PROLAB ORTHOTICS
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HISTORY OF FOOT ORTHOSES – PART 2

Last month, in my first newsletter for ProLab Orthotics, I described how custom foot orthoses have been used by medical professionals for at least 280 years for the treatment of mechanically-related foot and lower extremity disorders. In the many years since that time, foot orthoses have been continually modified using different materials and different construction techniques in an attempt to optimize the biomechanical treatment of mechanical pathologies of the foot and lower extremity.

Up until the late 1950s, custom foot orthoses were typically made by molding thin sheets of stainless steel into the shape of the plantar foot or using cork and leather to mold to the plantar foot. Each of these older materials used in foot orthosis construction had their specific advantages and disadvantages. Then, in 1958, a California podiatrist, Merton Root, began to construct custom foot orthoses out of thermoplastics, which were relatively new materials being used at the time (Root, M.L.: How was the Root functional orthotic developed? Podiatry Arts Laboratory Newsletter, 1981). Root's "functional orthosis", which he refined and developed during that time, was a thermoplastic orthosis with a relatively low medial longitudinal arch. He designed his "functional orthosis" with the belief that the subtalar joint (STJ) should function in the neutral position and that "compensations" for "rearfoot and forefoot deformities" should be prevented.

On the east coast, Richard Schuster, a professor of biomechanics at the New York College of Podiatric Medicine, approached the biomechanics of the foot and lower extremity and biomechanics of foot orthoses differently than his west coast contemporary, Merton Root. Rather than using a non-weightbearing method for making a mold for construction of orthoses, Schuster advocated a semi-weightbearing method for making a mold of the plantar foot (https://www.podiatrym.com/search3.cfm?id=15892). Schuster also preferred using flexible, non-compressible materials for orthoses (http://www.drpcoffin.com/biomechanics/schuster-biomechanics/). Many of the differences in how custom foot orthoses are currently constructed within the United States can be directly linked to the clinical beliefs of these west coast and east coast podiatric pioneers.

While working at the University of California Biomechanics Laboratory (UCBL) in Berkeley in 1967, W. H. Henderson and J. W. Campbell developed a high medial and lateral flanged foot orthosis with a very high "wrap-around" heel cup that they named the UCBL orthosis. These orthoses were specifically designed to treat flexible pes planus deformity in pediatric patients and are still in use today, especially within the orthopedic community (Henderson, W.H. and J.W. Campbell: U.C.B.L. shoe insert casting and fabrication. Technical Report 53. Biomechanics Laboratory, University of California at San Francisco and Berkeley, 1967). However, due to their poor shoe fit and tendency to irritate the medial foot of pediatric flatfoot patients, the UCBL orthosis never became popular within the podiatric community.

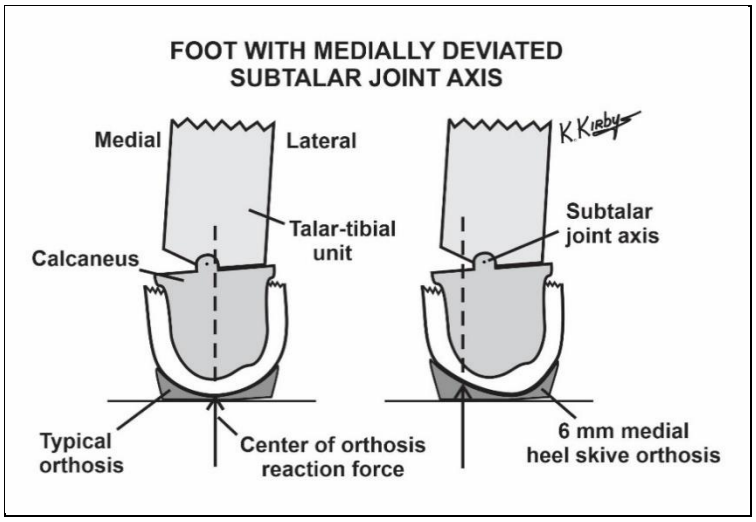

Figure 1. In a foot with a medially deviated subtalar joint (STJ) axis, a standard vertically-balanced Root style orthosis (left) will not shift the center of orthosis force toward the medial heel, thus losing the ability to create additional STJ supination moment. However, a foot orthosis with a varus-shaped heel cup due to the medial heel skive (right) will significantly shift the center of orthosis force toward the medial heel so that the orthosis can exert increased STJ moment on the patient's foot.

A new departure from traditional orthosis design was developed, in 1982, by Richard Blake, a podiatrist and Professor in Biomechanics at the California College of Podiatric Medicine in San Francisco. Dr. Blake came up with his unique foot orthosis design, named the Blake Inverted Orthosis (BIO), in response to his repeated observation that many of his runner-patients did not achieve sufficient "pronation-control" from more traditional Root orthoses in his sports

podiatry practice in San Francisco. To gain more pronation-controlling ability from his new foot orthosis, Blake used a highly inverted and deep heel cup and a flat rearfoot post in his BIO to better reduce pronation and relieve pronation-caused symptoms in his runner-patients. The highly inverted heel cup in the BIO was created by inverting the positive plaster cast of the patient's foot to 15^0, 25^0, or 35^0 frontal plane angles to increase the level of pronation-controlling ability in the orthosis (Blake RL: Inverted functional orthoses. JAPMA, 76:275-276, 1986).

Then, in 1992, after experiencing the success of Dr. Blake's inverted orthosis in outperforming the traditional Root orthosis in controlling pronation in his own patients, Kirby developed the medial heel skive (MHS) orthosis technique (Kirby KA: The medial heel skive technique: improving pronation control in foot orthoses. JAPMA, 82: 177-188, 1992). Rather than inverting the positive cast to produce a variable degree of varus-shaped heel cup in the orthosis as in the BIO, the MHS technique achieved its increased varus heel cup shape by "skiving" away from the medial aspect of the plantar heel of the positive cast of the patient's foot (Fig 1). The MHS orthosis design allowed a variable amount of varus heel cup shape to be ordered into the custom foot orthosis without affecting the frontal plane relationship of other parts of the foot orthosis.

The biomechanical effects of the varus heel cup shape produced in the MHS orthosis has been the subject of scientific research over the past decade. The MHS was found to produce an increase in peak pressure under the medial rearfoot in asymptomatic adults with a flat-arched or pronated foot posture (Bonanno DR et al: The effect of different depths of medial heel skive on plantar pressures. Journal Foot Ankle Research, 5(1):20, 2012). In addition, MHS orthoses were found to be effective in reducing pain and improving the functional performance in patients with patellofemoral pain syndrome (Bahramian F et al: The effect of custom-made foot orthoses fabricated with medial heel skive technique on pain and function in individuals with patellofemoral pain syndrome. Iranian Rehab Journal, 15(1):37-42, 2017) and in improving the physical function in individuals with flexible flatfoot deformity in their activities of daily living and in their sports activities (Bakhtiari F et al: Effects of custom-mold insole by medial heel skive technique on physical function in flexible flat foot. Iranian Rehab Journal. 19(2):181-188, 2021).

Another more recently introduced orthosis technique, the medial oblique shell inclination (MOSI) technique, was developed in 2011 by Paul Harradine and coworkers from the UK. The MOSI orthosis technique creates a varus heel cup shape within the foot orthosis to treat patients with medially deviated subtalar joint axes (Harradine P et al: The medial oblique shell inclination technique: a method to increase subtalar supination moments in foot orthoses. JAPMA, 101 (6): 523-530, 2011). In addition, in 1992, Kirby developed the lateral heel skive technique to treat patients suffering from pathologies due to excessive STJ supination moments, such as peroneal tendinopathy and lateral ankle instability. The lateral heel skive orthosis technique creates an increase in valgus heel cup shape in the orthosis to increase the STJ pronation moments during weightbearing activities (Kirby KA: Foot and Lower Extremity Biomechanics III: Precision Intricast Newsletters, 2002-2008. Precision Intricast, Inc., Payson, AZ, 2009, pp. 161-162).

As is evident from this brief review of foot orthosis history, for well over the past two centuries, the design and modifications to custom foot orthoses have been continuously changing within the podiatric and medical professions. During this time period, foot orthoses have evolved from simple wedges to complex, multi-part in-shoe medical devices that the podiatric physician may use to treat a number of mechanically-based foot and lower extremity pathologies. The modern podiatrist should not only be aware of the history of custom foot orthoses, but also should be aware of the numerous modifications that can be prescribed into their patients' orthoses. Even more importantly, the podiatrist needs to learn when these orthosis modifications should be ordered for each specific pathology. Continual educational improvement regarding foot orthoses will better enable the podiatrist to have a more successful custom foot orthosis practice.

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