Off-loading plantar pressure: Part 1 The Phalanges.

There is a now large body of supporting research, Guidelines and standards, DFA (Jaap van Netten 2018) & IWGDF 2019, NADC-HRFS-standards 2018. Telling us that we need to focus on achieving a PP (peak pressure) at or below 200kPa or a reduction of 30% to avoid re ulceration. This is a measurement of the whole foot with ISPM(In-shoe pressure mapping) technology, that allows us to measure the dynamic and static pressure with a thin sensor that covers the entire plantar aspect of the foot, between the foot and the orthosis, allowing us to now know and be guided by the objective data collected to provide our patients with an evidence based outcome that will reduce the possibilities of re ulceration by as much as 64% (Maria Luz Gonzalez Fernandez, PhD, University Complutense Madrid, Avda Complutense s/n, Madrid, 28240 Spain. (E-mail: luzalez{at}enf.ucm.es))

Six things to consider when looking at reducing the plantar pressure of the phalanges.

*Removing material from your orthosis is not always the right thing to do.

*Understand the ROM (range of motion) of the foot and ankle is crucial.

*Pressure mapping is just part of the whole process.

*Not everything is fixed by rocker soles.

*Not everything is about the orthosis.

*If the shoe doesn't fit, it won't work.

Fig #1 The end of this shoe was cut off to show the patient just how bad his shoe was fitting and was probably the cause of the ulcer between his Hallux and 2nd phalange.

Adding materials

When we look to add material to an orthosis to improve the off-loading, we need to clearly understand how well the shoe is fitting first. There needs to be enough room in the shoe prior to addition materials being added, If you want to add 10mm of felt padding, is there room to add 10mm of felt padding? Is the shoe really that poorly fitting? Are you going to compromise the fit of the footwear, creating other problems that are associated with poor fitting and possibly creating a new pressure injury at another location?

To add to an orthosis, we need to look at the depth of the footwear in three different sections, the Back, the Throat or Lugs and the Vamp areas.

Fig #2 The three areas of the footwear to consider, The Back, The throat or Lugs and The Vamp.

If you want to add material to an orthosis in the area covered by the Vamp, the fit of this area may need to be altered first. For the shoe stretching process in this area, you will struggle to change the portion of the Vamp known as the Toe box, as the Toe box of most footwear has a synthetic stiffener in this area. The synthetic stiffener is a thermoactivated material, with heat applied and pressure this can be altered, it will need to be held in shape until it cools. This is best done on a modified Last. If the shoe is not deep enough, you run the risk of create pressure injuries on the PIP or even cause the toe nails to catch at the top of the footwear's toe box as they walk.

Fig #3 An example of the injuries of excessive felt padding added to off-load a planta injury, creating a new PIP injury as a result. Injuries like this may only take hours to occur, but may take weeks or months to heal.

The use of Met bars is well documented to off load the MPJ's but the side effect of a Met bar is it can have the same effect as a speed hump on the road, slowing the progression of the foot increasing the Time Pressure Intracule(TPI), this is when understanding the Gait curve is important and can be a good indicator of change in this area.

Understanding the implications of restricted Range of Motion (ROM) on plantar pressure.

Understanding the ROM of the foot and ankle helps us to better understand the implications that our modifications will have on the foot and kinetic chain.

Adding a mid-foot medial arch padding won't always help to move the pressure to the more lateral portion of the foot if the foot can't be inverted. It may only create a new PP area under the medial arch and a contralateral LLD, that can create an increase in PP, (Motawea, El-Nahas and Armstrong, 2019).

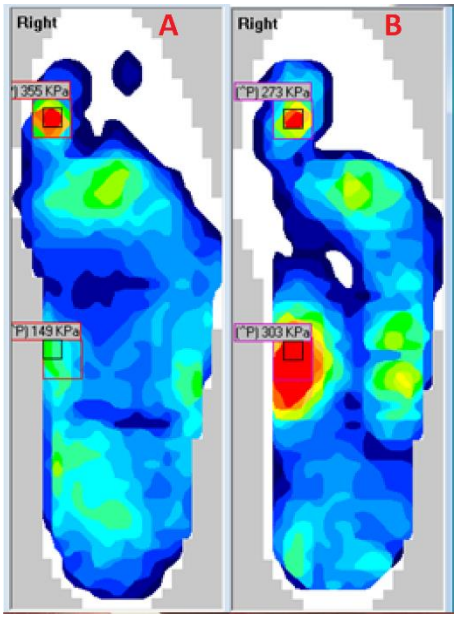

Fig #4 First ISPM shows a PP of 355kPa(A) under the IP of the Hallux. In an effort to reduce this, felt padding was added at the medial arch(B) to move the load more laterally, but with a fused ankle it only added a new PP area under the medial arch and created a Leg length discrepancy (LLD)

Trying to off load distal phalanges and IP's can be very challenging, often this is when a rocker sole modification should be the first priority, but we need to understand the cause of the increased PP first before we can apply a modification of the sole or orthosis.

A passive assessment of ROM at the MPJ's may work fine whilst the client is seated, it may not always reflect what happens when the patient stands. As some of the patient's struggle to stand still, with poor balance they use their toes to attempt to hold on to the ground, increasing the PP of the distal phalanges or simply have a heavy hammer toe flexion.

If the client stands weight baring on a flat surface, what happens when you perform a Jacks test?

Not to simulate the windlass, a rise of the arch, but to better understand the pressure under the distal phalanges, all of them, is there pressure under the distal phalanges of all toes or do they move with little effort, can the patient dorsiflex their toes whilst standing and not fall backwards?

.

Adding felt padding to off-load IP or distal phalanges may not help at all and a rocker sole may not hold all the answers either. So how do we off-load this area?

The simple answer maybe by removing the Toe spring of the shoe and not reducing part of your orthosis. The orthosis is often designed with impact absorbing materials like Poron and removing them or reducing the thickness of is not always a good idea. For this patient we removerd the Toe Spring of the shoe.

Toe spring is not direclty related to the rocker sole, we can remove the Toe spring and still have a rocker sole.

Toe spring is measured from of the toe end of the Last(C) to the ground, whilst the heel pitch is held at the correct height(A) and the Ball of the Last(B) is on the ground, in this case Toe spring is 15mm.

To see if this approach would work for your patient, place an item under their toes that is 15mm thick, does it effect their balance, is it under pressure?

If so, this patient will be best served by removing the Toe spring of the footwear and keeping the orthosis and its impacting absorbing materials to their maximum amount.

With a modified Last and some creative thinking we can remove the Toe spring of the shoe and still retain a good amount of the rocker sole function.

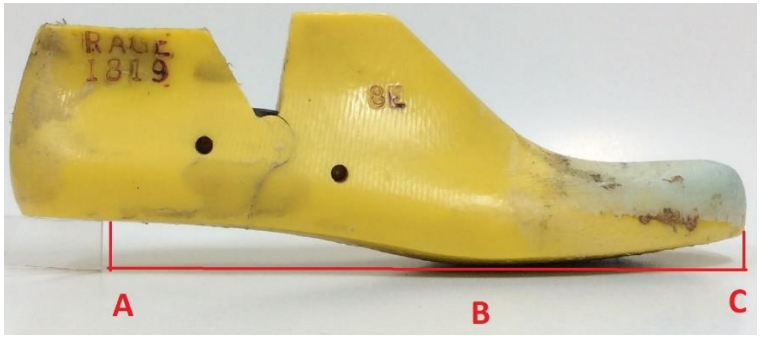

Fig #5 Measuring a Last, Heel pitch measurement, is height of the heel(A) from the ground with the Ball(B) of the Last sitting on the ground. To measure the Toe spring, the Ball of Last sitting on the ground. Toe spring measured from the ground to the toe end of this Last.

ADVANCED PRESSURE MAPPING

Fig #6 Toe spring of the right shoe has been completely removed, yet the rocker sole function is still retained and the depth of the toe box has also been increased by 12mm.

This image (Below) of before and after are the result of an interdisciplinary approach that included Wound care, Podiatry, Pharmacy, Pedorthist and the patient themselves.

Prior to this intervention the patient had a strong history of re ulceration over a long period of time every few months.

Once the Toe spring was removed and a new orthosis provided it took 4 months to close the ulcer and has remained closed to the date of writing this article, 14 months.

Fig #7 Using ISPM to guide us, we made alterations to the footwear and orthosis and reduced the PP to 98kPa at the IP of the Hallux, well below the recommended 200kPa.