The Use of Dynamic Orthoses in Reducing Knee Flexion Contractures in a Pediatric Patient with Myelomeningocele

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Introduction

Joint contractures may develop as a result of spastic muscle activity or prolonged immobilization.[1] It has been observed that, regardless of the etiology, the resultant pathophysiological changes are similar.[2] These include the remodeling of both the associated connective tissues and the muscles themselves to accommodate their shortened state.[3,4] Sound rationales have been presented on the importance of both "total end range time,"[5] and "low-load, prolonged stretching"[6] in clinical attempts at reversing the biological processes of contracture development. Dynamic-assist orthotic joints represent another treatment modality in which the orthosis actively stretches the contracted joints at a clinically determined torque and duration.

Among those patient populations at risk for contracture development are children with myelomeningocele. Contractures of the knee flexors are commonly observed, particularly among those children with a spinal defect at L3 or proximal, and those who are non-ambulatory.[7] While surgical release of knee flexion contractures has been widely reported,[7,8] we report on a single case in which significant knee flexion contractures were reduced using custom night-wear KAFOs incorporating dynamic extension-assist knee joints.

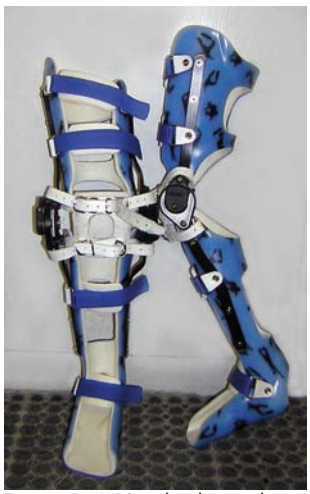

Figure 1: KAFO nightsplints with dynamic extension-assist knee joints laterally.

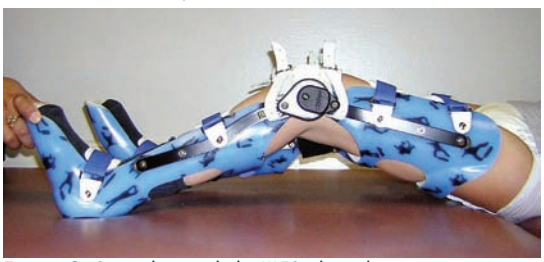

Figure 2: Case subject with the KAFOs donned.

Case

The subject presented at our office with a prescription for custom night-wear KAFOs with Ultraflex extension-assist joints at the knee. He was an eight-year-old male with low thoracic spina bifida. A chart review reveals a long orthotic history, comprising primarily solid AFOs, with limited daily use of parapodiums/swivel walkers. The child underwent anterior tibial tendon transfers at age five. The first mention of knee flexion contractures occurred when the child was six years old. These appear to have developed, in part, following a tethering of his spinal cord and the resultant spasticity. At our initial evaluation, the child's end-range knee flexion contractures measured approximately -40 degrees with the left knee slightly more contracted than the right knee.

The patient was provided bilateral custom KAFOs with a solid ankle. The devices were fabricated out of 5/32-in. low-density polyethylene to allow some movement in the transverse plane in an attempt to improve patient compliance. The inner surface of the orthosis was lined with 1/4-in. aliplast, except at the heel and posterior proximal thigh section, where 1/2-in. aliplast was used. Posterior cutouts were incorporated at the thigh and calf sections to reduce heat retention in the orthosis. Stainless steel knee joints with adjustable flexion stops were utilized on the medial and lateral uprights (Ultraflex KO SS1) with medium torque extension-assist power units (Ultraflex KO P3) utilized laterally on both orthoses (See Figures 1 and 2).

The devices were delivered according to the current protocols of our clinic when dynamic extension-assist joints are utilized: Patients initiate use of their night-wear orthoses with minimal torque settings (1/7 units). Flexion stops are set to allow approximately 15 degrees of motion beyond their R1 flexion angle, or the angle at which extensions resistance is initially encountered. Following the parent's demonstration of appropriate donning of the device, the patient is asked to lie in the brace for 20 to 30 minutes and

Table 1. Knee ROM values, stop settings, and torque amounts at successive follow-up appointments.

Date	R1 right	R2 right	R1 left	R2 left	R f. stop	L f. stop	R torque	L torque
5/17	-35°	-25°	-45°	-30°	-50°	-65°	1.5	1.5
5/31	-30°	-20°	-40°	-30°	-50°	-65°	1.5	2.0
6/14	-25°	-15°	-35°	-23°	-40°	-50°	1.5	2.0
7/06	-25°	-18°	-30°	-20°	-40°	-45°	2.0	2.5

then is checked for heel placement and redness over boney prominences. If these areas are positive, they are adjusted and a second trial is performed. If they are negative, then the patient is released and encouraged to increase wearing time until the orthosis can be regularly tolerated throughout the child's sleeping hours. An initial follow-up is scheduled for one to two weeks, with additional follow-up appointments approximately every three weeks. At every follow-up appointment, R1 and R2 values are reassessed. Torque settings are only increased if there have been no measurable reductions in the R2 values, or the end ranges of motion. Such increases are never in excess of one torque unit. Flexion stops are regularly adjusted to prevent flexion of greater than 15 degrees beyond the child's current R1 values.

The child was seen back for regular follow-up appointments. The various range of motion values, along with the position of the flexion stop and the torque settings of the power unit obtained during these visits are listed in Table 1. At the publication deadline, the child continued to wear the devices bilaterally throughout the night according to the protocols described. Further reductions in knee flexion contractures are anticipated.

Discussion

In their discussion on the use of dynamic orthoses in the management of joint contracture, Farmer et al. stated that "Successful treatment will depend on use of the appropriate device with a suitable regime of treatment." (Farmer 05) In our experience, the appropriate device refers not only to the type of dynamic joint utilized, but to the entire construction of the orthosis. While the orthosis should ensure the efficient transfer of the dynamic stretching component in the desired plane, the facilitation of some motion in other planes or at adjacent joints may serve to augment patient compliance. Patient compliance also may be affected by reducing the surface area of the orthosis via strategic windows or "cut-outs" and the incorporation of adequate padding, particularly in those areas where the greatest amount of force will be experienced.

In addition to proper construction of the orthosis and adherence to an appropriate treatment regime, we have found patient selection to be of paramount importance. Children with myelomeningocele and their families often are regularly seen by specialists in orthopedics, physical medicine, physical and occupational therapy, and urology. Thus, the demanding follow-up protocols used in our office simply may be more than a family is willing or able to commit to. Families should be made aware of the need for multiple follow-up appointments prior to fabrication of the device. An adequate degree of commitment to the proposed treatment should be ensured before an expensive, cumbersome, hot, time-consuming orthosis is provided.

However, in our recent experiences, when dynamic-assist joints are utilized in an appropriately designed orthosis, for properly selected patients according to an appropriate treatment regime, clinically apparent reductions in joint contracture may be realized.

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