Static Rotational Control Cervical Orthosis for the Treatment of Congenital Muscular Torticollis and Associated Plagiocephaly and Hemihypoplasia

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INTRODUCTION

Numerous theories have been advanced to explain the etiology of Congenital Muscular Torticollis (CMT), also known as Sternomastoid Fibrosis. Most prominent among these theories are molding and positioning of the fetus in late uterine life and injuries sustained to the sternomastoid muscle during birth. In late uterine life, if the fetal head is obliquely constrained for a prolonged time the sternomastoid muscle can be damaged through intermittent venous occlusion.[1] The incidence of obstetrical difficulties and traumatic deliveries is too low to implicate birth injury as a cause for Sternomastoid Fibrosis.[6]

Three forms of Sternomastoid Fibrosis are encountered in pediatric practice; first, a so called sternomastoid "tumor," usually seen in infancy; second, diffuse fibrosis, without localized tumor, also seen in infants; and third, established torticollis seen in older children. Torticollis in older children due to Sternomastoid Fibrosis is most likely the outcome of fibrosis which began in utero.[6]

Histological features of Sternomastoid Fibrosis indicate degenerative changes of muscle fibers with deposition of fibrous connective tissue. The amount of fibrosis within a certain muscle is highly individual and is directly correlated to the severity of the torticollis. Clinically, in 75% of all cases involving sternomastoid tumor, the tumor disappears by six months of age.[6]

DIFFERENTIAL DIAGNOSES FOR TORTICOLLIS

Postnatal torticollis may also result from other differential diagnoses. These are:

1) Postural Torticollis: Probably due to persistence of the position of the fetus in utero. The sternomastoid muscles in this case are normal.

2) Cervical Hemivertebrae: Produces torticollis in which the limitation of rotation is not due to tightness of the sternomastoid muscle. Instead, the limited range of motion is produced by a skeletal vertebral anomaly.

3) Delayed neuromuscular coordination may produce torticollis: This is especially true in infants between three and eight months of age.

4) Cerebral Palsy: With unilateral or regional hypertonia, can cause persistent rota-

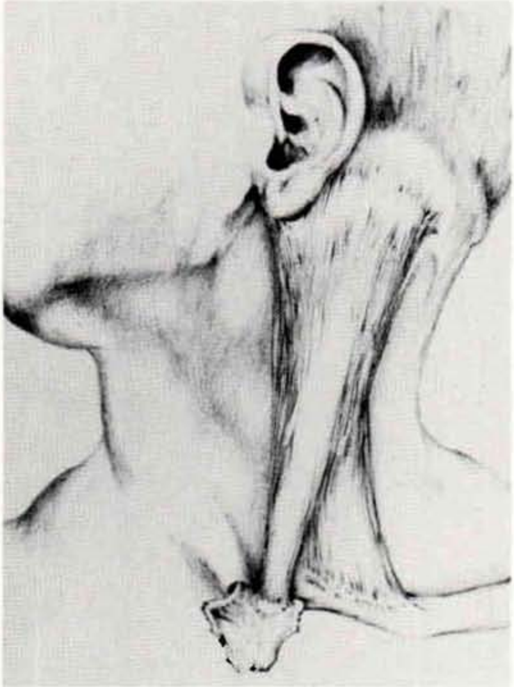

Fig. 1 — Sternomastoid muscle showing origin, insertion and action.

Fig. 2. — This is a one and one-half month old infant suffering from left sternomastoid fibrosis.

tion of the head to one side causing torticollis.

5) Ocular Torticollis: Many different types are seen clinically. This type is not present in early infancy since compensatory postural adaptations normally do not appear before ocular fixation.

REVIEW OF ANATOMY

The sternomastoid muscle is the largest muscle in the neck (Fig. 1). It is thick and narrow at its central part but broader and thinner at either end. It originates at its distal end by two heads. The sternal head has its origin on the anterior surface of the manubrium and the clavicular head on the upper surface of the medial one third of the clavicle. These heads blend below the middle of the neck to form a round thick muscle which inserts on the lateral surface of the mastoid process and superior nuchal line of the occipital bone. The function of the muscle, when it contracts individually, is to laterally flex the head in one direction and rotate it in the opposite direction, pointing the chin cranially.

Figure 2 shows the effects of a shortened, fibrotic, left sternomastoid muscle in a one and one-half month old infant suffering from CMT. Torticollis is defined as being lateral inclination of the head to the affected side and rotation in the opposite direction.

The main consequence of CMT in a zero to six month old infant is the decrease in neck rotational range of motion. This decrease in neck rotation has several secondary effects:

- Wasting of ipsilateral trapezius: may be very marked.
- Plagiocephaly: true facial asymmetry as seen from the vertex.
- Hemihypoplasia: true facial asymmetry as seen from the front.
- Spontaneous Involuntary Compensation: postural adaptations for torticollis.

DEFORMITIES

Figure 3 is a posterior view of a five month old infant suffering from left Sternomastoid Fibrosis. Please note the following conditions:

- Wasting of upper fibers of left trapezius, since the upper fibers of the trapezius laterally flex the head in one direction and rotate the head in the opposite direction. It works in unison with the sternomastoid muscle on that side. Inability to use the sternomastoid muscle results in disuse atrophy.
- Asymmetry of neck folds.
- A bald spot on the infant's right, flattened posterior parietal eminence. When this infant was placed in the supine position, he was constantly bearing weight on this area of the head which caused the hair to be rubbed away.

Figure 4a is a diagram of true plagiocephaly as seen from the vertex. The plagiocephalic skull usually exhibits deformities such as a bulged posterior parietal eminence that is situated more posterior than normal. The ear on the side of the flattened frontal area is also situated more posteriorly. Referring to Figure 4a, A plus B equals the width of the face as viewed from the front. The width of A, the flattened frontal area is usually larger than B, the bulged side. The long axis (P) of the cranium is displaced from the sagital plane, to the right or left, depending on the affected side. It is therefore a quadrilateral asymmetry which involves both right and left hemicrania and both frontal and occipital regions. The flattened frontal area is always on the same side as the affected muscle. For example, this figure is for right Sternomastoid Fibrosis.

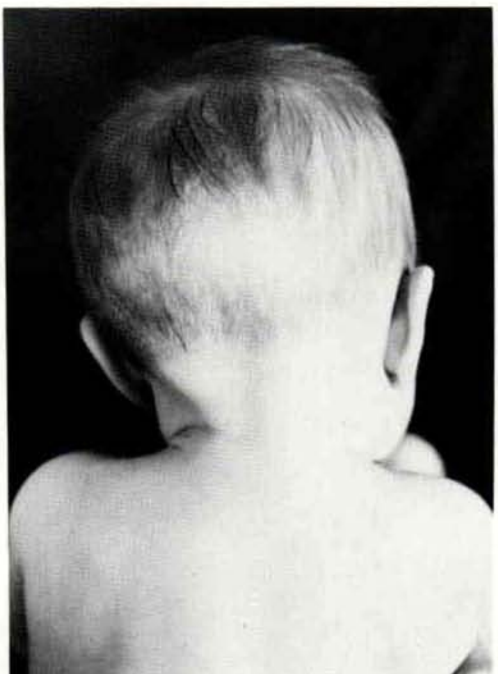

Fig. 3.—Posterior view of a five month old infant suffering from left sternomastoid fibrosis.

Figure 4b shows a photograph of a left Sternomastoid Fibrosis: Note the associated asymmetries.

Plagiocephaly can be congenital, deformational plagiocephaly, or it can be acquired after birth as the result of torticollis. In this latter case, the direction of rotation determines the shape of the cranium.

In the Oxford Child Health Survey[6] plagiocephaly was found in five percent of infants between birth and one year of age. Twenty-one of these infants were reexamined ten years later and in 19 (90%) plagiocephaly of some degree was still present. In an additional study of 35 infants by Peter Jones, plagiocephaly was found to persist in 58% of the infants after a six and one-half year period.[6]

Deformational plagiocephaly will resolve spontaneously in most infants, especially in the absence of torticollis. However, in some cases these deformities may persist into adulthood as a mild to severe cosmetic disability.[3] The removal of postnatal deforming forces such as torticollis will not always ensure a return of craniofacial symmetry. In one long-term follow up study of children treated with surgery for torticollis, early muscle resection did not result in a higher percentage of patients with normal shaped heads.[8]

Dr. Peter Jones offers the following hypothesis as a possible explanation for acquired plagiocephaly.[6] In the first six months of an infant's life, before he can sit erect, the head is constantly in contact with some part of the environment. In an infant with CMT, there is little or no variation in the position of the head. For example, an infant with left Sternomastoid Fibrosis, who cannot rotate his head to the left comfortably, will bear his weight while in the prone position on the left frontal lobe and while in the supine position on the diagonal right posterior parietal

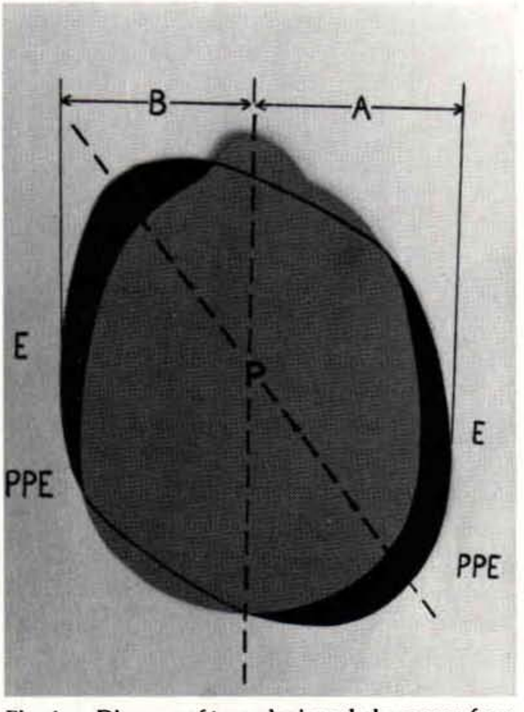

Fig. 4a. – Diagram of true plagiocephaly as seen from the vertex. P: long axis of the cranium; PPE: posterior parietal eminence; E: site of external ear; A and B: width of face as viewed from the front. This diagram shows a normal shaped head in gray and a rhomboid shaped head in black.

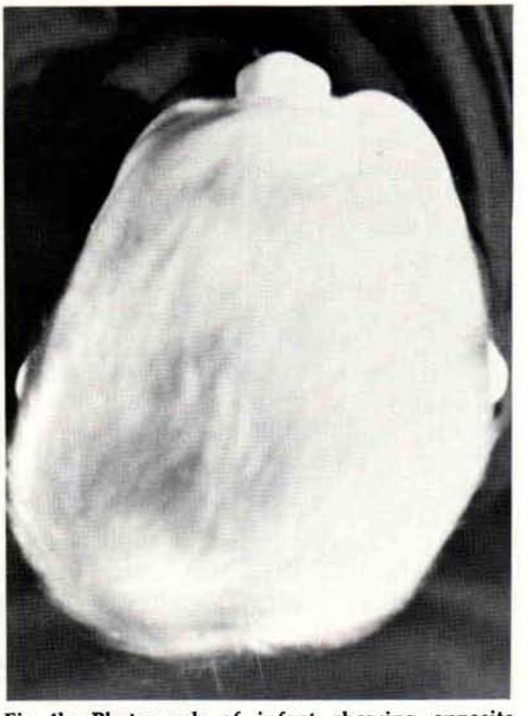

Fig. 4b – Photograph of infant showing opposite isomer. Note frontal and maxillary "horizons" with concordant asymmetry.

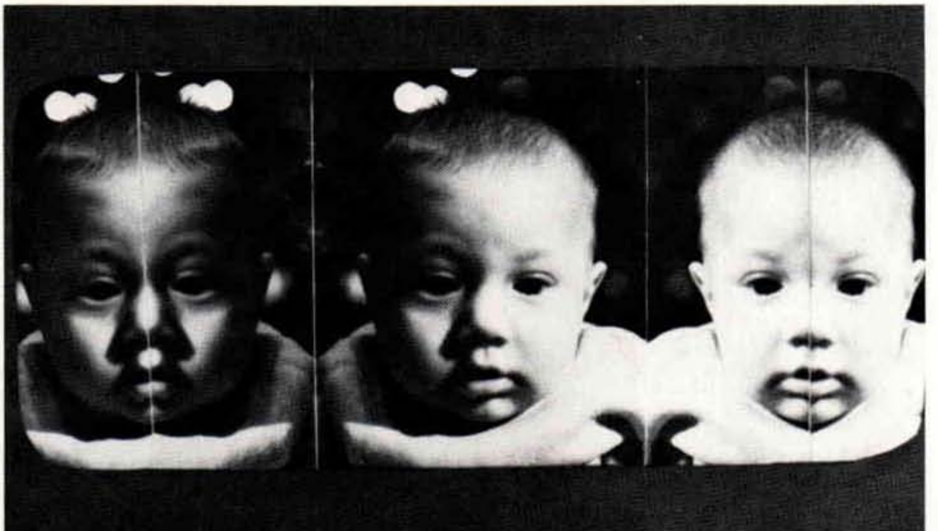

Fig. 5 – Photographs of infant showing facial asymmetry associated with plagiocephaly. The middle face (B) is the normal. The right face (C) is a composite of two right halves and the left face (A) is a composite of two left halves.

eminence. The head consequently assumes a rhomboid shape. Clinical observations support Jones' hypothesis because as the infant starts to sit up, the deforming forces, i.e., the effects of gravity, are removed and the head starts to assume a more spherical shape. Dr. Jones also proved that deformation by gravity was possible. He molded one kilogram (kg.) of molding putty into an elliptical sphere resembling the shape of the human cranium. A match was inserted as an anterior midline marker. He then heated the putty to 22° C and placed the mass of putty on an unyielding horizontal surface so that the long axis of the mass inclined 45°. In 15 seconds, the exact shape of a plagiocephalic skull developed.

The brain in the newborn weighs approximately .75 kg. and has even greater plasticity and compliance with gravitational force than putty. The cranium of the neonate is two to three millimeters thick and largely membranous. It is therefore possible that acquired plagiocephaly in infants with persistent rotation of the head to one side may be caused by directing the force of gravity in such a way that pressure is exerted by the brain on a specific segment of the cranium, imprinting upon it the shape of the plagiocephaly from within.

Walter, in other clinical observations in 1929, reported an extraordinary experience with one of his patients with torticollis. In this patient post-operative retention of the head in an over-corrected position in a plaster cast of the head and neck region was unduly prolonged for 17 weeks. As a result, the plagiocephaly and hemihypoplasia were found to have been transferred to the opposite side when the plaster was removed.

It has been suggested in the literature that if the child sleeps prone, facial asymmetry will increase and if he sleeps supine, cranial asymmetry becomes more pronounced.[3] Figure 5 shows the facial asymmetry which is associated with plagiocephaly. Note the flattened left frontal lobe and bulged right frontal lobe and cheek.

The next secondary effect of torticollis is hemihypoplasia. This term is defined as true facial asymmetry on the side of the affected muscle. The contour of the cheek is flatter, and the vertical height of the face is diminished while the horizontal width is usually greater. Plagiocephaly contributes to the width and horizontal aspects while hemihypoplasia contributes to the vertical aspect. The height of the face is defined as being the distance between the supraorbital ridge and the maxillary alveolus, i.e., eyebrow to top teeth (Fig. 6).

The mechanism by which sternomastoid torticollis produces hemihypoplasia has not been explained. Hemihypoplasia usually develops in patients whose torticollis persisted beyond the age of six months. The earliest age at which true facial hemihypoplasia was seen to develop was seven to eight months. There is not a close correlation between the severity of torticollis and the degree of hemihypoplasia. This condition does improve after surgery and no improvement in facial asymmetry is to be expected after the age of 18–20 years.

The last deformities seen in CMT are postural adaptations or spontaneous involuntary compensation for torticollis. Between

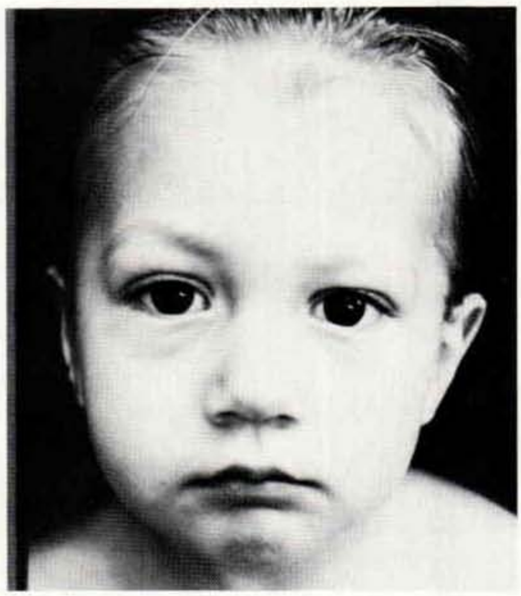

Fig. 6 – A photograph of hemihypoplasia in a two year old infant suffering from left CMT.

four and six months of age as the infant begins to sit erect a lateral inclination of the head is seen. As the infant develops there are two ways in which spontaneous involuntary compensation for sternomastoid torticollis could occur:

1) elevation of the affected shoulder and

2) lateral shift of the head towards the affected side (Fig. 7a and 7b). Both of these maneuvers are an attempt to relieve the tension on the sternomastoid muscle.

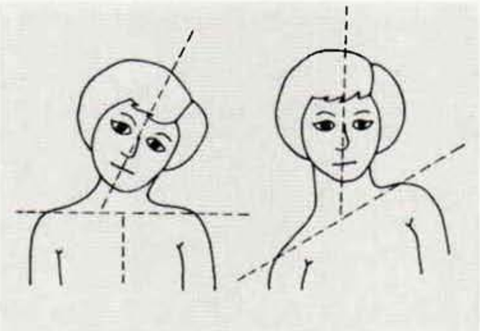

Fig. 7a—Elevation of affected shoulder.

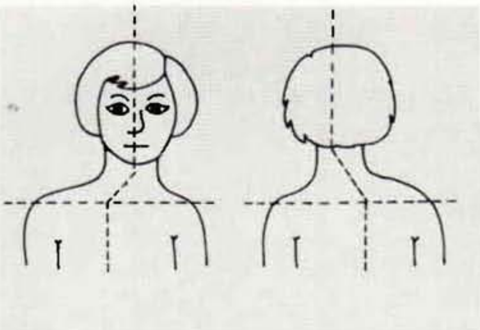

Fig. 7b—Lateral shift of the head toward affected shoulder.

ORTHOSIS DESIGN

A static rotational control cervical orthosis has been designed to stretch a fibrotic sternomastoid muscle (Fig. 8). There are two sections to the static rotational control cervical orthosis. The head section has asymmetrical trim lines which are dictated by the side the affected sternomastoid muscle is on and the thoracic section which is trimmed in a symmetrical fashion. The head section of the orthosis has an anterior projection on the side opposite the affected muscle. The projection functions to push on the xygomatic arch of the bulged side and not to push on the mandible on that same side. The head section of the orthosis also incorporates a posterior projection on the same side as the affected muscle. The anterior and posterior projections work together to prevent the infant from rotating his head in the direction of the affected sternomastoid muscle.

The head section and the thoracic section are interlocked in virtually any degree of rotation by a ring of ⅝″ wide Velcro (Figs. 9a and 9b). This freedom of rotation allows treatment to begin in a neutral rotation position, and progressively stretches a tight sternomastoid muscle by slowly increasing rotation. In addition, while the child is lying prone or supine he will pick up weight bearing on the bulged posterior parietal eminence and the bulged anterior frontal lobe and face thereby allowing the effects of gravity to successfully remold the plagiocephalic head into a more normal shape.

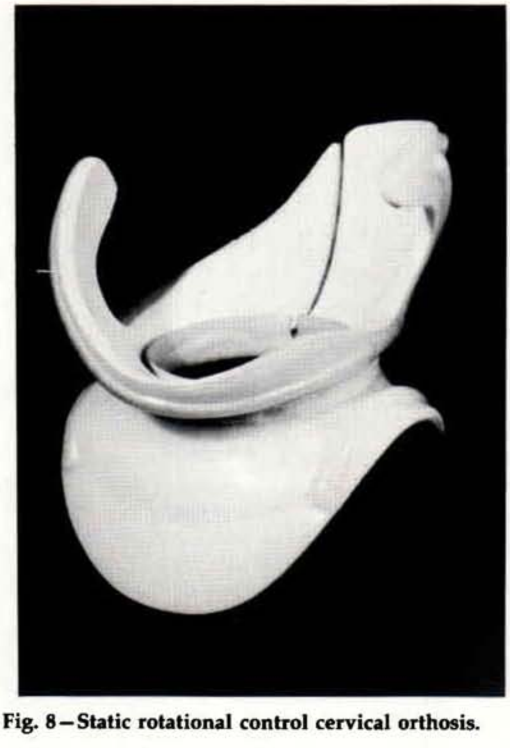

Fig. 8—Static rotational control cervical orthosis.

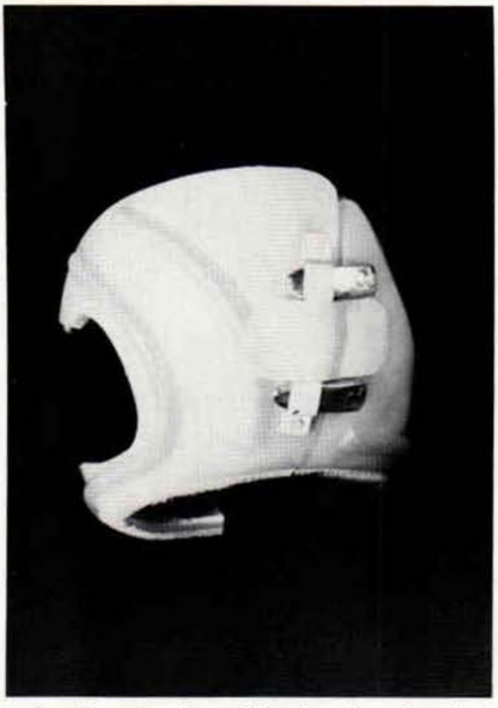

Fig. 9a—Posterior view of head section of orthosis showing slide interlock keepers and ring of Velcro.

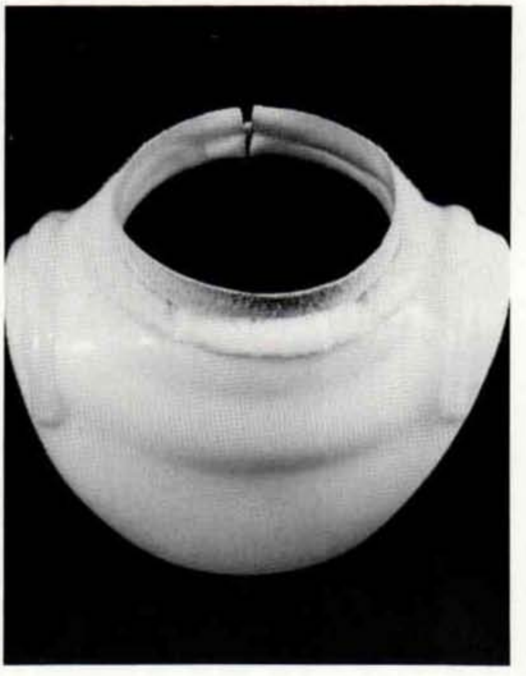

Fig. 9b—Anterior view, thoracic section. Shows ring of Velcro and Kip leather glued to the inside of the thoracic section. This leather functions to protect the patient's skin when the head section is rotated on the thoracic section.

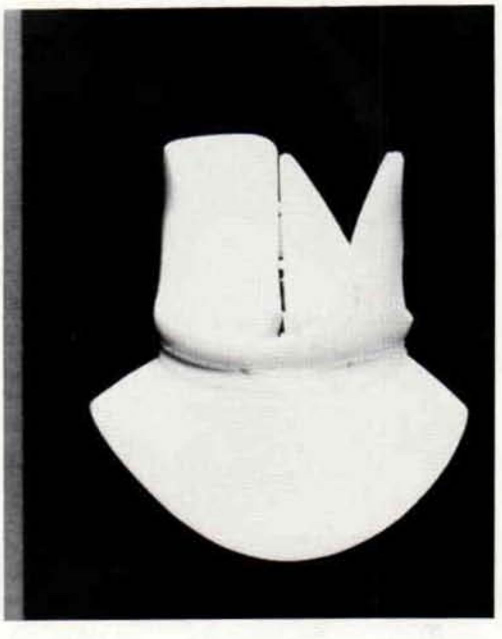

Fig. 10—Anterior view cervical orthosis without reinforcing corrugations.

Design Modifications

Some changes were made to the original design to create the current orthosis. The first design incorporated three-sixteenths of an inch cotton rope to make reinforcing corrugations on the head anterior and posterior projections (Fig. 8). The original theory was that the sternomastoid muscle would have to be forcibly stretched. However, after treatment of one infant it was found that this is not the case. A second orthosis was fabricated without corrugations and this modification made fabrication easier and did not hinder the effectiveness of the overall treatment (Fig. 10).

Two modifications to the anterior projection were made in the second design which makes treatment much more effective. Figure 11 shows the removable anterior projection with its slide interlock keepers and Velcro straps. The anterior projection is removed when the child lies in the prone position making him bear weight on the entire aspect of his face and frontal lobe. This, in theory, should cause the anterior craniofacial deformities to disappear more quickly. At this point, the orthosis has lost one of its counter rotation projections and if the infant can rotate out of the orthosis he will have to have his sleeper firmly pinned to this mattress to limit movement during sleep.

Figure 12 shows the second design modification of the anterior projection. This cervical orthosis was prescribed for a four year old male who has spasmodic torticollis of unknown etiology. The forces required to stretch a spasmodic sternomastoid muscle are much greater than the forces needed to stretch a fibrotic sternomastoid muscle. The anterior projection is reinforced with one-eighth inch thick aluminum. The reinforced anterior projection can be contoured in such a fashion that the patient is assured of receiving rotational corrective forces on the xygomatic arch only and not on the mandible of the same side.

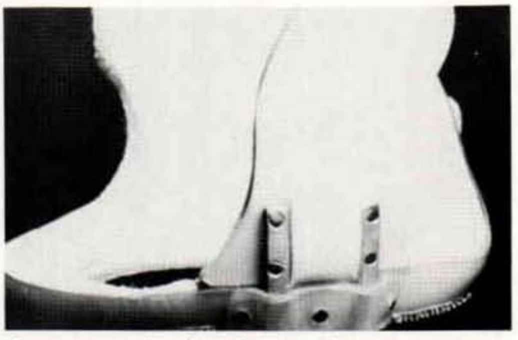

Fig. 11—Anterior lateral view showing removable anterior projection.

After the first static rotational control cervical orthosis had been in use it became readily apparent that a final modification was necessary to aid in the donning and doffing of the orthosis. The head and thoracic sections were cut into two equal halves in the mid-sagittal plane. Four piano hinges were then attached to the posterior aspect of the head and thoracic sections (Fig. 13). Slide interlock keepers and Velcro closures were attached to the anterior aspects of both head and thoracic sections (Fig. 12).

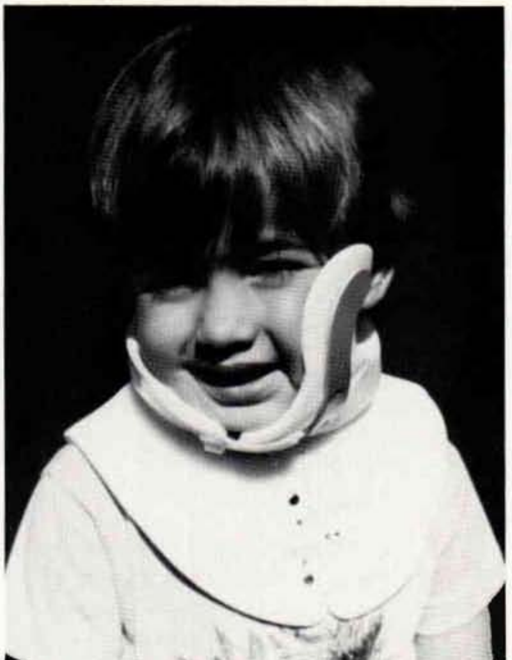

Fig. 12—Anterior view cervical orthosis showing reinforced anterior projection, slide interlock keepers and Velcro straps.

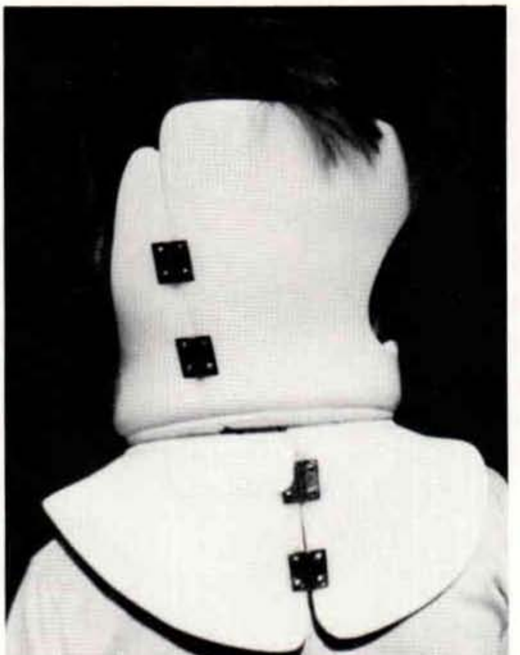

Fig. 13—Posterior view of static rotational control cervical orthosis showing four piano hinges.

NEGATIVE IMPRESSION PROCEDURE

If possible, the infant should be sedated prior to casting.

To obtain a cast impression for the cervical orthosis, a modified turtle neck shirt was fabricated and worn by the patient. A piece of one-quarter inch thick cotton felt, three-quarters of an inch wide, was placed on the neck of the patient and stapled posteriorly. A cast removal strip was applied posteriorly. The proximal right and left anterior sections of the sock were then stapled together (Figure 14). The shirt was made long enough so the distal anterior and posterior sections could be stapled together between the patient's legs. The following landmarks were then identified with a transfer pencil: right and left cars, clavicles, and right mandible.

To obtain a negative impression, circumferential wraps of elastic plaster bandage were molded on the head and neck areas of the patient. An effort was made to keep the wraps distal in the anterior left section and

Fig. 14 – Infant in modified turtle neck shirt.

Fig. 15 – Infant in plaster. Every effort should be made to take the negative impression with the head and neck held in neutral position.

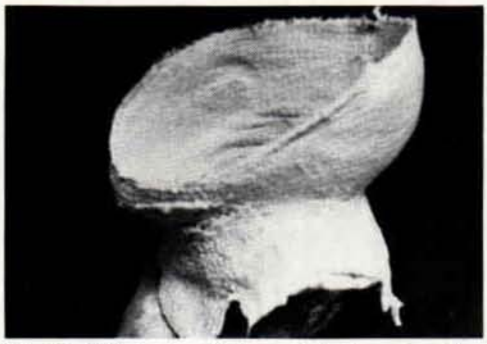

Fig. 16 – Efforts should be made to keep the plaster wrap proximal in the areas where the anterior and posterior projections are to be located.

more proximal in the posterior left and anterior right sections. Flexible plaster splints twelve inches long and three layers thick were applied from anterior to posterior to continue the mold distally to obtain an impression of the shoulder and thoracic areas. Care was taken to assure that the infant's head and neck were held in a neutral position (Fig. 15). Finally, Figure 16 shows the impression removed and plaster trim lines kept proximal in the anterior right and posterior left regions.

POSITIVE MODEL MODIFICATIONS

Remove the neck ring (cotton felt) from the negative impression. Fill the impression with plaster of paris. Place the pipe mandrel in the thoracic section of the model; it should not extend proximally into the neck region of

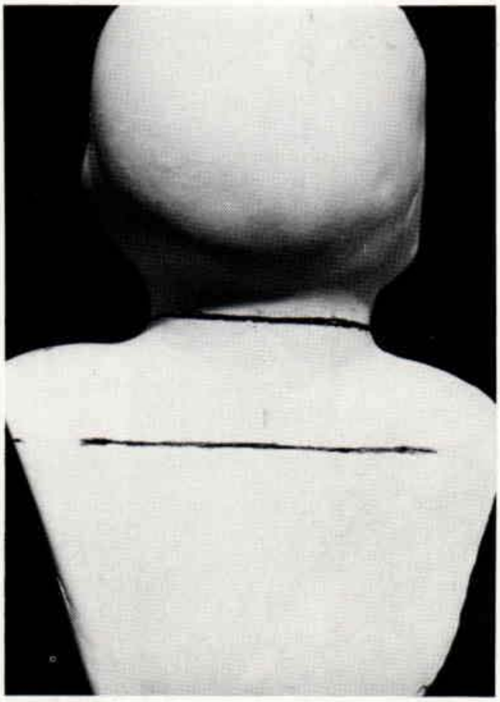

Fig. 17a,b,c — Transverse plane is identified in mid-neck region of positive model.

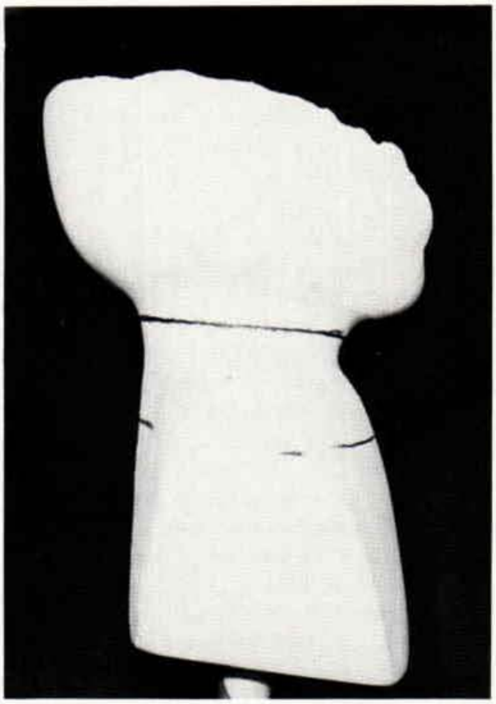

Fig. 17b

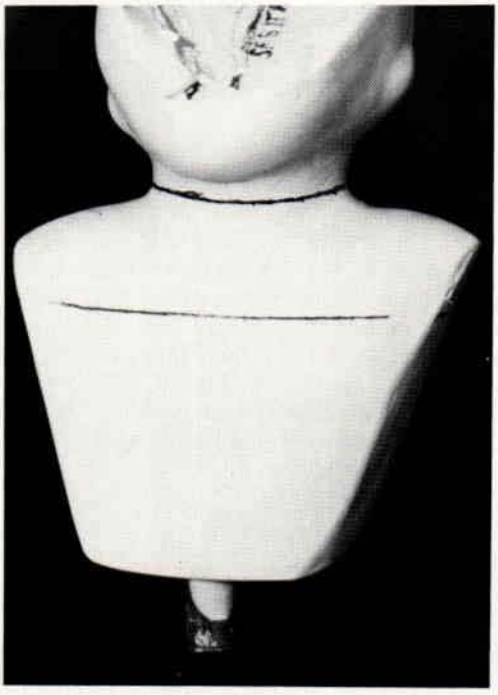

Fig. 17c

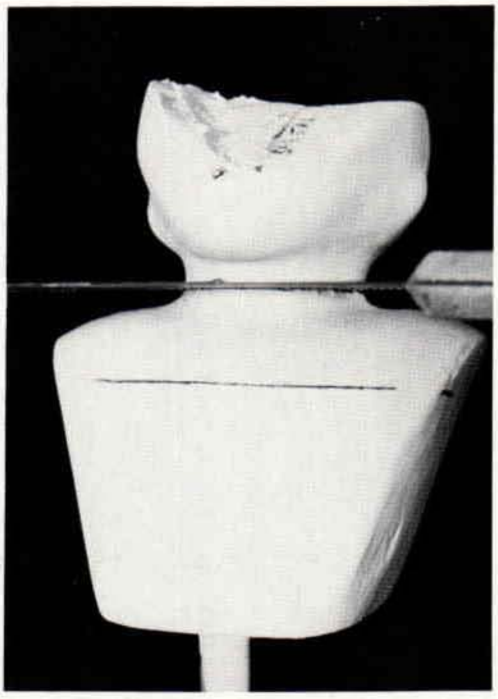

Fig. 18 — The positive model is bisected in the transverse plane.

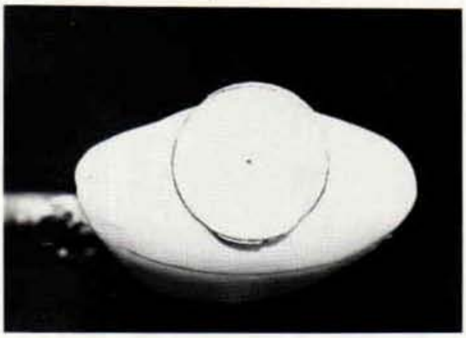

Fig. 19a,b – Vertex view of transverse plane on thoracic section and (b) head section.

the model. Smooth the positive model and add reliefs to the clavicular and mandibular and chin areas. A generous relief is needed in the mandibular area and slight build-ups are needed in the other areas.

Modify the neck section of the positive model as round as possible and bring it to the average dimension between the patient's neck M-L and neck A-P measurements plus three-eights of an inch; this is the inside neck measurement. A wire of solder wrapped around the neck area gives an exact shape of the model.

Remove additional plaster from the bulged posterior parietal eminence. In the mid-neck area of the model the transverse plane must be identified and marked with an indelible pencil (Fig. 17 a, b, c). The transverse line previously drawn acts as a saw line and the neck section of the model is separated from the head section (Fig. 18).

The exact centers of the neck areas are identified on the thoracic and head sections. A circular compass is used to scribe a circle of equal radius on both thoracic and head sections (Fig. 19 a and b). This line functions as a guide when modifying the positive model impressions into two equal circles. These are equal to the inside neck measurement.

A transverse plane slice approximately one-eighth of an inch thick is removed from the thoracic and head sections of the model. Removing this plaster allows for the thickness of the Aliplast lining and plastic cover (Fig. 20).

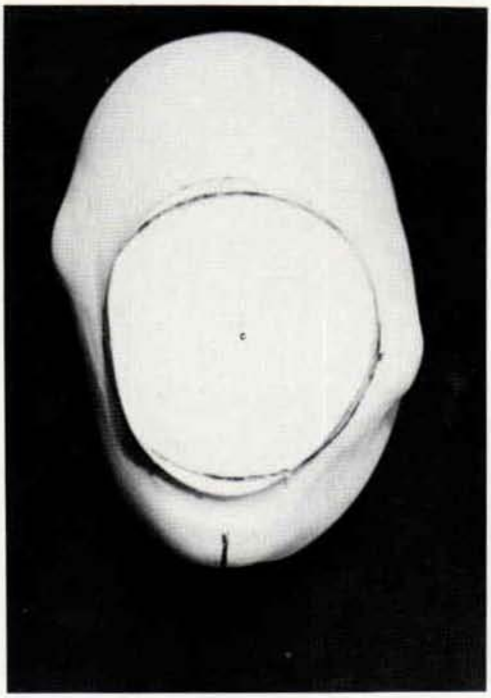

Fig. 19b

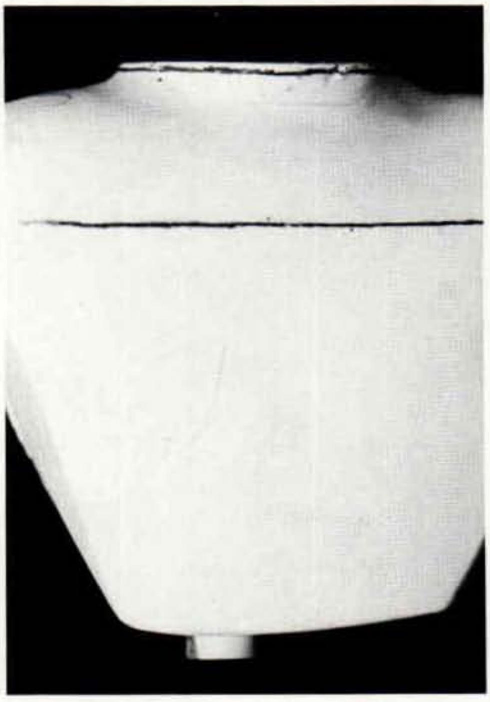

Fig. 20 – 1/8" of plaster is removed from transverse plane on both thoracic and head sections.

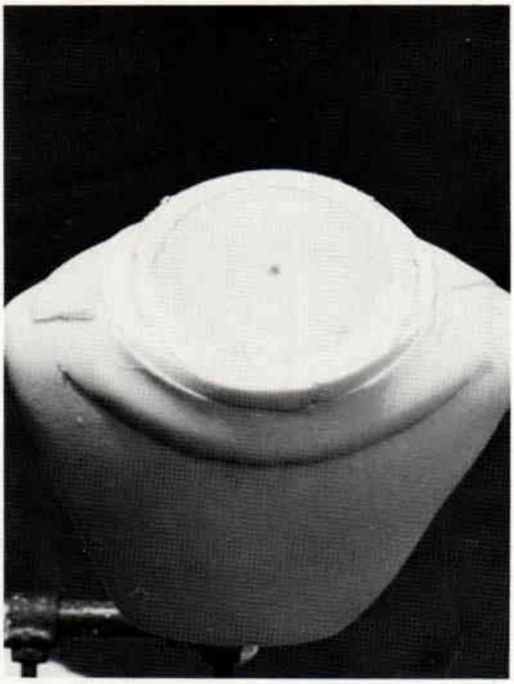

Fig. 21—Three or four layers of 1/4" thick Aliplast are successively glued around the anterior, posterior and lateral aspects of the positive model.

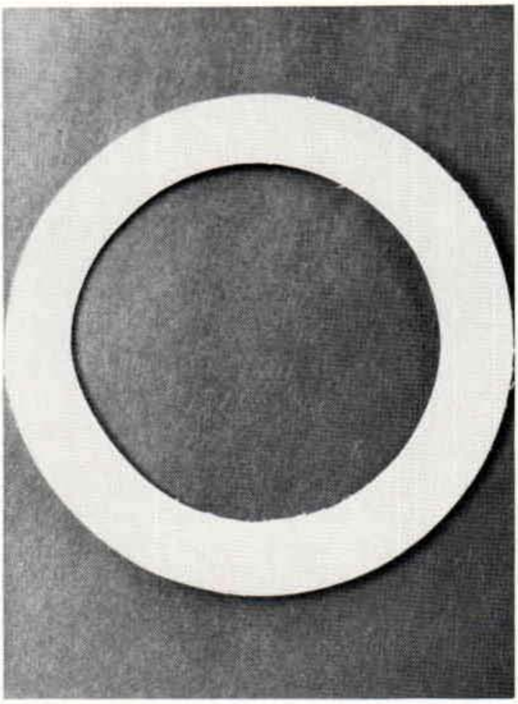

Fig. 22—This picture shows a circle of 3/4" wide, 1/16" thick high density polyethelene with the inside neck diameter equaling the inside neck radius of the model. This plastic is glued to the vertex aspect of the thoracic and head sections.

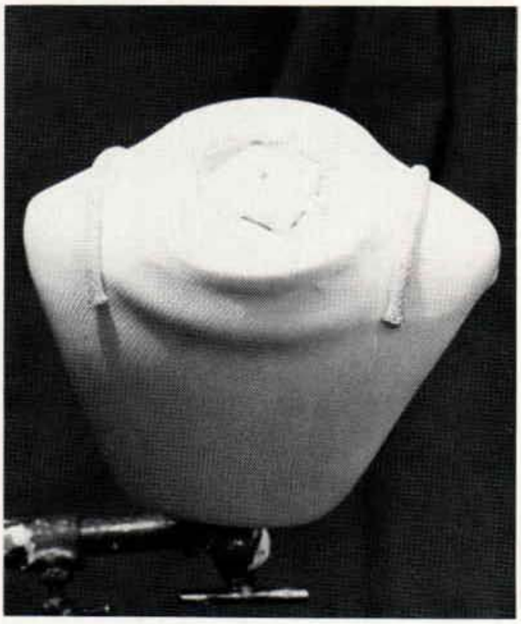

Fig. 23—The model is now ready for vacuum forming.

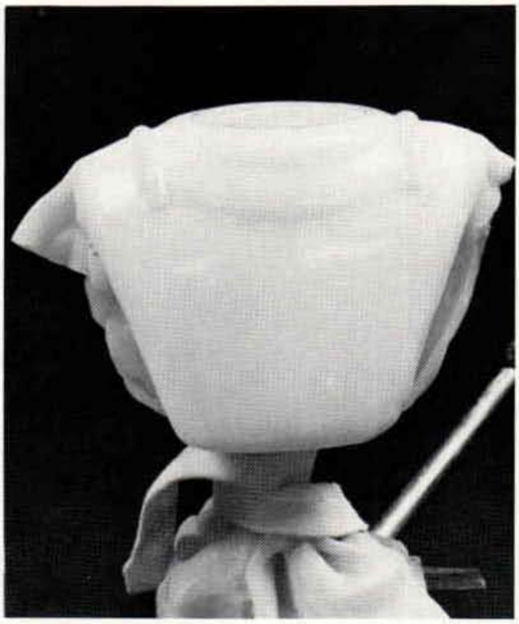

Fig. 24—1/8" thick low density polyethelene is vacuum formed over the model.

Thoracic Section Fabrication

Aliplast lining (1/8") is heated in the oven and pulled over the thoracic section of the model, after which the lining is built up with three or four layers of 1/4" Aliplast. These successive layers of Aliplast provide a build up which is approximately 3/4" larger in radius than the inside neck radius that was previously drawn. This build-up is then ground parallel to the transverse plane and made as flat and as thin as possible (Fig. 21).

Cut out a circle of 3/4" wide and 1/16" thick high density polyethelene with the inside diameter equaling the inside neck measurement of the model (Fig. 22). Center this plastic and glue it with polyadhesive to the proximal aspect of the model. The function of this plastic ring is to keep the 3/4" Aliplast build-up from collapsing when the model is finally draped and vacuum formed.

White tube-gauze stockinette is stapled in the center of the neck region and then pulled over the model and secured to the mandrel which has been prepared for vacuum forming (Fig. 23). In the initial orthosis design 3/16" cotton rope was used as corrugation material; this step is not necessary. Next, 1/8" low density polyethylene is vacuum formed over the model (Fig. 24).

Head Section Fabrication

To accommodate a pipe mandrel, a 3/4" hole is drilled in the center of the vertex aspect of the head section. One-quarter inch thick Aliplast is then heated in the oven, pulled over the model, and stapled into position.

Build up three layers of 1/4" Aliplast around the neck region to equal a circle exactly 3/4" larger in radius than the actual inside neck model measurement. This build-up is then ground parallel to the transverse plane. The additional Aliplast material, which is located outside the 3/4" build-up is removed by using a felt cone (Figs. 25 and 26).

Cut out a circle of 3/4" wide, high density polyethylene with the inside diameter equaling the inside neck measurement of the cast. This is glued with polyadhesive to the model. Tube gauze or white IPOS stockinette is then pulled over the model and secured to the pipe mandrel which has been prepared for vacuum forming. Vacuum form 1/8" high density polyethylene over the model.

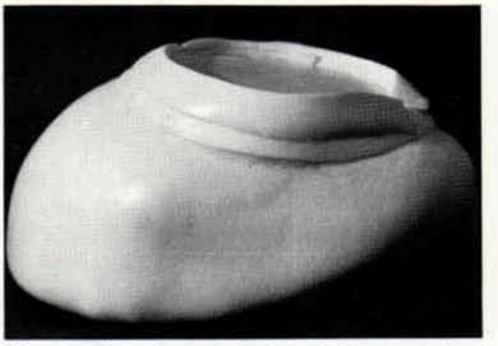

Fig. 25 – Three layers of 1/4" Aliplast are glued around the anterior, posterior and lateral aspects of the model.

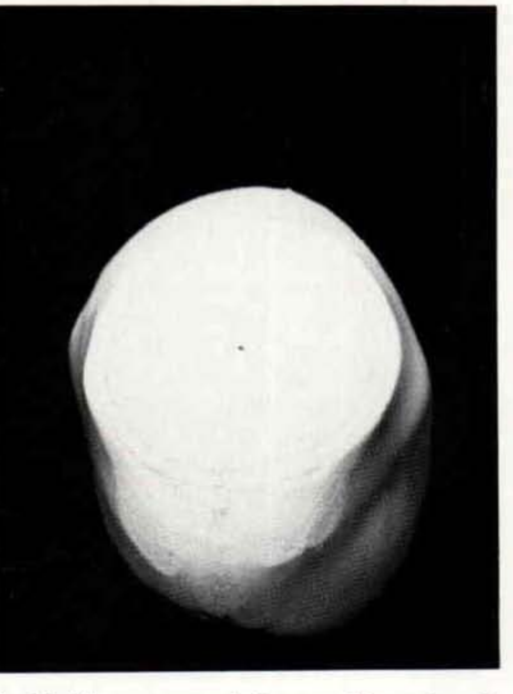

Fig. 26 – The excess material is ground flat and parallel to the transverse plane.

Trim Lines for Head and Thoracic Sections

Locate the anterior projection of the proximal section so it will press on the xygomatic arch and avoid pressure on the ear. Trim the lower portion of the anterior projection so as not to cramp the mandible on that side.

Trim the posterior projection as close to the ear as possible since the ear on that side of the orthosis is sometimes located more posteriorly, and, with correction, will move anteriorly. As the ear moves anteriorly, modifications to this area of the orthosis may be necessary to keep an intimate fit. The posterior trim line on the posterior projection swings distally just after the mid-sagittal line.

Trim the thoracic section in a symmetrical fashion without inhibiting any horizontal glenohumeral flexion. Leather (Kip or Elk) may be glued to the inside thoracic neck section. This functions to protect the infant's skin from being scratched when the head section is applied and rotated.

CASE REPORT

TJT is a male Caucasian. He was born healthy via an uncomplicated vertex delivery. When TJT was about two weeks old the mother noted that he preferred to sleep in the prone position with his head rotated to the right. At five weeks the mother observed a lump in the left side of the baby's neck. At five and one-half weeks the pediatrician found a small, hard tumor in the left sternomastoid muscle. The tumor was one centimeter in length and width and occupied only part of the muscle. Torticollis was present at this time with passive rotation to the left reduced to 40° (normal is 90°). Plagiocephaly was noted and stretching exercises were prescribed.

At 11 weeks TJT was seen by an orthopedist and X-rays were taken to determine if a hemivertebrae condition existed; it did not. At this time there was no marked increase in rotation to the left and plagiocephaly had increased. The parents were instructed to put the infant down to sleep on either side alternately, avoiding the supine and prone positions.

The parents were also instructed to always approach the infant from his left side thus making him rotate his head to the left, stretching the tight left sternomastoid muscle. The stretching exercises were continued.

At 16 weeks, passive rotation to the left increased to approximately 45°-50°, while the plagiocephaly was much the same. A prescription was given for a static rotational control cervical orthosis.

At five months of age, the cervical orthosis was applied to TJT. At this time passive rotation to the left had increased to 50° while the plagiocephaly stayed much the same.

Initially, the cervical orthosis was worn by the patient while supine and sleeping in a neutral rotation position. Wearing time was dictated by the patient's tolerance for the orthosis. As TJT's tolerance for the cervical orthosis grew, his ability to accept stretching of the sternomastoid muscle also increased. Consequently, rotation to the left was increased daily. After wearing the orthosis for one week, TJT's passive rotation had increased to 65°-70°. At the end of the first week of wear, TJT contracted a low grade intestinal flu which caused him to vomit occasionally. As a result, the orthosis was removed for the duration of the sickness.

As orthotic treatment progressed, TJT's rotation in the orthosis increased until he achieved almost full rotation while wearing the orthosis (Fig. 27). At approximately seven

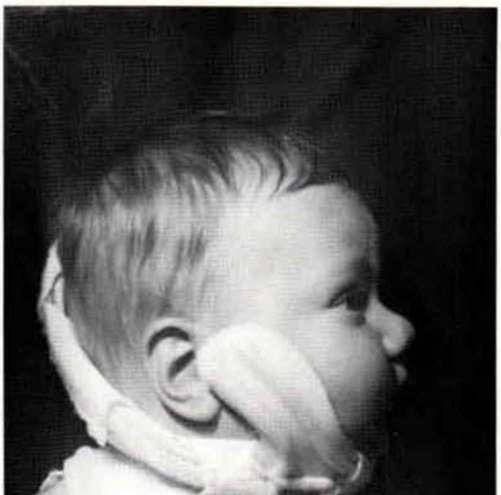

Fig. 27 — Picture showing infant at six months of age (one month into brace treatment) fully rotated towards the affected side.

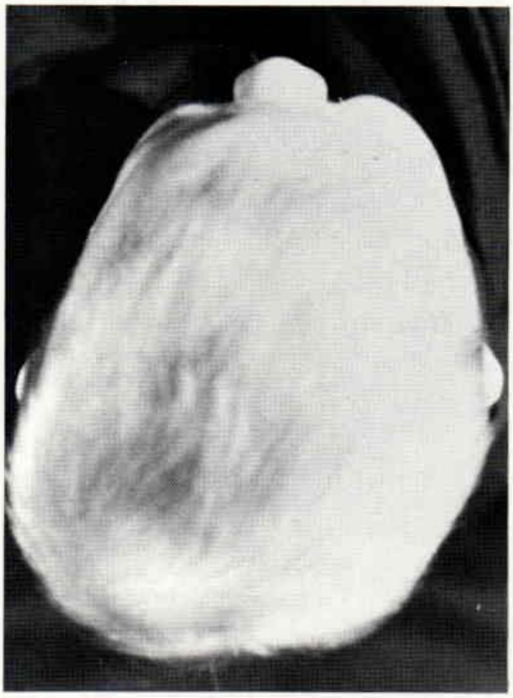

Fig. 28a—Comparative photos before and after treatment with the static rotational control cervical orthosis.

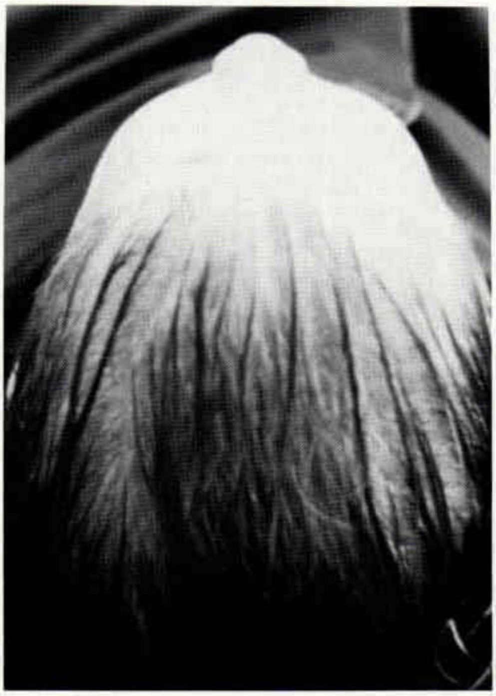

Fig. 28b—Left. Patient TJT at nine months of age, when orthotic treatment was terminated. Right, at two years of age only mild facial asymmetry is seen.

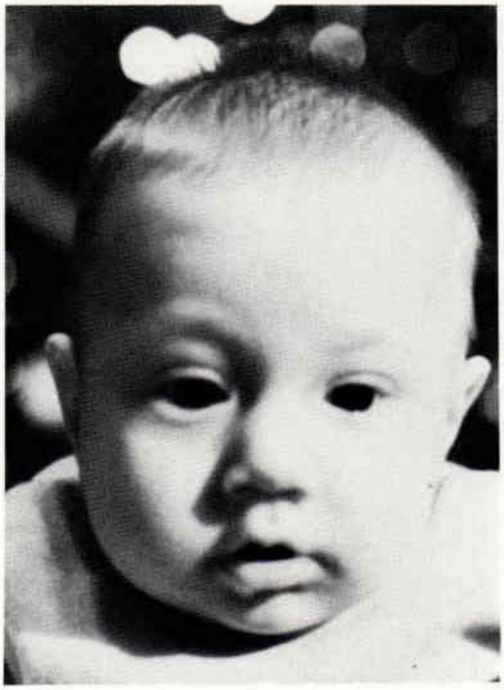

Fig. 28c

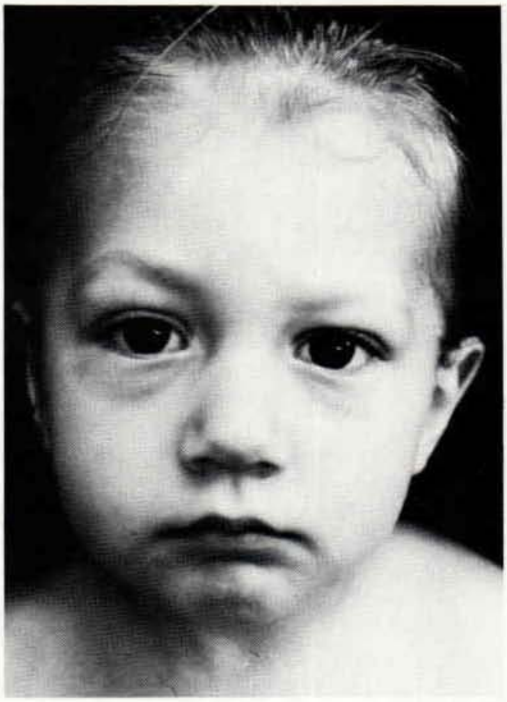

Fig. 28d

months of age TJT began balding on his left bulged posterior parietal eminence, and at eight months he began to show signs of an ulcer on this spot. Rotation was consequently changed periodically, i.e., maximum rotation applied one night and decreased to 40° the next night. The bald spot and ulcer were an indication that the cervical orthosis was indeed changing the weight bearing pattern on TJT's skull. This ulcer and bald spot could have been prevented if the removable anterior projection had been incorporated into his orthosis design and if he had been alternately placed in the supine and prone positions every other night.

At nine months of age, TJT began to roll from the supine to prone position while wearing the orthosis. Since it was undesirable for the infant to lay on the anterior projection the orthosis was removed and treatment was completed. At this time, cranial symmetry was achieved. Mild facial asymmetry did persist as can be seen in comparative photographs of the infant at two years of age (Figs. 28 a-b, c-d, and e-f).

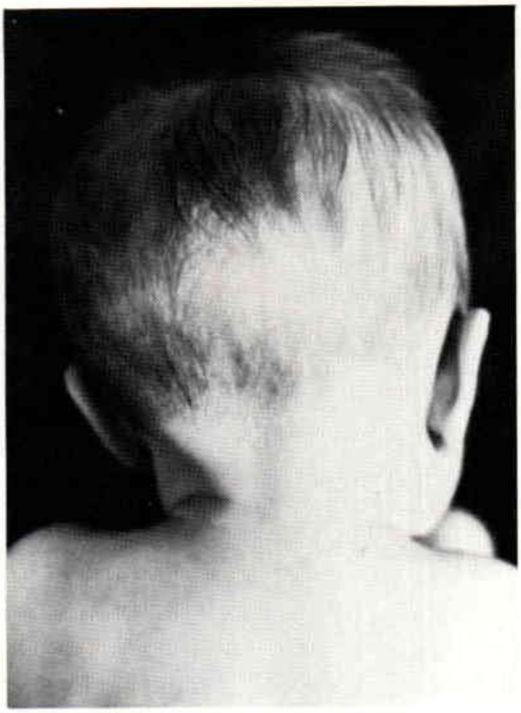

Fig. 28e

CONCLUSION

In this initial study, treatment has been safe and effective. In a patient undergoing static rotational control treatment between five and nine months of age, correction occurred within four months. In older infants, longer treatment periods should be anticipated because the skull is becoming less cartilagenous in nature.

It will not be known if the treated patient would have eventually spontaneously resolved his plagiocephaly. However, after removing the orthosis which TJT had worn for four months, very little spontaneous resolution has occurred. It is also believed that any remaining facial asymmetry could have been prevented by incorporating the removable projections into the original orthosis design.

A suggestion for the future is static rotational control treatment for all infants suffering from severe plagiocephaly and also for those in whom more moderate deformities persist for several months without any apparent spontaneous improvement. The orthosis may also be used in conjunction

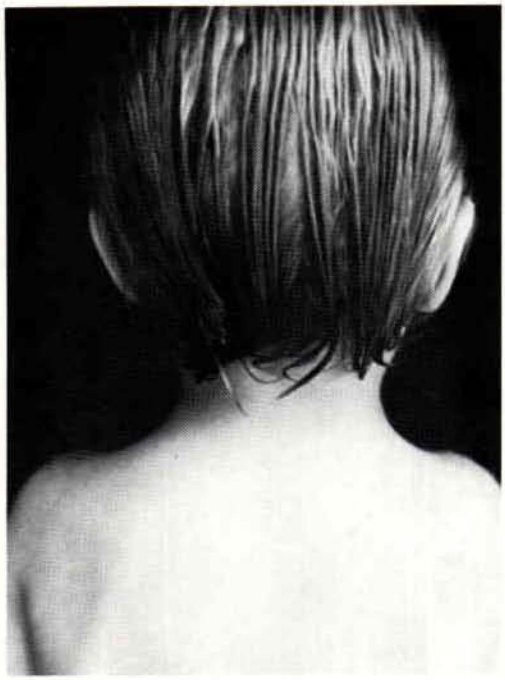

Fig. 28f

with surgery to improve the plagiocephalic condition.

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