Proceedings of the Annual Scientific Meeting of the International Medical Society of Paraplegia held at Heidelberg (Germany) on 3rd to 5th August 1972 (Part III)

METHODS OF BRACING IN THE REHABILITATION OF THE PARAPLEGIC CHILD

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INTRODUCTION

ONE of the most important milestones in the development of a child is the ability to stand and to walk. This ability has a profound influence upon the child's physical and mental development.

The child born with spina bifida and severe paraplegia is deprived of this important ability unless the enthusiastic orthopaedic surgeon provides him with the necessary treatment and apparatus to help him to overcome this to some extent.

METHOD

I believe that standing and walking should be started in congenital paraplegia at an age when it would be physiological for the normal child. It is at this age that the complex reflex pattern of the upright position will readily develop (Strach, 1957).

If there is flaccid paralysis without fixed deformities our task is simple. We need to support the paralysed legs and trunk with two calipers joined to a body brace. If there are deformities due to faulty posture, muscle imbalance or spasticity these will have to be corrected as far as possible before fitting the child with the brace.

The first walking appliance need not be sophisticated: the erect position is achieved by the three-point pressure system; anterior straps to prevent the knees from flexing; posterior supports at the hips to prevent them from buckling up and an anterior chest band to keep the spine straight (fig. 1). Connecting steel bands give the apparatus rigidity and lateral stability. Rigidity of the system is important because it gives the child confidence in the reliability of the brace: no hip or knee joints are necessary at this stage (fig. 2). Most children take to it quite readily and enjoy the new experience of standing. The appliance is worn for gradually increasing periods, care being taken to avoid any undue pressure on insensitive skin. The child is taught to stand and to use the hands for active support; the upper limbs are overdeveloped and in one case a child was able to do the handstand at the age of $2\frac{1}{2}$ years as part of the upper limb training (fig. 3).

Once the child has mastered the balance of standing by supporting himself with his hands on chairs or rollators he is encouraged to develop a walking action. This will be at first a rocking motion and many children become quite proficient with this type of gait. As the child grows older less trunk support will be required

FIG. 1
The three-point pressure system of the walking appliance.

FIG. 2

FIG. 3

Fig. 2.—The first walking appliance.

Fig. 3.—A child of $2\frac{1}{2}$ years with a myelomeningocele, level of paraplegia D.12, able to do the handstand as part of the upper limb training.

because the upper limbs will hold the spine straight; at this stage he will gradually develop a hinged type of gait at the hips and many special joints have been produced to allow limited hip movements without losing the necessary stability. At the same time a hip lock mechanism is introduced to allow flexion of the hips and sitting. A reciprocating joint is at present under trial, this would help the child to develop a more normal-looking hinged gait.

As the child reaches school age knee joints are incorporated to allow it to sit more naturally. Children soon learn to handle these joints and older children can get in and out of the walking appliance with little or no help, eventually they use the walking appliance during the whole day.

A different type of appliance was developed in Canada in the form of the Parapodium: the caliper shoes are attached to an elliptical platform, giving the appliance complete rigidity and stability. A drag-to or swing-through gait with crutches is developed; it serves the child quite well but it can never be converted to the more normal-looking hinged gait.

Gordon Rose (1970) developed his Shrewsbury splint which consists of a rigid chest to foot exoskeleton with base-plates for each leg connected to the shoe by a thrust-bearing joint allowing rotatory movements (fig. 4). This system allows an easy rocking or swivel gait leaving the hands free. It gives the child more independence as the hands are not used for support but are free for play and other purposes, such as opening doors, etc. Yet, the gait will never resemble the more normal-looking hinged or reciprocating gait.

I have been using a rigid ankle joint with a reinforced sole as advocated by Hahn (1970) in adult paraplegia (figs. 5 and 6). This system gives the appliance an inherent stability which is useful yet not as cumbersome as the Parapodium or the Shrewsbury splint and it facilitates the development of a hinged gait.

The choice of appliance depends on the individual child, *i.e.* the severity of the paralysis, age, build, mental capacity, and also on available facilities and individual preferences of the child and his medical attendants.

DISCUSSION

If bracing in spina bifida is to be a practical proposition the following requirements should be fulfilled (Strach, 1971).

1. The brace should be acceptable to the child and his parents; it should be a convenient and useful tool of life and not troublesome and time-consuming to use.
2. The brace should be easily fitted and removed.
3. It should be comfortable to wear and light in weight.
4. It should allow dissipation of heat.
5. The brace should be cosmetically acceptable; a pleasing shape and colour and a noiseless action will help its acceptability. Waterproofing will make it cleanable; the child should be able to sit in it and it should not be a hinderance to toilet requirements.
6. A low energy expenditure for walking yet a speedy progression will be of great advantage.
7. Steps and slopes should not be unsurmountable obstacles (fig. 7).
8. Minimal maintenance should be necessary.

FIG. 4
The Shrewsbury splint
as advocated by Gordon
Rose.

FIG. 5

Fig. 5.—The rigid ankle joint as advocated by Hahn.

FIG. 6

Fig. 6.—With the rigid ankle joint the child can stand without taking support from the upper limbs.

9. The splint should be reliable and there should be no deprivation because of breakage or growth.
10. A modular design would be ideal.
11. There should be no undue wear on clothes and shoes.

FIG. 7

With a paraplegia at the level of D.12 this boy can negotiate steps.

This is a formidable list of requirements but each item will help the child to accept the splint. Once the walking appliance has been accepted the advantages of walking even in the severest forms of paraplegia, become apparent:

- (a) mental and physical development are enhanced;
- (b) sores become rare;
- (c) pathological fractures do not occur;
- (d) urinary drainage improves.

If for one or another reason walking is abandoned a wheelchair life entails the following dangers:

- (i) obesity;
- (ii) pressure sores;
- (iii) bone fragility;

- (iv) deformities;
- (v) urinary stasis and infection.

A small child is easily made ambulant with the required bracing. At times it happens that the child gradually discards the appliance as he grows older and will take to a wheelchair in adolescence and adult life. Even if this happens, our efforts at rehabilitation will not have been in vain. The mastering of the task of walking will have given the patient a sense of achievement, self confidence and self respect. His physical and mental development will have been helped and the ability to walk will have helped in the formation of his character and enriched his experience. A friend has compared this to the achievement in the field of sport in the normal child. In spina bifida this sport can be called 'the walking game'.

RESULTS

Reviewing 148 cases of severe paraplegia due to spina bifida 44 patients (30 per cent.) were able to walk with braces for most of the day, without assistance and at a reasonable speed. Some had achieved self care. Thirty-seven (25 per cent.) could walk for part of the day with some assistance at a slower rate; 16 children (11½ per cent.) were unable to walk, 28 (19 per cent.) had died and 20 (13 per cent.) were untraced. This gives a success rate of 55 per cent. of the whole group or 68 per cent. of the survivors (Strach, 1971).

Such results can only be obtained by devoted teamwork; efficient bracing plays an important role in the rehabilitation of these children.

SUMMARY

1. Walking should be started in congenital paraplegia at 14 to 18 months.
2. An appliance consisting of two calipers joined to a body brace is used to support the paralysed legs and trunk by the three-point pressure system.
3. Rigidity of the appliance is essential in the young child and allows the development of the rocking gait.
4. In the older child less rigidity is required and hip joints are introduced facilitating the development of a hinged type of gait. Hip and knee joints enable the child to sit.
5. Other appliances such as the Parapodium and the Shrewsbury splint are discussed. Rigidity of the ankle joints is recommended.
6. The results of orthopaedic rehabilitation in 148 cases of severe paraplegia are given.
7. The ideal requirements of a brace in congenital paraplegia are listed.
8. The advantages of ambulation in severe congenital paraplegia are discussed.

RÉSUMÉ

1. Les enfants avec paraplégie congénitales doivent commencer à marcher dès 14 à 18 mois.
2. L'appareil se compose de deux calipères joints à un support du tronc. Il soutient les jambes et le dos paralysés par le système d'appui en trois.
3. L'appareil à marcher doit être raide dans l'enfant jeune, ainsi il facilitera une marche à pivot.
4. L'appareil doit être moins raide dans l'enfant plus âgé. Des charnières au niveau

des hanches permettent une marche reciprocante et avec des charnières aux genoux l'enfant peut s'asseoir avec l'appareil.

5. D'autres appareils sont décrits: le Parapodium et l'appareil de Shrewsbury. La raideur de la cheville selon le principe de Hahn est recommandée.

6. Les resultats de la rehabilitation orthopédique en 148 cas de paraplégie congenitales totales sont présentés.

7. Les besoins ideaux de l'appareil à marcher pour les enfants paraplégiques sont cités.

8. Les avantages de pouvoir marcher dans des cas de paraplégies congenitales complètes sont discutés.

ZUSAMMENFASSONG

1. Das paraplegische Kind soll schon im Alter von 14 bis 18 Monaten gehen lernen.

2. Der Geh-apparat besteht aus 2 Calipern und einem Rumpfteil. Er unterstützt die gelähmten Beine und den Rumpf durch das 3-Druck-system.

3. Der Geh-apparat muss bei dem kleinen Kind starr sein; er ermöglicht dann einen Drehring gang.

4. Bei dem älteren Kinde soll der Geh-apparat nicht so starr sein, Hüft-scharniere werden eingebaut, die einen Schwingen-gang ermöglichen und mit Kniegelenken wird sitzen möglich.

5. Andere Apparate werden beschrieben, so wie das Parapodium und der Shrewsbury apparat. Ein steifes Knöchel gelenk nach dem Princip von Hahn wird empfohlen.

6. Die Resulate der orthopaedischen Rehabilitation von 148 Kindern mit kompletten Paraplegien werden angegeben.

7. Die idealen Erfordernisse des Gehapparates für kongenitale Paraplegie werden angeführt.

8. Die Vorteile der Fähigkeit gehen zu können in Fällen von schwerer kongenitaler Paraplegie werden erörtert.

Acknowledgements. My thanks are due to Mr. Bayliss for the photographic reproductions.

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