



Dynamic Chiropractic – September 23, 1996, Vol. 14, Issue 20

Orthotic Casting Methods: a "Weighty" Discussion

By Kim Christensen, DC, DACRB, CCSP, CSCS

Since the publication of my last column on orthotics ("Orthotic Therapy for Musculoskeletal Shock," April, 8 1996 issue, pp. 24-25), I have been asked about the methodology for casting orthotics. Which process is best: weightbearing or non-weightbearing? Does the patient or doctor benefit through one concept over the other? Let's take a look at this "controversy."

Functions of the Feet

The feet serve three important purposes: support, locomotion, and shock absorption.¹ Support is through the "closed kinetic chain" concept.^{2,3} Locomotion relates to the gait cycle,⁴ both the stance and swing phases. Shock absorption begins with the heel fat pad and continues through the normal pronation mechanism at the subtalar joint complex.⁴

If any one of these functions is impaired, the body's biomechanical abilities can be affected. Because all three functions occur during the stance phase of the gait cycle, the body's weightbearing status becomes crucial when evaluating function and dysfunction.⁵

Rationale for Casting

Foot castings or impressions capture accurate images of the feet, which, in effect, become the "blueprints" for orthotic devices. The orthotics are then utilized to correct, support, align, and prevent dysfunction of (or improve function of) movable body parts.⁶ These devices can not only improve lower segment malalignment syndromes, but can also give relief to the patient.⁷

For any corrective foot orthotic to successfully lead to better control of pronation of the subtalar joint in the foot, certain criteria must be met. The correction must:

- result in an overall net increase in supination moment across the subtalar joint axis;
- be relatively comfortable and not cause other significant symptoms of pathology to occur; and
- be able to fit into available shoes that will not detract from the overall pronation control features of the orthosis.⁸

Casting Methods

Over the years, a variety of systems have been created in an attempt to record accurate foot images. These systems have ranged from plaster forms to vacuum bagging, heat molding, water gels, foam impressions, and force prints. The main difference involves the position of the foot when the image is obtained: neutral in-the-air (non-weightbearing), or standing (weightbearing).

ARNETTA: PLACE FIGURE 1

Non-Weightbearing Casting

For years, podiatrists have used the non-weightbearing process in making rigid orthotics. There is first an attempt to establish the "talus neutral" position, then an orthotic is built from a complex prescription. This approach can accommodate significant structural deformities, but claims of rigid control have not been validated, and the reliability of the measurements with the foot in the air has been questioned.⁹ Donald E. Baxter, MD, president of the American Orthopedic Foot and Ankle Society, believes that "the 'neutral' or 'corrected' subtalar position is ill-defined and not physiologically reproducible. Furthermore, the subtalar joint ranges through nearly 40 degrees of motion during running and we can't determine which of these 40 degrees is the 'correct' position ..."¹⁰

This approach has other disadvantages: a lack of data on the amount of support or laxity of foot joint ligaments; arch collapse and the extent of plastic deformation of fasciae; and the extent of abnormal metatarsal weightbearing. With the non-weightbearing method, significant additional training and

experience is required in order to produce a reliable cast. Also, the standard method of prescribing corrections is very complex and time consuming,¹¹ and modifications and patient complaints are both frequent. Iatrogenic biomechanical problems are a common occurrence, as well.

Proponents of the non-weightbearing method point to the need to determine subtalar neutral; however, studies assessing the reliability of goniometric measurements at the subtalar joint have been sparse. The measurements of calcaneal inversion and eversion are "crude and inexact" according to James, et al.¹² It is therefore necessary to average several separate measurements, to establish the most reliable estimate.

Two methods have been reported in the literature for the measurement of subtalar joint neutral. The first is a mathematical formula based on measurement of calcaneal inversion and eversion.¹³ The second method derives through palpation of the head of the talus.¹⁴ Debate continues as to which method is most accurate and/or reliable. This question becomes important because the amount of posting in a foot orthotic is frequently based on the subtalar joint neutral position in combination with lower extremity findings.

Some health care professionals place a lot of emphasis on the non-weightbearing measurements of the calcaneus and subtalar joint neutral. However, subtalar joint motion normally takes place through a closed kinetic chain which may not reflect the amount of motion if measured in a non-weightbearing position.

Weightbearing Casting

An image of the foot when bearing weight provides real-life, position-of-function information.¹⁵ Baxter states that "[P]lacing the foot in the functional weightbearing position as the starting point for constructing your ideal orthosis seems to make physiologic sense and customizes the subtalar position for each athlete."¹⁰ A skilled technician can take a good weightbearing impression and determine the extent of overpronation, plastic deformation of the arches, metatarsal weightbearing and foot imbalance.

Weightbearing casting also results in a much more accurate orthotic fit, since the actual length and width of the foot are assessed. Corrections are well tolerated by the patient, keeping modifications at a minimum. The resultant orthotics balance the feet, which helps to stabilize the entire kinetic chain structure.

Some studies have shown significant differences between weightbearing and non-weightbearing measurements: Smith-Oricchio and Harris say: "[W]eightbearing measurements are more accurate to take because the examiner is not required to passively move the calcaneus, thus removing some of the potential source of error from the protocol."¹⁶

Conclusion

A weightbearing casting of the feet gives an image of the musculoskeletal structure in the position of function. Such a casting procedure can lead to an orthotic which is made to help correct and balance the feet and stabilize the kinetic-chain structure of the body. Weightbearing meets the functional demands imposed by the gait cycle, and allows for the soft tissue deformation encountered in weightbearing posture to be considered in the design of the orthotic.

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Kim Christensen, DC, DACRB, CCSP
Ridgefield, Washington

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