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Key Insights On Digital Casting Techniques

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Digital casting reportedly facilitates more control of the orthotic impression, better efficiency and greater cost savings than plaster casting techniques. This author assesses the literature, shares biomechanical insights and offers pertinent tips on casting technique.

Digital scanners are affordable, save time for the practitioner and staff, and provide comparable outcomes to traditional plaster casting techniques. Techniques for digital casting range from traditional non-weightbearing subtalar neutral position casting to partial weightbearing casting. Regardless of the preferred technique, one can achieve the same outcome in the custom foot orthotic. The digital age has arrived and we can no longer ignore it.

The plantar foot impression is one of the key components in the creation of a custom foot orthotic. Traditional techniques for the creation of a negative cast of a patient's foot have utilized plaster almost exclusively. Plaster, of course, can be a messy procedure for both the patient, the practitioner and office assistants. Plaster casting takes time as well, reportedly taking an average of 11 minutes according to a cost benefit analysis study.[1]

While there are many other options for impression casting besides plaster, with the advent of digital technology in the custom foot orthotic manufacturing industry, more and more foot healthcare practitioners are turning toward digital scanning or casting of patients' feet.

According to a cost benefit analysis study which compares plaster impression casting versus digital impression scanning, plaster casting costs anywhere from $28 to 50 per casting event versus $3 to 11 per digital optical scanning event.[1] While plaster casting averages 11 minutes, digital optical scanning only takes two minutes on average. This shows a consistent potential time savings for busy practitioners and the ability to quickly make up the initial investment in the acquisition of a digital scanner.

There can be a large cost savings as well due to the elimination of shipping plaster casts to the lab for manufacturing and the potential risks of damage occurring to the plaster casts during shipment. Obviously, the initial investment in the acquisition of a digital scanner can be large but the study seems to support a significant return on investment through savings in both time and the materials that are used in the plaster casting technique.

Traditional plaster casting positioning usually consists of having the patient in a sitting, supine or prone position during the plantar foot impression. For most practitioners who are considering the use of a digital scanner, the first question they usually ask is: How exactly does one take the cast impression utilizing the scanner?

Knowing whether one can position the scanner in such a way so as to match a practitioner's usual impression casting style is very important. Most systems come with stands that allow for a variety of positioning for the scanner and the practitioner using it. It is also important to know there are other reliable and repeatable ways to capture a digital impression image.

Digital foot impression casting consists of: utilizing a digital scanner of some type such as a contact or non-contact optical laser scanner; a pressure pin digitizer; 3D image capture through digital photography or video, or a pressure mat system.

Debating Partial Weightbearing Versus Non-Weightbearing Casting

Most of the scanners mentioned utilize either a non- or partial weightbearing position when scanning the foot. The scanners allow for a true 3D representation of the plantar foot and, to some

extent, the sides of the foot and heel in that either the laser light, the pressure pins or the 3D image reconstruction are able to wrap around most of the architecture of the foot during scanning.

Pressure mat scanning uses static or functional evaluation of the full weightbearing foot. In most instances, pressure mat scanning cannot scan or come into contact with the complete architecture of the plantar surface of the foot. This form of scanning also cannot make a sufficient outline of the sides of the foot or the posterior heel.

Several studies have attempted to prove that a three-dimensional image can be constructed with the patient walking over a two-dimensional pressure mat.[2,3] While static and functional pressure images of the foot can provide much beneficial information, the ability to create a truly custom conforming, three-dimensional image from the patient simply standing or walking over a two-dimensional pressure mat is still questionable.

Studies comparing plaster impression casting, digital impression scanning and foam box impression casting have attempted to make some sort of determination on reproducibility and repeatability of the processes (i.e. plaster technique, digital imaging or foam box casting).[4-8] The studies focused on arch height comparisons and comparisons of the forefoot to rearfoot relationship and heel width to an independent assessment of the patient's foot in non-weightbearing neutral position. It is not surprising to learn from the studies that the non-weightbearing casting, whether the researchers employed digital scanning or plaster, were most consistent to independent practitioner evaluation of the non-weightbearing foot.

In many of the aforementioned studies, feet cast in partial weightbearing often had lower arches, both medial and lateral, as well as wider heels. The forefoot to rearfoot repeatability often had little if any difference whether the patient was in a non-weightbearing or partial weightbearing position.

Many practitioners have found the partial weightbearing technique easier to learn. This is apparently due to the reference of the foot to the flat plane of the scanner or foam box. It also may be due to the positioning of the hip, knee and ankle all being at 90 degrees during casting. With experience using the partial weightbearing technique, I have been able to reproduce almost exact devices from either technique, non-weightbearing or partial weightbearing scanning or casting.

There are definitely problems with some of these studies in relation to their performance of partial weightbearing casting and scanning. First of all, most of the practitioners who were involved in the casting studies were already familiar with non-weightbearing plaster casting. However, most of them had little, if any, experience with partial weightbearing casting of any type.

When the studies looked at partial weightbearing casting, using digital scanning or foam boxes, there was a very glaring error in the technique utilized because researchers made no attempt to "lock" the midtarsal joint during the partial weightbearing casting technique.

Key Biomechanical Considerations In Addressing The Forefoot Component

As stated in the Root text, "With the subtalar joint in its neutral position, and with the forefoot pronated to its maximum about both axes of the midtarsal joint, the plantar plane of the forefoot parallels the plantar plane of the rearfoot. In this position, the forefoot is locked upon the rearfoot so as to resist any further motion of the forefoot in response to any dorsiflexion or eversion forces directed against the planter surface of the forefoot by ground reaction."[9]

Plantarly loading the lateral column of the foot under or near the fourth and fifth metatarsal heads while dorsiflexing the forefoot is the accepted technique for "locking" the midtarsal joint while the subtalar joint is in the neutral position. The importance of this positioning is that the forefoot is dorsiflexed while it is pronated. It is important when utilizing this technique not to overload the lateral column, which can cause the subtalar joint to pronate and then allow the midtarsal joint to dorsiflex and abduct in compensation.

In a study comparing practitioner variability when utilizing subtalar neutral position casting of the foot, the researchers took an interesting step. Researchers looked at casts taken in a neutral subtalar joint position with both the midtarsal joint pronated and supinated about the long axis to decide if this made a difference in the variability of the forefoot to rearfoot relationship.[10]

The same practitioner did all the casting for this portion of the study. The practitioner did five casts with the midtarsal joint pronated and utilized an adductory force to the lateral forefoot. The practitioner also did five casts with the midtarsal joint supinated and utilized an abductory force to the lateral forefoot. According to their cast assessment, the researchers found this did not make any significant difference in the repeatability of the casts or in the comparison of the forefoot to rearfoot relationship.[10]

The study of the midtarsal joint, midfoot and forefoot function has been a focus of much research over the past few years. Forefoot positioning is very important when it comes to non-weightbearing neutral position casting techniques, especially in reference to the “maximally” pronated midtarsal joint of the foot, the so-called “locking” of the midtarsal joint and the reduction of forefoot supinatus via plantarflexion and adduction of the medial column of the foot.[11]

Some of the studies evaluating the forefoot and midfoot joint ranges of motion have found a significant amount of range of motion available within the sagittal plane between the midtarsal bones of the cuboid and the fourth and fifth metatarsal bases, and the navicular, cuneiforms and the metatarsal bases one through three.[12-14] Many practitioners regularly cast out the supinatus found within the medial column of the foot.[11] This technique consists of plantarflexing and adducting or pronating the medial column or first ray of the foot to reduce the soft tissue supination component, which often mimics a forefoot varus.

A Guide To Casting Technique

For the last five years, I have used one technique for partial weightbearing scanning or casting. This consists of having the patient place the foot on the scanner with the hip, knee and ankle joint all at 90 degrees. One then adducts or abducts the knee, which pronates and supinates the foot respectively while the foot remains fixed on the flat surface of a digital scanner.

The practitioner then seeks to find the subtalar neutral position by either palpating the talar head or assessing the equalization of pressures between loading the dorsal aspect of the first and fifth metatarsal heads against the scanner. The foot at this point is being loaded both from a plantar direction via the scanner surface and via gravity and the weight of the patient’s leg and foot against the scanner. During the actual scan of the foot, the metatarsal heads of the first and fifth metatarsals are lightly to moderately loaded at their dorsal surfaces. Due to this positioning, one can consider the forefoot to be dorsiflexed while the ankle is at 90 degrees.

This technique seeks to balance the dorsiflexory forces of the forefoot at both the first ray axis and also the long midtarsal joint axis. This is an attempt both to “lock” the midtarsal joint and reduce the medial column supinatus. To reduce the supinatus, one should position the forefoot in such a way that the medial column is pronated to maximize the medial column arch height.

One can achieve this via pressure dorsally to the first metatarsal head or by lightly extending the hallux at the first metatarsophalangeal joint. Physicians can achieve this positioning at the lateral column as well by exerting pressure dorsal to the fifth metatarsal head or by lightly dorsiflexing the fifth toe at the metarsophalangeal joint. This technique will help to maximize the lateral arch height as well. I also believe this technique helps support the medial column and the midtarsal joint at its potentially highest arch shape.

Ultimately, no matter what technique (non-weightbearing or partial weightbearing) you are comfortable using now, digital scanning has been at least as reproducible and repeatable as plaster casting.

Understanding The Impact Of Digital Scanning On Orthotic Prescriptions

After scanning the patient’s foot, the real significance of utilizing a digital scanner can come into play. After traditional plaster impression casting, practitioners learn to evaluate the plaster impression to determine whether they took a proper cast. Sometimes during this comparison, practitioners determine that the impression does not meet their desires.

This usually means that one must take a new plaster impression. This adds extra time and, at times, frustration to already busy days. Due to the programming with many types of digital scanners, one can view the finished scan from many different angles to determine whether the scan achieved exactly what you set out to capture for your patient. The practitioner can make a good comparison of the forefoot to rearfoot relationship to correlate the initial measurements and ensure that the conformity of the scan matches the patient’s foot shape exactly as you meant to capture it.

After determining that the digital impression meets your standards, you can then finish the prescription by filling out the orthotic form digitally. This will go to the lab of choice for finishing the custom foot orthotic exactly as preferred.

Some scanning software, such as the Correct and Confirm software (Amfit), allow one to add specific modifications to the scan or digital image that will be built into the finished orthotic in such a way that it will be visible right on the screen. This gives the practitioner great control in the determination of how their product will turn out, leaving little guesswork in the process. The physician can utilize many different modifications such as medial heel skives, metatarsal pads, varus or valgus forefoot and rearfoot wedges, heel lifts and accommodations or cutouts.

After completing the scan and filling out the prescription form, one can save the digital images for electronic transmission later in the day to the lab of choice. The patient's custom foot orthosis will be manufactured within days and shipped shortly thereafter. There is no need to wait for the plaster to dry and for the shipping company to deliver the plaster cast to the lab. Those costs and that time are now eliminated from the process.

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