

# THE APPLICATION OF SACH FOOT PRINCIPLES TO ORTHOTICS

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## Introduction

At a recent meeting of the Problem-Case Clinic at the Veterans Administration Prosthetic Center, Dr. Eugene F. Murphy, Chief of the Research and Development Division, Prosthetic and Sensory Aids Service, suggested that the heel wedge principle of the SACH (Solid-Ankle Cushion-Heel) foot be used in certain orthotic appliances. In particular, it was recommended that the principle be applied to limited-motion ankle joints (about 5 to 10 motion) stiff ankle braces and posterior-stop (equinus control) ankle braces.

## The Function of the Heel Wedge in the SACH Foot

The function of the SACH Foot heel wedge in an artificial limb is to simulate plantar flexion by providing cushioning at heel contact in a foot rigidly attached to the shank (without an ankle joint). Exceptionally stiff, or hard wedges and bumpers will cause inadvertent knee buckling in a prosthesis. Similarly, an ankle joint that strongly resists or entirely prevents plantar flexion in a brace forces the wearer to take very short steps in an attempt to place his foot flat on the floor. If he takes normal strides, the high forces (Figure 1) between the calf band and the calf, at heel contact, will tend to rotate the shin forward about the heel, tending to buckle the knee unless the quadriceps are strong; thus often an above-knee brace with lock joints at the knee is provided.

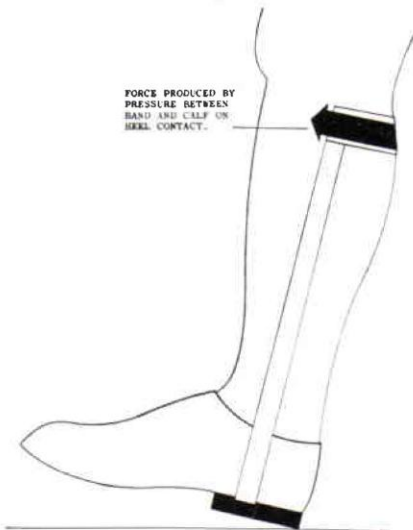


Figure 1

Leg Brace (or Below-Knee Brace) with no anatomical ankle motion allowable. The forces developed against the calf at the location of the calf band produce a moment which causes knee instability.

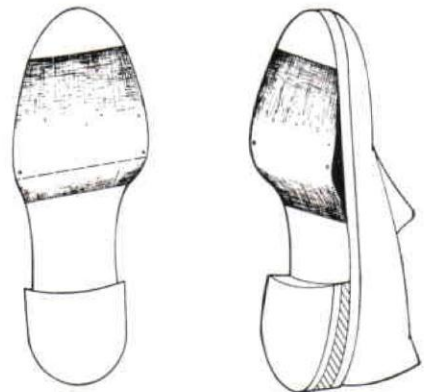


Figure 2

"Rocker" bar added to the sole of the shoe.

The heel-wedge principle, when applied to bracing permits a controlled plantar flexion as is now provided by many of the spring-loaded brace joints.

In contrast however, the damping action of the wedge occurs well below the natural ankle axis and reduces motion of the anatomical joint, a particularly significant feature for hemiplegics and arthritics or patients with painful bony fusions. The hemiplegic, in most cases, has a weak quadriceps condition which is susceptible to knee buckling. The damping effect of the brace wedge should not only minimize the tendency for knee buckling, but also should allow the hemiplegic to take longer strides during ambulation. The SACH Foot wedge will not only absorb shock and reduce the usually high posterior pressures in the calf area but will also permit a limited amount of inversion and eversion, reducing lateral calf band pressures when the brace wearer walks on uneven ground.

### The Use of a "Rocker" Bar to Simulate Keel Function

For stiff ankle braces, or braces limiting plantar and dorsi-flexion, the addition of a "rocker" bar (Fig. 2) just behind the metatarsal heads (in conjunction with the SACH Foot wedge) will provide the patient with a more natural roll-over from heel contact to push-off. The "rocker" bar, like the front end of the keel of the SACH foot, provides firm support until late in the stance phase, thus lessening support required of the toes. Also movement of the ankle joint and metatarsus are reduced, another feature especially helpful to patients with arthritis, fusion of part of the ankle, and other painful ankle and foot disabilities.

Patients with an ankylosed Chopart stump will also benefit from this technique since they experience the same problems as the orthotic types mentioned previously. The heel-wedge principle, when used with the rocker bar, stabilizes the entire ankle out to the metatarsals and should minimize much of the discomfort associated with this type of amputation, especially at heel contact and at push off.

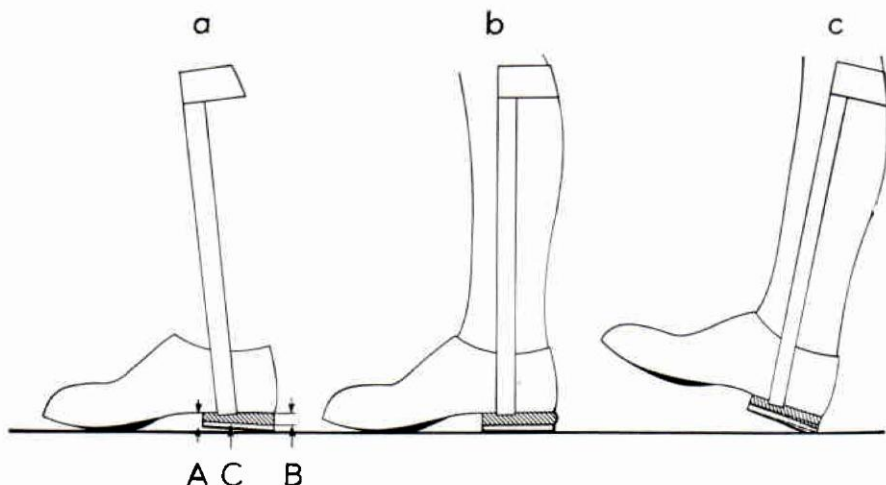


Figure 3

## Construction Methods

In Figure 3a the shoe is in slight dorsi-flexion with respect to the axis of the unweighted brace. The uncompressed wedge with "rocker" bar should have this appearance; i.e. only the posterior edge of the heel and the apex of the "rocker" bar should be in contact with the floor. Figure 3b shows the brace and shoe with wedge and "rocker" bar when under load with the uprights vertical. Note that the plane of the heel should be at 90° to the upright when under load in this position. Note also that the apex of the rocker bar is in contact with the floor. Figure 3c shows the dampening effect of the heel wedge at heel contact.

A simple method of installing the wedge was developed by Mr. Dominick Bonarrigo of the Orthopedic Shoe Section of the VAPC. The procedure for its installation is described in detail below as is the procedure for the installation of the "rocker" bar.

The wedge is made of "Pedic" sponge rubber of approximately 90 shore durometer. At the breast of the heel (A), Figure 3a, the wedge thickness is normally  $\frac{1}{4}$  to  $\frac{3}{8}$ ". At (B), it is usually  $\frac{1}{8}$ " thicker than at (A). The wedge dimensions can best be established by trial and error, i.e. temporarily glueing the wedge and heel to the shoe sole. To gain room for a wedge of maximum thickness the thinnest available conventional rubber heel is used. The wedge is glued to the shoe sole with STABOND. If a metal reinforcing plate is used on the exterior of the shoe sole, an epoxy adhesive should be used for fastening the wedge to the metal.

The heel (C) is then cemented to the wedge, also with STABOND. While cementing alone will perhaps be adequate as an extra precaution against accidentally tearing the heel away and against slow creep of the heel or wedge, five (5) nails are driven into the heel wedge and sole, and clinched inside the shoe. Due both to use of the nails and to the relatively thin heel, frequent replacement of the heel is recommended. Goodyear Neolite Edge Dye (brown or black) is used to dye the "Pedic" sponge rubber to provide a uniform appearance.

The "rocker" bar is usually made of "bends" leather or Neolite. Its apex is situated slightly posterior and parallel to the line between first and fifth metatarsal heads. The "rocker" bar is temporarily installed (with a few nails) to establish its optimum functional position. When it is located correctly, it is rough cemented and then joined with clinching nails around the outer border of the "rocker" bar.

## Clinical Experience

The wedge or wedge-rocker bar combination has been successfully used on fifteen (15) orthotic cases to date. Of the fifteen appliances, ten (10) were B/K weight-bearing braces (this type of brace was discussed in the June 1958 Journal\*), three (3) were leg-thigh ischial weight-bearing braces, and two (2) were positive-stop equinus-control ankle braces.

The B/K weight-bearing braces were prescribed for patients with such etiologies as non-unions of the tibia, partially anklyosed ankles, and other painful ankle and/or foot disabilities. Wedge rocker-bar combinations were used for all ten (10) patients; five (5) patients had stiff (stirrup) ankle joints, and the other five (5) had limited (5° to 10°) motion stirrups at the ankle. All of the patients felt that the wedge-rocker bar combination aided

\* *A below-Knee Weight Bearing Brace, William McIlmurray and Werner Greenbaum, Orthopedic and Prosthetic Appliance Journal, June 1958, 81-82.*

