GULF COAST ORTHOTICS & PROSTHETICS

FIRST STEP

Current Developments in Orthotics & Prosthetics Summer 2005

Upper-Limb Prosthetics 2005

Creating upper-limb function after an amputation or to resolve a congenital deficiency is regarded as one of the most challenging aspects of rehabilitative medicine. Each patient possesses distinct capabilities and requirements, and the functions to be replaced are complex.

However, many well-motivated adult amputees and most children with an upper-limb deficiency prove capable of remarkable things with a prosthetic arm and terminal device. Our role is to help them fulfill their dreams.

This issue of our newsletter explores the current state of upper-limb prosthetic practice and componentry. We hope you find the discussion informative and worthwhile, and we welcome your inquiries and referrals.

Courtesy, Otto Bock Health Care.

Building Blocks to Upper-Limb Restoration

Prosthetics Today

Patients referred to our practice for evaluation and restoration of an upper-limb deficiency, whether congenital or acquired, undergo a detailed process designed to provide the most practical and functional prosthesis for their individual needs, preferences and capabilities.

Definitive upper-limb prostheses cannot be pulled complete from a box but are unique combinations of socket type, suspension method, control scheme, perhaps wrist and/or elbow units, and a terminal (hand substitute) device. The management process is as much art as science.

Early intervention is key to a successful prosthetic upper-limb solution for patients undergoing amputation. Long-range success is normally best achieved with the patient at the center of therapeutic decision-making by a rehabilitative team including the amputating surgeon or rehabilitative specialist as team leader; a certified prosthetist for component selection, fabrication and fitting; physical therapist for residual limb care; occupational therapist for functional training; other professionals as needed, and the patient's family.

Courtesy, Motion Control Inc.

Patients may be fitted with a preparatory prosthesis to aid in their adjustment to the replacement limb. The preparatory system can be used to help mold the residual limb in readiness for fitting of a more permanent device.

Componentry

Aside from simple cosmetic solutions, the ultimate goal of upper-limb prosthetics is restoration of manipulation and grasping functions lost to amputation or congenital deficiency.

(Continued on page 2)

Welcome to the Summer 2005 issue of *First Step*, a professional publication of Gulf Coast Orthotics and Prosthetics, through which we endeavor to keep the West Florida rehabilitation community abreast of the latest trends and technology in the management of physically challenged patients.

We are proud to announce the addition of Shane Barrett, orthotic resident, to our staff at our Pensacola office. Shane is a graduate of the orthotic certificate program at Northwestern University in Chicago. Originally from California, he enjoys surfing and sunshine. Shane is interested in carbon composite orthotics and hopes to sit for his certification exams in 2006.

Our amputee support group continues to meet regularly and welcomes all participants. Please contact us for the next scheduled meeting.We hope you find *First Step* a useful resource and welcome your input, referrals and requests for further information. Call us at 850-477-4880 or contact us through our website, **www.gulfcoastoandp.com**

Upper-Limb Prosthetics—Both Art and Science

(Contined from page 1)

Thanks to years of research in surgery, rehabilitation and prosthetics, a vast range of componentry is available to fit patients with a system best suited to their functional requirements for work, leisure and activities of daily living.

Photos courtesy, Otto Bock Health Care.

Body-Powered Components — Conventional or body-powered systems use movement of the residual limb and shoulders to power a terminal device, prosthetic joint or locking mechanism. The force and motion necessary for movement are delivered by a cable and harness, which crosses the chest or shoulders. Each level of limb absence presents different prosthetic challenges. In general, the higher the level, the greater the challenge.

Advantages of body-powered systems are their relatively light weight, lower cost and high reliability. Disadvantages include the sometimes-exaggerated movements and high energy needed to operate the system. Nevertheless, body-powered systems have been the mainstay of upper-limb prosthetic solutions for decades.

Externally Powered Components — Components whose function is provided by an external power source, typically a battery, are most often controlled by electromyographic signals generated by muscle contraction in the residual limb and sensed by electrodes in the socket.

An alternate method of actuating externally powered components involves one or more touch pads strategically built into the socket for actuation by residual limb musculature. Like myoelectric sensors, touch pads are available with proportional speed control: The greater the input signal, the higher the speed of actuation.

Advantages of externally powered components are their more automatic function, which does not require a cable or action of the amputee to generate movement. Disadvantages include higher cost and sometimes the need for a more complicated and time-consuming maintenance or adjustments.

Socket Design

The interface between residual limb and the prosthesis is vitally important to ensure patient acceptance of a particular system. Socket design has improved over the past decade, incorporating more flexible and lightweight materials, providing secure skin contact while preserving sufficient protection for soft tissues.

The challenge with body-powered system sockets, with their associated harness and cables, is to sufficiently convey the physical movements needed to power the prosthesis. For myoelectric systems, the task is to secure electrodes against the skin covering muscle areas to convey signals and allow muscle contraction at the same time.

Newer systems incorporate self-suspending sockets with roll-on liners made of silicone or similar material. These liners provide the high levels of traction necessary to increase suspension strength while maintaining secure skin contact.

Wrists and Elbows

A prosthetic wrist allows an amputee to adjust a terminal device for optimal functioning. Both manual and myoelectric models are available. The simplest are friction units that maintain the terminal device in position under load while preventing undesired rotation; however, the amputee can still rotate the terminal device manually. Constant friction wrist units prevent rotation throughout the entire range of motion.

Quick-release wrist units, which allow the amputee to snap various terminal devices on and off quickly and lock them down firmly, are useful for frequent changes of implements for work or hobby activities.

(Continued on page 4)

Will Amputees Use Their Prosthesis?

Observations over the years have revealed adult amputees' acceptance of upper-limb prostheses to be relatively low. On the other hand, practitioners have noted that children fitted with a prosthesis at an early age exhibit great potential for acceptance and success.

Optimal acceptance by adults seems to occur when the initial fittings are performed in the first week to 30 days after amputation. Adults seem to respond best to a comprehensive program wherein they are thoroughly introduced to the prosthetic options with the ability to touch and feel the devices and understand their capabilities.

Therapists on the team are instrumental in evaluating how the patient works, uses his/her hands and arms, learns, and applies new knowledge. When these findings are integrated into an overall therapeutic plan, adult upper-limb amputees can claim a stronger ownership of their prosthetic system and its use.

For the best prosthetic outcome, patients should undergo casting and test socket fittings as soon as feasible after their full evaluation and receive and begin training in their prosthesis in the shortest time possible, with regular follow-up and adjustments along the way.

MYOELECTRIC COMPONENTRY COMING OF AGE

What's New

Having evolved gradually over the last three decades, myoelectric systems for upper-limb amputees are hitting their stride. Technologic advances in the computer industry, in motor and battery design, and even in cell phones and hand-held video wizardry have been put to use to aid in the search for highly functional prosthetic systems.

By means of surface electrodes embedded in the prosthesis socket, myoelectric systems detect and amplify muscle action potentials from voluntarily contracting muscles in the residual limb. These signals control one or more motors to actuate terminal device movement, wrist rotation and/or elbow flexion and extension.

Programmable microprocessor circuits have reduced the need for laborious adjustments in these advanced prostheses. Advanced sensory controls and lighter, more durable batteries are making upper-limb prosthetics more adaptable for the majority of patients and easier to adjust as their capabilities change.

Specialized prosthetic manufacturers have developed comprehensive systems for replacement of hands, wrists, elbows and even shoulders. The two highlighted below have passed through several generations of design and innovation, assisted by feedback from rehabilitation professionals and patients.

Courtesy, Liberating Technologies Inc.

The **Boston Digital Arm System** from Liberating Technologies incorporates a variety of advanced control features to augment the function of the company's core product, the Boston Elbow. The system's advanced microprocessors can control up to four other prosthetic devices in addition to the elbow—hand, wrist rotator, shoulder lock actuator, etc. Recent digital improvements now enable settings and adjustments to be made even while the patient is wearing the prosthesis. The internal microprocessor also allows for monitoring the system as it is being worn. These improvements reduce the need for prosthesis down time for disassembly and adjustments.

Motion Control's **Utah Arm 3**, the latest version of the pioneering system that first appeared a quarter-century ago, incorporates microprocessor technology and a computer interface to allow either the wearer or prosthetist to fine tune adjustments to the system. The Utah Arm 3 incorporates proportional control, which allows the wearer to move the arm and hand slowly or quickly in any position, providing more natural movement with less effort. Another significant Utah Arm 3 advance is that wearers can control its elbow and hand function simultaneously.

Additional notable componentry innovations include:

Courtesy, Otto Bock Health Care.

• The Otto Bock SensorHand SPEED electric terminal device adds a quieter motor and unprecedented opening and closing speed to its SensorHand "Autograsp" technology, which senses when an object held in the hand requires more grip force, then automatically adjusts tension, such as when filling a glass with water.

• Motion Control's powered terminal devices for the Utah Arm system include several hand components and a water-resistant hook-type component known as the ETD or Electric Terminal Device (see photo page 1). The ETD's hook "fingers" generally permit finer functioning than hand-type fingers. Moreover, its ability to resist liquids allows wearers to engage in "wet" activities of daily living, such as showering, with the device in place.

Courtesy, Motion Control Inc.

• Motion Control hands and the ETD all can be equipped with a new option called the Flexion Wrist, which can be set to one of three positions, allowing wearer the to flex or extend the wrist thus placing the hand in a more natural position for performing specific tasks.

• Liberating Technologies' recently introduced LTI Locking Shoulder Joint for high-level deficiencies is designed to provide a free-swinging joint that can also be locked in multiple positions, as required, with either manual or electronic control. Its lighter weight and relatively smaller profile make this component adaptable for both pediatric and adult use.

• As electric prostheses have become more functional, the need for a reliable, longer-lasting power source has become more critical. Recently improved lithium ion battery packs provide all-day power, if used appropriately, from a surprisingly lightweight package.

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:

Hosmer Dorrance Corp. • Liberating Technologies Inc.
Motion Control Inc. • Otto Bock Health Care • TRS Inc.

A Terminal Device for Every Patient Need

(Continued from page 2)

Depending on the amputation level, an elbow component may be necessary even when the elbow joint remains intact. Patients with high forearm amputation may not have the residual strength to perform the pronation, supination and flexion movements necessary to support a terminal device; thus, body-powered systems incorporate various types of elbow hinges to help support the prosthesis and allow for the rotation necessary to power it.

Griefer terminal device provides added degree of gripping power.
Courtesy, Otto Bock Health Care.

Electric-powered elbows, such as the Utah Arm, Boston Arm and the Hosmer Electric Elbow, include a friction or alternative turning mechanism to permit rotation of the humerus, as well as a locking feature to assist in positioning the terminal device. The ability to lift objects of some weight is critical, thus elbow component design is focused on providing reasonable lift capacity for functional use.

Lite Touch Hands
Courtesy, TRS Inc.

Terminal Devices

Regardless of the type and mechanism of an upper-limb prosthetic system, most are designed to replace the intricate manipulation and grasping functions of the normal hand. A hand substitute or terminal device (hands, hooks and work or recreational tools) is adapted to the prosthetic system as needed by the patient.

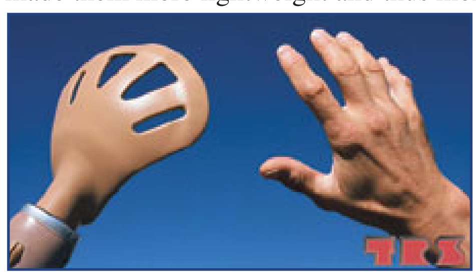
Passive Devices — Passive, lifelike hands are appropriate for some patients. Some have bendable or spring-loaded fingers, allowing patients the ability to grip objects. Others are specially fitted with a wide array of options to allow for the performance of household chores, gardening, sports or manual work.

Active Prehensile Devices — Active components incorporating the ability to voluntarily open or close by means of a cable deliver a much higher level of function than more passive devices. Voluntary opening and closing hands provide a more acceptable cosmetic solution for some patients, while affording a mild to moderate degree of grip and movement.

Grip prehensor
Courtesy, TRS Inc.

Externally Powered Hands and Prehensors — Fulfilling the need for ever more precision in replacing the manipulative power of the natural hand, researchers have developed a wide range of electric hands, hooks and grippers (or "greifers") to enhance grip and functional capabilities.

Cosmetic gloves and sleeves are available with some hands to give a more natural appearance for patients who express that preference. The use of silicone-based gloves and sleeves has made them more lightweight and thus more acceptable for use by patients of all ages.



Rebound Pro basketball hand
Courtesy, TRS Inc.

The march of technology continues to improve prospects and outcomes for upper-limb amputees.

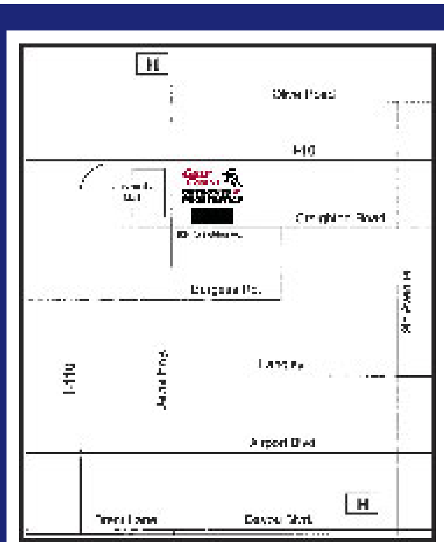
We welcome your inquiries about possibilities for your patients.

First Step
A publication of
Gulf Coast
Orthotics & Prosthetics

824 Creighton Rd.
Pensacola, FL 32504
(850) 477-4880
Fax: (850) 477-4766

www.gulfcoastoandp.com

Steven L. Gavin, CPO



Gulf Coast Orthotics & Prosthetics
824 Creighton Rd.
Pensacola, FL 32504