A Below Knee Vacuum Casting Technique

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INTRODUCTION

Accurate casting is thought by many to be the single most important factor in the successful fabrication and performance of the below knee prosthesis. Fitting is becoming increasingly accurate with improved socket materials (polyester resins, acrylic resins, and silicone compounds) and more sophisticated fitting techniques (total contact sockets, and check sockets). This article presents a below knee casting technique which utilizes vacuum pressure to draw the plaster against the patient's skin. This procedure produces negative impressions which duplicate residual limb contour and shape with a high degree of accuracy. The purpose of this research is to obtain the best possible method of casting for improved socket fit and increased comfort and control of the prosthesis for the patient.

HISTORY

At present, the most common casting technique involves wrapping the residual limb with plaster of paris and then molding it against the skin by hand until the desired negative impression is obtained.[1,9] To distribute the pressure equally around the residual limb, Gardner (1968)[3] described a technique using a pneumatic sleeve while Murdock (1968)[6] developed the Dundee socket which used fluid pressure to compress the plaster against the skin. Fillauer (1971) developed the two and three stage casting technique which duplicates the boney anterior prominences and soft posteriolateral tissue areas separately.[2] Other multistage techniques were developed by Gleave (1972)[4] and Rice (1979).[8] In 1971, Zettl and Traub reported a premodified casting technique[10], and, in 1982, Hanger presented a technique which used positive pressure provided by a controlled environment treatment (CET) machine to compress a bag over the plaster wrapped residual limb.[5] All of these techniques have attempted to accomplish the same result; that of creating as accurate a negative impression as possible.[7]

VACUUM CASTING

The below knee vacuum casting technique uses vacuum to draw the plaster against the patient's skin. This process ensures equal distribution of pressure around the residual limb, thus eliminating the need to mold the negative impression by hand. The amount of vacuum pressure applied to the extremity can be varied depending on the amount of detail desired. This technique is compatible with, and improves the accuracy of, existing casting techniques such as the two and three stage procedures of Fillauer. The vacuum casting technique utilizes standard equipment

Figure 1. Materials required for the vacuum casting technique.

which is widely available in prosthetics facilities.

The materials and equipment required for this technique are as follows (Figure 1):

1. Portable vacuum (Hosmer Cat. No. 51277)
2. ¼ inch wound tubing
   (Heritage Cat. No.430-04)
   (Zimmer Cat. No.1500-13)
   (Depuy Cat. No.5420-78)
3. Universal connector
   (Heritage Cat. No.460-01)
   (Zimmer Cat. No.1500-15)
   (Depuy Cat. No.5420-95)
4. 1 roll, 1 inch Microfoam tape
   (3M Cat. No.1528-1)
5. 1 roll, 2 inch Microfoam tape
   (3M Cat. No. 1528-2)
6. 1 roll, 1 inch double-faced tape
   (3M Cat. No.950)
7. 1½ inch × 14 inch Plastisol sealing band
8. Cast sock
9. Indelible pencil
10. 1 to 2 rolls standard plaster of paris bandage
11. 10 inch × 14 inch Zip-Lock® plastic bag
12. 1 Yates clamp
13. One pair scissors
14. Plaster parting cream
    (Otto Bock Cat. No.64025)

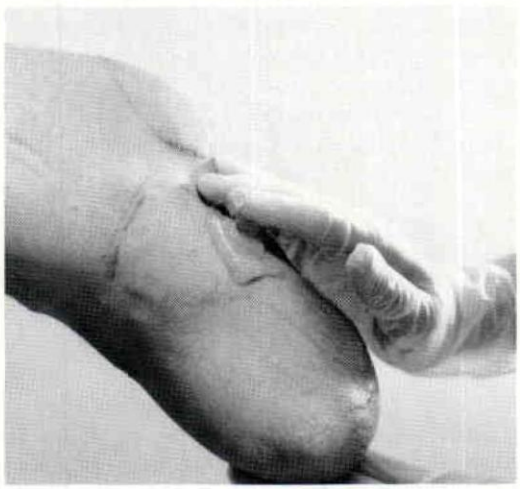

Figure 2. Apply plaster parting cream to the residual limb.

Procedure

The below knee vacuum casting technique is as follows:

1. Apply plaster parting cream on the patient's residual limb to facilitate easy removal of the cast (Figure 2).

2. Apply a wet cast sock to the residual limb. Draw the sock tightly against skin to eliminate any wrinkles (Figure 3).

3. Secure the cast sock with one inch Microfoam tape three to four inches above the Patella (Figure 4).

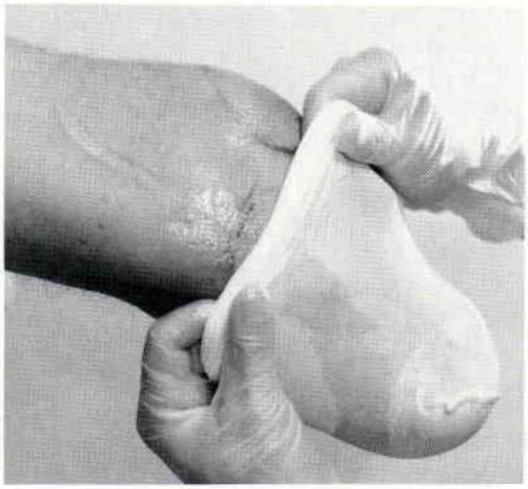

Figure 3. Apply the cast sock.

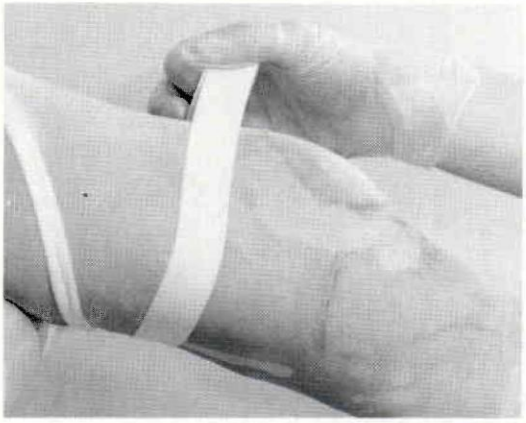

Figure 4. Seal the cast sock proximally using one inch Microfoam tape.

4. Cut off the excess stockinette and seal the entire proximal edge against the skin with two inch Microfoam tape. One or two layers is sufficient. This will create an air-tight seal against the skin (Figure 5).

5. Mark the boney prominences with an indelible pencil.

6. Feed the vacuum tube through the Plastisol sealing band until the perforated holes are all on the distal side of the band (Figures 6 & 7). Then place the sealing band on the two-inch Microfoam tape with the perforated side projecting distally. Lay the tubing down the residual limb and trim off the excess at mid-patella (Figure 8 & 9).

7. Cut a small hole in the stockinette just superior to the patella and feed the perfo-

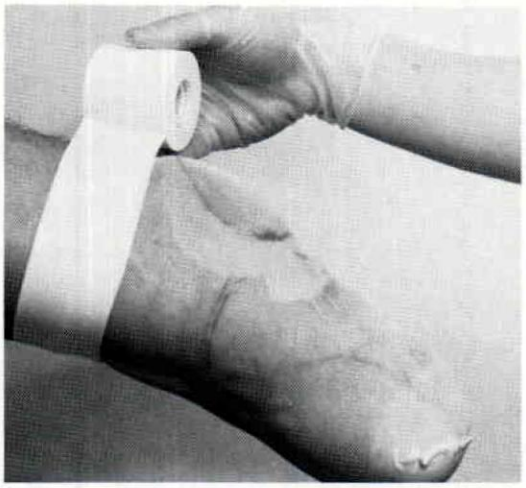

Figure 5. Seal the cast sock to skin using two inch Microfoam tape.

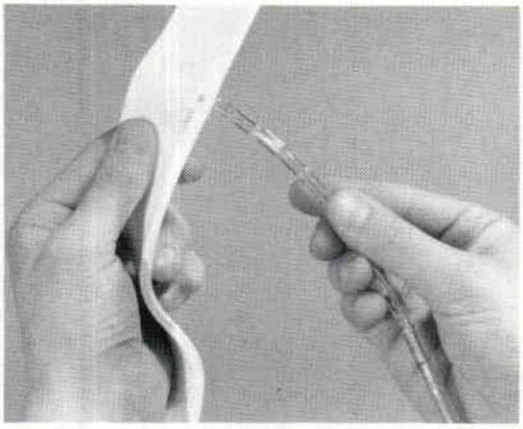

Figure 6. Feed the tubing through the flexible Plastisol band. Note: Silicone lubricant may be required.

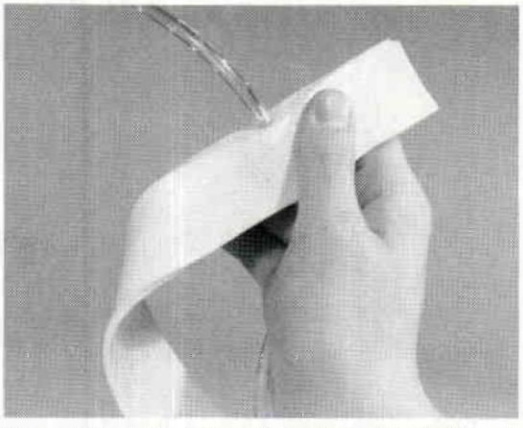

Figure 7. Feed the tubing through the Plastisol band until the perforated holes are on one side of the band.

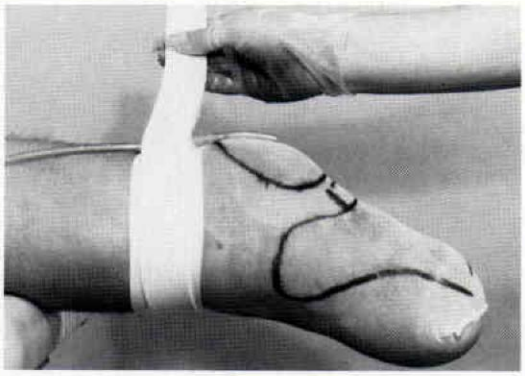

Figure 8. Seal the Plastisol band to the Microfoam tape. Note: If sealing becomes a problem, use double-faced tape.

rated tubing underneath the stockinette to the middle of the patella. The tubing must be under the stockinette to create an air passage during vacuum evacuation. Wrap the Plastisol band snugly around the Microfoam tape to create an air-tight seal (Figure 10).

8. Apply plaster of paris bandage over the patient's residual limb, being careful not to cover the Plastisol sealing band. Avoid wringing the water-saturated plaster bandages. They must remain wet to allow the vacuum pressure to draw the plaster against the skin. Wrap the bandage loosely to avoid distortion from roping.

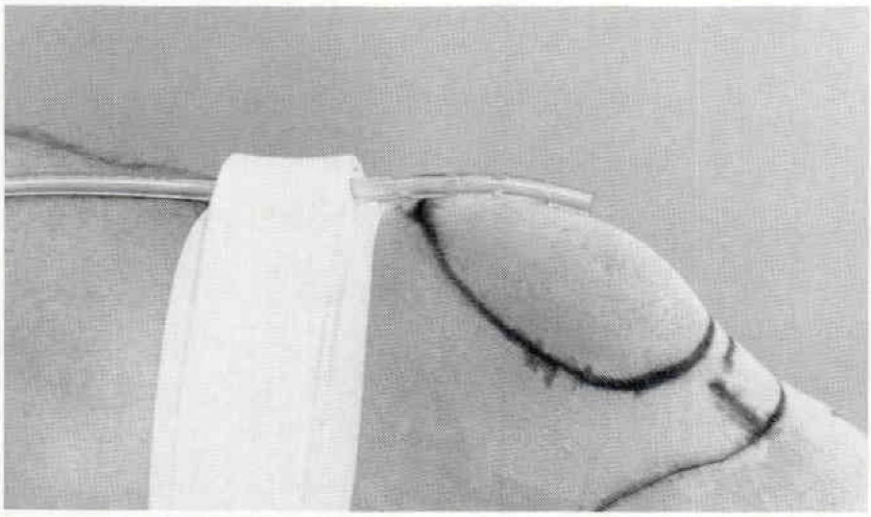

Figure 9. Trim off the excess tubing.

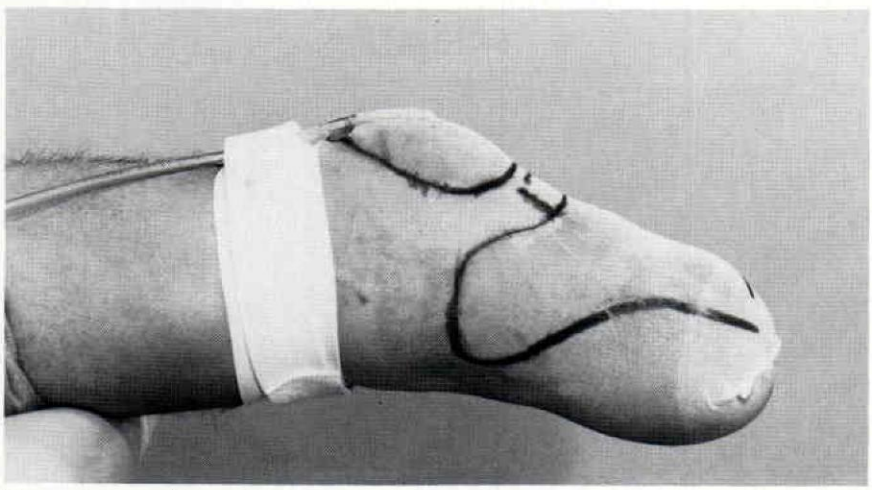

Figure 10. Lay tubing under the cast sock.

Figure 11. Apply plaster bandage loosely around the residual limb. Note: Do not exceed five layers in thickness.

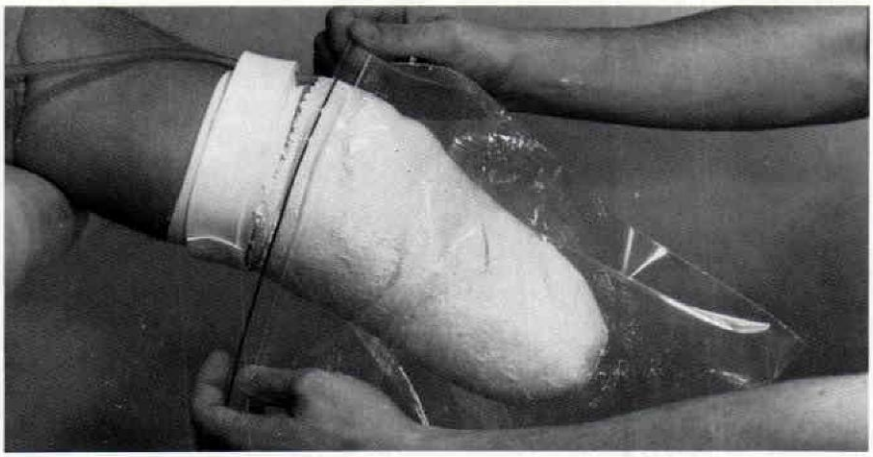

Figure 12. Apply the vacuum bag over the negative impression.

Figure 13. Seal the bag to itself and the Plastisol band.

Figure 14. Apply vacuum (20 to 30 inches of mercury).

Figure 15. Hand molding of the negative impression is optional but can be applied in critical areas if desired.

Standard bandages rather than elastic plaster bandages are used due to their greater strength. Three to four layers are sufficient. An excess of five layers cannot be drawn against the skin accurately because of the excessive vacuum pressure required (Figure 11).

9. Apply the Zip-Lock® plastic bag over the plaster wrapped limb, keeping the fastener in contact with the Plastisol sealing band (Figure 12). Using the Zip-Lock® fastener, seal the bag and secure with a Yates clamp (Figure 13). An effective seal is important; without it the vacuum casting technique will not work.

10. Apply vacuum pressure to the bag, drawing between 20 to 30 inches of mercury (Figure 14). While under vacuum, the negative impression may be molded by hand if desired, but this is not necessary. If molding is required, the vacuum casting technique has a unique tendency to hold the specified shape molded into the negative impression in position (Figure 15).

11. Once the plaster has hardened, the negative impression can be removed fol-

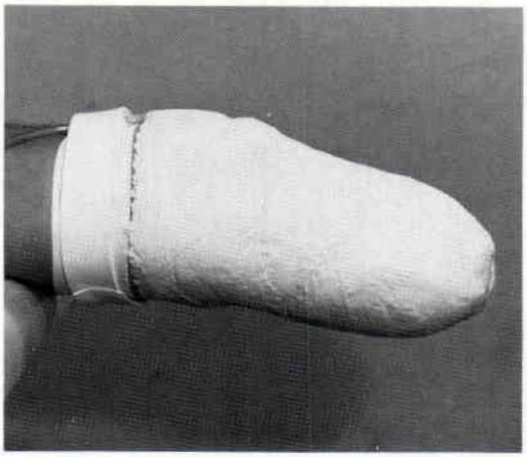

Figure 16. The vacuum bag is removed.

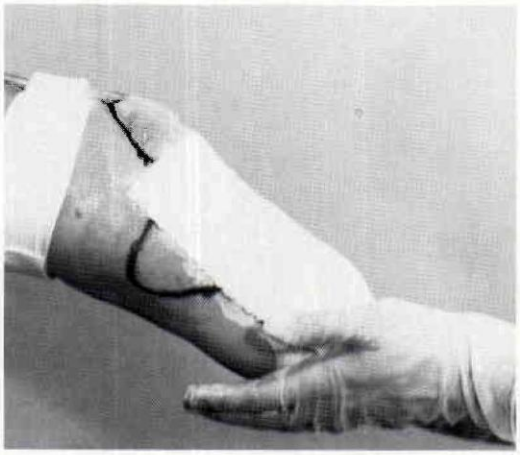

Figure 17. Application of the anterior splint.

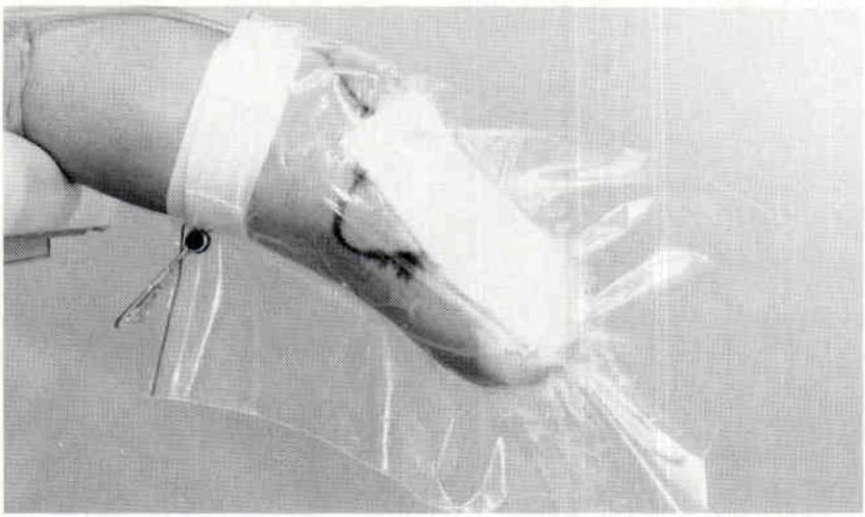

Figure 18. Vacuum is applied after first stage.

lowing removal of the bag, Plastisol sealing band, Microfoam tape, and finally the negative impression (Figure 16).

If a multistage cast (Fillauer's two and three stage technique) is used, the vacuum is applied after each wrap (Figure 17). Once the plaster has hardened, the vacuum bag is removed and the patient is ready for the next stage (Figure 18). Again, it is important that the wrap or splints (anterior or supracondylar) not exceed five layers in thickness. When using the three stage technique for supracondylar suspension, it is important that the Plastisol band be repositioned proximally to allow sufficient room for the proximal splint.

CONSIDERATIONS

While the below knee vacuum casting technique ensures equal pressure distribution, certain precautions should be taken:

1. Always use a clean tube. If a clean tube is not used, there is a greater chance that it will become clogged and the vacuum will be insufficient to draw the plaster against the skin.

2. Placing the tubing underneath the stockinette will function as: (a) a filter to prevent large plaster particles from being drawn into the tube and, (b) to keep the plastic vacuum bag from sealing directly

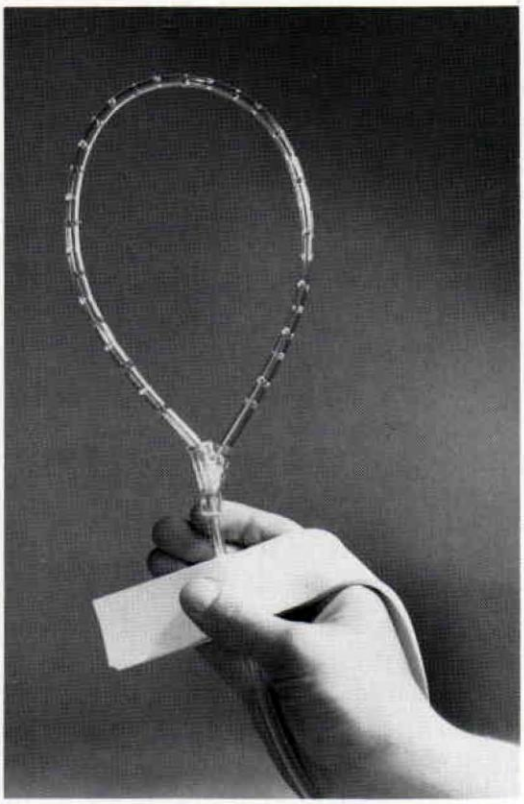

Figure 19. The tubing is connected back to itself using a "Y" connector.

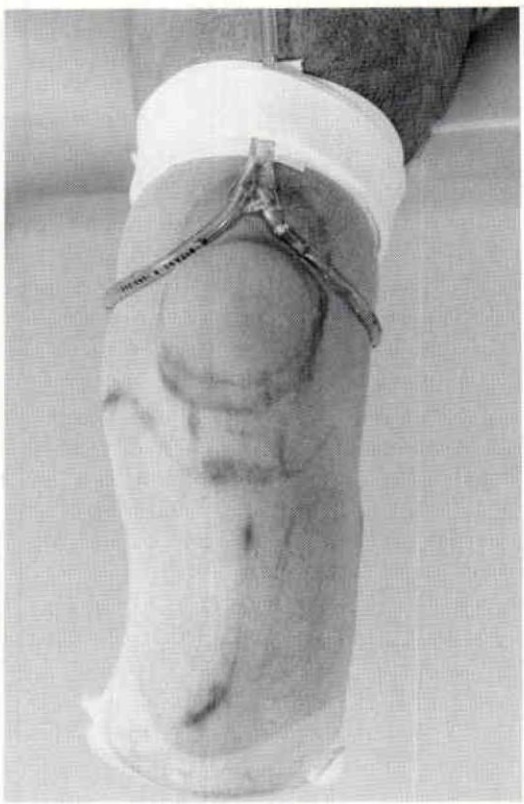

Figure 20. The tubing is then inserted through the Plastisol band and wrapped around the residual limb.

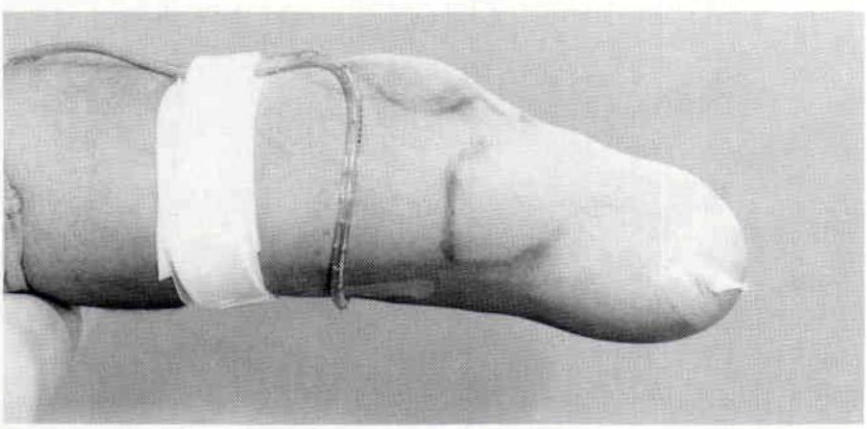

Figure 21. Lateral view. Note: The tubing should run under the sock before casting.

against the tubing and thus blocking the vacuum holes.

3. Seal the vacuum bag tightly against the Plastisol band. A good seal must be obtained or maximum pressure will not be achieved. If sealing does become a problem, wrap double-faced tape around the Plastisol band before applying the vacuum bag.

4. For improved posteriodistal vacuum pressure on the residual limb, the tubing may be wrapped proximally around the

extremity and connected back to itself using a universal connector (Figures 19, 20, & 21).

DISCUSSION

The vacuum casting technique is more efficient, and actually takes less time, than more conventional techniques when considering setup, application, and removal.

1. Less time is needed to mold the plaster in place because the vacuum creates the general contour.
2. The plaster sets quicker because vacuum removes water from the mold, which promotes setting and reduces the time required on the patient.

The vacuum casting technique is very accurate. Unlike existing hand molding techniques, the vacuum casting technique was developed for the specific purpose of eliminating impression variations, such as those encountered in serial casting a patient by the same practitioner and casting a patient by different practitioners. The prosthetist can now regulate and visually monitor the amount of pressure applied to the plaster negative. The resulting accuracy makes this technique easy to teach.

As many prosthetists are aware, exact duplication in conventional hand molding techniques is difficult because casting requires distorting tissue in some areas, and not in others, while maintaining total contact. However, the vacuum casting technique does exactly this. It provides total contact under equal pressure, and allows the prosthetist to mold the impression in particular areas if necessary. The vacuum casting technique has proven so far to be the most efficient system to offer both of these capabilities. This system can also be modified for use in orthotics, which will be discussed in a subsequent article.

CONCLUSION

The success or failure of any casting technique depends on its accuracy, but accuracy cannot be obtained without the ability to regulate and monitor the amount of pressure while casting. Under existing casting techniques, hand molding takes place which is dependent on the subjective judgment of the practitioner. This explains why variations occur between the same patient, different patients, and between practitioners.

The vacuum casting technique was developed for the specific purpose of minimizing impression variations by allowing the prosthetist to regulate and monitor the amount of vacuum pressure to achieve the detail desired. This technique also enables the prosthetist to modify certain areas simultaneously if desired. The vacuum casting technique appears to reduce time, be more efficient, and increase the comfort and control of the prosthesis due to the improved accuracy of this fitting system.

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