

Whatever Happened to Root Theory?

These teachable theories remain the foundation of foot orthotic therapy.

BY JEFF ROOT

Most podiatrists are familiar with the work of Merton L. Root, DPM and the term “Root Theory”. What exactly is Root Theory? If you survey podiatrists you get different and sometimes conflicting answers. Why? One reason is because of how “Root Theory” has been taught at different podiatry schools. The nature and scope of podiatric education and practice varies significantly, especially globally. While this may be more evident with respect to surgery, it also applies to non-surgical treatments such as foot orthotic therapy.

Over the past several decades there seems to be increased controversy about “Root Theory”. I’m going to propose that there is really no such thing as “Root Theory”.

Root described clinical techniques for finding and using the neutral position.

Merton Root (1922-2002) is my father but I am writing this article not as his son, but as someone who has spent the past forty-six years working in the prescription foot orthotic industry. I will refer to my father as Root throughout this article. Root’s work can be broken down into different elements. Root proposed multiple theories. For example, he proposed the theory of the neutral position of the subtalar joint (STJ) and provided a specific definition of the STJ neutral position, and described clinical techniques for finding and using the neutral position. Root also proposed a structural classification system as well as theories about biomechanical function of the foot. For example, he proposed theories about functional compensation due to structural conditions such as forefoot and rearfoot varus and valgus, tibial varum and valgum, and other factors such as the orientation of joint axes. Root also proposed treatment theories, created specific examination techniques and techniques on how to fabricate custom foot orthoses.

Improving the Basic Terminology

When my father was a student at the California College of Chiropractic in the early 1950’s, he realized that the existing terminology used to describe foot structure and



Figure 1: Heel Bisection using Root’s palpation technique

function was ambiguous and therefore, inadequate. Root began the task of trying to better understand the function of the foot and the lower extremity. That task began with an effort to improve basic orthopedic terminology. After developing the concept of the neutral position of the STJ, he began to compare feet with the STJ in the neutral position and with the midtarsal joint (MTJ) fully pronated.

Continued on page 93

The Clinical Forum

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Eventually Root developed a system of classifying osseous conditions of the foot and lower extremity with the foot in this standard position. He also began to examine the range and direction of motion of the STJ, MTJ, ankle joint and the 1st ray while utilizing the neutral position of the STJ.

Terms like forefoot and rearfoot varus and valgus were in common orthopedic use prior to Root's work. But

Using his heel bisection and standard positioning techniques, Root proposed specific anatomical definitions for forefoot and rearfoot varus and valgus.

Root recognized that these terms lacked precise anatomical definitions. In fact, in many cases no distinction was made between the position of the foot and the anatomical structure of the foot. For example, the literature might describe the foot as being in valgus but was this due to a temporary position or was it due to some underlying structural condition? What criteria and clinical techniques were there to determine if and when the foot was in valgus besides the gross appearance of the foot?

In his quest to improve his understanding of the structure and function of the foot, Root developed a very specific technique for bisecting the rearfoot using palpation of the posterior aspect of the calcaneus^{1,2} (Figures 1 and 2) Using his heel bisection and standard positioning techniques, Root proposed specific anatomical definitions for forefoot and rearfoot varus and valgus¹. Root believed that these techniques, if universally adopted, would improve understanding and communication related to the structure and function of the foot.

The Biomechanical Examination

Root went on to develop a standard lower extremity biomechanical examination technique¹. Some of Root's techniques relied on examining the foot and segments of the foot with the STJ in the neutral position. It also involved examining the patient's non-weightbearing range and direction of motion at various joints. Many of Root's techniques became the basis of the standard biomechanical examination process used by podiatrists throughout many parts of the world. With the assistance of John Weed, DPM and William (Bill) Orien, DPM, Root wrote a *Neutral Position Casting Manual*³ and the books *Biomechanical Examination of the Foot*¹ and *Normal and Abnormal Function of the Foot*,⁴ the latter of which contain many of Root's theories about the function of the foot and lower extremity.

Prior to publishing these works, Root developed the Functional Foot Orthotic. Root et al.'s *Neutral Position Casting Manual* would later serve as a casting guide for students and practitioners who were interested in utilizing Root type functional foot orthoses in the treatment of



Figure 2: A completed Root technique heel bisection

their patients. Root developed a very specific functional foot orthotic fabrication protocol and he went on to teach it to students, podiatrists and many commercial foot orthotic laboratories.

Controversy

Root's work is not without controversy. In 2017 in a paper titled *Challenging the foundations of the clinical model of foot function: further evidence that the Root model of assessments fail to appropriately classify foot function* by Hana Jarvis, Christopher Nester et al.,⁵ the authors concluded that "We believe that the assessment protocol advocated by the Root model is no longer a suitable basis for professional practice. **We recommend that clinicians stop using sub-talar neutral position during clinical assessments and stop assessing the non-weight bearing range of ankle dorsiflexion, first ray position and forefoot alignments and movement as a means of defining the associated foot deformities. The results question the relevance of the Root assessments in the prescription of foot orthoses.**"

One of the major problems with this study by Jarvis and Nester et al. is the fact that the study is based entirely on clinical evaluations conducted by one assessor. This factor greatly weakens the study because all of the study's data and conclusions are based on the findings of a single examiner. The study found that 87% of the subjects had ankle equinus, 76% had forefoot varus and some 97% had rearfoot varus. These findings seem unusually high which calls into question the examiner's individual training and technique. The study should have employed multiple assessors rather than just one so that any variability related individual assessors and technique could be identified. Had this been done, the results and conclusions of this study may have turned out much

Continued on page 94

differently. Root himself found that forefoot valgus was more common than forefoot varus, yet the result of this study found an overwhelming (76%) of individuals had forefoot varus. This suggests that the assessor did not follow Root's technique or that the subject group was a far different anatomically than those examined by Root. Ironically, in the 70's and 80's it was common knowledge in the U.S. that east coast podiatrists found a much higher incidence of forefoot varus compared to west coast podiatrists. It should also be noted that Root used a Forefoot Measuring Device¹ (Figures 3A and 3B) to measure forefoot to rearfoot relationships in his subjects. It is possible that the lack of a common measuring instrument played a significant role in this discrepancy in anatomical findings.

While recognizing that there are flaws in some of Root's theories and techniques, it is unlikely that most podiatrists would accept these author's conclusions and the far-reaching implications of them. In fact, non-weightbearing neutral position casting and Root's Functional Foot Orthotic fabrication protocol are still extremely popular and in common use today throughout the world.

Tissue Stress Theory

Another critic of Root's work is Kevin Kirby, DPM. Dr. Kirby graduated from the California College of Podiatric Medicine and was a student of biomechanics professor John Weed, DPM. Weed was a former student of Dr. Root's and later became Root's partner in private practice. Kirby has written several articles criticizing Root's work and what has come to be called "Root Theory". Kirby wrote an article in 2015 titled *Prescribing Orthoses: Has*

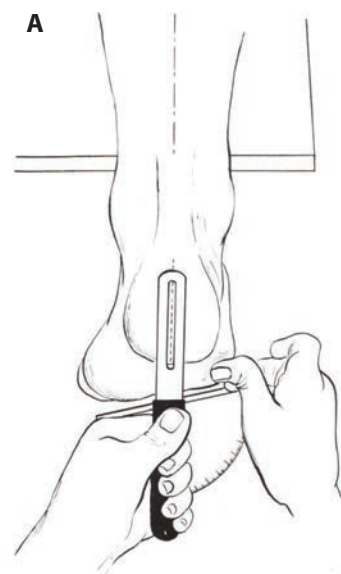


Figure 3 A and B: Root's Forefoot Measuring Device

Continued on page 95

*Tissue Stress Theory Supplanted Root Theory?*⁶ In his article Kirby advocates the use of the “tissue stress model for prescribing foot orthoses” and credits Thomas McPoil and Gary Hunt with popularizing the Tissue Stress Theory (TST) approach to foot orthotic therapy.

The concept of using an orthosis to reduce tissue stress was introduced as early as 1896 by Royal Whitman in his classic paper *A Study of the Weak Foot*⁷. The following are three excerpts from Whitman’s paper related to tissue stress:

“When the foot ceases to act or to be used as a lever it loses the support and control of the muscles which have balanced the weight in its proper relation to it, and the attitude of passive support must be assumed, in which ***the burden falls on the inner side and the strain upon the ligaments***. Whether this attitude is voluntarily assumed or whether it is forced upon the foot, the disuse of function

A functional orthosis only resists abnormal forces and promotes improved foot function.

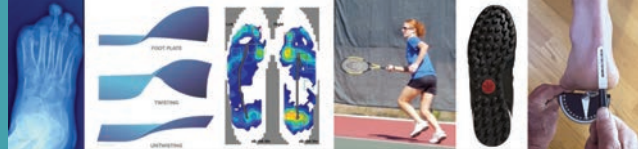
and ***the mechanical disadvantages to which the foot is subjected predispose to weakness and deformity***”.

Whitman continues “Not infrequently, early symptoms are pain and tenderness at the centre of the heel, explained in part by the jarring heel-walk which is always assumed when the foot is weak, and in part ***by the strain upon the attachments of the deep plantar ligaments***”. Whitman goes on to state “***The weak foot, because of inefficient ligaments and muscles, unable to hold itself in proper position, must in many instances be supported until regenerative changes have taken place in its structure***. Such support is necessary to retain the joints in proper position, otherwise normal motion is impossible, and ***to hold the weight in its proper relation to the heel and the strain in its normal relation to the foot***”.

In reading Whitman’s paper it is obvious that the concept of using a mechanical device to reduce pathological forces and stress on tissue existed over one hundred years before the concept was popularized by McPoil and Hunt. In fact, McPoil and Hunt themselves stated that “the tissue stress model is by no means a novel idea”⁸.

In response to a 1981 Consumer Reports Article *What to do when your feet hurt* which had a subsection titled “*Orthotics: An expensive name for arch supports*”⁹, Root wrote an editorial that was published in the California College of Podiatric Medicine’s Pacesetter publication. Root stated “An orthosis that is prescribed to resist specific abnormal forces identified by examination and is designed to promote improved function of the foot is called a functional orthosis. A functional orthosis does not support the arch of the foot. A functional orthosis does not “balance” a foot. ***A functional orthosis does not***

Continued on page 96



hold a foot in any position. A functional orthosis does not accommodate lesions or painful areas of the foot. **A functional orthosis only resists abnormal forces and promotes improved foot function.**¹⁰

Some critics have claimed Root believed that a functional orthosis should “hold the STJ in the neutral position”. This is a common and gross misunderstanding or an outright misrepresentation of Root’s body of work. As Root clearly stated above, a functional orthosis does not “hold a foot in any position” and that it merely acts to “resist abnormal forces”.

On the surface the tissue stress theory approach to foot orthotic therapy seems logical but there are a number of problems with employing it. One of the primary problems is the lack of any standard and accepted biomechanical examination technique by those advocating the use of TST. For example, McPoil and Hunt evaluated the passive range of subtalar and midtarsal joint motion in their patient assessment and describe it as being “within normal limits”. They also evaluated the first metatarsophalangeal joint extension with the ankle joint in neutral and describe it as being “within normal limits”. Although McPoil and

Jarvis and Nester stated that “None of the deformities proposed by Root et al. were associated with distinct differences in foot kinematics during gait, and static and dynamic parameters were not correlated. Even if this were true, why throw out the totality of Root’s teachings based on one perceived weakness of predicting posture during gait?”

Dr. Kirby has written and lectured extensively about biomechanics and foot orthotic therapy. In Kirby’s lectures and writing he routinely talks about forefoot and rearfoot varus and valgus and the neutral position of the STJ¹¹. How does Dr. Kirby define and determine the presence of forefoot varus or valgus? Does Kirby accept Root’s definitions, which depend on use of the STJ neutral position while fully pronating the MTJ as described by Root? If not, how does Kirby define and identify these conditions? Kirby does describe using Root’s neutral position casting technique and functional foot orthotic fabrication protocol. If Kirby is using some of these “Root Theory” concepts, then why would he claim that TST has “supplanted Root Theory”? At best, TST augments aspects of “Root Theory”. And like McPoil and Hunt, Kirby’s approach demonstrates a stark contrast to Jarvis and Nester, who concluded that “clinicians {should} stop using sub-talar neutral position during clinical assessments and stop assessing the non-weight bearing range of ankle dorsiflexion, first ray position and forefoot alignments and movement as a means of defining the associated foot deformities.”

McPoil and Hunt wrote ““The intent of this paper is to review these three problem areas which have been identified with the Root et al. theory as well as to propose the use of a “tissue stress model” which the authors have found to be an effective alternative for evaluating and treating foot disorders”⁸. The authors go on to write “As long as the individual maintains the level of tissue stress within the elastic region, tissue irritation and inflammation will most likely be maintained at a tolerable level, with overuse injury avoided”. Unfortunately, clinicians have no method for measuring tissue stress to determine if their intervention has actually altered tissue stress in order to maintain stress within the elastic region. And just like Jarvis, Nester et al., the authors provide no guidelines for casting/scanning the foot or for how to prescribe and manufacture foot orthoses.

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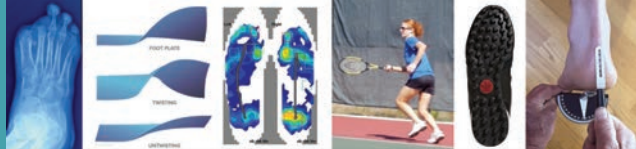
Hunt’s TST approach to foot orthotic therapy was advocated by Hana Jarvis, Christopher Nester et al. in their paper, the latter recommended clinicians stop using the very non-weightbearing assessments employed by McPoil and Hunt, who advocated the TST approach. This contradiction in the biomechanical examination process advocated by these two prominent groups of researchers and TST advocates outlines one of the major problems in implementing the TST approach to foot orthotic therapy.

Another problem with TST is the lack of any standard or specifically defined casting position and casting technique, and the lack of any standard protocol for prescribing and manufacturing foot orthoses. Jarvis, Nester et al. wrote “This questions the perceived importance and continued clinical use of ‘subtalar joint neutral’ **to both define deformities and for capture of foot shape as part of foot orthosis prescription**”. Unfortunately, these researchers don’t provide any alternative to Root’s system for evaluating foot structure and function or for casting/scanning the foot and for prescribing foot orthoses. The authors also do not provide any guidelines for producing foot orthoses using the tissue stress approach. Most importantly, Jarvis, Nester et al. did not conduct a study on the TST approach to treatment or demonstrate an alternative approach to treatment that is as—or more—efficacious than that proposed by Root.

Irreplaceability

Root, with the assistance of Orien and Weed, put many of his theories and techniques in writing so that others could utilize, evaluate and test them. While it may seem easy to find flaws in “Root Theory”, it is far more difficult to replace it. Root’s work has and continues to contribute to the successful treatment of millions of people throughout the world. It would be difficult to practice modern day foot orthotic therapy without utilizing some of Root’s techniques and theories. I would argue that there is no such thing as “Root Theory” and that it cannot be simply accepted or rejected due to the broad scope and nature of Root’s work. It is interesting that many critics of Root’s work criticize it as being un-

Continued on page 98



reliable but offer nothing clinically that can replace it. As previously discussed, key advocates of the TST appear to be deeply divided on how to implement the TST approach to foot orthotic therapy, thereby making the TST model impossible to teach, evaluate and test.

Foot orthotic therapy has been in a constant state of evolution since the days of the first shoe inserts hundreds of years ago. In order for modern-day foot orthotic therapy to be more efficacious, there needs to exist teachable theories, clinical guidelines and standard practices. Tearing down the foundations of foot orthotic therapy and building a new model with no real foundation does not seem like a recipe for future success. In the absence of a more coherent and testable model, who can blame podiatrists for continuing to practice “Root Theory” in the treatment of lower extremity-related pathology? **PM**

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¹⁰ Merton L. Root, California College of Podiatric Medicine, Pacesetter Volume II, Number I March-April 1982

¹¹ Kevin Kirby Foot and Lower Extremity Biomechanics, Precision Intercast Newsletters Vol. 1-4



Jeff Root was the owner and president of Root Lab and is currently president of KevinRoot Medical, a custom foot orthotic and AFO manufacturer. Mr. Root was president of PFOLA (the Prescription Foot Orthotic Laboratory Association) and has worked in the foot orthotic industry for forty-five years.