

The Hinnant Prosthetics Quarterly

Experience Our Road to Prosthetic Excellence

Summer 2000

Stepping Stones to Restored Mobility

The load of steel that fell on port supervisor Don McIntosh's right leg in 1984 didn't do all its damage immediately. Surgeons made several valiant attempts to save the limb, but eventually the persistent infection that developed in the days after the accident left amputation as the only viable management option.

Except for his infected limb, McIntosh, then 48, was in good health. His job supervising the loading and offloading of ships involved long days of walking up and down docks, ramps and irregular terrain. When informed of the need to amputate, he told his doctors he fully intended to resume his lifestyle and occupation when surgery and rehabilitation were completed.

McIntosh's course of rehabilitation provides an excellent illustration of the process a new amputee follows from surgery to a successful outcome. Not all amputees achieve prosthetic success, of course: Myriad factors can limit their ambulation potential and motivation—age, poor health, lack of strength and various psychological issues, among others.

However, those who successfully resume their pre-limb-loss lifestyle do so after completing a well-defined process

involving doctors (usually the amputee's personal physician, the amputating surgeon and sometimes a physiatrist), a physical (lower-limb) or occupational (upper-limb) therapist, perhaps a nurse and/or social worker, and of course, a well-qualified prosthetist.

This article reviews the typical mileposts a lower-limb amputee passes on the road to a successful prosthetic outcome.

Don McIntosh awoke from his surgery with a rigid dressing extending from his amputation

wound several inches below the knee to mid-thigh. A few days later, a pylon and prosthetic foot were added, providing a platform for early weight-bearing and facilitating exercise. Before leaving the hospital, Don completed several physical therapy sessions and received several visits from the prosthetist who would engineer his return to an ambulatory lifestyle.

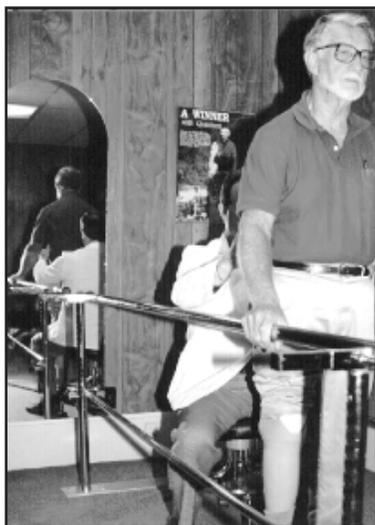
Referral and Post-op Care—

In an ideal world, prosthetic intervention would begin before the amputation with the prosthetist interacting with the patient to answer questions and relieve anxiety and taking part in discussions regarding amputation

level, the type of postsurgical dressing to be used, anticipated complications, and patient and family expectations. As a practical matter, such early involvement is often not feasible, and the prosthetist typically is called in a few days after limb removal.

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Prosthetics Today



Don McIntosh, assisted by his prosthetist, tries out new below-knee prosthesis for the first time.

About This Publication

Welcome to the second issue of *Prosthetics Quarterly*, a professional newsletter published to bring members of the rehabilitation community news of management trends and product developments from the prosthetics discipline.

Quarterly is published by Springer-Bremer Prosthetics in Flint and Bremer Prosthetics in Saginaw. Chief practitioner Tom Bremer was educated at Northwestern University Medical School and subsequently was accredited by the American Board for Certification in Orthotics and Prosthetics Inc. He is a member of the American Academy of Orthotists and Prosthetists and has been involved in designing advanced prosthetic systems for physically challenged patients since 1978.

We hope you find *Quarterly* to be informative and professionally relevant and welcome your comments, suggestions and requests for further information.

The Prosthetic Process – Pathu

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Once the amputation level is determined, a subsequent decision involves the type of dressing that will cover the wound. This choice can have significant prosthetic implications.

The conservative **soft dressing** is still widely used, particularly for older, dysvascular patients, because it allows frequent observation of the wound. Unfortunately, this choice slows healing, precludes early prosthetic intervention, reduces edema control, increases risk of contractures, and delays the start of prosthetic management.

While it minimizes opportunity for frequent wound inspection, the **rigid dressing** controls edema and thereby speeds healing, protects the wound from dehiscence (see glossary) and inadvertent injury, and when combined with a simple pylon and foot enables the amputee to begin weight-bearing and exercising the residual limb almost immediately. (Thus, this rigid dressing-nylon-foot combination is called an IPOP—immediate post-operative prosthesis.)

Between these poles are various compromise dressing options, such as the **removable rigid dressing** and **polyethylene semi-rigid dressing**, each offering unique advantages for specific situations.

Even if not involved before the amputation, the prosthetist can still initiate early intervention if the referral is made before the patient leaves the hospital. The sooner the prosthetists and therapists working with the new amputee can coordinate their efforts, the better.

After two weeks in the rigid dressing/IPOP, Don's sutures were removed, and he was discharged to continue his rehabilitation as an outpatient. A few days later, he made his first visit to the prosthetic office, where the first order of business was a

complete prosthetic exam, including detailed personal medical history, careful measurements of his residual and sound limbs, and assessment of the capabilities of his residual limb and general state of health.

Evaluation and Assessment—

A comprehensive initial evaluation and assessment of the amputee's ambulation potential are key to a successful outcome and appropriate expenditure of health care resources. The prosthetist needs to know how well the residual limb will bear up under the stresses of weight-bearing and whether the patient's overall state of health and other medical conditions will limit his/her ability to use a prosthesis effectively.

In some cases, particularly involving older amputees with a coexisting disease such as diabetes or arthritis, this evaluation may reveal that a new amputee will receive relatively little benefit from a functional prosthesis and that a simple cosmetic device or no

prosthesis at all is the most appropriate choice. At the opposite end of the spectrum are younger, active amputees who lost their limb to trauma, a localized tumor or other non-debilitating condition and are candidates for sophisticated, high-capability systems.

During the initial visit with his prosthetist, Don McIntosh was measured for his preparatory (sometimes called "training") prosthesis, the intermediate system he would use for several months, allowing time for the size and shape of his residual limb to stabilize. The preparatory system, consisting of a custom socket, pylon and



Transtibial amputation rigid dressing and IPOP.



Preparatory prosthesis

SACH (solid ankle-cushion heel) prosthetic foot enabled him to continue gait training with his therapist, which had begun on the IPOP soon after surgery.

Over subsequent weeks, as his walking proficiency improved and his residual limb volume continued to decrease, Don revisited his prosthetist several times for socket modification and alignment adjustment—key steps along the road to optimizing his gait. As his residual limb atrophied, he progressively added prosthetic socks to maintain effective socket fit.

At just over three months, the need for additional socks stabilized, indicating that the residual limb was nearing maturation. Moreover, Don was making good progress with his gait training and demonstrated he was ready for more-advanced componentry. He was ready to move on to his definitive prosthesis.

The Preparatory Prosthesis—

As its name suggests, the function of a preparatory, or training, prosthesis is to help a new amputee transition to a new life of walking on an artificial limb. It is typically an uncomplicated system that patients can manage while learning a new way of walking and adapting to their shrinking residual limb. The preparatory prosthesis also helps the clinical team determine the amputee's ambulation potential and the most appropriate components for the definitive system.

Patients normally wear the preparatory prosthesis for 3-6 months. During this period, prosthetist and therapist interact to help amputees adjust to their maturing residual limb and other physical changes. Several fit and alignment adjustments are

normally made during this period as the residual limb shrinks and the patient's gait becomes more efficient. In some instances, major changes during the preparatory period require a new socket and/or other componentry revisions.

Given his clinical condition, a prosthetic foot (PTB) bearing supracondylar prosthesis, a multi-articular system, was his next step. Even though the prosthetic componentry was Don's first prosthetic experience, his socket contact distribution remained cosmetic.

Definition and

most of the amputee's essential needs. Making the transition to the definitive prosthesis involves several key steps:

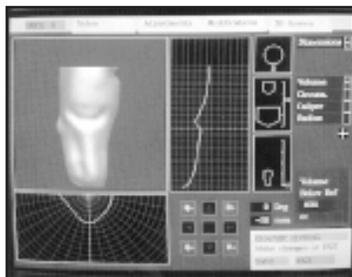
- the amputee's residual limb volume
- the level of the residual limb
- the type of prosthesis
- the components of the prosthesis
- the alignment of the prosthesis
- the fit of the prosthesis
- the cost of the prosthesis

Definitive prosthetic systems are designed to provide a functional, comfortable, and durable prosthesis for the amputee's long-term use.

Highway to a Positive Outcome

Given Don's good overall health, high activity level and vocational expectations, his clinical team decided upon a definitive prosthesis consisting of a PTB (patellar tendon-bearing) socket with supracondylar cuff suspension and an advanced multi-axis ankle-foot system, which would serve his need to walk on uneven terrain.

Starting with a negative cast impression of Don's nearly mature residual limb, the prosthetist made appropriate modifications, then fashioned a transparent check socket with which the degree of total contact and areas of undesirable pressure distribution could be visualized and corrected. After socket modification, the remaining components were added and a cosmetic cover applied to finish the prosthesis.



CAD/CAM software display

manufacturing) systems are now increasingly being used to streamline the process. Starting with information from a negative cast of the residual limb, CAD/CAM software presents a visual image of the limb, from which the prosthetist can design a socket on the monitor, optimizing the overall shape and trimlines and adding build-ups and reliefs as necessary. Finally, the CAD/CAM system

feeds the finished design to a carver that creates a positive model over which the shell of the finished socket can be vacuum-formed.

Don continued to wear his preparatory prosthesis while his definitive system was being constructed. After his check socket fitting, revisions were made to the socket design, and his definitive socket was fabricated. Pylon and foot assemblies

were added, along with a temporary dynamic alignment device.

After ensuring that the socket fit properly and testing the suspension, the prosthetist checked the static alignment, noting the length and angulation of the prosthesis as Don stood upright and relaxed. The next step was to observe Don's gait, making adjustments as necessary to maximize comfort and minimize energy expenditure. The alignment procedure was completed in about an hour.

Fitting & Alignment—Despite remarkable developments in componentry in recent years, it is the fitting and alignment of a lower-limb prosthesis that ultimately determine how well an amputee will walk. A unilateral lower-limb amputee expends an estimated 40% more energy walking than a person without limb loss, so it is essential that the limb function with optimal efficiency.

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Definitive Prosthesis Design and Fabrication

—Selecting the most appropriate componentry for a new amputee's specific needs and abilities is an essential part of the prosthetic process. Various factors must be weighed in making the prosthetic prescription:

- the condition and weight-bearing ability of the residual limb;
- the patient's overall health, activity level, vocational needs and expectations;
- the general prosthesis structure—exoskeletal or endoskeletal;
- the type of suspension most appropriate for the amputee;
- specific components to be used, including socket, foot, pylon and knee (if applicable);
- cosmetic finishing, and
- cost and funding.

Designing and building a definitive prosthesis is an art, requiring knowledge, skill and experience. Traditionally, socket design and fabrication have been primarily manual procedures; however, CAD/CAM (computer-aided design/computer-aided

Prosthetics Glossary

Alignment - Position of the socket relative to the foot, ankle and knee, if included.

Check or test socket - A temporary socket, usually transparent, used to evaluate the initial fitting of a socket.

Cosmesis - Appearance of a prosthetic limb, including shape, skin shade and surface details.

Definitive prosthesis - A complete prosthetic system, including finished socket, permanent components and cosmetic finishing.

Dehiscence - A breaking open or rupture of a surgical wound.

Endoskeletal (or modular) design - Contemporary prosthetic construction in which weight-bearing loads are borne through high-strength tubular core components, and shape and cosmesis are provided by a soft cover.

Exoskeletal (or Crustacean) design - Older-style prosthetic construction in

which weight-bearing and cosmesis are provided by a rigid outer shell.

Fit - The relationship of a prosthetic socket to the residual limb.

IPOP (immediate post-operative prosthesis) - A basic system, consisting of a rigid dressing, pylon and foot, applied immediately after surgery to enable limited weight-bearing and prosthetic management 2-3 days after surgery.

Pistoning - Slippage of the residual limb within a socket during ambulation.

Preparatory (or training) prosthesis - A cosmetically unfinished functional replacement for an amputated limb, which is worn for a limited period to accommodate changes in the residual limb, facilitate gait training and evaluate amputee performance potential.

Prosthesis (*pl. prostheses*) - An artificial device applied to replace a partially or totally missing body part.

Prosthetics - The field of science con-

Fit, Alignment Crucial to Prosthetic Success

(Continued from page 3)

Transparent check sockets can greatly enhance the ultimate socket fit, because they allow the prosthetist to view the residual limb inside the socket. Discovering areas of excessive pressure and absence of



Alignment fixture

total contact enable the prosthetist to make corrections in the definitive socket and thereby reduce the risk of skin breakdown, pistoning, discomfort and other problems that

would likely limit the patient's outcome.

Typically, alignment is completed in one or two appointments before the cosmetic finish is applied to the limb. The prosthetist adjusts the "slide," angulation and rotation of the lower components in relation to the socket to provide the best-possible balance, comfort, gait pattern, energy efficiency and cosmesis. Although alignment components can be built in to a permanent prosthesis, they add weight and complexity to the system. The standard technique, therefore, is to complete the alignment with a removable alignment device. Once the alignment is completed and the cosmetic finish applied, the prosthetic leg is ready to go.

By the time Don McIntosh received his new leg, he was anxious to return to work and, within five months of his amputation surgery, he did. Don remained at his same job for another 10 years before retiring in 1994. During those remaining work years, he returned for routine follow-up visits, in which his prosthetist made adjustments for residual limb changes and wear-and-tear concerns.

After five years, Don had "shrunk out of" his prosthesis—his residual limb had further decreased in volume to the point that effective socket fit could no longer be maintained—and it was time for a new one. This time, a Flex-Foot system was prescribed to accommodate Don's high activity level. He quickly adapted to the new system and used it for nine years—about twice the life of the average leg prosthesis—before it too required replacement...with another Flex-Foot.

Though Don retired from the docks in 1994, he still requires a high-activity leg: He opened a pressure-washing business and cuts firewood on the side. Now 62, he enjoys his life and says he sometimes goes for hours without being conscious that he is an amputee. He still makes

follow-up visits to his prosthetist 3-4 times per year.

Follow-up—Initially, after receiving their definitive prosthesis, new amputees usually return to their prosthetist frequently for adjustments and to pose questions that become evident as they gain endurance and

"spread their wings." After a few months, the need for follow-up visits typically declines to once every 3-4 months. Follow-up visits address any problems the amputee may be having and routine maintenance, cleaning and replacement of mechanical components. Follow-up is a lifelong activity.



Our well-qualified staff is prepared to escort amputees through the prosthetic process and help

them achieve the ultimate functional outcome of which they are capable. We welcome your inquiries about any aspect of prosthetic care or management options for specific patients.



Checking the fit of Don McIntosh's new leg prosthesis.

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