The Functional Science of the GelThotic

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This paper will describe in a point by point manner the general considerations and developmental goals of the GelThotic by Kendall Research Systems.

The general points of discussion:

- Orthoses radically alter shoe fit.
- Orthoses have “side effects”, or create their own problems.
- Hard surfaces, such as in a conventional orthosis, irritate the damaged foot and often encourage inflammation.
- Orthoses and conventional insoles either use materials that compact and shift geometries or have contours that are not therapeutic.
- Orthoses don’t adapt to the shoe that is being worn.
- The “planar” surfaces of most insoles are repeated in both the orthotic itself and the shoe taking unnecessarily large amounts of space.
- Conventional orthosis don’t sufficiently absorb shock.
- Most insoles, and few orthoses account for various foot types.
- Conventional insoles and Orthoses are ineffective in controlling multiple planes of movement such as in various sports including tennis, basketball, etc.
- Most Orthoses are generally unstable; being too narrow and high actually decreasing lateral stability.
- Many materials used in Orthoses are irritating, too thin, and compressible.
- Orthoses pick up microbes and odors after a time.
- Conventional Orthoses don’t account for the full “gait-cycle”.
- Conventional Orthoses don’t address all three of the major foot conditions: 1) Plantar Fasciitis, 2) Neuromas and problems of the forefoot, and 3) General Heel Pain.
- Orthoses don’t work with a removable insole.
- Conventional Orthoses don’t control motion as over-pronation throughout the gait cycle.
- Conventional Orthoses don’t distribute pressure over the whole heel and effectively “cup” it.
- Conventional Orthoses don’t work well with the high arched (cavus) foot.
- Conventional Orthoses don’t fit in dress shoes and high heels.
- The longitudinal arch of conventional Orthoses, even custom Orthoses do not reach high enough to fully distribute pressure and fully support the arch.
- The “arch” of conventional orthosis, even custom, lacks a “fasciial groove” to both support the arch and adapt to its contours.
- Conventional Orthoses and insoles do not follow the general geometrical and longitudinal axis of a given shoe.
- Custom Orthoses often employ a technique called “fill” to actually reduce the topography of the support for better tolerance but at that point it is questionable if it is custom, much less therapeutic.
- Conventional Orthoses are so invasive toward the longitudinal mid-line of the shoe that the foot is never in a neutral plane anywhere in the shoe.

- The human foot goes through phases of torsion, twisting, and internal movement that causes friction, burning, and abrasion in conventional Orthoses.
- All shoes have their own support features and must be accounted for in the selection of the Orthoses. But, this very important fact is almost never considered when purchasing the shoe and orthotic.
- Today's shoes have design elements of the midsole that extend into the area of the footbed causing conventional Orthoses to be altered in their support and stability.
- The removable insoles of today's shoes are designed for perfect fit; though they are often inferior materials, they fit very well.

Orthoses radically alter shoe fit.

Today's shoes employ computer programs that allow little tolerance for dimensional alteration. Even if a removable insole is taken out, there are changes to the shoe fit. Conventional Orthoses have posting which cause heel-slip and excessive tightness in the middle third of the shoe. Then the forefoot is usually thinner than the existing insole so there is actually excess room in that area. In shoes without removable insoles, there is an even greater problem. In terms of displacement, nothing is being removed but a significant amount of space is being taken by the orthotic. GelThotics have been engineered to use less space within the shoe than any other orthosis.

As examples; a sampling of various shoes:

1. Bicycling shoes, soccer shoes, and golf shoes follow a "cosmetic similarity" within the sport that has little to do with function. These sports have an expectation of a certain profile and line that must be followed for sport identification. The GelThotic is unsurpassed in fitting these difficult shoes. Such products as SuperFeet have such rigid plastic that don't adapt well to these shoe types and the midsole is oriented toward the heel/arch instead of being functional in the forefoot where these shoe-types especially need it. SuperFeet has a low-cost insole covering which compresses very quickly exposing the hard plastic frame to the soft tissue of the foot.
2. High-heels have a "downward curve" or "draft angle that is very inconsistent, based on the model. Conventional hard Orthoses either will teeter-totter across the midfoot or just not fit at all. The GelThotic easily follows these lines and drops; as well as the curvature of the shoe which is often very exaggerated in high-heels. The minimal nature of the device allows for a reasonable fit and excellent function within such a difficult shoe.
3. Shoes for Tennis, Basketball, and other "lateral" sports require support on the inside foot but also on the outside of the foot for stability. This "Catch-22" is addressed by the GelThotic and almost no others.
4. Ski Boots, Cowboy Boots, etc… These boots either have a defined or very narrow midfoot with no room for expansion. Conventional Orthoses often make these boots tight and they can't be easily or accurately changed. The GelThotic has proven itself in all of the above.
5. Athletic shoes in general require support and cushioning with the most reduction in friction that can be found. The GelThotic stands alone in providing all of these and more, while following the individual curve of the shoe and working with the existing insole. The fit is minimally altered with the GelThotic while combining all of these and more.

Orthoses have “side effects”, or create their own problems.

Orthoses are usually too narrow and allow the foot to be “pushed” over the outside of the shoe when supported to the inside…which is usual. They actually destabilize the foot to the lateral (outside of the foot) aspect.

Orthoses are often much too firm and damage the soft tissue or encourage the inflammatory cascades that accompany injury.

Orthoses may have either a too shallow heel cup or a descending angle in the back of the heel which is not appropriate for the person. This acts as a rigid knife creating mechanical injury to the soft tissue. And, the heel cup that is too shallow is a part of these orthosis’ instability.
Conventional orthoses usually can’t be adjusted in any significant way. The angles are never perfect and if they are creating injury by having too much, or too little pressure, there is not much that can be done.

Conventional orthoses are usually rigid and transmit shock up the chain where it “decelerates” at the level of skeletal tissue.

In terms of torsion, shear, or other forces in the natural gait of the human; conventional orthoses may create injury but can’t be altered.

The GelThotic has been engineered to minimize or eliminate all of these issues.

Hard surfaces, such as in a conventional orthosis, irritate the damaged foot and often encourage inflammation.

Many injuries such as plantar fasciitis may actually be made worse by the already irritated or inflamed tissue being supported by rigid or immovable surfaces.

Studies have shown this for years but in my own experience this has always been the case. The necessity of “fill” where the orthopaedic lab creates the positive from the cast or scan, then minimizes the contours by what amounts to a subjective or interpretive process of the topography needed still yields a hard surface; but now one that is not even a perfect representation of the foot. Perhaps 20 – 30% less than the starting anatomy.

Whereas, the GelThotic topography exceeds the anatomy, in most cases, in the softest medical grade silicone gel. Though by far the most expensive material, in my experience, nothing is as unabrasive or nonirritating to human tissue as soft silicone.

Orthoses and conventional insoles either use materials that compact and shift geometries or have contours that are not therapeutic.

Many orthoses being sold or prescribed today use materials that severely deform during use. This is always in the unwanted manner the foot is trying to move… so an almost negative support is slowly being formed. Popular insoles such as SuperFeet use polyethylene or EVA (ethylene vinyl acetate)

almost immediately start to lose both cushioning and shifting geometries. Worse, in custom orthoses, the "posting" under the heel is often made of the compressible material causing an already unstable orthotic to be actually causing injury. Unfortunately, this is very common.

Many of the systems, professional and otherwise, that use digital scans employ a technique that uses the scan to cut the scanned foot out of block of EVA with a computer controlled cutting head. At first, this seems to be a good idea but these orthoses are too narrow, still do not always reflect the true foot topography…much less therapeutic support, and are too firm. But, the worst aspect of this type of orthoses is that it compresses in exactly the most unwanted manner. Support degrades, topography degrades, lateral stability degrades etc.

Many hard shells sold by orthopaedists, podiatrists, etc. are made of polypropylene or similar materials that crack, flex, change with heat, etc.

These types are often sold to children. It is little wonder that patient compliance is so low in pediatric orthoses. These Orthoses hurt children, and if they don't initially then when the children grow, they really hurt.

Leather Orthoses of the old type can be very useful but absorb microbes, crack with the acidic, humid and saline environment of the foot.

Often, orthoses such as Birkenstock Orthoses are used in the quasi-medical market created as blended cork and latex. The latex is excellent but the cork also compresses and some people are allergic to latex.

"Microwavable" orthoses have been used in the last few years they are always materials that become malleable at low temperatures then are applied to foot. These products suffer because they still "move" under the extreme G forces of the human foot, only "fit" the foot with no therapeutic value, the contours change with the heat of the foot, and are still firm and uncomfortable.

The patented GelThotic uses medical grade silicone gel which does not degrade or compress and, doesn't need to be covered in an irritating material such as polyurethane. The "just right softness of the GelThotic" is permanent, therapeutic, and stable!

Orthoses don't adapt to the shoe that is being worn.

Shoes have a general x/y curve often represented by the deviation of the axis of the heel and forefoot. Shoes are often 10 degree curves, twelve degree curves, etc. Orthoses should match the general longitudinal axis of the shoe.

All shoes have a differing shank angle or "bridge" of the midfoot. High heels have a drastic midfoot angle, of course, often referred to as the downward curve, draft angle, etc.

Conventional orthoses do not adapt to these differing geometries and may even injure the foot by using them in many shoe types.

The GelThotic was engineered to follow the line of the longitudinal axis in the shoe, the shank angle, or any other geometric difference in the "base" of the, transforming it from an essential planar or non-anatomic base to a functionally anatomic and therapeutic orthotic.*

(*Please note that no orthosis should be applied to a commercial contour such as Birkenstock)

The "planar" surfaces of most insoles are repeated in both the orthotic itself and the shoe taking unnecessarily large amounts of space.

Most of the time, conventional orthoses and insoles that are added to shoes repeat the base or planar aspect of the shoe where it is just "level" material for cushioning and fit. When orthoses are worn as full length orthoses the internal dimension of the shoe is significantly decreased and some foot conditions can result. These are just even or level planes and are not the functional aspect of the orthosis itself.

The GelThotic is purely the elemental and functional aspect of therapeutic support. It is the essential aspect of support with nothing added. A way of thinking about this concept is to think that if a foot were to be in a given shoe and a "solidifying foam" were to sprayed into the shoe….. When the foot was removed, this "solidified foam" would be roughly the shape of the GelThotic when it was removed.

This is an example of why the shape of the GelThotic is the way it is but every millimeter of the device has been studied for the best therapeutic correctness a pre-made orthoses can provide. Including over ten years of allowing only health care practitioners to dispense the GelThotic in clinical situations.

Conventional orthoses don't sufficiently absorb shock.

Custom orthotics, such as those provided by orthopaedists or podiatrists, are extremely hard. It was thought the orthotic had to be firm to support but I have spent decades showing just the opposite. Conventional medical or custom orthoses are so firm that they almost always transmit most of the multi-form shock waves up the leg where the waves "decelerate" at the skeletal tissue doing at least some harm.

It was significant for us to use pure medical grade silicone because it is so expensive (almost five times the raw cost of what is in second place), but the result is a highly shock absorbent material that supports…. And does this with the least abrasive properties of all materials.

The Silicone Gel used in the GelThotics absorbs significant shock and does so for many years.

KENDALL GELThotics
A TECHNOLOGICAL BREAKTHROUGH IN PAIN RELIEF

Most insoles and few orthoses account for various foot types.

The radical difference between the “cavus” or “high-arched” foot and the “pes planus” or very “low-arched foot” is profound. In the interest of brevity, I will do my best to summarize the intrinsic nature of these two extremes, their fundamental needs, and the spectrum of foot types which lie between them.

I sometimes think of the foot-type extremes as being near-sighted, far-sighted and everything else falls somewhere in between. Still the same eye and still the same foot but the functional structure is different.

The “pes planus” or low-arched side of the foot represents the majority of the populous. Over-pronation and all the words you hear applied to this foot type make it sound as if you address it only one way and with a range of shoes and orthoses made for that foot type. Like everything else in life, it’s not that simple.

This foot moves more in the gait cycle than the cavus foot, or, it has a greater range of movement. It is necessary for the normal foot to pronate but in that phase of the gait, this foot type goes a little too far. Suffice it to say, most shoes and orthoses today are engineered to reduce this motion. Many of us think over 90% of the better running shoes are made for this exaggerated phase.

A very few of the highlights or considerations for the lower arched foot:

- The lower the arch the straighter the foot. But most shoes have curvature and this geometric mismatch often creates a long list of problems.
- This foot cannot usually tolerate commercial arch supports. They are too high and steep in their contours…. This foot requires a long, graduated arch contours to spread the resistive load over the larger surface area.
- This foot is often narrow which causes problems when the insole might be replaced by a conventional orthosis. The replacement insole/orthoses is often thinner and allows so much internal movement that it often defeats any benefit the orthoses might have.
- Most orthotic/insoles do not rise high enough up the medial (inside) of the arch so that many people will roll-over the arch area.
- If the orthoses sufficiently supports the patient then often the foot is being pushed to the outside of the shoe on the other side. There are a number of reasons for this but in trying to maintain brevity I will simply say this happens and causes decreased stability on the lateral side. Additionally, the relatively “straight” pes planus foot will often develop problems of the fifth metatarsal and toe. This “Catch-22” often occurs and must be addressed. One of my first experiences in biomechanical mistakes was when an orthopaedist put our entire women’s basketball team in orthoses whether they needed them or not; they all developed lateral knee and hip pain. I took them out and they “all” got better, teaching me something for life….orthoses are not a panacea; it’s so much more than “casting (digitizing) and dispensing.

The GelThotic was engineered to work through all phases of gait with any foot type. By working with over 150,000 people over 45 years I have been able to identify the various angles and supports that are most efficacious….including these into the five sizes of the GelThotic.

The GelThotic is high enough to support the pes planus and also supports the cavus foot without over-supporting and driving it off the other side of the shoe.

The “cavus” foot is an “immovable tight spring”, rigid and structurally sound. But, this foot is curved where the pes planus is straight; and the last thing this foot type needs is medial support or support against over-pronation. This is the very foot type that thrives in the less structured, but laterally stable shoes of today. But, there are very few. In running shoes, there might be only five models in all of running shoes that work well with a true cavus foot. This leads me to comment that some of the running shoe stores that recommend from a scan and “tread mill analysis” are some of the most embarrassingly incorrect conclusions I have ever seen in the years I have been doing this. I like computers more than people but I have to admit, they don’t yet have any place in foot care or creation of an orthosis.

The GelThotic was engineered to adapt, support, and biomechanically enhance every foot type, in almost every shoe.

Conventional insoles and orthotics are ineffective in controlling multiple planes of movement such as in various sports including tennis, basketball, etc.

I had mentioned earlier that one of my earliest experiences in biomechanics and orthoses was when an orthopaedist put our entire women’s basketball team in custom medical orthoses whether they needed them or not; and, they almost all developed lateral (outside) knee and hip issues…I took them out and they all got better…almost immediately.

Conventional orthotics not only have little or no ability to control lateral movement, they actually make matters worse. Because:

- They usually have an essential “cant”, or varus…”tipping” them toward the lateral side.
- And, because they are usually slick or low friction materials, this tendency is enhanced putting tremendous pressure on the lateral ankle, knee, hip, lateral soft tissue such as the ITB, etc.
- The “posting” which raises the heel in typical custom orthotics also raises the center of gravity and because most orthoses are too narrow in the base….the foot is very destabilized. A Porsche 911 is low and wide for a reason. The center of gravity is radically enhanced by it’s very low setting profile and the relative “width” of the car in relationship to it’s height. We knew this from SUV’s in the 90’s when these high, “narrow” cars were so unstable leading to sometimes catastrophic results.

The GelThotic uses every bit of “width” that the shoe allows and with it’s perimeter heel and the middle opening (of the heel; aperture) allows the heel to go all the way down to the base of the shoe. As the heel penetrates the “support gel” it is thoroughly wrapped and surrounded by support that we call “Perimeter Support of the Heel”. In this way, the full use of the shoe’s engineering is achieved for maximal stability(heel well), staying optimally low, and the heel “decelerates” into the “deforming” gel thus absorbing shock at very high levels as it gains in stability.

Many materials used in orthoses are irritating to inujury sites and skin, too thin, and compressible.

I never cease to be amazed at how materials for foot care and shoes are where companies decide to save money. I want to think that the people deciding on material use could do better but just don't for reasons of profit, etc.

Most of the polyethylene foams being used in insoles and orthoses start to degrade in less than a week, polyurethanes don't lose their cushioning as rapidly but tend to create feelings of "burning", etc. if they are too thin.

EVA (ethylene vinyl acetate) is also commonly used, but this material rapidly and permanently loses it's shape, function and properties profile.

I have already covered the difficulty of using hard plastics. But, when they are combined with some of the above materials, it gets even worse. These materials often expose the plastic to be too near the soft tissue, often either causing or extending injury.

The GelThotic is 100% pure medical grade silicone gel. Deep and thick, it supports, cushions, and diminishes friction at the highest levels. Expensive, and worth it.

Orthotics pick up microbes and have odor after a time.

The internal environment of a shoe is very humid, body oils and excretions, slightly acid Ph, and the materials absorb microbes for the perfect conditions to create infection and odor.

Foams are sometimes thought of as open-cell and closed-cell. The open-cell type trap microbes more easily; but, they both pick up these infective microbes. Even hard plastics are more porous than is usually known; such as polyurethane. Harder urethanes seem as though they wouldn't be porous but they actually are…. Even urethane films will allow microbes through the barrier.
The GelThotic, as mentioned, uses pure medical grade silicone which is not only very non-porous, it is water and "moisture-proof" when shoes have to be sprayed to make them water resistant, it is silicone that is almost always used. The GelThotic cannot pick up microbes and odor, and cleans perfectly.

Additionally, polyurethane and related compounds "yellow" or turn "amber". Polyurethane was mostly used as a glue in WWII by the Germans in it's earlier use, and when it is soft it is very sticky and tacky. Attempts to reduce tack require some serious chemistry…not health food.

The GelThotic will never "yellow", "amber", or become "tacky" or "sticky".