FABRICATING HIP DISARTICULATION SOCKETS USING THE VACUUM* METHOD

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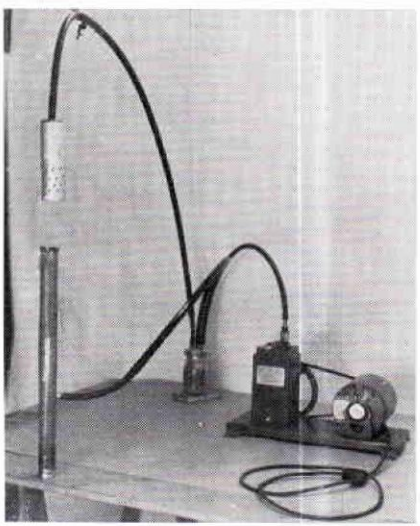
Introduction

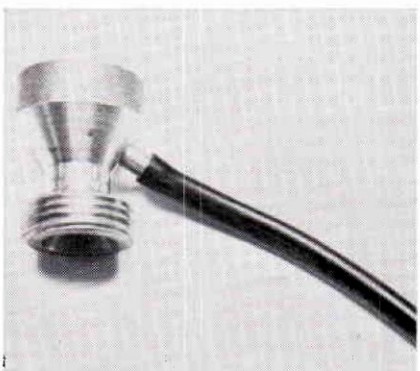
Vacuum laminating techniques have been used successfully in various applications in the reinforced plastics industry. In simpler prosthetic applications, such as arm and below-knee sockets where hand stringing is applied through a PVA bag, there seems to be little advantage in using a vacuum in the ordinary limb shop. However, in the more difficult applications such as hip disarticulation sockets the use of a vacuum prevents accumulation of resin and the formation of voids where large grooves or undercuts are present, and generally results in a more uniform laminate. This report describes one method of laminating hip disarticulation sockets utilising vacuum.

Vacuum Equipment

Photo 1 illustrates a typical equipment lay-out. A standard laboratory vacuum pump is an ideal source of vacuum, but if not available the inlet port of an air compressor may be used. This provides a negative pressure of approximately one half atmosphere. This should not injure a sturdy air compressor but may damage a light duty model not specially designed for this use. The cheapest suction device is a Venturi nozzle that uses water flow from a tap. They are sold in hardware stores for about $2 and are used for sucking liquid fertiliser into a garden hose. This type draws almost as much as a vacuum pump but takes a little longer. The suction pressure can be varied by changing the flow of water. If a short nozzle is used (Photo 2) a short section of hose must be attached to the outlet.



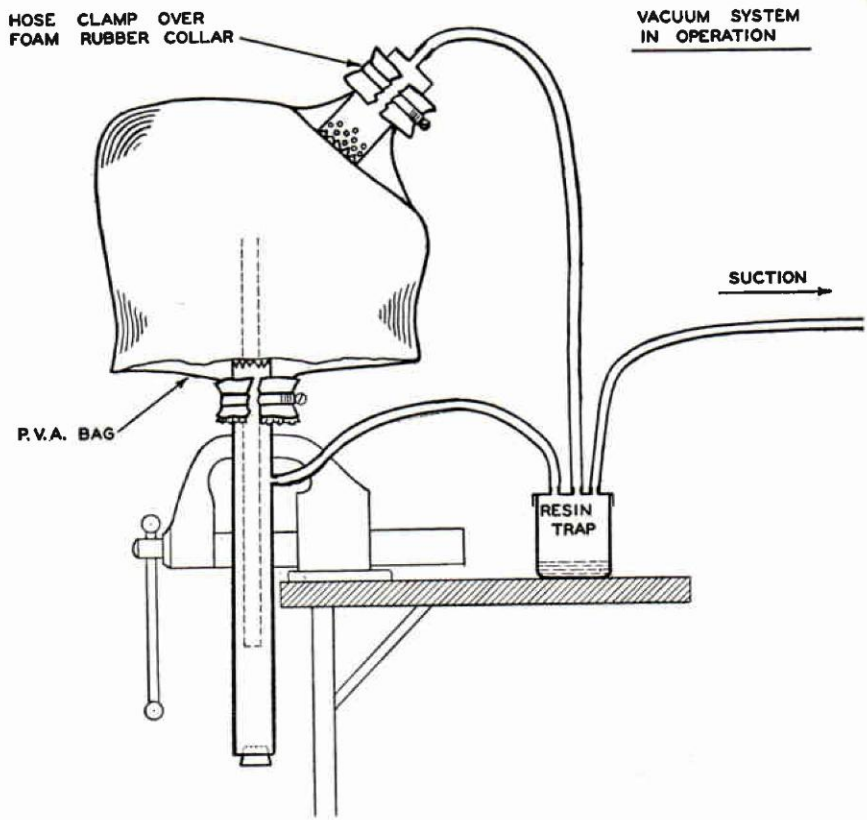
1. The equipment lay-out showing the vacuum pump, resin trap and perforated inlet tubes.



2. The Venturi type suction pump that operates by water flow from an ordinary tap.

* The term "vacuum" is used in this report to describe air pressure between 0 and 7 pounds per square inch ABSOLUTE.

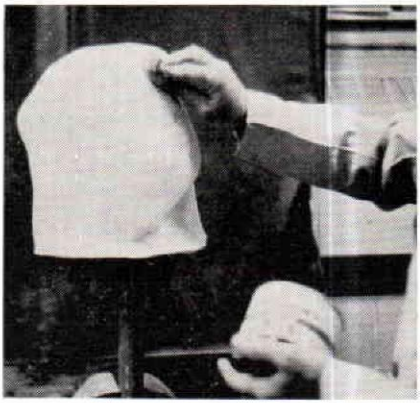
If a pump-type vacuum source is used it is essential to use a resin trap between the resin and the vacuum pump. An ordinary glass jar with three hose fittings is all that is required. The lid must be sturdy enough to prevent buckling under a high vacuum. Any flexible tubing is satisfactory for vacuum lines providing it will not collapse. Small size plastic water pipe is cheap and satisfactory, although not very flexible. The suction is applied through the bag to the laminate via a metal tube of about 2″ in diameter. The tube is perforated or notched so that the air or surplus resin may be drawn off without clogging the line. The bottom tube is clamped in the vise and acts as a receptacle for the pipe or rod supporting the cast. The PVA bag may be sealed off by clamping or taping to the suction tubes. If clamps are used foam padding should also be used to prevent cutting of the PVA bag. The main trap should be kept as close as possible to the lower suction tube since it usually becomes loaded with resin and cannot be re-used. Photo 1 illustrates the vacuum pump and equipment used. The drawing shows a schematic illustration of the vacuum system in operation.



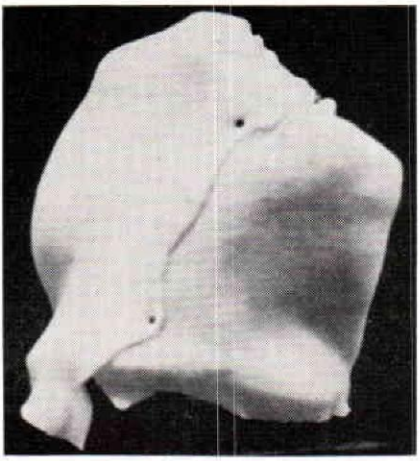
Dry Lay-Up

An effective method for sealing a wet or dry cast before lamination is an application of floor wax followed by a dusting of water ground mica spread lightly by hand. (Photo 3)

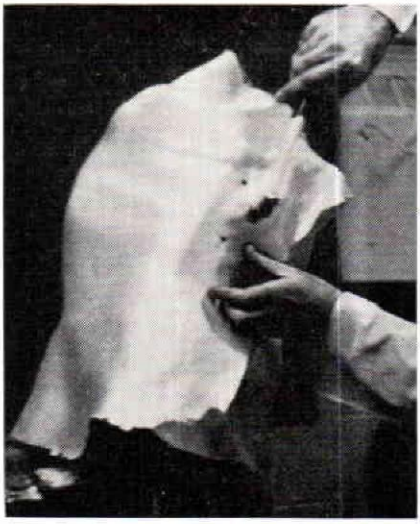
A typical dry lay-up consists of a layer of dacron felt (Photo 4), three layers of fibreglas overlapped to form six layers in the seat area (Photo 5), ten or twelve strands of roving reinforcing the area around the cut out, the back and the seat (Photo 6), an additional layer of fibreglas again overlapped in the seat area, and a layer of nylon stockinette or felt to hold the glass in position (Photo 7).



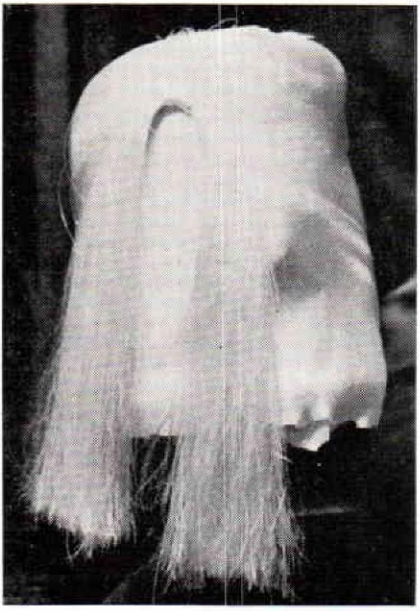
3. Applying wax to the cast.



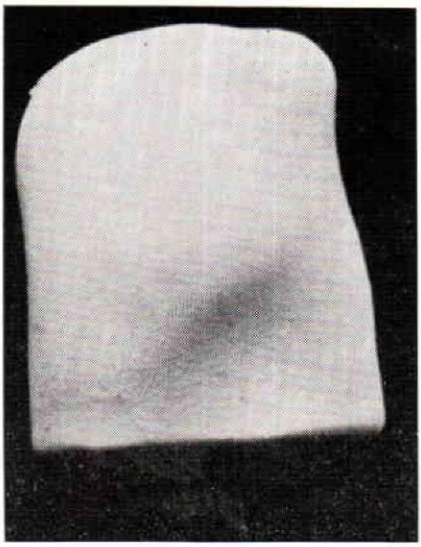
4. The initial layer of dacron felt. Note the section which will be later cut away.



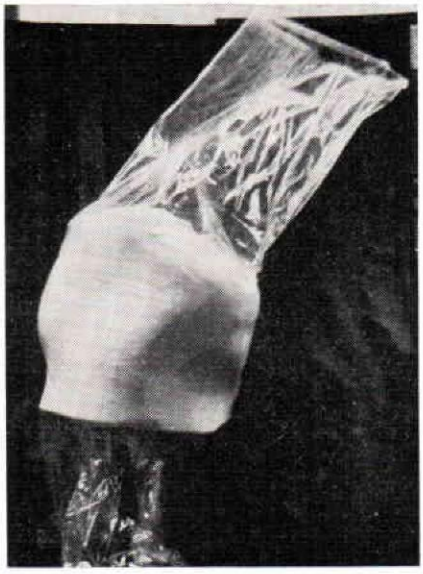
5. One of three layers of fibreglas cloth. Note that the cloth is overlapped in the seat area for double strength.



6. Glass roving reinforcing the lateral cut-out.



7. The final layer of nylon stockinette.



8. The PVA pulled on prior to adding the resin.

The PVA Bag

The PVA bag should be made to fit snugly on the sides with at least a foot (12″) extending beyond both the top and bottom (Photo 8). With these casts the large end may be uppermost; hence, the tapered bag should be pulled up over the cast.

Resins

Either polyester or epoxy may be used. The epoxy is, of course, much stronger but does not cure as readily as the polyester. Approximately nine 6 oz. cups of resin are used in an average socket. The epoxy resin (without hardener) may be heated to 120° F. immediately before using since this cuts down the viscosity, allowing a faster penetration and an accelerated cure time. Araldite 502 with 10% HN951 will gel in about one hour and harden in about 2 or 3 hours if preheated. Without preheating 20 hours may be required. If polyester is used it should be 90% rigid and 10% flexible. About 2% ATC catalyst and ½% Naugatuck #3 promoter will induce gelling in about 20 minutes and hardening in about 2 hours. Pigments prepared for polyester resin should not be used with epoxies. Special pigments may be obtained from the Plastics Colour Corp., 22 Commerce St., Catham, New Jersey. Since no flesh colour is available, red, white, blue and black may be mixed to the appropriate shade.

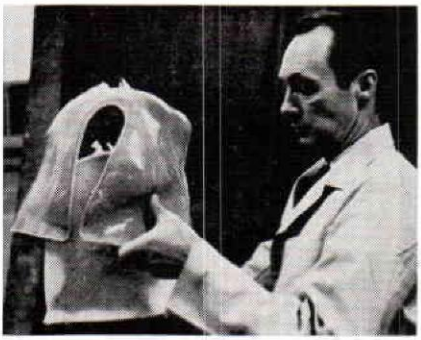
Vacuum Application

Before pouring the resin it is advisable to connect both the top and bottom vacuum lines and apply suction to insure that no leaks are present. The top line and inlet pipe is removed and stopped off so that suction is maintained at the lower end. The resin is then added at the top and strung down until the laminate is fully saturated. The suction at the lower end prevents the trapping of air bubbles during this process. When saturation is complete the upper inlet and vacuum line is inserted and sealed tight. Surplus resin may be expelled by hand pressure from the deep undercuts or grooves and strung up to the top inlet pipe where it can accumulate (Photo 9). The suction should be maintained until the laminate is cured. A heat gun or infra-red lamp may be used to accelerate the gelling. If the gelling process is prolonged the vacuum will tend to draw too much resin from the laminate.

Removing the Cast

The socket should be marked and cut to approximately the final outline before it is removed from the cast. This includes the lateral cut out. A Stryker cast cutter is an excellent tool for this purpose. The socket can then be sprung off without difficulty and without distortion (Photo 10).

9. Stringing the resin after the vacuum has been applied.



10. Removing the socket from the cast.