Clinical Prosthetics and Orthotics, Vol. 12, No. 3, pp. 119–122

The CAT-CAM-H.D.™ A New Design for Hip Disarticulation Patients

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The innovative features of the CAT-CAM™ above-knee socket design were outlined in the Fall, 1985 issue of *Clinical Prosthetics and Orthotics,* Volume 9, Number 4. Shortly afterwards, RGP of San Diego and the Sabolich Prosthetic Research Center in Oklahoma City combined efforts to develop a CAT-CAM™ type hip disarticulation prosthetic socket design. It was intended that this new socket would hold the ischial tuberosity and descending ramus in a special compartment of the socket. RGP worked primarily on the suspension system, and Sabolich worked on the ischial ramus containment.

The conventional hip disarticulation socket differs from the CAT-CAM™ type in that the old design has a flat inferior floor upon which the ischial tuberosity sits. Even worse, many times the tuberosity sits on the very edge of this table. As described in the original 1985 CAT-CAM™ article and in terms of the above-knee socket, this is not a desirable biomechanical situation because, first, the bone is touching a flat tangential surface rather than a contoured surface that conforms to the complex bony shape and thus distributes the load over a wider area and, second, because it does not provide medial-lateral stability. The new socket affords much more bony contact not only to the ischial tuberosity, but to the descending pubic ramus as well (Figures 1 and 2). Experience has shown that the ramus turns out to be of more importance than the ischial tuberosity when it comes to enhancing medial-lateral and rotational stability. Only the inferior pubis-ramus is allowed to exit the socket at the medial inferior dip of the medial wall (Figure 3).

In order to better understand the new hip disarticulation design, it must first be understood that the CAT-CAM™ above-knee design is not a narrow ML socket at the proximal portion. On the contrary, the proximal ML diameter of the CAT-CAM™ above-knee socket, which contains the pelvic bones, is wider than the mid and distal portions of the socket, which then narrows to conform to the medial-lateral thigh dimension in order to supply soft tissue compression. The new hip disarticulation socket follows this SCAT-CAM™ principle. Thus, it provides a better bony locking effect. Also, these bony pelvic structures are more fully encapsulated as a result of a V-shaped medial contouring of the socket and provide the hip disarticulation patient with a feeling akin to the above-knee socket, rather than that which results simply from sitting on a flat hard seat.

Some of the principles of the CAT-CAM™ total flexible brim are also utilized in this type of hip socket. The entire socket is flexible except in the area where the hip joint is attached. This can be accomplished in two ways: first, with a rigid frame and a flexible inner socket much like with the CAT-CAM™ and SCAT-CAM™ above-knee design; second, by a heterogeneous monolithic polyester socket that is rigid in the joint area and then gradually becomes flexible throughout the remainder of the socket (Figures 4 and 5).

Like the SCAT-CAM™ design, the hip socket is more bone and muscle contoured than the traditional bucket shaped hip disarticulation design (Figure 6). The new socket has a concave contour in the area of the ilium on the amputated side. On the contralateral side, there is

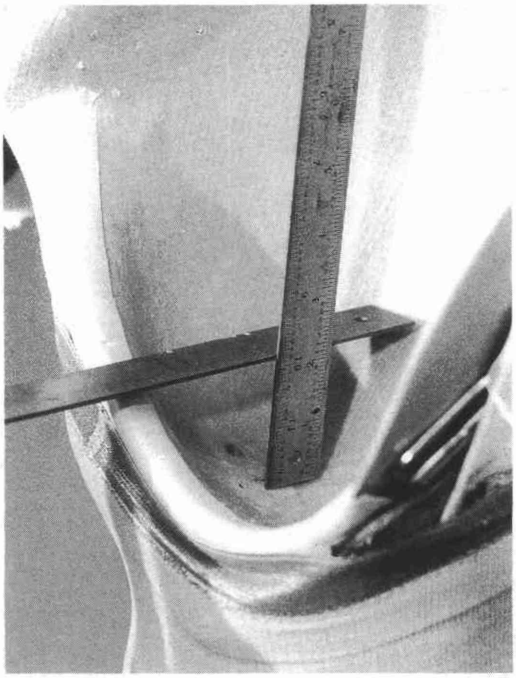

Figure 1. Demonstrates depth of ischial seat area relative to medial brim. Also shows how the ischium and ramus are in the socket.

a concave contour between the ilium and trochanter. This increases medial-lateral stability and results in improved gait when combined with the containment of the ilium, ischium, and ramus bones within the socket. This is contrasted to most conventional designs which bulge out and follow the flow of the soft tissue on both lateral sides of the socket rather than conforming to the body contours.

The "Inter Ilio Trochanteric Effect"† is one of the reasons it has been possible to suspend the socket in most cases without extending it above the iliac crests of the pelvis. Instead, the suspension is gained by conforming the socket into the notch between the ilium and trochanter and creating a counter pressure with the opposite concave shaped side of the socket. Of course, it is more difficult to suspend the socket in this manner when fitting heavy people with excessive adipose tissue.

Normally with a conventional hip disarticulation, it is easy for a prosthetist to pull the prosthesis off the patient by sliding it into abduction, away from contact with the residual

†See acknowledgments.

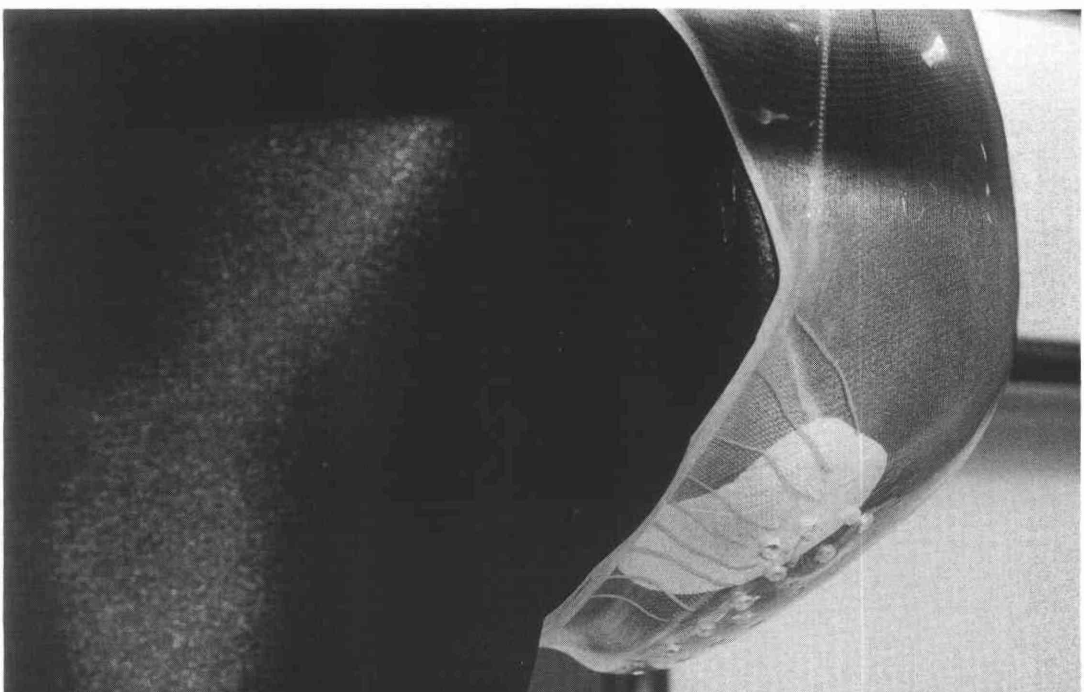

Figure 2. Postero-medial view of transparent diagnostic test socket on the patient with a patch of white paper delineating the ischial-ramus compartment.

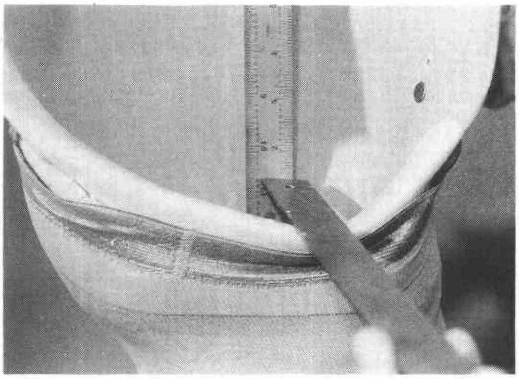

Figure 3. Medial view with rulers at the inferior-most point in the dip of the medial brim.

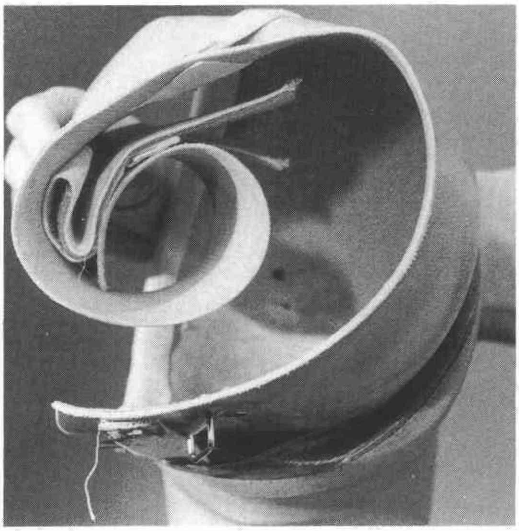

Figure 4. Laminated socket demonstrating flexibility of the contralateral portion of the socket. Superior portion of amputated side is flexible as well.

limb and the ischial tuberosity, when the prosthetic pylon is abducted off the floor. However, with the CAT-CAM-H.D.™ design, this maneuver is more difficult, and the socket resists this abduction tendency due to the bony lock about the ramus (Figure 7).

In the last four years, a combined number of 67 CAT-CAM hip disarticulation sockets have

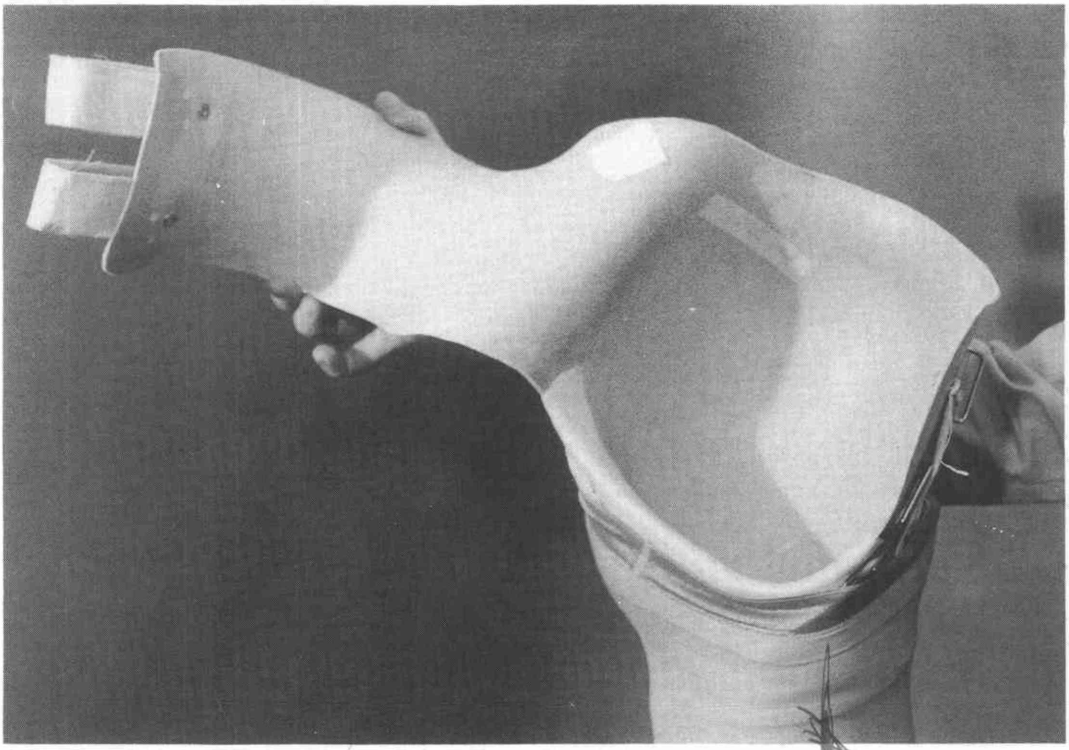

Figure 5. View similar to Figure 4 showing flexibility of socket. Also shows "V"-shaped contour of medial brim in sagittal plane.

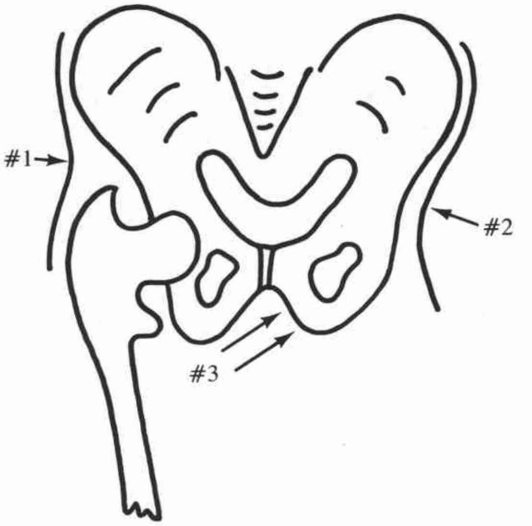

Figure 6. Schematic cross-section through the frontal plane. Vectors 1 and 2 demonstrate the suspension principle and also refer to the dark lines which represent the socket walls. Notice how the superior edges of the socket do not come above the ilium crests and the concave contouring inferior to the illiae. Vector 3 refers to the bony lock.

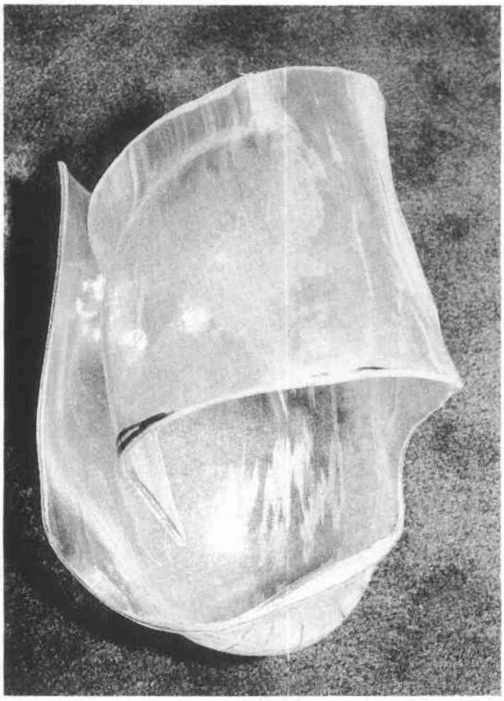

Figure 7. Medial view of the transparent diagnostic test socket showing height of medial brim relative to inferior most portion of the socket.

been fit in Oklahoma City and San Diego. These patients report that they do not feel like they are "sloshing around in a bucket" and have a "greater feeling of security and stability" (Figure 8). Three of these patients can run with their new prosthesis in a hop, skip fashion which has been recorded during video gait analysis. Two patients have been able to manage limited step over step running.

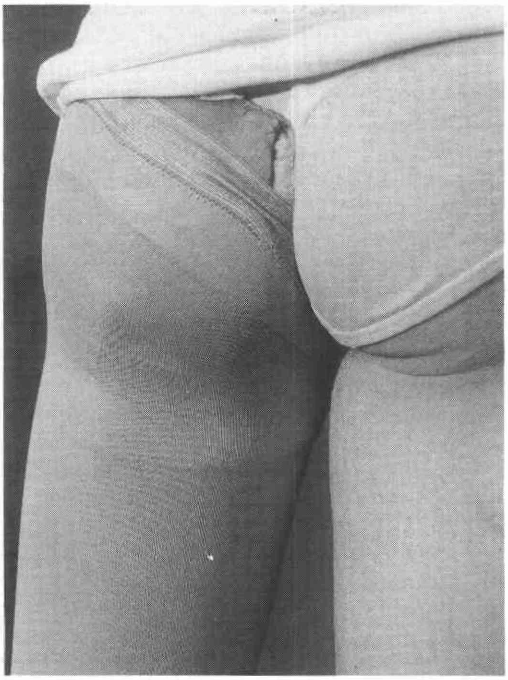

Figure 8. Posterior view of completed socket.

Acknowledgments

It should be noted that Mike Wilson, C.P.O., was the first person who suggested to me the principles of lateral pressure between the ilium and the trochanter on the contralateral side. He called it an "Inter Ilio Trochanter Effect."

Appreciation is given to Don Landis, B.S., R.P.T., for his editorial help in preparing this manuscript.

Appreciation is also given to Glenn Hutnick, C.P.O., and Alan Finnieston, C.P., who will be contributing to the next phase of research in hip disarticulation designs.

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