AN OCCIPITO-ZYGOMATIC CERVICAL ORTHOSIS DESIGNED FOR EMERGENCY USE—A PRELIMINARY REPORT

Gustav Rubin, M.D., F.A.C.S.
Orthopedic Consultant
Malcolm Dixon, M.A., R.P.T.
Health Sciences Specialist
Joel Bernknopf, B.S.
Staff Orthotist

Veterans Administration Prosthetics Center
252 Seventh Avenue
New York, New York 10001

INTRODUCTION

The purpose of this paper is to present an original, efficient, non-invasive cervical immobilization device, that can be applied to the patient at the scene of an accident to minimize transportation-induced secondary trauma. This device is to be used as a first step during immediate evacuation, and may remain in situ when emergency X-rays are taken. The metallic components will not obstruct a properly directed X-ray beam.

Statistics quoted by Pierce and Nickel (1) define the need for such a device: "There are probably upward of 10,000 cord injuries that result in paraplegia or quadriplegia each year in the United States and there are probably in the neighborhood of 200,000 paraplegic and quadriplegic patients presently living in this country." These authors further point out that one in every ten patients "has shown progression of symptoms of spinal cord or nerve root damage between the time of initial diagnosis at the scene of the accident and the beginning of definitive in-hospital treatment." These same authors further state that "*first-aid treatment of patients with spinal injuries is at present woefully inadequate* (italics ours) and, if it were adequate, it could in many cases prevent permanent sequelae or reduce neurologic residuals."

DESCRIPTION OF THE ORTHOSIS

Basic Features of Existing Orthoses

Non-invasive orthotic devices provide relatively ineffective immobilization of the cervical spine. A recent study (2) concluded that "lateral bending and rotation over the entire cervical spine as well as flexion-extension at the upper levels were not well controlled by any of the conventional orthoses," and that "the standard orthoses with mandibular and occipital supports are not well suited to controlling lateral bending or sagittal plane motion of the head."

Cervical orthoses (other than those that cannot be applied in the field, such as the halo) depend upon several points of support, the occiput and mandible superiorly, and the shoulder girdles and trunk inferiorly. The soft cervical collar is essentially a reminder orthosis rather than a supportive device (2), because the soft components cannot resist pressure distortion. Other conventional, readily applicable, non-invasive orthoses such as the four-poster and the SOMI (Sternal-Occipital-Mandibular Immobilizer) (2) are fabricated with rigid components, but such orthoses should not be locked rigidly against the mandible during transportation of the cervical-spine-injured patient because of the danger of interfering with respiration as well as with the removal of vomitus, and the possibility of inhalation of such material. Even in the alert and fully conscious patient, immobilization of the mandible interferes with feeding and speech. Therefore, existing conventional orthoses are fitted in such manner that the patient can lift his head and chin away from the orthosis support areas and move his neck to a significant degree in all directions. The only orthosis which comes "close to the theoretical total immobilization is the halo cast. It obviously does not totally immobilize the cervical spine but is very efficient" (3).

Basic Features of the New Design

Certain key components of the SOMI (2) orthosis were retained with specific changes aimed at achieving more efficient immobilization, while at the same time freeing the mandible from its traditional role as an orthosis support area. The changes consisted of:

1. Removal of the mandibular component of the SOMI and its replacement with a U-shaped zygomatic component (Figs. 1 and 2), while retaining all other components of the SOMI; and
2. The addition of a cranial vertex component with appropriate strap restraints (Fig. 3), to complement the extension restraint function of the occipital pad. This feature is particularly useful to limit head extension of the supine patient.

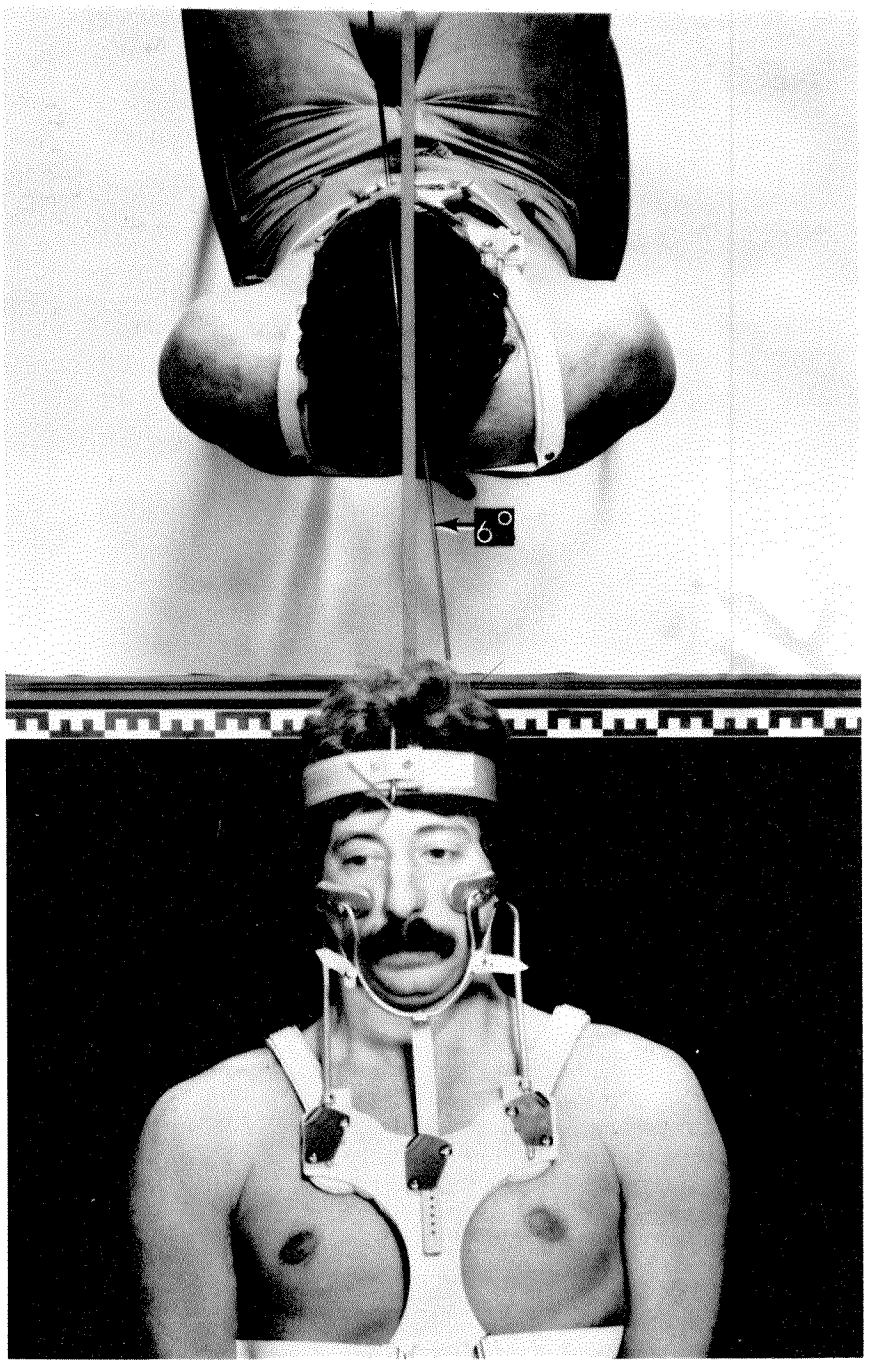
6°

FIGURE 1.—Note the replacement of the SOMI mandibular support by the sub-zygomatic yoke. The range of rotation to the subject's right with the orthosis is shown on the Figure. The subject retained slight movement capability while indicating that the adjustment was not uncomfortable. (This individual's normal range of rotation in the direction shown was measured to be 75°.)

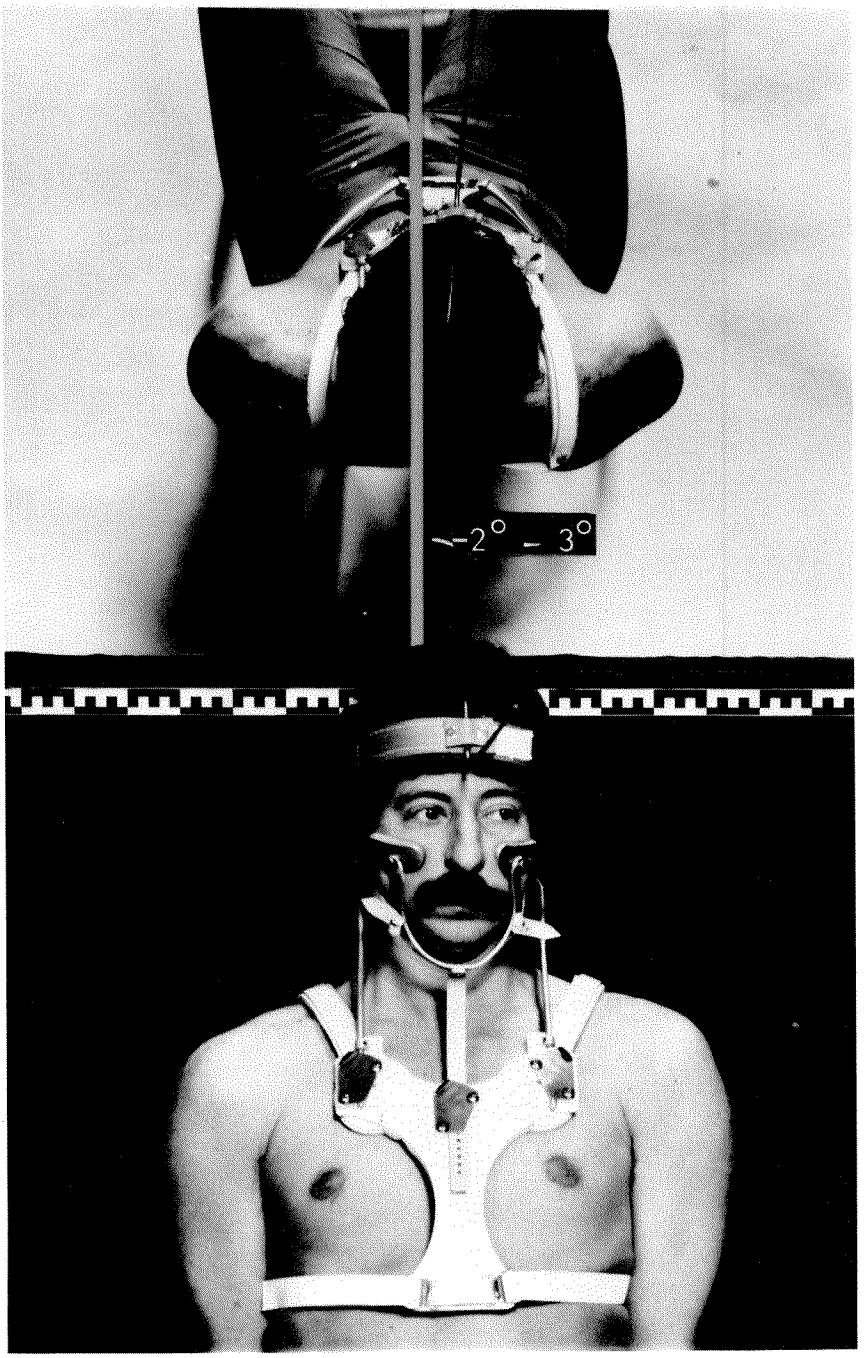
-2° - 3°

FIGURE 2.—Rotation to left in the orthosis. (This individual's normal range of rotation in this direction was measured to be 75°.)

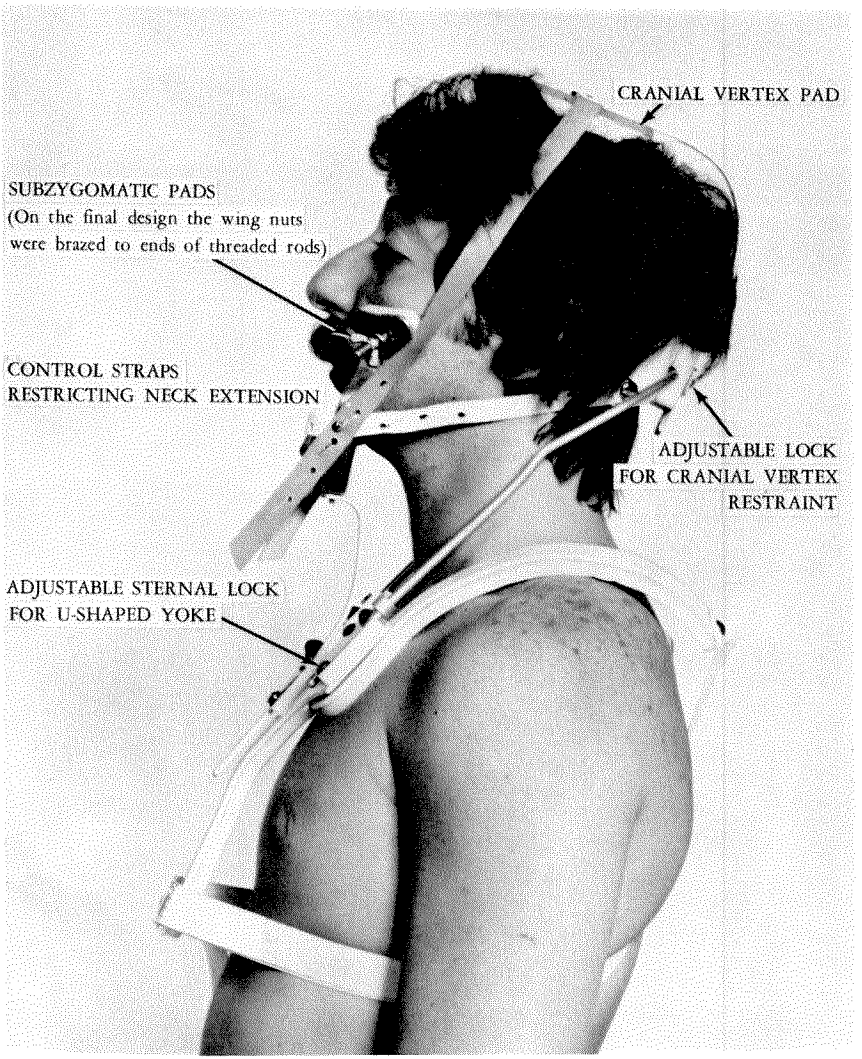

FIGURE 3.—Side view to demonstrate components. Note that there has been no attempt by the orthotist to custom-fit the shoulder/trunk components. Custom-fitting was deliberately avoided in this instance, because it is advised that this orthosis be employed as an emergency application device. In spite of that, flexion and extension are markedly restricted.

Advantages of the New Design

1. The yoke bypass of the mandible to the zygomata allows mandibular motion and permits the patient to open his mouth. The use of the sub-zygomatic support areas allows the orthotist to fabricate padded sub-zygomatic supports which are not only vertically supportive but are also placed obliquely in relation to the sagittal plane to restrain rotation effectively.

2. The pads, which are mounted on ball and socket joints, can be threaded in toward the zygomata or away from them, to accommodate different facial bone measurements.

3. Ease of application is retained. During application "gentle axial traction" (1) should be maintained by placing the hands on the chin and occiput. The orthosis can be applied over the patient's clothing in the manner of the application of the SOMI. The orthosis should be applied in four steps by two trained ambulance attendants. One attendant must maintain head traction with the patient in the supine position until application is completed. The four sequential steps are as follows:

   1. The trunk (shoulder-sternal) component is applied first and the criss-crossed straps are pushed beneath the patient to their anterior attachments points, and tightened.
   2. The occipital component is then fitted into place, vertically adjusted, and locked into the appropriate locks.
   3. The zygomatic yoke should next be positioned in the sternal slot and locked. The pads should be adjusted into the subzygomatic recesses by turns of the wing nuts. A final vertical readjustment of the yoke may be required.
   4. Finally, the cranial vertex component should be fitted snugly to the vertex and fixed in position in the lock. (Fig. 4).

Retention of the SOMI Design Principles

The original SOMI was designed to permit its application to the supine patient with minimal manipulation of the cervical spine. This aim was achieved by carrying the occipital support struts anteriorly to adjustable fixation points (Figs. 1 and 2). A fixation point over the sternal segment of the orthosis was included to allow for vertical adjustment of the mandibular component of the SOMI, which could then be locked into position.

In the present design, after the mandibular component had been removed and replaced by the sub-zygomatic yoke, the sternal attachment point was used in the same manner, i.e., to allow vertical

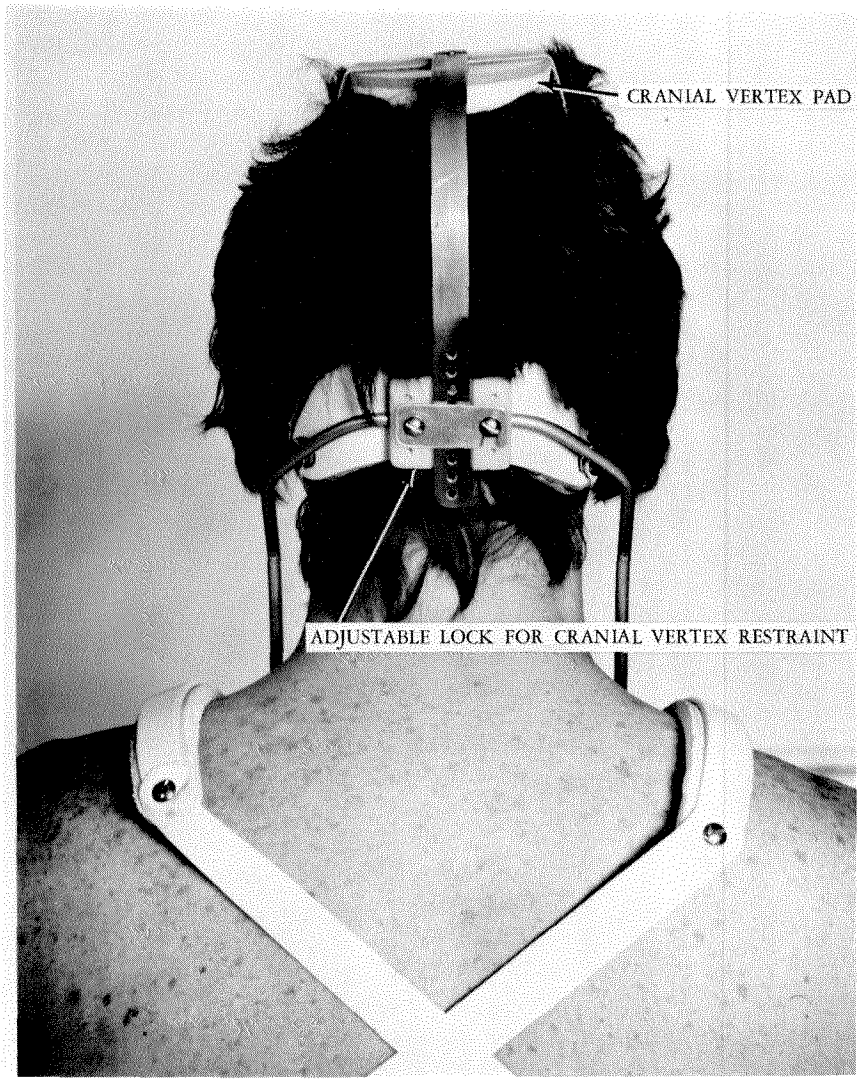

FIGURE 4.—Posterior view to demonstrate a lock for extension restraint.

adjustment and locking of the yoke. Finally, a similar adjustable fixation point was added to the occipital component of the SOMI for attachment of the cranial vertex restraint (Fig. 4). In essence, this device is more rigid than the SOMI (2).

EFFECT OF THE ORTHOSIS ON CERVICAL MOTION

A young, healthy, adult without cervical complaints was used as the subject. The zygomatic pads were adjusted until the subject indicated that they were not uncomfortable.

Head motion was measured in relation to the superior border of the 7th cervical vertebra by drawing a line across the superior border of that vertebra and relating this to a line drawn through two fixed points on the skull: the center of the occipital protuberance and the lower border of the mastoid process:

1. *Flexion* (Figs. 5 and 6)
   a. without the orthosis: 40 deg
   b. with the orthosis: 2 deg-3 deg
2. *Extension* (Figs. 7 and 8)
   a. without the orthosis: 83 deg
   b. with the orthosis: 0 deg
3. *Right Lateral Bending* (Figs. 9 and 10)
   a. without the orthosis: 30 deg.
   b. with the orthosis: 3 deg
4. *Left Lateral Bending* (Figs. 11 and 12)
   a. without the orthosis: 30 deg
   b. with the orthosis: 5 deg
5. *Rotation* — 75 deg in each direction (measured but not photographed). For this individual the range was greater than that recorded in the publication "Joint Motion" of the American Academy of Orthopaedic Surgeons (60 deg) (4).
   a. with orthosis, to right (Fig. 1): 6 deg
   b. with orthosis, to left (Fig. 2): 2-3 deg

INDICATIONS

The authors suggest the use of this new design for emergency application at the scene of the accident to virtually "lock" the head and neck into almost total immobility and limit the possibility of additional secondary iatrogenic damage to the already traumatized neck. The long term effect of pressure on the sub-zygomatic soft tissues is not known at this time and, for that reason only, prolonged therapeutic use cannot be recommended until such effects can be evaluated. (This device is currently being distributed to several spinal-cord-injury centers throughout the country for their use and evaluation.) Should this orthosis be employed for routine immobilization rather than for an emergency situation, the vertex restraint may be removed and the device may be custom-fitted (see caption for Figure 3).

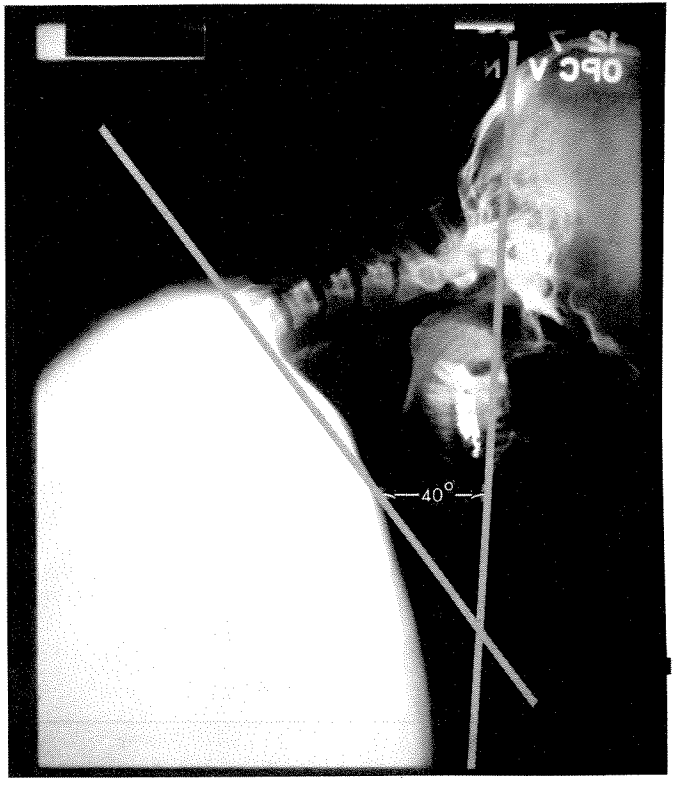

FIGURE 5.—Unrestrained flexion.

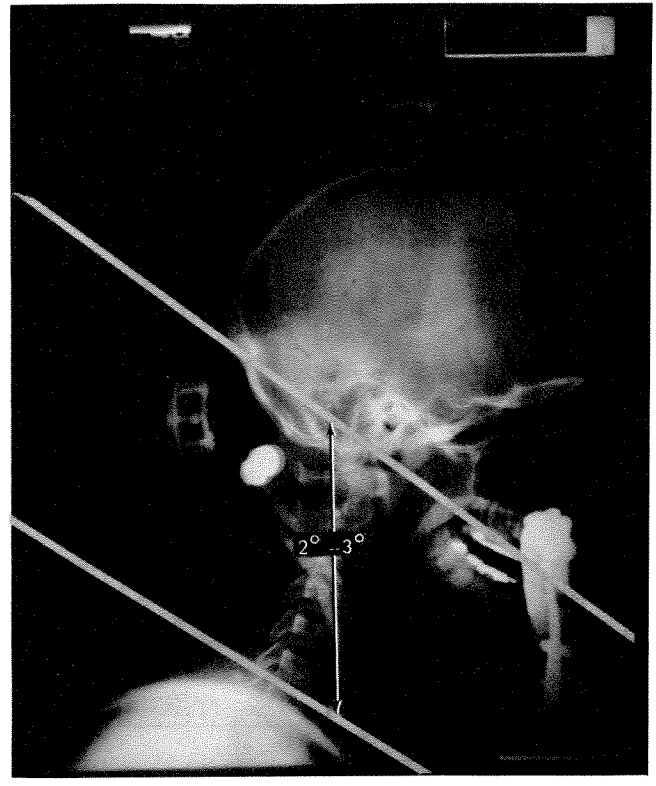

FIGURE 6.—Flexion in orthosis.

FIGURE 7.—Unrestrained extension.

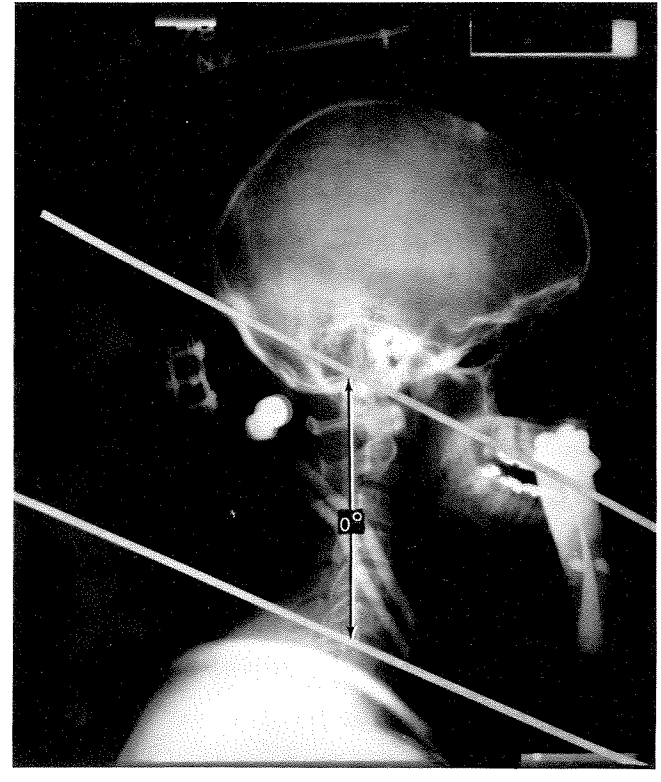

FIGURE 8.—Extension in orthosis. Note that the forceful effort employed by the subject in his attempt to extend caused bowing of the steel head restraint bar.

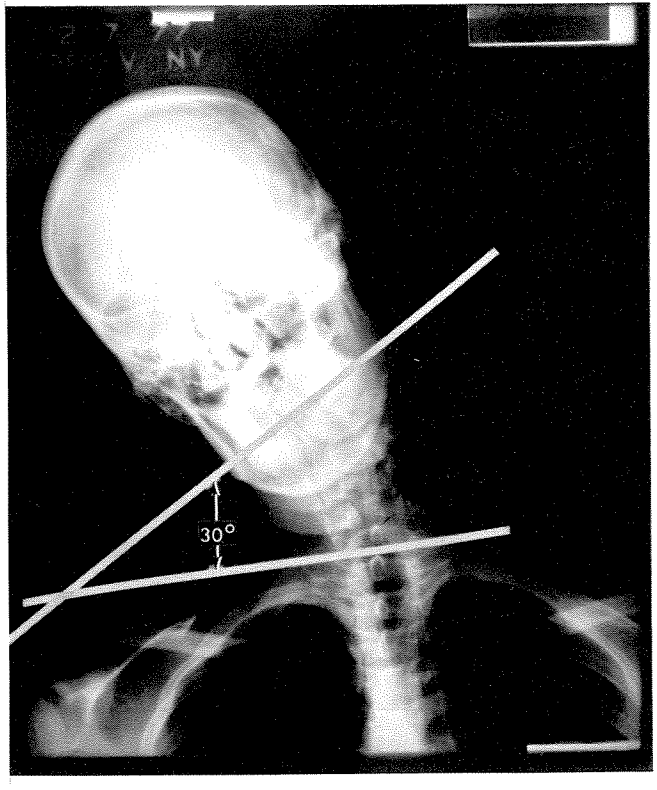

FIGURE 9.—Unrestrained bending to right.

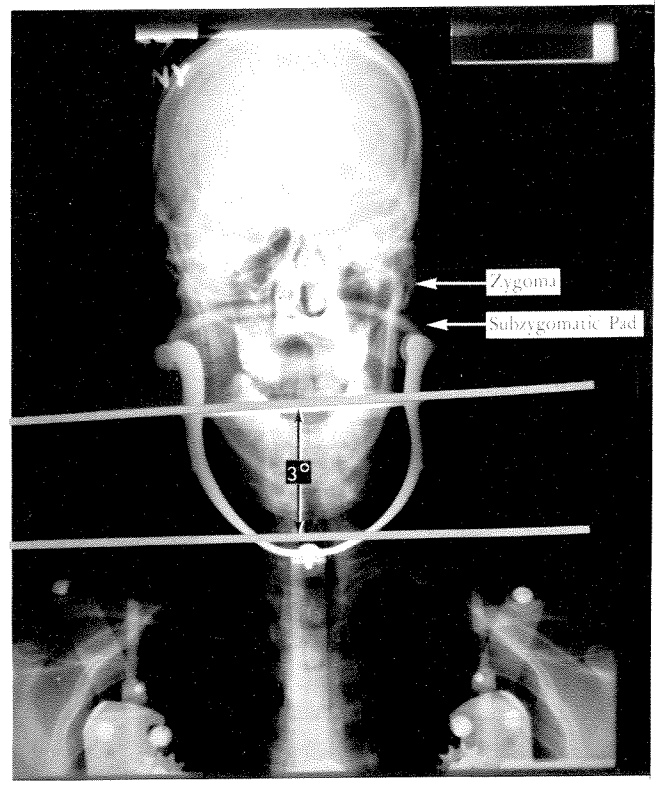

FIGURE 10.—Bending to right in orthosis.

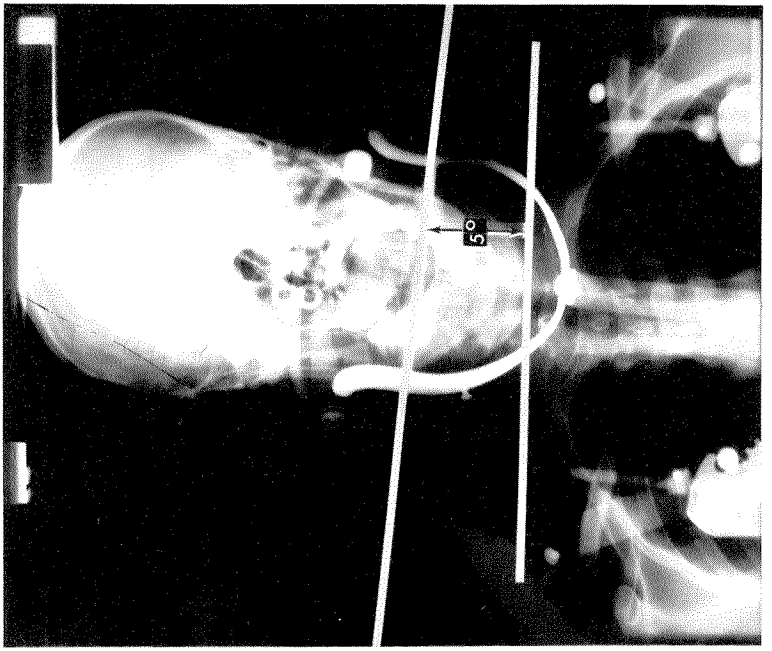

FIGURE 12.—Bending to left in orthosis.

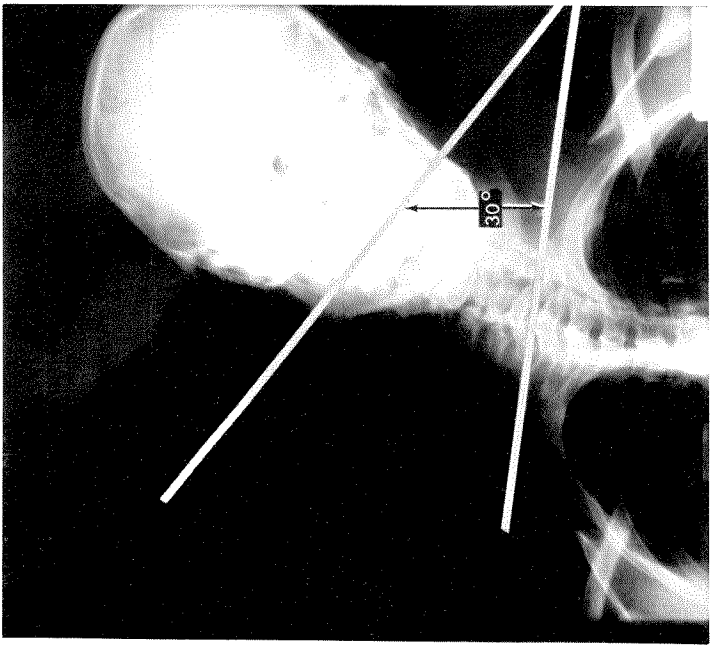

FIGURE 11.—Unrestrained bending to left.

ACKNOWLEDGMENTS

The authors wish to extend their appreciation to Michael Danisi, C. O. and Eugene Lamberty, C. O. for their contributions to the development of this orthosis.

REFERENCES

1. Pierce, D. S. and V. H. (sic) Nickel: The Total Care of Spinal Cord Injuries. Little, Brown and Co., Boston, 1977, pp. 1 and 2.
2. Johnson, R. M., D. L. Hart, E. F. Simmons, G. R. Ramsby, and W. O. Southwick: Cervical Orthoses. J. Bone & Jt. Surg., 59:A3:332-339 (quoted references, p. 338), April 1977.
3. Johnson, Allen S.: Spinal Orthotics. Limb Prosthetics and Orthotics. Report of a Workshop, University of Miami, April 1-3, 1977, p. 32. Reprinted from December, 1977 Ortho. and Prosth.
4. Joint Motion. Method of Measuring and Recording. Amer. Acad. Orthop. Surg., p. 86, 1965.

Note: For further information, *see also* Boldrey, E.: Supportive Immobilization of the Cervical Spine. J. of Surg., Gyn., & Obst., 80:107-108, Jan. 1945. (This article refers to the use of a custom-fitted orthosis employing the technique of subzygomatic support in a somewhat different manner than that reported here, but using the same principle. The orthosis described by Dr. Boldrey uses extensions passing from the occipital support component laterally around the side of the head to the zygomata. It is of interest that Dr. Boldrey found essentially the same degree of limitation of motion that the authors achieved. It is also of interest that Dr. Boldrey considered it advisable to attempt to fabricate a similar orthosis which could be used in emergency situations.)