Abduction for Shoulder Disarticulation Prosthesis

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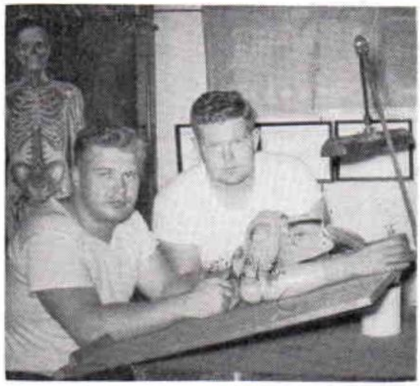
Shortly after returning from the Upper Extremities School at University of California at Los Angeles, several shoulder disarticulation prostheses were prescribed by the various participating clinic teams in this area. These were fabricated in the usual manner, with standard forearm, humeral section, and shoulder cap. (These sections were fabricated in one piece, or laminated separately with mating sections in each, called bulkheads. These were fastened securely together.) The forearm lift and terminal control were operated by scapular excursion. The elbow lock could be controlled by several methods, a perineal strap, chin nudge, or by an additional loop to the un-amputated shoulder at a higher level than the chest strap. The perineal strap operated the elbow lock by a cable which passed over a pulley or curved housing on the shoulder cap and distally to the elbow unit. Elevation of the shoulder actuated the lock. This system was undesirable because the strap length had to be changed as the amputee assumed different positions i.e., standing, sitting, also because of awkward motions involved in operation. The chin nudge control was quite simple in that very little amputee training was necessary, but it was bulky in appearance. The amputee actuated the lock by depressing with his chin a button located on the anterior superior border of the shoulder cap. The remaining elbow lock control system, opposite shoulder loop, is possibly the most desirable. The only disadvantage to this system was the inability of some amputees to differentiate between the two rather similar motions involved in locking the elbow and forearm flexion.



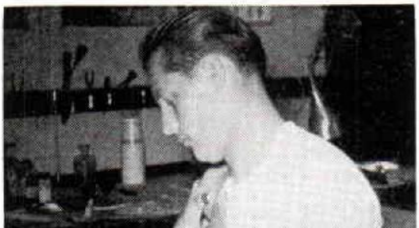
Robert N. and William E. Hitchcock.

Not long after fabricating and fitting several of these prostheses, we began to receive comments from the amputee such as, "I'm having difficulty in learning to operate my elbow lock," or "I can't get the forearm of my prosthesis on the desk to hold my papers," and "I have difficulty in putting on my shirt and coat with my prosthesis on." This type of complaint became quite common among our Shoulder Disarticulation Amputees and it became increasingly apparent to Bob* and me that we should do some thinking along these lines.

The most urgent problem was that of designing an abduction joint at the junction of the humeral and shoulder cap sections. This would allow the forearm to lie flat on a desk while sitting and to some degree solve the problem of dressing. On most cases the axis of the joints passes through a portion of the remaining shoulder

*Robert N. Hitchcock in Vice President of the Boston Artificial Limb Company, Inc., and conceived many of the technics herein discussed.

stump, so this precluded the use of a "thru-bolt" type of assembly. Because of this a small compact child's size Below Knee joint was indicated. We decided that the axis of these joints should not be exactly parallel with the sagittal plane but inclined anteriorly so that the humeral section would describe an arc anteriorly as well as laterally when abducted. (Our experiments showed that an angle of from 15 to 20 degrees to be optimal angle of inclination.)



When the prosthesis is fabricated with an abduction joint the forearm is permitted to lie flat on the table.

After the type and location of the joints are determined, they are placed on the laminated shoulder cap. This lamination has been fabricated in the usual way, following the contour of the stump, and forms the inner shell of a double wall shoulder cap. The joint heads are held in proper alignment by a spacer rod, which is cut to length, drilled and tapped for machine screws at each end.

A negative template for the outer contour of the shoulder dome is made from 1/8" aluminum or other suitable material. This template will be from 4" to 6" in diameter, depending on distance between the joint heads and have a radius of from 2-3/8" to 3" depending on the site of amputation and extent of atrophy in the amputated shoulder. (An accurate anterior-posterior drawing is taken of the entire shoulder area. From this, the difference in contour and hence the template radius becomes apparent.)

The wax may now be applied by building a paper cylinder and pouring in the molten wax. (Always allow the wax to cool to 150 degrees F., before attempting to pour a build up. The wax may be applied with a spatula if wax is cooled to 125 degrees F.) When the wax has hardened, it may be shaped into a hemisphere using the template. The remaining areas of the shoulder cap not covered by wax should be roughened to insure proper bonding of the outer lamination. The portions of the joint heads which are to remain exposed should be suitably protected from the resin. This may be done by coating with silicone compound, (Dow Corning #DCa) or by a wax dip. Protect joint heads with wax only if promoter is used.

The 4 to 6 outer layers of stockinette are now added and the impregnation completed in the usual way. (Before placing laminate in curing oven, be sure to make a small hole (1/8"), in the under side of the dome for a wax escape.)

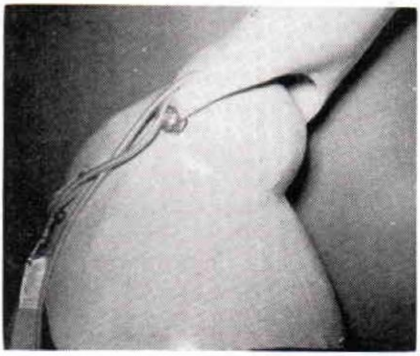
The fabrication of the humeral section is fairly simple. A paper cylinder is made of the correct humeral length with the elbow turntable at one end and a male template of the dome at the other. This cylinder is sealed with tape and poured with wax. A 1/2" dowel is inserted at the proximal end through the template for ease of handling during lamination. When the wax has cooled and the paper removed, appropriate grooves are made in the proximal end for the lower joint straps. Care must be exercised to keep the heads of the joints in proper alignment, and at the same distance apart so as to mate properly with the shoulder section. This may be assured with a spacer rod. When these are in place and the entire humeral section shaped to a pleasing contour, the laminating again is carried out in the usual manner. After curing and trimming, the prosthesis is assembled.

Thus we overcame one of our most difficult problems and we now turned our attention to some way of improving the control system. Here the problem was one of obtaining sufficient excursion to elevate the forearm to the face level (135 degrees) and then operate a terminal device. We noticed that at the mid-scapular level where we had our chest strap, the average amputee had more than enough force, but a limited amount of excursion. A simple 2:1 pulley system was indicated. The pulley was placed in the control system. This increased the amount of force required to operate the terminal device, but also gave us two times the amount of harnessable excursion. In our first models the pulley was placed on the proximal end of the control cable at the mid-scapular level and incased in clear plastic tubing. This system enabled the amputees who could not get sufficient excursion, to operate a terminal device. A further refinement was to place the pulley within the humeral section itself. It may be well to note here that any control cable originating in the humeral section and passing to the shoulder cap over the abduction joint must pass through a housing which is secured at each end. This is done so that when the arm is abducted the cables will be free to operate without sharp bends.

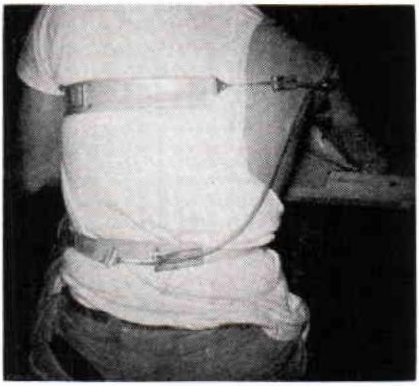
Our remaining problem was to design if possible an easier way to operate the elbow lock.* Any control system must meet three basic requirements:

A. Ease of operation.

*In the case of shoulder disarticulation with pectoral cineplasty, this problem is resolved with the use of an inertia type elbow lock. Here the scapular excursion operates the forearm lift and elbow control. The terminal device is operated directly by the cineplasty tunnel.



Posterior view showing forearm lift, and terminal devise control, and elbow lock control by abdominal band.



Posterior view of the abductive prosthesis. Note that the control cables pass out of the humeral section as close to the joint head as possible.

B. Must be inconspicuous under clothing.

C. Position of the amputee must not affect operation.

Most of the elbow units in use today require a travel of 3/8″ to 1/2″ to operate the lock, so we had to find some place where we could obtain the necessary excursion. The lower extremities were ruled out because of the length differential in the control cable when the amputee assumed a sitting position. The opposite shoulder control was not desirable because of the similarity of motions previously mentioned. At last, we decided to see how much excursion could be harnessed around the abdomen. To our surprise even thin patients whom we tested had an excursion of upwards of 2″ (We had 4″ each). Here we felt was a good site to attempt control. A 1½″ Vinyon abdominal belt was made with a buckle in front and the entire posterior third of 1″ elastic webbing. The standard elbow lock control cable was replaced with one long enough to reach the waist level, and placed in a plastic covered housing. The housing emerged from the humeral section near the head of the abduction hinge. The entire control cable assumes an "S" shape terminating at waist level. A "T" bar is installed on the housing and a hanger soldered to the cable end. This arrangement enables the lock to be operated when the circumference around the abdomen is increased. This type of control has been used on several cases to date and has proven satisfactory. I believe the procedure herein described represents a definite improvement in the fabrication of shoulder disarticulation prosthesis, however, it is by no means the final answer to the difficult problems in this the most challenging field of upper extremity prosthetics.

OALMA Elects New Regional Directors
New Board Takes Office at Assembly

In a secret mail ballot the members of OALMA have picked the eleven regional directors who will hold office for the year beginning October 19. The new directors will be formally installed in office at the OALMA Assembly Banquet in New Orleans.

Five of the directors are newcomers to the Board and will be guests at the luncheon meeting of the outgoing officers October 15 at the Jung Hotel.

In announcing the election results, OALMA Director Glenn Jackson, paid tribute to the voters wisdom, declaring that the eleven men chosen all met essential qualifications as a good Director.

The membership of the new Board and the states they represent are:

Region I. (New England States) *Karl W. Buschenfeldt* of Stoughton, Mass.

Region II (New York and New Jersey) *John A. McCann*, of Burlington, New Jersey.

Region III (Pennsylvania, Delaware, Maryland, District of Columbia and Virginia) *Charles W. Wright* of Philadelphia.

Region IV (North and South Carolina, Tennessee, Kentucky, Mississippi, Alabama, Georgia and Florida) *D. A. McKeever* of Atlanta, Ga.

Region V (West Virginia, Ohio, Michigan) *Paul Leimkuehler*, of Cleveland, Ohio.

Region VI (Eastern Missouri, Illinois, Indiana, Wisconsin) *McCarthy Hanger, Jr.* of St. Louis, Mo.

Region VII (Minnesota, North and South Dakota, Wyoming, Western Missouri, Nebraska, Iowa, Kansas, Colorado) *Robert Gruman*, of Minneapolis, Minn.

Region VIII (Texas, Oklahoma, Western Louisiana, Arkansas, New Mexico) *James D. Snell* of Shreveport, La.

Region IX (Southern California, Arizona) *Arthur Ritterrath* of Los Angeles, Calif.

Region X (Northern California, Nevada, Utah) *Matthew Laurence*, of Oakland, Calif.

Region XI (Washington, Oregon, Idaho, Montana) *L. C. Ceder*, of Tacoma, Washington.