

Variable Abduction HKAFO in Spina Bifida Patients

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The spina bifida child who has an intact lumbar neurosegment at the L3-4 level without distal motor function has a high risk of hip dislocation during the first year of life because the hip flexors and adductors are not balanced by hip extensors and abductors. These children have functioning quadriceps, and when this set of muscles develops sufficient strength, the patient has potential for ambulation. Therefore every effort should be made to maintain hip reduction for better mechanical support and gait efficiency.

Neurosegmental lesions below L4 may also result in hip subluxation that progresses to dislocation, and should thus be reduced. Lesions above L2 with only hip flexors and hip adductors and without a functioning quadriceps, and those who have little or no hip muscle activity do not require operative hip reductions, especially when the condition is bilateral. The degree of ambulation is necessarily limited, and whether the hips are reduced or dislocated has not been demonstrated to influence eventual gait performance.

At the Birth Defects Center at the University of Rochester, we are following 95 children with spina bifida, as a multidisciplinary team effort. Orthopaedics is involved, often prior to back closure, in the initial comprehensive evaluation. A complete examination is performed with special emphasis on the musculoskeletal system. Functioning muscle groups in the lower limbs and any significant spinal, hip, knee or foot deformities are documented.

Serial cast correction of foot deformities is begun when the patient is first seen. Physical therapy is initiated and parents are given specific instruction for exercise of the hips, knees, and feet. Faradic muscle stimulation is performed early in determination of baseline data, and is repeated at periodic intervals.

This article is a preliminary report on the use of a new variable abduction hip, knee, ankle, foot orthosis (HKAFO) in six spina bifida patients.

The orthosis was designed originally because there was no adequate program for maintaining hip reduction without producing resistant hip flexion-abduc-

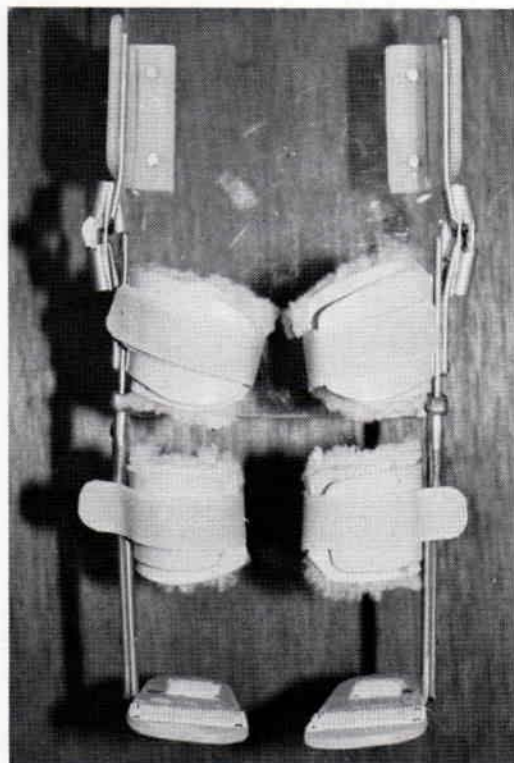


Fig. 1. Variable abduction HKAFO in neutral position showing Velcro foot plates.

tion contractures. Our hypothesis is that hip alignment can alternate between the reduced and adducted-extended position to accomplish reduction and prevent flexion-abduction contractures.

The orthosis (Figs. 1 & 2) has bilateral uprights which are attached to a Plexiglass or polypropylene back support. The hip position is controlled by a bi-directional stainless steel hinge with pre-set angles (Figs. 3 & 4). Thigh and calf supports are made from either sheepskin or Kydex lined with Pelite foam. Velcro straps are used to restrain the legs. No permanent padding is used on the back support in order to avoid soilage problems. The knee joints are the single axis type with drop locks that allow flexion

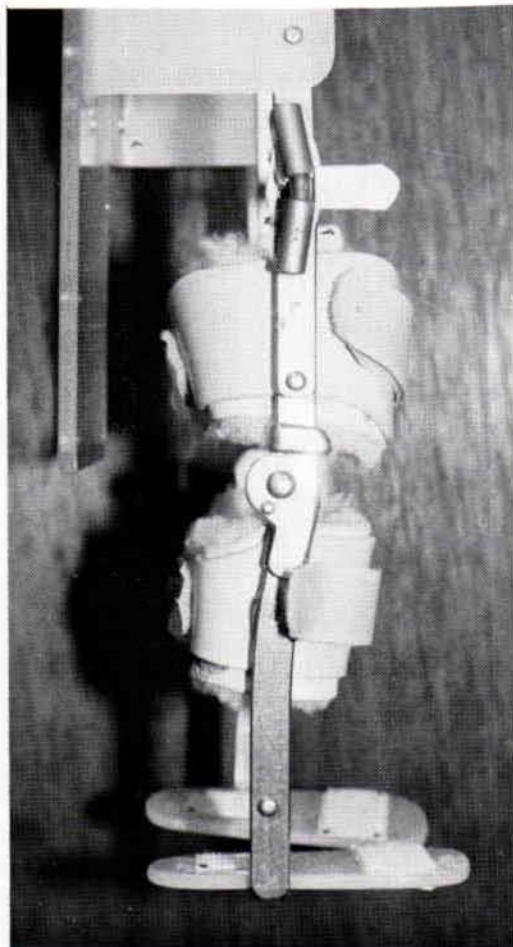


Fig. 2. Side view of variable abduction HKAFO in neutral position. Note variable hip position joint, drop lock knee, and 45-deg. knee flexion stop.

from 0 to 45 deg. The lateral bars are attached to a polypropylene foot piece. Ankle joints are not provided. The shoes are attached to the footplate with Velcro tape.

The entire orthosis can be converted into a standing brace by attaching it to a plywood frame with metal uprights that hold the back portion rigid. This frame may be used prior to the age that they can satisfactorily use a more conventional standing brace or Parapodium.

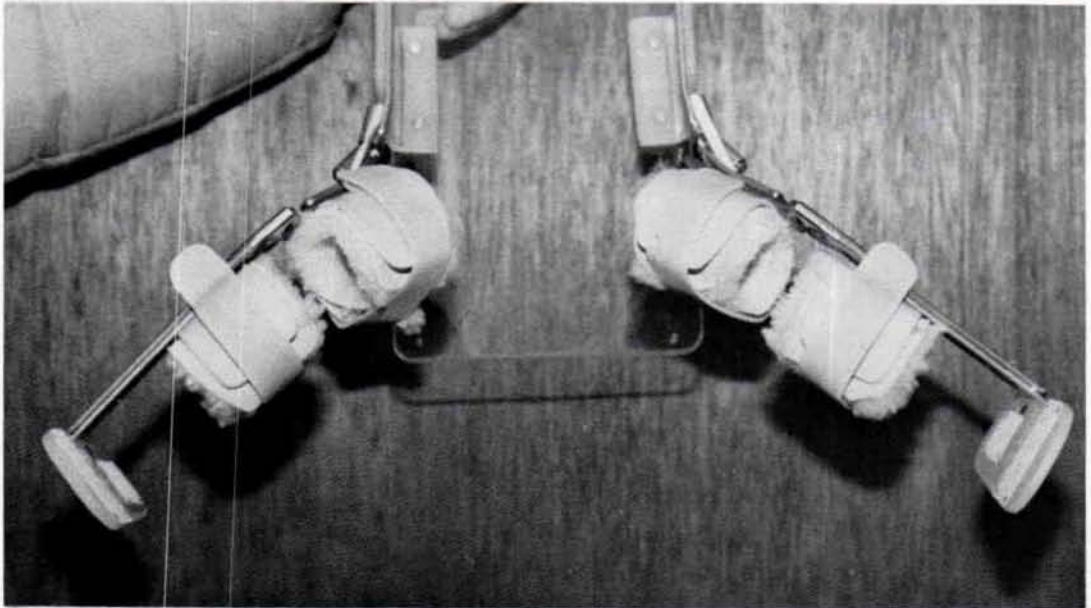


Fig. 3. Anterior view of the variable abduction HKAFO showing flexion, abduction, and internal rotation features. The exact position is determined by the clinical examination.

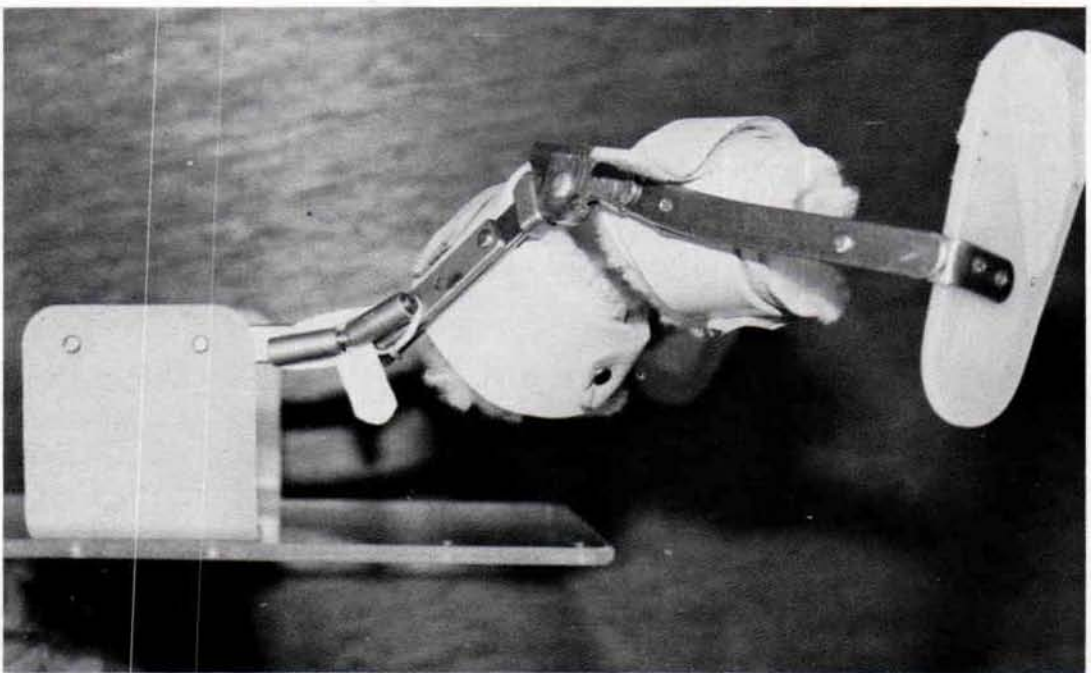


Fig. 4. Lateral view of flexion, abduction, and internal rotation of the variable abduction HKAFO. Note hip lock tab is now down.

Patient Material

1. K.P. (97-39-49), is a 13-month-old white female with a lumbar meningocele and an L4-5 neurosegment level who underwent back closure on the third day of life. At three months of age, right hip subluxation was noted and the variable abduction HKAFO was fitted. Initially, she was in the orthosis for 16 hours in the flexed abducted and internally rotated position and then four hours in the neutral position and four hours out of the orthosis. She began Parapodium ambulations at 13 months of age, but has continued to use the variable abduction HKAFO for 15 hours per day in the flexed position. She will require hip stabilization surgery to maintain reduction.

Comment: The hips have been maintained in a reduced concentric position during the time the variable abduction HKAFO was used. However, she will require hip muscle stabilization for maintenance of reduction. Use of the orthosis has delayed the immediate need for hip surgery and has allowed her to grow.

2. B.I. (98-01-32), is a five-month-old white male with a lumbar meningomyelocele and a partially intact L3-4 neurosegment level. He underwent back closure on the third day of life. At birth he had bilateral 30-deg. hip flexion contractures. Hip abduction was 30 deg. bilaterally. At three weeks of age, subluxation of the left hip was noted radiographically, and at five weeks the variable abduction HKAFO was ordered but was not used due to religious conflict. At five months of age passive abduction had increased to 80 deg. and there was no hip subluxability. He was fitted with the variable abduction HKAFO and a flexed position was maintained for 15 hours per day.

Comment: The hips remained reduced in spite of his not using the orthosis ini-

tially. Abduction will be continued at night, and he has been fitted for a Parapodium.

3. J.D. (93-72-57), is a two-year-old white female with a lumbar meningocele and an intact L3-4 neurosegment level whose back was closed at two days of age. The variable abduction HKAFO was started initially when she was seen and the flexed position was maintained for 16 hours, the neutral for four hours, and for four hours no orthosis was used. At 13 months of age she sustained a right femoral fracture, and the variable abduction HKAFO was used as an external splint in the extended position until healing was noted. At 15 months of age the right hip, and at 20 months of age the left hip noted to be subluxed radiographically. The variable abduction HKAFO was used at night in the flexed position and was attached to a standing brace during the daytime. At two years of age she underwent bilateral hip stabilization procedures consisting of adductor transfer, external oblique transfers, and varus derotational femoral osteotomies.

Comment: She is using the Parapodium now and has active hip abduction. The hips are reduced and are well maintained.

4. S.J. (91-73-74), is a three and a half-year-old white male with a lumbar meningomyelocele and an intact L3-4 neurosegment level. He had a left hip dislocation at birth. An abduction splint was used initially, which maintained the reduction, but an abduction contracture developed prior to the development of the variable HKAFO. At six months of age the variable abduction HKAFO was fitted and used in the flexed position for 16 hours, neutral for four hours, and out of the orthosis for four hours per day. The abduction contracture gradually regressed. He began ambulation with a

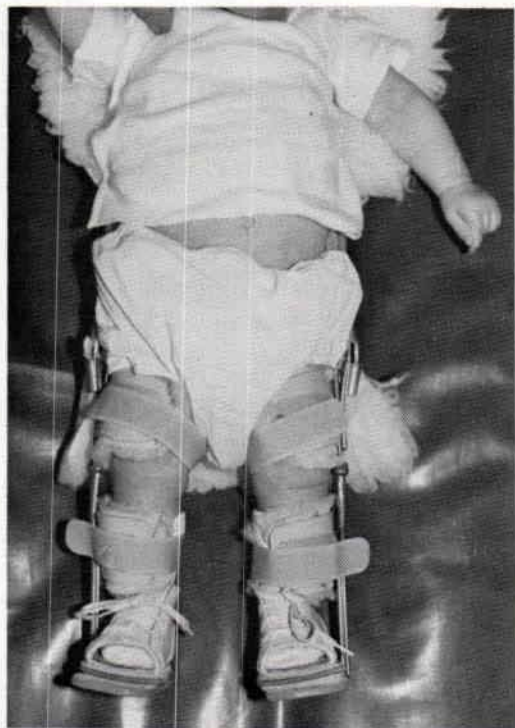


Fig. 5. Four-week-old patient in the variable abduction HKAFO.

Parapodium at 15 months of age, and right hip subluxation was noted at 20 months of age. The variable abduction HKAFO was used only at night. He underwent bilateral varus derotational femoral osteotomies at 27 months of age. Post-operatively the variable abduction HKAFO was used in the flexed position for 12 hours, seven hours in the neutral, and five hours out of the orthosis per day. At three years of age the internal fixation devices were removed and the variable abduction HKAFO was used at night with Parapodium use during the daytime. His latest X-rays demonstrate left hip subluxation.

Comment: The orthosis held his hips in the reduced position. However, left hip reduction could not be maintained. He will require hip stabilization surgery.

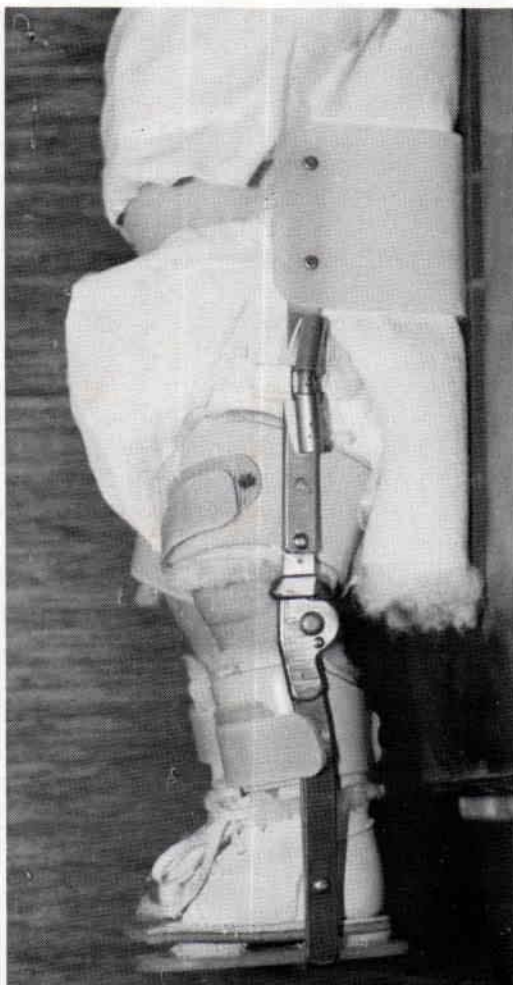


Fig. 6. Lateral view of the patient shown in Figure 5. The sheepskin padding protects the skin from excessive pressure.

5. B.M. (95-50-77), is a two-year-old white male with a lumbar meningomyelocele and an intact L4 neurosegment level who had early back closure and required a VP shunt at four weeks of age. He underwent bilateral posterior foot releases at three months of age. He began using the variable abduction HKAFO at seven months of age for 14 hours in the flexed position, three hours in the neutral position, and seven hours out of the orthosis per day at which time he was using his Parapodium. At 20 months of age

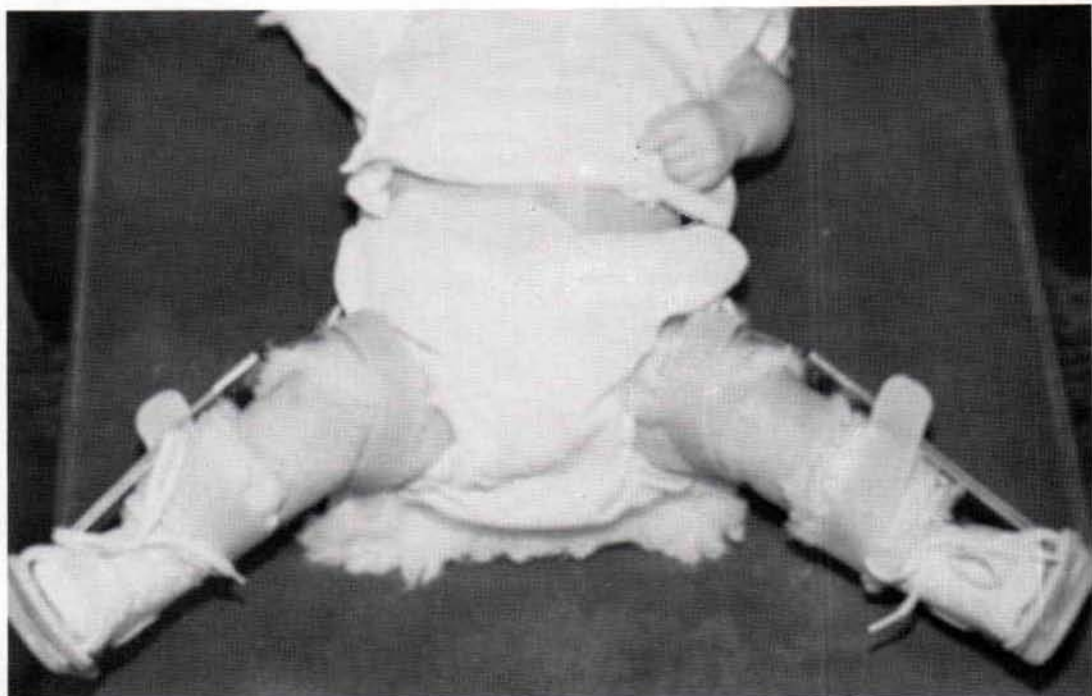


Fig. 7. Anterior view of the patient shown in Figure 5 with flexion at 30 deg., abduction at 45 deg., and internal rotation at 15 deg. Sheepskin posteriorly can be removed for cleaning.

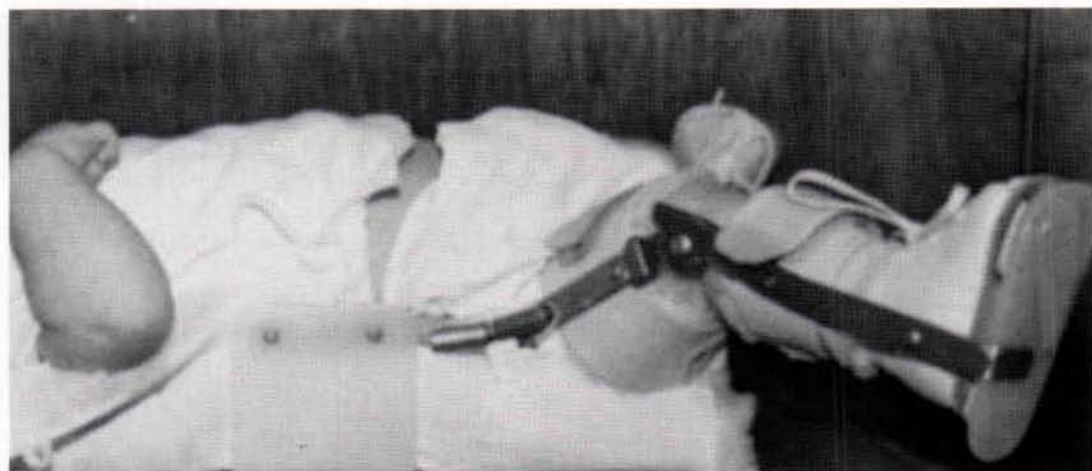


Fig. 8. Lateral view of patient shown in Figure 5. The 45-deg. knee flexion stop allows a natural position.

he had reciprocal gait. Hip abduction was to 25 deg. passively, and he is presently using the variable abduction HKAFO in the flexed position for nighttime and nap use. The remainder of the

time he is either using his Parapodium or has no restraints.

Comment: No hip surgery is planned. Hip reduction has been maintained.

6. J.S. (101-64-19), is a 10-week-old white female with a lumbar meningo-myelecele and an intact L3-4 neurosegment level who underwent back closure within 24 hours of birth. The left hip could be subluxed. She had bilateral calcaneal foot deformities due to unopposed anterior tibial activity. Splinting of the foot deformities was started. The variable abduction HKAFO was applied at four weeks of age (45 deg. abduction, 15 deg. internal rotation, and 30 deg. flexion). (Figs. 5, 6, 7, 8). The flexed position was used for 16 hours, neutral for four hours, and the orthosis was left off for four hours.

Comment: She has a subluxable left hip and will probably sublux her right hip. It is too early to evaluate the results of the orthosis. Her hips should be reduced and maintained as she is potentially a community ambulator.

Discussion

This is a report of our first attempts at early external hip stabilization by using a variable abduction hip, knee, ankle, foot orthosis. The neurological level can be well documented soon after birth, and the prediction of hip instability anticipated, especially in those cases where the L3-4 neurosegment level is intact. If the position of hip reduction can be maintained early in life, the need for surgery may be prevented or delayed until the child is older and the anatomical structures are of more substantial size.

The reason for varying the hip position is to avoid fixed hip flexion-abduction contractures, which would make Parapodium standing impossible without further surgical releases. Hip spica casts, harnesses, and static abduction splints are used effectively for the child with hip dysplasia in the absence of muscle imbalance. Children with hip muscle imbalance secondary to spina bifida do not tolerate long periods of time in one position.

The exact degree of hip position is determined by the clinical and radiographic examination of maximum hip stability. This is usually 30 to 45 deg. flexion, 30 deg. abduction, and 10-15 deg. internal rotation. We have used an initial program of 16 hours flexed and abducted, 4 hours in neutral and 4 hours out of the orthosis. The timing has been empirical, the flexed and abducted positions being maintained to the point where they can just be reversed by the neutral position. The orthosis may be used effectively even when casts or splints are applied for foot correction. We strive to position these children upright in the Parapodium at approximately 12 to 15 months of age, which is the time the normal child is beginning to stand and walk. We would like to have the major surgical procedures, especially to the hips and feet, completed as soon as possible to avoid repeated hospitalizations.

Summary

This is an initial report of six patients with lumbar meningo-myelecele who have been treated with a variable abduction HKAFO as part of their early comprehensive therapy. It is too early to tell whether this will have a significant effect on preventing or delaying hip surgery, and further follow-up is currently being carried out. Our main objective is to maintain hip reduction in those patients who will be functional community ambulators (intact L3-4 neurosegment level), without introducing further complications (hip flexion-abduction contractures).

Footnotes

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