Why most orthotic inserts don’t work

As a Lab owner and clinician of some 20 years it’s always been of interest to me how many patients attend my clinic with previously prescribed orthoses which have either been clinically unsuccessful or which were never worn due to the discomfort they caused. When we first started making orthoses most patients who attended our clinics had never worn custom orthoses. Over the years this trend has changed and I now see many patients who have previously been issued with orthoses.

These patients are understandably sceptical about orthoses and given that many of them have previously parted with a great deal of money they are also understandably sceptical and distrusting of our profession. These unsuccessful outcomes are occurring against a backdrop of technological advances like dynamic foot pressure systems, video gait analysis, 3D foot scanning. These have facilitated greater understanding of the foots movements and have led to ever more complex biomechanical theories and concepts emerging. One could be forgiven for thinking that all the advancements in biomechanical technology would lead to a concomitant improvement in orthotic management outcomes but this does not appear to be the case. If not it begs the question “where are we going wrong?” The science of Podiatry biomechanics has become incredibly complex and at times completely baffling. So much so that one lab technician recently asked “why is it when one of our customers does a Masters in biomechanics do their orthotic prescriptions become incomprehensible?” We have also seen many biomechanical gurus emerge who seem to fuel the fire of complexity and confusion while at the same time promising to help us poor mortals understand if we just attend one of their seminars. I well remember one such guru being slightly embarrassed when one of our more pragmatic lecturing staff asked him if sub-talar joint pronation could be prevented by rolling a handkerchief up and placing it in the medial arch area of the shoe.

Has Podiatry as a profession created a science of biomechanics that is at best confusing and at worst self-serving and which has become detached from the devices we ultimately ask patients to wear? Allow me to become a little philosophical for a moment and describe the difference between two fundamental aspects of biomechanics. Firstly perception (observation) is of what is actually the reality there on the end of the patient’s leg. It’s not complicated and is directly observable. Secondly conception which is created in the mind and while attempting to describe reality is at least one step removed from it. As concepts build one on the shoulders of the other they increase in complexity and move further away from the simplicity of observable reality. This is not to say that all concepts in biomechanics are valueless but it is important to distinguish between those that help and those that merely complicate the subject and elevate those who espouse them to Guruship.

During my 20 years working with the Ministry of Defence being under pressure to see large numbers of patients and to produce consistent results I gradually started to dispense with many of the biomechanical concepts which had been taught in college as if it were carved in stone and handed down from above. The first thing to go was sub talar joint neutral, others included drawing lines on soft tissues to represent bone and measuring inversion and eversion of the calcaneum. The most valuable idea we left behind was the notion that taking a non-weight bearing cast is the only and best means of producing an effective orthotic. As many of the service personnel brought in orthoses which had been made at different locations around the world it was easy to see which orthoses worked well and why. This impacted not only on my biomechanical approach but also on our manufacture methods. Much of our approach today actually relates much more closely to orthopaedic work by people like G. K Rose in the 1950s than to the theory's put forward by Roote, Weed and Orion which became the foundation of Podiatric biomechanics.

Leaving aside inappropriate prescribing of devices there are 7 reasons why in my opinion many patients don't get optimum results from orthoses. So let's take a look at those reasons and see how we might avoid these pitfalls.

1. <u>Podiatry Concepts</u> By far the greatest majority of the custom orthoses being issued today are provided to reduce the effects of abnormal subtalor joint pronation. When we studied biomechanics at college we were told that a custom orthoses must never be referred to as an arch support. The reason for this was that a custom orthotic is designed to control calcaneal eversion and thus control abnormal pronation. A curious thing happens when you try to use an orthotic purely in this way, firstly the patient finds the upward force applied by the device in a relatively small area of the foot (anterior/medial aspect of the calcaneum) uncomfortable and secondly the correction simply does not work other than in cases of extremely mild abnormal pronation. This in my opinion is the reason why one of the most common modifications made to dysfunctional orthoses in an attempt to get them to work is the addition of a D medial arch filler.

2. <u>Posting Circles</u> Rearfoot posting we were taught was the key to successful prescription outcomes with orthoses. However if we take a cross section through most modern custom orthoses we will find that many of them are circular in shape. What this means is that no matter how much rearfoot

posting is written on the prescription the heel cup never actually changes shape and it's face angle (that part of the device which is meant to alter with different rearfoot posting measurements) remains the identical Fig1 and 2.

Fig 1

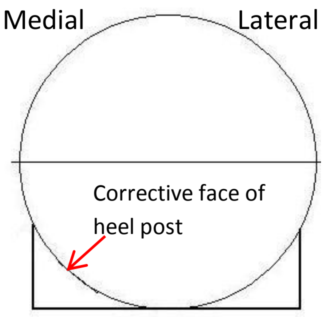
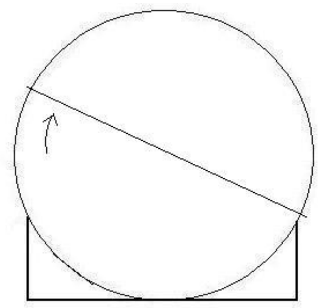


Fig 2



Why then is it that most orthoses are circular in cross section? The simple answer is that most labs are now using some degree of automated design and experience has shown that computers like regular shapes ie circles. This non-changing of the face angle has given rise to the now common use of medial skives Fig 3. which are a means to increase function around the medial aspect of the calcaneum by increasing invertory Ground reactive force (GRF). I personally don't question this for those who believe in calcaneal inversion as a means of correcting foot position but I do question the reasons why it has become necessary. It's a strange paradox given how apparently important this rearfoot posting angle is that many practitioners tick the box for labs discretion for rearfoot posting on their prescription forms.

Fig 3 Medial skive a flattened area on the anterior medial aspect of the calcaneus designed to increase GRF.

3. <u>Arch Contact Angle</u> The main area where movement takes place in patients with abnormal ST joint pronation is the talo/navicular joint with in most cases very little eversion of the calcaneum. This again explains repeated use of D filler arch pads. So all the fuss about taking calcaneal measurements and completing calculations to identify Podiatrys Holy Grail of subtalar joint neutral are seen to be of very questionable value particularly in the light of what's been said about the resultant rearfoot posting. If most of the movement in an over-pronating foot takes place at the talo/navicular joint wouldn't it make sense that this is the best place to effect change?

It's interesting to note that the main antipronatory muscle groups attach in this area. To reduce either a movement itself or a force acting in a particular direction a force must be applied in the opposite direction. The further from perpendicular the face angle of the orthotic is to the force or movement, the less correction created. When looking at the talo/navicular joint what we see is a downward and medial movement due to the displacement of the Talus. These are known as navicular drop and drift respectively. The degree of drop and drift varying for each individual patient depending on the axial relationships of the rearfoot joints. These two movements resolve into a single downward and medial movement. Fig 4. It is in this area that in my opinion most orthoses fail. Most devices either have a face angle which is not perpendicular to the motion or force they are trying to correct or they are not in contact with the foot in this vital area.

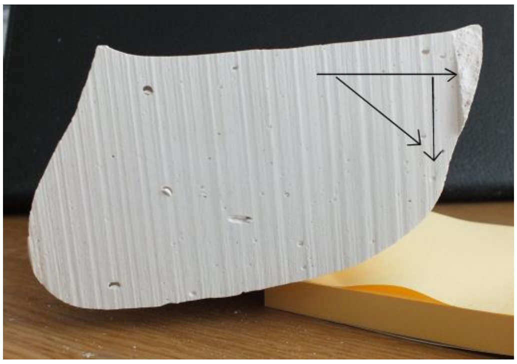


Fig 4. Horizontal line Talo/nav drift and vertical line Talo/nav drop. Diagonal line is the resultant angular movement which must be opposed by the orthotic

It is clear then that the more medial drift the more vertical the side wall of any corrective orthotic needs to be. This gives rise to a fabrication problem as many of the new CAD-CAM systems don't like vertical surfaces as they are extremely difficult to mill from a solid piece of material and the systems often default to a different shape rather than attempt to mill a near vertical surface. They also have limitations in the depth of material they can mill and this prevents extremely high flanges like those in Fig 5. The orthotic in Fig 5 illustrates this with an extreme case were the patient had a rupture of her tibialis posterior and wanted an alternative to an ankle foot brace. The device was almost 55mm deep in the medial arch and was almost vertical in the area of the talo/navicular joint.

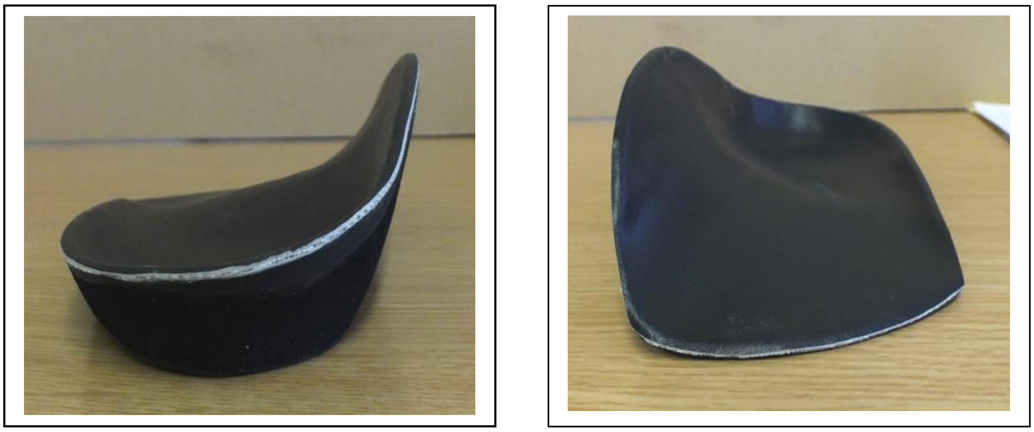


Fig 5 High verticle flange to control tal/nav drift

4. Arch curvature In order that the load across the arch should be spread as evenly as possible the curvature of the arch profile should be as close as possible to that of the corrected arch itself Fig 5. While this statement seems self-evident it is strange that many orthoses have a cross sectional curvature which actually curves away from the foot. Fig 6 This has 2 effects a) It means that the correction through the medial aspect of the device is completely lost and b) It increases the load or force created by other areas of the device and therefore creates areas of low pressure and non-function, and areas of disproportionately high pressure and discomfort.

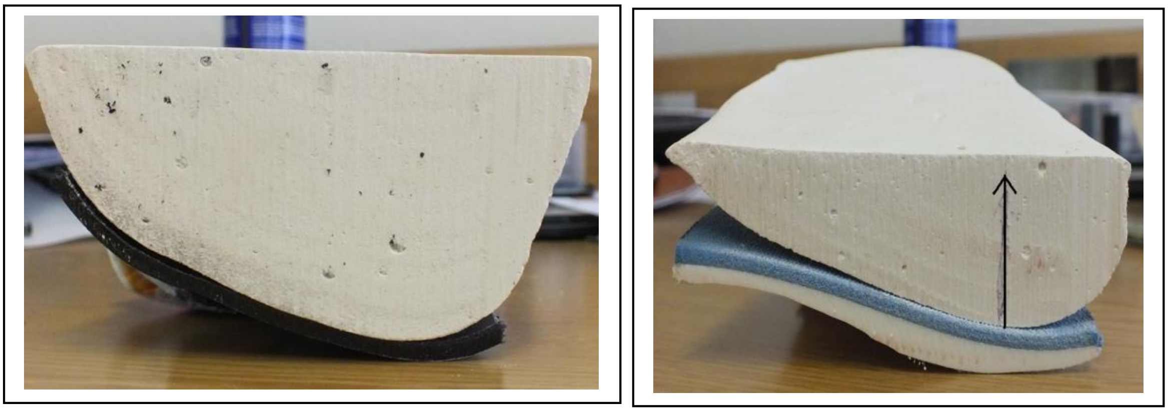


Fig 6 Showing contact through talonavicular area of orthotic

5. The lateral aspect of orthoses often gets ignored during discussions and yet it is one of the most misunderstood parts of the device. Even in poorly fitting orthoses the lateral border usually fits well as it is reasonably straight in most feet. Notice in Fig 6 that the vertical line of GRF on the orthotic is lateral to the ST joint axis and is therefore creating a pronatory force which is not counterbalanced by the poorly fitting medial aspect of the orthotic. This creates an orthotic which actually increases pronatory force rather than reducing it.

   Almost all the orthoses that I review where the outcomes have been unsatisfactory have these two aspects in common, a closely fitting lateral border and a poor fitting medial arch. If we look at an orthotic and draw a line on the device which corresponds to the angle of the ST joint in the transverse plane it is clear that all upward GRF lateral to the line is pronatory while and all force medially is antipronatory. It is thus essential that the orthotic fit equally across its entire surface if these forces are to be balanced.

6. I've mentioned CAD-CAM manufacture a number of times in this article and I guess by now I must be in the minority of those who believe that it is not currently the best way to make orthoses. The reasons for this are many and diverse. a)CAD-CAM systems are in my opinion being developed and used not to make better orthoses but to reduce the labour intensity of the process which leads in my opinion to compromises in quality as the main selling points of the systems are price and ease of use. b) To date I have seen few systems which do not use some aspect of preformed generic library shape technology. C) Any CAD-CAM system runs on a set of parameters outside of which it can never operate and which limit the amount of different shapes which can be produced as opposed to plaster which as a liquid can be poured into any shape. The following photographs Fig 7 and Fig 8 show a cast of foot which had completely collapsed. The first orthotic from a CAD-CAM system was unable to deal with the unusual shape of the particular foot and defaulted to a standard profile while the plaster cast with a vacuum formed device fits like a glove.

d) Barriers to entry - In the early days of orthotic therapy a great many Podiatrists made their own orthoses this meant they had to trouble shoot, review and modify their own devices necessitating a sound knowledge of the devices they prescribed. When commercial Podiatric manufacture labs started to operate most had a high degree of specialist knowledge as they were either owned by a Podiatrist or they had a Podiatrist or an Orthotist as the technical manager. This situation has steadily changed with the increasing availability of CAD-CAM systems. Today you're just as likely to find a computer programmer or an entrepreneur running a lab without anyone from a specialist background being involved. As one salesman for a well-known CAD-CAM system said to me recently "we can train someone to operate our system in about 2 days" this has removed all the restrictions to entering the orthotic market and made the running costs much lower. After the initial investment the system can be run by anyone with a basic knowledge of computers. I first saw this trend in 1996 when we were buying our first 3D foot scanner. I didn't want to direct mill in this country so we went to a company in Austin Texas (Bloch Labs) run by a Jeff Bloch a larger than life character who owned an orthopaedic shoe shop. Jeff had bought a library shape system and employed a few student computer boffins to run it. He then simply undercut the whole market by offering direct milled orthoses at $40 pair and captured a huge chunk of the American Orthotic market in a very short period of time. He laughed at the idea of hiring a Podiatrist to oversee things. "All I need is someone who can press buttons and a few glue guys for finishing". I vividly remember watching a part-time staff member scanning hundreds of slipper casts for hours on end, if the casts didn't fit into the scanner aperture he cheerfully hammered them flat with his fist. On questioning this process I was told "the system only needs the basic dimensions of the cast and then it does the rest". These changes have come about at a time when Podiatry schools which once had their own labs where students could learn and hone their skills are now buying orthoses. The reasons for this are that it becomes financially difficult to justify these in-house labs and the increasing academic load has meant that many where underutilized. Podiatry as a profession has also, in an attempt to make itself more specialised moved away from manufacture in favour of prescription, so the gulf between the lab and the end user has never been wider. At a recent conference I was the only lab owner in the auditorium as all the others not being Podiatrists where in the sales area and would have been totally unaware of any changes in orthotic theory or practice being put forward in the conference. How these labs give customer support or case conference difficult patients remains a mystery. The role of lab owners has been reduced to one of keeping up sales volumes and reducing costs to a minimum. This divorcing of our profession from the physical manufacture of orthoses has also meant that many Podiatrists have little or no idea of how the devices they buy are made. When I asked a newly qualified Podiatrist recently about orthoses they told me that all orthoses that have a plaster cast taken are custom and that CAD-CAM devices have to be the most accurate way of making orthoses. Another said that his companies orthoses were not custom made but were custom fitted.

With this degree of sophistication it's hardly surprizing that the issuing of orthosis is now being undertaken by Physiotherapist's Chiropractors and others and in many cases with as much success as Podiatry can claim. With Podiatrists continually wanting to be seen as clinical specialists who prescribe rather than make orthoses it's not unusual to find a recently qualified Podiatrist who has never set foot in a lab, never put a top cover on and knows almost nothing about the production process. This in my opinion has been a great loss to our profession. At a recent foot and ankle conference I attended one of the guest speakers who was a Podiatrist and apparently specialised in biomechanics was unable to clearly answer a basic question put forward about the casting method, production and function of an orthotic. Luckily a physiotherapist who knows the subject and who has spent years perfecting her knowledge of biomechanics and orthotics and who has spent time physically making and modifying orthoses was able to answer the question with a clarity that would be the envy of many Podiatrists. I have noticed at least one lab which is now using the conveniently ambiguous term "prescription orthoses" to give the impression that the devices are custom while all the time using off the shelf shells with heel posts and top covers added. This I think represents a crisis in our profession as we risk losing the trust of the public at large if this continues.

7. <u>Restoring movement</u> - The previous discussion has mainly been on the reduction of forces and movements. Much of the abnormal pronation we see is due to a lack of normal movement somewhere within the kinetic chain either due to soft tissue tightness, muscle dysfunction or joint damage. If orthoses are to be successful it is important that all issues both functional and structural be addressed. It is therefore essential that the issuing clinician has the ability to find the underlying cause of the reduced movement and attempt to rectify it by any means possible. This is an area to which Podiatrists can sometimes be accused of paying lip service. Not fully dealing with the underlying cause of pronation has 3 main effects. 1) It reduces the possibility of a successful outcome for the patient. 2) By not reducing the pronatory force caused by the underling dysfunction the foot hits against the orthotic with a greater degree of force. In very severe cases the pronation causes the foot to be battered against the orthotic like a ship dashing against rocks. In the long term this can cause a complete break- down of the structural integrity of the foot to a point where in many cases surgical intervention may be required. 3) It creates a situation where orthoses are seen as a treatment and not as a part of a much broader co-ordinated approach to the patient's

management. In my own experience restoration of proper function is almost always better if approached with the co-operation of a Physiotherapist.

<u>Conclusion</u>

Having given this article the title ”why orthoses don’t work” it is probably best to put that statement in context. As a manufacturer and prescriber and designer of orthoses for the past 20 years I firmly believe that orthoses are of enormous benefit to those who need them if two essential criteria /conditions are observed. Firstly that they are used as a part of a treatment plan and are not used in isolation as a treatment in and of themselves. Secondly that they are made in such a way that they closely fit the foot in its corrected alignment. If these two criteria are not met then we will be acting as orthotic sellers and will being doing ourselves, our profession and most importantly our patients a great disservice.