

# Case Study: Use of CROW WALKER AFO to Prevent Amputation

Keith M Smith CO LO FAAOP

## History/Background/Pathology

Patient presents with type II diabetes mellitus, (diagnosed in 1971), and peripheral neuropathy with Charcot Neuropathic Arthropathy midfoot deformation and associated medial side protuberance with ulceration under this prominence(Figure 1) of the left foot. Patient is a 70 year old male that is 6'3" 305 pounds that is retired and resides in the Midwest with community ambulation but no exercise due to limitation associated with Charcot deformity and risk of ulceration. Patient exhibits a loss of eccentric contraction of the dorsiflexors causing a footslap in early stance. Patient does have grade 4/5 concentric contraction though of this gastrocnemius muscle so does clear ground in swing and gets heel strike. Patient does though have limited sagittal plane ROM of ankle to 90 only, lacking any range into dorsiflexion, which causes a midfoot strain when the tibia tries to rollover the foot. In other words, the patient achieves the second rocker of walking with a midfoot collapse through the midtarsal joints, (talonavicular and calcaneocuboid joints), instead of tibia advancement due to the absent dorsiflexion ROM. Knee stability and ROM is within normal limits. Patient does however exhibit a very antalgic and unsteady gait pattern due to proprioception and sensation issues secondary to the peripheral neuropathy. Ptnt is motivated to get the ulceration healed and to then have the goal of maintaining this healing. Ptnt was facing the alternative and prognosis of transtibial amputation if healing did not occur as he was also working closely with his podiatrist due to infection. Ptnt also has a fixed amount of hindfoot valgus and fixed forefoot varus as well that increased the challenge here as that results in increased pressure along the medial border and thereby under the charcot deformity. As Van Tiggelen et al point out that deformities such as pronation or supination can result in modified contact zones of the foot with the ground and result in higher peak load on plantar surfaces of the foot which leads to higher friction force and blister formation.(1)It should be noted as well that when callouses form, they themselves can also create pressure points that will increase the friction force at the location and therefore increase skin shear.(2) In their study of exercise induced blisters, the author goes on to site that friction is defined as the tangential force resisting relative motion of two surfaces against one another and that friction is the most apparent factor influencing blister formation.(2) Friction blisters(ulcers) result from the pressure and sheer forces causing delamination of the Stratum Spinosum producing an accumulation of serous or bloody fluid.(3,4)

## Assessment and Planning Phase

Previous to this acute treatment, the patient had bilateral custom molded orthotics with an ipsilateral Arizona AFO, (Figure 2), molded over this orthotic with the goal being lower friction with an expected outcome of decreased callouses and prevention of blister(ulcers) formation. The AFO was incorporated in this hybrid design to give a triplanar support to specifically limit the ankle talocrural motion specifically the dorsiflexion as well as coronal plane motion of further valgus deformity of the ankle. All with the goal of decreasing the pressures on the medial border of the skin and the integrity of the joints orthopedically. The Orthotic was fabricated by vacuum forming first a 3/16" pink plastizote layer

followed by layers of white plastizote foam over mold of Foot and then continuing to shave the foam under the prominence from the charcot deformity and resultant bony deformity until this outside bottom of orthotic was flat but then the inside of foot orthotic had accommodation to the deformity. This fabrication then presented with more thickness of foam proximal and distal to that prominence of the midfoot (Figure 3). In essence we are biomechanically bringing the ground up to reach every aspect of the foot to redistribute weightbearing away from this prominence.

## **Orthotic Design and Fabrication**

Due to the ulceration from the charcot deformity and noncompliance at times to the above mentioned bracing protocol, a charcot AFO was fabricated as a clamshell design  $\frac{1}{4}$ " copoly posterior with a  $\frac{1}{8}$ " anterior shell and a molded insert modified in the positive molds as described above.(Figure 4) Only difference was that since a shoe was not being used, fabrication could be thicker and therefore the overall thickness of the finished FO was  $\frac{1}{2}$ ". Important to note as well that socks that were low friction and wicking were suggested and implemented due to a strong desire to minimize in orthosis moisture as well as friction to prevent any further blistering to arise throughout the foot in the healing phase. Moisture wicking socks have been shown to reduce blister formation(1,5,6)

Keeping in mind that we are stopping all motion of that ankle in all three planes that the potential for compensatory type motions inside the boot such as the tendency for an early heel rise could lead to potential other friction areas develop. The use of the rocker heel and sole on the external and also shaved into the foam of the CROW walker as well would help combat this compensatory motion as the combination of that with friction from the sock can be catastrophic inside the AFO. Numerous studies of socks cite the goal of socks being to reduce friction between the sock and the skin, control temperature, and to control humidity of the foot. (4,7) Wet socks vs dry socks tend to increase the risk of foot blisters.(4) Due to the CROW walker AFO being a totally enclosed orthosis, it is important to pay attention to the factors of heat that result. It is important to note that friction is aggravated by perspiration.(8,9) Studies have pointed out various fabrics available for socks and that looking at runners that put high friction loads on the plantar aspect of the feet that socks made of acrylic materials rather than cotton result in dramatic prevention of blisters.(5) With our patient, we recommended two to three socks changes daily as well throughout treatment.

## **Initial Fitting and Followup**

At delivery, a good total contact was achieved and we further shaved under the prominence and filled the area on the orthotic with PPT until the bottom looking from outside was again flat but contoured and accommodative on inside. A strong rocker sole was used due to the loss of all three rockers of ankle motion with the solid ankle design. We recommended that the

orthosis be worn all day and also reapplied in the nighttime when ambulating to the restroom. Due to patient's balance issues associated with his peripheral neuropathy, the contralateral shoe was built up to level the pelvis to proactively prevent the patient from taking a fall. It is important to note though that even with a rockered sole, the patient's balance was still negatively impacted massively with this loss of the three rockers of walking. Patient oftentimes used a walker in unfamiliar areas and avoided all terrains that weren't flat.

At each follow-up, the patient's ulceration was monitored and improvement continued. Patient after 9 months of treatment healed the ulcer as can be seen in Figure. Our goal then shifted to prevention of the ulceration from ever resurfacing. Education was provided to our patient on continued use of appropriate socks as discussed above as well as increased compliance to the orthoses described previously as well.

### **Discussion and Clinical Significance**

Goal of healing and skin closure was achieved (Figure 5) and then new goals of prevention strategies were discussed with the patient. Compliance was the factor that led to the initiation of the ulceration. The patient was instructed on the importance of being proactive vs treating retroactively the results of being noncompliant. We emphasized that he healed successfully the symptoms but that the underlying cause still remains. In other words, the friction created from poor sock choice and an ankle in ambulation without any support on to prevent the hindfoot valgus and accommodate the forefoot varus. It has been 5 years now since this CROW walker treatment and patient is doing well and absent of any ulceration on the foot. Replacement of the Foot Orthotics is scheduled on a rotation of three pair per year and then the Arizona replaced when worn out.

It is beyond the scope of this case study, but it is important also to educate your patient on the importance of maintaining the oil elasticity of the skin as well since with the symptom of any autonomic nervous system disorder, the diabetic peripheral neuropathic foot can be extremely dry and show evidence of fissures and cracking of the skin. So patients should be working closely with their physician that treats them for their diabetes on the best approach for them to maintain the optimal balance of moisture on the foot.

**Figure 1 Various Views of the Ulceration Throughout Treatment**



**Figure 2 Arizona AFO and Insert, CROW WALKER**



**Figure 3 Molded Insert Bringing Ground up to Meet Every Aspect of the Foot**



**Figure 4 CROW WALKER**



**Figure 5 All Ulcerations Healed**



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