A Comparison of Different Casting Methods and How They Affect the Orthotic Device Produced.

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PED 121

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The exact essay title that was suggested was as follows: “In order to make custom orthoses an impression of the foot must somehow be taken. Describe the advantages and disadvantages of different casting methods and how they may affect the orthotic device that is produced.”

As a pedorthist we tend to focus on casting technique as per convenience, the method first taught to us, what C. Ped (C) Bill does, the time it takes and cost of the casting material or the latest thing a sales rep has shown us. The most important thing we should be considering is the difference each negative casting technique makes on the positive cast because there are many considerations that need to be made.

I have always felt that a plaster slipper cast yields a smaller orthosis than a biofoam cast. I can not remember ever reading a paper or listening to a presentation about this but by osmosis, I just seemed to know. I feel pedorthic education seems to focus on clinical skills rather than the importance of a good cast and the ability to design a pair of orthoses fittingly to the cast taken.

I decided to perform a little subjective and simple experiment with the most common casting techniques to pedorthists. Three negative casts were taken of my right foot in subtalar neutral: prone-plaster slipper, supine-plaster slipper and seated biofoam. My foot was landmarked with an indelible pencil at the calcaneal bisection, 1st met head & 5th (plantar and sides) met head which transferred to the negative cast. A plaster mixture was poured into the negative cast to create a positive cast. The positive cast was simply cleaned, obvious foreign bumps/imperfections removed, and the landmarks transferred/reinforced. The positive casts were then further landmarked to created consistent points to measure from, as follows: (see attached pictures) I used a modified
version of the method set out by J. W. Philps in “The Functional Foot Orthosis” (Chapter 5, also refer to page 49, fig. 5.18)

1. The positive cast was placed on its plantar surface and a line (1cm + thickness of pencil) was drawn around the perimeter of the cast.
2. The positive cast was then placed on its dorsal surface and the center of the heel (widest part, transverse plane) was marked.
3. The distance between the intersections formed between the center (transverse) heel mark and the medial & lateral perimeter line served as the point of Heel measurement.
4. The distance between the intersections formed between the already transferred 1st and 5th met heads (sides) and the medial & lateral perimeter line served as the MTPJ measurement.
5. A Brannock device was used to measure Arch Length, the already transferred line on the 1st met head was used as the distal reference point. The reading was simply measured in millimeters with a standard ruler.
6. All measurements were taken with a digital caliper, with the exception of Resting Calcaneal Bisection in which a Magnetic Polycast Protractor was used.
7. Medial longitudinal arch height was measured at the apex of the arch along a longitudinal line drawn from the bisection of the 1st met head and the existing medial heel cup line.
8. One experienced C. Ped (C) performed all castings.

The following table represents the summary of my measurements of the negative casts yielded from each of the positive casting techniques used:

<table>
<thead>
<tr>
<th></th>
<th>Heel Width (mm)</th>
<th>MTPJ Width (mm)</th>
<th>Arch Length (mm)</th>
<th>Relative Arch Height (mm)</th>
<th>Resting Calcaneal Bisection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prone Plaster Slipper</td>
<td>68.42</td>
<td>97.61</td>
<td>175.0</td>
<td>29.0</td>
<td>3 varus</td>
</tr>
<tr>
<td>Supine Plaster Slipper</td>
<td>72.3</td>
<td>99.10</td>
<td>180.0</td>
<td>31.0</td>
<td>5 varus</td>
</tr>
<tr>
<td>Seated Biofoam Cast</td>
<td>72.68</td>
<td>104.85</td>
<td>188.0</td>
<td>26.0</td>
<td>2 varus</td>
</tr>
</tbody>
</table>

So how do these measurements affect the final orthoses? First, I feel we should discuss the need to modify the positive cast before manufacture. To summarize J. W. Philps (The Functional Foot Orthosis, 2nd Ed. pg. 39) he describes the modification of a positive cast.
is a procedure that, “involves a harmonious blend of technical skills together with certain empathy for the foot and its comfort when wearing the orthosis.” Philps goes on to suggest some of the purposes of plaster cast modification:

1. Removes the risk of blisters in the medial longitudinal arch.
2. Allows for tissue spread around the heels.
3. Allows for elongation of the weight bearing foot.
4. To encourage or effect a redirection of forces through the foot.

**The following are some of my opinions based on the observations:**

**The prone plaster cast yields the narrowest heel width at 68.42 mm which is 3.88 mm < the supine plaster cast and < 4.26 mm the biofoam cast.**

This measurement is very significant to the width of the heel cup on our completed orthoses.

If the heel cup is too narrow, your patient may be irritated as the heel cup will dig in to the plantar aspect of the heel. Special attention should be given to expanding the plaster negative of a plaster slipper cast prone>supine to avoid this potential problem.

If the heel cup is too wide, your patient will have shoe fitting issues, will lose function support and the plantar calcaneal heel pad will not be contained. In regard to the biofoam cast, attention should be given to avoid plaster expansion at the heel as the fat pad has already been expanded sufficiently to accommodate weight bearing.

**The prone plaster cast yields the narrowest MTPJ width at 97.61 mm which is 1.49 mm< the supine plaster cast and <7.24 mm the biofoam cast.**

The distal width of the orthotic shell is determined by the bisection of the 1st and 5th MTPJs. (Clinical Biomechanics of the Lower Extremity, Valmassy pg. 300 fig. 13.3) The wider the cast the wider the distal shell unless you grind it narrower. In this case the biofoam cast is almost 3/8” wider than the prone plaster cast, which is quite significant when putting the final product in the shoe.

This measurement is very significant to the width of the distal end of our orthotic shell, especially when added flanges/clips/wings are added to the orthoses. If the MTPJ is too narrow we run the same risk as above with the heel cup, the shell digging into the plantar aspect of the foot. If the cast is too wide, the added flanges/clips/wings are of no functional use/control and take up unnecessary room in a shoe.
**The prone plaster cast yields the shortest arch length at 175.00 mm which is 5 mm < the supine plaster cast and < 13 mm the biofoam cast.**

Generally, it is accepted that we cut our distal shell 10mm proximal to the 1st MTPJ and 5mm proximal to the 5th MTPJ, (The Functional Foot Orthosis, JW Philps pg 40 fig. 5.1) to allow best functional support and minimize impinging flexion of the MTPJs. This measurement is significant as it will dictate the overall length of the final orthotic shell. The prone cast yields a cast that is over 1/2” in the difference thus a technician may want to cut the distal edges of the orthoses closer to the MTPJs than previously suggested to avoid making a very short shell. The short shell could result in irritation under the medial long arch and would tend to be undercorrective. If the distal aspect of the shell was left too long by not adhering to the above recommendations, the pedorthists runs risk of creating potential iatrogenic injury to their patient by limiting natural flexion at the MTPJs.

Due to the large difference of arch length between the prone cast and the biofoam cast, one would need to question the extra expansion/movement of the foot during the biofoam casting process.

**The supine plaster cast has a higher medial longitudinal arch than the prone plaster cast by 2mm, and much higher than the biofoam cast by 5mm.**

Medial longitudinal arch height is a subjective measure but it has to be taken into consideration when building the orthoses. Arch filling a positive cast is done to allow for fat pad expansion, arch lowering from nwb to wb, and controlling the midfoot during midstance. The more arch fill you add to a positive cast the less corrective your final orthoses will be through the medial long arch & the less arch fill-the more corrective.

The biofoam cast yields the lowest arch due to the fact that it was taken semi-weight bearing (so it already has natural expansion) vs. the prone and supine plaster casts that were taken NWB. Michaud (p. 203) suggests that we add ¼” (5mm) arch fill to our cast, so by applying this recommendation, the supine plaster cast would yield a more supportive arch while the semi-weight bearing cast would yield a less supportive arch, even though the same amount of plaster arch fill was added to each cast! The pedorthist has to take into consideration that the cast dictates the starting point of the correction, thus they have to recommend more arch fill if they want less correction and less arch fill if they want more correction.
**The Resting Calcaneal Position of a negative cast should help us to consider our posting options:**

As you may notice, I did not say Rear Foot angle due to the fact that we can not measure a rear foot angle without a tibial reference line. In my case I have been approximated to have a NWB, rearfoot varus of about 4-5 degrees, while my forefoot is neutral. My relaxed calcaneal stance is also neutral. It has been suggested by the experienced C. Ped (C) to add a 3 degree extrinsic rearfoot varus post to my custom foot orthoses for better heel strike and midfoot control.

So, for argument sake let’s take his advice and add 3 degrees extrinsic posting to my custom foot orthotic. (No balancing to the forefoot) Doing so will yield three different resting positions of rearfoot shell of the orthoses: Plaster-supine- 8 degrees varus, Plaster-prone-6 degrees varus & biofoam-5 degrees varus. Consecutively, each one more functionally supported than the other.

As a pedorthist, we have to recognize that by positioning the foot in subtalor neutral, we are already adding correction to the cast we are taking thus we may need to add, take away, or not use posting according to the cast technique used to avoid over/undercorrection.

In conclusion, I have had many discussions with a fellow C. Ped about the best ways to cast: plaster, biofoam, STS sock, wax, direct mold, Amfit, force plate, scanning, weight bearing, non-weightbearing, semi-weight bearing, dynamic and the list goes on and on…. Refer to “Contemporary Pedorthics” (Decker/Albert pg. 260) for some more research for the advantages/disadvantages of casting methods. What I have discovered is that there is no best way to cast a patient. A pedorthist has to be diverse enough to cast in multiple ways to accommodate the needs of the patient. For example a pregnant lady may not be able to lay prone while you plaster cast her, a patient with a Stress # doesn’t appreciate you pushing on the dorsal aspect of their foot while taking a biofoam cast and some patients move their feet around trying to see you as you plaster cast them in the supine position. Every casting method has it’s strengths and weakness, it is up to the pedorthist to recognize what they are and how they can utilize them to their advantage.

Along with casting technique/ability, a pedorthist should pride themselves on their ability to design a pair of orthoses. Many pedorthists do not want to focus on the technical side of their trade by actually manufacturing but you should be able to recognize and articulate your lab order as to your casting method. The pedorthist should understand what and how is being done to their negative cast at the lab.
Casting and orthotic design, all “boils down” to this old saying: “A carpenter doesn’t blame his tools!” I don’t feel there is one best casting method however, I feel our little experiment addresses the fact that different casting methods yield different results but as long as we address the advantages/disadvantages of our chosen casting method and hone our casting skills our patients will get the best final orthoses available.

**Research Texts/References/Consultations:**


Foot Orthoses and Other Forms of Conservative Foot Care, Thomas Michaud

Contemporary Pedorthics, Decker/Albert

Clinical Biomechanics of the Lower Extremity, Ronald Valmassy

Reducing Bulk in our Orthotics-presentation, Mark Glen, C. Ped

Casting- Freeman Churchill, C. Ped (C)