The String Casting Technique for Below Elbow Amputations

Timothy B. Staats, M.A., C.P.

INTRODUCTION

The String Casting Technique+ is a method of casting the below elbow amputee for a socket that provides good range of motion, self suspension and very high trim lines.

The principles of self suspension of below elbow sockets became largely acceptable with the introduction of the Muenster Casting Technique.[1] The Muenster Technique involves a hand holding technique for casting that results in good suspension but normally has a limited range of motion (Fig. 1 and 2). As the residual limb is flexed, the anterior trim line, by design, impinges on the cubital fold area thereby preventing full flexion.

Billock[2] described a self suspension casting technique which provides an excellent range of motion, supra-epicondylar suspension, and has an identifiable trim line which sweeps distally on the anterior surface of the socket (Fig. 3). Billock maintains that research has shown high trim lines are not necessary because the major weight distribution in the below elbow amputee occurs in the distal 1½" of the residual limb. The Billock technique does not attempt to encapsulate the residual limb during casting and a classic bulging normally appears about the cubital fold.

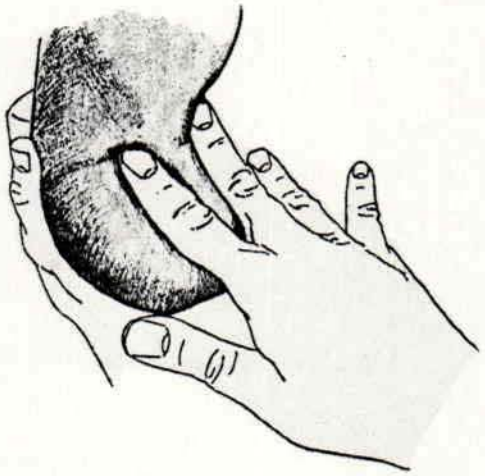

Fig. 1 – The Muenster casting technique utilized proper hand positioning to determine the anterior trim line. From the New York University manual.

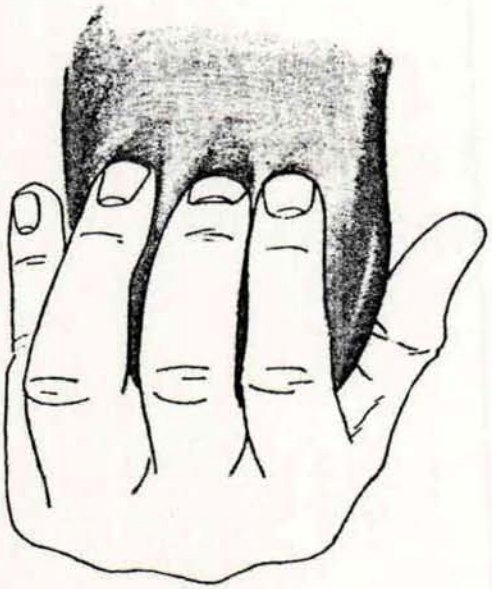

Fig. 2—The Muenster technique determined the posterior trim line and olecranon relief by proper hand cupping and finger pressure proximal to the olecranon.

The German casting technique[3] involves the use of two types of plaster and cut patterns to create classical shapes and excellent results exhibiting good range of motion, high trim lines, self suspension and good stability. In the German technique the hands are held in a manner that greatly reduces flexion impingement, however both hands must remain on the cast and extra steps of plaster casting are involved.

In 1980 the String Casting Technique was developed at the U.C.L.A. Prosthetics-Orthotics Laboratory as a simplification of the German casting technique. It clearly achieves the same result as the German technique but is faster, easier to control and not quite so messy. The following is a description of the casting and mold modification technique.

The principle of the String Casting Technique is to wrap the plaster bandage on the below elbow amputation with the elbow held in full flexion. As the plaster sets a string or cord is held in the cubital fold to create a thin anterior trim line that will natu-

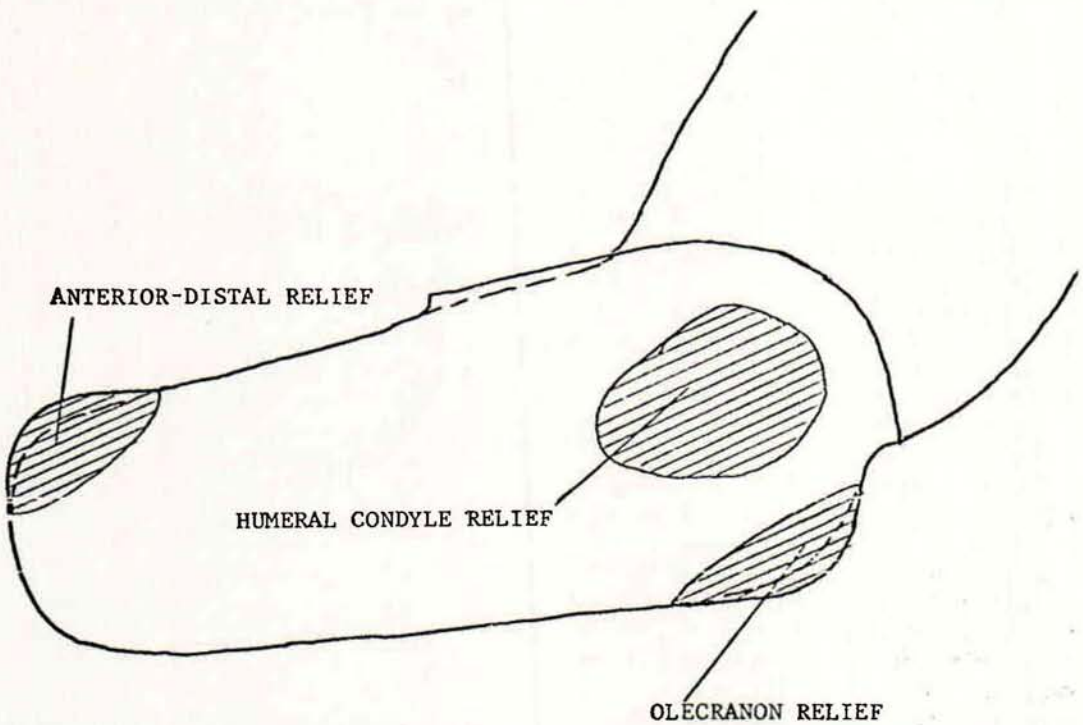

Fig. 3—Northwestern self suspending socket (Billock) features a low anterior trim line to allow use by mid-forearm and longer amputations.

rally conform to the cubital shape as flexion occurs without impeding elbow flexion range of motion.

The String Casting Technique simplifies the German technique but incorporates its cast modification principles. Advantages of high trim line in the below elbow amputee is for distribution of forces over the greatest surface area of the residual limb, particularly during flexion activities with a very short amputation and during lifting procedures where the mid-forearm is used, and with myoelectric prostheses where electrode placement is critical.

NEGATIVE IMPRESSION PROCEDURE

The String Casting Technique steps are as follows:

1. Apply two layers of tube gauze over the below elbow residual limb. Secure with tape or elastic webbing.
2. Apply elastic plaster bandage with turns of plaster around the length of the amputation. Usually two layers are sufficient (Fig. 4).
3. Continue with circular coverings with the residual limb in increasing flexion.

Fig. 4—Two layers of tube gauze are applied to the residual limb and elastic plaster is used to begin the impression. The plaster should extend to the cubital fold.

4. Care is taken *not* to allow multiple layers of plaster to accumulate in the area of the cubital fold. Excess plaster in this area will limit motion of the elbow flexion.
5. Complete the plaster wrap with careful coverage of the residual limb.
6. Place a string or cord (⅛″) across the cubital fold area (Fig. 5), catching the leading edge of the plaster bandage in the cubital fold. Plaster should not extend beyond the crease of skin in the cubital fold but should extend above the humeral epicondyles by about ½″ to ¾″.

Fig. 5—A string, or cord, of 1/8″ thickness is placed on the plaster at the leading edge of the cubital fold.

7. The string is pulled into the crease of the cubital fold (Fig. 6) from a point 6″ behind the elbow. The string must be pulled posteriorly and above the medial and lateral epicondyles of the humerus. The angle of the string must not cross these bony prominences otherwise impingement and unacceptable results will occur. If the string is held tightly around the circumference of the humerus rather than 4″–6″ away, a constriction will occur on the cast and removal or reapplication will be difficult. In a modification of the String Casting Technique developed at the

Child Amputee Prosthetic Project at U.C.L.A., Baron & Moseley use a technique that does constrict as a special requirement of the child amputee where no condyles are present.

Fig. 6 – The string is held together six inches behind the arm and pulled so that it does not impinge on the epicondyles.

Fig. 7 – As the plaster sets, the elbow is fully flexed and the tube gauze is pulled down to form a horseshoe-shaped trim line 1" proximal to the olecranon.

8. Fully flex the elbow as the plaster sets.
9. As the plaster sets, gently pull downward on the inner layer of tube gauze in the area of the olecranon fossa to create a horseshoe shape trim line in that area (Fig. 7). Normally the posterior trim is about 1" proximal to the olecranon process or tip of the elbow. Care must be taken not to disturb the plaster wrap height above the humeral epicondyles.
10. Reinforce the cast if necessary before removal. Careful removal technique is important so as not to distort or disturb the shapes that have been created.
11. Before removal, some ranging is possible to check range of motion. While no criteria is set as to acceptable limits of range of motion, it is suggested that variations of the casting technique be attempted to determine suitability for each individual's needs. Generally almost full range of motion can be achieved.

POSITIVE MODEL MODIFICATION

The steps of model modification of the String Casting Technique wrap cast are essentially the same as for the German casting technique.

1. The negative impression is filled with plaster in the normal manner using tape or plaster to build-up an excess of plaster above the margins of the cast itself.
2. The Anterior Trim Line. The modification of the positive model will require that the anterior trim be reduced to about ⅛" radius as the residual limb flexes in order to create the proper effect about the elbow. The small radius will naturally fold into the crease of the cubital fold (Fig. 8).

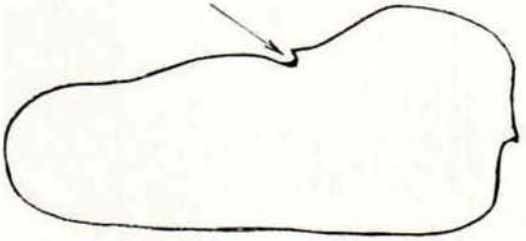

Fig. 8 – The anterior trim line is modified on the positive model to leave a 1/8" radius, which will naturally fit into the cubital fold.

Fig. 9—A snug fit is insured by removing 1/8" to 3/16" plaster from the positive model on the radial and ulnar aspects of the proximal trim line.

3. Small amounts of plaster are removed from the radial and ulnar sides of the proximal margin of the trim line. Normally ⅛" to 3/16" removal in this area is adequate to insure a snug fit (Fig. 9).
4. A build-up is applied to the anterior surface of the cast just distal to the anterior trim line. This will create a cavity for tissues to bulge into when the elbow is flexed. The build-up should be no more than ¼" and shaped as shown in Fig. 10.
5. Normally the posterior trim line is established during the cast taking. However, the trim line may be adjusted at the time of modification to create perfect radius shapes and to raise or lower the trim (Fig. 11).
6. For myoelectric applications, the electrode sites should be slightly flattened according to specifications established by the manufacturers of the components. A check socket is extremely useful in checking the range of motion of the modified model.

DONNING THE SOCKET

The socket is trimmed to fit and pulled on with a pullsock or is slipped into, using a small amount of skin lubricant. Excess anterior tissue is gently maneuvered into the cubital belly cavity of the socket. The elbow should be able to fully flex without impingement on the olecranon, the epicondyles, or the cubital fold (Fig. 12). In laminated sockets the epicondylar flares may be laminated using flexible resin to assist the patient in applying the socket and to provide a pliable and comfortable fit.

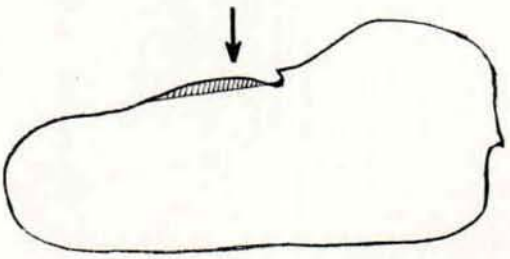

Fig. 10—A buildup of no more than 1/4" is added to the anterior surface to allow for the tissue to bulge when the elbow flexes.

Fig. 11—The posterior trim line is established during the casting procedure, but can be corrected or improved at this time.

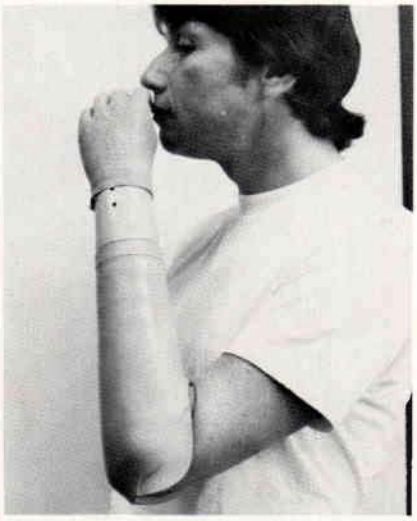

Fig. 12 – Full elbow flexion is possible in the prosthesis without impingement in the cubital fold.

Fig. 13 – Patient with dislocated total elbow prosthesis. An orthosis to stabilize the elbow was prescribed.

CONCLUSION

The advantages of the String Casting Technique are: 1) the ease in which a cast can be taken; 2) full range of motion and self suspension are provided by shapes and contours created in the cast and modification procedures, and 3) a high trim line distributes forces over the entire residual limb providing excellent lifting, suspension and surface

Fig. 14 – The string casting technique used for the impression for an elbow orthosis.

contact characteristics. The String Casting Technique has been used for below elbow arthroplasty orthoses. In figure 13 a patient at the U.C.L.A. Prosthetics-Orthotics laboratory exhibits gross elbow instability due to a dislocated total elbow replacement. Utilizing the String Casting Technique an orthosis (Fig. 14) was fabricated to hold the elbow in position and allow full range of motion. Further information is being gathered on orthotic designs and applications of the String Casting Technique.

Acknowledgments

Special thanks is extended to Mr. Larry Mott, Director of Education at the Otto Bock Company of Minneapolis, Minnesota, Mr. David Varnau, C.P.O. of the U.C.L.A. Prosthetic-Orthotic Laboratory and Barbara Brown for their assistance in the preparation of this paper.

References

1. Kay, Hector et al, *A Fabrication Manual For The "Muenster Type" Below-Elbow Prosthesis*, New York University, April 1965
2. Billock, J.N., "Northwestern University Supracondylar Suspension Technique For Below-Elbow Amputations" *Orthotics and Prosthetics* December 1972 pp. 16–23
3. German Casting Technique as taught at Otto Bock Myoelectric Seminar in Minneapolis, Minnesota

Timothy B. Staats, M.A., C.P., Technical Director United States Manufacturing Company. The Technique was taught at the United State Manufacturing Company Myoelectric Seminars and is a modification of the German casting technique as taught by Otto Bock Orthopedic Industry, Inc. in Minneapolis, Minnesota.