

Removable Rigid Dressing for Below-knee Amputees

by Yeongchi Wu, M.D.
Harold Krick, C.P.

BACKGROUND

According to the National Center For Health Statistics, there were 274,000 patients with amputations of major limbs in 1971 in the United States. This number rose to 358,000 in 1977. Kay in 1975 reported 53.8 percent of the 6,000 reviewed new patients had had amputations at the below-knee level.³ If the percentage and the number of amputees remained unchanged, there would be at least 200,000 below-knee amputees in this country at any given time. It is possible that this number could have been doubled in the past ten years. The most recent information regarding amputation available to the authors was the Vital and Health Statistics published by the U.S. Department of Health and Human Services in April, 1986. A review of 192,000 medical records from the 407 hospitals that participated in the 1984 National Hospital Discharge Survey showed an estimated 32,000 below-knee amputations alone. Therefore, improvement in the management of below-knee amputees will certainly benefit a significant number of patients.

At the V.A. Lakeside Medical Center (VALMC) and Rehabilitation Institute of Chicago (R.I.C.), members of Northwestern University-McGraw Medical Center, Chicago, three techniques have been developed for treatment of below-knee amputees. These include the Removal Rigid Dressing (R.R.D.), ScotchcastTM preparatory prosthesis, and the "one-step socket lamination definitive prosthesis." These approaches have been invaluable in the management of below-knee amputees.

This paper describes the Removal Rigid Dressing for postoperative management of the below-knee amputee. Clinical experiences

since 1977 have shown the benefits of the R.R.D. to be the following:

1. Rapid residual limb shrinkage
2. Prevention of edema
3. Possibility of frequent residual limb observations
4. Soft tissue immobilization to facilitate wound healing
5. Elimination of skin breakdown commonly seen in elastic bandaging
6. Simplicity of donning and doffing
7. Development of tolerance to weight bearing
8. Prevention of residual limb trauma
9. Reduction of wound pain

With nine years clinical experience at this university medical center and dissemination through the Northwestern University Prosthetic School, it appears to us that this technique has its merits in the postoperative and pre-prosthetic management of the below-knee amputee.

In a study done in 1977, the average hospital stay for amputees at VALMC was reduced by 90 days after the development of the R.R.D.⁶ This was achieved primarily by complete elimination of skin breakdown seen previously from elastic bandaging and by speeding stump shrinkage with the R.R.D.⁷

In the 1970s, at the VALMC in Chicago, there were many problems in postoperative below-knee residual limb care. For many years, the below-knee amputees were managed with a soft dressing or thigh high cast, i.e. Immediate Post-Surgical Fitting (IPSF) without pylon, followed by elastic bandaging, as many hospitals did at that time. The technique was done by the therapists, nurses, and patients, following the procedure learned directly or indirectly from

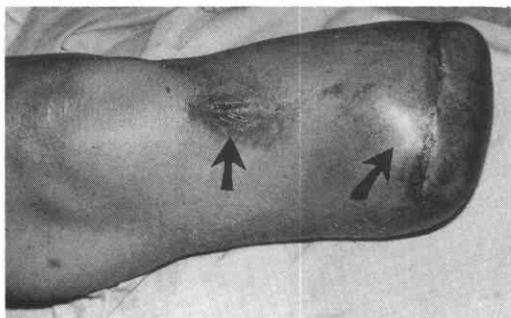


Figure 1. A typical pressure sore over the tibial tubercle and distal edema from conventional elastic bandaging.

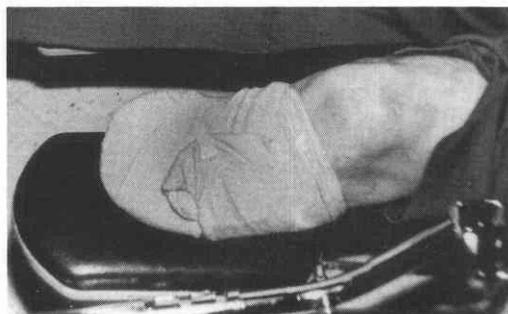


Figure 2. A conventional elastic bandage is an unreliable technique in a patient's hand.

the Northwestern University Prosthetic/Orthotic School. There was no special team or particular therapists assigned to amputee care. Inevitably, many techniques differing from the original were used by different individuals. For a long time, the staff was puzzled by the very high frequency of skin breakdown and distal edema (Figure 1). At times, it was a surprise at the V.A. Prosthetic Clinic when a patient presented who was free of any residual limb complications.

It was apparent that inconsistent limb care techniques by the staff and the patient himself was a contributing factor (Figure 2). Many thoughts came to mind and many attempts were made to remedy this problem, such as using a protective covering made of thermoplastic or a donut shaped sponge over the tibial tubercle to prevent skin breakdown. Nothing was promising until one afternoon in early 1977 when the idea of the R.R.D. came to light.

This happened after seeing a 90 year old man develop a tibial pressure sore on his well healed limb only three hours following the change from a thigh high plaster cast to an elastic bandage. We decided that the elastic bandage was guilty and should never be used for below-knee amputees again, and the thigh high cast could be modified to continue the excellent results. We analyzed the principles behind the thigh high plaster cast and incorporated them into the R.R.D. system.

The design was completed on the same day and the same principles have been kept until this date without any further modifications. This system is a below-knee plaster cast suspended by a stockinette to a supracondylar sus-

pension cuff (Figure 7). Underneath the below-knee plaster cast, sport tube socks are added to provide-continuous controlled compression.

WHY DOES R.R.D. WORK?

No matter how successful this method has been, we certainly were inspired by the important pioneer work by Dr. Weiss in Poland, and later by Dr. Burgess^{1,2} in this country. A few of the principles that made the R.R.D. an effective procedure were originally utilized in the IPSF system:

1. Use of a non-expandable dressing prevents the development of edema following amputation.
2. Use of supracondylar suspension keeps the cast in place.
3. Rigid dressing is effective in immobilization of soft tissue, which is essential for wound healing and pain control as well as trauma prevention.
4. Controlled compression of the residual limb avoids skin breakdown and facilitates shrinkage.

FABRICATING THE R.R.D.

The R.R.D. consists of four components: a) tube socks, b) below knee plaster cast, c) suspension stockinette, and d) supracondylar cuff (Figure 3).

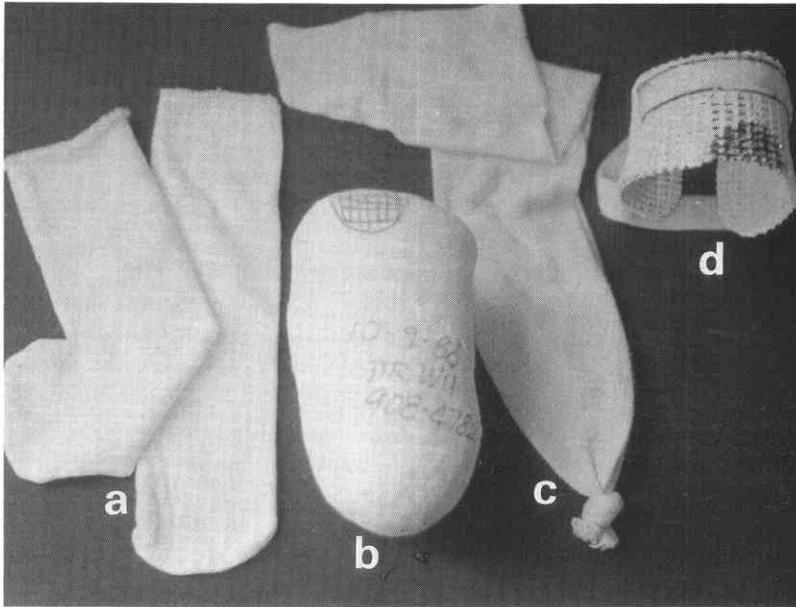


Figure 3. Components of the Removable Rigid Dressing: a) athletic tube socks with the elastic band removed, b) below-the-knee cast, c) suspension stockinette, and d) thermoplastic supracondylar suspension cuff.

Tube Socks

The idea of using tube socks arose because of the difficulty in obtaining wool socks from the V.A. supply center in early 1977 and the necessity of hand care of wool socks. By replacing the elastic bandaging with R.R.D., we noted that below-knee residual limbs changed from their previous conical shapes to cylindrical contours. The measurements of properly fitted wool socks for our patients differed from those supplied by the V.A. supply center. For a while there was a shortage of socks for our patients. This led to the need for alternatives. One day, we tried a large size tube sock on sale at the V.A. canteen store.

To this date, we still use tube socks routinely at the V.A. hospital and R.I.C. They can be changed daily by the patient and are machine washable. They also provide excellent sock marks on the skin for determining the degree of pressure over the residual limb. They are cheaper and available at most department stores (Figure 3A). We simply cut off the elastic tops and use them as nice fitting #2 size, 2 ply socks.

Tube socks are cut in long and short lengths. Short tube socks are effective for localized compression with a bulbous limb so that progressively diminishing shrinkage can be achieved from the distal to proximal area.

For the large residual limb, when the tube socks may not be long or wide enough, Soft-socks (Knit-Rite, Inc.) can be used.

Plaster Cast

The cast for a R.R.D. (Figure 3B) is shorter than that of the IPSF. It extends only up to the knee level for easy removal. The casting procedure also differs slightly for pressure relief. In the IPSF, felt paddings are used to bridge the bony areas. In the R.R.D., cotton paddings, six layers at the center and tapered to the margins, are used as "spacers" over the bony prominences of the tibial tubercle, tibial crest, fibular head and any pressure sensitive areas. Once the cast is made, the spacers are discarded. An empty space between the cast and the skin is formed to provide a controlled pressure relief (Figure 4).

The trim line of the plaster cast is up to mid-patellar level anteriorly and lower posteriorly to allow knee flexion. It is wider proximally in order to ensure easy removal and reapplication of the cast. This is especially true with a bulbous limb where the concave side needs additional padding to avoid a cast that is too tight at the top (Figure 5). In case of a narrow proximal opening, a longitudinal cut on the back of the cast can be used to widen the proximal part and allow reapplication (Figure 6).

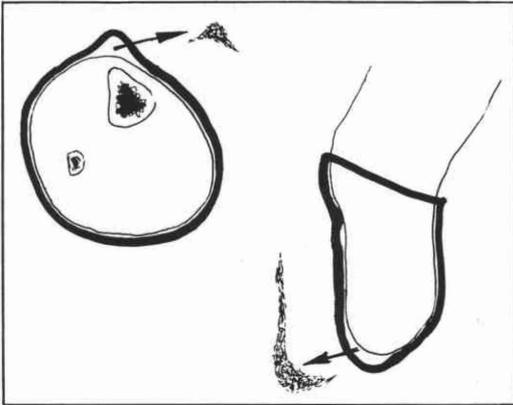


Figure 4. Cotton paddings are used as spacer for pressure relief.

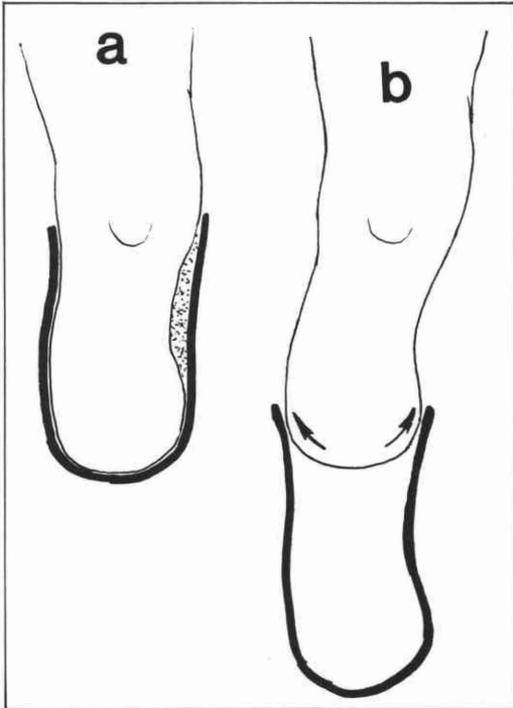


Figure 5. Adequate medial padding is needed to assure a wider proximal opening for easier cast re-application (a). A narrow opening makes cast reapplication impossible (b).

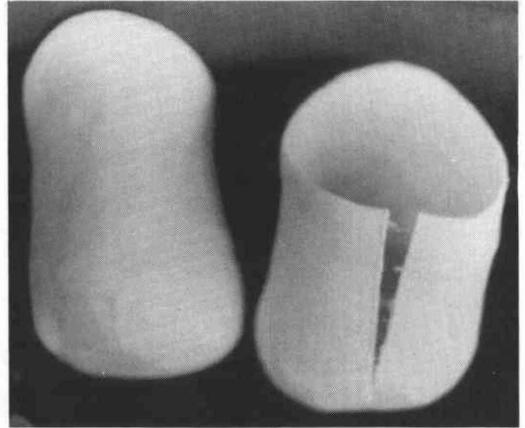


Figure 6. If cast opening is too narrow, a longitudinal cut on the back of cast allows widening of the cast proximally while still maintaining distal compression.

Suspension Stockinette

The suspension stockinette, made of 4-inch casting stockinette with one end tied, secures the cast to the suspension cuff (Figure 3C).

Supracondylar Suspension Cuff

The suspension cuff is made of thermoplastic material. It has a Velcro® closure to keep the cuff in place and a strip of Velcro® hook along the upper edge to secure the suspension stockinette (Figure 3D). For the obese patient who has very limited purchase over the femoral condyles because of tissue bulk, a fork strap with a waist belt can be used.

APPLICATION OF THE REMOVABLE RIGID DRESSING

After the surgical wound is properly dressed, the proper number of tube socks are applied layer by layer to avoid possible wrinkles. Then the plaster cast is applied and followed by the suspension stockinette and the supracondylar cuff (Figure 7). To make the application easier, a semi-circular mark is made on the cast and another on the supracondylar cuff so that the patient can match both marks to form a circle over the patella.

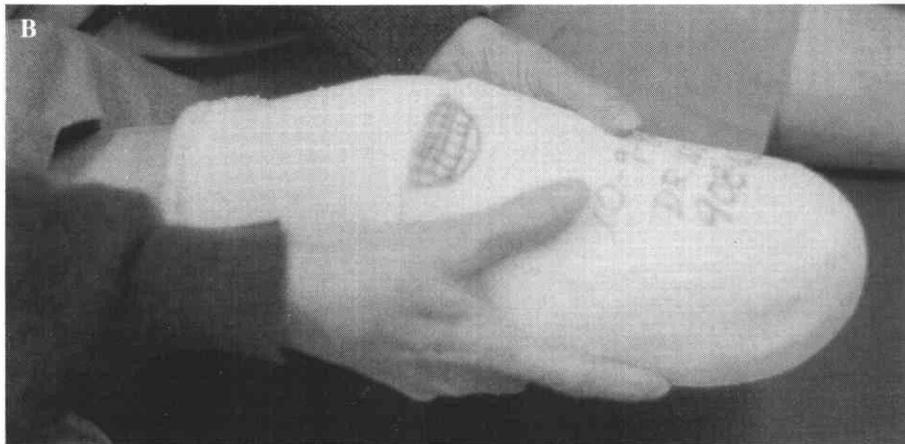


Figure 7d, e, and f (right). Application of the Removable Rigid Dressing: d) the supracondylar cuff, e) pull the stockinette, and f) fold the suspension stockinette to make sure the cast is secured over the supracondylar cuff.

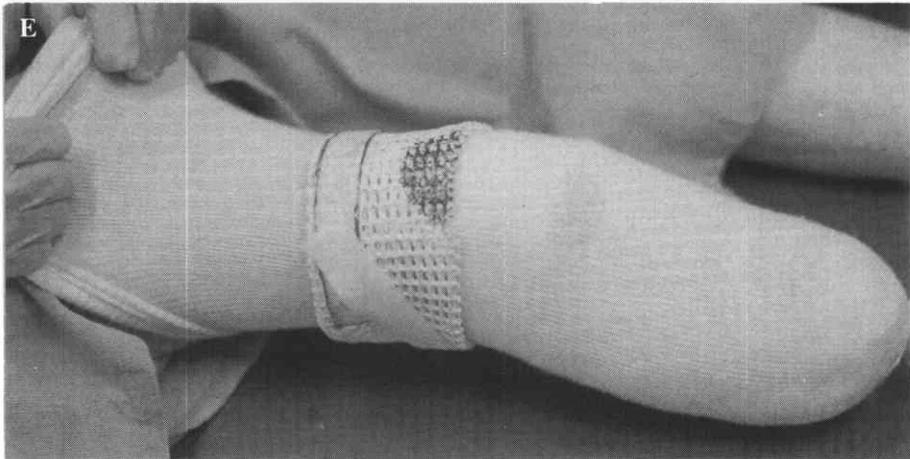
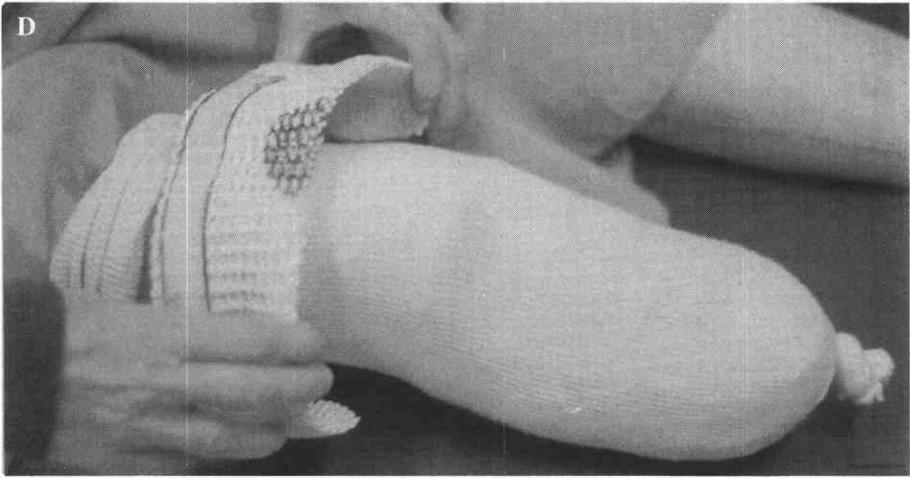




Figure 8. A strap is attached to the arm rests for the patient to exert partial weight bearing exercise while in the wheelchair (left). A car jack mounted onto plywood becomes an inexpensive adjustable stool for weight bearing and balance exercise (right).

The patient is then instructed in how to apply the R.R.D. A strap with Velcro® closure on one end is attached to the armrest of the wheelchair for static weight bearing exercise (Figure 8). The R.R.D. is worn continuously except for periodic observation to the residual limb and hygiene procedures, or when the prosthesis is being worn.

WHEN TO APPLY THE R.R.D.

The R.R.D. can be applied at the completion of surgery or when the first thigh-high rigid dressing is removed for wound inspection. It can be used whenever there is a need for limb shrinkage in any new or old amputee.

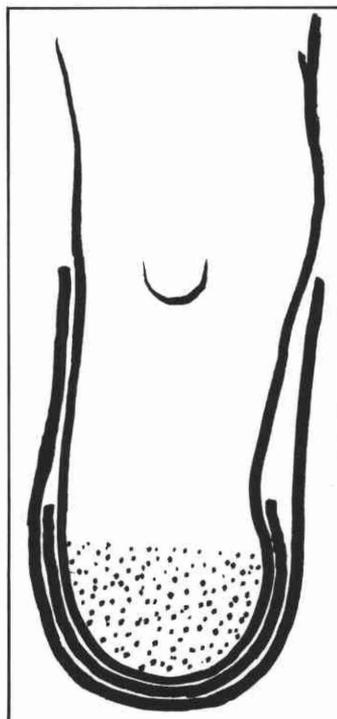


Figure 9. Short tube socks provide localized compression in bulbous stump.

ADDING SOCKS

When possible, additional socks are applied to maintain a comfortable snug fit and to facilitate progressive shrinkage. Sometimes short socks distally are preferred to provide localized distal compression without building up the thickness proximally (Figure 9).

WEIGHT BEARING EXERCISE

It is not possible to say how many days after amputation one can start weight bearing. In general, initiation of weight bearing exercise is determined by the state of wound healing, usually seven to 14 days after surgery. Immediate postoperative weight bearing is likely to cause mechanical shearing from movement and delay wound healing during the first two weeks after amputation, as reported by Mooney.⁴ However, steady pressure without mechanical shearing on the residual limb using a wheelchair strap can be very beneficial (Figure 8). We have found this can be used even within the first week after surgery. While in the wheelchair, the patient is encouraged to push frequently with the R.R.D. against resistance of the strap.

Because it is removable, one can decide the time to start body weight bearing exercise based on the wound condition. The R.R.D. allows observation of the limb after each graded weight bearing exercise. By doing so, one can plan both the amount and duration of the next weight exercise.

For unilateral amputees, the weight bearing exercise can be done by standing on a padded car jack (Figure 8).

For bilateral amputees, the tilt-table is used for weight bearing. The degree of weight stress is controlled by the inclination of the tilt table and the duration of standing. This proceeds progressively to the upright position and is followed by ambulation with walking heels attached to the casts (Figure 10). Walking with

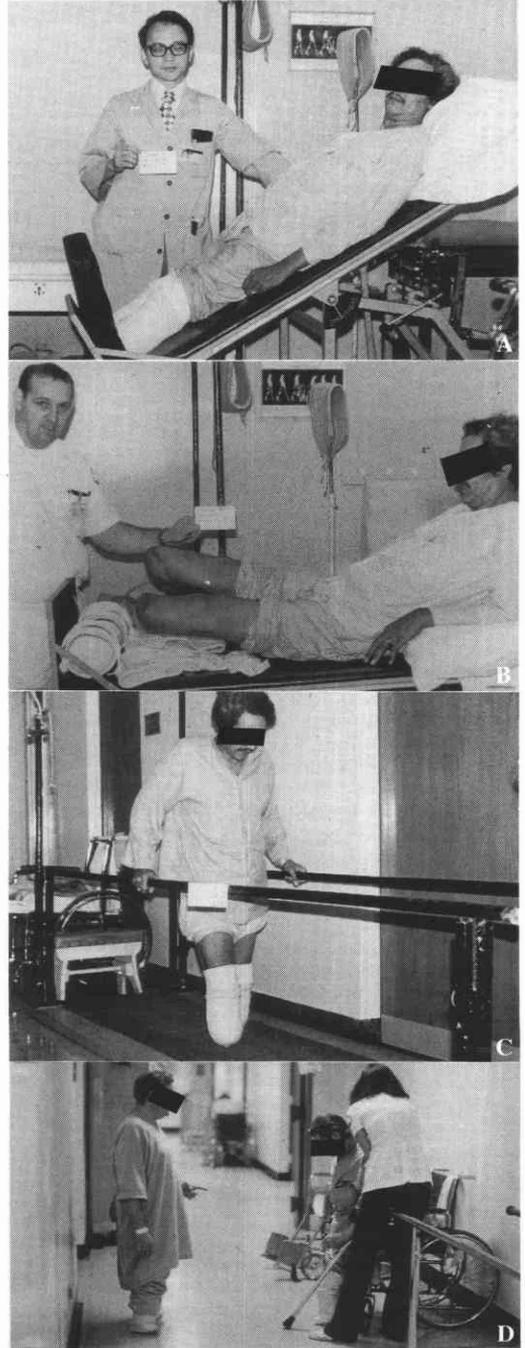


Figure 10. A) For bilateral amputees, weight bearing exercise is done on the tilt table. B) The stump is examined to modify the amount of weight bearing, i.e. the degree of inclination and duration of weight bearing. C) Weight bearing continues to the upright position in the parallel bars, and D) eventually to ambulation with walking heels attached to the casts or with a preparatory prosthetic fitting.

Rigid Dressings helps bilateral amputees develop balance and sometimes is preferred by the obese and cardiac patients at home (Figure 10). Walking with the R.R.D. also assists the evaluation of questionable candidates for prosthetic fitting. Ambulatory use of the R.R.D. produces simulation of prosthetic stress, allowing the amputee to quickly adapt to the actual prosthesis, an impossible step when using the conventional elastic bandaging method.

MAKING A NEW CAST

The below-knee cast is changed whenever the residual limb has shrunk to the point at which too many tube socks are being used, usually about 10–14 ply of socks. The total number of casts needed depends on the speed of progressive shrinkage. Frequently three or four casts are required before the patient is ready to be fitted for a preparatory prosthesis.

R.R.D. COMPARED TO IPSF

Both the R.R.D. and the thigh high rigid dressing provide immobilization of soft tissue, prevention of trauma, and prevention of edema. However, being removable, the R.R.D. allows frequent limb observation without a need for cast-cutting and cast-reapplication as needed in a thigh high rigid dressing. More importantly, it permits frequent addition of tube socks for fast shrinkage.

Because space is provided between bony prominences and the plaster, adding tube socks will produce compression force to soft tissues, but will not cause pressure sores (Figure 4). If there is excessive pressure over an area, the cast can be softened from outside with a hammer, then pushed from inside for relief.

Being removable, the R.R.D. has been very useful in monitoring the limb's response to weight bearing exercise. This facilitates progressive weight bearing within the safe tolerance range. Both undesirable skin breakdown from excessive weight bearing activity and hesitation in application of early graded weight bearing stress are minimized.

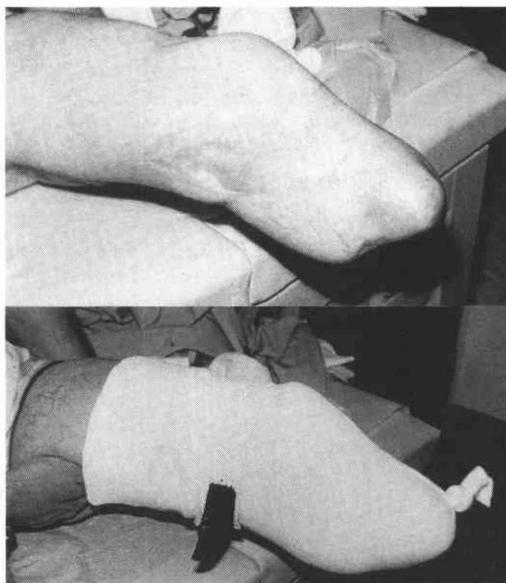


Figure 11. A stump with bony prominence and scars cannot tolerate the elastic bandage, but has no difficulty with Removable Rigid Dressing.



Figure 12. A one handed patient, either due to hemiplegia or upper limb amputation, can use the system easily.

R.R.D. COMPARED TO THE SHRINKER

The residual limb shrinker is an effective method for shrinkage, except for the danger of excessive pressure over bony areas or thin grafted skin. It does not protect the limb from unexpected falling, nor does it allow weight



Figure 13. One of the first patients achieved 15-ply shrinkage in 7 days and spontaneous healing of the right pretibial sore caused by an elastic bandage.

bearing exercise. The compression force can be adjusted by sewing the shrinker periodically rather than by adding socks as with the R.R.D.

R.R.D. COMPARED TO THE ELASTIC BANDAGE

The elastic bandage is not only difficult to apply for the staff and the elderly below-knee amputees,⁵ but also is so unreliable that it frequently causes skin breakdown and distal edema (Figures 1 and 2). It cannot protect the limb from trauma due to accidental falling. With the R.R.D., it is much easier for the patient to don and doff as well as adjust the compression, accommodate progressive shrinkage,⁵ and perform weight bearing exercise.

Since the adoption of the R.R.D. at this medical center, the problems of skin breakdown and distal edema, commonly seen in the past from elastic bandaging, have been completely eliminated (Figure 13).

R.R.D. FOR DELAYED WOUND HEALING

Delayed wound healing is not a contraindication for using the R.R.D. or a preparatory

prosthesis. The R.R.D. is a useful means to facilitate wound healing, because the system reduces edema and tissue tension. The size of the open wound can be reduced and the edges of the wound can be brought closer together. With frequent debridement of the necrotic tissue and adding socks for shrinkage, often a big open wound can be healed without surgery (Figure 14).

SCOTCHCAST™ PREPARATORY PROSTHESIS

When the patient is able to tolerate full weight bearing in the R.R.D. and the residual limb is no longer bulbous, a Scotchcast™ preparatory prosthesis can be fit for early gait training and further shrinkage.⁸ The advantages of the Scotchcast™ preparatory prosthesis are its moderately light weight, comfortable fitting, rare need for realignment, and reduction of fabricating time. This is achieved by, 1) direct formation of the socket on the residual limb with special pressure relief techniques, 2) use of a wool sock lining as the soft interface, and 3) precise semi-dynamic alignment of the prosthesis. Since the Scotchcast™ prosthesis can be



Figure 14. Removable Rigid Dressing facilitated shrinkage of the limb (upper left) and the open wound. By frequent debridement and prosthetic fitting (upper right), the wound completely healed without skin graft (lower left).

fabricated within 1½ hours during the patient's initial visit, the delivery of this prosthetic service is very efficient and cost effective.

CONCLUSION

The Removable Rigid Dressing has proved to be a very reliable means of preprosthetic

management of the below knee amputee at this institution and others for the past nine years. It has proven to shorten the time from amputation to the initial preparatory prosthesis; is shown to be equal to or superior to all other means of preprosthetic stump management; features easy application; simple donning and doffing by the patient; progressive stump shrinkage by adding socks under the cast; gives protection through its rigidity for the not yet healed stump; ease in wound inspection; and allows early weight or pressure bearing to be started, thus conditioning the soft tissues for the first prosthesis. The R.R.D. has no contraindications other than application to a residual limb with a deep wound infection that requires surgical intervention.

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AUTHORS

Yeongchi Wu, M.D. and Harold Krick, C.P. are with the Rehabilitation Institute of Chicago, 345 E. Superior Avenue, Chicago, Illinois 60611.

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