Introduction

Background: Historically foot orthoses have been manufactured using materials with uniform properties. The only way to alter the forces under the foot was by changing the geometry or thickness and hence stiffness of the material. For the first time it has become possible to prescribe foot orthoses that don’t solely rely on geometric shape and uniform stiffness to alter forces under the foot.

3D printed foot orthoses have received much recent publicity and anticipation of revolution. However, the actual uptake of them and understanding of what this technology enables from the foot orthoses perspective remains limited. This case study describes the decision making process behind one particular prescription. This prescription, whilst far from a unique one, is uniquely addressed by the material properties of the 3D printed foot orthoses.

Iain Twaddle is an elite, Masters fell and cross country runner based in the North East of England

• Pain to the dorsum of the left foot - same pattern to a 2011 career halting stress fracture.
• Previous polyprop orthoses with met dome no longer being effective
• Aims were pain relief and pressure remapping, hence restoration of function.

Results

Iain had instant early results in pain relief.

Running pressure readings in old orthoses show max pressures to the left halluc and lateral deviations consistent with functional hallucus limitus and pain avoidance.

Subjective comments Iain Twaddle:

In October 2014 I felt similar stress fracture symptoms coming on again, this time I went to see David Eardley to have a very thorough Gold analysis to see why this was occurring.

I have now been wearing my insole for about 9 months and have had a great time with them. After such a long time (7 years) of inconsistent running, it’s good to have had such a long time of injury free running.

In the last 3 months I have some 4th in a 10k trail race (1st set 40); 2nd in the British Masters cross country championships, selected to represent the North east at the British Inter Counties fell running championships where I finished 2nd last.

My Main target of the year was the Choue Chase, a 20 mile fell race in the Cheviots. During my training I had a period of high mileage, before going on to win the race our right.

Training for this race I did a lot of my running off road on brist, forest trails, cross country and roads. The Orthoses were essential to getting through this... I wore them in road shoes, which you would expect to fit with ease, but they also fit excellently in my fell shoes and cross country spikes which are very low cut and low volume shoes.

While fell running, the ground is very uneven and undulating, the subject is often wet and muddy and the Orthoses were great on hills, they are light, flexible and don’t hold any water. Some Orthotics that I’ve used previously have been quite thick and at times I’ve felt as though my foot could slip out of the shoe as I’m running through stickly mud, not so with these. After my run a quick rinse under the tap and a quick shake is enough to clean them.


definition of terms

Therapeutic effect
Prescription
Traditional plaster foot orthoses solution
3D print and optimised placement of progressive flex
Met dome and flexible medial arch with stiffening zones

Conclusions

• The digital prescription and digital prescription protocols process enables precise component placement.
• The selective laser sintering 3D printing process allows for intrinsic component additions to aid therapeutic effect.
• Zones of differential stiffness can be incorporated into a device to alter Orthotic performance where the same geometric shape prevails.
• In this case study a differentially flexible medial arch can replace a first met cut out in Functional Hallux Limitus.
• A flexible metatarsal dome can be added instead of an ‘all stiff’ or ‘all flexible’ or glued in soft extras that will degrade or lose their material properties (e.g. sponge met dome).

Further Work

Development of optimized zones is indicated. This can include compliant zones in all foot segments.

Materials and methods

Examination and prescription

Optimal Orthoses properties for this elite fell runner:

1. Thin and flexible for its material properties.
2. Carbon fibre/ TPU soft.
4. ExN: Too bulky for the shoe and moisture absorbent.
5. Milled polypropylene? May not fit easily into the shoe.
7. Optimal placement of components.
8. Flexible metatarsal dome and heel post design that digs into midfoot.
9. Milled polypropylene? Manufacturers have been unable to make really flexible met dome.

Testing

3D printed foot orthoses were manufactured with unique and bespoke stiffness attributes. These were made to the same geometric shape then compared to the 4 year old polyprop orthoses in the walking and running state. Inhouse pressure measurement readings were taken in all 4 states on a sprinter treadmill at self selected speed.

References


Further information

David Eardley is a Podiatrist in full time private practice employed by Peacocks Medical Group, Newcastle upon Tyne.

Declaration of Interest: David advises on the clinical aspects of Podfo foot orthoses to the Peacocks Medical Group research and development team. He has been a key contributor to Podfo 3d printed foot orthoses development.