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WOUND DRESSINGS: SOFT, RIGID, OR SEMIRIGID?

A Review by
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In the sequence of events comprising lower-limb amputation and prosthetic restoration a number of discrete steps are readily identified:

1) the amputation itself, including the surgery, wound closure, and provision for drainage;
2) the application of a dressing of some type over the fresh surgical wound;
3) postsurgical management—which may include one or more of such considerations as exercise and other therapy modalities, provision of a temporary prosthesis, removal of sutures, and mobilization and/or ambulation of the patient;
4) provision of the definitive prosthesis and additional prosthetics training, if necessary.

The details of some of these procedures, as well as their timing, may vary in conventional amputee management, immediate postsurgical procedures, and early postsurgical procedures. This brief review focuses on the second of these considerations—the postoperative dressing applied over the wound.

THE SOFT DRESSING

In traditional amputation management the dressing typically applied to the fresh surgical wound has been "soft," i.e., comprised essentially of gauze pads and a gauze bandage. Again typically, this type of dressing has been maintained, with changes, until the wound has healed. Subsequent management might include exercise and other modalities for the residual limb, and the application of a "shrinker" sock, "Ace" bandage, or other elastic materials to prepare the stump for prosthetics fitting.

Thus the use of a "soft" dressing is ordinarily associated with "delayed" prosthetics fitting and, in the ischemic patient, with above-knee amputation. However, this is not necessarily so. Gay and Heard *(7)* have reported a high level of healing success (80-plus percent) in a series of below-knee amputations in which "soft" dressings were used in conjunction with long posterior flaps.

RIGID DRESSINGS

With the advent of "immediate postoperative fitting procedures," *(1-3,11,17-18,21-23)* considerable emphasis was placed on the application of a rigid plaster-of-Paris cast immediately after amputation. This cast, carefully applied to provide "total contact" or "total tissue support," was considered to have two prime functions:

1) The limitation of fluid accumulation (stump edema) with consequent reduction in pain and accelerated wound healing; and
2) The provision of a foundation on which, either immediately or soon, the patient could stand and bear at least part of his weight, or even ambulate, by means of a simple pylon prosthesis attached to the cast. In this way fitting of the definitive prosthesis could be expedited.

The report of a survey published in the April 1975 issue of *Newsletter . . . Amputee Clinics (6)* indicates that the use of the rigid dressing is still viewed quite positively in regard to the first of these functions, even when the second is not utilized. Details concerning various methods of applying rigid postoperative casts may be found in the references.

According to some users, rigid dressings can present difficulties as well as benefits. A summary of the pros and cons advanced by various practitioners might read as follows:

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ADVANTAGES

- The dimensions of the plaster cast will be the limiting factor in any increase in tissue volume.
- Stump movements, and changes in pressure across the interface associated with standing and walking, will promote beneficial reductions in stump volume.
- These pressure changes may improve blood circulation in the tissues, thus expediting wound healing.
- Psychological benefits accrue to patients through the achievement of early walking.

DISADVANTAGES

- The correct application of the postoperative cast requires specific skills, particularly if felt pads or other modifying materials are incorporated.
- If the cast is not applied correctly or if there are subsequent changes in stump dimensions, localized high-pressure areas may develop.
- Some surgeons find unacceptable the lack of easy access to the stump for inspection. Moreover, once the cast has set, changes in the environment to meet changing tissue conditions can usually only be effected by replacement of the entire cast.
- Some surgeons are inadequately trained or do not wish to take the time to apply the postoperative cast themselves in the operating room, their assistants lack the skill, and prosthetists are unwelcome or unavailable.
- Plaster casts provide limited protection against bacterial infection and little or no control of temperature and relative humidity in the immediate environment of the stump.

SEMIRIGID DRESSINGS

In attempts to obtain the benefits of rigid dressings without the attendant difficulties, a number of wound-encasement substitutes for postoperative procedures have been tried recently. It is these substitutes that we are referring to as "semirigid" dressings. Two lines of approach are discernible, Unna paste and the air splint.

UNNA PASTE

Although we understand that Unna paste has been available and in use for about 50 years, its values have been stressed most recently and most strongly by Ghiulamila and his co-workers *(8,9,13)*. Originally the paste was prepared by combining one part zinc oxide, two parts gelatin, three parts water, and four parts glycerin, and heating the mixture in a double boiler until it became smooth. The warm paste was brushed over succeeding layers of gauze applied to the limb remnant. Now, however, bandages impregnated with a similar paste (Dome Paste Bandage) are available commercially. Once applied, this bandage acts as a liner which is soft but inextensible, thus maintaining the shape of the stump. Over it a temporary prosthesis can be fitted.

A brief abstract of the technique of application as described by Dr. Ghiulamila for below-knee amputations follows. Interested readers are referred to the complete text of the referenced publications.

After the skin is closed in the operating room, the suture line is covered with one layer of nonadherent gauze or Telfa. For below-knee amputations the stump is wrapped with Unna paste and bandage applied directly over the skin from the distal end to the junction of the middle and proximal thirds of the thigh. Typically, two Dome Paste Bandages 2 in. wide by 10 yd. long are used. The wrap must be applied with a complete absence of folds.

After the first bandage has been applied, protective felt pads are placed over the medial and lateral sides of the stump and the patella, as is done in the rigid casting by the Seattle method *(24)*. The felt pads adhere easily and firmly to the first layer of Unna bandage while the second layer is wrapped in the same manner (Figs. 1-A through 1-F).

For above-knee amputations three bandages are needed to wrap the stump and include the pelvis in a spica.

Application of the Prosthesis

Since the semirigid bandage will not permit any swelling or change in stump shape, the prosthesis may be fitted immediately in the recovery room.

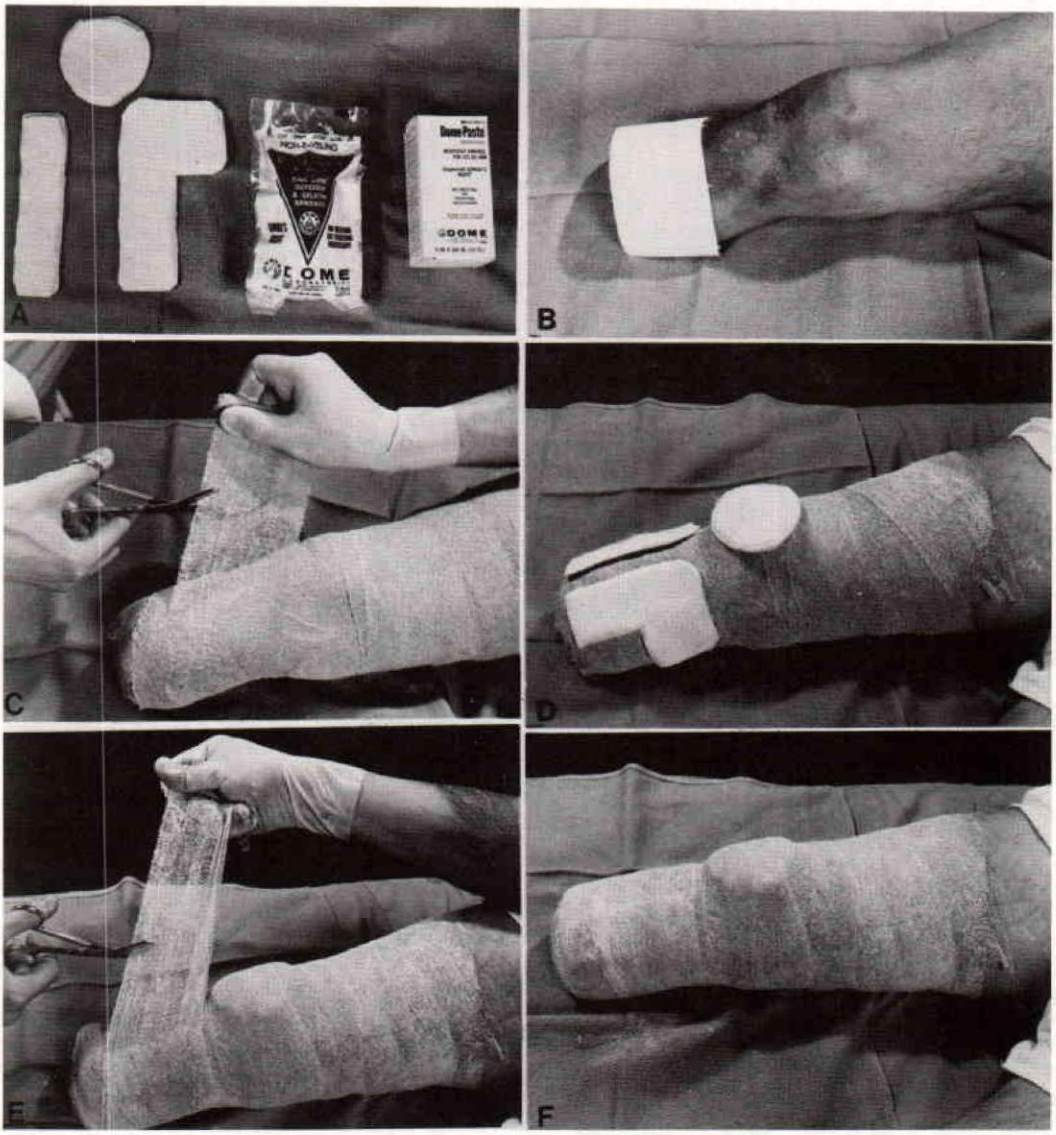

Fig. 1-A. Material: two Unna paste bandages and felt pads.
B. Gauze dressing is placed over the incision.
C. One Unna paste bandage is applied to the skin over the stump and cut to avoid any folds.
D. Felt pads are positioned to protect the skin at pressure points.
E. Second Unna paste bandage is applied to hold the felt pads in place, avoiding any irregularity.
F. Completed semirigid dressing.

However, in these circumstances the moist bandage must be covered with talcum powder and stockinette. Or the prostheses may be fitted on the following day or subsequently. Under these circumstances the bandages are left to dry and the knees maintained in the extended position so as to avoid creating any folds in the bandage. In the cases cited by Dr. Ghiulamila, the prosthetist fitted the amputee 24 to 48 hours after amputation, thus was not involved in the operating schedule. The type of prosthesis fitted was a temporary patellar-tendon-bearing device with a Polysar socket *(21,23)* for below-knee amputations (Fig. 2). A prefabricated quadrilateral socket adapted to a modular unit with a manual-locking knee is used for above-knee amputations (Fig. 3).

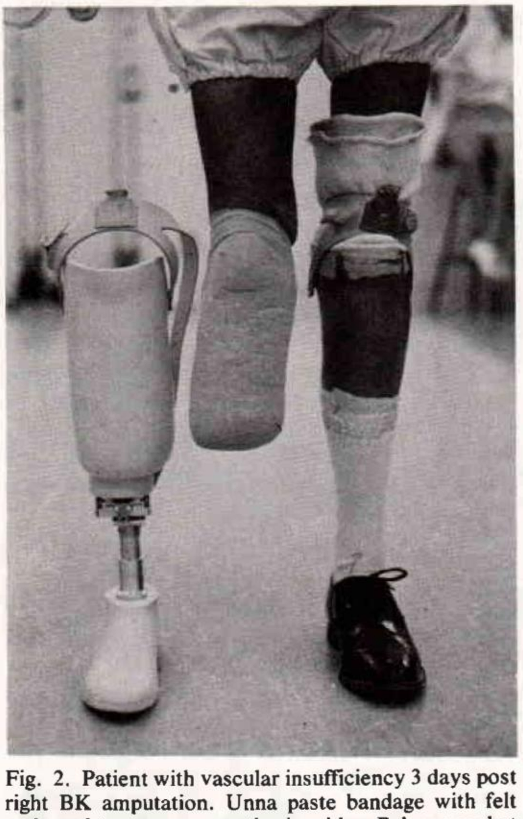

Fig. 2. Patient with vascular insufficiency 3 days post right BK amputation. Unna paste bandage with felt pads and temporary prosthesis with a Polysar socket and SACH foot. The patient had previously a left BK amputation treated with the same technique.

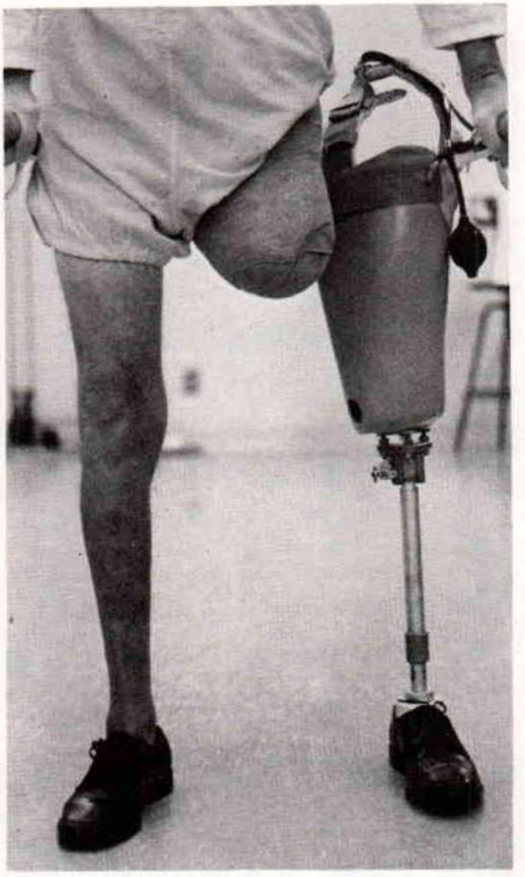

Fig. 3. Patient with left AK amputation 10 days post surgery. Unna paste bandage and temporary prosthesis with prefabricated socket, inflatable bladder, and modular unit (Cosmevo).

With the Unna paste bandage serving as a liner in the temporary prosthesis, according to Dr. Ghiulamila, the patient can begin standing between parallel bars with progressive weight-bearing instituted almost immediately.

For removal of the drain or inspection of the suture line, the tip of the bandage can be cut with scissors. After removal or inspection, the borders of the cut end can be taped in place. For removal of sutures, or if bleeding occurs, it is recommended that the bandage be completely replaced.

AIR SPLINTS

Little

The use of a plastic air splint as a compressive and weight-bearing component in a temporary prosthesis first came to our attention in the writings of J. M. Little *(14,15,16)*. The device described can be used both as an immediate and as a temporary prosthesis. It is said to be easy to use, requiring little training on the part of rehabilitation personnel. Essentially the temporary prosthesis consists of a plastic pneumatic bag and a rigid aluminum frame to which a SACH foot is attached by means of a telescopic fitting (Fig. 4).

Fig. 4. Two parts of a temporary prosthesis, showing plastic air splint and aluminum frame. The length of the prosthesis and the direction of the SACH foot can be adjusted.

A simple modification allows the prosthesis to be used by above- as well as below-knee amputees.

After the amputation has been completed a light dressing of one layer of rolled cotton-wool is held in place by one or two bandages. No drains are used. The specifically designed air splint (A. & L. Company, Sydney, Australia[2]) is placed around the stump and its length adjusted to match the sound limb (Fig. 5). The splint is then inflated to a pressure of 25 mm Hg and left in place for 48 hours. The pressure is checked several times each day. At the end of 48 hours the splint is removed and the stump dressing is reinforced with another layer of cotton-wool and additional bandages. On the following day the splint is reapplied *(sic)*. The patient is then assisted from the bed into a walking frame. For increased comfort the splint pressure may be increased to approximately 30 mm Hg to prevent vascular pooling. Supported by the walking frame the patient learns to make touchdown contact with the ground. Subsequently, limited walking is allowed in the frame (Fig. 6).

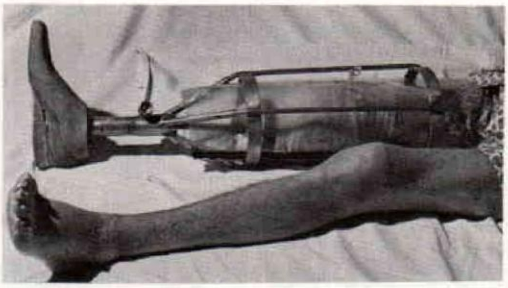

Fig. 5. Prosthesis in place on amputation stump, which has been placed so that its lower end is at the level of the lower ring of the aluminum frame.

Full weight-bearing is possible with the present splint design. Balance training can begin within the first days after amputation; however, since the splint functions essentially as a pylon, proper gait training is not really possible.

Kerstein

Kerstein *(12)* agrees in principle with the values of early ambulation facilitated by a rigid dressing. However, he stresses the difficulties attendant upon the lack of a fully-trained and available team and ready access to the postoperative wound.

As an alternative, Dr. Kerstein proposes the use of a "long-leg" air splint[3] following below-knee amputation. The splints he uses were originally designed for immobilization of the lower limb following fracture (Fig. 7). Low cost, ease of application, and ability to view the wound are cited as appealing factors.

As described by Dr. Kerstein, the application technique appears to combine the air splint with basic rigid-dressing procedures, as follows:

1) Following completion of the amputation procedures a sterile dressing is applied to the site. Fluffed gauze or lamb's wool is

[2]The frame and foot for the temporary prosthesis is also supplied by this company.

[3]Jobst-Jet Air Splint, obtainable from Jobst Institute, Inc., 653 Miami Street, P.O. Box 653, Toledo, Ohio 43694; Park Davis ReadiSplint, obtainable from Park Davis and Company, 205 Flanders Road, Westborough, Massachusetts 01581.

Fig. 6. Weight-bearing on prosthesis.

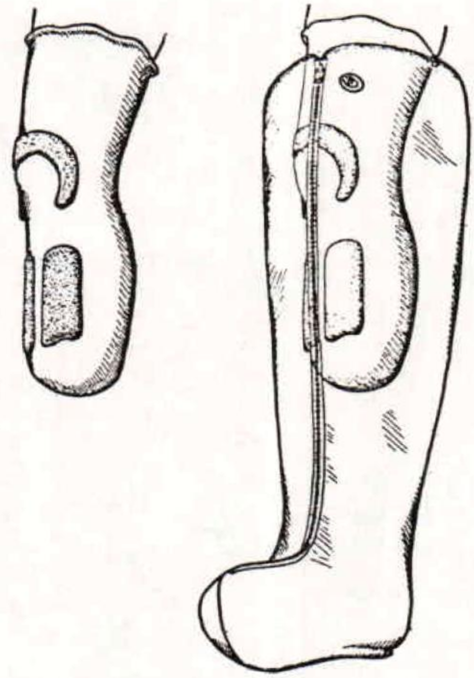

Fig. 7. *Left,* schematic drawing of below-knee amputation with application of an Orlon lycra stump sock and felt pads as reliefs on either side of tibia and above the patella. *Right,* application of pneumatic inflatable splint, inflated, over below-knee stump, with ability to view dressing.

placed over the operative wound, and a sterile Orlon lycra stump sock is rolled over the dressing. As in the Seattle-type technique, the sock is carefully applied so as to avoid damage to suture lines and is held under firm tension with the primary pull applied on the anteroproximal aspect of the thigh.

2) Felt or polyurethane relief pads may be applied to the appropriate areas to relieve pressure. Again as in the Seattle procedure, these pads are applied medially and laterally to the tibial crest, and a horseshoe-shaped pad is applied in the suprapatellar region.
3) The "long-leg" air splint is applied and inflated to a pressure of 25 mm Hg, or until resistance is noted on oral insufflation. The air splint is adjusted to the length of the opposite leg and extends to mid-thigh. It is of clear plastic and incorporates the design of a leg and foot. A zipper on the interior surface facilitates application. The below-knee stump is literally encompassed in a double wall of plastic. The stump sock aids in the absorption of perspiration.

At the time of his report Dr. Kerstein had utilized the air splint on 11 male patients with satisfactory results.

Sher

Sher *(20)* describes the use of an air splint that appears to be very similar to the one discussed by Kerstein. In Sher's technique, however, neither felt pads nor an objectively measured pressure are used (Fig. 8).

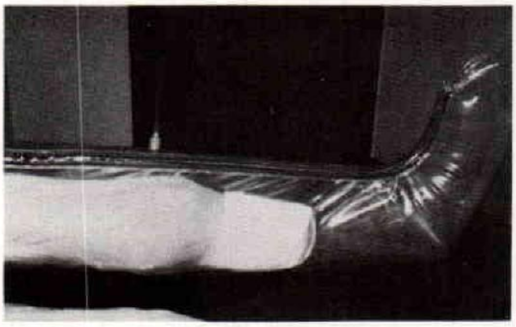

Fig. 8. Air splint applied to amputation stump. Note molding of lining to stump.

A CONTROLLED ENVIRONMENT

A provisional report recently received from R. G. Redhead *(4,19)* describes an ongoing "Post-Operative Wound Management" project at the Biomechanical Research and Development Unit (BRADU), Roehampton, England. The objective of this project was to develop a postoperative wound "dressing" that would require no skill to apply; that would permit the surgeon to have an accurate control of such parameters as pressure on the wound and surrounding tissues, and the temperature and relative humidity of the environment immediately adjacent to the enclosed limb; and that would ensure that the conditions around the wound were bacteriologically sterile at all times.

It was required that the dressing permit visual observation of the wound and indirect palpation through the covering of the dressing without jeopardizing the sterility of the wound environment.

The BRADU system of wound treatment incorporates a control console (Figs. 9-A and 9-B)

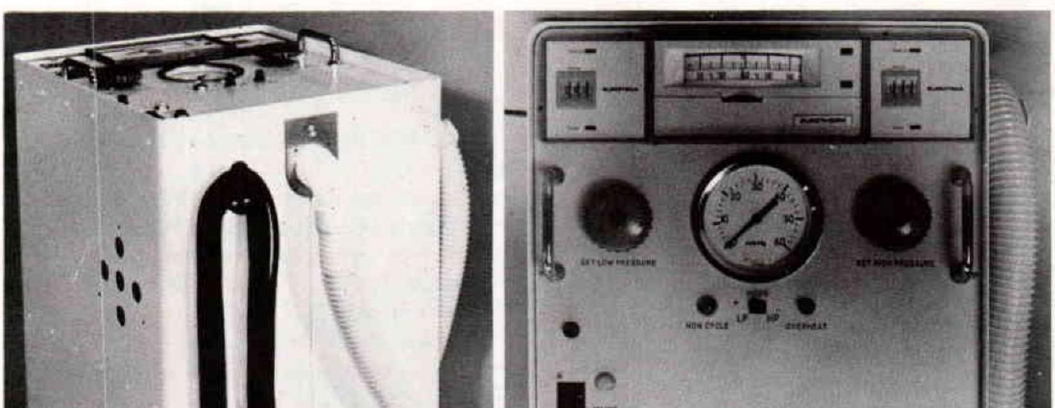

Fig. 9. Three-quarter and top views of the Mark II C.E.T. (controlled-environment technique) console.

containing a multistage centrifugal air compressor, from which the air passes via pressure-control valves and pressure-cycle timing devices to a bacteriological filter. From the filter the now sterile air passes over a thermostatically controlled heating element which raises the air temperature to the required level and also reduces the relative humidity. From there the air passes to the "dressing bag" through a length of flexible hose.

The dressing bags are made of clear flexible PVC in a variety of sizes at present suitable for use on the upper limbs following injury or surgery involving the hand and distal forearm, and for use on the lower limbs following below-knee or through-knee amputations (Fig. 10). The bags incorporate a pleated-type air seal at their proximal end. The seal maintains the raised air pressure within the dressing, without exerting a "tourniquet" effect on the limb, yet allows the escape of some air to provide ventilation for humidity and temperature control of the wound environment.

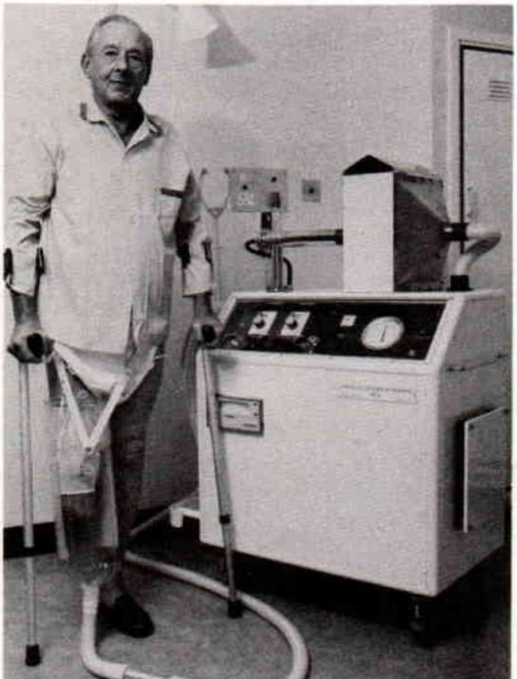

Fig. 10. A patient, 5 days after amputation, standing beside a Mark 1B C.E.T. console.

The dressing bag is kept in place on the patient by means of a lightweight webbing harness.

As soon as possible after the amputation has been completed, the limb is placed in the dressing bag and the controlled environment treatment program started. Of particular interest to this reviewer was a provision in the program for alternating "high" and "low" (air) pressures applied to the stump. These pressures and their durations varied with the time lapse after operation.

No values, actual or potential, are claimed for these pressure variations. Nevertheless, one cannot help being struck by the similarity, in principle at least, to the word reported recently by Hardt *(10)*. The abstract of Hardt's report states: "In New Zealand rabbits, pulses of pressure (70 mm of mercury at two-second intervals) applied by a pneumatic tourniquet placed about the leg and connected to an animal respirator consistently increased femoral nutrient vein blood flow 16 to 150 percent when the pulses were superimposed on an ambient pressure of 5 mm of mercury, while the same pulses superimposed on an ambient pressure of 20 mm of mercury consistently reduced blood flow 25 to 59 percent."

CONCLUSIONS

There appears to be general (but not universal) agreement as to the values of rigid plaster-of-Paris dressing applied to an amputation stump immediately following surgery. Control of edema, a lessening of pain, and faster healing of the wound are claimed whether postsurgical ambulation is "immediate," "early," or "delayed."

To obtain these benefits other materials which are said to require less skill in application than plaster of Paris have been tried with increasing frequency. The techniques involving these alternate materials appear quite promising. According to its proponents, the procedures involving Unna paste have yielded consistently satisfactory results, while those using air splints appear particularly promising from the point of view of simplicity. These devices apparently can be used with or without extensive wound dressings, with or without modifying materials such as felt pads; and the air pressure exerted on the limb remnant can be controlled. An additional facet of great interest is the possibility that controlled fluctuations in the circumambient pressure may increase blood circulation and expedite healing. In fact, it begins to appear that air splints might be used in two distinct but possibly connected applications:

1) Solely in the promotion of healing. Here the condition might be that the patient is at rest, i.e., in bed or in a chair. Pulses of higher pressure (70 mm Hg at two-second intervals) might then be superimposed on a basically low ambient pressure (5 mm Hg) *a la* Hardt and Redhead. Edema would presumably be controlled and blood circulation enhanced.
2) As a means of getting the patient upright in order to practice balancing, partial weight-bearing, etc. Here the pressure in the splint would apparently need to be in the range of 25-30 mm Hg. Edema would be controlled in this application also, but presumably the stimulus to circulation would be less.

The possibility of changing from one set of pressure conditions to the other as circumstance might indicate is intriguing.

In concluding this review it is appropriate to underscore a point made by Victor Cummings *(5)*. He remarks that a widespread but false assumption is that the rigid dressing is applied primarily as a prelude to early weight-bearing, early ambulation, early prosthetics rehabilitation, and hence early discharge from hospital. These factors, while of value if they can be achieved, should be considered "fringe benefits" rather than prime purposes. According to Dr. Cummings, the prime aim in applying a rigid dressing immediately after surgery is *to enhance healing of the amputation stump.*

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