The Hinnant Prosthetics Quarterly

Experience Our Road to Prosthetic Excellence

Autumn 2005

The New Socket of the 21st Century

MAS Design Advances Standard For AK Gait, Comfort, Cosmesis

In creating a prosthetic limb for a transfemoral amputee, the design and construction of the socket is usually the primary determinant of ultimate functional outcome. The lower componentry—knee system, pylon and ankle-foot—may be of the highest caliber and capability; but if the socket design does not enable the amputee to walk comfortably with a mostly natural gait, the chances of regaining pre-amputation mobility and quality of life are not particularly good.

For many years, two above-knee (AK) socket designs have predominated: the quadrilateral or quad socket, in which primary weight-bearing is achieved by the ischium resting on the posterior socket brim, and the ischial containment (I.C.) socket, which features high trim lines that totally encompass the ischial tuberosity. Each design has particular advantages and limitations, although I.C. sockets are generally preferred for active patients. Many I.C. variations have been developed over the years, but the search for the ideal AK socket continues.

Prosthetics Today

As the new century approached, a dedicated prosthetist-engineer in Mexico set about to address a common complaint among young female (and other) above-knee amputees seen in his practice: the unsightly socket bulge created by the projecting posterior brim of the socket, visible under all but the loosest-fitting clothing.

MAS design gives wearers greatly enhanced hip flexion while still holding suction.

In 1999 Marlo Ortiz unveiled his solution, an ischial containment variation that has come to be known as the Marlo anatomical socket® or MAS. Providentially, it turns out his still-evolving design improves gait function, range of motion and patient comfort as well as appearance and is becoming widely regarded as the first major socket breakthrough of the 21st century.

(Continued on page 2)

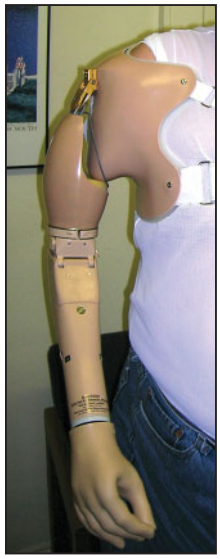
New Technology Report

The early years of the new century have been an exciting time of innovation in the world of limb prosthetics. In this issue, we report on three notable technological advances that promise better outcomes for amputees—the MAS transfemoral socket design, the RapidFit reusable test socket system and the Utah Arm 3 above-elbow limb system.

We hope you find this content worthwhile and welcome your questions and referrals.

MAS socket

RapidFit test socket



Utah Arm 3

Hinnant Prosthetics Quarterly is a professional newsletter published since 1998 by Hinnant Artificial Limb, Co. to keep physicians, therapists and other rehabilitation professionals abreast of the latest trends and technology in the prosthetics discipline.

Hinnant has been serving the needs of amputees and patients with congenital limb deficiencies in North and South Carolina for more than seven decades. We specialize in applying the latest proven technology commensurate with each patient's capabilities, lifestyle and personal desires.

We hope you find our newsletter to be interesting and professionally relevant and welcome your comments, referrals and requests for further information.

We also encourage you to visit our website at:

www.hinnantprosthetics.com.

Thank you for your continuing support.

Marlo Socket Opens New Horizons for Transfemoral Amputees

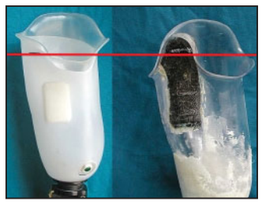
(Continued from page 1)

It Can't Be Done, But...

Ortiz's initial response to his patients' cosmesis concerns was "It can't be done." He then went to work to prove himself wrong.

He began by trimming back the posterior wall of an I.C. socket to the gluteal fold, allowing the gluteus maximus to remain outside the socket and eliminating the skin bulge caused by the socket brim pushing into soft tissue. He also trimmed the medial socket wall to relieve pressure on the lower portion of the pelvis and lowered the anterior wall as well.

The unconventional lower trim lines of this socket produce more favorable encapsulation of residual limb structures, notably the ischial tuberosity and part of the ischial ramus within the medial aspect of the socket brim. Ischial ramus containment is achieved with a proximal extension at the posterior-medial corner of the socket. The location and contour of this extension is critical to the socket's function.



MAS socket (right) features distinctly different and generally lower trim lines than typical ischial containment socket.

MAS Benefits

Although his initial goal was improved appearance, Marlo Ortiz soon discovered that his new lower-profile socket promised other important benefits, notably increased range of hip motion, improved gait, and enhanced comfort, both walking and sitting. Today MAS, which incidentally is Spanish for "more," does indeed promise more in terms of functionality, comfort and appearance than most previous above-knee socket designs.

Can you tell which side has the prosthesis?

Comfort—With a properly fitted MAS, the socket maintains total contact with the residual limb in flexion, extension, adduction and abduction. The amputee experiences virtually no concentrated pressure on the residual limb, resulting in an exceptionally comfortable socket fit. Some amputees wearing a MAS prosthesis are unable to identify where they are carrying their weight; moreover, the lower posterior brim does not push the buttock above the amputated limb higher than on the sound side.

Another pleasant surprise appears the first time a new MAS wearer sits down. Unlike the typical unpleasant sensation of sitting on a hard plastic brim, especially in a hard chair, as is common with other AK sockets, the MAS low-profile posterior dimension allows the amputee to sit on the gluteus muscle group, thereby preventing pelvic imbalance during sitting.

Gait—The MAS socket provides enhanced stability of the pelvis and gives the amputee better control of the femur. The superior containment of key residual limb structures allows the socket to be aligned in an increased adduction position, approximating the angle of the sound leg, for greater prosthetic control and a more normal, energy-efficient gait. A key element of MAS construction is to allow sufficient room for full adductor function during gait.

With other, particularly quad, sockets, amputees often experience skin irritation on the inner upper thigh from the prosthesis shifting laterally under the amputee's weight during ambulation. With a MAS socket lateral socket shift is all but eliminated, yielding advanced levels of control and balance on the prosthesis. Because they MAS wearers spend less effort trying to maintain their balance, they have more energy for doing other things—the things they want to do.

MAS socket ready for action.

Donning—Though the MAS design can be used with all existing methods of socket suspension, suction valve and silicone liner applications predominate. The lower trim lines, reduced restriction proximally and overall socket design typically enable MAS wearers, notably older patients, to lock into and remove their prosthesis with more speed, confidence and ease than with traditional designs.

Appearance—With this design, socket outlines are all but invisible. See accompanying photos.

New Prosthetic Horizons

With these attributes, the Marlo Anatomical Socket opens new horizons for transfemoral amputees. The design can work for patients of virtually any age, and the socket is compatible with all available prosthetic knees and feet.

However, not just any practitioner can apply this design with success. Although the design is based on simple principles, it is unlike any other socket concept, and a well-contoured fit is essential to a successful outcome. Our prosthetic staff has taken the time to learn and fully understand the biomechanics of the system and gain hands-on practice.

For additional information on the MAS design or to discuss a MAS socket for a particular patient, we invite you to call our office.

Socket? What socket?

A MAS Success Story

The MAS socket provides improved muscular, vascular management of the residual limb, making possible advanced lateral hip abduction, as demonstrated here.

W. D., a 75-year-old male, became a right transfemoral amputee in 1954 consequent to a work-related accident. Though technically classified as a "senior citizen," this is one amputee who is intent on living life to the fullest through a wide range of active hobbies including camping, biking and travel.

Through his more than a half-century as an amputee, W. D. has experienced a wide range of prosthetic componentry and is constantly on watch for new improvements. He recalls that in the 1970s, his prosthesis allowed him to ride motorcycles, deer hunt, work scaffolding and ladders, teach his sons scuba diving in the ocean and comfortably wear his leg for 48 hours. "Of course, I was much younger in those days."

After researching MAS socket developments on the internet, W. D. traveled cross-country to access the new design. He presented wearing an already advanced prosthesis incorporating an Otto Bock C-leg but looking for a socket that would provide more comfort, stamina and leg strength with which to enjoy his hobbies. In addition to the MAS socket, his revised prosthesis incorporates the advanced LuXon Journey foot and some new abilities (see photos).

Lower MAS socket walls and trimlines allow constant total contact with residual limb through sitting, standing, abduction, adduction and lateral scissoring.

Reusuable Test Sockets Help Resolve Post-delivery Fit Issues

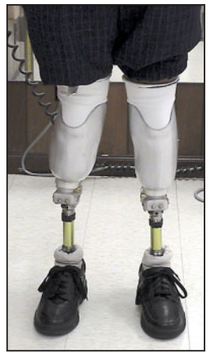
In the creation of a new limb, the prosthetist frequently employs a check or "test" socket to evaluate various aspects of the final socket's construction and make modifications that will help maximize the patient's functional outcome.

The clear test socket, which can incorporate or be connected to key prosthetic elements of the finished prosthesis—such as a locking mechanism, knee unit (if for an above-knee amputee), pylon and prosthetic foot—allows the prosthetist to observe the residual limb inside the socket environment and determine just how residual limb structures react during weight-bearing and ambulation.

In particular the prosthetist can evaluate:

- design and fit of the custom socket
- relief of bony prominences
- optimum socket depth
- degree of total contact
- location of the suspension locking mechanism, if used
- the wearer's facility with donning and removing the prosthetic limb
- reliability of the limb's suspension method, whether pure suction, roll-on liner with pin or lanyard, TES belt, etc.
- length of the prosthesis, and
- appropriateness of components chosen for the prosthesis.

In traditional practice, the clear plastic test socket body is generally discarded once the initial socket evaluation and resulting modifications are complete. Because insurance normally will not pay for additional locking mechanisms, adapters and other components bonded into the typical test socket, these items are most often cut out and reused on the finished prosthesis, essentially ruining the test socket for future use.



RapidFit clear plastic test sockets enable prosthetists to view amputees' socket environment… again and again.

What's New

And that is unfortunate, because that discarded test socket could serve a valuable post-delivery role by again allowing the prosthetist to see what's going on inside the socket environment when problems develop...instead of having to rely primarily on the patient's perception of the difficulty.

Retained test sockets are valuable for:

- diagnosing causes of pain patients may experience after receiving their prosthetic limb;
- revising sockets to accommodate bone spurs, neuromas or other unusual residual limb changes;
- assessing when a socket needs replacing due to physical changes to the residual limb;
- providing medical justification for a replacement prosthesis to insurance companies; and
- serving as a record of patients' prosthetic management, which can be particularly useful when an amputee changes prosthetists or a second opinion is desired.

All these benefits are now available through a recently developed socket system called RapidFit, consisting of a unique thermoplastic seamed socket and a series of specially designed adapters and other components that can be removed without cutting the socket. Patients can now be cost-effectively fit and evaluated with several test sockets before their definitive socket is fabricated and thus obtain the best socket design for comfortable weight bearing, total contact and optimal prosthetic alignment.

Once a patient receives the finished prosthesis, a RapidFit test socket can serve as a valuable aid in restoring a secure, comfortable limb-socket interface subsequent to residual limb changes and other factors. Such changes most often result from residual limb size variations caused by atrophy of the muscles and skin tissue. In addition, patient weight change can affect socket fit, as gaining weight may decrease total contact on the bottom of the socket, and weight loss may increase distal total contact on the bottom of the residual limb.

If a patient evaluated with a RapidFit test socket develops a fitting problem days, months or years after prosthesis delivery, his/her test socket can be reassembled and temporarily reattached to the replacement limb. The current fit of the finished socket and function of the whole prosthetic system can then be dynamically evaluated, since the clear RapidFit test socket is a duplicate of the permanent socket. The definitive socket can then be adjusted to correct for the issues the prosthetist has been able to observe first-hand.

RapidFit test socket are available for both transtibial and transfemoral applications. In addition, the RapidFit method has also been applied to the fabrication of definitive sockets...but that's another article.

‘Two-Handed’ Again with a Utah Arm 3

An upper-limb prosthesis incorporating the state-of-the-art Utah Arm 3 electric elbow component can enable high-level upper-limb amputees to perform many outwardly routine, but for them remarkable, activities of daily living.

Utah 3 componentry, including the elbow and selected electric wrist and hand units, can be controlled either by myoelectric sensors or touch pads built into the socket. These devices can be mastered by otherwise healthy, motivated, cognitively sound amputees, even those with a very short residual limb or shoulder disarticulation.

N. S. wears his Utah Arm 3 prosthesis during follow-up visit.

While many upper-limb amputees can get along quite well with a healthy natural “other” arm, their reality changes somewhat when that contralateral limb is or becomes dysfunctional. For some, that transition may come years or decades after their amputation.

N. S., 58, lost his right arm high above the elbow subsequent to being wounded in Viet Nam in 1970. After surgery he received a prosthetic arm, but because he received no concurrent occupational therapy (O.T.), he never learned to use it properly and therefore proceeded to get along without it for 35 years.

Recently, however, he presented on a Veteran’s Administration (V.A.) referral seeking to re-attempt prosthetic intervention due to failing function of his remaining arm resulting from osteoarthritis and carpal tunnel syndrome. Upon evaluation, his rehab team recommended an electric prosthesis with touch pad control, wrist rotator, greifer terminal device and electric elbow; a prosthesis built around a Utah Arm 3 was chosen as the most appropriate system for him. This time, ample O.T. was prescribed and subsequently approved by the V.A.

Down to Cases

When N. S. was first introduced to the Utah 3, the intended touch pad control scheme proved ineffective; instead, the arm was reconfigured with a cable-actuated linear potentiometer for elbow control and myoelectric sensors contacting sites on the lateral deltoid and pectoralis for wrist and hand actuation. With this layout, the patient gained control of the arm within minutes. He was cast for a new socket and received his new arm a week later.

Within a month, he exhibited excellent control of the prosthesis, including the ability to wave and carry shopping bags, newspapers and writing instruments; a month later with some basic O.T., he could feed himself. Subsequently after more intensive therapy, N. S. was ready to receive his definitive terminal device. After experimenting with the originally prescribed greifer, he came to prefer the hook-type ETD (Electric Terminal Device).

Eight months after his first appointment, this patient is fully acclimated to his prosthetic arm and has nearly mastered its many capabilities while integrating the system into his daily activities.

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.

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