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THE VAPC LUMBOSACRAL ORTHOSIS

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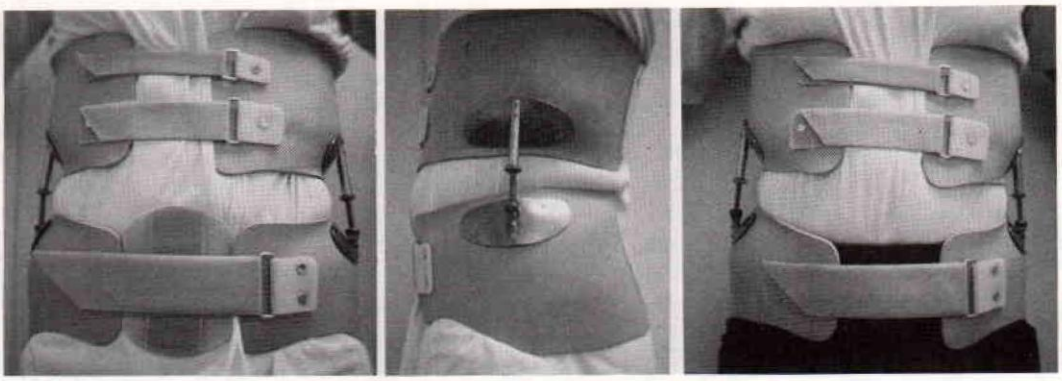

Long-established principles and new concepts have been combined in the design of the Veterans Administration Prosthetics Center's lumbosacral orthosis, which provides a stimulus to withdrawal and is classified as an A-P and M-L control orthosis.

The orthosis is recommended for use in "salvaging" cases in which all other attempts to provide comfort have failed. It is prescribed for any one of the following conditions:

- Unsuccessful disc surgery
- Unsuccessful disc surgery followed by fusion (nonunion)
- Unsuccessful conservative therapy (in situations where surgical intervention is medically contraindicated or rejected by the patient)

It is not recommended for the patient whose discomfort is alleviated by a fabric-type or a "chairback" orthosis, such as the Knight Spinal, because it is more restrictive than either of those devices. The patient who has chronic pain in spite of all previous therapy will readily accept increased restriction of motion in lieu of the pain.

DESIGN PRINCIPLES OF PREVIOUS ORTHOSES

All of the low-back orthoses available today are fabricated to provide forces that are directed anteriorly and posteriorly. The abdominal pressure provided in this manner has the effect of partially unweighting the lumbar and lumbosacral discs, as Bartelink (*1*) suggested and Nachemson and Morris (*4*)

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demonstrated[4]. The posterior elements of such orthoses as the Knight Spinal add support to this area. This support is added to the rigidity provided by the patient with *severe* low-back pain who spontaneously "splints" his own lumbosacral junction by squatting to reach down rather than bending the spine.

The combination of relative immobilization plus unweighting of the lumbar spine through the agency of abdominal pressure is the basis for the relief obtained by the use of existing orthoses. When pain is mild and the patient can bend over, the effect of the immobilization component is reversed. Under such circumstances, stresses on the lumbosacral junction are increased by the longer lever provided by the rigid orthosis. But we are concerned here only with patients with severe back problems, and they do not flex their trunks.

Specific Features of the VAPC Orthosis

The VAPC orthosis includes the features outlined above plus others unique to it. They are:

- Improved end-point fixation, achieved by contouring the upper plastic band beneath the rib cage or alongside the flexible lower ribs, and contouring the lower band over the iliac crests.
- Externally applied vertical support to the thoracic cage to complement the effect achieved internally by abdominal pressure and thus provide uplift of the diaphragm, the thoracic cage, and the lumbar spine. The external force to provide the uplift is achieved by adjusting the metal uprights to provide slight distraction.
- Introduction of a stimulus to withdrawal, empirically introduced to mimic the "Milwaukee Brace."
- Provision of a socket in which to rest the rib cage in slight distraction. The socket is contoured in a manner somewhat similar to that of the hemipelvectomy socket.

Improved fixation is obtained by fitting plastic bands (Prenyl) over the iliac crests distally in the manner of the Milwaukee Brace, and, at the proximal level, beneath and around the lower thorax in the manner of a hemipelvectomy socket. The stimulus to withdrawal is obtained by introducing a mild upward pressure on the rib cage, which can readily be relieved intermittently by deep inspiration and elevation of the rib cage away from the upper plastic band. Threaded struts are employed to provide sufficient separation (about 3/8 in. to 1/2 in.) of the plastic bands to introduce the mild upward pressure on the lower ribs. This is *not* a continuous pressure. The patient can, at any time, withdraw his rib cage away from the upper Prenyl band. Any localized areas of discomfort, usually over a prominent rib or the anterior iliac crest, will manifest themselves in a day or two at which time appropriate relief can be provided.

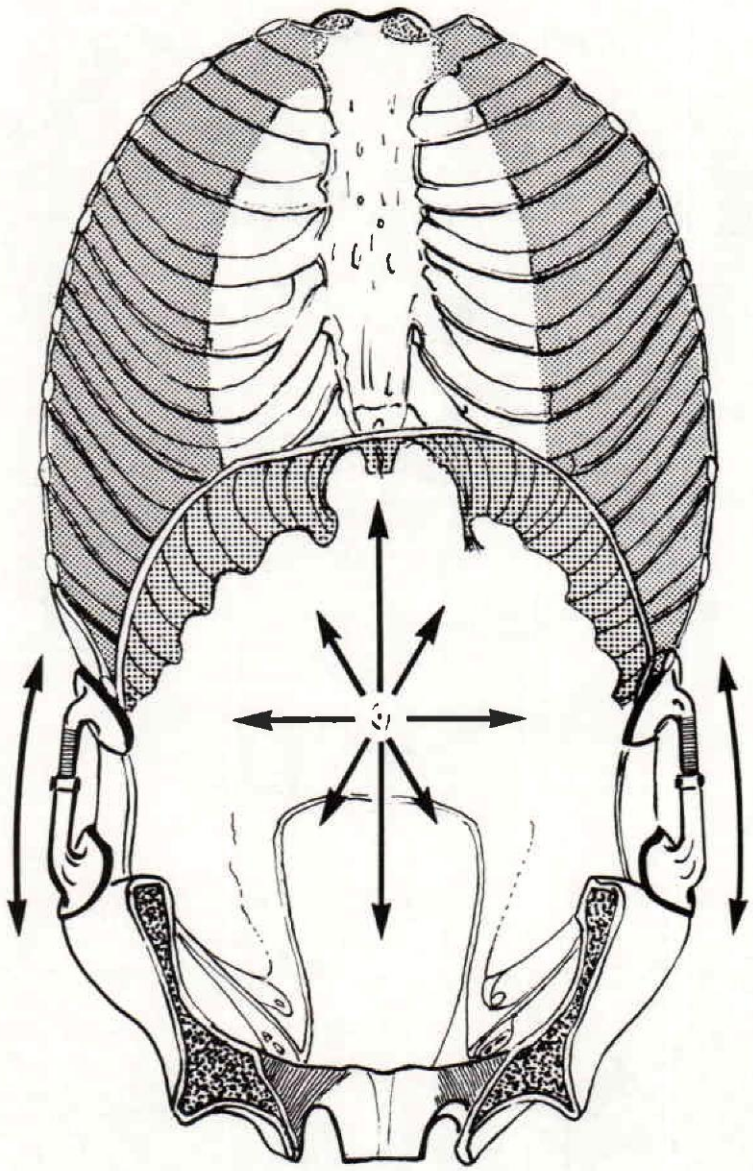
The support of the rib cage in the proximal "socket" of the orthosis is illustrated in the frontal section of the trunk shown below. The arrows demonstrate the distribution of pressure applied to the abdomen and the semifluid abdominal contents. As Morris[5] has shown, this pressure is the most important feature of existing three-point-pressure orthoses in that it functions to provide a degree of unweighting of the lumbar discs. In addition to the paravertebral component of pressure, there is pressure distribution upward against the diaphragm, the diaphragm being a muscle attached peripherally to the rib cage, which, in turn, has ligamentous and muscular attachments to the thoracic vertebrae, and, by crura, to the upper three lumbar vertebrae.

It is the authors' belief that the external support of the rib cage (in slight distraction) and the stimulus to withdrawal complement the effect of the upward pressure on the diaphragm by the abdominal pad in providing an increased element of "uplift" to the thorax and thus unweighting of the lumbar spine.

Prefabricated components of the orthosis are available in kit form. One size has been found to be sufficient for use on most adult patients. Included in the kit are two pelvic bands contoured to fit snugly

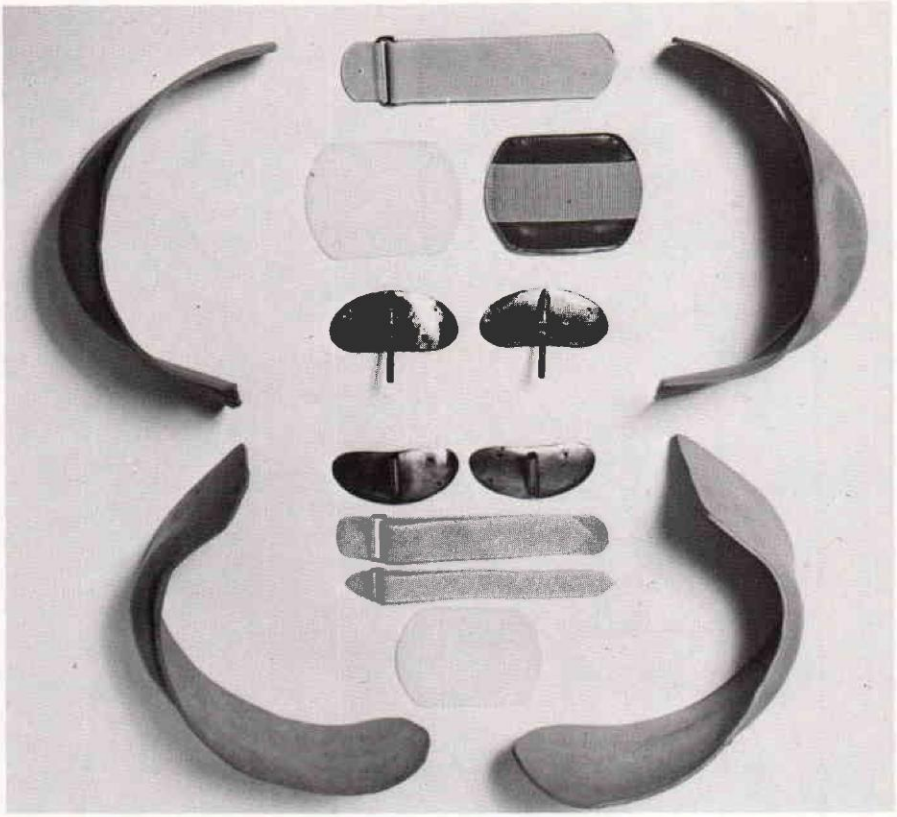
[4]These investigators inserted intradiscal needles into the lumbar area, attached these to manometers, and showed that, by increasing the abdominal pressure, the intradiscal pressure was significantly reduced.

[5]"It would appear that the efficacy of corsets and back supports is due largely to compression of the abdomen with a resulting decreased load on the vertebral column itself."(*3*)

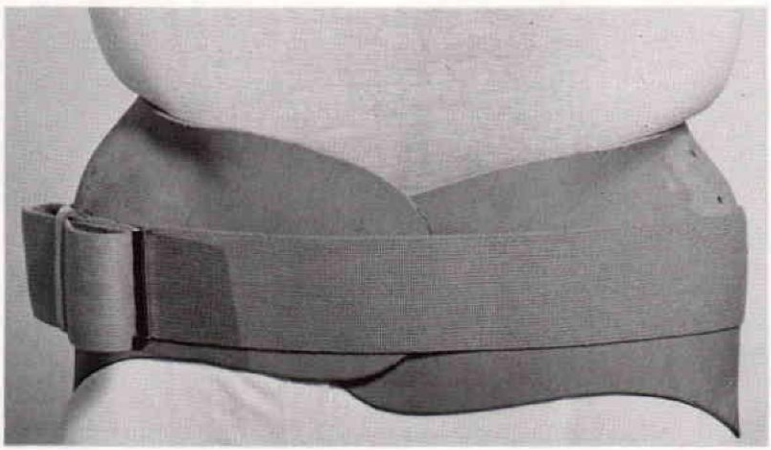


over the iliac crests and two thoracic bands fabricated for fitting beneath and around the lower thorax. These bands are made from 3/16-in.-thick Prenyl^{R}, a semirigid thermoplastic that can be formed at a relatively low temperature.

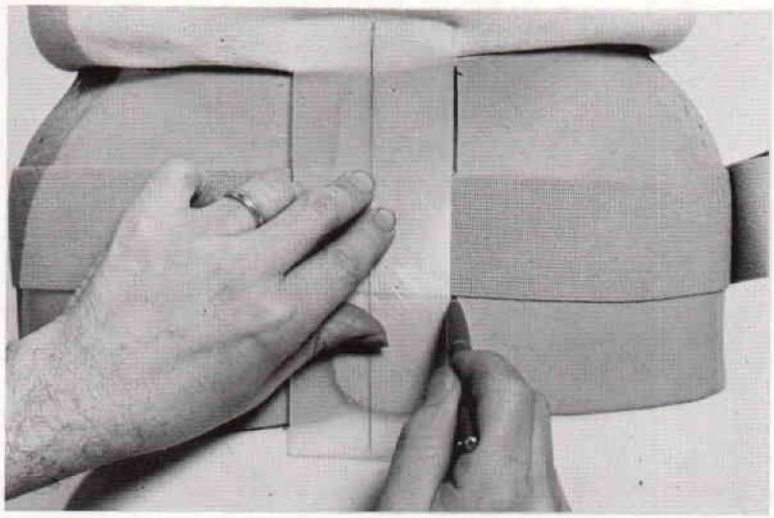
Two threaded metal struts with a ball joint riveted to stainless-steel plates for attachment to the pelvic bands, and two metal tubes riveted to similar stainless-steel plates for attachment to the thoracic bands are provided. Two polypropylene strips for connection of the bands posteriorly, an abdominal pad, and three Velcro straps complete the kit.



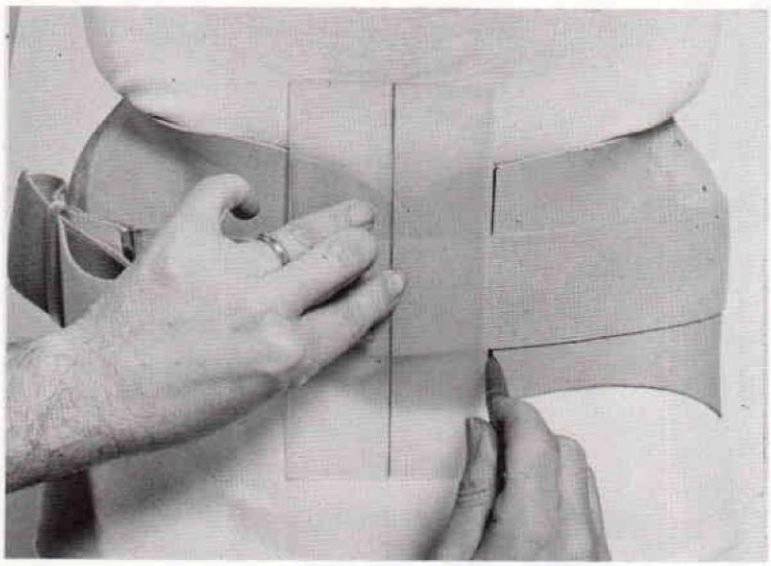
FITTING PROCEDURE



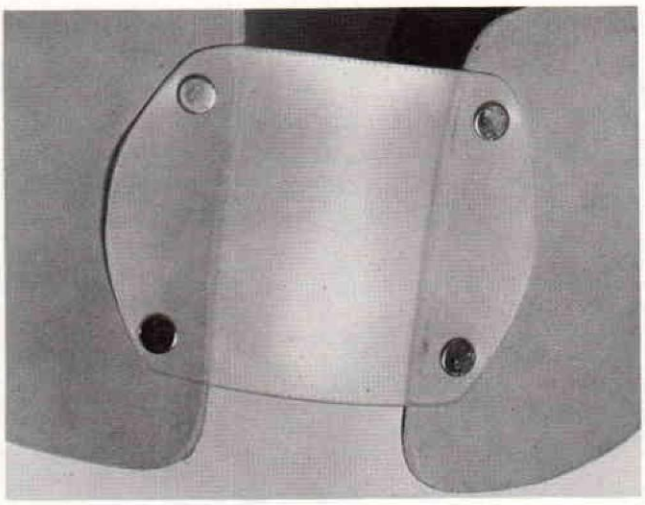
The pelvic bands are placed on the patient and held firmly in place over the illiac crests with a webbing belt.



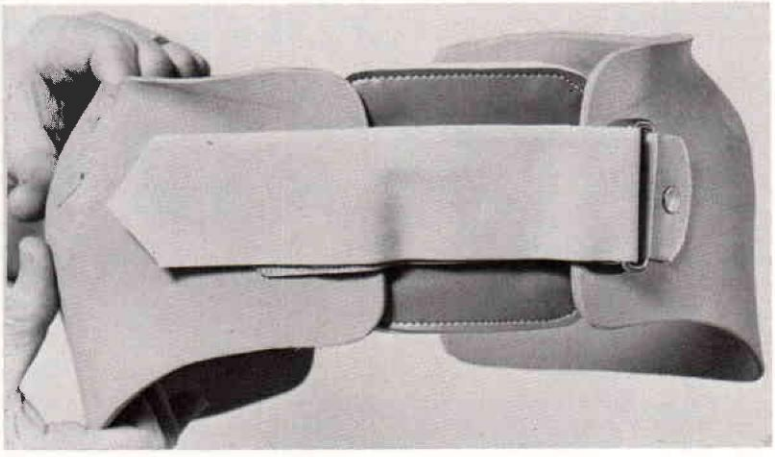
Trimlines are established on the posterior aspect so as to fall 1 1/4 in. on each side of the center line of the spine.



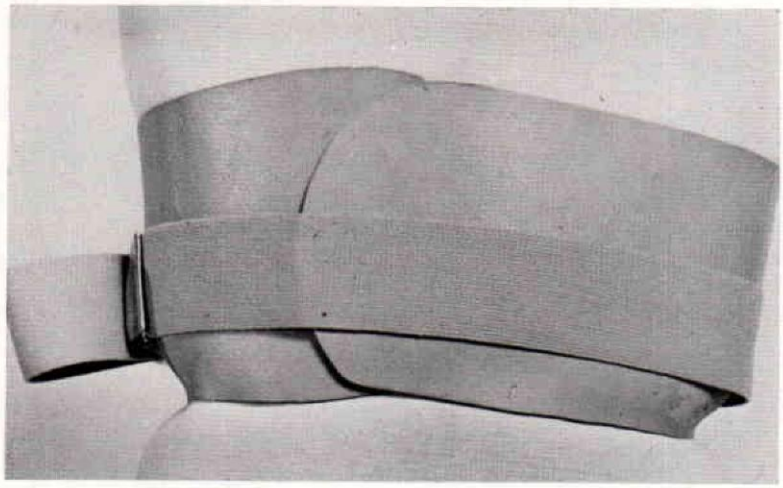
Trimlines are established on the anterior aspect so as to fall 1 3/4 in. on each side of the vertical center line of the body.



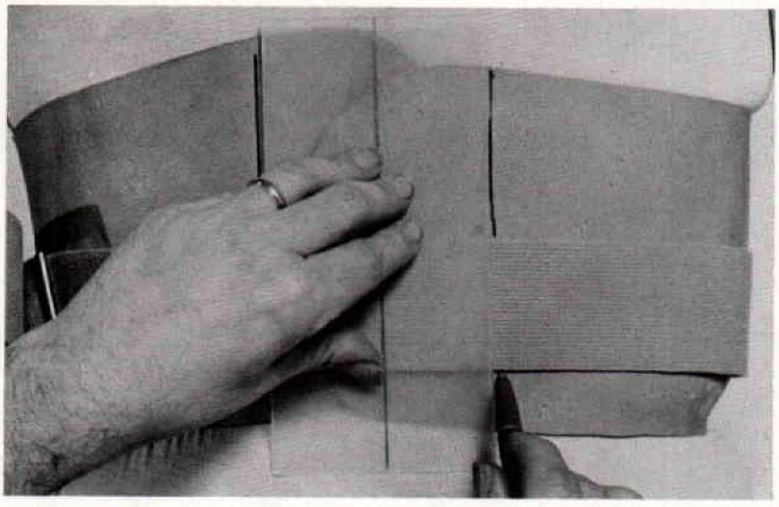
The Prenyl bands are trimmed as marked, the edges are sanded, and the posterior portions are connected using the polypropylene strip.



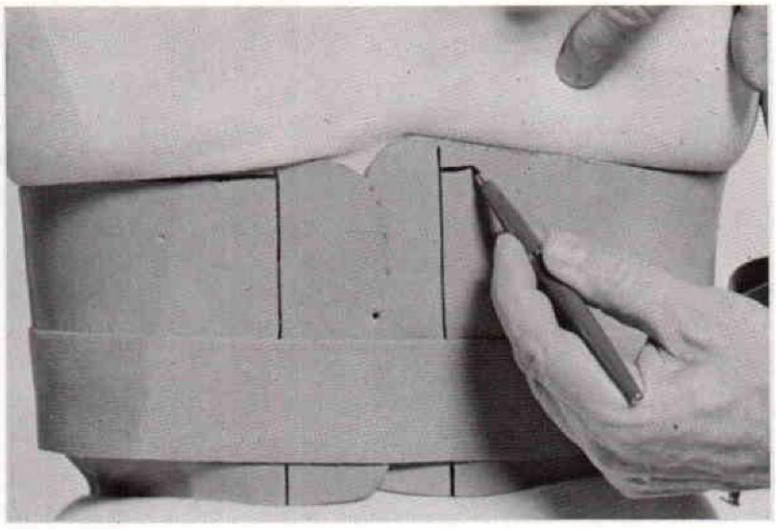
On the anterior aspect, adjustable closure is provided by using 2-in.-wide Velcro strap to which the abdominal pad has been attached.



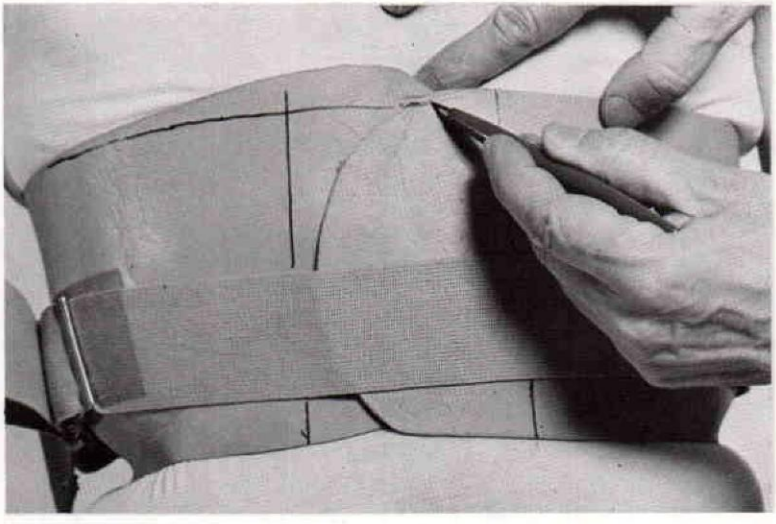
The two thoracic bands are placed on the patient so they fit firmly around and under the lower rib cage, and a strap is used to hold them in place.



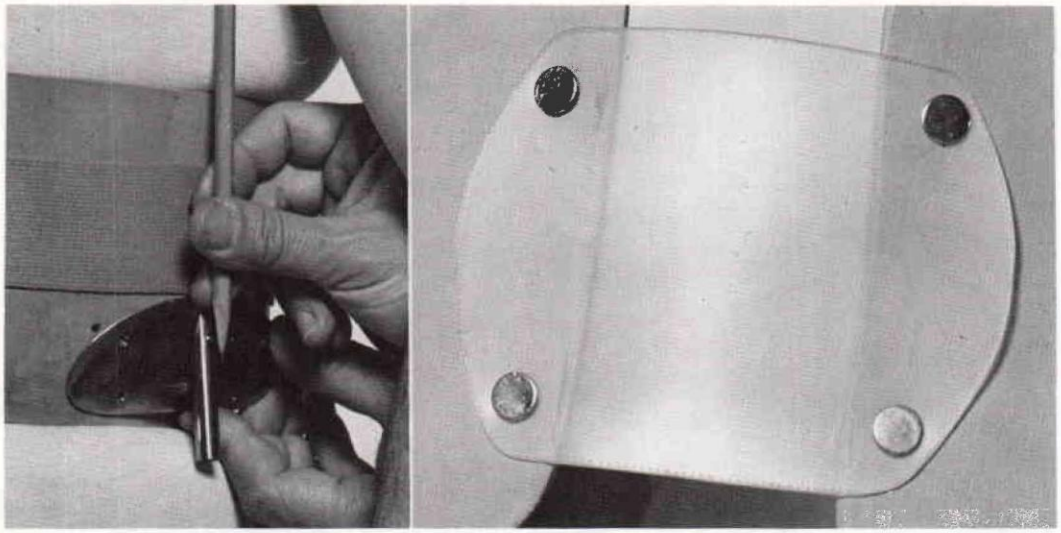
The posterior and anterior trimlines are established, using the same measurements as used on the pelvic sections.



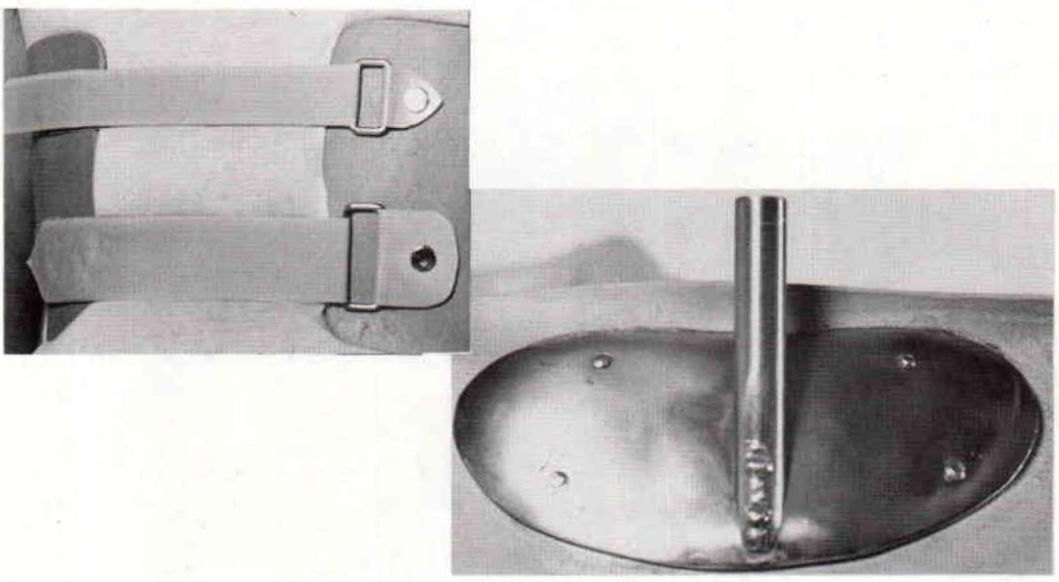
The trimlines on the proximal-posterior aspect of the thoracic bands are located and marked so that the upper edges will come to a level 1 in. below the inferior angle of the scapula.



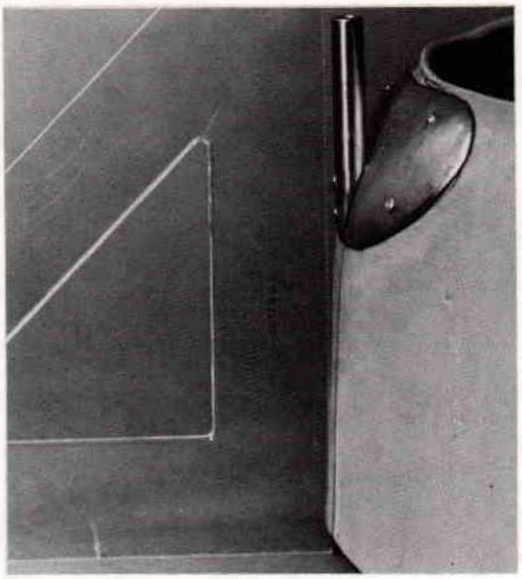
The trimline on the thoracic bands on the proximal-anterior aspects are located and marked so that the upper edges come to the level of the xiphoid-sternal junction.

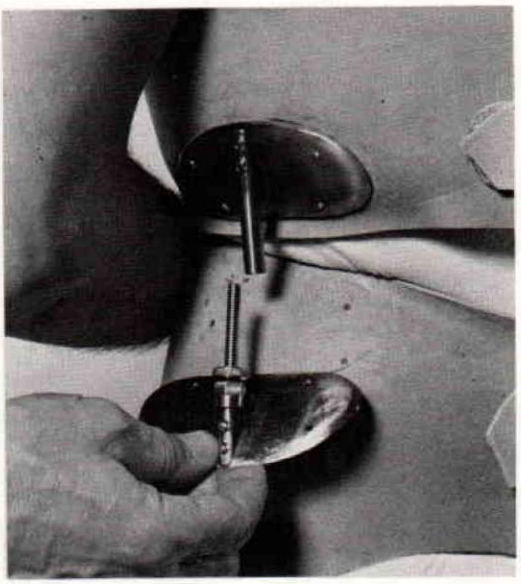


The location of the metal plates that have the tubing attached is established. The plate should be placed as close to the lower edge as possible, and the tube should lay in the frontal plane that bisects the body. The thoracic bands are trimmed as marked, the edges are sanded, and the bands are connected on the posterior aspect with a polypropylene strip.



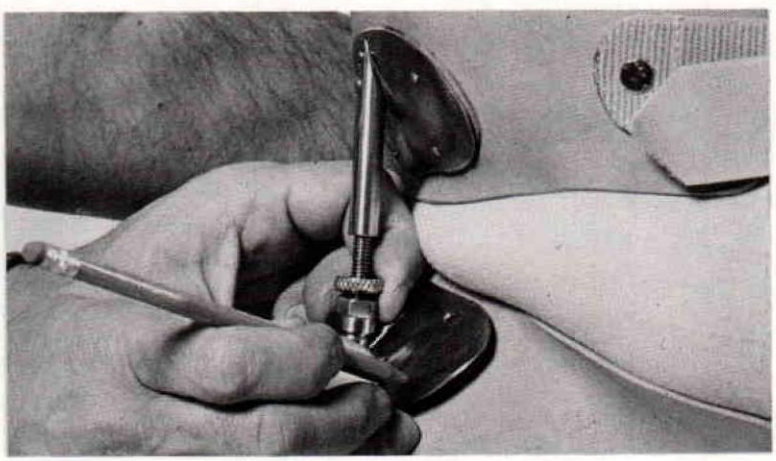
The thoracic bands are connected on the anterior aspect with two Velcro straps. The metal plates are riveted to the thoracic bands as marked.



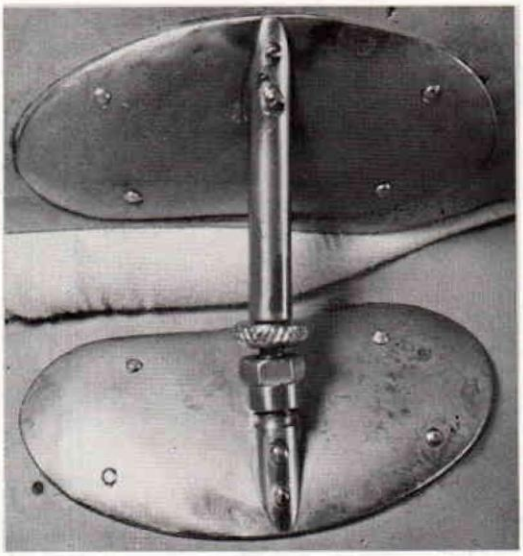


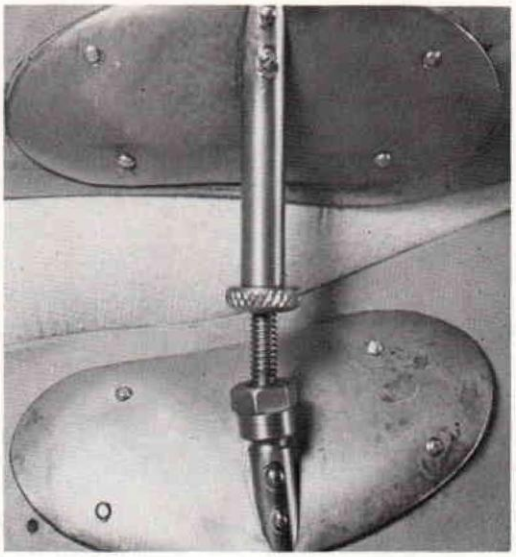
The metal tubes must be parallel to each other in all planes. If necessary, slight changes are made in the location to accomplish this.

Both sets of bands are placed on the patient. The threaded rods of the lower plates, which have not been attached to the lower band as yet, are inserted in the tubing of the upper plates.



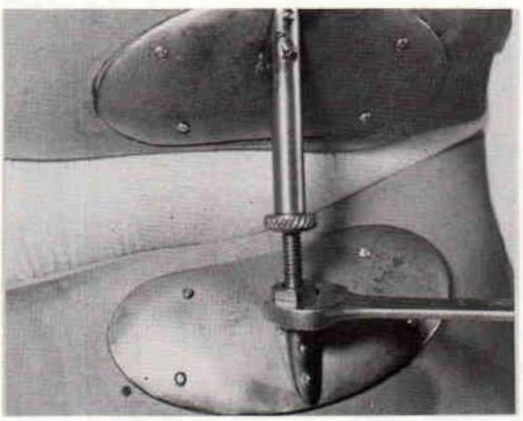
The location of the lower plates are established on the pelvic bands. The ball joints must not be locked at this time.

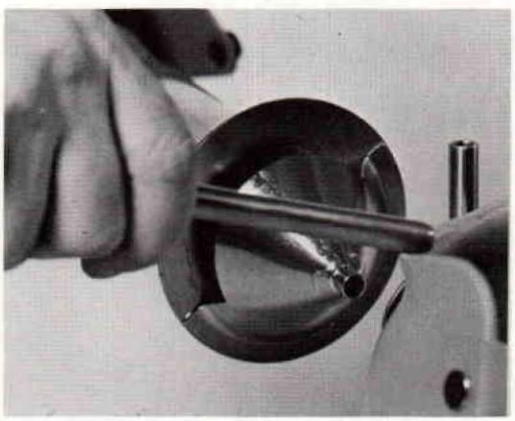




After the plates have been riveted to the pelvic bands, the orthosis is reapplied to the patient, while making sure that the bands are located correctly over the iliac crests and under the rib cage (or, in the case of the short, stocky patient, alongside the flexible lower ribs). The metal plates are placed as close to the midline as possible.

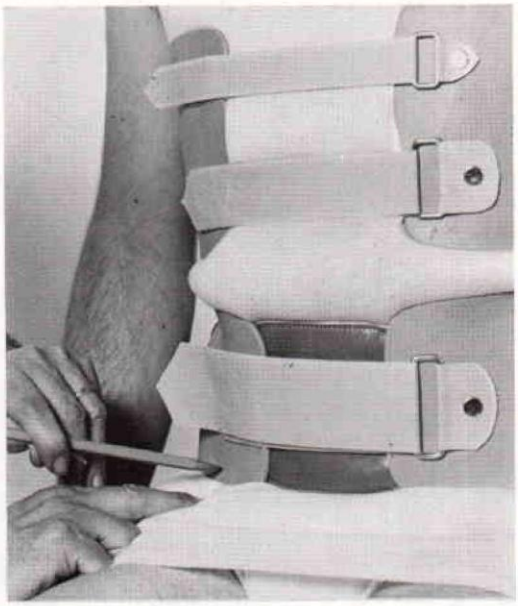
At this time, the patient is asked to take a deep breath and to elevate his lower rib cage away from the thoracic bands. The adjustment devices on the plates are threaded upward until there is about a 1/2-in. separation between the thoracic and pelvic sections.

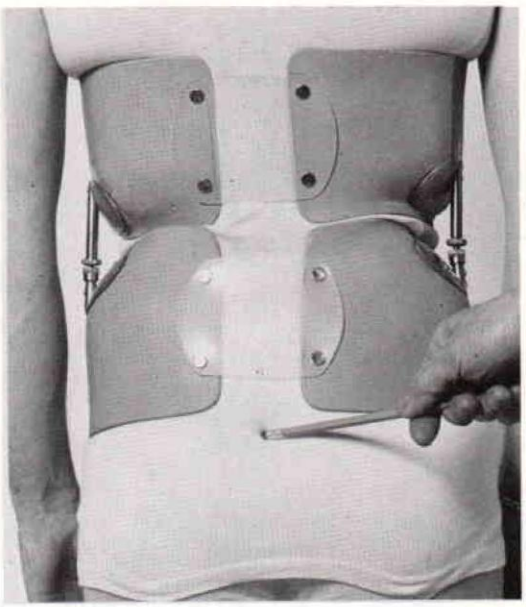




The ball-joint adjustment is locked, and the patient is instructed to relax while the fit of the orthosis is checked for any pressure areas. If the ball joint loosens due to excessive stress, which may occur in the case of overweight patients, it should be "frozen" in place with an epoxy adhesive.

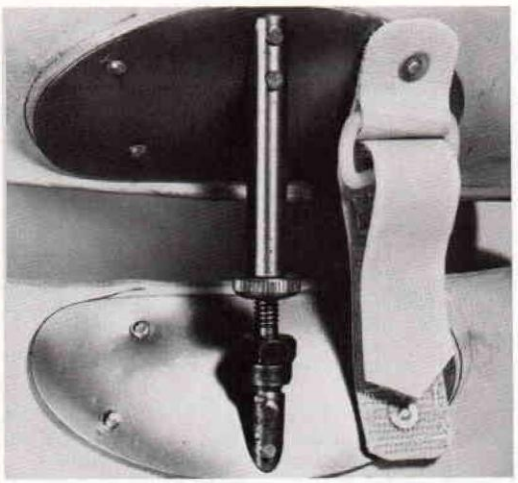
If the edges of the Prenyl bands "dig in," they should be rolled out with a round metal rod and with the help of a heat gun. Other areas of discomfort are provided relief in a similar way.

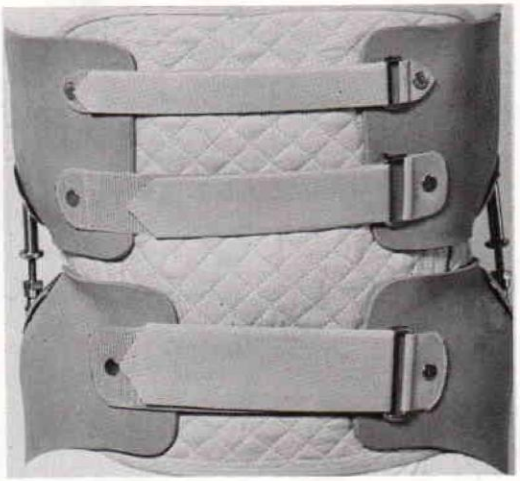




The patient is asked to sit while the fit of the orthosis in the inguinal fold is checked. The pelvic bands are trimmed in this area if necessary.

The lower posterior border of the orthosis should not extend distal to the sacrococcygeal junction.





If the solid metal uprights tend to slip within the tubular components as the patient bends laterally, they may be retained in position by the addition of Velcro straps in parallel, snugged down to maintain pressure on the nut. Of course, a locking nut may be added if necessary.

In the case of an obese patient, the abdominal pad is replaced with a full abdominal coutil apron.

FITTING THE COMPLETED ORTHOSIS

- When applying the brace, the first step is adjustment of the lower Prenyl band so that the curved upper brim fits *over* the iliac crests.
- The thoracic Prenyl band is placed and tightened around the rib cage by the lower of the two straps. The upper strap should be closed with light tension.
- The threaded rods should be adjusted upward 3/8 in. to 1/2 in., or an amount sufficient for the patient to sense mild upward pressure on the rib cage. When the patient takes a moderately deep inspiration, it should be possible for the orthotist to pass his fingers between the rib cage and the upper band. When the patient relaxes from the moderately deep inspiration, his rib cage should rest in the "socket" of Prenyl without *localized* areas of bone discomfort.
- The orthotist, upon sliding his fingers, palms upward, horizontally beneath the lower margin of the upper Prenyl band just anterior to the metal struts, should find that the fingers either contact the lower, flexible border of the rib cage or slide beneath it.
- An undershirt must be worn beneath the orthosis. In those occasional instances when excessive perspiration occurs, perforation of the Prenyl should be considered.
- If the patient is a wearer of snugly fitted trousers, the posterior seam should be opened at the belt line to allow closure over the orthosis.

INDICATIONS FOR USE

This brace should be used for patients who have persistent, severe, low-back pain, with or without sciatic radiation, and who have not obtained significant relief from the use of other rigid back braces, such as the Knight Spinal orthosis. Prior disc surgery is not a contraindication to its use.

CONTRAINDICATIONS TO USE

As a corollary to the above, patients who obtain relief from fabric-type reinforced lumbosacral orthoses, or "chairback braces," should not be issued the VAPC orthosis. It is contraindicated for patients with inguinal or diaphragmatic hernias. The prefabricated components have not been designed to be fitted to patients with waistlines greater than 42 in. or less than 34 in.

COMMON FITTING ERRORS

- The upper of the two thoracic straps has been adjusted too tightly.
- The lower posterior polypropylene strap has been left excessively long, and, therefore, the lower Prenyl band has not been adequately seated *over* the iliac crests. This will allow the pelvic band to slip down alongside the pelvis.
- The metal uprights have been placed too far laterally. This will not only make the metal components appear to be short, but will adversely affect cosmesis.
- Discomfort from pressure on a rib or the iliac crest has not been eliminated. Prenyl is a thermoplastic material, and such areas of discomfort can be eliminated easily.

POST-FITTING INSTRUCTIONS

- The patient should be instructed to return to the orthotist one week from the time of delivery. Problems which were not obvious at the initial fitting will have manifested themselves by that time and they can be eliminated.
- The patient should be given "withdrawal" exercise instructions:
  a. Frequent deep inspirations to lift the thoracic cage away from the upper band.
  b. Frequent tilting of thorax, first to one side and then the other, accompanied by pushing downward on the brim of the upper Prenyl band on the side from which the thorax is tilted.
- Isometric abdominal muscle tightening exercises should also be taught.

CONCLUDING REMARKS

The response of the VAPC patients who have used this orthosis has been uniformly positive and frequently enthusiastic. The design of the orthosis introduces what the authors consider to be maximum modularity for a device of this type. Fabrication is relatively simple.

There are a large number of chronic low-back patients who are permanently disabled even though they have been treated by well-established procedures (*4*), and therefore there is a need for an orthosis of this type.

ACKNOWLEDGMENTS

The authors wish to state their indebtedness to Mr. Michael Danisi, C.O., and Mr. Eugenio Lamberty, Orthotic Technician, for their contributions and enthusiastic cooperation.

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