Prosthetic Modifications for the Treatment of Marginally Viable Below-Knee Amputations

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INTRODUCTION

When one is confronted with a marginally viable below-knee amputation which has an open suture line or other epidermal problems related to post-operative treatment, what is the best prescription for these patients prior to temporary prosthetic fitting? This type of residual limb is found mostly with geriatric amputees, and is often complicated by paraesthesias associated with Diabetes Mellitus (Figure 1).

The ultimate goal for the prosthetist is to produce a snugly fitting, carefully contoured socket, which offers the maximum amount of area for weight bearing. This leads to better control and comfort while ambulating on a lightweight prosthesis. This is a goal which may be achieved by utilizing special modifications to the prosthesis, thus allowing these types of amputees to progress rapidly and comfortably throughout their prosthetic rehabilitation.

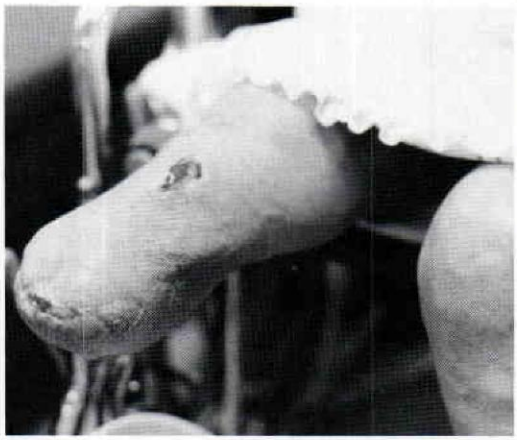

Fig. 1. A marginally viable below the knee amputation showing slow healing suture line and pressure sore.

PROSTHETIC MODIFICATIONS

Joints and Corsets

One modification, allowing early ambulation for the amputee with a slow healing suture line, is the addition of a thigh corset using either polypropylene or nylon knee joints.[1] (Figure 2). The thigh corset offers some control of weight bearing on the distal one-third of the residual limb. With the addition of two or three two inch Velcro® closures, the corset is easily adjusted by the patient (Figure 3). The polypropylene or nylon knee joints offer the advantages of lightness and ease of workability (Figure 4). These joints work quite well in supporting weights of up to 180 pounds. However, one must take caution when setting the shape of the uprights on heavier patients. A gradual bend in the upright will support weight better than a radical bend will. This will also lead to less

Fig. 2. A completed below the knee prosthesis utilizing polypropylene knee joints and Velcro® closures.

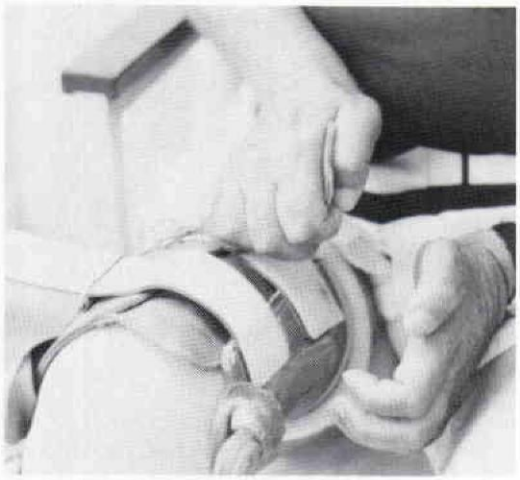

Fig. 3. A thigh corset with Velcro® closures is easily adjusted by the patient.

problems of breakage. These knee joints should also only be used on patients with a sound knee joint, as they offer limited medio-lateral stability. The joints can be used on a long term basis with a moderately active patient. This modification to the prosthesis can work well, but only with a qualified physical therapist routinely monitoring the patient's progress on the prosthesis until healing has occurred.

Special Inserts

In addition to, or apart from the thigh corset and side joints preparation, specially fabricated inserts should be created on an individual basis when dealing with an asensitive residual limb of a geriatric amputee.

If a patient's weight is 120 pounds or less, and he has a moderate activity level, a very soft insert composed of an inner layer of 1/8 inch Plastazote™, and an outer layer of 1/8 inch PPT[2] produces an equitable environment for the residual limb. The Plastazote™ will stay compressed after use in the most dense tissue areas, where pressures are concentrated, while constantly adjusting to changes. This is backed by a layer of PPT, which offers continual protection for the residual limb, and resists compression. Due to the combined total durometer of the Plastazote™ and PPT insert, adequate support effectively helps patients who fall in the lightweight and moderately active category.

Patients who weigh 130 pounds or more and who are moderately to highly active, can benefit from an insert composed of an inner layer of 1/8 inch PPT and an outer layer of Pelite. PPT offers direct tissue shear stress protection while being backed by the firm durometer of the Pelite. This combination of materials offers an environment that will protect the residual limb

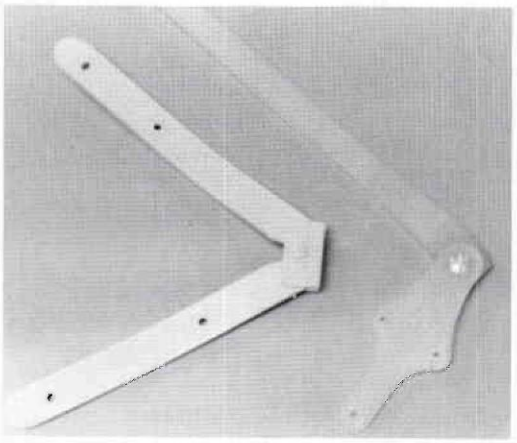

Fig. 4. Nylon (left) and Polypropylene (right) knee joints work well in supporting weight of up to 180 pounds.

throughout the entire day by relieving the tissues of stress which could lead to skin breakdown. The typical patient requiring this type of insert might be a moderately active 200 pound, six foot tall man with a four inch residual limb. This residual limb would be subjected to intense pressure at all times, thus necessitating this type of insert.

Young, highly active below-knee amputees can also benefit from the control of tissue breakdown. This type of insert absorbs a majority of the compound torques and pressures on the residual limb under stressful conditions, while still offering little increase in the overall weight of a sport-type prosthesis.

An insert made solely of ¼ inch PPT offes excellent protection for the patient with a very short, predominantly bony, well atrophied below-knee residual limb with very little or no protective tissue. Patients with moderate activity levels and weighing up to 130 pounds can benefit from this tissue supplemental material. This material can prevent tissue irritation, which is so common amongst these patients. This insert also allows the patient to ambulate comfortably without the need for a multiple prosthetic sock fitting. As normal atrophy occurs, this type of insert aids in the protection of the residual limb, even as the initially intimate fit begins to fade.

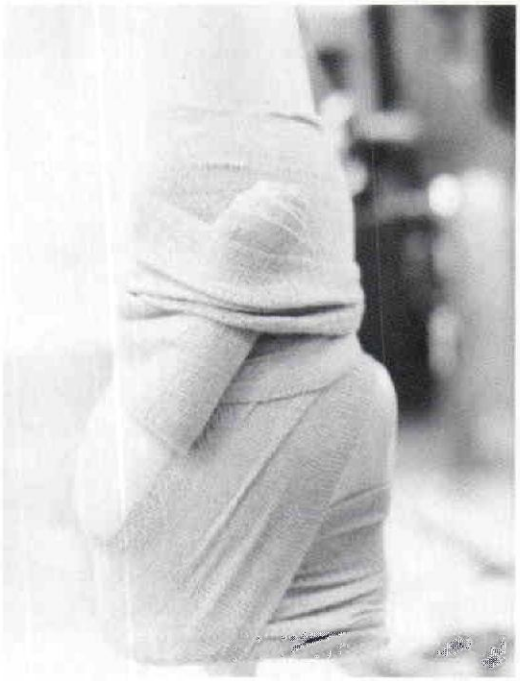

Fig. 5. Plastazote™ forms similarly to Pelite around a positive model.

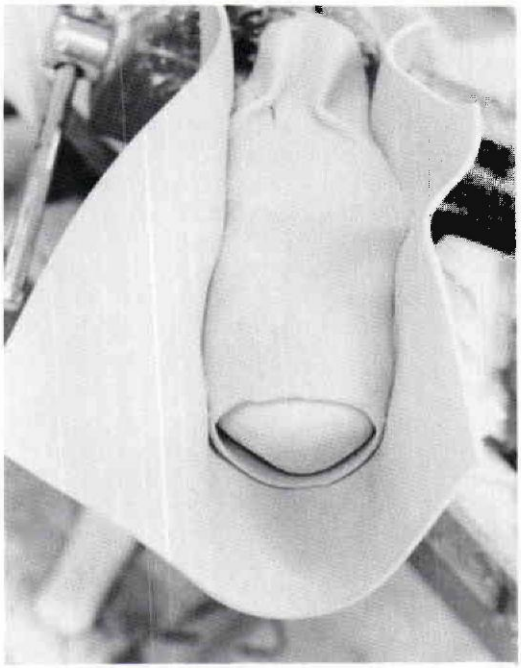

Fig. 6. Starting at a point on the anterior of the positive mold, contour the PPT by carefully applying it around the posterior where the PPT can be trimmed to permit one seam.

FABRICATION

The Plastazote™-PPT insert can be fabricated quite rapidly and simply. A suggested method is to cut out a measured area of ⅛" Plastazote™ just as you would in producing a standard Pelite insert. Complete and apply this to the positive mold as you would with a Pelite insert, only use much less heat (Figure 5). After it has been adequately shaped to the positive mold, cover it completely with a thin coat of Barge®, or similar type contact cement. Then apply a coat of the adhesive to an equal area of ⅛" PPT. Starting at a point on the anterior of the positive model, contour the PPT by carefully applying it around to the posterior where the PPT can be

trimmed to show only one seam in the posterior (Figure 6). Proceed to cap the insert as desired. Caution should be taken when gluing the PPT so as not to apply adhesive to the coated side of the material, marked with the brand name, as the adhesive will remove the coating from the material leaving a weak bond. It is preferable to obtain uncoated PPT material and avoid this problem.

The PPT-Pelite type insert is fabricated differently than the above type, but is still very easy and quick to create. Cut an appropriate area of 1/8" Pelite and an equal area of PPT and bond the two materials together with a thin coat of adhesive. Skive the edges approximately 1/2" as you would in constructing a Pelite insert. Sanding the skive is recommended over cutting a skived edge. Prepare a cone as in the standard Pelite insert technique. Heat the Pelite, which is on the outside, until it is slightly pliable, and carefully pull the inverted cone over the positive model and shape as you would a standard Pelite insert. Again, cap the insert as you normally would (Note: It is suggested that the A.P. modification of the positive model be tightened by 1/8" to 3/16".

Fabricating the 1/4" PPT insert is different from the others mentioned above, as by itself it is not thermal molding and tends to maintain its original shape. Produce this insert in the same manner as a standard Pelite insert, except that the application over the positive model is done without the use of heat. It is simply pulled carefully into place. It is suggested that you modify the positive mold to produce a one-ply fit.

All three insert types should be laminated into the socket using the same vacuum settings and techniques as with a standard Pelite insert. Care must be taken on the breakout of the positive model so as to protect the finished insert. Socket pulling as a means of separating the socket from the positive model is not recommended, due to possible damage to the insert. The inserts should always be marked for trimming after the patient has been ambulating and is still in the prosthesis, and the nonconforming PPT is pushed into place. There is approximately 1/2" of displacement in the material under loading as it is made to conform to the socket shape (Figure 7). These lightweight special inserts can easily be fabricated and replaced when necessary and the longevity is similar to that of a Pelite insert. Modifications can be made by adhering Pelite to the outside of the insert in the appropriate areas, thereby accommodating volume changes of the residual limb. A thin coat of adhesive works quite well in the bonding of all these materials.

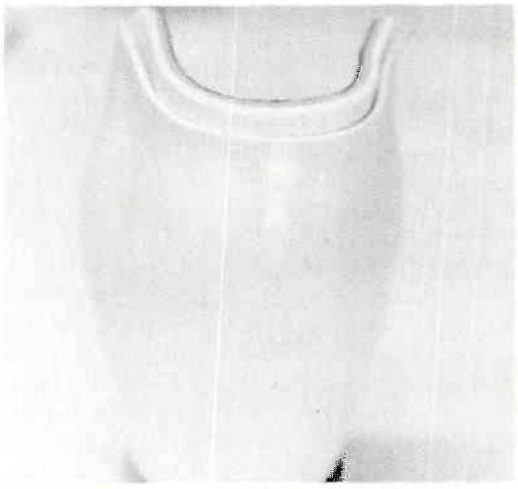

Fig. 7. Mark the insert for trimming with the patient in the prosthesis to allow for approximately 1/2 inch of displacement under loading.

SUMMARY

In conclusion, if careful attention is taken in fitting special below-knee residual limbs, higher success rates and more rapid prosthetic rehabilitation can be achieved. Use of special materials and fabrication techniques can assist the prosthetist in this endeavor.

REFERENCES

[1]Nylong prosthetic knee joint is available through American Prosthetics, Inc., 406 Cookson Drive, West Branch, Iowa 52358.
[2]Polypropylene knee joints are available through United States Manufacturing Company, P.O. Box 100, 623 South Central Avenue, Glendale, California 91209.
[3]PPT is available through Professional Technology, Inc., 21 East Industry Court, Deer Park, New York 11729.

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