

The Hinnant Prosthetics Quarterly

Experience Our Road to Prosthetic Excellence

Winter 2001

In Search of... Extraordinary Socket Comfort

Dear Friends...

This issue of our newsletter addresses perhaps the most important aspect of the prosthetic art: socket comfort. For the majority of amputees, regardless of age or activity level, no factor is more critical to achieving a positive func-

tional outcome. Though a prosthesis might incorporate the most advanced design and materials, it may be relegated to the "back of the closet" if the wearer routinely experiences pain or excessive movement of the residual limb within the socket.

But otherwise-capable patients need not suffer that outcome. These articles describe the exciting advances in socket design and fabrication technology that have entered mainstream prosthetic practice in the last few years.

We hope you share our excitement about these new capabilities, which promise improved quality of life for a great many amputees presenting with challenging anatomical and/or biomechanical conditions.

Best wishes for a satisfying and rewarding 2001!

– M. Kale Hinnant, C.P., FAAOP



Kale

The Total-Surface-Bearing Socket

For the better part of the last three decades, the patellar tendon-bearing (PTB) socket has enjoyed almost universal acceptance for use in transtibial prostheses. While sockets for other amputation levels have undergone substantial modification and improvements over the years, the tried-and-true PTB has continued as the socket of choice for below-knee

systems with relatively minor changes.

Now there's a new kid on the block, the total-surface-bearing (TSB) socket, an alternative design offering specific advantages for various patients. The total surface-bearing approach represents a fundamental departure from the PTB philosophy, i.e. focusing weight-bearing stress on certain pressure-tolerant structures, notably the patellar tendon and

**Prosthetics
Today**

Hinnant Opens Gastonia Office

Hinnant Prosthetics' quality patient services are now available to physically challenged patients in the Gastonia area through Compleat Rehab and Sports Therapy Center, a licensed comprehensive clinic offering prosthetic, orthotic and rehabilitation services. Our 19,000 square foot freestanding facility at 2675 Court Dr. in Gastonia enables our board-certified practitioners to design and fabricate custom, state-of-

the-art prosthetic and orthotic devices on site in minimum time.

At all of our locations, we work closely with referring physicians to provide the most appropriate and best possible outcome for each patient, coordinating our efforts with physical and/or occupational therapy. We accept assignment from Medicare, Medicaid, Crippled Children's, Vocational Rehab, and most insurance carriers.

For details, call us in Gastonia at 704-824-7800.



ICECAST pressurized casting instrument used for creating TSB sockets.

medial tibia flare, and relieving pressure-sensitive areas. In a TSB socket, weight-bearing forces are distributed as evenly as possible over the entire residual limb surface, including areas previously considered pressure-sensitive. For many patients, this approach proves more comfortable.

A common application of the TSB design is in sockets incorporating viscoelastic interfaces, such as the silicone, gel or urethane liners discussed in this issue. By minimizing concentration of pressure on any one part of the interface, the TSB socket decreases the likelihood of puncture and "tired liner disease," which sometimes develop over time at areas subjected to

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The Socket Interface — Where Amputee

in-te-grate *v.* —*tr.* **1.** To make into a whole by bringing all parts together; unify. **2.a.** To join with something else; unite. **b.** To make part of a larger unit.

in-ter-face *n.* **1.** A surface forming a common boundary between adjacent regions, bodies, substances, or phases. **2.** A point at which independent systems or diverse groups interact.

The prosthetic socket, essential point of integration between human tissue and replacement limb, is most often also the place where degree of prosthetic success is defined.

- It is the socket that initially accepts and transfers the stresses of weight-bearing, suspension and ambulation to the residual limb.

- It is the socket that protects and accommodates the often irregular and tender tissues of the residual limb and thereby helps determine how well, and for how long at a time, an amputee can function in his/her prosthesis.

- It is the socket that can, through intimate and comfortable fit, smoothly deliver the advanced gait performance promised by today's sophisticated prosthetic limb components.

- It is the socket, in other words, where an amputee's hopes and dreams for re-stored function meet reality.

The ideal socket, one achieving a virtual "seamless" unity between limb and prosthesis, remains in the future; but adaptation of advanced materials and

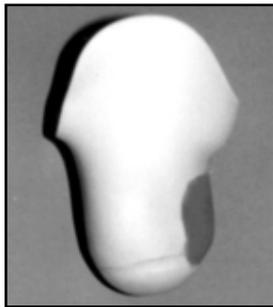
development of improved designs are bringing us rapidly closer to that goal.

The Socket Interface

The residual limb presents two age-old difficulties to those creating prosthetic sockets: adequately protecting fragile skin and underlying tissue from vascular insult and breakdown, and compensating for volumetric changes—resulting both from postoperative healing and from routine daily variation. From the not-so-good (wooden sockets and woolen

socks), we have progressed to increasingly flexible (both literally and figuratively) designs, which are substantially more functional and comfortable.

A major improvement was the introduction of soft interface inserts to provide added cushioning and protection within the hard outer socket shell. Some of the first inserts were made of a rubber-like material encased in leather. Then in the early '80s,



Pelite Foam Liner



ICEROSS silicone liner

polymer foam liners were introduced, delivering surprising shock-absorbing capability at relatively light weight. Foam liners have become a mainstay in socket construction and remain popular today. In addition to full socket liners, sockets are often fitted with smaller distal pads to provide added protection for the end of the residual limb.

While polymer foam inserts have become the most common socket interface, rapidly emerging *viscoelastic* products are poised to surpass them as the new interface materials of choice for the future. These materials, predominantly silicones and urethanes, offer several particularly desirable characteristics:

- High energy-absorption, providing added protection for bony prominences and other sensitive areas of a residual limb.

- Flexibility—These materials deform easily when stressed, then recover slowly, subjecting limb tissues to less shock and abrasion, distributing impact and weight-bearing forces over a

wide area and providing a massaging action that may aid circulation.

- Transparency, allowing visualization of the residual limb and fit assessment inside a socket or liner.

TSB Socket Can Enhance Outcomes

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higher pressures. Some liner manufacturers recommend the TSB design for sockets in which their products are used.

Fabricating a total-surface-bearing socket involves precise casting of the residual limb as it will exist within the socket environment. This process can be accomplished by modifying traditional casting techniques or using a pressurized casting instrument such as the Össur ICECAST. This device applies uniform pres-

sure to the residual limb, under which the soft tissue tends to redistribute and take on the shape that will produce equal weight-bearing across the entire limb surface. The prosthetist creates the cast in this environment.

Although the TSB socket can be used with traditional modes of suspension, it was originally designed and lends itself particularly well to suction suspension in conjunction with a roll-on silicone, gel or urethane liner. Suction offers the multiple

advantages of a less-cumbersome method of suspension, reduced pistoning of the residual limb within the socket, substantial lessening of skin breakdown and apparent improved residual limb circulation.

Though far from a widespread replacement for the venerable PTB design, the total-surface-bearing socket gives us another important option for providing optimum comfort and functional outcomes for amputee patients.

Amputee Dreams Meet Prosthetic Reality

- **Adhesion**—Properly applied, viscoelastic components will create and maintain a negative atmosphere seal about the residual limb surface, producing either full or partial (i.e. in combination with a sleeve, belt or similar device) suction suspension.

Viscoelastic materials are gaining increasing acceptance for use in both custom and prefabricated liners, suspension sleeves, gel-impregnated sheaths and socks, and distal pads for both transtibial and transfemoral, as well as upper-limb applications.



Silipos soft gel liner

Roll-on Silicone Liners

Flexible silicone suction liners are now firmly entrenched in the prosthetic mainstream. Össur Kristinsson is credited with the initial idea; his Icelandic Roll-On Suction Socket (ICEROSS) is widely used in socket fabrication today.

From the original ICEROSS design have grown several enhancements, notably the Comfort and Comfort Plus, which are especially good liners for residual limbs with fragile or exposed tissues, bony prominences and conical residual limbs. The ICEROSS Comfort provides a 6 mm silicone gel wall thickness distally, tapering to 2 mm proximally. When a patient shrinks out of his/her socket, the Comfort liner can be replaced with a Comfort Plus, which has a uniform 6 mm thickness throughout. ICEROSS liners now come with a nylon outer cover for slide-on donning.

The ALPS South Corporation developed transparent silicone liners, which allow the prosthetist to see exactly how the residual limb surface is impacted by the socket environment. This capability is particularly significant around scar tissue, grafts and invaginated areas. The Fillauer Silicone Suspension Liner is another popular option.

These liners incorporate an attachment for a locking device to secure the liner to the hard socket. They all come in a variety of prefabricated sizes and can be custom-molded to accommodate an unusually shaped residual limb or an older-style socket. While a major role of roll-on liners is to provide full suction suspension, they still play a valuable protective and comfort-enhancing role for patients who cannot tolerate negative pressure or prefer another type of suspension.

Gel and Urethane Liners

After the acceptance of silicone interfaces, other materials were applied to the fabrication of socket liners. The Ohio Willow Wood Alpha Cushion Liners and ALPS Easyliners are made of a mineral-oil gel, which is gentle to the skin. Both come with a fabric cover to facilitate donning and are available in both tapered and constant thicknesses and various sizes.

Another variation, the TEC (Total Environment-Controlled) Interface System, utilizes a transparent urethane polymer. TEC products include custom-made suction liners for all levels of upper- and lower-extremity amputation sites and orthotic applications. TEC liners are a good choice for most amputees with highly sensitive residual limb surfaces and for otherwise hard-to-fit patients.

Gel Socks and Sheaths

Viscoelastic properties can also improve the comfort and protective capability of socks and sheaths commonly worn with a socket by diabetic as well as active amputees, who are at increased risk of skin breakdown. Most gel socks, sheaths and liners feature a polymer gel laminated between fabric, the thickness of the gel defining the name and particular application of the product.

Gel-product pioneer Silipos uses a patented polymer material incorporating a medical grade mineral oil that gradually dissipates into the skin, providing con-

stant moisturization for the residual limb surface and thereby added protection from the perspiration, itching and abrasion that frequently accompany prolonged socket wear. From its original Silosheath, equivalent to a conventional two-ply sock, Silipos has significantly improved the scope and durability of its product line, including single- and double-layered full gel liners, comparable in thickness to three- and four-ply socks respectively.

Good hygiene is essential with these products. Gel socks, sheaths and liners should be changed daily, washed regularly and never donned unless completely dry. Most patients are given at least two so that one can be "recovering" while the other is in use. Residual limbs should be washed thoroughly after each use.

Suspension Sleeves and Distal Pads/Cups

Silicone and urethane sleeves are proving an excellent method for providing partial or complete suspension of a prosthesis. Silicone sleeves, such as the ALPS ClearLine, require less than half the compressive force of conventional latex and neoprene sleeves and therefore are more comfortable. The sleeves frequently are used to serve as both sleeve and liner.

Some amputees with a particularly bony or tapered residual limb require added protection over distal tissues and in some cases filling for a prefabricated liner. Össur markets an ICEROSS distal cup to both protect and "round out" a residual limb, while ALPS and Silipos offer end pads that can be placed directly inside a socket or liner.

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Alpha Gel Liners

Note to Our Readers

Mention of specific products in our newsletter does not constitute endorsement, nor does it imply that we will select such products for use with any particular patient.

We offer this information to enhance professional and individual understanding of the prosthetics discipline and the capabilities of our practice.

Enhancing Socket Comfort

(Continued from page 3)

A Few Limitations...

As with most exciting new products, the viscoelastic interfaces discussed above present occasional drawbacks. For one thing, they are sometimes not as durable as foam components. Silicone liners punctured, by a sharp fingernail for example, must be replaced from time to time. Fortunately, with continued research and development, the durability of these products is improving.

Expense is another issue. A patient may go through a number of liners, pads, gel socks, etc. during the normal life span of more traditional components. On the plus side, prices are coming down with increasing acceptance of these products and healthy manufacturing competition.

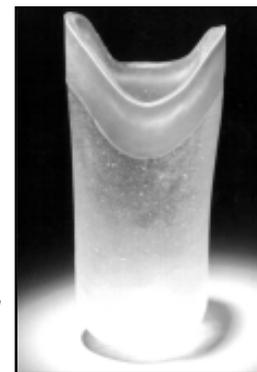
While some of these components may add to socket weight to a degree, most wearers do not find the increase objectionable, because (1) the added weight is applied at the residuum with resulting less impact than if applied more distally, and (2) patients usually find the increase in

comfort more than offsets any negative impact of the added mass.

Finally, though viscoelastic materials are largely chemically neutral and hypo-allergenic, a few patients experience skin sensitivity to them, some simply having a hard time adjusting to their unique feel. Most find the tactile sensation of these products pleasing, however.

All things considered, the impact of silicone and urethane socket interface components has been overwhelmingly

positive. They have become an important addition to our patient care armamentarium, and we can expect that they will become the socket interface materials of choice in the foreseeable future.



TEC urethane liner



ICEROSS Distal Cup

So Much to Choose from...

With such a broad spectrum of options available for constructing a socket interface, how do we decide what is best for our amputee patients? That's where the knowledge and experience of our board-certified prosthetic staff makes a big difference.

Every amputee, every residual limb, presents a new situation...a new challenge. Each patient brings his or her own circumstances, lifestyle, expectations and dreams into our office. Our role is to provide the best, most practical substitute limb we can assemble and thus restore maximum possible function.

Some patients do well with the basic hard socket and woolen sock routinely provided 25 years ago. Others present with an extremely difficult

residual limb or other complications requiring the most up-to-date protective interface we can create. Still other patients will not tolerate advanced designs or materials such as the viscoelastic interfaces described in this issue. No standard recipe will work—each prosthetic limb we create is unique.

Our prosthetists thoroughly evaluate each new patient—physically, biomechanically and personally—before embarking on a limb design. We strongly encourage physician, therapist and family participation in that process.

For additional information or consultation on a particular patient or situation, give us a call.

Hinnant Prosthetics

Prosthetic Specialists Since 1934



*Experience
Our Road to
Prosthetic
Excellence...*

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