A Single-Bar Above-Knee Orthosis

Robert O. Nitschke,* C.P.O.

I would like to present a different approach to the design of above-knee, or "long leg", orthoses. When weight-bearing is not necessary, I have been using a single-bar orthosis almost exclusively for three years.

The single-bar orthosis (Fig. 1) has been fitted successfully to patients with a variety of diagnoses. It is intended to exert slight to moderate forces in order to maintain knee stability during standing, and to maintain proper alignment of the leg during walking. It is contraindicated when large corrective forces are necessary for "heavy-duty" application and for weight-bearing.

* Rochester Orthopedic Laboratories, Rochester, New York.

DESIGN

The orthosis must be designed to meet the specific needs of each patient. For the orthosis to be made so that it will function effectively, an understanding of the bio-mechanical principles is required.

A simple experiment demonstrates that with a load of 150 lbs. on metal uprights when the knee joint is flexed 7°, a force of 20 lbs. is required to prevent the knee from buckling. When the knee joint is flexed 30°, however, the force required to prevent the knee from buckling is 80 lbs. Therefore, if

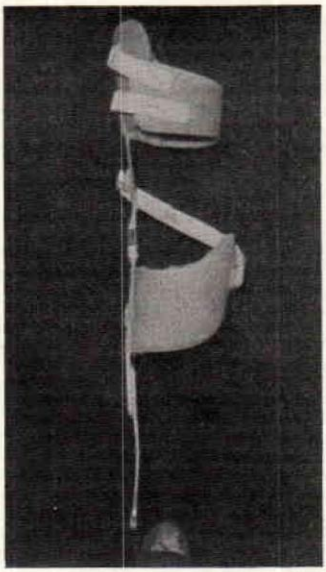

Fig. 1

Posterior view of the above-knee orthosis.

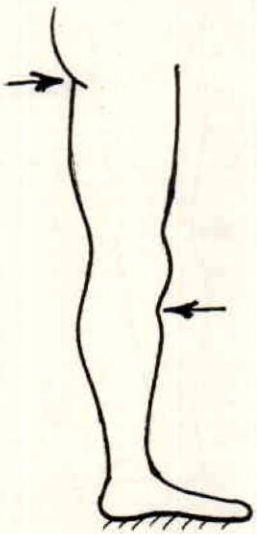

Fig. 2

Application of forces needed to control buckling of the knee.

the leg can be passively returned to near normal alignment, only small horizontal forces are required to maintain that position, and a single-bar orthosis can be used.

The fundamental supporting area common in each application is the foot. A half-stirrup is attached either to the shoe or to a shoe insert. The other two supporting areas necessary for a three-point force system are placed according to each individual's needs.

The single bar, which may be of either aluminum or stainless steel, runs on the lateral side from the ankle joint to a pre-tibial cuff, through a knee joint with a lock, to a thigh cuff (Fig. 1). This type of construction reduces the weight and bulk of the orthosis. A bar can be used on the lateral side when additional strength is required.

The pre-tibial cuff is made of synthetic balata (Polysar) and is carefully formed on the patient into a PTB shape with high medial or lateral portions, as desired, for control of valgus or varus. It is reinforced with a strong aluminum band. The thigh cuff is made of metal covered with leather, and may be either the open or closed type.

A unique feature of this orthosis is the 1-inch wide dacron strap which closes the posterior part of the pretibial cuff. It is fastened at the lateral bar 3 or 4 inches below the knee joint, runs diagonally across the popliteal area through a metal loop at the pre-tibial aluminum band and laterally upward to the side bar again, making a three-point attachment which loosens when sitting and tightens when standing (Fig. 1). This provides comfort when sitting, as well as control during the stance phase of gait.

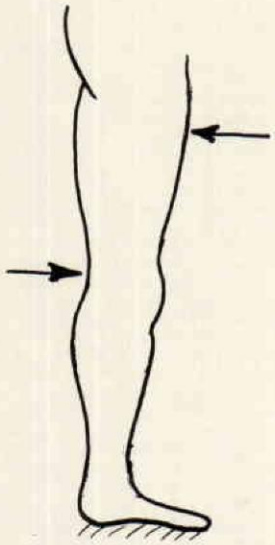

Fig. 3
Application of forces needed to control genu recurvatum.

Another unique feature is the optional use of a Silesian belt that goes around the hip and attaches to the side bar. By attaching the belt below or above a trochanter pad, control of hip abduction or adduction is obtained if needed. The patient sometimes objects to the belt and the initial feeling of restriction, but, in most cases, the patient has more control and unweighting of the orthosis is made possible.

Another benefit of the single-bar design is that placement of the ankle and knee joints is simplified, and changes or modifications can be made easily.

APPLICATION

To control buckling of the knee, the force system as shown in Figure 2 is used. The most effective area to prevent knee flexion is the anterior-proximal tibia, not the patella. The posterior counterforce should be just below the gluteal fold and somewhat lateral, where the femur is located.

The force system to control genu recurvatum is shown in Figure 3.

The orthosis must be designed to force the knee into flexion, and the patient must be trained not to force the knee into hyperextension. It is not always possible to use the single-bar orthosis for this condition because the Dacron strap does not provide solid support posteriorly. In the case of severe recurvatum it is necessary to use the conventional double-upright orthosis with forces applied on the posterior femoral condyles and anterior thigh.

The force system for control of valgus of the knee is shown in Figure 4. The support areas should be the medial aspect of the femoral condyles and the lateral thigh just distal to the greater trochanter.

The force system to control varus of the knee is shown in Figure 5. The support at the lateral side must be shaped accurately so there will

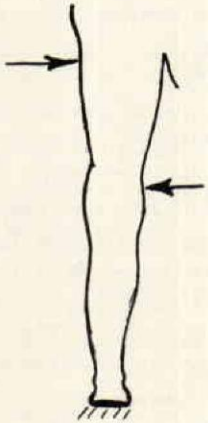

Fig. 4
Application of forces needed to control valgus of the knee.

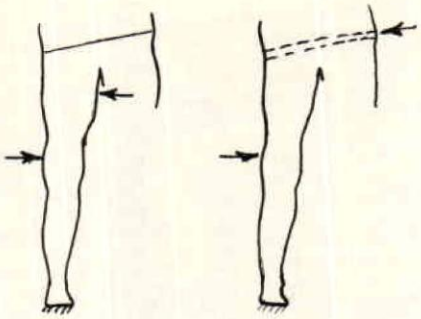

Fig. 5

Application of forces needed to control varus of the knee. Left, when a Silesian belt is not used; right, when a Silesian belt is used.

be no pressure points. To apply the counter-force at the medial aspect of the proximal thigh is not very effective or comfortable because this is a soft and most sensitive area. A Silesian belt can be used effectively to pull the side bar against the lateral aspect of the thigh and leave the medial aspect free.

EXAMPLES OF APPLICATION

The patient shown in Figure 6 is

Fig. 6

A 70-year-old female patient with Charcot knee.

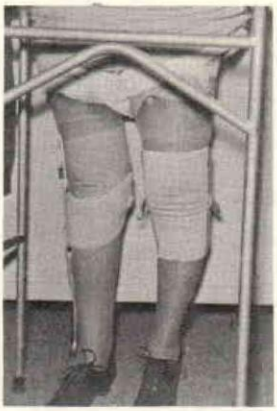

Fig. 7

The patient shown in Figure 6 fitted with a single-bar above-knee orthosis.

a 70-year-old female with a Charcot knee. When bearing weight her right knee goes into 45-50° of valgus. For 15 years she wore elastic knee cages but could walk only a few steps even with the aid of a walker. Her leg can be brought into natural alignment passively.

A single bar orthosis was fitted to her (Fig. 7). The pre-tibial shell was made high medially, and an aluminum knee joint and side bar were used. Quite small forces were

Fig. 8

A male patient, veteran of World War II.

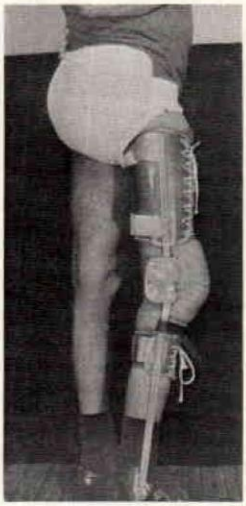

Fig. 9

Patient shown in Figure 8 with orthosis that forced hip and knee into flexion.

required to hold her knee in position, and she is now walking with the aid of only one cane.

The patient shown in Figure 8 is a veteran of World War II. His

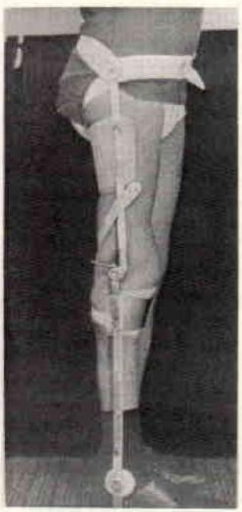

Fig. 10

Lateral view of patient shown in Figure 8 with single-bar orthosis.

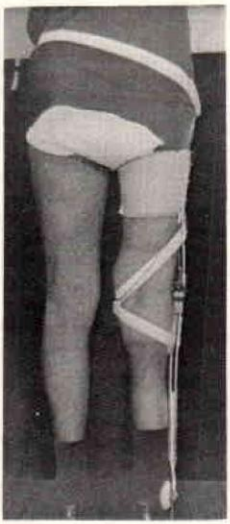

Fig. 11

Posterior view of patient shown in Figure 8 with single-bar orthosis.

previous orthosis (Fig. 9) forced his knee and hip into flexion causing pressure boils in the gluteal area and effective shortening of the limb. He was fitted with a stainless steel dual-bar orthosis as shown in Figures 10, 11, and 12. Note particu-

Fig. 12

Lateral view of patient shown in Figure 8 with single-bar orthosis sitting, with the knee in extreme flexion.

larly the natural alignment and comfort in sitting.

A 15-year-old male paraplegic patient, who sustained a spinal cord injury at the L1-L2 level and who had about 15 per cent of hip flexor and extensor power remaining, was fitted with two single-bar aluminum orthoses. The Silesian belts permitted effective control of hip motion without need for cumbersome pelvic bands and metal hip joints. Medial uprights were not needed, resulting in greater freedom of motion and more comfort.

SUMMARY

It is not necessary, except in severe cases, to enclose the complete leg from top to bottom with metal bands, leather straps, and knee-pads in order to give sufficient support for stability and ambulation. I am convinced that the much simpler designs are more effective and will be welcomed by patients, physicians, and orthotists alike.