Importance of Musculature of the Amputation Stump

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Orthopedic technicians of Germany, by developing the suction or grip prosthesis (with its exact static structure and by the fashioning of the socket rim with the so-called "tuber (ischial) seat," which requires great mechanical ability, anatomic knowledge, and a capacity for patient understanding and adjustment), have provided for those, who suffered amputation above the knee, a replacement of the lost member, which can justly be called an "artificial leg."

The modern thigh prosthesis makes great demands of the thigh stump, if it is to be as useful, as the amputee as well as the orthopedic technician, justly expect it to be. Many thigh stumps resulting from injuries in the two World Wars do not meet the requirement of the modern thigh above knee prosthesis. The reasons are known: the shortage of well-trained surgeons in the presence of an overwhelming number of severely wounded casualties; the winter campaigns; the retreats in Russia, the adversities of defeat and of the after-war period. These often made necessary the use of emergency prostheses, which seemed to make the "guillotine amputation" advisable and often led to premature discharge from the war hospital. The emergency operation, which had been thought to be provisional, and which was to be followed by a correction of the stump by well-trained specialists, remained the permanent treatment. There are still tens of thousands of amputees with poor, defective stumps. The prosthetic care of these stumps involves great efforts for the orthopedic technician. They demand of him time-consuming, and often repeated fittings, and they may even present him with problems, which are technically impossible to solve. The disappointment of the orthopedic technician with the the limitations of his ability is just as great as the disappointment of the amputee, who is incapable of wearing the artificial limb. The repeated attempts at altering the prosthesis cause accumulation of governmental expenditures, and the general public is burdened with a dissatisfied, discouraged, "disabled" war veteran.

When the prosthetic equipment of a thigh amputee causes difficulties for the orthopedic technician, confidential consultations between the craftsman and the surgeon are essential, and will be a help for the amputee. There are some amputation stumps which even a master craftsman in orthopedic mechanics will be unable to equip with a prosthesis, until a surgeon rectifies the defects of the stump. Every orthopedic technician knows from his own experience what poor stump conditions are. In such cases, the orthopedic technician should try to overcome the "operation-phobia" of the amputee, by calling his attention to the progress in surgery, and in the modern methods of anesthesia, and by impressing on him the necessity of improving his defect by a surgical intervention, and by urging him to consult a surgeon.

It is essential that the skin covers the stump snugly (closely) and smoothly. Deep retractions, flap-like

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scar formations result in skin irritation and eczema formation, and, like protruding skin-tail formations, can be removed by simple corrective interventions. Scars adhering to the bone stump with a broad surface, have a tendency to ulcerate, always cause discomfort and should be removed in all cases. Highly sensitive amputation scars should be removed by scar correction, because the terminations of sensory nerves are baked into these cicatrices. Sensitive bone proliferations on the end of the bone stump are often connected with a vessel or nerve stump and require the resection of the bone projection and the shortening of the neurovascular stump. Osteomyelitic fistulas and chronic inflammatory foci in the bone can be eradicated by the use of antibiotics such as penicillin, streptomycin, terramycin, etc. Highly sensitive nerve ganglions and phantom-limb pain can be cured by the combined use of nerve resection, antibiotics and roentgen irradiation.

It is surprising that exact management of the stump musculature has so far received insufficient attention in amputation and stump correction. Strong and functioning muscles on the amputation stump are of vital importance for activating the prosthesis, and particularly for the circulation in the amputation stump. The stronger the stump musculature, the better also the blood perfusion of skin and subcutaneous tissue, and the warmer and healthier will be the amputation stump. An amputation stump with optimal circulation is warm to the touch, not subject to profuse sweating nor to irritation and discoloration of the skin and the customary stump disorders.

It is generally believed that the muscles which have been cut through during amputation, have lost their function permanently and will atrophy. Attempts have been made to accelerate this atrophy by "wrapping (bandaging)—out." We reject the

Fig. 1. During amputation a part of the adductor musculature is transversely divided and usually left without definitive care.

"wrapping-out" of the stump, and believe that by joining the flexor and extensor muscles, which act as counterbalancing forces, and by joining the divided adductor musculature of the thigh with the *Tractus iliotibialis* and the *Musculus vastus lateralis*, the divided muscles will also become amenable to exercise, and better blood perfusion of the amputation stump will result, and this in turn will produce a healthier amputation stump.

For the last several years we have carried out this principle of careful adjustment of the antagonistic stump musculature on a large case material. We regard it as a decided progress and believe that this method can be recommended.

In the management of thigh stumps, the divided part of the adductor musculature is generally left as such, and this implies a considerable loss of strength for the stump and causes the development of disturbances. The adductor muscles which draw downward in a wide wedge on the inside of the thigh, are muscles of the hip joint. Their great functional performance is exceeded only by that of the extensor muscula-

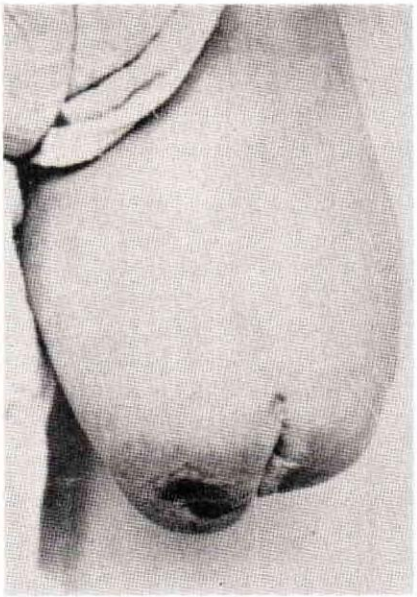

Fig. 2. Hardening and discoloration of skin at inner end of the stump, because the divided part of the adductor musculature received no definite repair.

ture of the hip joint. The adductor muscles are antagonists of the abductors of the hip joint (Fig. 1), and over and above that, depending on their origin and attachment, they strengthen flexors, extensors, and the internal-and external rotators of the hip joint. Together with the abductors of the hip joint they insure maintenance of the equilibrium during standing on one leg and in collaboration with the other hip muscles, they are of greatest importance for the functioning of the artificial leg. During walking and standing, the adductors hold the thigh, so that the abductors can elevate the opposite side of the pelvis. Every considerable weakening of the adductor muscles leads to disturbances in walking. If the abductor muscles gain dominance through a weakening of the adductor muscles, the stump end in the socket deviates laterally and to the front. The end of the stump is pressed against the lateral wall of the socket, the prosthesis is shifted toward the outside, so that a pocket is formed between trochanter and the lateral rim of the socket and a painful pressure area develops at the inner rim of the socket. In such cases, brownish-red skin discolorations are observed on the inner side of the thigh, which are the result of the pressure exerted by the internal rim of the socket.

Particularly in case of the suction prosthesis, the unattached portion of the adductor musculature, during walking, draws backwards like a roll and is pressed against the inner wall of the socket. These contusions and clampings of the retracting adductor musculature produce constantly repeated circulatory disturbances and blood effusions, which in turn cause the well-known indurations and dark brownish-red discolorations of the skin at the inner end of the stump (Fig. 2.) In all cases with this dark brown-red discoloration and induration of the tissue at the inner end of the stump, we found, that the part of the adductor musculature which had been cut through at the time of amputation, had not been properly taken care of.

If one examines the amputation stump, while the amputee is standing and the musculature is tensed, one can see how the divided part of the adductors retracts like a roll. During the correction of such stumps, the musculature is usually readily pulled forward and can then be united over the bone stump by means of a suture, a shortening of the bone stump being generally unnecessary. We join the stump musculature over the bony end of the stump in two separate layers (Fig. 3-4). We recommend that in the first deep, layer the divided part of the adductor musculature be joined to the *tractus iliotibialis* or to the *M. Vastus lateralis.* Over this, we join in a second layer, crossing over the first one, the flexor with the extensor muscles. Active muscle exer-

cises are begun two weeks after the operation.

On stumps of below-the-knee amputations, the joining of the divided flexor and extensor musculature to a "muscle play" (muscular system) is possible only over a bone bridge between tibia and fibula, which Bier recommended as the osteoplastic amputation. Ertl greatly improved Bier's surgical technique of the osteoplastic below-the-knee (lower leg) amputation and made this method more widely known (Fig. 5-6).

The often repeated assertion that the osteoplastic stump of the lower leg is capable of weight-bearing (Gocht) implies a stump, which can support the entire body weight for a considerable time. The osteoplastic (Bier-Ertl) stump of the lower leg is not suitable for weight-bearing, but it is capable of bearing a greater load than the ordinary lower-leg stump and it gives a particularly good "ground feeling." In addition to this, the osteoplastic lower-leg stump has other essential advantages over the ordinary lower-leg stumps. The fact that tibia and fibula are rigidly joined by a bone-bridge corresponds to the natural fixation of both bones in the region of the ankle joint. Behind this bone bridge the stumps of vessels and nerves are protected against irritation and the musculature is protected against compression and the circulatory disturbances inherent therein. The otherwise poorly functioning flexor and extensor musculature is joined by suture over the bone-bridge and thus can be exercised again. The strengthening of the musculature, which has been joined into a "muscle play," produces better circulation of the entire lower-leg stump and prevents stump disorders. The advantages of the osteoplastic (Bier-Ertl) lower-leg stump, such as stabilization of the bony frame-work, capability of exercising the residual musculature, better blood perfusion, of

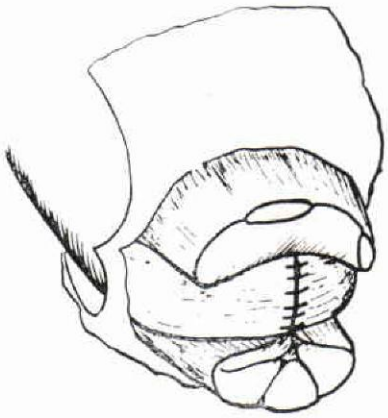

Fig. 3. Over the stump end of the bone the vastus lateralis.

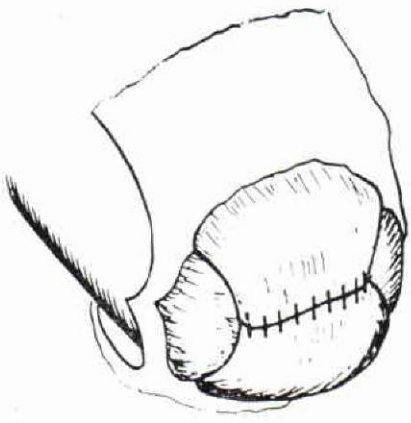

Fig. 4. Over this, as a second layer, the flexor and extensor musculature is joined by suture.

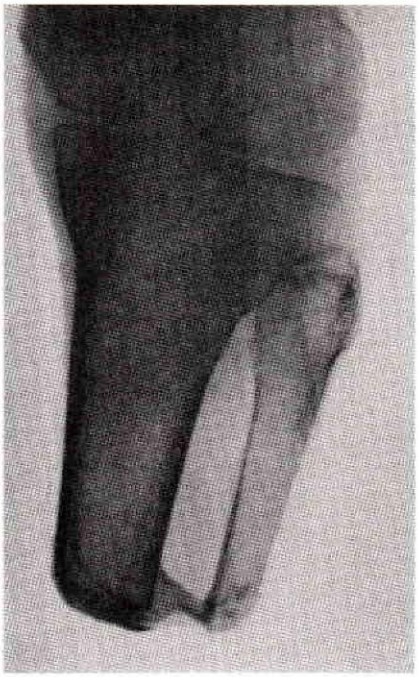

Fig. 5. Osteoplastic lower-leg amputation according to Bier-Ertl. Stabilization of fibula and tibia by a periosteal-bone bridge.

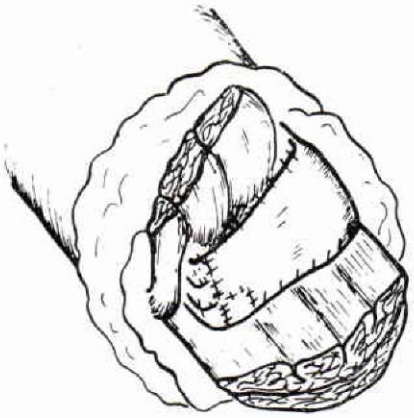

Fig. 6. Over the periosteal-bone bridge, between tibia and fibula, the flexor and extensor musculature is joined by suture.

the entire stump, and protection of the nerve and vessel stumps against irritations, are so great, that we recommend the osteoplastic, below-the-knee amputation as the method of choice, not only for first amputations but also for necessary stump corrections.

Lower-leg prostheses hitherto available are not suitable for the osteoplastic (Bier-Ertl) lower-leg stumps. Orthopedic technicians have the task to devise newer and better prostheses with a new socket shape to facilitate a better weight distribution, and with a multi-laterally movable foot joint, which will protect knee and hip-joints against hard impacts and so protect them against early wear-out.

"What's New(s)"

• TERRY MOORE is now the manager of the *Florida Brace Corporation* at Winter Park, Florida. This company features the Jewett Brace for hyperextension of the spine. Many bracemakers throughout the country find great satisfaction for their patients and considerable profit for themselves in handling this brace. The local brace firm makes the measurements, sends them to Florida and then makes the subsequent adjustments as required. Delivery is forty-eight to seventy-two hours to most places in the country by air-mail from the time the measurements are sent, since shipment is made within three hours after the order is received. This is very important since these cases demand three to four day service.