

# The Hinnant Prosthetics Quarterly

Experience Our Road to Prosthetic Excellence

Summer 1999

## Partial Foot Prostheses

Prostheses for partial foot amputations vary widely in direct relation to the level of surgery (see diagram at right). Typically, the more proximal (higher) the amputation, the higher the trim-lines and greater the complexity of the prosthesis.

Regardless of the level, a partial foot amputee retains the advantage of weight-bearing on the residual foot with near-normal proprioception, major benefits when learning to walk again after surgery. In fact, in an emergency, and sometimes for short-term household ambulation, partial foot amputees can get around without a prosthesis at all.

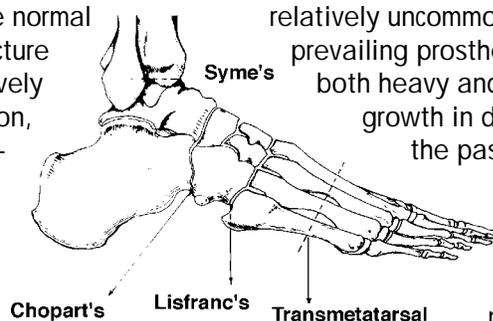
The key factor in the partial foot amputee's ease of resuming a normal gait pattern is preserving as much of the



**Supramalleolar partial-foot system. Unfinished device at upper right shows energy-storing footplate.**

toe lever as possible. One approach is to perform, where possible, a longitudinal ray amputation (toe and metatarsal) in lieu of a transverse procedure at the mid-foot or

higher. At the transmetatarsal level and higher, the normal weight-bearing structure of the foot is effectively destroyed. In addition, the loss of joint function that occurs in amputations above the transmetatarsal level complicates the prosthetic solution.



Because partial foot surgery has been relatively uncommon until recently, the prevailing prosthetic designs were both heavy and bulky. But the growth in distal amputations of the past 15 years or so and the application of new lightweight plastics and energy-storing metals to prosthetic

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### The Distal Amputations



DEAR FRIENDS:

This issue of our newsletter focuses on the "distal amputations," i.e. partial foot and Syme's (ankle disarticulation) surgery. From a strictly surgical standpoint, transtibial and above amputations have traditionally been favored over foot and ankle operations, except for nonsalvageable traumatic cases in which adequate circulation and oxygenation at the wound site could be reasonably anticipated.

But technological improvements have since greatly enhanced the efficacy of distal amputations for the much greater population of patients requiring limb removal for vascular disease. Another hesitancy relates to cosmesis. Foot and ankle amputations, particularly the Syme's procedure, tend to result in a disproportionately large prosthetic limb as compared to a healthy contralateral limb.

Nevertheless, distal amputations offer impressive functional benefits, including

- substantially better proprioceptive feedback;
- significantly reduced duration of prosthetic training;
- a much more efficient gait with less energy consumption; and
- distinct psychological advantages resulting from a less-severe change in body image and less-conspicuous prosthetic gait.

Improvements in medical technology and surgical technique have been paralleled by progress in prosthetic design and materials. Our professional staff is prepared to design and fabricate quality custom devices designed to maximize the functional outcome of these patients. We invite you to explore the possibilities.

— M. Kale Hinnant, C.P., FAAOP

# Partial Feet Highly Individualized

(Continued from page 1)

fabrication has produced an array of new lighter and more functional designs.

**Toes** — Amputation of one or more of the lesser toes has relatively little effect on overall foot function; however, loss of the great toe does limit the final push-off. Toe prostheses generally consist of a foam shoe filler, which serves to protect the amputation site and to keep the residual foot stable within the shoe. If

the great toe is involved, the lost propulsive function can be addressed by adding an energy-storing footplate or energy-storing rod known as a Morton's toe extender.

**Rays** — The prosthetic need after a ray amputation is to distribute the forces of

physical activity over the remaining surface area as evenly as possible and in the case of a first or fifth ray removal to counter lost mediolateral stability. The usual approach is a custom-molded insole, which may be laminated to enhance durability. For more-extensive ray amputations, a foam shoe filler may also be used to maintain shoe fit.

**Transmetatarsal** — Designs for this level are similar to a toe prosthesis, being addressed primarily with a forefoot filler. In addition, loss of the load-bearing surface under the metatarsal heads requires a custom-molded longitudinal arch support. An energy-storing footplate

may be added as well to provide additional push-off.

In the approaches heretofore described, the prosthesis is maintained in correct relation to the residual foot by the patient's shoe. For the more proximal levels, a socket approach must be employed to prevent relative motion between the residuum and the prosthesis resulting from the dorsiflexion moment created when weight is applied to the forefoot.

**Lisfranc's (tarso-metatarsal)** — This midfoot disarticulation removes more of the foot's weight-bearing capability and control of ambulation forces. It is generally considered the most proximal amputation level that can be used in young children without complication.

**Chopart's (mid-tarsal)** — This level is perhaps the most demanding with regard to prosthetic restoration, because there is less surface area over which to distribute weight-bearing forces and upon which the socket can gain purchase. Ankle stabilization is generally required.

Two primary prosthetic approaches are available for these more proximal levels. Both involve a custom-molded flexible

the heel and anterior brim. Later versions of these designs include a full-length energy-storing footplate, rocker sole and toe filler fabricated into the AFO. If necessary, the AFO can be constructed with a



*Custom covers can provide an amazingly lifelike finish.*

solid ankle to eliminate motion when ankle function is missing or abnormal.

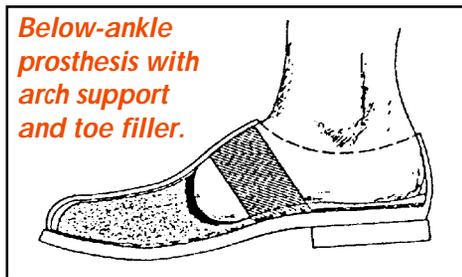
**Below-ankle** or "slipper-type" prostheses are appropriate for lower-level partial foot amputations when ankle function is normal and patients are in reasonably good mental and physical condition. As a rule, these designs are more comfortable and more cosmetically acceptable to patients. We generally recommend them for patients who do not require

restriction or augmentation of ankle function, can tolerate plantar surface weight-bearing and will not have suspension problems with a below-ankle system.

*Lisfranc's-level socket and slipper.*



*Below-ankle prosthesis with arch support and toe filler.*



plastic socket, either in the form of a total-contact plastic enclosure or an ankle-foot orthosis (AFO).

**Above-ankle designs** are frequently employed for Chopart's, Lisfranc's and transmetatarsal amputees to resist the dorsiflexion moment created during weight-bearing through counterforces at

The most important consideration, however, is that every partial foot amputee's situation and needs are unique, thereby requiring a unique prosthetic solution. Our role is to understand our patients' specific needs and to create the most appropriate prosthetic solution to those needs. We welcome the opportunity to consult on the care of specific patients.

# SHOULD YOU CONSIDER A SYME'S?

For various reasons, the Syme's ankle disarticulation has not found widespread acceptance among surgeons as an alternative to transtibial amputation for patients who would be candidates for either procedure. Perhaps a re-evaluation is in order.

The procedure, which was introduced more than 150 years ago by Scottish surgeon Dr. James Syme, retains the heel pad and allows end weight-bearing, thus preserving proprioception and near-normal sensory feedback. As a result, Syme's amputees typically require less training and are able to ambulate more efficiently and with considerably less energy expenditure than comparable transtibial patients. Moreover, because the procedure retains the distal epiphysis, it allows continued growth of an immature residual limb and precludes bony overgrowth—significant advantages in pediatric applications.

The Syme's disarticulation, long reserved for trauma cases, has more recently been shown to yield good results for removing diseased feet as well, notably among the dysvascular geriatric population. These patients demonstrate superior gait velocity, oxygen consumption and endurance relative to similar patients with higher-level amputations. Another surprising finding is that a Syme's patient may actually walk more efficiently than a midfoot amputee wearing only a shoe filler.

So, with all these benefits, why isn't the Syme's operation more prevalent? The reasons can be boiled down to three:

- **Surgeon's preference.** The Syme's disarticulation is generally regarded as being more difficult than a routine transtibial amputation and in the past has suffered from a greater wound failure rate, which has been substantially reduced in recent years. Some surgeons have reported success with a two-stage procedure in which revising the lateral malleoli to produce a less-bulbous distal residual limb is postponed until the risk of infection has subsided.

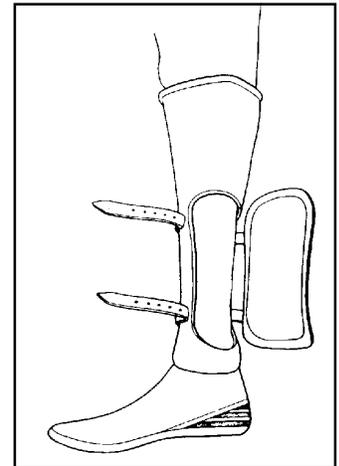
- **Limited prosthetic designs.** Because the Syme's disarticulation was performed infrequently for many years, prosthetic design and materials improvements lagged the innovations being applied to more common amputation levels. In the last decade however, they have come a long way, with the introduction of dynamic-response Syme's feet and high-strength, lightweight materials and designs.

- **"Fat Ankles."** Despite efforts during surgery to revise the bulbous distal end of the residual limb and during prosthetic fabrication to narrow the exterior dimensions, a Syme's prosthesis will appear substantially larger than a normal contralateral limb. Patients for whom cosmesis is a primary consideration often prefer to trade function for appearance by choosing a transtibial amputation over a Syme's.

Designing and fabricating a Syme's prosthesis entail certain challenges and advantages. On the plus

side, the majority of Syme's amputees achieve prosthetic success and tolerate the prosthesis well. The long lever arm of the Syme's residual limb produces decreased limb pressures within the

socket and less skin breakdown than most lower limb systems. Moreover, the characteristic bulbous distal end of the residual limb enables most Syme's prostheses to be self-suspending.



*Syme's prosthesis incorporating medial panel for donning, doffing.*

On the other hand, introducing that bulbous distal end into the narrower areas of a Syme's socket typically requires some special engineering. One method utilizes a window cut-out at the narrow part of the socket, which

(Continued on page 4)



*Laminated Syme's socket and ultra-low profile foot.*

## Syme's Pros and Cons

### Pros:

- End weight-bearing
- Short-term household ambulation possible without prosthesis
- Self-suspension
- Excellent proprioception
- Better gait velocity, cadence and oxygen consumption <sup>1</sup>
- Less skin breakdown <sup>1</sup>
- Less therapy and training required <sup>1</sup>

### Cons:

- More-complex amputation surgery
  - Slightly higher wound failure rate
  - Prosthetic limb is cosmetically larger than contralateral limb
- <sup>1</sup> as compared to transtibial amputees

# Syme's Offers Many Functional Advantages

*(Continued from page 3)*

can be opened for donning and doffing. Another approach, sometimes used when the distal residual limb circumference has been reduced during surgery, employs a flexible inner socket within the rigid outer shell. Inflatable bladder devices may be added to maintain a snug socket fit.

Shaving the malleoli during surgery to produce a more cosmetically pleasing outcome can reduce residual limb distal circumference by up to one-third, which may require an alternative suspension method, such as silicone suction suspension.

Because Syme's amputees as a whole exhibit a higher activity level than other amputees, they tend to be harder on

strength materials. The trick is to balance strength and weight to match the abilities and needs of the patient.



*Left: preparing to don socket liner; center: donning Syme's prosthesis. Right photo shows cosmetic difference between Syme's and normal ankles.*

In the final analysis, many Syme's candidates who currently undergo transtibial amputation instead could enjoy a significantly better functional outcome with this approach. With its inherent surgical complexity and cosmetic deficiency, the Syme's disarticulation certainly is not for everyone; however, for many, the functional benefits will far outweigh the deficiencies.

their prostheses, thus heavy-duty construction is indicated. Most Syme's systems consist of an exoskeletal shell made of many laminations of high-

In considering a Syme's level disarticulation, please know that Hinnant Prosthetics is prepared to apply the latest in prosthetic design and fabrication technology to the rehabilitation effort. We welcome your calls.

## Reese Mulligan, C.P. Joins Hinnant Team



Hinnant Prosthetics is proud to introduce certified prosthetist Maurice ("Reese") Mulligan, who joined our professional staff in January. Reese entered the field as

a prosthetic technician in 1989, then attended Northwestern University where he earned his degree in prosthetics in 1994. He performed his prosthetic residency at J. E. Hanger in Raleigh and earned his prosthetic certification from American Board for Certification in Orthotics and Prosthetics in 1996.

Reese comes to us from Total Rehabilitation in Fayetteville, where he was responsible for all prosthetic patient care in 1997 and 1998.

Reese is a welcome addition to our staff, and we commend his skills and experience to you in the care of your amputee patients.

### Hinnant Prosthetics

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