Temporary Below-Knee Prosthetics

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INTRODUCTION

In recent decades amputee management has advanced significantly. With the advent of blood flow studies and new surgical procedures, more knee joints are being saved. Physical therapists, using advanced facilitation techniques such as proprioceptive neuromuscular facilitation (PNF), are better able to restore limb strength, range of motion, and coordination. Advances in the field of prosthetics include the development of ischial weight bearing suction sockets, patellar tendon bearing (PTB) below knee sockets, supracondylar suspension, hydraulic knee joints, and multiaction feet.

The prosthetics field has advanced not only in its mechanical and engineering aspects, but in its rehabilitative aspect as well. Among contributions to better amputee management in this area are the development of immediate post-operative prosthetics (IPOP), and the use of temporary prosthetics. The fact that the use of IPOP and adjustable temporary above knee prostheses hastens the patient's return to a more functional lifestyle has been well documented. However, temporary BK prostheses have not been used to their full advantage. Given a more functional, better fitting temporary prosthesis, BK amputees would be better able to use their definitive prosthesis to its full potential.

This article will review some of the literature which traces developments made in the field of temporary BK prothetics; and will set forth criteria for the fitting of BK amputees with functional temporary prostheses.

REVIEW OF THE LITERATURE

In 1965, Hammontree et al,[1] reported on a temporary BK prosthesis being used on a group of geriatric patients. Their clinical team was attempting to provide, "an inexpensive, temporary walking leg, that will not only give the elderly BK amputee an adequate socket for the purpose of limb shrinkage and shaping, but will also get the geriatric patient back on his feet within three to four weeks after operation." The authors also suggested the possible use of the prosthesis as a diagnostic tool with

regard to further prosthetic rehabilitation.

The prosthesis used in Hammontree's study incorporated a plaster socket, either the Northwestern BK pylon or an aluminum pylon, SACH foot, and cuff suspension plus waist belt. Despite drawbacks to this system, it did prove successful in its purpose, and a great deal about temporary systems was learned.

In 1976, Charles H. Pritham et al,[2] reported on the use of thermoplastic components in temporary prostheses. Their prosthesis utilizes either a standard plaster of paris or a plastic PTB socket that is laminated into pieces of galvanized pipe strapping which is attached to a PVC nylon and ankle plug. The use of a plastic PTB socket with a pylon that can be continually adjusted has undoubtedly contributed to the success of this system. The authors report that with only a few exceptions, their patients have been able to wear the temporary prosthesis up to and exceeding six months.

The importance of the use of temporary BK prosthetics was further illustrated by William A. Tosberg, C.P.O., in an article entitled "Temporary Prostheses"[3]. He states, "Following long hospitalization, the patient may be debilitated. The limb may be edematous and painful. Motivation may be impaired. It is therefore essential that the physician has a choice of prescription. All former criteria which determined the type of limb indicated are no longer valid for this type of patient. If a standard prosthesis is prescribed for such a patient, he may never be able to utilize its full potentials."

CRITERIA

The authors of this article agree with Mr. Tosberg that a standard definitive prosthesis is not always the best choice of prescription for a first prosthesis. Temporary prostheses, if made correctly, can be worn until the residual limb completely stabilizes. Thus, when the patient receives his definitive prosthesis, he will be ready to achieve his full rehabilitative potential. While the advantages of a functional temporary prosthesis for the new BK amputees have been acknowledged, criteria with which to fit them have never, to our knowledge, been established. Based on our study of pertinent literature, and our direct experience with temporary prostheses, we now propose the following four criteria to be used in fitting temporary BK prostheses:

- Temporary prosthetic sockets should be a PTB custom fit.
- The temporary prosthesis should be capable of continual adjustment.
- The weight of a temporary prosthesis should be similar to that of a definitive prosthesis.
- The temporary system should meet indications set forth by existing pathological and physical conditions.

Criteria 1

Temporary prosthetic sockets should be a PTB custom fit. There are two important advantages to a PTB custom fit; it distributes pressure in the correct places, and it protects bony areas. As a result, the PTB custom fitted temporary prosthesis is better able to shape and shrink the residual limb than standard plaster of paris sockets.

Criteria 2

The temporary prosthesis should be capable of continual adjustment. In order for an amputee to attain the most function possible from a prosthesis, the prosthesis must be mechanically correct. In a new amputee, the biomechanical situation is constantly changing. As gait improves and the residual limb matures, the prosthesis must be adjusted to accommodate the change. For example, once an amputee becomes more accustomed to walking in a prosthesis, it is often possible to further inset the foot, thus less energy is consumed and ambulation further enhanced.

Criteria 3

The weight of a temporary prosthesis should be similar to that of a definitive prosthesis. When the amputee is ready to wear a definitive prosthesis, the transition should be as smooth as possible. The definitive prosthesis must be lightweight

without compromising strength. The temporary prosthesis should come as close as possible to matching that weight. The exception to this is the patient who would use the temporary leg as the definitive prosthesis, in which case an ultralight BK prosthesis is the choice of prescription.

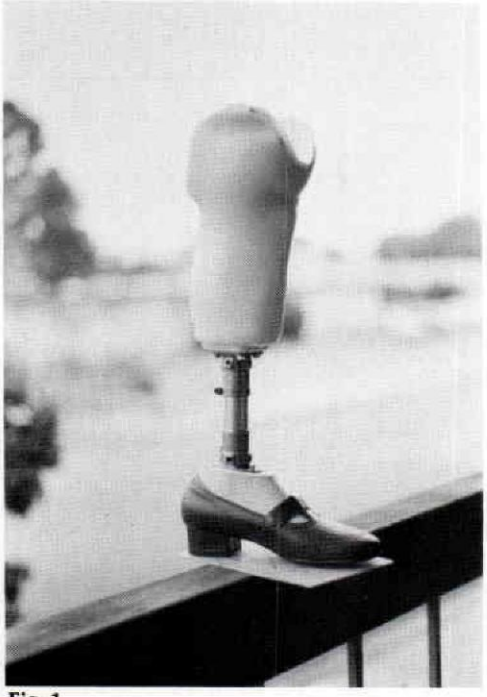
Criteria 4

The temporary system should meet indications set forth by existing pathological and physical conditions. When fabricating the definitive prosthesis, the pathological reason for amputation and the resulting physical condition of the residual limb must be taken into consideration. As the main purpose of temporary prostheses is to prepare the amputee to make the best possible use of the definitive prosthesis, it is essential that these considerations be recognized. The temporary system should be versatile, allowing the use of the same foot and suspension as will be used in the definitive prosthesis.

METHOD

The temporary BK prosthesis used in our facility was developed by Chris Herman C.P. and consists of a custom made 3/16 inch polypropylene PTB socket attached to an Otto Bock endoskeletal pylon (Fig. 1).

By modifying a positive model taken for each patient, we meet the first criteria. Table 1 represents 14 of 17 BK amputees fit at our facility at the time this study began. Because our patient population is small and not all of these amputees have received a definitive prosthesis, statistically significant data can not yet be determined. However, analysis to date indicates that 78.6% of these patients have increased their number of socks worn by five ply or more, and 57.1% by at least 10 ply. Thus, amputees wearing a temporary PTB socket have been able to significantly shrink in volume, maintain a PTB fit, and not lose one day of ambulation time. When shrinkage necessitates a new socket, it can be replaced, when ready, in a matter of minutes during an office or home visit.



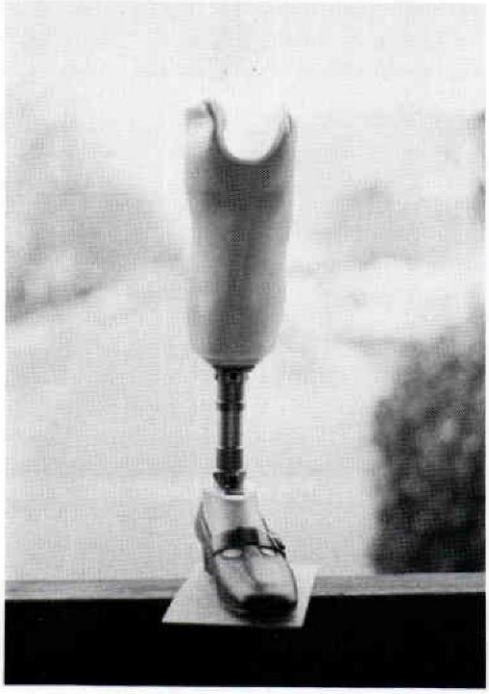


Fig. 1

The second criteria, that of adjustment, is met by the use of a Bock endoskeletal pylon. This system has adjustments at the socket attachment plate and ankle plug, therefore accurate linear and angular adjustments are possible. This system was also used at our facility on the three patients not included in table 1. All three patients were put in temporary BK prostheses for unique reasons. Two are bilateral amputees, and the other presented with a 45° flexion contracture. In the case of the bilateral amputees, having a means of adjustment proved invaluable as they became more accustomed to ambulation on two prostheses. The amputee with a 45° flexion contracture underwent intensive physical therapy to stretch the hamstring muscles. Although this degree of contracture often makes ambulation with a prosthesis difficult, the prosthesis was a valuable tool in maintaining the work of the therapist. The contracture eventually was reduced to 20°. Furthermore, the constant alignment and height adjustments required were easily made with no loss in rehabilitation time.

Criteria number three is met through the combination of a lightweight polypropylene PTB socket and an Otto Bock endoskeletal pylon system. We have found the weight of this combination closely approximates the weight of a conventional exoskeletal BK prosthesis.

In satisfying the final criteria, the Bock pylon and plastic socket have proven versatile in meeting various prosthetic indications. There have been no limitations in choosing the type of prosthetic foot desired since the pylon is designed to accommodate just about all prosthetic feet on the market today. The 3/16 inch polypropylene is strong and durable enough to sustain supracondylar or suprapatellar cuff suspension.

DISCUSSION

The vast majority of amputees receiving temporary BK prostheses present with extremely edematous residual limbs at the time of casting. This is due to a combination of factors including: 1) The trauma of a major surgical procedure, 2) the reluctance of many physicians to use rigid dressings on new amputees, 3) a lack of activity after surgery, and 4) the improper

Patient	Months in System	Equivalent Increase in Number of Sock Ply While in Temporary Prosthesis
1	8	14
2	3	4
3	5	5
4	7	25
5	2	6
6	3	27
7	6	26
8	5	10
9	6	0
10	4	2
11	4	12
12	6	12
13	5	13
14	5	8

Table I

use of ace wraps and shrinkers. The resulting large circumferential discrepancy between mid-patellar tendon (MPT) and the levels distal to MPT, create difficulties not only in the casting for, but in the donning and doffing of the temporary prosthesis. The following modified procedures have proven useful in working with an edematous residual limb:

- The placement of a shrinker under either the cast sock or tube gauze. This helps distribute the residual tissues evenly, allowing the cast to be more easily removed. Many amputees who wear the shrinker under regular prosthetic socks have felt it to be beneficial in hastening residual limb maturity.
- The addition of a double layer of pelite or neoprene glued to the proximal posterior aspect of the insert. When this is done prior to lamination, it can be used to help the patient slip the insert past the narrow anterior-posterior dimension.
- The fabrication of the insert and socket over a three ply sock. This helps to insure a comfortable fit for those patients suspected of little or no limb shrinkage prior to prosthetic wear.
- The drilling of a small hole in the bottom of both the insert and socket. This allows trapped air to escape as the bulbous distal end squeezes past the MPT circumference, making donning easier.
- The placement of a piece of dacron, to be used as tabs, around the medial and lateral sides of the insert. This helps the amputee in doffing a prosthesis with supracondylar suspension.

CONCLUSION

In a study done by O.D. Parker,[4] a comparison was made between amputees fitted with temporary BK prostheses as a first prosthesis, and those immediately fitted with definitive prostheses. The amputees fitted with the temporary prosthesis passed final checkout in the clinic 9.4 months earlier than those who received permanent prostheses. Furthermore, temporary prosthetic wearers received the final permanent prosthesis an average of 8.3 months before those treated in the conventional manner.

As a result of the success we have had with temporary BK prostheses, and our research into studies such as those reviewed above, we have begun to fit all our new BK amputees with temporary prostheses.

In an article published in *Clinical Orthopaedics*, C. Leslie Mitchell, M.D. wrote, "Clearly, in spite of the impressive advances that have been made toward solution of problems of prosthetics, large areas remain for exploration . . . And a tremendous gap yet remains between what an amputee can do and what he should be able to do."[5] The goal of modern prosthetics is to enable the amputee to achieve maximum function with his prosthesis. The correct and diligent use of temporary BK systems enhances the possibility of the amputee reaching this goal.

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