THE NEWINGTON BRACE FOR CEREBRAL PALSY

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As a form of treatment in cerebral palsy, bracing has yet to meet universal acceptance.[2,5,6] Besides published opinions slighting the value of braces, in practice one frequently encounters a prejudice against prescribing them in "spastic" disease. This attitude, it must be granted, is not groundless. Phelps,[4] a proponent of braces, refers to the danger of aggravating spasticity with braces of poor design. Our own experience has taught us that attempts to brace spastic muscles in correction beyond tolerance succeed only in alienating the patient and frustrating the doctor. Design problems and the simple difficulty of knowing where to lay one's hands on a mechanically sound brace have also militated against full recognition of the value of braces in cerebral palsy. Often the mechanical requirements for effective bracing in a spastic or an athetoid patient are such as to tax the ingenuity of bracemaker and orthopaedist alike.

So far as objections in principle to bracing are concerned we find dogma difficult to sustain in a condition where progress in the course of treatment is scarcely separable from progress in the course of time. In any event, a well-designed brace has such a variety of uses in cerebral palsy that physicians objecting to one application may perhaps find another quite helpful. This description of an adaptable lower-extremity brace has been prepared in the hope of interesting physicians not presently employing braces in cerebral palsy, as well as others who may wish to compare the brace that they are now using with the Newington model. It is perhaps unnecessary to add that bracing is not in itself a system of treatment and must be co-ordinated with physical therapy and other lines of training. Our approach to habilitation in cerebral palsy is similar in general outline to that described by Deaver.[3]

The Newington brace receives its name from the institution where it was developed—The Newington Home and Hospital for Crippled Children, in Newington, Connecticut. The present model results from progressive redesigning of the brace used for meeting the needs of our more severely handicapped children. The only brace available to us 10 years ago, a polio caliper model, was adapted initially to cerebral palsy use by substituting uprights of rigid aluminum alloy for steel and mounting ball bearings in all pivotal joints. After experimenting with various devices to hold the medial thigh uprights apart we attained the more satisfactory solution of eliminating them altogether. This was accomplished by increasing hip-joint diameters and using adequately heavy stock for the lateral uprights. We found that knee caps could be dispensed with if thigh and calf cuffs were of sufficient length. Before discussing the brace in detail a brief note should be made of basic concepts involved in its use.

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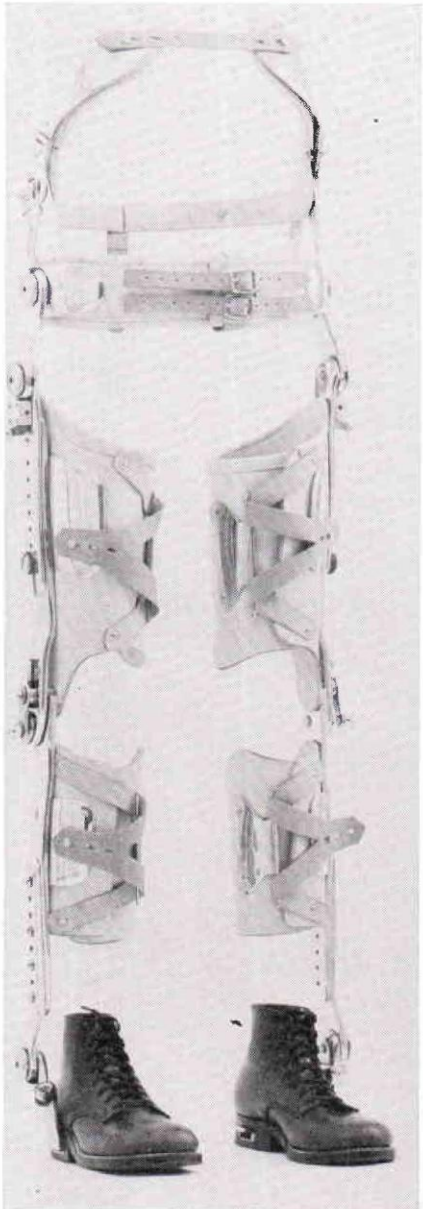

Fig. 1. The Newington brace for cerebral palsy is made of 24 ST4 aluminum with steel double-race ball-bearing joints at pelvic band, hip, knee and ankle. Locks at 180° are provided at the hip and the knee. Pelvic band and leg cuffs are of nylon-treated calfskin with russet leather straps; linings are horsehide. The pelvic band is padded with sponge rubber. A spring steel catch engages a heel slot incorporated in a full-length steel sole plate, permitting ready removal of the shoe. By changing screw positions in the uprights, the brace may be lengthened approximately 6 inches to keep up with the child's growth.

A Note on Gait Training

Attainment of serviceable gait should be regarded as a prime goal in the treatment of the cerebral palsied child, ranking in importance with speech training, self-care and the acquisition of school subjects. Indeed, the extent to which these latter accomplishments can be utilized and enjoyed by the patient depends on his ability to get about. While we cannot begin to cover the subject of gait training here, it is pertinent that among a variety of factors determining gait acquisition in cerebral palsy two of fundamental importance are the ability to balance and a sense of independence or confidence on the part of the patient. The child must attain these if he is to walk. To be sure, he must also attain a gait pattern,

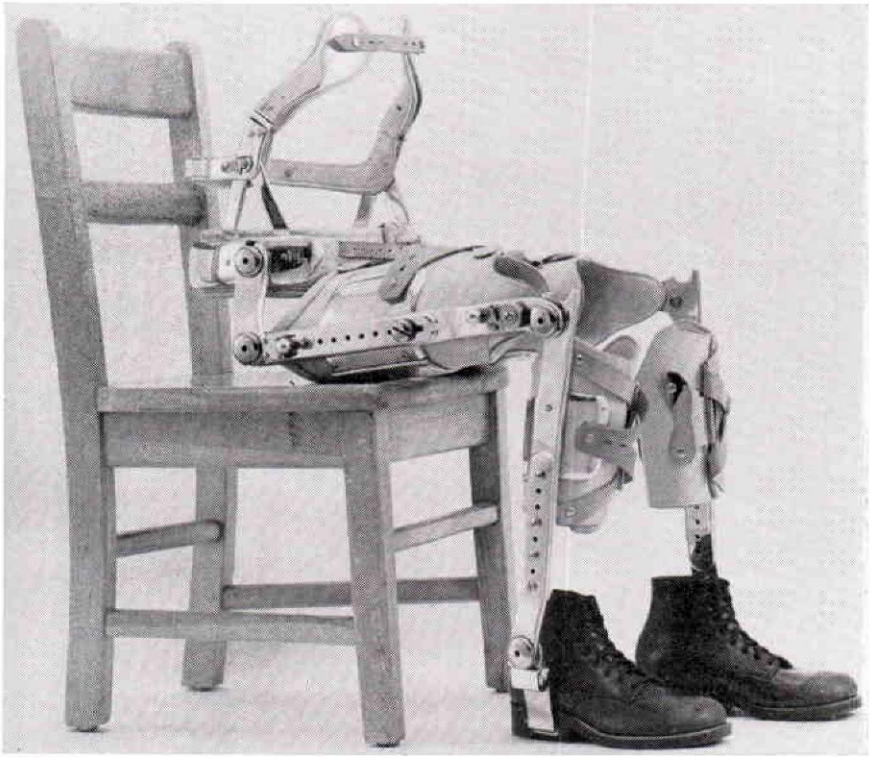

Fig. 2. Properly designed, a brace should fit as well in the sitting as in the standing position. The hip joints should block at 90° of flexion to offset slump; if they can be locked in this position, as in the Newington brace, trunk balance is aided. 90° knee locks (not illustrated) help children with uncontrollable quadriceps overflow to sit comfortably. Observe how posterior hinging of the thigh band permits adaptation to a flat surface, enhancing comfort and fit in the sitting position.

yet reciprocal motions learned on a plinth are of little use to the child lacking sufficient balance, confidence or control to utilize the motions when upright. Balance and confidence are dynamically acquired, not taught; for the severely involved child they may be painfully slow acquisitions requiring years of effort. In training these children, therefore, it is worth while to introduce lower-extremity bracing early. Braces, unlike walkers, readily accommodate to the patient's body image and facilitate the acquisition of balance, free stance and gait: partly because they bring these attainments within the child's comprehension and mental reach; partly because they aid him to integrate postural and equilibratory reflexes into functionally useful patterns.

Brace Requirements

In treating large groups of cerebral palsied children, a range of lower-extremity braces and splints is required to meet varying indications—ankle calipers, foot-drop models, night braces, various splints based on the Denis Browne principle. For severe forms of paraplegia and quadriplegia, brace-shop operations can be geared conveniently to a general utility brace meeting the usual needs of this class of patients. In developing the Newington brace, one objective was a single model for both spasticity and athetosis.

This was not, in itself, a difficult goal to attain, since basic brace requirements, such as lightness, strength and rigidity, free joint mobility and positive locking, comfort in all positions, ease of application and presentable appearance, are alike in both forms of cerebral palsy. These requirements have been met satisfactorily in our present model, which has been used by 108 patients. Additionally, the brace has other desirable features to be referred to later.

Construction of the Newington Brace

Except for steel stirrups and small parts, the Newington brace is of alluminum alloy construction throughout (Figs. 1 & 2). The average 6-year-old celebral palsied child requires a brace weighing approximately 6 pounds; children in the 10- to 14-year-old group demand a brace weighing 8½ pounds (without shoes). As already indicated, scissoring is offset by eliminating the medial uprights of conventional braces and building stress resistance into the lateral uprights and hip joints. Larger hip joints and heavier uprights may be substituted for stock sizes in children with a strong scissoring tendency. (Among our patients, the only one for whom this design proved inadequate in maintaining leg alignment was a ruggedly built young man, nearly 6 feet tall, with unusually severe adductor spasm.) The hip joints of the Newington brace, as well as knee, ankle and pelvic band joints, are of double-race ball-bearing construction, permitting free mobility even in the presence of torsional and lateral strains. As further stress protection of brace joints and uprights, a hinge which allows slight lateral excursion is incorporated in the shoe assembly immediately below the ankle joint (Fig. 3).

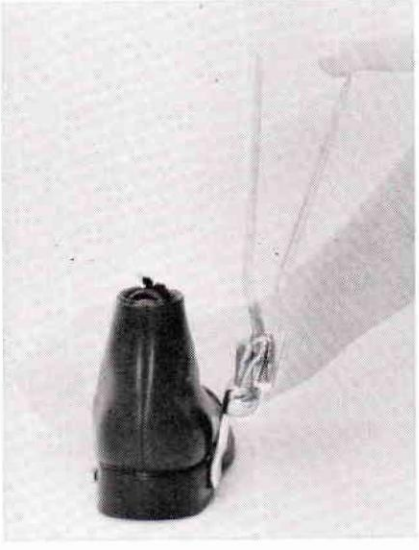

Fig. 3. Although desirable from the patient's standpoint, lateral rigidity may give rise to brace stress in older patients or those with strong involuntary movements. The double-exposure photograph shows how the hinge below the ankle joint in the Newington brace reduces stress on the hip and the knee joints by allowing lateral play. In any instance where this motion may be detrimental, the hinge can be sealed. Occasionally, a medial as well as a lateral upright is required to control the ankle or the foot or to offset internal rotation of the tibia. In such case the medial upright is attached to the calf band above and an ankle joint below, the hinge being omitted. Braced children require regular check of their leg alignment to guard against the development of tibial rotation.

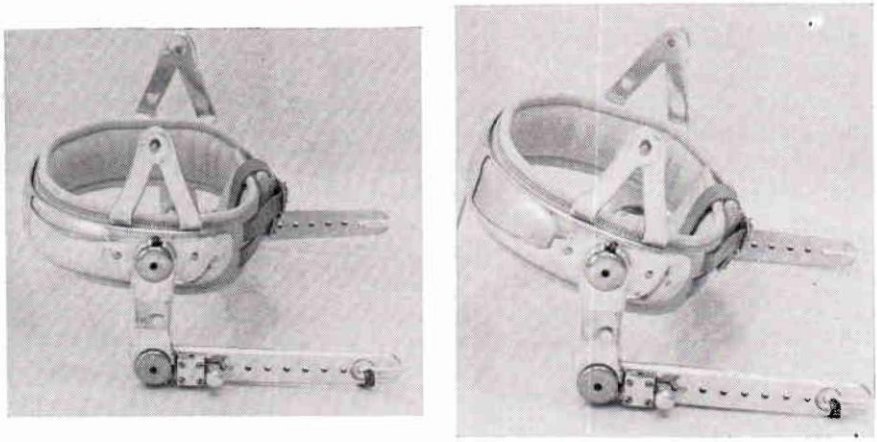

Fig. 4. A limited swivel introduced at the upper end of the hip section allows flexibility in the pelvic band. With flexion of the lumbar spine in sitting, the pelvic band moves in an accommodating arc of approximately 20°. This prevents digging in of the lower rim of the pelvic band posteriorly and permits some freedom of the trunk.

A limited swivel at the attachment of the pelvic band to the hip section, permitting flexion of the pelvic band, accommodates flexion of the lumbar spine in sitting, thus obviating the sometimes annoying complaint of pressure from the inferior rim of a pelvic band (Fig. 4). Further construction details are illustrated in Figure 5.

Attainment of Balance

The trunk unit of the Newington brace (Fig. 6) is not intended for passive support but as a training aid in developing balance. Its design is based on the concept that posture maintenance is essentially reflex in character and that exteroceptive stimuli are of value as reminders of trunk position in children with deficient balance mechanisms. Our knowledge of the reflex basis of postural muscular contraction affords little reason to suppose that these children can be taught balance as a voluntary skill.[1] So far as posture is "learned" at all, the process is one of integrating or modifying postural reflexes on the basis of experience in the upright position. Standing tables and stabilizers are helpful to the child in beginning balance; a trunk support, like that of the Newington brace, advances his concept of

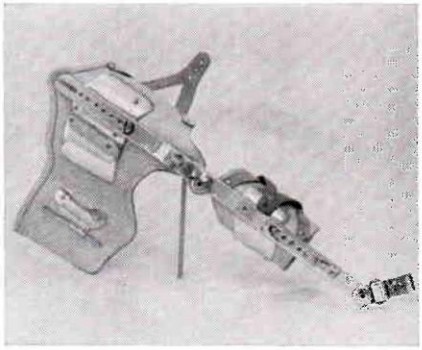

Fig. 5. Simplicity of brace application and removal conserves the therapist's time when the patient receives physical therapy. An easily managed brace also encourages the patient in self-care. The illustrated fastener for thigh and calf bands can be closed or released with one hand. However, laced cuffs are preferable for children with severe spasm or involuntary movement. The flip knee lock can be managed by quadriplegic patients and opened even in the presence of strong hamstring spasm.

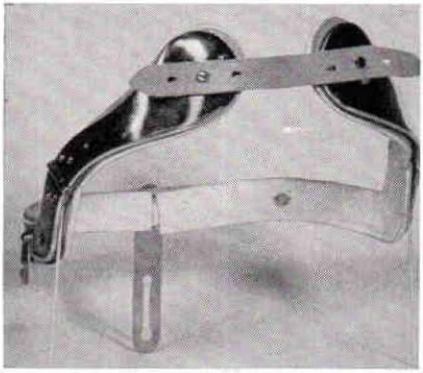

Fig. 6. Balance is a dynamic acquisition, achieved by the severely involved cerebral palsied child only through prolonged and repetitive practice. The conventional back brace, passively slinging the trunk, discourages balance attainment. In the Newington brace the trunk unit has been designed not for support but as a constant reminder of trunk position. The pressure exerted by the pectoral wings on the patient's chest can be controlled by the vertical tie link (illustrated) through a screw attachment to the pelvic band. While ordinarily the trunk unit is mounted as shown in Figure 1, it can be attached in reverse, with the pectoral wings in posterior position, for children with retropulsive movements of the trunk.

free standing, at the same time assisting him to achieve this goal.* The child's active contribution is implicit in the design of the brace: it will not stand up by itself, nor will the pelvic and trunk units maintain an erect carriage. Nevertheless, considerable help is given the child in developing sitting and standing balance by such devices as the hip-joint lock (shown in Fig. 4), which is designed to engage in both the 90° and the 180° positions. These locks, together with those at the knees, simplify initial training through mechanical control of the lower extremities while the patient is developing neck and trunk balance. As improvement in balance is achieved, the hips and the knees are unlocked for increasingly longer training periods.

Disassembly

In keeping with its primary function as a training aid, the Newington brace can be completely disassembled (Fig. 7). Our objective in physical habilitation is to give the child all the independence that his handicap allows, eventually including independence from the brace. While, unfortunately, it is impossible to accomplish this latter aim in many severely involved children, the majority are able to omit sections of the brace on a progressive basis over a greater or a lesser period of time. The trunk unit is first omitted during treatment periods, later entirely, to be followed by the pelvic band. These sections are always removed for comfort in bed when the leg sections are used for night splinting.

Indications for the Newington Brace

Full lower-extremity bracing has been an indispensable adjunct in our clinic to treatment of moderate and severe forms of paraplegic and quadriplegic cerebral palsy. While this applies to children for whom the possibility of walking and standing can reasonably be thought to exist, the Newington brace is also useful in chairbound patients with uncontrollable movements or postural slump. In the latter cases a Taylor back brace may be attached to the pelvic band in lieu of the trunk unit. For trainable children, as already mentioned, the brace has served as an integral feature of our physical therapy

*Braces are sometimes objected to on the ground that they "weaken" muscles. Without attempting to discuss this contention, it may be noted that the fit of trunk unit and pelvic band in the Newington brace is sufficiently loose to allow free contraction of paraspinal, chest and abdominal musculature.

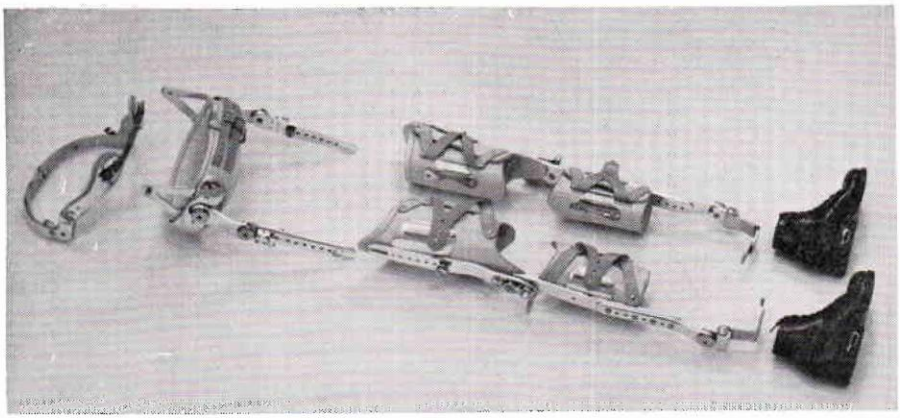

Fig. 7. The brace is separated easily into 4 sections: trunk, pelvic and leg units, and shoe assembly. Sectional construction is essential to a brace designed basically for training purposes, since this allows withdrawal of the brace piece by piece as the child is trained in self-control of the part. One hopes, in the usual course of events, to discard successively the trunk, the pelvic and the leg units, thus attaining the objective for which the brace was applied—to enable the child to get along without it.

program in balance and gait work. The brace, by assisting trunk and leg control, correcting torsion and reducing involuntary movement, frees the attention of the patient and the therapist for the more immediate requirements of reciprocation and crutch handling. For parents it is sometimes a revelation to observe how the brace steadies a precarious gait or makes progression feasible for a child whose adductor spasm had previously caused hopeless tangling of the legs. Perhaps in the long run it is only in a minority of cases that bracing makes the difference between success and failure in gait attainment, but experience gives us reason to believe that a well-designed brace will assist many children to walk sooner and more easily than would otherwise be the case.

Besides these principal indications, the Newington brace has a range of secondary applications which may be very helpful in certain circumstances. By reducing involuntary movement in the lower half of the body, leg and trunk bracing often gives considerable aid to the occupational therapist working on upper-extremity control in athetoid children. We have observed repeatedly that these children are enabled to concentrate more effectively on arm and hand movements. The brace should be prescribed for young children who cannot otherwise be prevented from assuming harmful positions, such as a common one of squatting on knees and haunches, with the legs to either side. If long maintained, this posture leads to fixed internal rotation deformity of the femur, not to mention leg and foot deformities. Some children with balance deficit will creep for long periods rather than essay the hazards of walking; here the brace can be applied, initially with the knee joints locked, to prevent creeping and encourage the upright position. We prescribe bracing routinely in early hip subluxation, with the object of preventing increased adductor shortening, femoral torsion and coxa valga. However, to date we have not been able to come to any firm opinion of its value in this connection. The leg sections of the brace, detached and used as

night splints (preferably with interchanged shoes, toe caps cut out) are helpful in offsetting contractures of the tendo achillis and the hamstrings.* Postoperatively, when lengthening of these tendons has been performed, the leg sections double as day braces and night splints.

Conclusions

In our experience, bracing has played an indispensable role in the treatment of cerebral palsied children. Well-designed braces of various models should be extremely helpful to case management in any cerebral palsy treatment center. Braces are as specific in purpose as medication, and should be prescribed with definite objectives in view. The physician assumes responsibility for determining the objectives in each case and prescribing a brace that can reasonably be expected to achieve them. Physician and bracemaker are jointly responsible for the proper design and fitting of the brace, and should ensure that any question arising in the parents' minds regarding the purpose and the application of the brace is answered. In prescribing a major brace in cerebral palsy, such as the Newington brace, it must be remembered that bracing is only one aspect of a multifaceted training program. Institutional supervision often is needed until the brace becomes familiar and its place in the program clearly defined.

Summary

Among braces of various models used in the treatment of cerebral palsy in children, a lower-extremity brace with pelvic band has been found indispensable in handling the more severe forms of paraplegia and quadriplegia. The Newington brace has been especially designed to provide light yet effective support for the lower extremities and trunk. Sectionally constructed, the brace is also highly useful as a training aid, since it can be left off, part by part, as the child improves in voluntary control. The design and the application of the brace are illustrated in a series of photographs.

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* Contractures and fixed deformities in cerebral palsy cannot be corrected by bracing. As a corollary, the position imposed by a brace should be attainable passively without discomfort. Disregard of this rule is not infrequent, perhaps accounting for the disrepute of braces in some quarters. A properly designed brace is always comfortable for the wearer; and children, excepting an occasional child with a severe emotional disturbance, do not object to wearing day or night braces that are comfortable.