The Knee-Ankle-Foot Orthosis (KAFO)

44.1 Orthosis Variations

Although knee-ankle-foot orthoses have long been used for various indications, there have been a number of changes in manufacturing methods (see Manufacturing Methods: Comparison) and model variations - particularly in recent years. A big step forward was made in Italy by Dr. A. Ferrari, who was the first to use an anterior thigh cuff to protect the still-functioning quadriceps muscle against contractures and make sitting with the orthosis more comfortable. Another feature to enable smoother walking is in the ankle joint movement of up to 15 degrees. What's new here is the use of dorsiflexion stops (82 to 80 degrees) adjusted to the strength of the knee extensor muscles. But this movement may be permitted only in the ankle joint, and presupposes that the subtalar and lower foot joints are well controlled by the orthosis.

44.2 The Ankle Joint

Where muscles crossing the ankle joint are disabled, a limited motion double-action ankle joint with a foot-lifting function or a center-of-gravity actuated ankle joint with power unit is used to increase stride length.

44.3 Prerequisites for Knee-Ankle-Foot Orthoses

Patients with such an orthosis should have good sense of space and balance, and not have any attention deficits. Good trunk mobility in the frontal and sagittal planes must be present. Severe skeletal or joint deformities, such as severe scoliosis, flexion contractures of the hips or torsional deformities of the legs can lead to impaired gait and make it unfeasible to use a KAFO.
44.4 Demands on the Orthosis

To permit reliable walking and standing, the orthosis must hold and control foot position, as well as support the leg (via the condyles if required). In addition, using posterior offset orthotic knee joints can aid the absence of knee flexion components and better utilize residual strength of the quadriceps muscle. The ankle joint can be provided with 0 to 15 degrees of movement, depending on deformity and activity level. The ankle joint must also provide a foot-lifting function during the swing phase. The sole of the orthosis and accompanying footwear must be adapted during dynamic fitting to allow a smooth, economical gait.

44.5 Functional Classification of Knee-Ankle-Foot Orthoses by Lesion

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44.5.1 Deficit at Lesion Height L4

Not only the entire foot and lower leg muscles are affected, but also to some extent the knee extensors, hip extensors and hip adductors, with the exception of adductor longus. Primary or birth deformities include hip dislocations on one or both sides, flexed, adducted hips (with restricted mobility), genu recurvatum and club foot. Without orthotic support, free standing and walking are only rarely possible. For hip extension, additional support by the upper extremities is usually required.

44.5.1.1 Orthotic Management with Salera Orthoses

Variations in paralysis result from lesion areas crossing over several segments. This results in differences in orthotic management as well. For example, in the L4/5 lesion, it could be best to start with a HKAFO using partly limited 3-D hip joints. Ambulators with good endurance may experience an increase in partial activity of the gluteus medius and minimus muscles. In such cases, the patients can be subsequently transferred to KAFOs with pelvic band as designed by A. Ferrari (using T-shaped uni-axial hip joints without flexion / adduction stops, sacral pad, and crossing gluteal bands to assist the external hip rotators). In rare cases, reliable walking and standing at this lesion height are achieved even without the pelvic band.

44.5.2 Deficit at Lesion Height L5

Not only the foot and lower leg muscles are affected, but also the knee flexors, hip abductors and hip extensors. Primarily, a varusupinated stiff talipes equinus, and possibly a tibial torsion deformity may be present. Without orthotic support, the knees are flexed and the arms are used to shift the body weight posteriorly to compensate for hyperlordosis. If secondary hip flexion contractures are pronounced, the patient requires arm supports.

44.5.2.1 Changing to Ankle-Foot Orthoses

Variations in paralysis result from lesion areas crossing over several segments. This results in variations in orthotic management as well. For example, in the L5/S1 lesion, the orthosis of choice is preferably with KAFOs at first for inexperienced ambulators. With children 4 years and older, gait observation in the frontal plane (with help from video recordings), supported by ligament stability tests and adequate knee stability, can be used to decide whether to change to AFOs with supracondylar support.

44.5.3 Deficit at Lesion Height S1

This affects the intrinsic foot musculature, plantarflexors, knee flexors and partly the hip extensors (principally gluteus medius). Primarily, varusupinated talus equinus with tibial internal rotation, talus verticalis, or a weak foot deformity may occur. Without orthotic
support, the upright position can only be achieved by standing on one spot and pushing the knees together, or by means of additional external support.

44.6 Pendulum Gait

The first step is initiated by shifting the weight onto the supporting leg with simultaneous extension of the hip. The lateral tilting of the trunk to the supporting leg side allows the free leg to be lifted. The swing leg is then moved forward by rotation of the pelvis.