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A KNEE-STABILIZING ANKLE-FOOT ORTHOSIS

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The knee-locking ankle-foot orthosis (KAFO) designed by Saltiel (*2*) appeared to be an ideal replacement for the double-bar KAFO customarily used for patients with paralysis of the quadriceps. However, initially we were unable to apply the concept successfully.

The problems encountered came about because of Saltiel's description of the basic fabrication technique, i.e., "it is indispensable to maintain the foot in a fixed equinus position because the force acting at the knee acts only as long as *the heel does not touch the floor*. (Italics ours.) The moment (*instant that*) the heel touches the floor the brace ceases to be functional." (*2*)

When the orthosis is fabricated and applied in the prescribed fashion, we found that the force exerted at the proximal-anterior segment of the orthosis produced pain. When this dominant complaint was eliminated, another cause of extreme discomfort came to the fore: the stresses produced in the popliteal area elicited a response to pain and then to patient rejection of the device because of the excessive hyperextension produced.

The AFO developed at VAPC eliminated both of these problems when certain conditions were met:

1) a knee-flexion contracture does not exist.

2) An adjustable ankle joint is included in the AFO to correlate the degree of equinus with the degree of knee hyperextension. This arrangement permits the heel to make contact with the ground before popliteal stresses can be introduced.

3) The orthosis should be prescribed for patients with impaired quadriceps on one side only. The orthosis should not be prescribed for patients with bilateral involvement.

The VAPC orthosis is illustrated in Figure 1. Proximally, the posterior force is applied at the level of the patellar tendon, and a patellar-tendon shelf is included in the orthosis. This area tolerates pressure well.

Distally, Pope[3] ankle joints are used, incorpo-

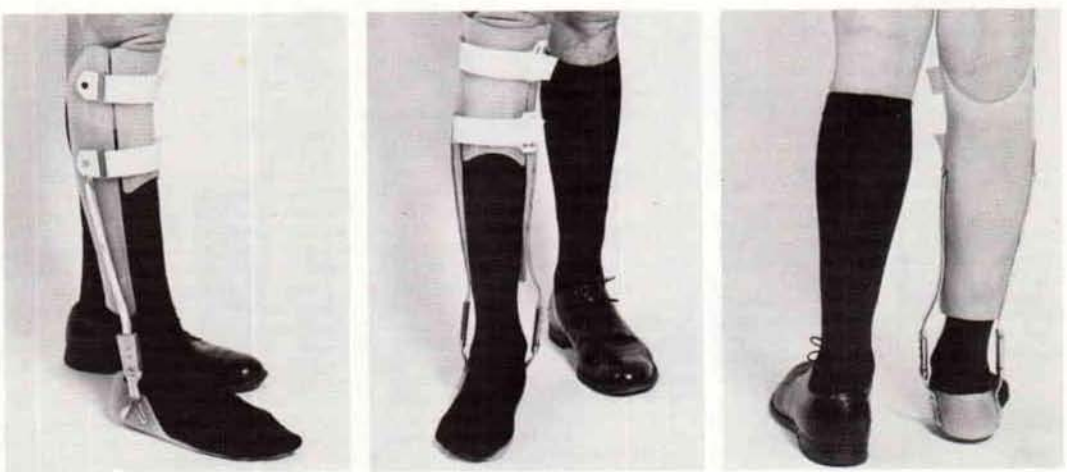

Fig. 1. Three views of the VAPC knee-stabilizing AFO.

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rating a spring in the posterior section and a solid rod in the anterior section to stop dorsiflexion. The dorsiflexion stop allows for equinus just sufficient to stabilize the knee. The amount of dorsiflexion can be controlled and can be "fine-tuned" during dynamic fitting. The spring loading permits adjustment for accommodation for stride variations. When the patient takes a long stride and strikes on the heel, the foot goes into the foot-flat position. With a rigid ankle, a "de-stabilizing" moment is introduced that flexes the knee.

We have found this to be a useful approach within the limits of the previously outlined criteria. However, it is our impression that it may be worthwhile to present not just the end result but all of the experimental devices tried, with a view to preventing others from unnecessarily following unrewarding courses we pursued.

After fabricating the Saltiel AFO as the developer described it (*1*), we decided to use polypropylene rather than a plastic laminate and to apply the anterior force to the patellar tendon (Fig. 2). Even this area could not tolerate the force that developed when the heel was not permitted to make contact with the ground.

In an attempt to overcome this problem, the device was designed according to Lehneis (*1*) (Figs. 3 and 4) to distribute the anterior force over a broad area. The immediate complaint by the patient was related to cosmesis (Fig. 5).

Fig. 2. Polypropylene version of the "Saltiel" orthosis. Included here are efforts to take rather large loads over the patellar-tendon area.

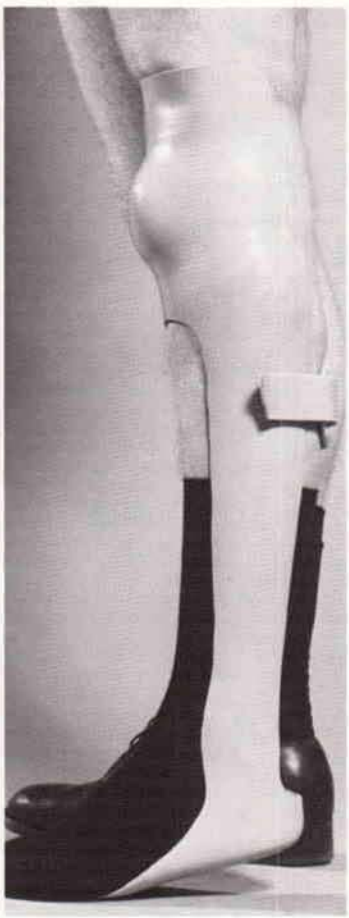

Fig. 3. Lateral view of orthosis patterned after Lehneis.

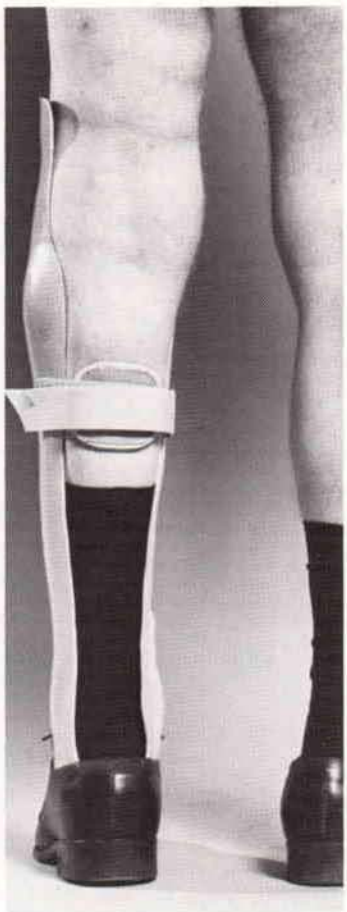

Fig. 4. Posterior view of orthosis patterned after Lehneis.

Fig. 5. View of patient in sitting position while using an AFO patterned after Lehneis. The cosmesis problem is self-evident.

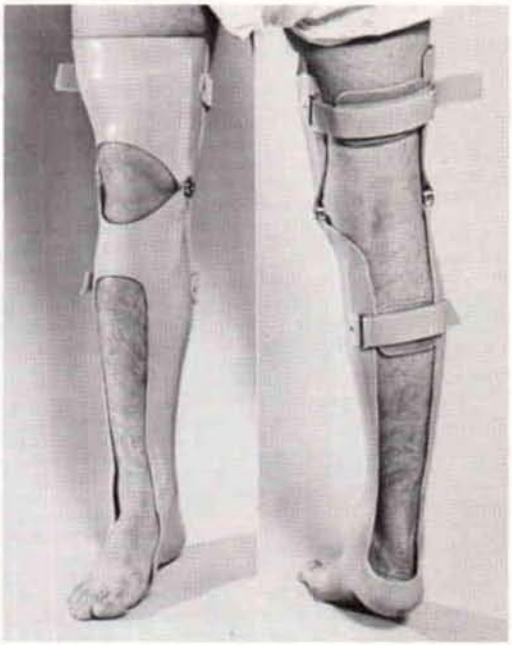

Fig. 6. Application of knee hinges to the Lehneis design to improve cosmesis. Cosmesis was achieved at the expense of excessive pressure in the popliteal area.

The cosmetic problem was overcome when hinges were introduced (Fig. 6) at the suggestion of one of our orthotists (Eugenio Lamberty, C.O.). When satisfactory cosmesis had been achieved the patient became more conscious of the stress in the popliteal area, and it became the principal source of pain and rejection.

This led to the use of a ratchet joint at the ankle (Fig. 7) with the view that the equinus would be adjusted to permit heel contact before excessive hyperextension stresses were introduced at the knee. In this fashion popliteal stresses could be avoided. In fact, the anterior force would be reduced to a minimum and an AFO could be used rather than a KAFO. The adjustments permitted by the ratchet joints were too coarse, but the principle seemed to be worth pursuing.

The orthosis reported at the beginning of this presentation was the final development and one that the authors believe to be useful, within the limits set forth.

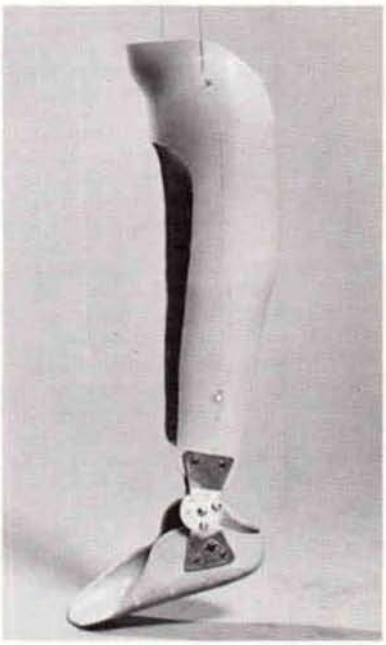

Fig. 7. Application of a ratchet-type ankle joint to the Lehneis design. Adjustments permitted by this particular ratchet were too coarse, but further work along these lines is recommended.

LITERATURE CITED

1. Committee on Prosthetics Research and Development (Report of) Seventh workshop panel on lower-extremity orthotics. *Orth. and Pros.*, 25:1:1–31, March 1971.

2. Saltiel, Jimmy. A one-piece laminated knee locking short leg brace. *Orth. and Pros.*, 23:2-68–75, June 1969.