



Falk Prosthetics & Orthotics QUARTERLY

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No. 23

The Latest in Prosthetic Liners

Gel liners, sometimes known as roll-on suction sockets, aren't particularly new anymore—they've been a part of main-stream prosthetic practice going on two decades, and today increasing numbers of amputee patients are wearing them.

That growing history doesn't mean the innovation is over, however. In reality, new interface designs are coming to market at a rapid pace, giving prosthetic patients new possibilities for comfort, function, prosthetic endurance and quality of life.

One recently introduced concept combines the advantages of a cushion liner with those of a hypobaric sock to provide reliable suction suspension without an external sleeve. **Iceross®**

Seal-in Liners incorporate a circumferential sealing membrane, which conforms to the inner socket wall and maintains secure suction suspension, even if the wearer's residual limb volume changes during the day. Benefits for appropriate patients include more reliable suction suspension, increased range of motion, and increased comfort and endurance.

Also new is a liner designed specifically for upper-extremity applications. Previously, liners prescribed for upper-limb amputees were in reality lower-limb products of an appropriate size for the patient's residual arm. The **Alpha® Upper-Extremity Liner** retains the attributes of its lower-limb cousin but features a unique oval-shaped umbrella that better matches the upper-limb shape and allows for a more comfortable fit. It is available in three prefabricated sizes as well as custom versions for challenging limb shapes and conditions.

A **custom liner** most always gives amputees the best fit and performance and is particularly recommended for limbs with sharp or irregular contours, a high level of sensitivity, and/or significant scarring. The central ingredient of custom liners may be silicone, urethane or thermoplastic elastomer; each offers specific properties and advantages, which are evaluated by our prosthetic team in relation to each patient's needs.

More and more liners are being provided with an outer fabric layer, which serves to facilitate the donning process and extend the life of the liner.

Another significant new advancement in interface technology is the **Iceross Synergy**, a liner incorporating two distinct silicone gel layers—a soft inner layer designed to soothe and protect

the residual limb and a firm outer layer to maintain liner stability during active wear. This product also features a reinforced fabric built into the distal end to provide additional protection to the end of the residual limb and limit longitudinal stretching and therefore undesirable liner movement on the residual limb (pistoning).



Custom silicone liners

Courtesy Otto Bock Health Care

What's New



Transfemoral Seal-in Liner for conical limbs

Courtesy Össur



Alpha upper-extremity liners

Courtesy Ohio Willow Wood

(Continued on page 4)

Welcome, Paul Rothman, CPO

Falk Prosthetics and Orthotics is pleased to introduce Paul Rothman who recently joined our staff. Paul, an American Board Certified and Florida licensed prosthetist-orthotist, will be working closely with David Falk in our Delray Beach office.

Paul has been a prosthetist-orthotist for 24 years. He graduated from the State University of New York at Binghamton with a B.A. in psychology, then completed a two-year graduate program in prosthetics and orthotics at New York University. Paul served as assistant director of the prosthetics department at The Kessler Institute for Rehabilitation in East Orange, N.J., where he managed a heavy prosthetic load and gained valuable experience handling complex cases. His knowledge and expertise will be a valuable asset to our staff as we continue to provide outstanding personalized care and service as well as prompt response to area hospitals.

Falk Prosthetics & Orthotics is a full-service prosthetic and orthotic company serving Palm Beach County with offices in Delray Beach and Jupiter. Our ABC certified practitioners and friendly staff work closely with our patients, referring physicians and physical therapists to maximize the functional outcome of each patient.

We hope you find this publication informative and welcome your questions, comments and suggestions. Visit us on the web at www.falkprosthetics.com.



Paul Rothman, CPO

Suction? Liner? Belt? Suspension Choice a Key Element of Prosthetic Success

In its limb prosthetics application, the term suspension derives from a primary definition of its root word *suspend*... “to hang from somewhere.”

In fact, that definition reveals the primary challenge of attaching a replacement limb to the human anatomy: Hanging from a residual limb, the prosthesis is subject to gravity, which in most postures applies a distal force that seeks to pull the replacement limb away from the body. In lower-limb applications, this displacement occurs primarily during gait swing phase; it is reversed during stance phase as the patient’s weight and momentum push the residual limb down into the socket. The resultant distal-proximal movement of the prosthesis on the residuum during ambulation is known as *pistoning*, a process that significantly hampers prosthetic performance through suboptimal gait, increased energy expenditure, discomfort, fatigue, substantial skin breakdown, and safety risks.

Prosthetic science has made great strides in recent years at minimizing pistoning through improved suspension methods and socket designs. Finding the right suspension option for any given patient is frequently the pre-eminent factor in achieving prosthetic success.



Suction Suspension

For appropriate patients, suspension methods utilizing an atmospheric vacuum to hold the residual limb in the socket usually provide the best outcomes. Suction options—whether provided by “pure” suction, a roll-on liner, hypobaric sock, and/or some type of vacuum assist—limit pistoning and provide the best level of proprioception and greatest range of motion of all current suspension methods.

With **pure suction**, precise socket fit enables residual limb skin to remain in total contact with the socket wall, thereby maintaining the vacuum created at donning. Success with pure suction requires that the wearer consistently be able to don and doff the prosthesis properly. Donning typically involves actuating an expulsion valve at the distal end of the socket to evacuate air as the residual limb enters. A “pull sock” or lubricating agent may be used to assist the donning process, and a vacuum pump may be employed to enhance the suction once the residual limb is established in the socket.

Transfemoral suction socket

Courtesy Otto Bock Health Care

Note to Our Readers

Mention of specific products in our newsletter neither constitutes endorsement nor implies that we will recommend selection of those particular products for use with any particular patient or application. We offer this information to enhance professional and individual understanding of the orthotic and prosthetic disciplines and the experience and capabilities of our practice.

We gratefully acknowledge the assistance of the following resources used in compiling this issue:

**KISS Technologies, LLC • Ohio Willow Wood • Össur
Otto Bock Health Care • Wounded Warrior Project**

Prosthetics Today

Contraindications to successful suction use include bony or irregular residual limb contours, as are often encountered with transtibial amputation levels; significant residual limb volume fluctuation; residual limb skin challenges; and physical or mental impairment that will interfere with donning and creating the needed suction or with removing the socket.

Suspension Liners—A roll-on suspension liner can overcome most of these obstacles, protecting the residual limb from shear forces, providing an easier donning method, and compensating for irregular skin contours.

“Cushion” liners can enhance a suction suspension and improve amputee comfort. More common are liners incorporating some type of locking device—pin and shuttle lock, lanyard or locking strap—to securely attach the liner to the socket.

Pre-fabricated liners, available in a variety of materials, designs, and sizes, will work for many patients, while custom liners can be created for patients with major residual limb issues or special needs. Innovation continues to produce more functional and enduring prosthetic gel liners.

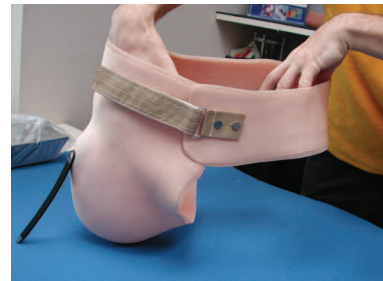
Other suction suspension aids include hypobaric socks, which incorporate a gel band to maintain the seal between the skin and socket wall; elastic suspension sleeves, which cover the proximal end of a transtibial socket and extend over the knee to the thigh; and the Harmony Vacuum Assist Socket System, which incorporates a small weight-actuated suction pump that sustains the negative pressure in the socket and helps compensate for residual limb volume loss.



Patellar tendon-bearing socket with supracondylar suspension

This method can provide excellent suspension as well as a degree of rotational control.

Other anatomic suspension options include constructions that take advantage of congenital protuberances, often involving a cutaway section of the socket and a “door” panel that is applied after the residual limb is in place.



Short transfemoral liner with lateral locking strap and auxiliary waist belt

Courtesy Otto Bock Health Care

Anatomic Suspension

When suction methods prove unfeasible, suspension utilizing anatomic structures frequently provides a viable alternative, particularly in transtibial and knee disarticulation prostheses.

Supracondylar suspension is accomplished by extended medial and lateral socket walls that fully encompass the femoral condyles and a compressible, contoured wedge that fits snugly above and against the medial condyle. The wedge can either be fabricated into the proximal socket wall or molded into a soft socket insert donned before the prosthesis.

This method can provide excellent suspension as well as a degree of rotational control.

Other anatomic suspension options include constructions that take advantage of congenital protuberances, often involving a cutaway section of the socket and a “door” panel that is applied after the residual limb is in place.

Straps, Belts and Hinges

When suction or anatomical suspension is unavailable for various reasons, some older suspension methods may be employed. Strap suspension schemes, often used in combination with a waist belt, are relatively easy for the wearer to adjust and therefore are sometimes a good choice for individuals likely to encounter substantial changes in residual limb volume, as in the weeks after amputation surgery. However, strap methods allow significant pistoning and are generally not as comfortable as other suspension types.

A suprapatellar cuff, which encircles the thigh over the femoral condyles and attaches to the socket with straps, may be a good choice for transtibial patients who have good knee stability. It is normally used with a waist belt. A thigh corset with metal side joints may be prescribed for a delicate residual limb unable to withstand weight-bearing loads.

For transfemoral amputees who cannot use suction, a silesian belt, total elastic suspension (TES) belt, or pelvic joint and belt may be used for suspending the prosthesis.

Upper-Limb Suspension

Suspension methods for upper-extremity prostheses, both body-powered and externally-powered (myoelectric), are in many ways similar to those for a lower-limb system: They may utilize suction,

intimate fit around anatomic structures, a gel liner, one of several tried-and-true harness suspension methods, or a combination of these.

Harness systems are generally easy to don and remove but can significantly restrict range of motion, and strap chafing is common.

Pure suction, where applicable, can provide excellent suspension and is a desirable choice for an externally powered system that does not require a harness for body control. Upper-limb suction sockets require some skill to don and generally stable residual limb volume.

Gel liners can be used for both above- and below-elbow systems and function mostly like lower-limb liners; in fact, it was not until recently that liners designed specifically for upper-limb applications have been offered. A pin and shuttle lock may be used for short-to-medium transhumeral and transradial limbs, while a lanyard system is generally indicated for long transradial and wrist disarticulation levels.

Various transradial and wrist disarticulation socket designs incorporate anatomic suspension utilizing the humeral epicondyles. The best-known of these is the Muenster socket for short transradial deficiencies.

Determining, designing, and creating the most effective suspension method for any prosthetic patient is a role properly reserved for the well-experienced, board-certified prosthetist.

We welcome your inquiries and referrals.



Courtesy Otto Bock Health Care

Keeping Suspension ‘Simple’

In their on-going search for more precise and functional ways of replicating the function of the human limb, prosthetic practitioners regularly evaluate new ideas and technology that may provide improved functional outcomes for their patients.

The **Keep It Simple Suspension (KISS)** system provides a potentially better method of suspension for patients with a transfemoral deficiency, notably those who encounter difficulty donning their prosthesis. KISS components include a roll-on locking liner configured with distal and proximal attachment straps (photo 1) and socket fabricated with openings in the distal end and lateral side. The accompanying series of photos demonstrates how the system works.

In donning the prosthesis (either standing or sitting), the patient rolls the locking liner onto the residual limb in the usual manner (photo 2), threads the distal liner strap through the opening in the end of the socket (photo 3), feeds the lateral liner strap through the lateral socket opening (photo 4) while sliding the residual limb into the socket opening, inserts the distal strap into a D-ring sewn into the lateral strap (photo 5) and through pulley action seats the residual limb fully in the socket by pulling down on the distal strap and affixes the strap to a Velcro attachment on the socket’s distal exterior (photo 6).

The KISS attachment method has been demonstrated to virtually eliminate pistoning and distal draw and minimize rotation, even in the presence of volume loss.



Photo 1



Photo 2



Photo 3



Photo 4



Photo 5



Photo 6

Photos courtesy KISS Technologies, LLC

The Greatest Casualty Is Being Forgotten

A sad reality of the Global War on Terrorism (GWOT) is that many American soldier-heros are coming home with battle wounds, many involving the loss of a limb. While the medical and rehabilitative care provided by the federal government is frequently excellent, often involving a state-of-the art prosthesis, there's just so much a hospital team can do for a young, recently vital soldier whose unlimited life possibilities have suddenly been shattered by a sniper's bullet or improvised explosive device (IED).

That's where the **Wounded Warrior Project** (WWP) steps in to make a difference by helping servicemen and women heal both physically and mentally and making sure they do not feel abandoned.



Courtesy Wounded Warrior Project

Soon after war casualties began returning from Iraq and Afghanistan, a group of military veterans realized that these wounded men and women had special needs beyond medical care. They founded WWP to bring comfort and support to wounded service personnel and their families in the transition from hospital bed to an independent and productive life.

WWP programs encompass in-hospital support, benefits counseling, advocacy, adaptive and outdoor sports, mentoring and work transition assistance.

The Wounded Warrior Disabled Sports Project, a partnership between WWP and Disabled Sports USA, provides year-round sports activities for recovering amputees and other severely wounded war veterans. The program recently was expanded to encompass outdoor sports including hunting, fishing, boating and camping, through which participants learn hobbies they can enjoy with friends and family without the need for special equipment or ongoing training.

These activities play an important role in a wounded service member's recovery. Typically war amputees go through a difficult adjustment period—most are in their 20s and accustomed to being active, involved and in charge of their life and body. The sudden traumatic change in physical ability makes them vulnerable to psychological and emotional as well as physical trauma, which severely impacts them and their families. Participation in WWP sports programs shows wounded warriors the promise of a bright and active future and provides a foundation for developing a positive self-image.



The Wounded Warrior Project provides a way for a grateful nation to thank its wounded servicemen and women for their sacrifice. Details can be found at woundedwarriorproject.org.

Liner Choices Growing Steadily

(Continued from page 1)



Synergy liner with Wave feature

Courtesy Ossur

An optional feature of the Synergy liner is a new type of outer covering called the Wave feature, designed to make the liner easier to bend at the knee for transtibial amputees and thereby better able to adapt to the wearer's movements. During knee flexion, Wave liners exhibit less bunching at the knee posterior and more elasticity anteriorly and posteriorly, which combine to deliver greater freedom of movement.

A final development worth noting is the creation of **conical liners** for transfemoral amputees. By more closely confirming to the anatomy of patients with a distinctly conical residual limb shape, these liners may eliminate the need for auxiliary belts, straps and/or suspension sleeves.

Custom urethane liner

Courtesy Otto Bock Health Care



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