

# PROSTHETIC SOCKS AND LINERS

IF I WERE TO ASK A ROOM FULL OF AMPUTEES WHAT THE MOST IMPORTANT FEATURE OF THEIR PROSTHESIS IS, I AM CERTAIN THAT COMFORT WOULD BE HIGH ON THE LIST OF RESPONSES. WITHOUT COMFORT, THE MOST TECHNOLOGICALLY SOPHISTICATED COMPONENTS BECOME USELESS. AT THE MOST BASIC LEVEL, COMFORT WITHIN A PROSTHETIC SOCKET IS ACHIEVED BY GOOD PRESSURE DISTRIBUTION AND THE MANAGEMENT OF FRICTION (SHEAR) FORCES. PROSTHETIC SOCKS AND LINERS ARE THE INTERFACE MATERIALS IN CONTACT WITH THE RESIDUAL LIMB AND ARE INTEGRAL TO THE COMFORT OF THE PROSTHESIS.

## Prosthetic Socks

Traditionally, prosthetic socks have provided cushioning and a means to adjust the volume of the socket. Prosthetic socks are available in several materials including wool, cotton and synthetics. Sock thickness is measured by the “ply” rating, most commonly from 1-ply to 6-ply. By varying the ply number and/or the number of socks worn, amputees can adjust for changes in the size of their residual limb. Prosthetic socks should protect the skin against the destructive forces of pressure and friction in the skin-socket interface, while also absorbing perspiration with a wick-like action and allowing for ventilation.

## Sock Materials

### Wool

Wool is an excellent fiber for prosthetic socks due to its resiliency, absorbency and conformability. Wool’s resiliency offers cushioning and provides maximum comfort to the wearer. Its ability to absorb perspiration quickly without feeling wet provides excellent comfort in cold, hot, humid and dry climates. Due to the variety of residual limb shapes, it is also important for the prosthetic sock to conform to the contours of the limb without wrinkling. Knitted wool provides a smooth, wrinkle-free fit.

### Cotton

Cotton has limited application as an interface material in prosthetics. Its advantages are that it is nonallergenic and neutral to any skin type. It can also be washed and bleached with little dimensional change and it is tough; however, cotton does not offer the level of absorbency or the cushioning provided by wool.

### Synthetic Fibers

Man-made fibers are widely used in the production of prosthetic socks and may be used alone in their construction or in combination with natural fibers. One example of an all-synthetic sock is made of polypropylene and Lycra. This combination provides wicking of perspiration and transports moisture across the fiber and away from the skin. The Lycra serves to accommodate edema or atrophy more easily due to its elasticity and ability to return to its prestretched shape.

Wool is increasingly being blended or combined with man-made fibers. These products provide the softness, strength or resiliency of the man-made fibers used and are easier to care for because they tend to resist shrinking and felting. They also cost less than all-wool socks and can take advantage of plaiting - the knitting of one fiber on the outside of a sock and another fiber on the inside to benefit from the qualities of both

fibers. One such sock uses wool on the outside for resiliency and toughness and Dupont CoolMax on the inside, which provides softness and keeps the skin cool by transporting perspiration away from the skin faster than any other fiber. The fibers spread perspiration over a larger area so that it will evaporate more quickly. This sock also contains Microsafe fiber that resists bacteria and fungus growth for skin health and odor reduction. Lycra/spandex provides excellent conformability and free motion of the knee.

### Nylon Sheaths

Nylon sheaths perform the valuable function of providing a moisture barrier and controlling friction between the skin, the sock and the prosthesis. Sheaths look like hosiery but are specially constructed at the distal end to offer maximum smoothness. The top and toe are reinforced so that pulling taut is possible; however, leaving a little slack is advised to prevent stressing the sheath. Sheaths are generally worn in combination with a thicker sock, creating a prosthetic sock system.



*Nylon sheaths come in white and flesh.*

### Gel Socks

Socks and sheaths are also available with gel attached to, or sandwiched between, the fabrics. The gel is usually made of silicone and provides excellent cushioning, pressure distribution and reduced friction. The thickness and stiffness of the gel will dictate the cushioning qualities of the sock. Because gel tends to flow from areas of high pressure to areas of lower pressure within the socket, maintenance of a more even pressure distribution is possible. If the sock or sheath is constructed with the gel exposed, the gel should be worn against the skin. This will help protect the skin from the friction forces created during walking, since the motion will tend to occur between the gel sheath and the prosthesis rather than between the gel and the skin.



*Flesh-colored nylon sheath with silicone insert.*

### Volume Management

All amputees are aware that the size of their residual limb changes over time. Most experience subtle, and sometimes not so subtle, changes in volume over the course of a single day. Factors that affect the volume of the limb include reduction of postoperative edema, muscle atrophy, changes in body weight and the temporary reduction of fluids in the limb caused by the normal pumping action of walking in a prosthesis. To maintain an even, comfortable fit, it is necessary to accommodate for these volume changes by adjusting the thickness of the prosthetic socks. This can be done either by changing to a thicker sock, i.e., from a 3-ply to a 5-ply, or by adding another 1- or 2-ply sock over the existing sock. Care must be taken not to overdo this. If too many socks are used, the socket will not fit properly and may cause discomfort and skin breakdown.



*Different ply of prosthetic socks:  
Top: 5-ply  
Middle: 3-ply  
Bottom: 1-ply*



## Liners

For purposes of this article, I will limit my discussion of liners to those that are worn directly against the skin and either take the place of socks or are worn in combination with them. Over the last decade, we have witnessed a rapid increase in the variety of liners commercially available. Depending on their intended use, these liners can offer some or all of the following benefits: excellent protection against friction, dynamic pressure distribution resulting from the “flow” characteristics of the materials, and suspension of the prosthesis when fitted with a distal attachment.

## Liner Materials

Prosthetic liners are available in silicone, urethane or a mineral-oil derivative. They are applied by turning the liner inside out and then pressing the closed end against the residual limb and rolling the liner onto the leg. They are available with or without a fabric backing, which can ease donning of the liner as it allows the material to easily slide against itself. The backing also serves to reinforce the gel for improved durability. All of these liners are airtight so that perspiration cannot escape. This is generally not a problem, however, because the skin tends to sweat less within the airtight liner once it is accustomed to the sealed environment.

## Locking Liners

Silicone Suction Sockets were first introduced in the mid-1980s. These liners are made of a relatively thin silicone and their primary purpose is suspension of the prosthesis. An attachment mounted on the end of the liner mates with a locking device on the end of the prosthetic socket, thereby providing a secure coupling of the residual limb and the prosthesis. These liners also protect the skin against shear forces because movement occurs between the outside of the liner and the adjacent material. Later, thicker

liners were developed with a softer gel that provides more even pressure distribution as the gel material flows from areas of high pressure to areas of lower pressure. Today, these liners are available with or without the distal locking feature and are usually worn with traditional prosthetic socks to allow for volume adjustments.

Oils and lotions such as mineral oil and Aloe Vera may be integrated within the gel liner to help prevent drying and chafing of the skin.

## Hygiene and Sock Care

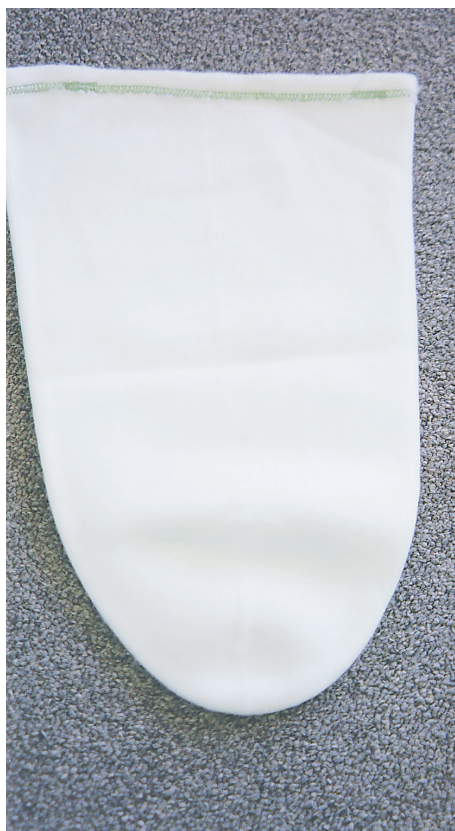
Prosthetic socks and liners should be washed daily, carefully following the manufacturer’s recommendations. Wearing a sock stretches it and perspiration hardens it. Washing and proper care restore its shape and soften it. Proper care of socks will reward the amputee with longer service and greater comfort. A sufficient supply of socks should be maintained to allow

clean socks to be worn each day and to allow several days after washing before wearing. Wool socks should be worn in rotation, as this gives an interval of several days during which the socks can “rest.” Such a rest period allows the wool fibers to regain their natural resiliency and elasticity for optimal comfort.

## Conclusion

Socks and liners are a critical component of the prosthetic system and impact comfort dramatically. When used properly they provide a cushioning effect within the socket, help to minimize friction forces, and provide even pressure distribution. As with other prosthetic options, the selection of the most appropriate socks and/or liners for each amputee depends on a variety of factors that are best explored with his or her prosthetist.

—by Jack E. Uellendahl, CPO



*A typical 5-ply prosthetic sock.*