An Assistive Device to Develop the Pectoralis Major and Biceps Brachii Muscles in Post-Operative Cineplasty

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The isolated development of the pectoralis major and the biceps brachii muscles following the formation of "muscle motors" in these areas by the surgical procedure of cineplasty presents a problem to the therapist. Exercises performed pre-operatively in order to hypertrophy these muscles are rather easily administered since the muscle insertions to the arm or forearm are intact. However, after cineplastic procedures these muscle insertions are liberated from their bony attachments and so do not present levers to which resistance can be applied.

The Prosthetic Devices Research Project, University of California, prepared a paper in April, 1950, for the Advisory Committee on Artificial Limbs, National Research Council, which states that:

> "The dressings are removed between ten and twelve days after operating and the sutures are removed. With the removal of the dressings and the initial insertion of the muscle pin the patient should start the post-operative exercise program. Initial exercises should consist of passive stretching of the tunnel performed by the patient himself. He merely grasps the "muscle pin" with his normal hand and gently pulls downward. The first stretches should be carefully done and only through a pain free range; however, as the patient's tolerance to the stretch improves, he should stretch his muscle to the limit of its range, then stretch just a bit more and hold it briefly in this position . . .
>
> At the time the initial stretching is instituted the patient should also start active contractions, using no resistance. These should be done with the muscle pin in the tunnel. He should contract and hold it, then relax and repeat . . .
>
> When healing has taken place and the tunnel has attained some degree of flexibility, exercises against resistance and stretching should be started . . .

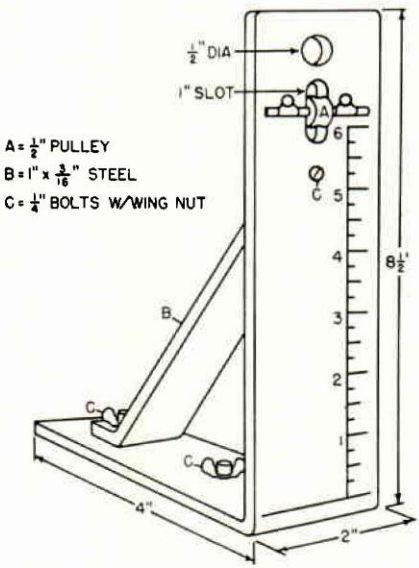

Fig. 1. Stretching and Resistance Unit.

These exercises should consist of two types; (a) exercise performed with loads, during which the patient lifts the load through the full contraction range and then attempts to "pull up" even more; (b) exercises performed against heavy loads with the subject lifting the load as high as possible. If, before each contraction, the load is allowed to hang on the passive muscle, additional stretching is achieved. (From Prosthetic Devices Research Project, University of California, April 1950. *Biceps Cineplasty and Prosthesis for Below-Elbow Amputation*, pp. 8-9.)

The device herein presented was designed and produced to fulfill the requirements set forth in the quotation above. It will be seen that this device can be used during the very early training of the patient in the use of various types of terminal devices for the arm prosthesis as well as for stretching and hypertrophying the "muscle motors."

In addition, the designing of this device was to produce a simple, easily adjusted and safe piece of apparatus that could be readily adapted for use by all patients having cineplastic procedures. The final product consists of four parts: (1) a heavy resistance and stretching unit; (2) a muscle pin and cable linkage; (3) a spacer bar; (4) a unit which when combined with (1) and (3) enables the patient to use various terminal devices.

Description

The resistance and stretching unit. The hypertrophy of the muscle containing the "muscle motor" and the increase of the excursion of the "muscle pin" are obtained by using the unit shown in Figure 1. The unit is depicted in use by a patient in Figures 3 and 4.

The unit was made of ⅛ by two inch aluminum braced by a piece of 3/16 inch by one inch steel. This steel brace was used after braces made of various strengths of aluminum failed when patients lifted heavy

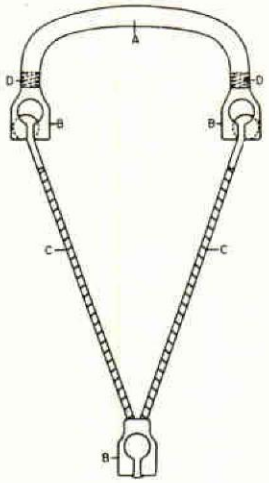

Fig. 2. Muscle Pin and Linkage Unit. A-¼" Stainless steel rod 4" long. B-Ball and Socket Fittings. C-Northrup Arm Cables 4" long. D-Note that ball and socket fittings are internally threaded to "A".

weights. The axle for the pulley was fastened to the face upright by means of two cable clips. The ½ inch hole in the top of the upright is for placing the terminal devices.

This part of the device is fastened to the plinth by means of a ¼ inch by 1¼ inch bolt with a wing nut. (It will be noted that this type of bolt and wing nut is used throughout the device. It was found that "thumb tight" would suffice in all operations of the apparatus).

The muscle pin and linkage unit. Originally a "question mark" shaped pin (see Figure 4) was used through the "muscle motor." This was connected through the pulley of the device by means of a twenty-four inch Northrup Cable. Later, however, as the "muscle motor" became stronger this pin had a tendency to slide out. This necessitated the development of the pin and linkage shown in Figure 2. A Northrup Cable, eighteen inches long was used with this unit. The pin was made of ¼ inch stainless steel internally threaded on both ends. The internal threads were used to prevent scratching of the inside of the muscle tunnel. (In addition to this, one half

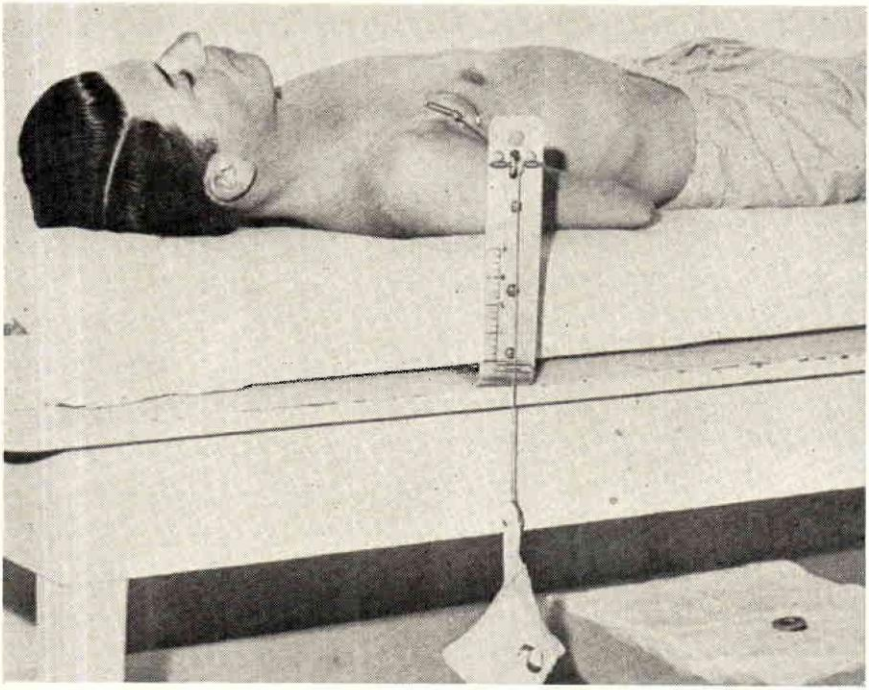

Fig. 3. Patient Using Stretching and Resistance Unit. (Beginning of Muscle Contraction.)

of a gelatinous capsule was put on the end before passing the pin through the tunnel). The ball and socket fittings are of the type usually found in artificial limb shops of United States Army hospitals. This pin and linkage was found to be equally effective in use for both pectoralis major and biceps brachii cineplasties.

The spacer bar and horizontal pulley support. The spacer bar was a piece of steel two inches by 3/16 inch. Here again the use of a steel bar was arrived at through trial and error in the use of aluminum.

The horizontal pulley support was made of two inch by ⅛ inch aluminum with right angle bends at both ends. A ½ inch pulley in a housing was used and this was fastened to the support with the wing nut and bolt axle. The wing nut and bolt axle afforded adjustments of the pulley housing for various angles of pull of the connecting cable.

The apparatus assembled for use with one or the other of the various terminal devices is shown in Figure 5. It will be noted that the device is fastened to the plinth by the use of two bolts with wing nuts. By having two holes on each side of the plinth the device can be used by either right or left arm amputees.

Figure 6 shows a patient using the apparatus with a terminal device, which in this case happens to be an APRL hook (Army Prosthetic Research Laboratory). One can readily see that both the hook and the "muscle motor" are in full view of the patient as he practices the operation of the hook. Here also the terminal device need only be "thumb tight." The Dorrance hook was also used with this apparatus. By using increasing numbers of rubber bands on the hook, increasing resistances were presented to the "muscle motor" thus aiding in the hypertrophy of the muscle.

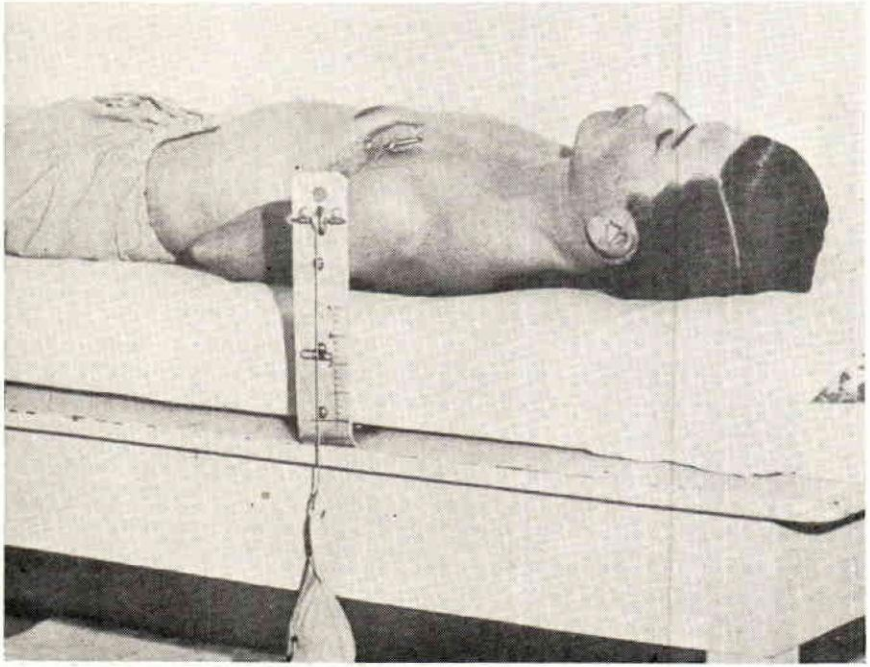

Fig. 4. Patient Using Stretching and Resistance Unit. (End of Muscle Contraction.)

Use of Apparatus and Results

One of the most important factors in selecting cineplasty is the mental adaptation of the patient. The surgery is relatively simple but the patient must be intelligent and cooperative because cineplastic procedure is not something automatic. The patient must learn the true use of the "muscle motor" himself.

The apparatus described in the foregoing was used in several of the cineplastic procedures performed at Letterman Army Hospital. The patient was started on progressive resistive exercises as set forth by DeLorme and Watkins as soon as the physiatrist determined that the muscle tunnel was healed sufficiently to permit resistance. (DeLorme, T. L. and Watkins, A. L., *Progressive Resistance Exercise*, Appleton-Century-Crofts, Inc., New York, New York, 1951.)

Treatment periods were scheduled twice daily and each lasted from twenty to thirty minutes. The treatment period was divided into two phases: (1) stretching and resistance, (2) practice with both the APRL and Dorrance hooks. By using a paper clip attached to the cable of the linkage unit, an accurate measurement could be made of the distance each weight was lifted. A constant check was thus maintained on the patient's effort to secure full contractile range. The shot bags usually found in physical therapy clinics were used as the resistance. The paper clip was positioned after the weight was allowed to stretch the muscle.

After the progressive resistance exercises, the patient rested while the apparatus was assembled for the second phase of the treatment. This rest period usually amounted to three minutes. The APRL hook was used first and the patient concentrated on excursion of the "muscle pin." Since

one position of this hook requires little strength and excursion the patient met with instant success. (This was a real "morale shot"). The Dorrance hook was used next and afforded exercises in both excursion and resistance.

The following cases present an indication of what has been accomplished with this apparatus:

Case 1. A biceps cineplasty for a below elbow amputee. On 3 August 1951 this patient could lift five pounds through a one inch range. On 9 August 1951 he lifted fifteen pounds through a range of two inches.

Case 2. A biceps cineplasty for a below elbow amputee. On 29 June 1951 this patient lifted two pounds with an excursion of $\frac{3}{4}$ of an inch. On 23 July he could lift thirty-five pounds through an excursion of three and one-half inches. Following a seven day furlough, the patient lifted thirty-five pounds through a two and one-half inch range.

Case 3. A pectoralis major cineplasty for an above elbow emputee. On 18 May 1951 this patient lifted twelve pounds through a five and seven-eights inch range. On 19 June 1951 he raised thirty pounds a distance of four inches.

Case 4. A pectoralis major cineplasty for an above elbow amputee. On 4 May this amputee could lift ten pounds through a distance of three and one-half inches and on 18 June 1951 he lifted thirty-three pounds through an excursion of four inches. An interval of confinement to bed interrupted PRE treatments. (PRE: Progressive resistance exercise). Upon return to PRE treatments on 9 August 1951 the patient lifted forty-five pounds a distance of five inches. On 15 August 1951 the patient lifted fifty pounds with a five inch excursion.

Case 5. A pectoralis major cineplasty for a shoulder disarticulation.

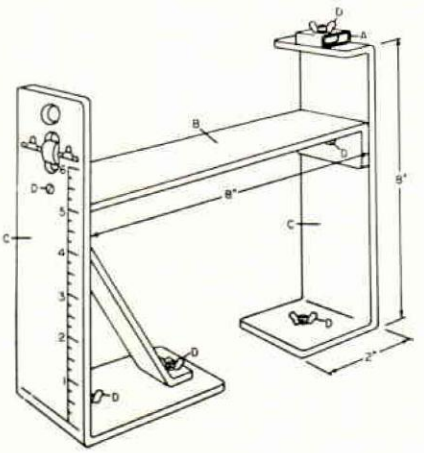

Fig. 5. The Assembled Device. A—½" Pulley in housing. B—2"x3/16" steel. C—2"x⅛" aluminum. D—¼" bolt W/Wing nut.

On 22 May 1951 this patient lifted two pounds with an excursion of one inch. On 11 June 1951 he could lift nine pounds a distance of two and one-half inches.

Summary

This piece of apparatus offers a means of developing a specific muscle under the careful supervision of a therapist. It can be used under clinical conditions. One piece of apparatus can be used for many patients and eliminates the necessity for making a separate temporary device for each patient. A steel pin covered with soft acrylic or a pin made of lucite may be substituted for the pin hereintofore described. In any case the pin should lend itself to sterilization after use by each patient. The patient can follow his progress by objective measurements. This device presents no mechanical problem to the therapist because of its simplicity and because it can be assembled and used without the use of tools. Finally, the device presents an opportunity for the amputee with a cineplastic procedure to develop ability in the operation of the various terminal hooks many

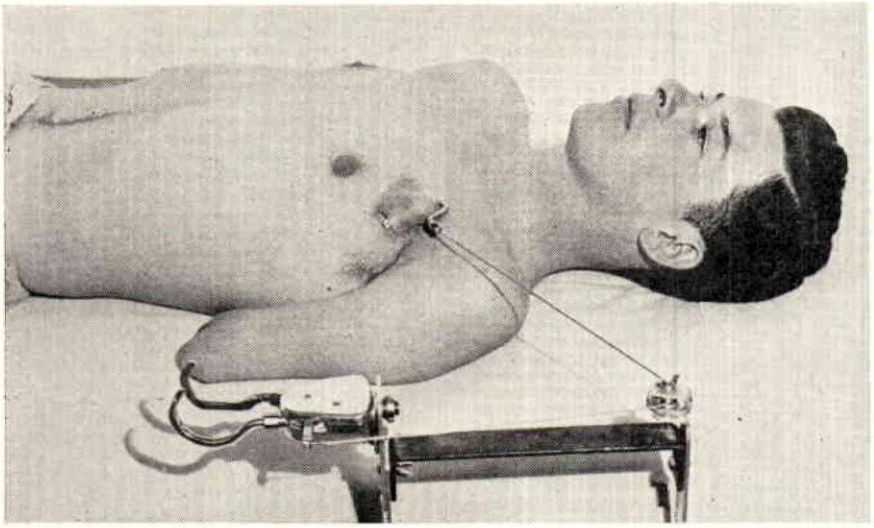

Fig. 6. Patient Using Assembled Device with Army Prosthetic Research Laboratory Terminal Hook.

weeks before he receives his artificial arm.

Bibliography

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START PLANNING NOW

Now is the time to start making plans for attendance at the 1953 National Assembly of the Limb and Brace Profession, which will be held at the Drake Hotel in Chicago, September 27, 28, 29, 30 and October 1.

Howard Thranhardt, program chairman, reports that plans for this annual meeting of OALMA and the Certification Board are well-advanced. Many members are arranging vacation schedules to fit in with the Assembly dates.

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John J. Keys graduated from the University of Illinois, B.S. degree, and from Pennsylvania State College, M.S. degree. He was Chief of the Orthopedic Brace and Limb Shop, McCloskey General Hospital, Chief Philippine Amputation and Prosthetic Unit, during World War II. Major Keys served as Chief of the Physical Reconditioning Section of the Percy Jones Army Hospital at Battle Creek, Michigan, and is now Chief of the Physical Reconditioning Section at Letterman Army Hospital in San Francisco, California. He is a member of the Association of Military Surgeons of the United States, and the Association for Physical and Mental Rehabilitation. Major Keys is the recipient of the Certificate of Merit of the American Congress of Physical Medicine.