Celebrating 39 Years of Excellence

PROSTHETIC & ORTHOTIC UPDATE

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Taking the Guesswork out of Walking

C-Leg System Offers Confidence, Mobility to Above-Knee Amputees

In the world of prosthetics, function is king, and most amputees are in perpetual search of the level of function they enjoyed before amputation. With the introduction of microprocessor-controlled knee systems, transfemoral amputees are closer to their goal than ever.

From the development of the first artificial knee device long ago, walking with a transfemoral prosthetic limb has either required a great deal of concentration or been extremely awkward. Either the wearer walked stiff-legged with the knee locked, or he/she had to think, and often worry, about controlling the limb in swing phase...on a level surface at a constant speed. Changing cadence or ambulating on uneven terrain introduced a whole new degree of difficulty!

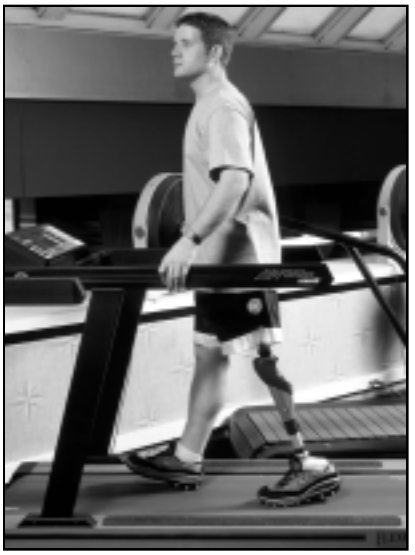
The introduction of the 3C100 C-Leg® microcessor-controlled knee-shin system in 1999 initiated a revolution of sorts in transfemoral ambulation. Essentially, the C-Leg's on-board circuitry does the thinking and lets the above-knee amputee concentrate on other things while walking.

The C-Leg functions through real-time gait analysis to control hydraulic swing- and stance-phase resistance. Built-in sensors provide information to the microprocessor 50 times per second to determine the precise phase of gait.

The microprocessor then makes instantaneous adjustments to knee function, using algorithms developed from studies of how thousands of people walk, fine-tuned for the wearer's unique needs and characteristics.

C-Leg® knee-shin system

For example, data from the knee angle sensor is used to adjust dynamic swing phase control any time the wearer changes cadence. And a force sensor in the C-Leg's shin component measures toe and heel loading to inform the system when it is both safe and efficient to transition from stance phase to swing phase.



The latest version of the C-Leg enables wearers to select between two preset options optimized by their prosthetist for a particular activity. Typically, one is set for everyday, all-around use and the other for a specific activity, such as bicycling. An intentional tap of the foot induces the mode switch, which is confirmed by a beep tone and vibration.

(Continued on page 3)

I am pleased to announce the addition of Mark Stipanov, CPO to the staff at Nobbe Orthopedics, Inc. Mark is a certified orthotist and prosthetist and most recently practiced in San Luis Obispo. He has served as a practitioner on the Central Coast for more than 10 years and brings with him depth of experience and community involvement.

Originally from Florida, Mark was graduated from Florida State University in 1988. He completed his orthotic and prosthetic education and residencies at Rancho Los Amigos and Northwestern University, respectively. Mark joined our team in April.

His primary responsibilities are in our Santa Maria and Lompoc offices. With his experience and his commitment to his patients, Mark will enhance our quest in providing the highest quality of orthotic and prosthetic services to Santa Barbara's north county residents.

Mark Stipanov, CPO

Sincerely,
Ralph W. Nobbe, CPO, president

www.nobbeorthopedics.com

Great Strides for Transfemo

Though above-knee prosthetic management is made particularly challenging by the loss of both knee and ankle joints, recent advances in socket design are enabling transfemoral amputees to make great strides in regaining mobility.

Despite improved surgical methods and growing awareness of the major prosthetic advantage of preserving the knee whenever possible, an estimated 20 to 30 percent, depending on the source quoted, of all lower-limb amputations still occur at knee level or above. Of these, more than 80 percent result from vascular insufficiency, so the population tends to be older and not particularly robust.

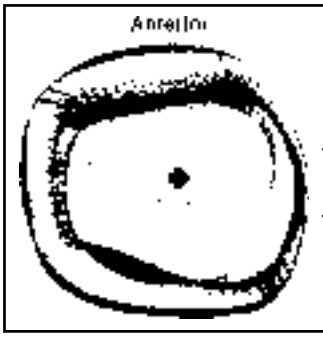
For this group, optimal socket fit, comfort and ease of use are essential to a positive functional outcome. Comfort proceeds from a proper fit. If an amputee is uncomfortable wearing his or her prosthesis, a less-than-optimal socket fit is a likely culprit, and a lightweight flexible design fabricated with the aid of a test socket offers a primary solution.

Dynamic suction socket, I. C. design

With increased understanding of residual limb anatomy and how to take advantage of the desirable properties of flexible sheet plastics, prosthetists today are able to give above-knee amputees a new level of comfort and control, which significantly improves their opportunity to regain effective mobility.

These designs, variously known as "dynamic" or "flexible" sockets, are closely contoured to the wearer's residual limb anatomy and feature a lightweight, flexible plastic interface capable of expanding and contracting with action of the residual limb muscles. This inner socket typically fits within a sturdy but lightweight laminated outer frame for strength and stability. Sometimes anterior and/or posterior windows are cut into the outer socket to allow for increased quadriceps and hamstring activity and improved wearer comfort.

With its enhanced flexibility, the socket brim conforms better to the residual limb, enhancing amputee comfort and tolerance, notably when sitting down (see page 4). Amputees generally find flexible sockets provide better proprioception and are less-confining and cooler to wear on hot days.



Quad socket shape

While some patients still do well in traditional quadrilateral sockets, the majority of today's above-knee sockets are derivations of what has come to be classified generically as the ischial containment (I. C.) total contact design.

Advantages of this shape, as compared with older designs, include enhanced amputee comfort, greater rotational stability and a more-normal gait, yielding greater velocity with less energy and oxygen expenditure.

Another New High-Tech Knee System

While the C-Leg has been getting the lion's share of hype and media attention since its debut four years ago, it's not the only, the first, or necessarily even the best in all cases, microprocessor knee system available today. That's a plus for amputees, as innovators continue striving to bring better and more reliable products to the market.

What's New

The first microprocessor-controlled prosthetic knee was the Intelligent Prosthesis, first introduced in 1995. Now, the developer of that pioneer system, Blatchford, Ltd. through its U.S. subsidiary Endolite, has introduced its latest generation of computerized knee control, the Adaptive system.

The Adaptive is unique in that it provides both hydraulic and pneumatic knee control... hydraulic for controlling heavy-duty functions: supporting the wearer's weight in stance, and descending ramps and stairs; and pneumatic for reacting quickly to cadence changes. Like the C-Leg, the Adaptive performs real-time gait analysis and computes the appropriate degree of swing- and stance-phase dampening for whatever the amputee and the knee are doing at that split second. The Adaptive is considered so good at this function that Endolite declares conscious thought by the wearer is required only for descending steep slopes and stairs.

Once a prosthesis incorporating the Adaptive system is fabricated and mechanically aligned, the prosthetist programs the device for various activities from standing, to walking up and down inclines and uneven surfaces, to climbing and descending stairs. The system even incorporates a stumble recovery mode, triggered by premature knee flexion. In programming the system, the prosthetist uses a wireless controller to adjust various parameters in reaction to direct feedback from the wearer.

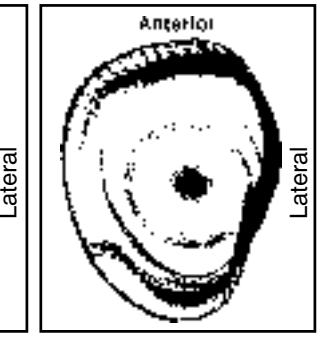
The Adaptive is considered generally appropriate for K-3 community ambulators with a medium-to-long residual limb and good voluntary control. Experienced wearers describe the limb as being "a part of my body" and that they feel a sense of innate security because they know where it's going to be at any one time, and that helps them walk well.

Additional information on the Adaptive is available at www.endolite.com.

ral Amputees

The I. C. concept features a narrow medial-lateral dimension, wide anterior-posterior measurement, high proximal brim lines that encase the medial and posterior sides of the ischial tuberosity, and a "bony lock" created by the socket clasping the ischial ramus medially and the greater trochanter laterally. This final feature prevents lateral displacement of the femur within the socket during weight-bearing, thereby precluding a primary drawback of older sockets, namely an awkward, lurching gait caused by the residual limb being able to move within the socket.

Further contributing to comfort and function of today's transfemoral sockets are improved methods of suspension—notably gel liners and direct contact suction. Suction suspension without a sock or liner between the socket and residual limb provides the wearer with the greatest degree of proprioception—a sense of where the limb is in space—and control. However, direct suction suspension can be lost with perspiration, and the method is generally not appropriate for amputees with residual limb skin grafts, scar tissue or other trauma.



I. C. socket design

Gel liners are probably the most popular method of above-knee suspension today. They are rolled on like a sock and once in place maintain suction with the residual limb. Some gel liners, when inserted into the socket, maintain suction with the socket wall as well. Others incorporate a distal pin that fits into a mechanical lock in the socket, or a lanyard, which is drawn through a hole in the socket and used to pull the residuum into the socket, then clipped to the socket exterior. These liners protect residual limb tissue both by absorbing impact stress and reducing surface friction.

Drawbacks of gel liners include difficulty mastering how to insert a locking pin into the shuttle lock, particularly among older wearers; durability issues requiring frequent replacement; and hygiene issues resulting from insufficient cleaning after use. Nevertheless, gel liners tend to provide the highest level of overall wearer satisfaction.

When neither suction nor locking liner suspension will work, a hip joint and pelvic band provides a less-rigorous alternative, particularly for geriatric patients and when stability is an issue.

Socket design is highly individualized, both with regard to the patient and the prosthetist. The socket must intimately reflect the wearer's residual limb shape, musculature and sensitivity as well as his/her overall health, lifestyle and activity level. Every prosthetist has his/her own unique approach to socket engineering and will often incorporate elements of different socket shapes into a hybrid design that will meet the unique needs of a particular patient.

C-Leg Research

(Continued from page 1)

Two studies have been undertaken to evaluate the C-Leg's performance relative to different conventional hydraulic knees also made by the C-Leg's manufacturer, Otto Bock Health Care. In one, 10 unilateral transfemoral amputees completed four tests in each of three knees, the single-axis C-Leg, the 3R45 single-axis knee with integrated hydraulic swing-phase control, and the 3R80 single-axis knee with rotary swing- and stance-phase control.

The tests included two gait analysis trials, a kinetic test for stance-phase loading, and another kinetic test for swing-phase performance while walking 1000 meters on a treadmill at three different speeds.

The most telling results showed the C-Leg clearly superior at higher speeds on the swing-phase treadmill test, in swing-phase behavior, and in reduction of residual limb forces.

The second analysis sought to compare the physiological cost of ambulating in the C-Leg with that of another Otto Bock conventional single-axis hydraulic knee, the 3C1. Six experienced 3C1 wearers were involved in the study. After gaining experience in the C-Leg for several weeks, the subjects were evaluated at three walking speeds on a treadmill, first in the 3C1, then the C-Leg. All other aspects of the wearers' prostheses were as identical as could be provided.

Results show the C-Leg to be more energy-efficient with a significant reduction in oxygen consumption ranging from 7 percent at slow walking speed to 4 percent at the fast speed. Details can be found at www.ottobockus.com/products/C-Leg_benefits.pdf and www.ottobockus.com/products/C-Leg_energy.pdf.

In addition, an ongoing Prosthetic Research Study project is comparing the activity level of patients using the C-Leg with those using conventional knee units. Primary results are due in the summer of 2004.

Clearly, the C-Leg is a good option for vigorous, health amputees, but it is also applicable to many other transfemoral amputees as well. Of course, not everyone is a candidate, but for those who are, an increase in ability of one functional level is certainly possible.

For additional information on this exciting advance in prosthetic componentry, we invite you to contact our office.

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 Endolite North America and Otto Bock Health Care in compiling this issue.

Down to Cases — The C-Leg

'My Wife Has Me Back on the Dance Floor'

For the majority above-knee amputees, just being able to walk around the house is a big deal...even though they would seem to be capable of additional function. Sometimes, they are limited by their prosthesis; others, the culprit is simply lack of confidence in the prosthesis.

For many in this population, the 3C100 C-Leg is proving to be a good solution to both problems.

Before the highway accident that cost him a major portion of his left leg, Mark D. was an avid outdoorsman, fisherman, soccer coach, father and employer...one active guy. After surgery and fitting with a conventional prosthesis, he despaired of ever returning to his former activity level. "I felt like I was going to fall down all the time," he recalls. For example, "Going down ramps, I'd have to stiff-leg it down..." not very efficient, or comfortable.

Though his insurance company would not agree to pay the full bill for the not-inexpensive computerized system (a problem still far from uncommon, though improving somewhat), Mark readily accepted the opportunity to switch to a C-Leg. The results have been dramatic.

"It just feels great; the stability is just incredible," he says. "I knew that the first time I put it on. Now, I don't have to think about each step as I did with my previous prosthesis. I can move freely, speeding up or slowing down at will. My gait is natural instead of artificial."

It wasn't long before Mark was rediscovering his former life. With the C-Leg, Mark has regained most of his former abilities and activities. "Knowing I can do everyday tasks as a dad, husband and employer has changed my life," he says. "My wife even has me back on the dance floor...so we dance."

The Importance of Sitting Down

Most literature about lower-limb prostheses relates to ambulation. In fact, however, the majority of amputees spend considerably more time sitting than standing or walking, so a successful transfemoral socket design must also provide comfort and remain securely attached to the residual limb when the wearer sits down, shifts his/her weight on a sitting surface, or stands up.

Older rigid socket designs usually don't fare well in this requirement, notably on a hard seat: The posterior brim tends to jab into the residual limb and thigh tissue, which tends to redistribute when an individual sits down, is restricted from doing so and thus feels pinched.

Flexible brim socket

Dynamic sockets generally don't have that problem. The flexible brim gives under the residual limb's weight, and thigh tissues are able to reshape within the relaxed enclosure.

Maintaining suspension is another challenge, as it is easy to break suction and thus total contact when residual limb muscles relax and tissues reshape upon weight transfer. Amputees with a well-toned residual limb can correct this tendency with timely muscle control when standing or sitting. Another solution is a roll-on gel liner with a pin or lanyard locking device, which greatly reduces the chances of losing suction.

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Nobbe Orthopedics, Inc.

3010 State Street
Santa Barbara, CA 93105
(805) 687-7508
FAX (805) 687-6251

203 East Fesler
Santa Maria, CA 93454
(805) 925-8290
FAX (805) 346-8713

www.nobbeorthopedics.com

Nobbe Orthopedics, Inc.
3010 State St. • Santa Barbara, CA 93105