Ambulation with the reciprocating-gait orthosis

Experience in 15 children with myelomeningocele or paraplegia

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We reviewed 15 children with spina bifida or paraplegia who have used a reciprocating-gait orthosis between 1985 and 1995. All were nonfunctional ambulators. The level of the spinal lesions ranged from Th10 to L3. The mean age of fitting the orthosis was 5 years. 8 children have stopped using it at an average age of 10 years. The maximum ambulation level with the orthosis was a community ambulator in 4 children, household ambulator in 9 children and 2 remained nonfunctional ambulators. The average daily use was 6 hours by community ambulators to 0.5 hours nonfunctional ambulators. Bilateral dislocations of the hip, mild flexion deformities of the hips and knees and scoliosis were well tolerated with orthotic wear. Since functional ambulation could be achieved in 6 children with no quadriceps power, the use of this orthosis can be advocated for upper lumbar and low thoracic lesions. Strong motivation, realistic goals and expectations, the ability to participate in a training program and journeys for frequent orthosis repairs are of importance for successful use of this orthosis.

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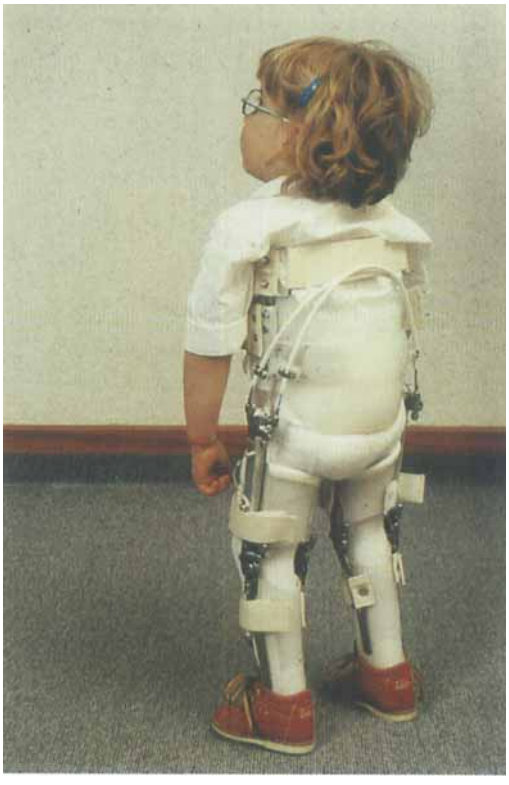
Submitted 96-12-07 Accepted 97-05-14

Functional ambulation is difficult for children having spina bifida with lesions above the level L2-L3 (Hoffer et al. 1973). Hip-knee-ankle-foot orthoses and crutches can give paraplegic patients having a distal lesion the opportunity to stand and walk, but this is usually not achieved by children with a thoracic lesion. The reciprocating-gait orthosis provides a more natural and energy-efficient four-point gait (Douglas et al. 1983, Mazur et al. 1990). This device consists of a trunk support, a pelvic band and bilateral knee-ankle-foot orthoses, which are connected with dual-cable movable hip joints (Figure). The coupling of both hips gives hip stability during standing by preventing simultaneous flexion. Flexion in 1 hip activates the cable system to extend the contralateral hip, permitting ambulation. Disconnection of the hip and knee joints permits simultaneous flexion for sitting. The knees can be locked in extension for standing and ambulation. Although the initial experience with this device was optimistic, reporting long-term usage, improved ambulation and energy consumption (Yngve et al. 1984, McCall and Schmidt 1986), we were concerned about the varying success rate in our children with spina bifida. Therefore we have reviewed our patients who have used a reciprocating-gait orthosis.



The reciprocating-gait orthosis (RGO) consists of a trunk support, pelvic band and bilateral knee-ankle-foot orthoses, connected with dual-cable movable hip joints.

Data on 15 patients with myelomeningocele or paraplegia, using a reciprocating-gait orthosis for ambulation

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	F	M	L1	5/0	2	++	10/10	0/5	20	1.4	S	1.2	H	2
2	M	M	L1	0/0	3	++	0/0	5/5	20	3	D	0.8	NF	3
3	M	P	L1	0/0	6	+	15/15	20/5	90	7.5 [a]	D	8	C	5
4	F	M	L1	0/0	7	+	10/10	20/10	20	5.8 [a]	D	6	C	3
5	F	M	L3	2/2	3	++	0/0	0/0	0	1.3	S	0.3	NF	1
6	F	M	L1	0/0	3	+	0/10	0/0	56	6	S	11	C	5
7	M	M	L3	5/5	9	++	10/10	0/0	0	4.3 [a]	D	1.4	H	4
8	F	M	L3	3/5	5	++	20/10	20/20	0	1 [a]	S	2	H	1
9	M	M	L3	4/4	7	++	10/10	10/20	20	3 [a]	D	0.6	H	2
10	M	M	L3	5/5	6	++	0/10	0/20	0	0.5 [a]	S	0.2	H	1
11	F	M	L3	5/5	5	–	10/10	0/20	0	1.6 [a]	S	0.2	H	2
12	M	P	Th10	0/0	5	–	0/0	0/0	10	4	S	0.4	H	3
13	F	M	L1	0/0	3	–	0/0	0/20	0	3.2 [a]	S	0.4	H	3
14	M	M	L1	0/0	5	+	30/20	20/0	0	5	S	0.8	C	5
15	M	M	L2	2/2	4	–	20/30	0/0	0	0.8	S	0.4	H	1

A Case
B Gender
C Etiology
  M myelomeningocele
  P paraplegia
D Neurosegmental level of lesion (Sharrad 1964)
E Quadriceps strength, right/left
F Age at fitting orthosis, years
G Hip dislocation
  + unilateral
  ++ bilateral
  – absent
H Flexion contracture of the hip, degrees, right/left
I Flexion contracture of the knee, degrees, right/left
J Scoliosis, Cobb angle, degrees
K Years of orthosis use
  [a] stopped use
L Satisfied/dissatisfied with orthosis
M Hours of use per day
N Ambulation level in the orthosis
  C community ambulator
  H household ambulator
  NF nonfunctional ambulator
O Number of orthoses worn out

Patients and methods

Our data were collected from the records of our Spina Bifida and Paraplegia Team, in which 340 children are registered. In the period 1985–1995, 15 children (8 boys) had used a reciprocating-gait orthosis. These children were selected on the basis of the neurological level and cooperation of the child and parents. Children with mental retardation, obesity, severe contractures or spasticity were excluded. All were nonfunctional ambulators and had used a parapodium before using the orthosis. We recorded the cause and level of the spinal lesion (Sharrard 1964), quadriceps power (grades 0–5), ambulation level, age at fitting the orthosis, lower-limb contractures, hip stability and scoliosis (Table). At follow-up, all parents and children were interviewed and all children were examined. We recorded the hours of use per day, use of the orthosis in years, maximum ambulation level (Hoffer et al. 1973) while using the orthosis and number of orthoses that had been worn out (Table). If a child had stopped using the orthosis, we tried to determine the reasons.

13 patients had spina bifida, 1 had a congenital spinal malformation with paraplegia and 1 had paraplegia after a traumatic injury to the spinal cord during delivery. Prior to fitting the orthosis, 28 surgical procedures had been performed in 9 patients, partly to facilitate fitting of the orthosis. These included soft-tissue releases at the hip in 4 patients, of the knee in 8 patients and of the ankle and foot in 7 patients. All but 4 patients had a uni- or bilateral dislocation of the hip. After fitting the orthosis, all children participated in a training program, supervised by members of the spina bifida team.

Results

The average age for fitting an orthosis was 5 (2–9) years. At follow-up, 8 patients had stopped using this after a mean period of 3 (0.5–8) years. The 7 children still using an orthosis had used it for an average period of 3 years. The average age of discontinuing its use was 10 (6–13) years. 9 children had progressed from nonfunctional ambulators to household ambulators and 4 from nonfunctional to community ambulators; 2 remained nonfunctional ambulators. 12 children were independent when ambulating; 4 could independently move from sitting to standing, all others needed assistance. When walking with the orthosis, 9 children used crutches and 6 used a rollator.

The average daily use of the orthosis was 2 (0.2–11) hours. For community ambulators, the average daily use was 6 hours, for household ambulators 1 hour and for nonfunctional ambulators 0.5 hours. All children declared that they enjoyed the vertical position, a certain degree of independence and a different

perception of the environment. 10 children and their parents were very satisfied with the use of the orthosis; 5 patients were not satisfied or disappointed with its use. The 8 children who had stopped using it had various reasons. 4 children (patients nos. 7, 9, 11 and 13) reported that walking in the orthosis took too much energy and moving in a wheelchair was faster and more efficient. Child no. 10 had recurrent pressure sores; no. 8 had increased involuntary muscle activity, which stopped when the orthosis was discontinued. These 6 children are now entirely wheelchair-bound. Children nos. 3 and 4 discontinued the orthosis because they were able to walk short distances without the orthosis. The average number of orthoses that had been worn out by children who had stopped using the orthosis was 3 (1–5).

Discussion

Even children who have achieved a short-term period of ambulation will outperform those who have never done so (McCall and Schmidt 1986, Mazur et al. 1989). Physical benefits of ambulation may include cardiovascular and musculoskeletal fitness, with decreased fracture and contracture rates, decreased frequency of urinary stones and prevention of pressure sores (Jaeger et al. 1989). The reciprocating gait orthosis since the introduction in 1969 has gained wide acceptance. Early reports described an improved gait pattern, with control of lumbar lordosis and hip flexion (Yngve et al. 1984, McCall and Schmidt 1986) and energy consumption studies reported decreased oxygen consumption (Flandry et al. 1986). Some have expressed the optimistic view that many patients would walk as adults (Rose et al. 1983). These studies did not evaluate the long-term use and efficacy of the orthosis, however. Recent studies, focusing on the long-term results of continuous bracing have shown that the orthosis is not a cure for ambulation and many patients eventually discard it in favor of the wheelchair (Guidera et al. 1993, Vogel and Lubicky 1995). The presence of hip and knee flexion contractures and scoliosis does not preclude the use of the orthosis, since it can be adjusted for hip flexion contractures up to 20° and knee flexion contractures up to 35° (Guidera et al. 1993). Scoliosis is generally considered a contraindication (Guidera et al. 1993) but we did not find this. One of our children with a scoliosis of 90° became a community ambulator. Therefore, extensive surgery is not routinely justified to permit fitting of the orthosis, but plantigrade feet and mobile hips and knees are a prerequisite in our opinion. In our series, two thirds of the children thought it worthwhile to invest time and energy to achieve a period of walking and one third became community ambulators with the orthosis. Even 6 children with little, if any, quadriceps power achieved a level of ambulation, which has encouraged us with others (Philips et al. 1995) to use the orthosis for upper lumbar and thoracic lesions as well. Although most of the children and their parents were satisfied with the orthosis, they had several problems. It may interfere with normal daily activities like playing, sports and home-work. Putting it on and off may take considerable time. Moreover, it is impossible to carry things, since the hands lean on crutches.

Many parents complained of repeated orthotic breakdowns, large and small and the frequent problems of adjusting the orthosis during growth or changes in body-weight. Considering these factors, and the considerable cost of the orthosis (about USD 4,500), the selection of children is important. Physicians and children must have realistic goals and expectations and the motivation of the patient is important. The children should have sufficient upper extremity strength and coordination, good trunk balance and mobility of the hips and knees that allow the orthosis to be fitted. Contraindications include obesity, mental retardation, severe lower extremity contractures and spasticity or involuntary muscle activity that prevents free and coordinated mobility. With growth, many of these children tend to avoid the use of bulky orthotics (Vogel and Lubicky 1995) and prefer the use of a wheelchair; this must be balanced against parental goals. The use of a wheelchair for long-term mobility must be accepted and not considered a failure in these children.

References

Douglas R, Larson P F, D'Ambrosia R, McCall RE. The LSU reciprocation-gait orthosis. Orthopaedics 1983; 6: 834-9.

Flandry F, Burke S, Roberts J M, Hall S, Drouilhet A, Davis G, Cook S. Functional ambulation in myelodysplasia: the effect of orthotic selection on physical and physiologic performance. J Pediatr Orthop 1986; 6: 661-5.

Guidera K J, Smith S, Raney E, Frost J, Pugh L, Griner D, Ogden J A. Use of the reciprocating gait orthosis in myelodysplasia. J Pediatr Orthop 1993;13: 341-8.

Hoffer M M, Feiwell E, Perry R, Perry J, Bonnet C. Functional ambulation in patients with myelomeningocele. J Bone Joint Surg (Am)1973; 55: 137-48.

Jaeger R J, Yarkony G M, Roth E J. Rehabilitation technology for standing and walking after spinal cord injury. Am J Phys Med Rehabil 1989; 68: 128-33.

Mazur J M, Shurtleff D, Menelaus M, Colliver J. Orthopedic management of high-level spina bifida: early walking compared with early use of a wheelchair. J Bone Joint Surg (Am) 1989; 71: 56-61.

Mazur J M, Sienko-Thomas S, Wright N, Cummings R J. Swing-through vs. reciprocating gait patterns in patients with thoracic-level spina bifida. Z. Kinderchir (Suppl I) 1990; 45: 23-5.

McCall R E, Schmidt W T. Clinical experience with the reciprocal gait orthosis in myelodysplasia. J Pediatr Orthop 1986; 6: 157-61.

Philips D L, Field R E, Broughton N S, Menelaus M. Reciprocating orthoses for children with myelomeningocele: a comparison of two types. J Bone Joint Surg (Br) 1995; 77: 110-31.

Rose G K, Sankarankutty M, Stallard J. A clinical review of orthotic treatment of myelomenigocele patients. J Bone Joint Surg (Am) 1983; 65: 242-6.

Sharrard W J W. Posterior iliopsoas transplantation in the treatment of paralytic dislocation of the hip. J Bone Joint Surg (Br) 1964; 46: 426-44.

Vogel L C, Lubicky J P. Ambulation in children and adolescents with spinal cord injuries. J Pediatr Orthop 1995; 15: 510-6.

Yngve D A, Douglas R, Roberts J M. The reciprocating gait orthosis in myelomeningocele. J Pediatr Orthop 1984; 4: 304-10.