



The Evolution of Socks and Compression Sleeves

These products can facilitate performance and help in injury prevention and recovery.

BY BEN PEARL, DPM

Socks have always been a critical component to the modern athlete's wardrobe. Recently, the consumer sports medicine marketplace has begun to offer a number of sock designs to help prevent and treat injuries. Back in the late '70s, the confluence of the running boom and a robust economy in the '80s inspired sock manufacturers to start thinking about ways to improve sock construction and design. Interest in sock research and development led to advancements in four areas: wicking materials, materials with decreased friction, pressure management, and compressive support. Recently, compressive sleeves in the ankle and shin have spun off from the core sock business as additional sock-related garments to help with injury prevention and workout recovery.

Sock Fibers

In order to examine the characteristics of sock materials, one must first understand the difference between "hydrophobic," which refers to wicking water through the fiber, and "hydrophilic," drawing water to the fiber. These terms can be used conjointly when describing the fluid dynamics in socks, as some fibers have characteristics of both components. The key is that whatever sweat or moisture is produced needs to be moved away from the foot, whether it

is wicked through the fiber or drawn into it. The coefficient of friction increases with moisture on the skin; therefore, blisters are more likely to occur with socks that do not provide moisture management.

used in many wool blends for higher performance and durability.

Polypropylene is a cheaper material that is hydrophobic and used in some sports synthetic socks. Nylon, by contrast, is hydrophobic, and nor-

Compressive sleeves in the ankle and shin have spun off from the core sock business as additional sock-related garments to help with injury prevention and workout recovery.

When combining hydrophobic qualities and mechanical fiber qualities, the fibers that wick moisture are, from best to worst: CoolMax® (Figure 1), acrylic, polypropylene, wool, and cotton.



Figure 1: CoolMax® socks.

If you are using high-grade materials, a two-layer system can be more effective with CoolMax®, a polyester fiber, as the outer layer. CoolMax® has its roots in the concept writings of DuPont scientists in the '20s. Dacron, a precursor polyester fiber, was later modified and renamed CoolMax®, which is unique in its four-layer hydrophilic construction.

Acrylic is a material that has good heat retention and hydrophilic properties, only slightly less than CoolMax®. Acrylic is another less costly material

mally blocks the moisture. Today, there are moisture treatments that can change the aqueous nature of some fibers, like nylon, making them hydrophilic. Although this can be an expensive process, Polypropylene is a cheaper material more frequently used by manufacturing companies supplying discount sporting goods items. Also, spandex, the fiber used to optimize fit and stretch, is quite critical to sizing. Most higher-end performance or diabetic sock products will offer multiple sizing as compared to cheaper brands.

Wool is one of the oldest natural fibers used in socks and offers excellent wicking properties in product lines such as Smartwool. One of the downsides is that it wears out more easily. Therefore, some companies, like Darn-Tuff, offer lifetime warranties for their combinations. Smartwool extends a performance guar-

Continued on page 98



Evolution (from page 97)

antee, but stipulates that reasonable wear will not be covered.

Pressure and Friction Management

Assuming you have a properly fitted shoe, the sock is the first layer of defense against skin injury. There have been attempts to use double-layer socks for an anti-blister effect but adding a second layer can generate excess heat, which, in turn, produces more sweat. The problem with accumulating moisture in wet material is that it collapses. This is important with so-called performance socks. The extra friction and shear protection they give requires that the terry padding or layers stay relatively dry. It has been studied and proven

by Dr. Richie, et al., that moisture wicking, properly padded and/or layered socks prevent blistering and skin injury in runners.

Doug Richie, DPM, outlined the seminal work of Veve regarding the reduction of pressure with padded socks in his CME paper, in 2008. Thorlo sports socks were studied, along with experimental socks and reductions in pressure were noted in both. Donaghue and others demonstrated durability in pressure management of Thorlo socks.

There has been little credible research done on anti-microbial properties in socks. It is generally accepted that these treatments and fibers create a healthier environment for the foot. But the EPA heavily regulates the technology involved in this process

and the standard of proof for benefit is too costly for most companies.

The Role of Compression

Dave Higgins, former president of Thorlo, is the designer of the FS6 Plantar Fasciitis Sleeve, along with other compression sock brands. He has been in the sock development industry for decades. He and Doug Richie collaborated on diabetic sock development in the early '90s and are recognized as inventors of the diabetic sock marketplace. Higgins' current company, ING Source, has partnered with several firms to distribute the FS6 in the podiatric market.

The idea behind the FS6 Compression Foot Sleeve is to create an orthopedic product that provides both support and pain relief to heel pain and plantar fasciitis sufferers. This is achieved by keeping a consistent stretch across fascia. It can also be used to treat Achilles tendonitis and

Continued on page 99

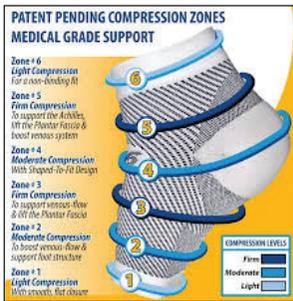


Figure 2: FS6 Compression Foot Sleeve



Evolution (from page 98)

ankle sprains. Introduced in the fall of 2012, it makes up 35% of all orthopedic appliances sold. Since June 2013, the product has been the top-selling orthopedic appliance in running shops across America. At the Running Expo in Austin Texas, it was crowned “New Product of the Year.” Mel Chrestman, an outdoor and running sales representative, notes that there were almost 20 new sock and orthopedic manufacturers at the Expo.

Compression support sleeves and socks are the third innovation that has evolved in the sock industry. Zensah makes a compression leg sleeve geared at athletes for quicker recovery from calf problems and shin splints. Zensah is more fashion-forward than

most companies, offering an array of vivid, bright colors. Other brands are also quickly growing in both the general health and sports market.

standard for medical stockings. This does not mean that non-standardized socks will not work, but they may be less effective or, in the worst case,

The FDA regulates the formula for the compression gradient in compression socks.

The FDA regulates the formula for the compression gradient in compression socks. However, only some companies have chosen to manufacture their products within FDA guidelines.

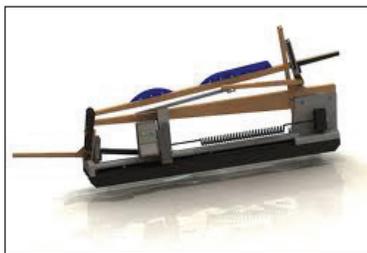


Figure 2: FS6 Compression Foot Sleeve

Garments are tested on a CMD100 compression tester (Figure 3) for compliance to FDA standards. The test equipment is calibrated to the British

create a tourniquet effect. The FDA also expects companies to abide by approved manufacturing practices. ING Source’s FS6 and its Calf Sleeve, CS6, are both FDA-registered and targeted more for medical market use.

There has been a trend by runners, most notably marathon champion Paula Radcliffe, to wear performance compression socks and sleeves. Pro teams, including the NFL, also use compressive performance socks. Matt Werd, DPM, a seasoned

Continued on page 100



Evolution (from page 99)

Ironman Triathlete and past president of the American Academy of Podiatric Sports Medicine, notes that about one in ten triathletes use some form of compression sleeve or sock. He occasionally uses compression socks in training but generally refrains from using them in competition because of the heat created by knee-high compression socks, particularly in warmer weather climates. He has tried Herzog, a company based in the Netherlands. He notes that leg and arm sleeves are frequently used for temperature regulation in endurance training and competition.

Sigvaris and CEP are two major manufacturers of performance socks and sleeves. They have recovery socks rated at 15-20mm HG and performance socks rated at 20-30 mm Hg. Sigvaris points to a number of benefits accrued in using their line of sport socks and sleeves, including increased circulation and improved blood flow, increased oxygen to muscle tissue, reduced pulled muscles and less exercised-induced muscle soreness in the legs, and less lactic acid buildup in the legs during exercise.

Compression Efficacy: Marketing Hype or Evidence-Based?

The research on the efficacy of compression socks is limited. One small study, by Kemmler, et al., showed

increased maximal load with use of the compressive socks. The study conceded that there could have been a placebo effect, but a pre-questionnaire showed hesitancy to wear compressive socks, which would seem to lessen a placebo effect. The evaluation of lactate and lactic acid as an indicator for muscle fatigue in studies is controversial. Len Kravitz PhD., an exercise physiologist, summarized: "Lactate production is actually a consequence of cellular acidosis and NOT the cause of the acidosis. More blatantly, lactate production actually retards acidosis. Lactate is a temporary 'neutralizer' or 'buffer' to the cells' elevated accumulation of protons during high-intensity exercise. Since increased lactate production coincides with acidosis, lactate measurement is an excellent 'indirect' marker for the metabolic condition of the cell."

The most basic explanation of efficacy seems to be that assisting venous return in exercise seems to help recovery, but the scientific proof remains elusive. The role of compression socks in our patient population with venous insufficiency, however, has been more clearly established.

The development of socks from garments to injury preventative socks and orthopedic sleeves has made the discussion even more relevant for podiatric sports medicine practices. Most sock companies require large inventory to become vendors. Compression sleeves do not require the same inventory and have less size skews than socks, making stocking easier. The medical grade companies have a broader range of size skews, and many will allow smaller orders as healthcare providers. These products have become tools for assisting athletes and patients in performing better and for helping in injury prevention and recovery. **PM**

References

Chrestman, Me—Interview 2013.
 Higgins, Dave—Interview 2013.
 Kemmler, W., von Strengel, S., Kockkritz, C., Mayhew, J., Wassermann, A., & Zapf, J. 2009, "Effect of compression stockings on running performance in men runners", *Journal of Strength and Conditioning Research*, Vol 23, No. 1, pp. 101-105.
 Kravitz, Len. (2005). Lactate: Not guilty as charged. *IDEA Fitness Journal*, 2(6), 23-25
 Naylor PE. Experimental friction blisters. *Br J Dermatol*. 1955;67:327-335.
 Parker, Tim—interview 2014.
 Richie, Jr. Douglas H., *DPM Socks & Your Feet Socks: Hosiery -Essential Equipment for the Athlete* 2008.
 Verduyssen, F., Easthope, C., Bernard, T., Hausswirth, C., Bleuzen, F., Gruet, M., et al. 2012, "The influence of wearing compression stockings on performance indicators and physiological responses following a prolonged trail running exercise", *European Journal of Sport Science*, Vol. 1, pp. 1-7.
 Werd, Matt, DPM (interview) 2014.



Dr. Ben Pearl graduated from PCPM in 1991. After starting as walk-on in track at Indiana University, he took up competitive bike racing and raced in IU's Little 500. In addition to serving as a consultant at the National Institutes of Health and his private practice in Arlington, VA, he teaches skiing professionally part-time in the winter at a resort in Pennsylvania. Pearl is a Fellow of the American Academy of Podiatric Sports Medicine.