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SPINAL ORTHOTICS

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There are at least two pertinent questions which can serve as an introduction to this topic. First, is it possible to actually immobilize the spine with an orthosis that the patient can tolerate? Second, in attempting to immobilize the spine with an orthotic device, can the normal differences in posture of the spine from standing to sitting be accomodated in the fit?

We should continue to ask more questions than we answer, choose some of the better ones and get on with it.

Keeping these questions in mind, we will look at spinal orthoses of two basic types: 1) those for general immobilization of the spine and 2) those which have specialized goals. By general immobilization, I mean the orthoses for painful backs, postoperative orthoses and postinjury orthoses. Under orthoses for specialized goals, we will discuss those concerned with specific problems such as scoliosis, kyphosis and spinal cord injuries.

Spinal orthoses generally are classified according to the anatomical areas to which they are applied. We will discuss them under cervical, thoracic, thoracolumbar and lumbosacral (and I am aware of CTLSO). The presentation of each area will be broken down into orthoses which are now available and orthoses for future needs. For those now available, we will ask what they actually accomplish and if there are deficiencies.

ORTHOSES NOW AVAILABLE FOR THE CERVICAL SPINE

Beginning at the top with cervical orthoses, those which are now available are of several types: the various types of collars including the full-molded plastic collars, the four-posters, the two-posters, the SOMI's and, by extending the definition of orthoses, the halo jacket and halo cast.

Collars (Figs. 1A-B) have been used for a long time and can be reasonably comfort-

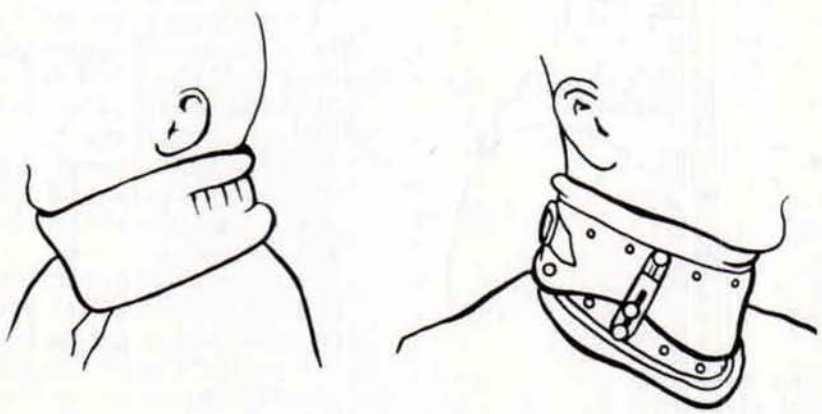

Fig. 1A: Soft collar (foam) and B: Hard collar (polyethylene). (From American Academy of Orthopaedic Surgeons: *Atlas of Orthotics: Biomechanical Principles and Application,* St. Louis: The C. V. Mosby Co., 1975, p. 361.)

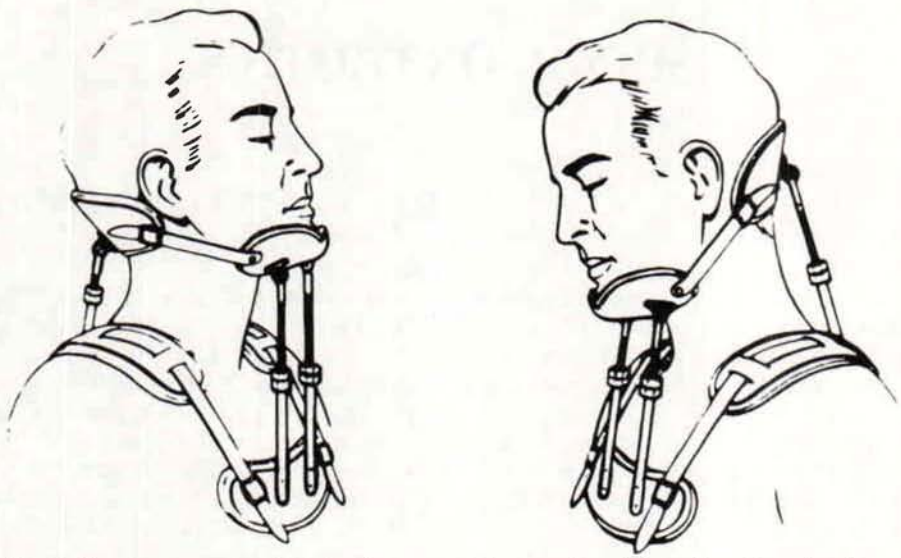

Fig. 2: Four-poster orthosis in A: flexion and B: extension. (From American Academy of Orthopaedic Surgeons: *Atlas of Orthotics: Biomechanical Principles and Application,* St. Louis: The C. v. Mosby Co., 1975, p. 362.)

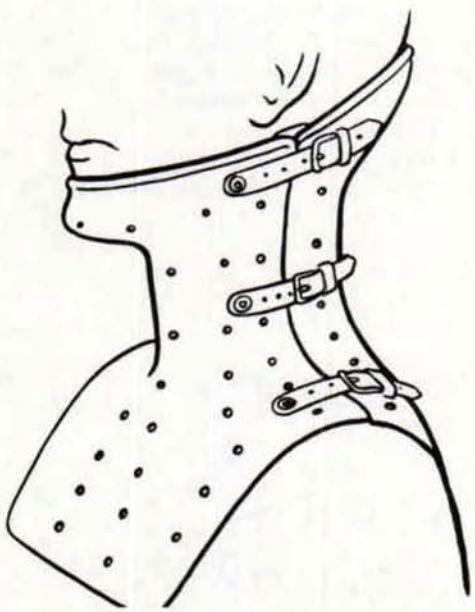

Fig. 3: Custom-molded orthosis. (From American Academy of Orthopaedic Surgeons: *Atlas of Orthotics: Biomechanical Principles and Application,* St. Louis: The C. V. Mosby Co., 1975, p. 363.)

able. They limit either flexion or extension and can be designed or adjusted to do one or both, but they don't immobilize. They do very little to limit rotation. They are removable by the patient for comfort and for hygiene.

The four-poster brace (Fig. 2), and some better two-poster braces, are more complicated devices which generally give better control of the head with limitation of rotation. When fitted tightly against the chin and occiput, they are relatively uncomfortable for the patient and many require frequent realignment. The SOMI brace also accomplishes the same function and is possibly a little more comfortable, but like the others is removable by the patient. In general, the efficiency of this group of braces is directly related to the amount of chin-occiput pressure for which they are fitted.

Of the removable collars, the Philadelphia or molded orthosis (Fig. 3) which encloses the neck, chin, occiput and base of the neck is probably the most efficient. It gives better limitation of rotation combined with limitation of flexion and extension than the ordinary collars. It can be made reasonably comfortable.

Fig. 4: Halo cast.

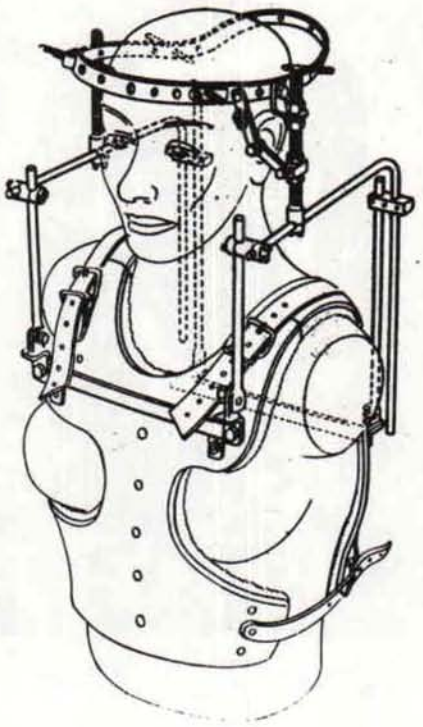

Fig. 5: Halo-vest assembly (halo jacket). (From brochure on "Halo Traction Equipment," Ace Orthopedic Co., Hawthorne, California.)

The only orthosis, if I may call it that, which comes close to the theoretical "total immobilization" is the halo cast (Fig. 4). The head is rigidly held by the halo which is attached to a snug cast on the torso. It obviously does not "totally immobilize" the cervical spine, but is very efficient.

The removable halo jacket (Fig. 5) which is being marketed, and with which I have had no first hand experience, at least potentially can be harmful. If by applying a halo to the skull, you imply that the instability of the cervical spine is significant, then an efficient immobilization device is needed. The halo jacket system allows the possibility of loosening or partial removal of the jacket by the patient and dangerous alteration of position of the head. The long lever arm attached rigidly to the head just above the spinal instability, would seem to magnify the risk and stress to the unstable segments. This is an empiric concern, and I don't really know whether it has proven to be real. Perhaps, some of the participants of this workshop can shed light on this.

Future Needs in the Cervical Area

From the physician's standpoint, I would like to see a method of immobilization of flexion, extension and rotation without skull penetration. From the patient's standpoint, three qualifications should be met: 1) the orthosis should be reasonably comfortable, 2) the patient should have the ability to continue his occupation, and 3) the patient should have reasonable ability to remain clean.

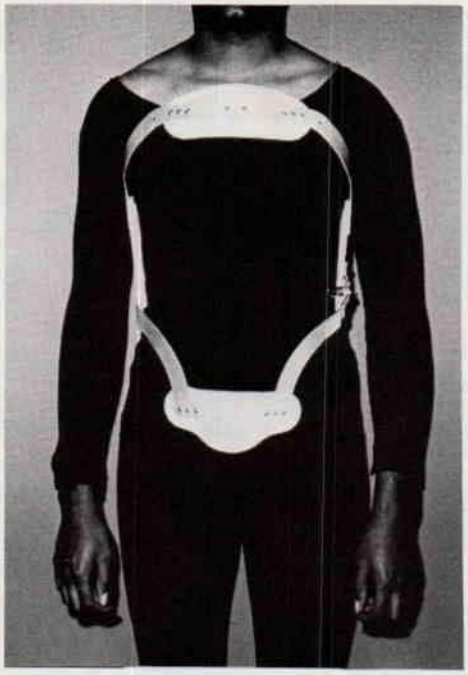

Fig. 6A: Jewett Brace—front.

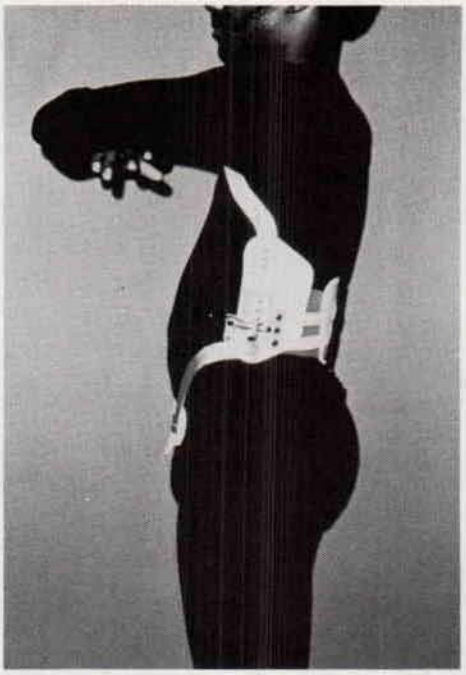

Fig. 6B: Jewett Brace—side.

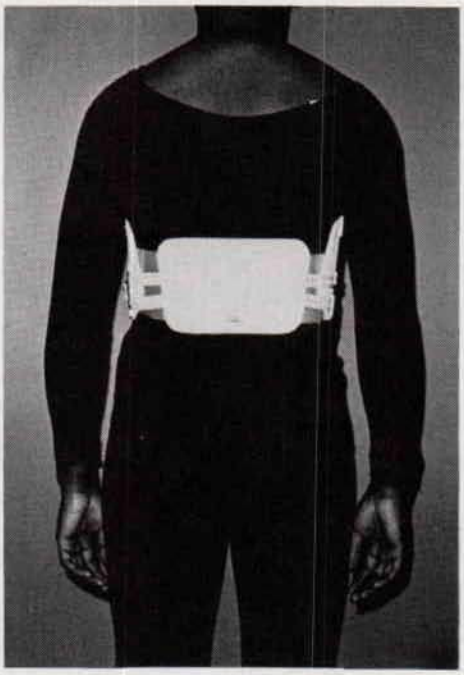

Fig. 6C: Jewett Brace—rear.

ORTHOSES NOW AVAILABLE FOR THE THORACIC AND THORACOLUMBAR SPINE

I will discuss these together. We have three basic types: 1) the Jewett (Figs. 6A-C), which prevents flexion primarily in the thoracolumbar area, 2) the long Taylor (Figs. 7A-C), which is reasonably efficient in preventing flexion, extension and lateral motion, and 3) the cow-horn brace, which accomplishes much the same. There are basic deficiencies in orthoses for the thoracic spine in that unless a cervical orthosis is attached rigidly, there is little support or immobilization above T-7 or T-8. The orthoses which are designed to limit flexion are reasonably efficient when properly fitted. Long Taylor orthoses can support the spine in extension also but are efficient only when very tightly applied around the shoulders and the axillae.

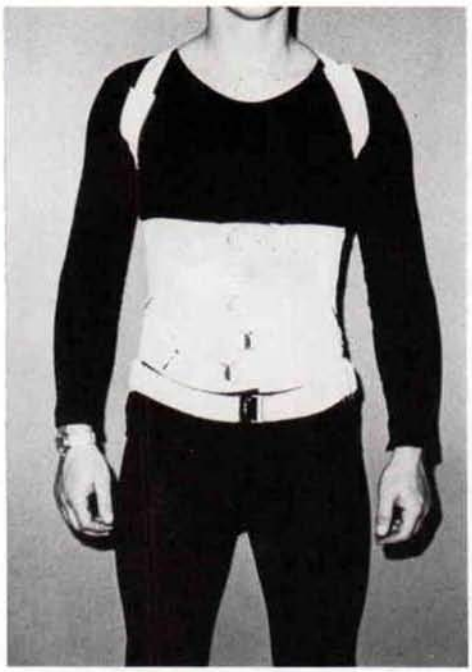

Fig. 7A: Long Taylor Brace—front.

Fig. 7B: Long Taylor Brace—side.

Fig. 7C: Long Taylor Brace—rear.

Future Needs in the Thoracic and Thoracolumbar Area

Future needs for the physician are: 1) better methods of immobilization of the upper half of the thoracic spine, and 2) some means of maintaining immobilization and support while allowing changes in posture from standing to sitting. Again, the patient is looking for reasonable comfort, the ability to continue his work and reasonable means of maintaining good hygiene.

LUMBOSACRAL ORTHOSES PRESENTLY AVAILABLE

I have grouped these since a good orthosis for the lumbar spine which does not include the pelvis probably doesn't exist. There are at least three general types: 1) the Knight, chairback or low Taylor type, 2) the William's flexion brace and 3) the rigid molded plastic jackets, many of which are flexion jackets. The Knight (Figs. 8A-C), chairback or low Taylor brace does a reasonable job of

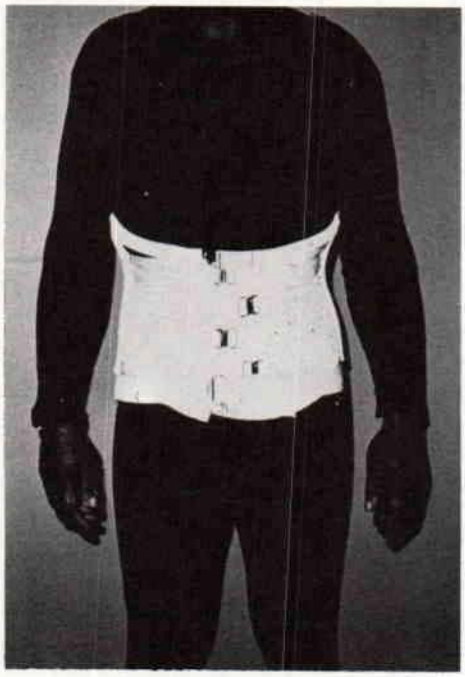

Fig. 8A: Knight Brace—front.

Fig. 8B: Knight Brace—side.

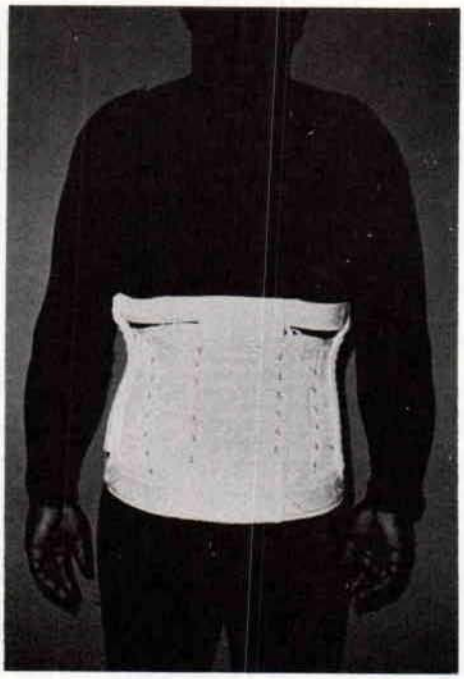

Fig. 8C: Knight Brace—rear.

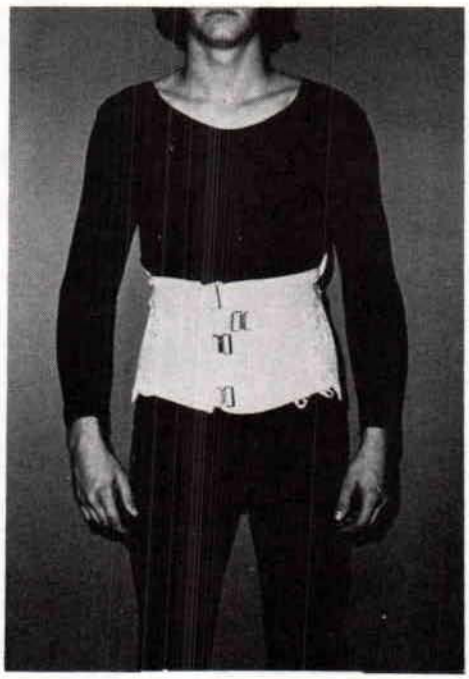

Fig. 9A: Williams Brace—front.

Fig. 9B: Williams Brace—side.

Fig. 9C: Williams Brace—rear.

limiting flexion and extension as well as lateral bending. The Williams (Figs. 9A-C) flexion brace limits extension and tends to maintain a posture of slight flexion. The rigid molded plastic orthoses (Figs. 10A-D), especially those with inflatable pads and those with a compressible lining probably are the most efficient toward a goal of immobilizing the lumbar and lumbosacral spine in all planes. Abdominal pressure tends to unload the spine and, apparently, is a significant part in the increased efficiency of this type of orthosis. Its chief drawback is that these rigid orthoses are frequently uncomfortable when fitted low enough around the pelvis and trochanters and high enough around the ribs. Many adults cannot tolerate this for a significant period of activity. For most efficient wearing, a custom-made appliance is probably necessary. There should be some debate on this point.

Future Needs in the Lumbosacral Area

As for the future, I'd like to have an orthosis to accomplish the efficient immobilization of the rigid jacket with the abdominal pressure to unload the spine and produce minimal discomfort so that the orthosis can be worn during the entire working period.

ORTHOSES FOR SPECIAL GOALS

We now move on to orthoses for these special goals: treatment of scoliosis, kyphosis and spinal cord injury.

ORTHOSES FOR SCOLIOSIS

The orthoses now available for scoliosis include the standard Milwaukee brace and a number of "underarm" orthoses and rigid jackets for the trunk. These underarm jackets and braces include the rigid Lexan jacket from Pasadena, the orthoplast jacket from the du Pont Institute in Wilmington and the Boston prefabricated system. All are designed to treat a lateral deformity of the spine in growing children.

Fig. 10A: Rigid molded plastic orthosis with inflatable pads—front.

Fig. 10B: Rigid molded plastic orthosis with inflatable pads—side.

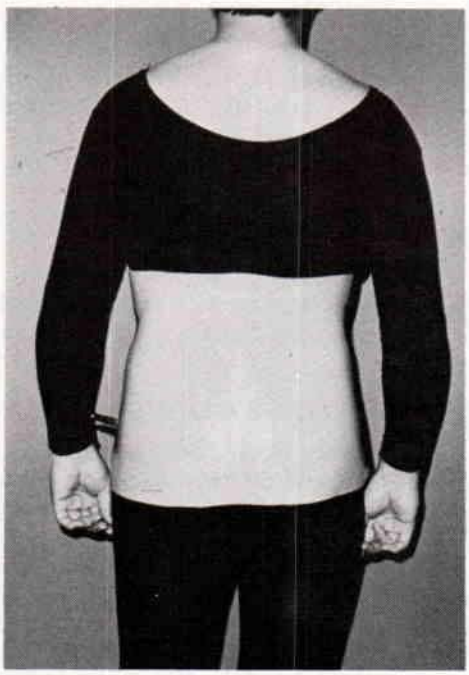

Fig. 10C: Rigid molded plastic orthosis with inflatable pads—rear.

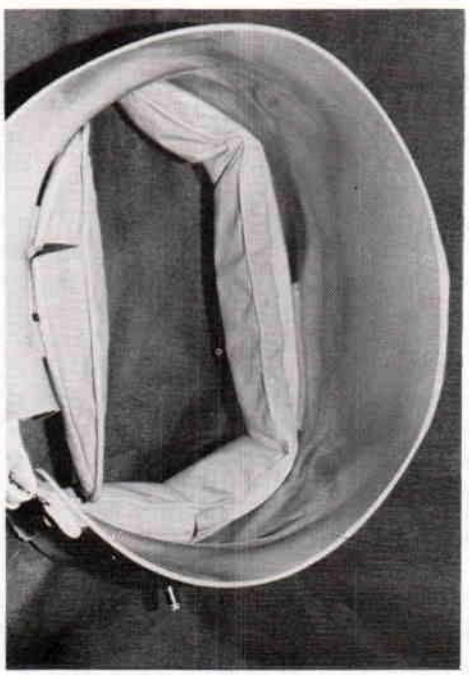

Fig. 10D: Interior view showing inflatable pads.

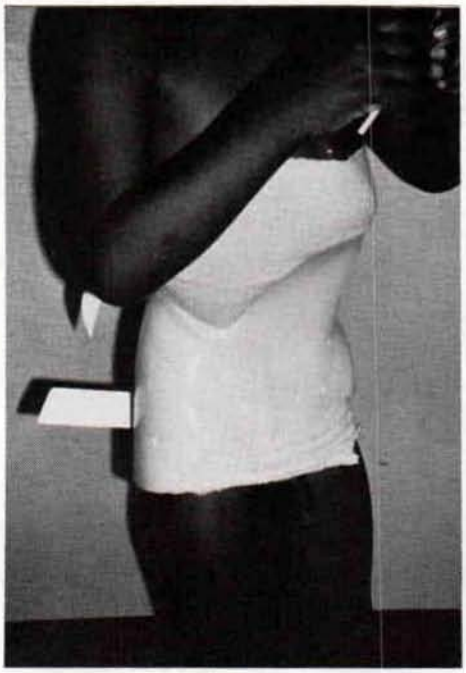

Fig. 11A: Underarm prefabricated orthoses for scoliosis. Lumbar lordosis is also controlled—front.

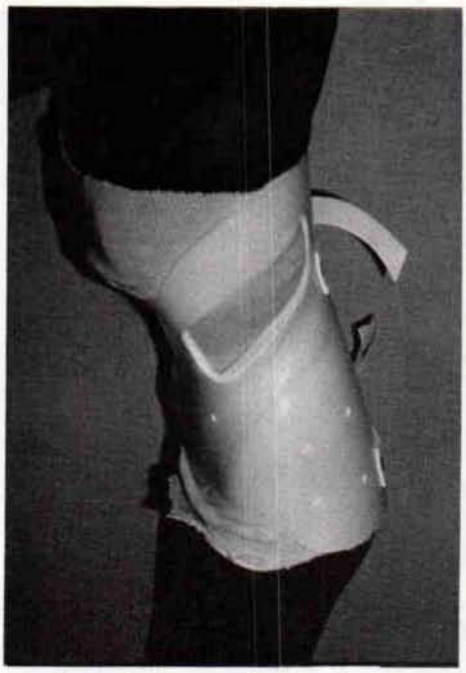

Fig. 11B: Underarm prefabricated orthoses for scoliosis. Lumbar lordosis is also controlled—side.

The Milwaukee brace, which produced improvement believed to be permanent in the lumbar, thoracolumbar and thoracic curves but not in upper thoracic curves, is now being seen in a little different light. Series of parents from both Minneapolis and from Milwaukee indicate that most of the "permanent" correction is eventually lost even though there are obvious spectacular exceptions. The Lexan jacket from Pasadena and the orthoplast jacket from Wilmington also seem to be "holding devices" for stopping progression of scoliotic curves in growing children and seem to offer little hope for actual improvement of the scoliosis.

The verdict is not yet in on the Boston orthosis (Figs. 11A-B and 12A-C) as for as"permanent improvement" is concerned. After only a few years of usage, it seems to be very efficient in treating lumbar and thoracolumbar curves and may prove satisfactory in thoracic curves although this is still not yet determined. This orthosis provides very rigid immobilization of the lumbar and thoracolumbar spine, but as I see it, does not al-

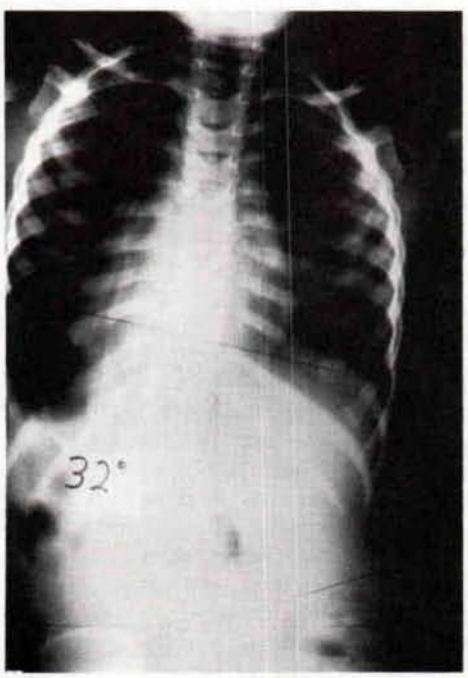

Fig. 12A: Nine-year-old male with left lumbar curve of 32 degrees.

Fig. 12B: With plastic orthosis applied, curve measures 7 degrees.

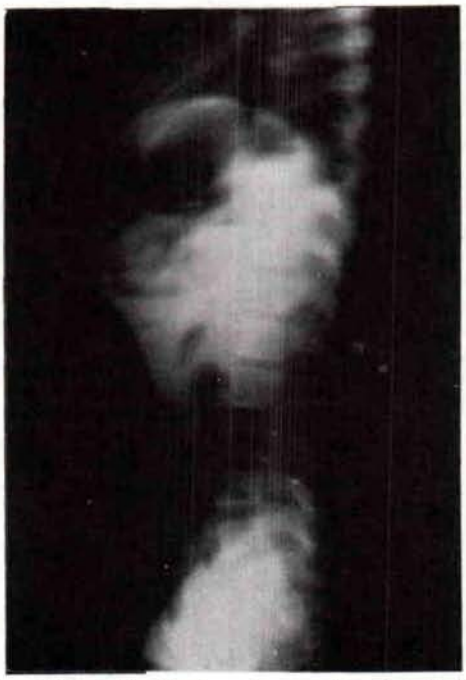

Fig. 12C: Lateral view shows almost complete flattening of the lumbar lordosis.

low the same freedom of activity of the trunk as the standard Milwaukee. Whether or not this will make a difference in the long-term results will not be determined for another 10 to 15 years. Prefabricated plastic girdles (Fig. 13A) of several types are available. In the Boston system (Figs. 14A-C), the blank for the girdle is constructed so that the major portion of the underarm orthosis is also prefabricated.

As for the future needs for orthoses for scoliosis, we are still looking for production of permanent improvement in the scoliosis and permanent improvement with the least restriction of trunk and total body activity. Removal for trunk exercises seems to be important. The patient again is looking for cosmetic acceptance, good hygiene and minimal restriction in activity. The cosmetic advantages of the underarm brace are obvious to everyone. If they live up to their promise, they may well be a great step forward in orthoses for scoliosis. Wally Blount has pointed out repeatedly for many years that underarm braces were not effective in controlling or improving scoliosis.

Fig. 13A: Milwaukee brace with prefabricated plastic girdle.

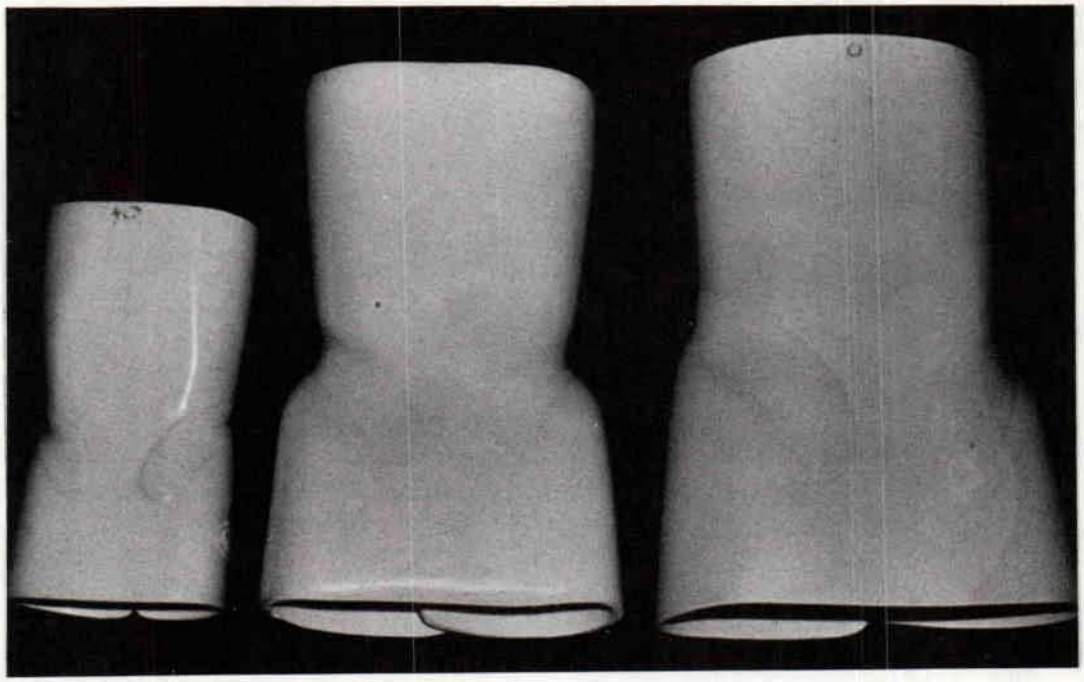

Fig. 13B: "Fixed" lumbar pad.

Fig. 14A: Blanks for prefabricated plastic girdles.

Fig. 14B: Blanks for prefabricated plastic girdles.

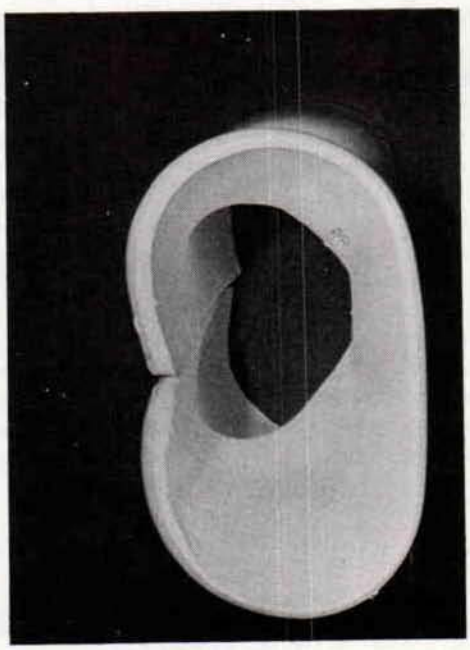

Fig. 14C: Another blank for a prefabricated plastic girdle.

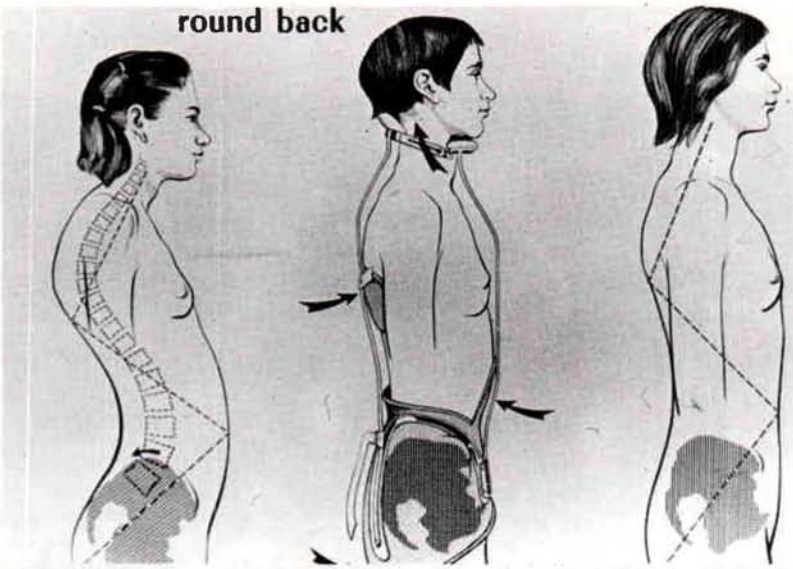

Fig. 15: Milwaukee brace principle for kyphosis bracing. (From Blount, Walter P., and Moe, John H.: *The Milwaukee Brace.* Baltimore: The Williams and Wilkins Co., 1973, p. 74.)

ORTHOSES FOR KYPHOSIS

Moving on to kyphosis braces, the ones now availavle are two types: 1) the standard Milwaukee brace and 2) the underarm braces employing the flexion or antigravity principle. There is no question but that the full Milwaukee brace (Fig. 15) with control of the head and neck and the upper portion of the thoracic spine is far more efficient than any of the underarm or antigravity type braces. The molded prefabricated pelvic girdle which is very efficient in flattening the lumbar lordosis, added to the regular Milwaukee superstructure becomes the most efficient orthosis for kyphosis to my knowledge. Again, as for scoliosis, for the future we need an orthosis to produce permanent improvement and restrict the activity of the trunk and the patient as little as possible. In addition, we must have cosmetic appearance. Again also, the greater cosmetic acceptance of the underarm braces is obvious and would seem to be the direction for future development.

ORTHOSES FOR SPINAL CORD INJURY

The last area to be covered is that of orthoses for adults with spinal cord injury. I know of no suitable orthosis for the quadriplegic which can be used for other than very short periods of time. This includes orthoses similar to long Taylors, molded plastic jackets and so on. The combination of a collapsing paralytic spine and insensitive skin is formidable. For a paraplegic with low level and protective sensation over the lower abdomen, and in the fortunate patient with sensation around the iliac crest, most of the thoracolumbar or lumbosacral orthoses can be used. Probably the most frequently used is the Jewett type of extension orthosis which does not depend on pressure around the crest of the ilium or over the sacrum.

While it is certainly true that a long spine fusion with internal fixation will provide the best permanent stability for the spine of a spinal cord injury patient, a dream for the future in orthotics is a spinal orthosis with a pressure fit around the pelvis and the thorax sufficient to support the spine without producing skin necrosis. Included in this must be a fit around the abdomen which does not inhibit or restrict respiration to any significant degree. For patients with high level spinal cord injury, a shell type modification of the seating device may be the only reasonable answer.

These comments should serve as an introduction and without question are not all inclusive. The "big picture" as I have presented it will undoubtedly look different to many of you. Perhaps, the workshop will get us into the planning or possibly sketching stage of a new big picture.