The Short Term Effect of Percutaneous Tendo-Achilles Tenotomy on Radiographic Changes in Patients with Midfoot Charcot Neuroarthropathy

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Statement of Purpose

The purpose of the current study was to investigate the radiographic changes on weightbearing lateral radiographs following percutaneous tendo-Achilles tenotomy in patients with midfoot Charcot Neuroarthropathy (CN).

Methodology & Hypothesis

Kaiser Permanente Institutional Review Board (IRB) exemption was obtained for this study. Electronic chart review was performed of all patients seen at the primary author's institution (J.P.) from 2008 to 2010 for diabetic midfoot CN. Patients with midfoot Charcot collapse who underwent percutaneous Achilles tenotomy were identified. Patients with available preoperative and postoperative standard weight bearing lateral radiographs and at least one year of follow up were included in this study. Charts were reviewed for demographic data and medical comorbidities, presented in Table 1.

- Skin lesions were categorized into "ulcerative" and "pre-ulcerative" lesions. Pre-ulcerative lesions included hyperkeratosis or a focal erythematous area underneath the midfoot corresponding to the apex of deformity.
- Charts were reviewed to evaluate the patient's ambulatory status at the time of final follow up, postoperative complications, resolution of the pre-operative skin lesions, and development of a calcaneal gait or transfer heel lesion.
- Standardized lateral weight bearing projections were used to assess preoperative and postoperative radiographic changes. The angle formed by the plane of support and plantar border of the calcaneus determined calcaneal inclination angle (CIA). Talar declination angle (TDA) was measured by the longitudinal bisection of the talus and the plane of support. The lateral talo-first metatarsal angle (TFMA) was formed by the longitudinal bisection of the talus and the longitudinal bisection of the first metatarsal.
- Preoperative and postoperative angular measurements for the three radiographic angles, CIA, TDA, and TFMA were compared in two ways: using a parametric paired t-test and a non-parametric Wilcoxon signed-rank test. Paired tests were based on the differences between the two measurements for each member of the sample and were computed for each of the three variables of interest. To determine which test to use, a test for normality of the distribution of the differences was computed for each variable. CIA and TDA were found to be normally distributed so t-tests were used for the comparison. The Wilcoxon signed-rank test was used for TFMA. All statistical analyses were conducted using SAS. A p-value < 0.05 was considered statistically significant.

We hypothesized that by releasing the Achilles tendon, improvement of the three distinct lateral radiographic angles would be observed postoperatively.

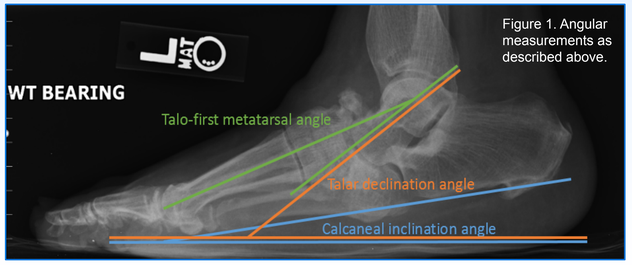

Figure 1. Angular measurements as described above.

Procedure

The percutaneous Achilles tenotomies were performed by a single surgeon (J.P.) in an outpatient procedural suite. All patients were placed in the supine position. No cases required a tourniquet for hemostasis. The posterior distal leg was infiltrated with local anesthesia proximal to the planned surgical incisions, followed by sterile prepping and draping. No other form of anesthesia was employed during the procedure. The operative limb was elevated and dorsiflexory force was applied to the foot. A traditional triple hemi-resections of the Achilles tendon was attempted first. However, in all instances this resulted in insufficient release of the equinus contracture. The middle hemi-resection was then converted to a full tenotomy. The operative limb was then placed into a total contact cast (TCC) for approximately seven weeks patients were transitioned into a custom molded shoe or Charcot Restraint Orthotic Walker (CROW).

Literature Review

The role of equinus in increasing pedal plantar pressure during gait has been well documented. Motor neuropathy can weaken the anterior muscle group causing compensatory gastrocsoleus contracture with equinus deformity (1-3). Many investigators have implicated limited ankle dorsiflexion due to equinus as a major contributor in increased plantar forefoot pressure leading to ulceration (4-6). There are a number of studies demonstrating the beneficial effect of heel cord lengthening in pressure reduction and healing of neuropathic plantar forefoot ulcerations in diabetic patients (4-6). Mueller et al. conducted a randomized trial to study the effect of Achilles tendon lengthening on neuropathic plantar ulcers (4). When lengthening was used in conjunction with total contact casting (TAL group), he observed complete healing in 100% of the patients as opposed to 88% of the patients in the group receiving just total contact casting (TCC group). The risk of ulcer recurrence was also 75% less in the TAL group versus the TCC group at seven months and 52% less at two year follow up. Lin and colleagues found similar results in that patients who underwent percutaneous TAL and TCC did not have ulcer recurrence at 17.3 months whereas 19% of ulcers recurred in the TCC group (5). Armstrong et al. found that peak pressures on the plantar aspect of the forefoot were significantly reduced following percutaneous TAL in diabetic patients who have previously healed forefoot ulcerations (6). They suggest this procedure could be used as an adjunctive or prophylactic measure to reduce the risk of ulceration in high risk diabetic patients.

Midfoot Charcot is frequently characterized by a rocker-bottom deformity with significant bony protuberance that often leads to chronic plantar ulceration. Interestingly, the midfoot is the most commonly affected joint complex in CN but there is a lack of literature on the effect of heel cord lengthening in midfoot Charcot deformity. This may be partly because no study has definitively shown if equinus contributes to the progression of midfoot CN or if it's merely a secondary consequence of the collapsed midfoot. Thordarson et al. have noted through a cadaveric study that the Achilles tendon can have a deforming effect on the arch and a case report demonstrated improvement of midfoot collapse after Achilles tendon lengthening (7-8). Laborde and colleagues reported their preliminary results for primary gastrocnemius-soleus recession for midfoot CN (9). They followed 25 feet for an average of 37 months post operatively and found favorable outcomes in 22 of 25 feet which was defined as healing of existing ulcers, no new ulcers, no obvious progression of deformity and no amputation.

Bevan et al., in 2008, conducted a retrospective analysis of patients with diabetes and midfoot CN (10). Weight bearing radiographs were reviewed to find a possible correlation between the severity of midfoot collapse with midfoot ulceration. He found that lateral TFMA of greater (more negative) than -27 degrees was significantly associated with midfoot ulceration.

Results

There were 3 female and 2 male patients in this study with an average age of 57. The average duration from the diagnosis of CN until surgical intervention was 16 months (range 5 months-40 months). Two patients had plantar midfoot neuropathic ulcers with an average duration of 5 months at the time of surgery, the other 3 patients had pre-ulcerative lesions. All lesions were located on the plantar midfoot corresponding to the apex of deformity.

The results of the paired t-tests indicate that the mean of the difference between the pre- and postoperative measurements for both CIA and TDA were statistically significant. The Wilcoxon signed-rank test for TFMA indicated no significant difference between the pre- and postoperative measurements.

There was resolution of the lesions in four patients (1 ulcer and 3 pre-ulcerative lesions) and all were ulcer free and ambulating in a CROW or custom molded shoe at the time of final follow up at an average of one year. One patient failed to heal the preoperative ulcer and subsequently underwent a reconstructive procedure. One patient had superficial dehiscence of the surgical incision, which healed after one month of conservative treatment. One patient died from an unrelated cause. None of the patients developed a transfer lesion on the heel or calcaneal gait as a direct cause from the procedure at one year follow up.

Table 1. Summary of patient demographics

Patient	Gender	Age	Laterality	Co-morbidities	HgBA1c	Ulcer/Preulcer	Schon	Final WB status	Heel ulcer
1	M	61	L	DM2, CAD, AF, HTN, HL, CHF	7.4	Ulcer	III	custom molded shoes	No
2	M	47	R	DM2, CKD, PVD, HL	7.7	Preulcer	I	CROW	No
3	F	69	L	DM2, AF, CAD, ESRD on HD	9.1	Preulcer	II-B	custom molded shoes	No
4	F	49	L	DM2	7.7	Preulcer	III	custom molded shoes	No
5	F	58	R	DM2, morbid obesity, HTN	7	Ulcer	II	*underwent subsequent reconstruction	No

Table 2. Summary of radiographic evaluation

Angles	Preoperative (Average)	Postoperative (Average)	Improvement (Average)
Calcaneal Inclination	-10	5	14 **(p-value 0.0086)**
Talo-First Metatarsal	-29	-8	21 (p-value 0.125)
Talar Declination	42	30	-12 **(p-value 0.0214)**

Figure 2a. Preoperative lateral weight bearing view.

Figure 2b. Postoperative (s/p Achilles tenotomy) lateral weight bearing view.

Conclusion

At times, a complex reconstructive procedure is required to restore a plantar-grade foot affected by the Charcot process. However, patients in this study had a significant number of medical co-morbidities unfavorable for successful reconstructive efforts. In many instances, the patient would refuse a reconstructive surgery for social and economic reasons due to its long postoperative convalescence and the potential for post-operative complications.

The current study shows the preoperative average TFMA of -29 degrees and a postoperative average of -8 degrees. Although the analysis did not show statistical significance, that is an average of 21 degrees of improvement. Postoperative TFMA was less negative than -27 degrees in all but one patient in this study. This finding suggests that patients were at less risk of midfoot ulceration postoperatively per Bevan's finding (10). All three distinct radiographic angles improved in all five patients postoperatively and were closer to the established normal values.

Over-lengthening of the Achilles tendon can lead to heel over-load, which can be concerning for insensate feet. Weakening of the plantar-flexory power can result in a calcaneal gait increasing the heel pad plantar pressure during gait. In the study by Mueller et al., the TAL group was found to have a 34% increase in the hindfoot peak plantar pressure compared to the TCC group and four of the thirty-one patients developed a heel ulcer following the procedure (4). He observed that after seven months the plantar flexor peak torque had returned to baseline but the hindfoot plantar peak pressure did not return to preoperative values. Holstein et al., performed percutaneous Achilles lengthening in 68 patients with 75 forefoot neuropathic forefoot plantar ulcers (11). He observed healing in 80% of the patients in the Achilles lengthening group however 11 patients developed a transfer heel ulcer in the same group. We did not observe transfer heel ulcers or calcaneal gait in our group of five patients at one year follow up.

There are limitations to this study as it is a retrospective study with a small number of patients. The average follow up is also relatively short. Further research with a greater number of patients and longer follow up would be helpful in observing the longevity of the effectiveness of this procedure and possible long term consequences of Achilles tenotomy.

We propose the following indications for this procedure:

1) Negative calcaneal inclination angle.
2) Lateral talo-first metatarsal angle less than (more negative) than -27^0.
3) Pre-ulcerative or full thickness ulceration unresponsive to conservative therapy.
4) Poor surgical candidate for reconstruction or lack of consent for surgery secondary to multiple medical co-morbidities.
5) Attempt a percutaneous triple hemi-resection and if it does not produce sufficient improvement of the equinus contracture, then convert the middle hemi-resection into a full tenotomy.

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