A Suction Socket Prosthesis Without Suction*

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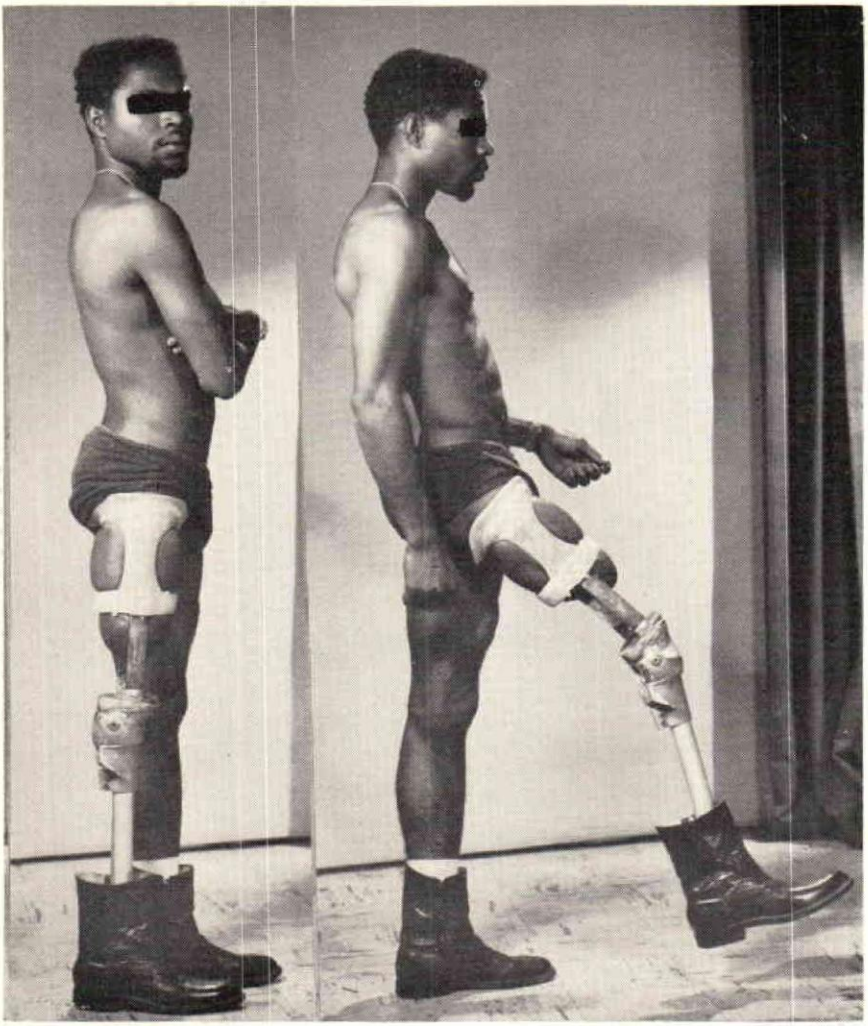
The term "suction socket" prosthesis has become common with usage among prosthetists and physicians concerned with fitting an artificial limb which does not require any harness to maintain it in place. The name implies that the socket is held in place by "suction." Gravity attempts to pull the socket from the stump, causing a reduction of the air-pressure within the sealed space between the socket and the stump. This results in a relative increase of the air-pressure on the outside of the socket and produces this so-called "suction action." It is the opinion of this observer that this term "suction" has been misleading to many of the prosthetists concerned with the manufacture of this type. The correct term should be "lowered atmospheric pressure." Like the airplane which stays aloft due to a decrease of atmospheric pressure on the upper surface of the wing, the prosthesis remains attached due to decreased pressure within the confines of the socket.

With observation and study of these amputees in five years of fitting suction sockets it became apparent that other factors were involved in the maintenance of socket in position than "lowered atmospheric pressure." It was shortly after the suction socket program was instituted that we discovered some patients were able to maintain the socket in position by contracture of their stump musculature. It was also noted that the sockets which were most satisfactory and produced the least complications due to strangulation of the end of the stump, were those which were under-cut anteriorly and posteriorly. From these initial observations, alterations in the configuration and concept of the shape of the socket gradually developed.

In order to demonstrate an important role which anatomy and kinesiology (muscle function) plays in the suction socket prosthesis an entirely new type of socket was manufactured. This socket does not employ any suction whatsoever. The socket is maintained in position by the contracture of the thigh musculature, the tissue mass at the end of the stump, and the anatomical configurations of the socket. (See illustration No. 1 and No. 2.)

The socket demonstrated in these photographs consists of a carefully shaped inlet, adhering closely to the anatomical configuration of the thigh at the hip joint. The socket compresses the thigh along its medial and lateral aspects. It is open along the anterior and posterior aspects, allowing the muscle tissues of the thigh to extend out of these open areas. When the wearer contracts the thigh musculature it becomes larger in circumference than the inlet of the socket. As a result the ischial seat becomes more securely pressed against the ischium and better control of the prosthesis is possible. This male amputee was able to run without losing his prosthesis; to play basketball and even touch football without any circulatory complications or cramping of the muscles of the stump. He did not develop edema of the end of the stump. In several cases, edema of the end of the stump has been corrected by fitting the patient with this type of socket. Since

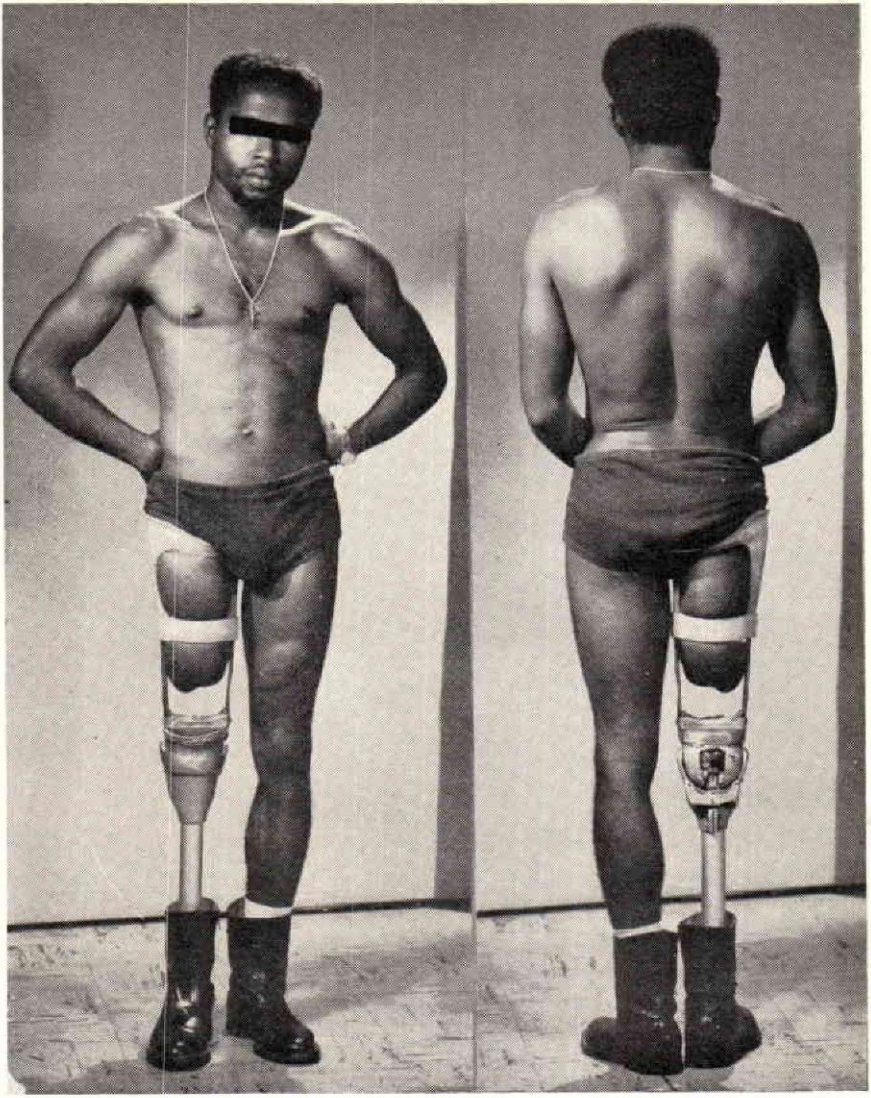
* The Carl Woodall Artificial Limb Co., Los Angeles, provided the photographic material and fabricated the sockets.



No. 1. Plastic covered metal forms the socket. Notice the bulging muscle distal to the inlet.

there is no encircling band below the femoral triangle there is no physical cause for edema to develop. The woman amputee demonstrates an alteration in the original socket: the front and back openings of the socket being partially closed by leather. This young woman is a professional dance instructor and entertainer who is able to do complicated dance routines in spite of her above-knee amputation.

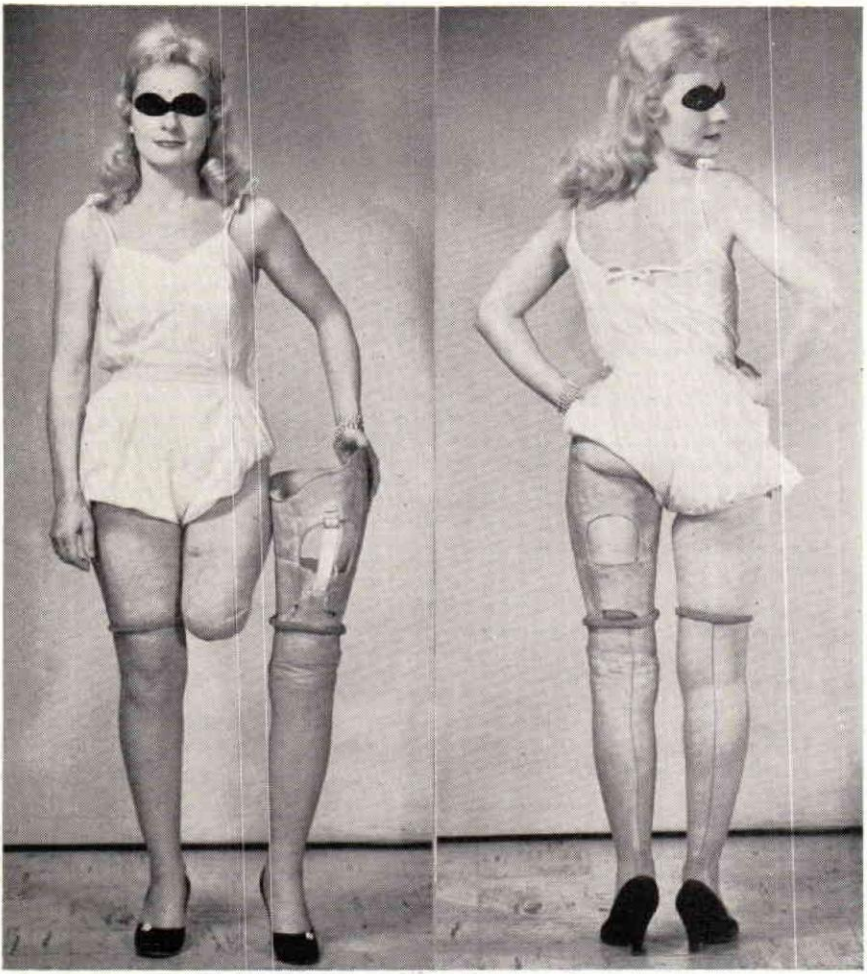
The fact that this type of socket can be successfully fitted and worn without complications indicates that a review of our concept of the anatomy of the stump is indicated. If one considers a muscle and its function, one immediately appreciates that with contracture of a muscle the muscle changes in size and shape. The muscle becomes shorter and of greater circumference. This is invariably true of all skeletal muscles. These muscles would become



No. 2. The end of the stump can be free, or supported by leather.

compressed and embarrassed in their function if they were placed adjacent to joints where motion takes place. Nature has accommodated for this situation by forming tendinous and fascial extensions of the muscles in these areas. Thus we find about the knee, elbow, hip, ankle and wrist, tendons and fascia rather than muscle mass. This is also true of the anatomical organization of the muscles about the hip joint.

When a muscle is divided and its insertion removed so that no change in length of the muscle is possible, the muscle atrophies and becomes replaced by fibrous tissue. On amputation of a leg above the knee, all muscles originating on the femur and having their insertion in the upper tibia atrophy.



No. 3. Socket is plastic. The leather covering over the distal end of the stump is soft and adjustable in circumference.

There are only a few muscles in the thigh which originate on the femur and insert on the tibia. The greater majority of thigh muscles pass across the hip joint and insert on the pelvis. This allows a range of motion for the muscle and makes contracture possible, even after thigh amputation. With use these muscles will maintain contractile power and muscle mass. It is the shortening and increase in circumference produced by the contracture of these muscles which is utilized in the fitting of this special type of socket.

The principles in fitting this socket are not new. The first appliance utilizing these principles was the ischial weight bearing brace. This socket is an improvement upon the fitting of the ischial weight bearing ring and is especially designed for the functioning muscles remaining in a amputation stump. There is the rectus femoris anteriorly, the adductor muscle medially, the gluteus maximus and hamstring muscles posteriorly which need space for their contracture. The remaining musculature can be compressed to secure stabilization as it atrophies completely due to disuse. The vastus lateralis is one of these muscles.

No. 4. Again note the muscle protruding through the openings in the socket.

In order that this socket be given an adequate trial we have postponed this report until twenty-five were fitted and in use. Some of the patients have worn them for more than a year now. All are pleased with the prosthesis and several have recovered from rather persistent and severe edema and ecchymotic berets of the end of the stump.

This report on this contoured socket with an opening in front and in back is presented with hopes that it will stimulate your thinking regarding the shape and fit of the "suction socket."