The "Gillette" Sitting Support Orthosis for Non-ambulatory Children with Severe Cerebral Palsy or Advanced Muscular Dystrophy

J. MARTIN CARLSON, M.S.* and ROBERT WINTER, M.D.†

This paper presents a brief review of the need for better sitting support for those children confined to a wheelchair and lack the voluntary means to sit with good posture. The "Gillette" Sitting Support Orthosis consists of a thin but rigid, plastic shell mounted in a foam block. The shell extends to the axilla laterally and to T1 posteriorly. The system often includes anterior support just under the clavicles and some form of head control. The orthotic systems are custom fabricated and are designed to: (1) support the lumbar and thoracic spine to reduce the size and progression of kyphotic and scoliotic curves, (2) securely position the patient in a posture which reduces the incidence and strength of spastic reflexes, (3) control sitting surface pressure distribution, and (4) resist the action of spastic hip adductors.

The Sitting Support Orthosis is designed and fabricated as the central component in a system which includes wheelchair, lap board, and communication system. One hundred sixteen orthoses have been fitted during the past three years with excellent acceptance by patients, parents, and others who teach or care for these children.

During the past three years, the Orthotic and Prosthetic Laboratory at Gillette Children’s Hospital has developed a sitting support orthosis which has become very important in the treatment of the non-ambulatory child with severe cerebral palsy or advanced Duchenne muscular dystrophy. The Gillette Rehabilitation Therapy Department has also been very actively involved in the development and use of the sitting support orthosis. Their knowledge of the problems associated with cerebral palsy has ensured that the orthosis not only addresses these problems but is compatible with the complementary to the rest of the child's adaptive equipment and his daily routine. Specific problems of concern are those of feeding, communication, reflex patterns, abnormal muscle tone, and learning potential in addition to spinal deformity. The medical staff of our cerebral palsy service, our spine service, and our growth and development service has provided the impetus, encouragement and support for the project (Figure 1).

*Gillette Hospital, St. Paul, Minnesota
†Director of Medical Education and Chief, Spine Service, Gillette Children's Hospital, St. Paul and Professor of Orthopedics, University of Minnesota Hospitals.

Fig. 1 — The "Gillette" Sitting Support Orthosis with anterior thoracic support and head support.
Background and History

The development began on our cerebral palsy service. Most cerebral palsy children who do not acquire the ability to ambulate, lack the balance or voluntary means to have a good sitting posture in their first decade of life. They sit in a kyphotic or kyphoscoliotic posture. The pelvis is often not horizontal. In some cases, balance, voluntary control, and sitting posture improve rapidly enough so that the flexible spine deformity of the first decade does not become a rigid, progressive deformity during the second decade. However, a significant portion of non-ambulatory cerebral palsy children do progress during the second decade to a serious spinal deformity. The spine curvature may make sitting very difficult or eventually even impossible. A hip can dislocate and become quite painful due to fixed pelvic obliquity. Cardiopulmonary function may be seriously compromised. Another important consideration is that a small but significant portion of these patients have an average or superior intelligence. Their education, social interaction and self-esteem are very important and greatly affected by their sitting posture and function.

The child with Duchenne muscular dystrophy begins to develop his spinal deformity about the time he becomes non-ambulatory. The deformity progresses to become a very large single curve. The deformity includes rotation, scoliosis, and either kyphosis or lordosis. The spine deformity sometimes affects cardio-pulmonary function and almost always creates a sitting posture so poor that the patient’s function is seriously compromised. This happens long before the patient would lose this function because of other manifestations of the disease.

Our approach on seating in the past had been to utilize the hospital’s carpentry shop to construct wedged seats with upholstered lateral supports. This approach is very common around the country and is successful to some degree. However, it does not adequately control the location and orientation of the pelvis. Lack of contoured conformance to the anatomy results in a concentration of the pressures generated by gravity and supports. The padded, upholstered sides of the seat were too bulky to extend lateral thoracic support very high in the sub-axillary area. Even the best of these seats accomplished very little in the way of real spine support.

Spinal Orthoses

The body jacket type orthosis is able to exert quite strong (though not always successful) control of the spine and is typically used to control spinal deformities in cerebral palsy (Figure 2). However, this orthosis represents a major impact on the patient and his family. It obviously steals some of the patient’s motion and mobility. It must be applied very carefully, and the
skin must be monitored faithfully. Although it supports
the torso completely, it does so as a unit. This unit still
must receive external support to maintain proper sitting
posture. In our experience, the child with advanced
Duchenne muscular dystrophy will not tolerate the
body jacket type orthosis. He and his family are
reluctant to work through the initial period of
discomfort for him. More important, he will not give
up the upper thoracic motion which helps him greatly
with hand placement and elbow control.

The Milwaukee orthosis is also capable of exerting
strong controlling forces on the spine (Figure 3).
However, it becomes a serious irritant for any patient
not having the voluntary control to be able to withdraw
from contact with the neck ring. Also, the neck ring is a
hazard in some patients, because it does not permit
them to position their head to best see what their hands
are doing. The advanced Duchenne muscular dys-
trophy patient requires all his available head motion for
self-feeding.

Gillette Sitting Support Orthosis

The sitting support orthosis developed here at
Gillette consists of a custom-molded, plastic shell
mounted on a base (Figure 4). The plastic shell is
fabricated by vacuum forming hot polypropylene sheet
material over a positive plaster model of the child's
posterior and lateral surfaces. Thus, the plastic shell
conforms to the body contours posteriorly and laterally
from the knees to the upper thorax. The base provides
the proper support to the shell and allows the unit to be
removed from the wheel chair for use in the car or other
places. A lap belt is provided to hold the pelvis snugly
back into position. The hips are positioned in the
amount of flexion recommended by the physical or
occupational therapist. Reflex patterns in severe
cerebral palsy are frequently affected by the degree of
hip flexion so we follow the recommendation of the
occupational or physical therapist in this regard. These
children also very often have overactive hip adductors.
The pommel prevents excessive hip adduction, and it
also helps to prevent the patient from sliding out of the
seat. In the case of muscular dystrophy patients, the
hips are positioned as close to 90° of flexion as
possible. The pommel is usually not necessary and is
eliminated in favor of easier usage of the urinal.

Various anterior components are added as neces-
sary. A lordotic muscular dystrophy patient will need a
large abdomino-thoracic apron to pull him upright. For
the kyphotic patient, a fabric halter or rigid,
custom-contoured, subclavicular support (Figure 5)
may be necessary, depending on the force required to
obtain an acceptable posture. Stabilizing the thorax
obviously aids the patient's voluntary head control, but
sometimes additional head support is necessary
(Figure 6). In some cases, head control is used
continuously to prevent certain head positions and the
reflex patterns which are triggered by those positions. In other cases, it is appropriate to make the head support removable so that it may be used part-time only or for feeding. This is another aspect of the design which requires consultation with an experienced therapist who has had a chance to become acquainted with the child.

The exact angle of recline is not decided until fitting the orthosis to the child. We try to bring the child as nearly as practical to a vertical sitting position.

The thin plastic shell design permits us to extend our lateral thoracic support right up to the axilla without impinging uncomfortably on the medial aspect of the arm. This support eliminates most of the collapsing action of gravity.

When the child wishes to roll around and play on the floor, supporting hardware is automatically left behind in the chair. He is free to roll or scoot around unencumbered. When the child is horizontal, gravity is not operating to collapse the spine.

**Results**

As of this date, we have fitted 116 sitting support orthoses on ninety-seven patients. Ninety-eight were for children with cerebral palsy, and eighteen were for children with advanced Duchenne muscular dystrophy.

How effective this approach will be in reducing the progression of spine deformities during the growth
years will require several more years of observation and study.

At this time, the sitting support orthosis has been very successful in several ways. The system has proven capable of providing the stabilizing support necessary for a near-normal sitting posture (Figures 7 and 8). Head control or position is usually improved, sometimes dramatically. Better head control, whether it comes indirectly through stabilization of the thorax or directly by head support, is extremely important. A child who is chronically looking straight down or straight up or sideways at the world is deprived of normal avenues of discovery, stimulation, and social interaction.

The orthosis usually improves the child’s comfort and position to the point that the intensity of reflex patterns and abnormal muscle tone are reduced. Stability provided by the sitting support orthosis frees up the child’s hands in some cases where they would otherwise be used for support. This also means the child does not have to try to pay attention to so many things and can better concentrate on such things as head control, communicating, or learning in the classroom. The orthosis has also greatly improved or simplified the sometimes very difficult task of feeding these children.

Discussion

The sitting support orthosis must fit quite closely to be effective. The child will not fit in his orthosis when bundled up in heavy winter clothing. Sometimes it is advisable for the child to be in his orthosis during schoolbus rides, and the temperature may be quite low. The orthosis can be accommodated under a winter coat by using a larger size or making simple adaptations. The orthosis is outgrown usually between eleven and twenty-five months after fitting.

The involvement and cooperation of the entire health team creates an overall equipment system which works. It works because the various components are compatible, and the important problems in the child’s life are recognized and dealt with. Figure 9 is a photograph of a child with cerebral palsy and his sitting support orthosis, wheel chair, and lap board with in-laid communication figures.

Our most enthusiastic response and encouragement has come from the parents, teachers, therapists, nurses, and other people who teach or care for the child in the community. These people who live or work with the children on a daily basis know better than anyone the current effect of treatment on the total child.

Acknowledgments

The authors wish to acknowledge the important contributions to this development made by: Fran Hollerbach, Mary Hartung, Scott Webber, Gene Berglund, Arturo Vazquez Vela, and other orthotic and prosthetic laboratory staff members; Jan Headly, Rehabilitation Director; Diane Twedt, Rehabilitation Therapy Supervisor; Karen Beck, Martha Talmadge, Marilyn Kochsiek, Sue Swanson, Collette Carlson, and Lee Schueviller, Rehabilitation Therapy staff members; Dr. Thomas Comfort, Dr. Lowell Lutter, and Dr. John Lonstein, Gillette orthopedic staff members; and Dr. Richard Zarling, neurologist, Fairview Hospital.