techniques, outcomes, and complications associated with multiple operative procedures for pes valgus deformities. It included discussion of the isolated triple arthrodesis, triple arthrodesis with tarsometatarsal fusion, triple arthrodesis with lateral column lengthening, and an isolated subtalar fusion. There was no mention of using an isolated TN arthrodesis as a possibility for the treatment of severe adult

acquired pes planovalgus. This sentiment was noted in an earlier publication that discussed the complications of surgical treatments for adult pes valgus deformities. Overall, the surgical literature is somewhat lacking in regard to in-depth discussion based on even modest case reports of the potential benefits of isolated TN arthrodesis for the treatment of pediatric and/or adult pes valgoplanus deformity.

Lombardi and Dennis reported the results of combined TN joint arthrodesis and Evans calcaneal osteotomy for the treatment of posterior tibial tendon dysfunction. At an average of 35 months follow-up, 10 of their patients demonstrated significant improvement in both their subjective discomfort and in the structural alignment and function of their feet. Their patients displayed an improvement in the average AOFAS Ankle-Hindfoot Rating Scale when the pre- and postoperative (42.3/100 and 83/100, respectively) values were compared. Even though their sample size was relatively small and the follow-up period rather short, their results were favorable. Furthermore, they explained that their rationale for combining the talonavicular fusion with the Evans calcaneal osteotomy was two-fold. The Evans, they noted, was performed first, placing the foot in an improved position with the TN fusion performed to stabilize remaining instability if needed. Second, the authors remarked on the effectiveness of the Evans in regard to increasing the lever arm of peroneus longus thus, at least theoretically, improving forefoot varus.

Lombardi and Dennis further hypothesized that the combination of procedures was more effective than either alone, but only reported on the 2 procedures performed together. Further still, it is interesting to note that cadaveric studies have shown that the TN joint is the key articulation in the reciprocating subtalar and rearfoot joint complex (TN, talocalcaneal, and calcaneocuboid joints) and, as such, arthrodesis of the TN joint alone conveys the ability to both align and maintain rearfoot position. The results from the current study demonstrated improvements in talar head uncovering and calcaneocuboid abduction, thereby demonstrating the procedure's ability to reduce substantial amounts of forefoot abduction. Similarly, the medial column was also restored on the lateral radiograph as demonstrated by the improvement in the talar-first metatarsal declination angle. Based on the radiographic findings that we observed, we believe that forefoot varus and forefoot abduction can be satisfactorily addressed with an isolated TN fusion without the need for adjunctive Evans osteotomy.

Mann and Beaman recommended the combination of TN and calcaneocuboid arthrodeses for collapsed pes valgus deformities. They reported the results of 16 patients with a 4.5-year average follow-up period. Their rationale for adding a calcaneocuboid fusion was to eliminate lateral midfoot pain and to allow correction of greater amounts of forefoot varus. However, in our investigation, only 3.92% (2/51) of the patients complained of postoperative lateral column pain, and neither of these patients required further surgery. Mann and Beaman also described an increased rate of nonunion following isolated TN fusion. Despite their findings, we only encountered 2 (3.92%) delayed unions postoperatively, and both of these resolved with extended nonweight bearing and the use of external pulsed electromagnetic field bone stimulation without the need for bone graft or bone graft substitutes, or implanted bone growth stimulation.

Fortin reiterated some of the same concerns that Mann and Beaman expressed with isolated TN fusions, and also noted an additional concern for the development of adjacent arthritis of the ankle, most often attributed to residual hindfoot valgus leading to valgus collapse of the ankle. Thus, he recommended the combination of TN fusion with medial displacement calcaneal osteotomy in the treatment of pes valgus in adults. In our follow-up, which averaged 43.3 (range 11-113) months, we did not encounter any complaints of adjacent arthritis of the ankle and, unfortunately, calcaneal axial radiographs were not a component of our protocol so we were not able to indirectly compare our results with those related by Fortin. We did, however, encounter the development of postsurgical arthrosis involving the naviculocunieform joint. In fact 3.92% (2/51) of the feet upon which we operated underwent additional surgery for the treatment of painful naviculocunieform arthritis following TN arthrodesis; and an additional 3.92% (2/51) feet also developed subtalar joint arthritis, 1 of which required subsequent arthrodesis.

Harper in 1996, and Harper and Tisdel in 1999, reported on isolated TN fusions for the acquired adult flatfoot. In these 2 separate studies, a total of 55 adults, mean age 58 (range 39-74) years, with painful flatfoot deformity were treated with TN fusions and followed postoperatively for an average of 26 and 27 months. In the first study, consisting of 26 patients, 92% (24/26) of the patients were rated as having either a good or excellent result, with either no pain or pain only after heavy weight-bearing activity. The repair, moreover, showed no evidence of deterioration of foot position for up to 5 years following the surgery. In the first case series, no bone graft was used for the first 6 patients; thereafter, iliac crest grafts were used in all patients. In the second case series, consisting of 29 patients, there was an overall satisfaction rate of 86% and the results were categorized as excellent in 11 patients, good in 14, and fair

in 4 patients. Of particular interest, ankle motion was found to decrease an average 10°, and 6 patients developed adjacent arthrosis in the ankle, calcaneocuboid, naviculocunieform, and tarsometatarsal joints following the TN fusion. Those authors speculated that excessive stress transferred to adjacent joints caused the transfer arthrosis, which was relatively mild, and they considered this to be a disadvantage of the procedure. The adult patients in these case series, however, were nonathletic, middle-age or older individuals, and the loss of motion did not significantly alter their activities. The patients in both of these case series typically retained some limited hindfoot motion, whether through the subtalar joint or the ankle, or a combination of these joints. In both series, moreover, the authors concluded that TN arthrodesis was a valuable technique in treating the adult acquired flatfoot deformity. The procedure addressed posterior tibial tendon abnormalities while providing reliable stability and reduced pain through a single approach with low morbidity.

In the group of patients described in this report, we observed a 100% rate of TN fusion. Despite this rate of union, we also observed a number of complications including bilateral delayed unions in a 65-year old woman. This particular patient required the use of an external bone growth stimulator, which was started on both feet at 14 weeks postoperatively. She required bone growth stimulation for 4 months on the left foot and 5 months on the right foot. She also had a twenty-year history of smoking, but an otherwise unremarkable medical history. Four patients (4 feet) developed secondary arthritic changes at the naviculocuneiform joint, 2 of which eventually required arthrodesis. Two patients (2 feet) developed subtalar joint pain; one resolved with a corticosteroid injection (1.0 cc marcaine 0.25% with epinephrine, 1.0 cc dexamethasone phosphate, and 0.25 cc dexamethasone acetate) and 1 required fusion. Four patients (4 feet) developed postoperative plantar heel pain that resolved with conservative treatment, and 3 patients (3 feet) developed superficial wound dehiscence that healed uneventfully. There were no postoperative infections, and none of the patients required removal of their internal fixation devices.

Our study involved a broader age range than did previously published reports, including 6 pediatric patients (10 feet), 4 of which underwent bilateral TN fusions. In all of the pediatric patients, activity levels increased postoperatively. The most common complaints among the pediatric patients were swelling after excessive activities and the encumbrance of using crutches during the recovery stages. Overall, 87.8% (36/41) of patients were satisfied with the procedure and would undergo the procedure again. A surprising complaint during the immediate postoperative recovery was difficulty ascending and descending stairs once weight bearing was initiated. When questioned about this complaint, these patients stated repeatedly that adjusting to having their foot repositioned under their leg made ascending and descending stairs difficult initially. Although we did not regularly employ bone grafting techniques in our series of TN fusions, it is interesting to note that bone grafting is used more often than not in the cases described in previous published reports. In our cohort, bone grafting was employed in 10 patients (10 feet), 4 of which were autogenous cancellous graft harvested from the distal tibia, and 6 of which were packed with allogeneic cancellous chips. None of the patients in our cohort received any orthobiologic agents or implantable bone growth stimulators.

In summary, the authors evaluated the results of 51 isolated TN arthrodeses in 41 patients or various ages and, using repeated measures analysis of variance, showed that all of the radiographic variables considered in the study were found to be statistically significantly improved between the pre- and postoperative periods. More importantly clinically, the mean pain level before the surgery statistically significantly improved from a preoperative value of 7.6 to a postoperative value of 1.9. Based on these results, we concluded that isolated TN arthrodesis is safe and effective for the treatment of painful pes valgus deformity in pediatric and adult patients.