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# Preparatory Prosthetics

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The use of preparatory prostheses has for some time been a widely accepted methodology for the immediate or early management of the amputated limb. Burgess, et al., first introduced and popularized the immediate postoperative fitting procedure back in the late 60's.[3] Since that time, the use of early weight bearing prostheses has become the norm in fitting centers around the country and indeed in other parts of the world.

This paper will deal primarily with preparatory prostheses as they relate to the below-knee amputee. The rationale for such devices will be emphasized in a generalized fashion, as opposed to presenting a different array of commercially available systems or components.

The word "preparatory" denotes that these prostheses are used to prepare the amputated limb for definitive fitting with a prosthesis. Within this context, the scope of prostheses which may be considered preparatory in nature ranges from immediate postoperative fitting to the laminated socket with pylon and SACH foot. In between these two ends of the spectrum are such devices as the pneumatic air cast and Wu early fitting prosthesis. All of these devices have the major purpose of either controlling postoperative swelling or promoting the inevitable atrophy of muscles which were transected during surgery.

## SHORT TERM VERSUS LONG TERM DEVICES

The differences between prostheses used for immediate or very early fitting and those used for long term are worth noting. We will clarify the terms "temporary" and "intermediate" to distinguish between the two types of devices. The term "temporary" will be used to describe those prostheses which are intended for relatively short usage; they are applied soon after amputation, and usually are applied directly to the patient using plaster or a plaster substitute. "Intermediate" describes those prostheses which are intended for relatively long-term use; they are generally applied following the use of a temporary prosthesis and are fabricated from plastic over a positive model instead of being formed directly over the patient.

## TEMPORARY PROSTHESES

A temporary prosthesis is primarily used to control postoperative edema and is often the initial step in the residual limb maturation process. But the temporary prosthesis has many additional functions, one of which is early mobilization of the patient. This is especially critical to the physiological well-being of elderly patients. The less time the generally debilitated patient is confined to a bed or a wheelchair, the better the chances for overall recovery and successful long-term prosthetic use.[1] Indeed, the early mobilization of any patient can shorten the hospital stay and, therefore, save the patient and the insurance company the costs of increased hospitalization.

Another benefit of the temporary prosthesis is the psychological lift it can give the new amputee by reducing phantom pain and permitting early ambulation. Temporary fitting may also help offset some of the anxiety the patient experiences after an amputation.

## TEMPORARY DESIGN CONCEPTS

A temporary prosthesis is essentially a rigid dressing with a foot and pylon attached (Figure 1). It is a total contact system, encapsulating the amputated limb, including the patella, and extending to the mid-thigh. The knee is main-

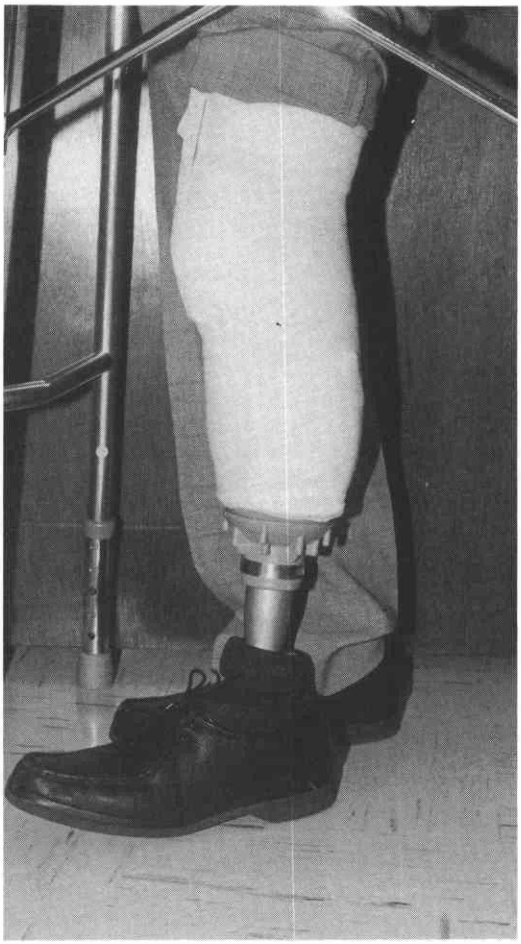

**Figure 1. Temporary below-knee prosthesis.**

tained in five to ten degrees of flexion. Suspension is by total contact, with some purchase over the adductor tubercle of the femur, and by a waist belt incorporated into the cast. Padding is provided for the distal end and bony prominences.

The standard mid-thigh height of the temporary prosthesis serves some definite purposes. This design assists in sharing weight bearing over a larger surface area, which reduces the load on the amputation site itself. The amputee can also ambulate with less risk of traumatizing the residual limb.

Encapsulating the knee also helps prevent knee flexion contractures, which are a very real threat to successful rehabilitation. In spite of the well-documented benefits of early fitting, all too often patients are sent home in an Ace® wrap to languish in a wheelchair for a period of weeks until their "stump toughens up enough" to be fitted with a prosthesis. This is the scenario that results in the elderly patient appearing for prosthetic fitting with hip and knee flexion contractures and an edematous residual limb.

Although the knee is fully encapsulated in the traditional temporary prosthesis, knee contractures are rare; partially because the cast is usually changed at weekly or biweekly intervals over the period of use. To enhance knee motion, the patient should be encouraged to flex and extend the knee through its range of motion at the time of each cast change. Intermittent weight bearing in the prosthesis also prevents a knee contracture, much as it does in the case of a long leg weight bearing case used in fracture management.

The non-removable nature of the temporary prosthesis has the advantage of continuous control of the tissues. When left to the patient to control via an Ace® wrap or shrinker, the limb is often wrapped intermittently or not at all. Rigid dressings have proven in most cases to be far superior to elastic wrappings in reducing the limb's soft tissue volume, especially in conjunction with controlled weight bearing.[4]

The inclusion of a waist belt, or billet, is essential in maintaining suspension in this type of system. As the residual limb shrinks, the prosthesis will piston on the limb if not supported by this auxillary suspension.

The pylon system is equally important with respect to the success of the temporary prosthesis. Although the patient walks with a stiff knee, appropriate alignment is essential for single limb stance stability.

## INTERMEDIATE PROSTHESES

The primary role of the intermediate prosthesis is to act as a preparatory device to reduce the limb to a definitive fitting status. It is generally fit when the postoperative swelling and distal edema have been reduced to a point where the bulbous end can be introduced into a socket. This prosthesis acts as the interim step between the temporary and definitive, thus the term "intermediate." The intermediate differs significantly from a temporary in that it is re-

movable and allows free flexion of the knee. Residual limb shrinkage is accommodated by prosthetic socks as opposed to cast changes. Aside from the obvious advantages of full range of motion and free access to the residual limb, the intermediate prosthesis allows the patient to learn appropriate sock ply management prior to being fitted with a permanent prosthesis.

The length of time a patient wears his intermediate prosthesis varies from person to person. Body type, cause of amputation, level of activity, and other considerations all play a part in how rapidly a residual limb will mature to a definitive fitting status. The duration of use can be anywhere from two months to six months, or longer. A general guideline which may be used to determine whether a limb has "plateaued" with regard to shrinkage is when weight bearing and wearing time have stabilized, and the patient has gone approximately three weeks without adding any additional plys of socks.

## INTERMEDIATE DESIGN CONCEPTS

The design of the intermediate socket is generally consistent with the standard PTB or TSB configuration (Figure 2). A soft liner may or may not be incorporated in the system. In either case, it is appropriate to fit the socket to the patient with as few ply of socks as possible. A one ply or even a nylon sheath fit is preferable in light of the fact that shrinkage, and thus the need for additional plys, is inevitable. As with the temporary, dynamic alignment plays an important role. This importance is now magnified by the fact that the patient is ambulating in essentially the same manner as he will in his definitive prosthesis. Again, it is recommended that the patient be fit with some sort of waist belt suspension to minimize relative motion between the socket and limb as shrinkage continues.

## GAIT TRAINING

At the time of fitting of the intermediate prosthesis, gait training becomes most significant. This is one of the great advantages of preparatory prostheses: the patient can be monitored and guided by a physical therapist in regard to an appropriate gait pattern while a prosthetist can periodically make alignment modifications as the patient becomes a more proficient ambulator. This advantage is lost, of course, in some of the commercially available systems, which do not allow for fairly precise alignment adjustability.

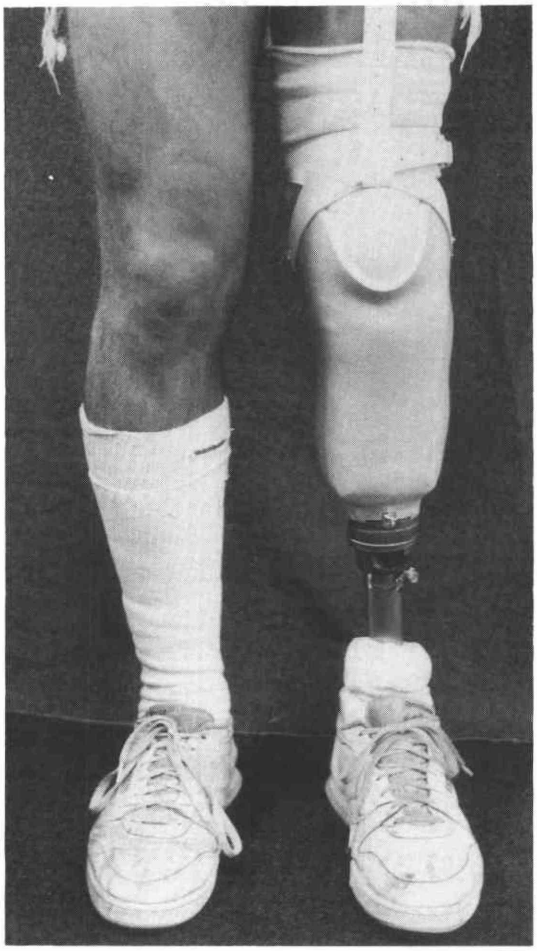

**Figure 2. Intermediate below-knee prosthesis.**

## THE FORGOTTEN LIMB

One of the least considered aspects of the benefits of preparatory fitting is the contralateral leg. Not only does the preparatory device make it easier for the amputee to maintain his balance, it also allows him to share his weight

partially on the prosthesis instead of totally on his remaining limb. In the case of the diabetic or peripheral vascular disease patient, this can be critical, as the remaining leg is usually at risk as well. Any additional trauma, such as prolonged single limb body support or hopping, should be avoided. Preparatory prostheses make this weight sharing possible, and thus prevents overuse or trauma to the remaining leg and foot.

It is clear that the role of preparatory prostheses and the management of the new amputee is a necessary and essential component in reaching the fullest rehabilitation potential of the patient.[5] The encroachment of non-traditional providers into the prosthetic arena, especially with regard to early fittings, poses a real threat to the realization of these patients' full potentials. It is critical that the prosthetist understand and appreciate the important role of preparatory prostheses in the total regimen of medical and prosthetic care. Success with preparatory fittings depends upon competent management by all members of the rehabilitation team. Temporary and intermediate systems must be applied and managed competently by the prosthetist. Weight bearing, gait training, and residual limb atrophy must be monitored carefully.

The term ''preparatory'' implies that such systems are designed to achieve specific desirable objectives. In this case, the objectives are the maturation of the residual limb and optimum patient readiness for definitive fitting. Comprehensive patient management with preparatory systems produces many advantages, including the provision of maximum early function, improved evaluation of the patient's long-term needs, and reduction of rehabilitation time and expense.[2]

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