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Experience with the Use of Alginate in Transparent Diagnostic Below-Knee Sockets

by C. Michael Schuch, C.P.O.
Tony Lucy

Transparent test sockets have been available in various materials for more than ten years,[5,7] but their use has not been as widespread or as routine as one would expect. Only recently has the emergence of new materials and new evaluation techniques, as well as third-party awareness and reimbursement, made the use of test or check sockets more appealing.

The objective of this article is to present a refined technique for using test sockets and aliginate to guarantee that total contact exists between socket and stump. This technique has been developed as a standard procedure for each and every below-knee amputee fitted with a prosthesis at the University of Virginia. We consider it to be the single most important and recent technique for enhancing the fit of prostheses for our below-knee amputees.

Robert Hayes, C.P., described his alginate technique first in 1975 in *Orthotics and Prosthetics*[3] and more recently in an updated version in *Clinical Prosthetics and Orthotics*.[4] In 1984, Timothy Staats, C.P.,[6] described a technique for introducing alginate into the negative cast mold, which is used as a test socket after molding. No doubt there are other prosthetists using similar or variations of these techniques. However, the important point is not who or how many are using the technique, but how many still do not use this technique for refining below-knee socket fit.

Equally important is the fact that any system of diagnostic socket evaluation should be more than just algination. The routine use of multiple, transparent, skin-fit sockets, evaluated both statically and dynamically as a progressive system, will provide assurance of optimum socket fit. It seems rather obvious that if amputees can ambulate successfully with a skin-fit, hard socket, then use of a definitive socket with a minimal number of prosthetic socks, with or without a soft liner, will be that much more comfortable and successful.

A 12″ × 12″ sheet of ⅜″ thick Durr-Plex[1] or Thermocheck[2] is used for the average below-knee socket. This material is transparent, strong and rigid, is easily vacuum formed (Figure 1) using the frame and platen technique, and can be modified later by spot heating. Of course, any other transparent material that can be vacuum formed is equally suitable.

Lubrication of the stump with petroleum jelly, or equivalent lubricant, is necessary for donning the check socket when it is used without a prosthetic sock. The patient then stands bearing weight in the test socket, which rests on a platform or stand that can be adjusted in height so that weight-bearing is the same on each side and the pelvis is level (Figure 2). While the patient continues to stand, the stump in the transparent socket is evaluated by identifying changes in skin color. Blanching, or even whiteness, indicates that the pressure levels are

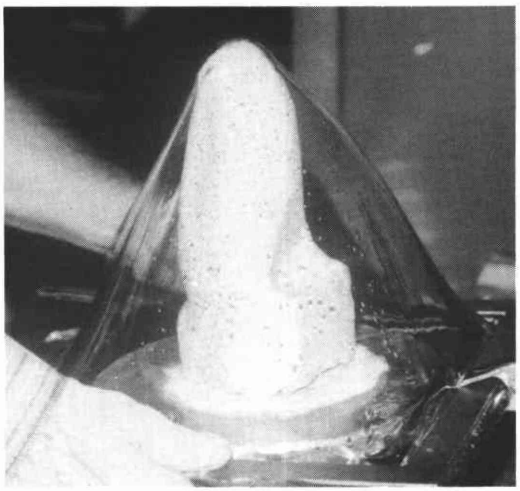

Figure 1. A transparent socket is vacuum-formed over a plaster cast that has been modified in the usual manner.

Figure 2. The patient bears one half of his weight in the transparent socket for evaluation of fit by the prosthetist observing the color of the skin.

acceptable. Excessive shiny blanching indicates increased pressure, which is perhaps excessive. Redness indicates voids or lack of total contact. If a patient complains of too much pressure when an area is surrounded by red, then alginate should provide relief by establishing total contact. If the patient complains of too much pressure when an area is surrounded by white and blanching, relief is provided by spot heating and stretching the socket in the area of complaint. A thin flat probe, like a corset stay, is often useful for specifically locating pressure areas for purging small pockets of trapped air, or gauging skin tensions within the socket (Figure 3).

A reliable technique for the evaluation and modification of the fit of below-knee diagnostic test sockets is available using the dental material, alginate. The viscosity and other properties of alginate makes it suitable for: (1) filling any voids between the socket and stump to insure total contact, or total surface bearing; (2) providing proper compression of soft tissues for better distribution of weight-bearing pressures.

A mixture of 20 grams of powdered alginate† and 6 ounces of water provides the proper ratio and amount for most below-knee patients. The water should be lukewarm and dyed with food coloring to provide a definite contrast in color to the skin and socket.

The socket is sanded lightly on the inside to promote adherence of the alginate, and escape holes are drilled medially and laterally approximately one inch proximal to the distal end. Small pin holes are also drilled over void areas to allow air to escape as the alginate fills. The water and powder are mixed with an electric drill and paint stirrer, and then poured into the test socket and slushed around the walls to completely coat the inside of the socket. The patient then enters the socket and stands with equal weight-bearing bilaterally. The alginate fills void areas, establishing total contact. The excess is evacuated, and gelling occurs in one to three minutes (Figures 4 and 5). The patient is

† Type II, Normal Set Alginate, Coe Laboratories, Inc. Chicago, Illinois 60658

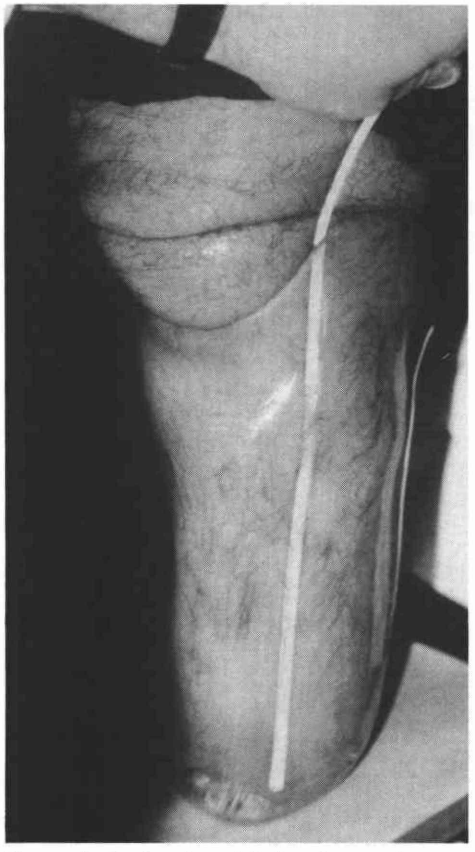

Figure 3. Evaluation of fit by observation can be augmented by use of a flat slender probe.

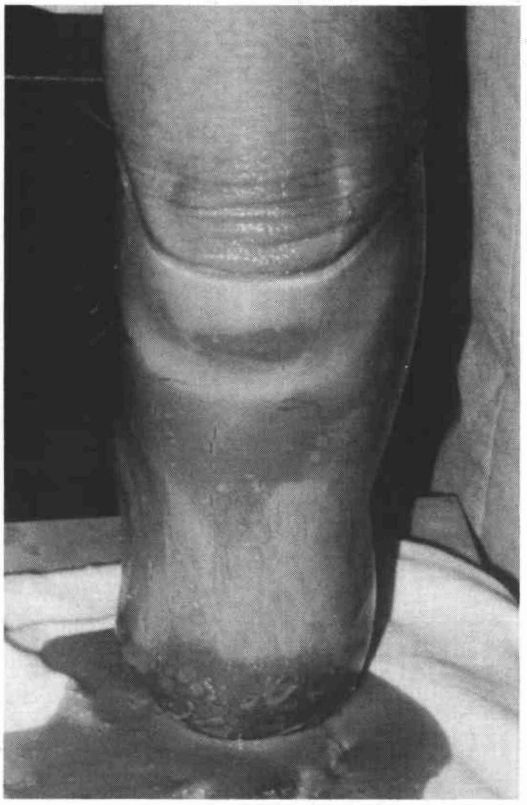

Figure 4. Alginate fills void areas while patient bears one half of his weight into the socket. Excess alginate flows through small relief holes drilled for this purpose.

then seated and the socket is carefully removed, after breaking the suction seal. The alginate will adhere to the inside of the socket.

When the socket is filled with plaster, a positive model that has been redefined by the alginate under weight-bearing conditions is obtained. When the plaster has set, the test socket is removed by cutting it off. The alginate will adhere to the cured plaster model (Figure 6).

The new positive model is now evaluated. Information such as location and thickness of the alginate fill is useful feedback concerning the original casting and model modification. At this point the alginate is removed and the new positive model is smoothed using sand screen. The model is now ready either for use as a follow-up transparent test socket or for fabricating a definitive socket.

If one chooses to proceed with the definitive socket, prosthetic socks are added over the model before the liner or socket is fabricated to allow for the thickness of socks desired in the final fit.

RESULTS

Records were kept and studied for a series of 40 below-knee amputees fitted using the alginate test socket system. The data recorded were: (1) location of areas filled by alginate (i.e. voids in the prealginated socket); (2) thickness of fill with respect to location; and (3) results of dynamic and final fittings (i.e. adjustments required to improve socket fit at post-algination fitting sessions).

Areas filled with alginate were very consistent and included the posterior distal soft tissue area, the tibial tubercle, the lateral tibial flare,

Figure 5. Alginate solution cures between one and three minutes.

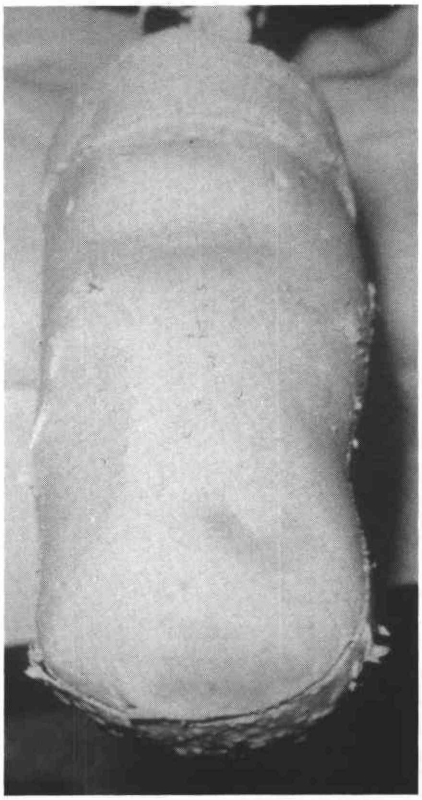

Figure 6. Alginate is removed from new positive model before smoothing and vacuum-forming definitive socket or a new check socket.

and the anterior distal tibia. As the series progressed, the model modification technique changed based on this previous experience. As a result, the thickness of the alginate fillers gradually decreased, as did the plaster build-up over bony prominences on the original model. None of the 40 subjects required socket adjustments to improve comfort or fit at the time of dynamic alignment, delivery alignment, or delivery of the prosthesis.

We have been involved, either directly or indirectly, with fitting more than 150 patients in this manner. The use of alginate with multiple transparent test sockets is a valuable tool in patient management and helps provide better below-knee sockets through improved weight-bearing pressure distribution.

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AUTHOR

C. Michael Schuch, C.P.O., and Tony Lucy are with the Department of Orthopedics and Rehabilitation at the University of Virginia.