The Hinnant Prosthetics Quarterly

Experience Our Road to Prosthetic Excellence Summer 2001

Best Feet Forward!

The past 15 years have seen an explosion of new technology, materials and product designs that now enables prosthetists to provide a more exacting prosthesis for each patient, closely suited to individual physiology, capabilities and expectations. Nowhere is this proliferation of new designs and products more evident than in foot and ankle componentry.

The "business end" of a lower-limb prosthesis, the point of contact between an amputee and the surface over which he or she would ambulate, is crucial to achieving prosthetic success. The closer the ankle-foot system matches the abilities, environment and activity desires of the amputee, the better the outcome.

Single-axis foot

The Health Care Financing Administration's system of functional levels governing Medicare reimbursement for lower-limb prosthetics provides a convenient framework for categorizing the various ankle-foot options by performance and patient type. Predicted functional level is generally determined by the referring physician and prosthetist, taking into account (1) the patient's history; (2) current status, including condition of the residual limb; and (3) his or her desire to ambulate.

— About This Issue —

Kale

Dear Friends,

An ongoing challenge of prosthetic practice is keeping abreast of mushrooming technology and product innovation. No class of componentry is experiencing more development these days than prosthetic feet and ankles.

This issue of our newsletter presents an overview of the popular foot/ankle options of today as well as some new designs, which may well provide improved patient outcomes tomorrow. We hope you find this information beneficial.

Our board-certified staff stays constantly attuned to the latest developments in prosthetic design and technique and is ready to help clinicians and amputees select the best combination of components for each situation.

We welcome your comments, inquiries and referrals: 1-704-375-2587.

– M. Kale Hinnant, C.P., FAAOP

Level 1 - Household Ambulators

Amputees in this category have the ability or potential to use a prosthesis for transfers on level surfaces at a fixed cadence and tend to be older patients who have undergone amputation due to vascular insufficiency. They generally require safe, basic function and light weight for moving relatively short distances. The SACH (solid ankle, cushion heel) foot is generally the foot of choice for this type of patient, although a single-axis foot may be appropriate for transfemoral amputees.

The ***SACH foot*** simulates plantar flexion at heel strike by compression of an elastic heel wedge and provides forefoot dorsiflexion by means of a flexible toe section. The SACH foot's simple construction (no moving parts), light weight, and low cost make it an ideal choice for Level 1 amputees, although enhanced versions are frequently selected for Level 2 and occasionally Level 3 patients. With its simplicity and comparative low cost, the SACH foot is frequently selected for preparatory prostheses.

Appropriate Foot Selection Key Deterr

(Continued from page 1)

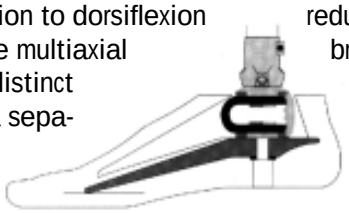
Note: The SACH foot generally offers less knee stability at heel contact than single- and multi-axis foot designs.

The ***single-axis foot*** provides fore-aft movement about an "ankle" axis, limited and cushioned by plantar flexion and dorsiflexion bumpers. Single-axis feet are typically lightweight, low-cost and light-duty, although certain models incorporating dynamic response characteristics are rated as high as Functional Level 3. Because single-axis feet increase knee stability in early stance phase, they are often preferred for above-knee amputation levels.

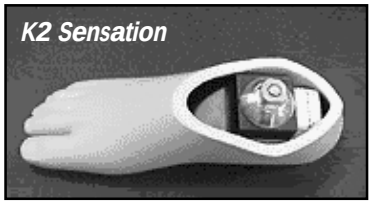
Level 2 - Limited Community Ambulators

These amputees have the ability or potential for ambulation with the ability to traverse low-level environmental barriers, such as curbs, stairs and uneven surfaces. They can benefit from more-durable SACH foot models, certain multiaxial designs, and feet incorporating lower-level dynamic response characteristics.

Multiaxial ankles are well-suited to community ambulators in that they accommodate uneven terrain by providing inversion-eversion and some degree of transverse rotation in addition to dorsiflexion and plantar flexion. The multiaxial mechanism may be a distinct component mated to a separate prosthetic foot (e.g. the Seattle C-stance ankle used with a Seattle Lightfoot) or an integral part of the foot (e.g. the Flex-Foot K2 Sensation).



C-Stance ankle mated to Seattle Lightfoot



Multiaxial ankle/foot systems are particularly appreciated by amputees who enjoy outdoor activities, notably hikers and golfers. They also lend themselves well to the needs of bilateral amputees.

Level 3 - Active Community Ambulators

Amputees within this classification have the ability or potential for ambulation with variable cadence. Feet for this group typically incorporate a flexible keel to provide dynamic assist at toe-off, helping propel the leg into swing phase.

These patients frequently benefit from a dynamic response foot built around a flexible keel, which deforms during weight-bearing, storing energy, then releases that energy during late-stance phase, providing forward propulsion.

Carbon Copy

Early dynamic response systems were created mostly for amputee athletes, but steady improvements in design, weight reduction, reliability and cost have brought these components within the realm of moderately active, "everyday" amputees. They are commonly prescribed and reimbursed for Level 3 patients, often in combination with a multiaxial ankle.

Some leading dynamic response feet now available include:

- Endolite Dynamic Response Foot/ Multiflex Ankle
- Ohio Willow Wood Carbon Copy 2 Light Foot and Carbon Copy HP (High Performance)
- SAFE II Foot
- Kingsley Steplite
- Seattle Light Foot
- OttoBock Dynamic Plus, Greissinger Plus and C-Walk

Level 4 - High Activity — Child, Active Adult, Athlete

True Level 4 applications are typically high tech, high impact and high cost. They also serve as the proving ground where the mainstream systems of the future are developed. Arguably less than five percent of all amputees will qualify for reimbursement of ankle-foot components in this category, but the principles underlying these sophisticated systems will benefit many more-typical patients as time progresses.

For example, lightweight carbon-fibre systems designed around the needs of amputee athletes have since been refined and incorporated into products more suited to the needs of Level 3 and sometimes even Level 2 patients.

Flex-Foot has incorporated the proportional response, active heel and ankle motion built into its most advanced components into its mid-market Flex-Walk and Sure-Flex models. Meanwhile, its engineering department continues to

Choosing the 'Right' Foot

Faced with an ever-increasing selection of prosthetic foot models, our prosthetic staff strives to stay current on the latest proven products and help the prescribing physician and amputee understand the pros and cons of the various components under consideration.

Foot selection typically entails tradeoffs among performance, durability, weight and cost. While active patients and amputee athletes garner most of the media and marketing attention, the far greater numbers of lower-limb amputees occupy the opposite end of the ability spectrum: typically older, dysvascular people who have neither the desire nor the energy to walk more than a block or two. For these patients, low weight, and often low cost, become overriding factors.

Reimbursement, particularly under Medicare, often limits the range of choices. In some cases prosthetists are prevented from providing the foot they feel will be of most benefit to a patient, because it will not qualify for reimbursement.

Our practice is prepared to recommend and provide the most appropriate prosthetic components for every patient we serve, reflecting both physical and fiscal realities.

minant of Amputee Functional Outcome

HP

push the envelope with new designs such as the Re-Flex VSP and low-profile Allurion (see page 4).

Springlite products likewise span the spectrum from light-duty geriatric applications to athletic. Unique features include one-piece construction, high durability and custom design and manufacture of each system to prosthetist specifications. The signature Advantage DP (dynamic pylon) offers dynamic response multiaxial function and up to 16 degrees of rotation in an extremely lightweight, single-piece construction.

The College Park TruStep, also appropriate for very active amputees, provides a fully articulated foot, split-toe design and dynamic response.

1D25 Dynamic Plus

Advantage DP

Though this discussion has highlighted many of the leading ankle-foot components available to the lower-limb amputee population, there are in fact many more. We welcome your inquiries about any of these components and will be pleased to work with you to devise the best solutions to amputee needs.

Shock Absorbers Enhance Prosthetic Success

Critical factors for achieving lower-limb prosthetic success include maintaining tissue viability of the residual limb and maximizing patient comfort when walking. Prosthetic ambulation can be quite painful and damaging to the residual limb as impact forces at heel strike are transmitted through the prosthetic limb through the socket to the residual limb and on to the upper leg, hips and back.

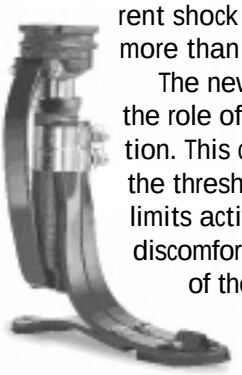
Undampened, these unfriendly forces can discourage even the fittest amputees from achieving their functional promise. This concern is particularly applicable to transfemoral amputees, who have less residual limb surface over which to distribute impact forces.

Prosthetists have long sought to minimize ambulation stresses. The common SACH foot, for example, features a cushioned heel, which absorbs some of the shock. Socket padding and liners also are regularly used to help amputees withstand the repetitive jolts of heel strike.

Lately, product designers have developed some new approaches to impact reduction, including in-line shock absorbers and innovative new heel designs.

Shock Pylons

In its basic application, the pylon of an endoskeletal prosthesis—typically a metal rod of a length to match the amputation level—serves as the connector and weight-bearing member between the foot component and the socket of a below-knee prosthesis or the knee unit of an above-knee system. The primary expectations of basic pylons are that they withstand the recurrent shock of heel strike and weigh no more than absolutely necessary.



Re-Flex VSP

The new generation of pylons adds the role of shock—and torsion—reduction. This capability not only can raise the threshold at which an amputee limits activity due to residual limb discomfort, but further replicates some of the natural gait characteristics lost with key musculature during amputation.

Engineers have taken several different approaches to pylon shock absorption:

- The ***Endolite TT pylon*** incorporates a high performance spring, selectable by patient weight and activity level.
- The new ***Pathfinder*** (see page 4) also employs a pneumatic approach, allowing the wearer to select the level of cushioning by the amount of air pumped into the cylinder.
- The Century XXII Innovations ***Total Shock*** uses urethane control elements to provide up to 14 mm of vertical compression and 10 degrees of rotation in each direction.
- The Flex-Foot ***Re-Flex VSP*** *(vertical shock pylon)* utilizes telescoping tubes and a carbon fibre external spring assembly to provide advanced cushioning and dynamic response.
- While many of the shock pylons are too long to be used for patients with a long residual limb, the spring-actuated Flex-Foot ***ICON*** pylon can be combined with a low-profile foot such as the new Allurion (see page 4) to create a minimum clearance solution.

Impact-Storing Heels

A different approach to impact stress reduction is a dynamic heel, such as the ***CarbonX Active Heel,*** a standard Flex-Foot feature for moderate-to-active amputees.

At heel strike, the Active Heel deflects; as the foot moves through foot flat to midstance, the heel's stored energy is transferred to the forefoot for release during late stance phase and toe-off, supplementing the energy return from the deflection of the forefoot itself.

These shock absorbers work well for some patients and not for others. Dynamic pylons carry a weight cost and are often not appropriate for patients with a long transtibial amputation. While transtibial amputees can benefit from shock pylons, they are usually considered more beneficial to above-knee patients. Dynamic heels are still relatively new and are generally provided to younger, more active amputees.

Shock absorption is an intriguing, emerging component of prosthetic practice. We welcome your inquiries.

Foot Technology Marches Forward

What's New

The march of prosthetic technology continues strong with the recent introduction of several new prosthetic feet that offer some significant advantages over previous models.

• The Flex-Foot ***Allurion*** and Springlite ***Lo Rider*** are new very-low-profile feet incorporating dynamic heel and toe response, and lightweight, low-maintenance construction. Both can be used on prostheses for almost any amputee level, but they are particularly applicable to amputees with long residual limbs. The Lo Rider in fact is an ideal selection for Symes applications.

• The ***1C40 C-Walk*** foot from Otto Bock is a dynamic response, multiaxial model incorporating a unique "C" spring to provide wearers with a surprising high level of comfort.

The C element loads at heel strike, then releases the stored potential to facilitate a smooth rollover to mid-stance. As forefoot loading increases, the C-spring loads again, storing energy that will be released at toe-off.


Allurion


Lo Rider


C-Walk

This foot is particularly appropriate for highly active transtibial amputees who engage in a broad range of activities, including leisure sports.

• The Ohio Willow Wood ***Pathfinder*** presents a revolutionary design featuring a pneumatic shock absorber, composite toe springs and composite footplate in a triangular arrangement. This construction approximates polycentric ankle motion without including an actual ankle component, prolonging foot-flat and thus enhancing balance and control. The Pathfinder is rated for Level 3 and 4 amputees but has also been applied successfully to certain Level 2 patients.


Pathfinder

For more information on these and other prosthetic foot advances, please call our office.

A Word to Our Readers

Mention of specific products in our newsletter neither constitutes endorsement nor implies that we will select such products for any particular patient. We offer this information to enhance professional and individual understanding of the prosthetic and orthotic disciplines and the capabilities of our practice.

We gratefully acknowledge the assistance of the following manufacturers and suppliers in compiling and illustrating this issue:

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