A LUMBOSACRAL A-P AND M-L CONTROL ORTHOSIS[a] INCORPORATING A STIMULUS TO WITHDRAWAL

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INTRODUCTION

The principles upon which present day braces are based have undergone little change since the first lumbosacral-level orthosis was applied to the first patient with a low-back problem. "All of the low-back braces available today are fabricated to provide anteriorly and posteriorly directed forces. None accomplishes satisfactory immobilization, and, in fact, braces with a high thoracolumbar purchase area increase lumbosacral motion (1)."

The back brace described here [a] incorporates not only the three-point-pressure system, but also adds two new features:

1. Improved fixation proximally and distally.
2. A stimulus to withdrawal, empirically introduced in an attempt to mimic the effect of the Milwaukee brace at a lower level, with the aim of introducing a potential for the relief of disc and nerve-root pressure.

The improved fixation is obtained by fitting plastic bands over the iliac crests distally in the manner of the Milwaukee brace and beneath and around the lower thorax, in the manner of a hemipelvectomy socket, at the proximal level. The stimulus to withdrawal is obtained by introducing a mild upward pressure on the rib cage. Intermittently, this can be readily relieved by deep inspiration and elevation of the rib cage away from the upper plastic band. It is this intrinsic muscular action which simulates the Milwaukee brace "withdrawal."

The original "spring-loaded low-back brace (1)" required critical

[a] Previously designated "a spring-loaded low-back brace (1)."

fitting. The brace was anatomically fitted to the satisfaction of the orthotist *before* the springs were released, and, on release of the springs, sufficient separation of the plastic bands was obtained to introduce upward pressure on the rib cage (Fig. 1 and 2). This pressure was not a continuous spring-loaded pressure. The patient could, at any time, withdraw his rib cage away from the discomfort. There was never a problem of sufficient localized soft-tissue irritation to even remotely presage breakdown. The patients will only tolerate minor discomfort,

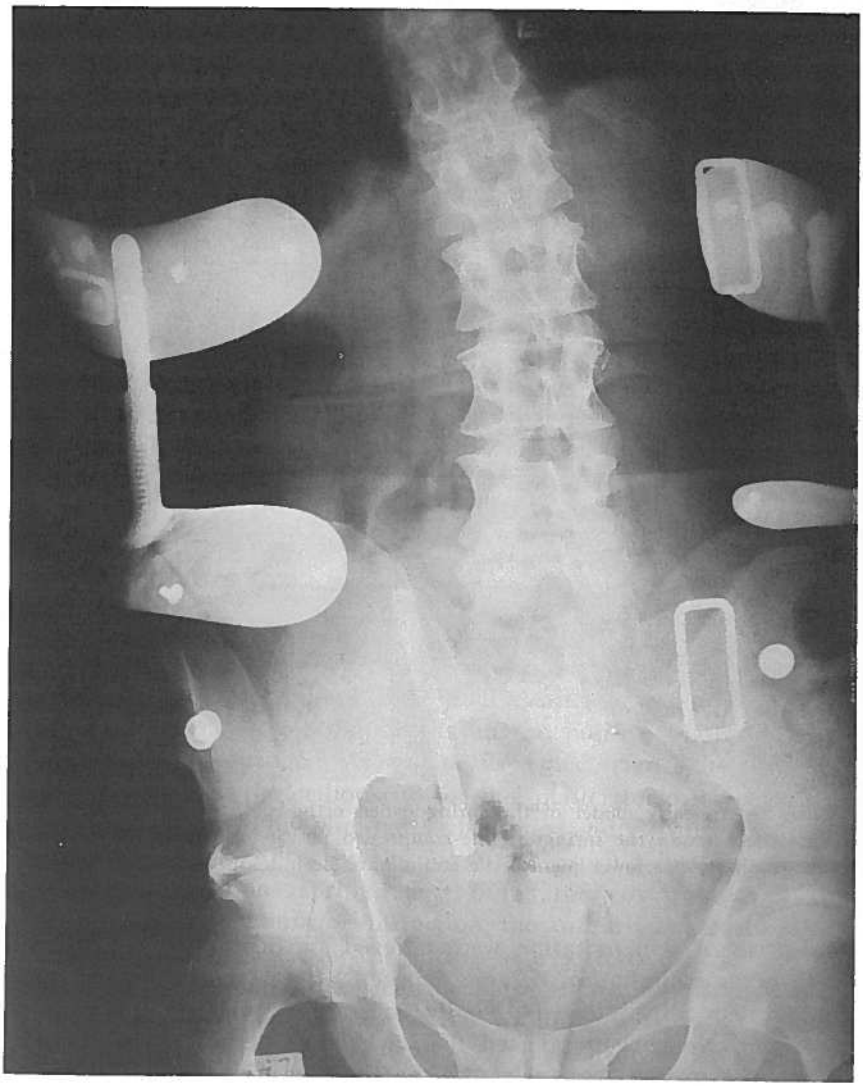

FIGURE 1.—Note the spring within the supporting strut.

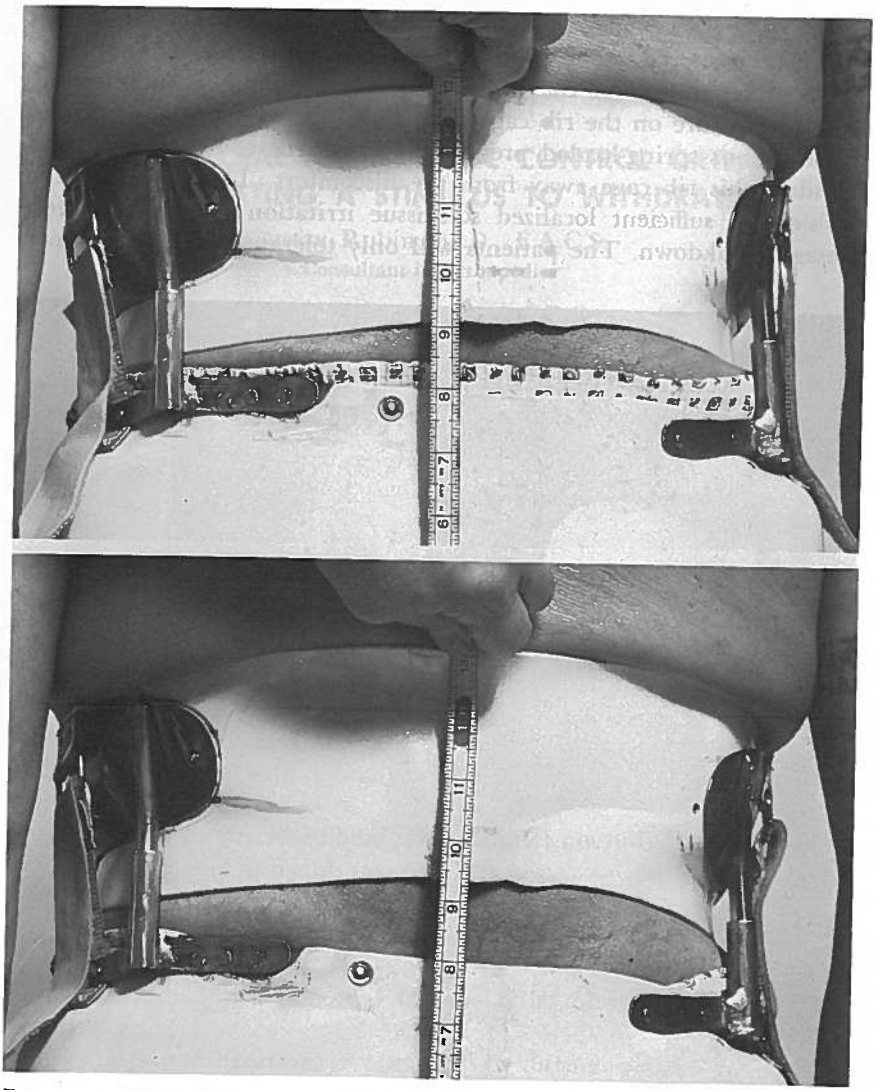

FIGURE 2.—An early model of the spring-loaded orthosis. Velcro straps have been employed to retain the springs in the compressed position as shown in the upper photograph. In the lower picture the straps have been released.

and areas of skin irritation were relieved as with any other orthosis. Such areas of irritation became manifest after a day or two of wear and were readily relieved. Usually one or two such corrections were necessary. No patient rejected the back brace because of discomfort. When the springs were released, the limit of their extensibility was only 3/8 of an inch, from which point there was no further continuing spring effect.

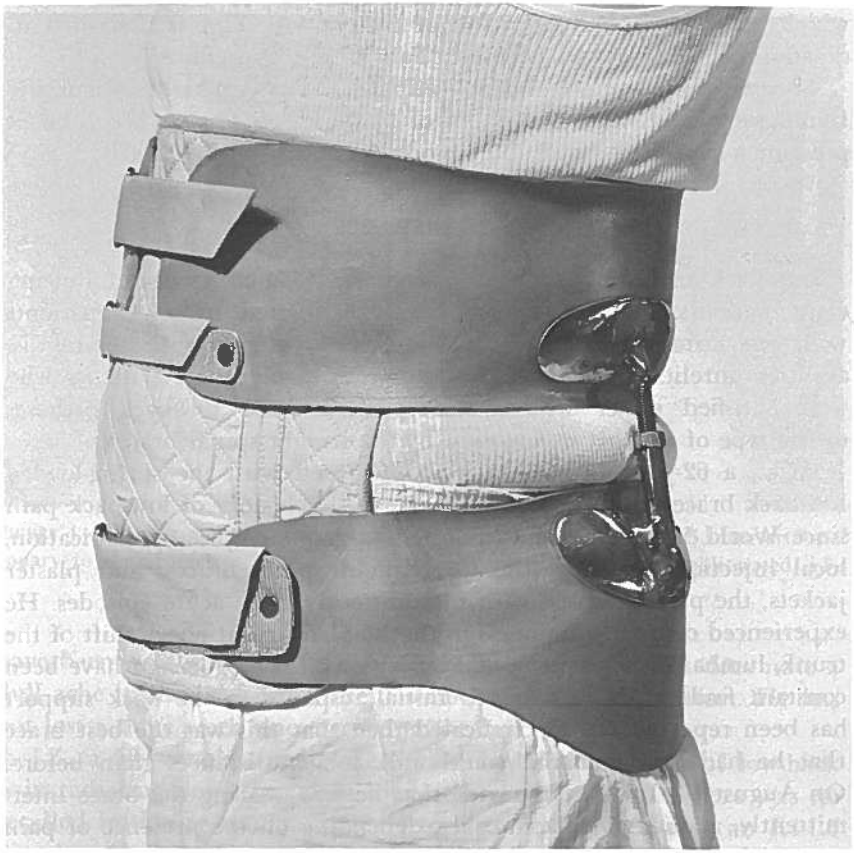

FIGURE 3.—A late model of the threaded rod orthosis.

To accomplish modularity, the fabrication of the "spring-loaded low-back brace," which required individual casting of each patient and fabrication of the brace components on the positive plaster torso of that patient, was changed. As will be described below, the versatility of Prenyl [b] enables the orthotist to use one plaster torso for waist sizes from 34 to 42 in. This eliminates the time- and expense-consuming individual casting. Since the purpose of the spring loading was not that of a continuous spring effect but rather to produce a predetermined, fixed amount of distraction, the authors decided to obtain this same goal by replacing the spring with a threaded rod and nut (Fig. 3). This eliminated the need to achieve as critical a fit as with the spring, since more or less distraction could be readily introduced. And, finally, the metal components have been evolved into a design

[b] A thermoplastic material distributed by Orthopedic Equipment Company, Inc., Bourbon, Indiana 46504.

which will permit prefabrication of these parts. This is described in detail under the section entitled "Fabrication Procedure."

This article reports on a followup of the patients for whom the Lumbosacral A-P and M-L Control Orthosis was prescribed, and it presents a simplified fabrication procedure based on modularity.

CASE HISTORIES

Low-back orthoses were constructed and issued to the following eight patients. Referral agencies were requested to select patients with one criterion in mind: they must be patients with severe disabilities unrelieved by previous treatment, to eliminate patients who were satisfied either with fabric-type reinforced low-back orthoses or the type of support exemplified by the Knight spinal brace:

1. M.L., a 62-year-old-male lawyer, was fitted with the spring-loaded low-back brace on March 10, 1971. He had a history of low-back pain since World War II and had rejected surgery. In spite of medication, local injections, physical therapy, Knight spinal braces, and plaster jackets, the pain persisted with intermittently more acute episodes. He experienced constant numbness in the L5-S1 distribution. A shift of the trunk, lumbar muscle spasm, and a positive left Lasègue sign have been constant findings. The patient's initial response to the back support has been reported (1). He indicated then that this was the best brace that he had ever had and could walk longer distances than before. On August 10, 1972, he reported that he was wearing the brace intermittently, about two times weekly, depending on the presence of pain or anticipation of doing work around the house. He stated that the pain in his back, the sciatic radiation, and the numbness of the left lateral foot were much relieved.

2. J.S., a 49-year-old-male accountant, was issued the spring-loaded low-back brace on September 24, 1971. A left thoracoplasty had been performed during World War II and the upper six ribs removed. He developed a severe dorsolumbar scoliosis (Fig. 4), and has experienced low-back pain for many years. This had been unrelieved by such supports as the Knight spinal and Knight-Taylor braces. In July 1971, he had awakened with sudden onset of more severe pain across the lower back, radiating down the right lower extremity to the back of the knee. This was constant until issuance of the spring-loaded brace. The patient's initial reaction to the brace (October 26, 1971) was very enthusiastic. He stated that the "bad pain" disappeared within a week, i.e., the pain across the low back radiating down the posterior thigh to the knee. He was pleased with the brace, and he wears it from about 6:30 a.m. to 11:00 p.m. daily. On August 10, 1972, he reported that he now leaves the brace off occasionally in the evening and there

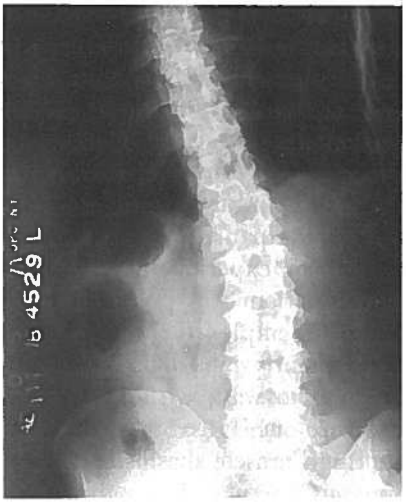

FIGURE 4.—J.S.-Dorsolumbar scoliosis secondary to thoracoplasty.

FIGURE 5.—J.Z.-The L4-L5 intravertebral disc space is completely obliterated. L5-S1 space is narrow.

have been no recurrences of the above-described pain. He does note a dull ache in the back which he describes as a mild discomfort. He has not lost a day's work since receiving the brace.

3. J.Z., a 58-year-old unemployed male, had sudden onset of low-back pain radiating down the right lower extremity in 1943. There was no recalled initiating trauma. After 4 to 5 months of bed rest, an L4-L5 disc herniation was removed surgically. For 1½ years prior to his evaluation at the VAPC Clinic Team meeting on November 3, 1971, the patient had had episodes of severe back pain radiating down the left lower extremity. He stopped working. On examination on the above date there was lumbar spasm and flatness, marked limitation of all trunk motions, and equivocal diminution of the right knee reflex. First toe dorsiflexor power and sensation were not grossly impaired. The X-rays showed fusion of the L4-L5 interspace and narrowing of the L5-S1 and L3-L4 interspaces (Fig. 5). A spring-loaded low-back brace was delivered to the patient on January 6, 1972. On January 26, 1972, the patient reported that he had been ill at home with influenza and when he got out of bed he was tilted to one side. He put on the brace and noted that he was "straight" in about ½ hour. He stated that the brace felt "100 percent better" than his Knight spinal brace. On May 26, 1972, he indicated that he wore the brace about 4 to 5 hours daily, but took it off when he was inactive about the house. His back condition was reported as much improved, but the radiation down the lower extremities was only "slightly improved." On August 10, 1972, the

patient returned for followup and stated that when he wore the spring-loaded brace his back felt much better than with the Knight spinal brace and that he could walk 3 to 4 blocks before he had to rest. He tried changing back to the Knight spinal brace and found that he had to rest after walking one block. His paresthesias were unchanged.

4. S.O., a 41-year-old unemployed male, had a history of onset of low-back pain in 1953. This became more severe in February 1972, with pain radiating down the right lower extremity, accompanied by "dragging" of the right foot. He also stated that he had been experiencing "spasms" in the right thigh several times a day. The patient was provided with a low-back brace on May 10, 1972. This version employed threaded rods instead of spring loading, as did all subsequently issued orthoses. On May 31, 1972, he reported that he was able to walk without fear of falling (and this had been a prominent feature of his disability), that he was no longer dragging his foot, and the thigh muscle spasms had been noted on only three occasions in the preivous 3 weeks. The pain along the course of the sciatic nerve had not improved. On June 28, 1972, the patient reported that, shortly after the previous clinic visit, the sciatic radiation had disappeared completely and remained absent as long as he wore the brace. The back pain had lessened but was still present. On awakening in the morning he noted sciatic radiation, but on application of the brace the radiation disappeared and remained absent for the rest of the day. On August 10, 1972, he reported the back pain as "just a dull ache." The sciatic radiation continued absent except in the a.m. prior to application of the brace.

5. J.B. is a 52-year-old-male engraver, with a left above-knee amputation sustained during World War II and a history of fracture of the right tibia and fibula, with secondary osteoarthritis of the knee for which an osteotomy was done in March 1970. He was examined by the VAPC Clinic Team on July 11, 1972. At that time he stated that he had recurrent low-back pain for many years, more acute for the previous 3 months. He complained of pain across the low back with paresthesias in the right thigh. A myelogram had recently been done and was reported to be negative except for osteophytosis. Since this patient had traveled to the clinic from another state, it was desirable to fit him without unnecessary delay. A back brace was available which had been made for one of the authors (G.R.) for testing purposes, and this was modified for the patient and delivered that same day. The patient had a 36-in. waistline and was 5 ft. 10 in. in height. The brace that was modified for him had been worn by an individual with a 38 in. waistline who was 6 ft. 1 in. in height. Nevertheless, the versatility of the material was such that the brace was readily modified. At the followup clinic on August 10, 1972, the patient stated that, although he had been out of work for 3 months prior to receiving the brace, he was able to

return to work the day after he started to wear this brace. He had come into the clinic with crutches initially, but returned carrying a cane. He said he discarded the crutches after he had had the brace for 3 days. His back felt much improved and the paresthesias in the right thigh had disappeared.

6. S.L., a 62-year-old physician, was examined on May 5, 1972, with a history of back pain with radiation down the left lower extremity since February 1972. This was associated with a left drop-foot gait. The patient is also a mild diabetic and he had had bypass vascular surgery to both lower extremities 1 year before being seen by the VAPC Clinic Team. There was also a history of two cardiac infarction episodes during the past few years. The onset of the low-back condition was sudden with severe sciatic radiation, and a myelogram was done shortly after onset. The patient was informed that this showed disc protrusions at several levels as well as osteophytosis. In view of the patient's general condition surgery was contraindicated. On examination at the VAPC Clinic Team meeting on May 5, 1972, it was noted that the right ankle and first toe dorsiflexor power were markedly diminished and that there was diminished sensation over the right medial foot. The differential diagnosis between diabetic neuritis and a disc syndrome presented a problem. The patient was issued a shoe-clasp orthosis for his drop-foot condition and this functioned well.

At the time of evaluation at the VA Prosthetics Center, the patient's low-back pain had completely subsided, and he had no complaint of either low-back pain or sciatic pain, although it is clear from the manner in which he bends over, even while wearing the back brace, that he has back disability (Fig. 6). This was confirmed by clinical examination which revealed the anticipated findings of marked spasm, flatness, and limitation of motion of the trunk.

This patient was issued a low-back orthosis on June 13, 1972, with

FIGURE 6—S.L.-Note the manner in which the brace conforms to the trunk. The patient's limitation of motion is in part due to the effect of his back condition with lumbar spasm and flatness and in part due to the orthosis.

the sole aim of determining if nerve root pressure could be relieved to aid recovery of the ankle dorsiflexor weakness.

On June 23, 1972, the patient reported that, on two successive mornings, he had awakened with mild left sciatic radiation which was relieved by application of the back brace. He has had no such recurrences since then. At the followup Clinic Team meeting of August 10, 1972, the patient stated that he continued to wear the brace only because it gave him a "great sense of security," and he felt that it protected him against further episodes. The drop-foot condition remained unchanged. His back had not been painful for the period before using the brace and was not so at the time of followup. Sciatic radiation had not recurred. He does wear the brace continually and only removes it at night.

The following patients are only briefly reported because of either short or inadequate followup.

7. A.S., a 63-year-old unemployed male with a history of thoracolumbar pain, osteoarthritis, and osteophytosis since World War II, had had operations on the dorso-lumbar spine on several occasions, twice at the Mayo Clinic and once at the Brooklyn VA Hospital, without improvement. Most of the conservative modalities had been employed in treatment and did not help. He had previously had Knight spinal, Knight-Taylor, and Jewett braces.

He was provided with a spring-loaded low-back brace on January 27, 1972. On February 3, 1972, he telephoned to state that this was the best back brace he had ever had, but that he had iliac crest discomfort. He was advised to come in for adjustment, but stated that he was leaving in the afternoon for a vacation. Except for a letter received February 19, 1972, indicating that the "brace is fine—except for one spot," we did not hear from him until he telephoned in response to our followup clinic recall letter. He had been hospitalized repeatedly for rectal and cervical surgery and had not given the brace an adequate trial. He did, in fact, call us from a hospital bed. This patient will return after an adequate period of followup, following discharge from the hospital.

8. S.K., a 72-year-old-male physician in active practice, had a history of a low-back episode in 1954 lasting 1 month and a recurrence on May 10, 1972, without known initiating trauma. This was associated with severe pain radiating down the right lower extremity to the foot, paresthesias in the foot, and some radiation to the left posterior thigh. He was hospitalized for 5 weeks. Since discharge he had been ambulatory, but low-back pain had persisted. Examination revealed the expected findings of lumbar flatness, spasm, tilt, and restriction of motion. There were no demonstrable neurologic deficits.

On August 10, 1972, the patient was fitted with a VAPC low-back

brace. His response by August 15 was that his pain was less, he felt more comfortable, and could walk longer distances than when wearing the Knight spinal brace.

On August 16, 1972, the patient returned and reported that he wore the brace 12 hours daily. The pain radiation down the right lower extremity had disappeared. When he returned home at night he took the brace off and pain recurred about 1–2 hours later, remaining until the a.m., when he reapplied the brace.

FABRICATION PROCEDURE

A basic plaster-of-paris torso replica is used for construction of the Prenyl components for a wide range of orthoses from 34-to-42-in.-waist size. This torso is a positive plaster model of a patient with a 40-in. waist. Modification of the Prenyl components is accomplished anteriorly and posteriorly to retain centering over the crest of the ilium. Posterior separation and reattachment of the Prenyl bands allow the orthotists to make the adjustments described.

1. A moderately obese patient with a waist measurement of approximately 40 in. is selected. This patient's plaster torso can be used as the model for most adult-size low-back orthoses.
2. A positive cast is made. The area beneath the rib cage and over the iliac crest is exaggerated by removal of plaster of paris. The maximum increase of about 1 in. in depth is developed in the region of the mid-axillary line. This will provide an adequate "seat" for the Prenyl components (Fig. 7 and 8).

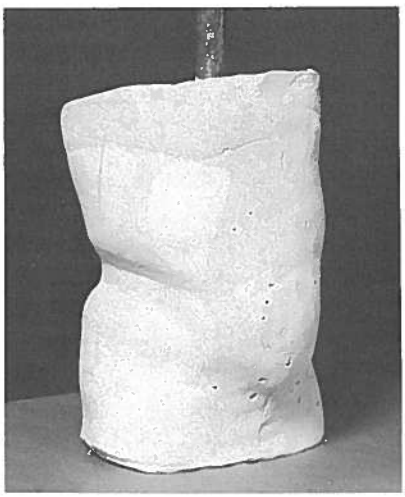

FIGURE 7.—A positive cast modified as indicated in the text. Oblique view.

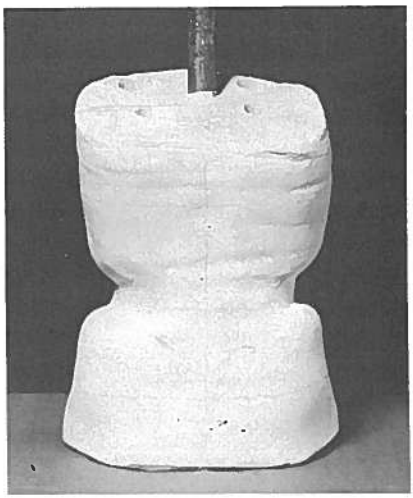

FIGURE 8.—Modified positive cast. Posterior view.

FIGURE 9.—Paper pattern being prepared.

FIGURE 10.—Paper pattern.

3. A paper pattern is prepared (Fig. 9 and 10).
4. 3/16-in. Prenyl is cut using the paper pattern as a guide (Fig. 11).
5. The Prenyl is shaped to the cast by applying heat (about 150 deg.). An elastic strap is used to pull the heat-softened Prenyl into the plaster mold to achieve the desired conformation (Fig. 12).
6. The same process is used for the upper band (Fig. 13).
7. The Prenyl is divided posteriorly to allow about 1 to 2 in. of

FIGURE 11.—Prenyl cut to pattern.

FIGURE 12.—Heat molding of Prenyl. Note the elastic strap which shapes the softened Prenyl to the cast model.

FIGURE 13.—Note the conformation of the Prenyl beneath the rib cage and over the iliac crest. The anterior spacing of the bands can be varied to the degree shown and effectiveness of the orthosis retained.

separation of the bands which are rejoined by polyester-impregnated Dacron webbing (Fig. 14). The amount of Prenyl removed will depend upon the waistline of the patient. Since the Prenyl is flexible (Fig. 15) as well as thermoplastic, the basic torso can, as previously indicated, be used for waistlines from sizes 34 to 42.

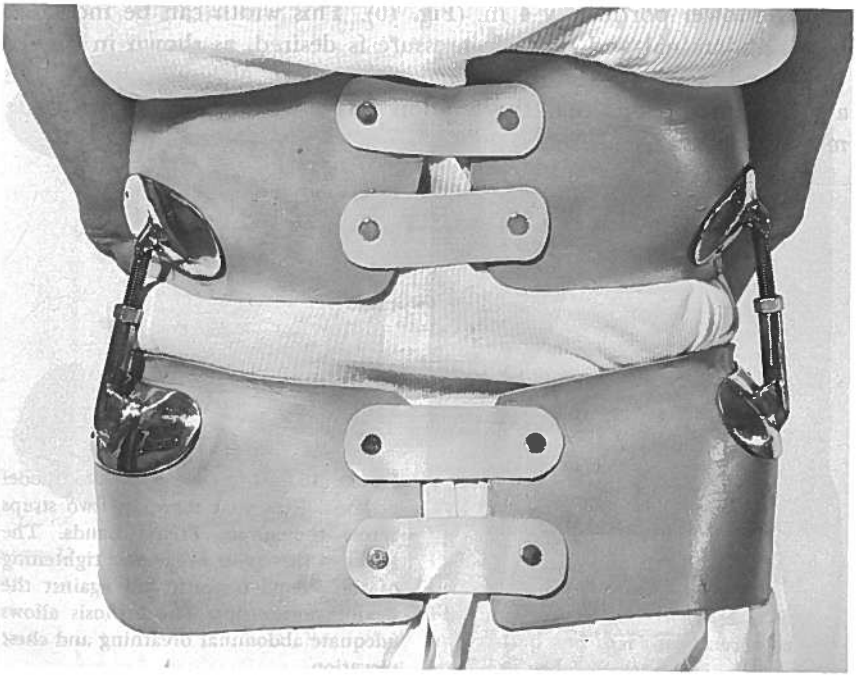

FIGURE 14.—Posterior view of the completed late model orthosis.

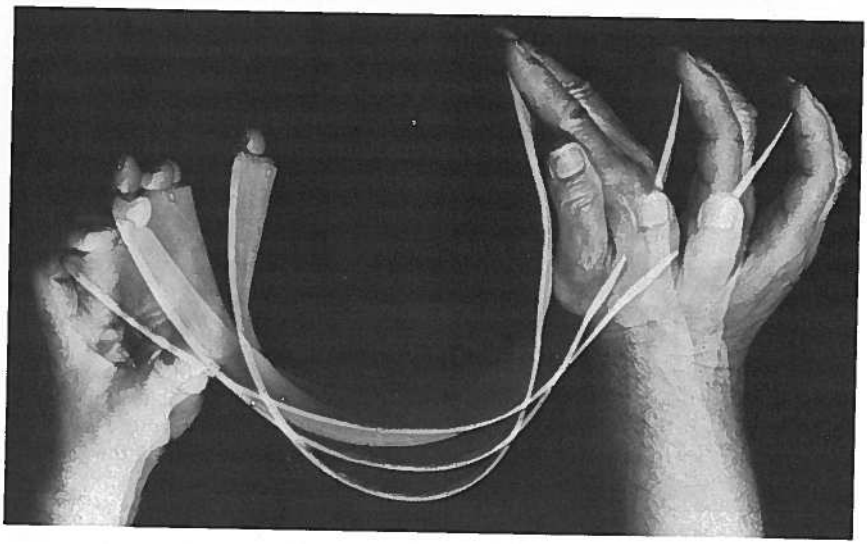

FIGURE 15.—The flexibility of the Prenyl is the basis for the orthotist's abiltiy to use one torso, size 40, as the basic model for orthoses from sizes 34 to 42.

8. The Prenyl is similarly divided anteriorly to conform with the waistline measurement of the specific patient. The upper portion of both Prenyl bands should be separated anteriorly by 1½ to 3 in. and the lower portion by 4 in. (Fig. 16). This width can be increased if less abdominal and thoracic pressure is desired, as shown in Figure 18. The brace will still retain its effectiveness, although it was the authors' impressions that the fixation was more satisfactory with the measurements given here.

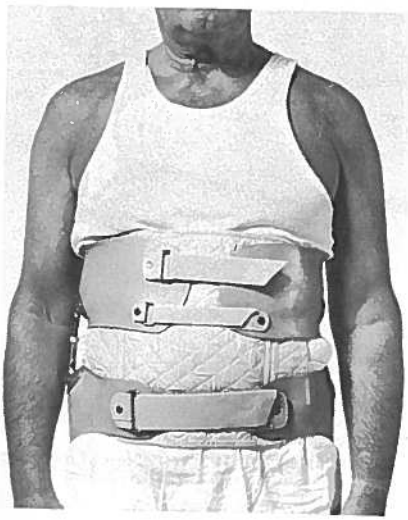

FIGURE 16.—Front view of late model orthosis. Note that there are two straps across the upper Prenyl bands. The lower of these two straps aids tightening of the Prenyl beneath and against the flexible lower ribs. The orthosis allows adequate abdominal breathing and chest elevation.

9. We anticipate that the metal parts (and possibly the Prenyl bands) will be prefabricated in the future. At present they are prepared individually: a. Four pieces of .090 stainless-steel plate are cut into oval patterns, 4½ in. by 2¾ in. These are hammered out to mold over the curves of the iliac crests and the lower thoracic cage. b. Two pieces of unthreaded .070 stainless-steel tubing 3 in. long, ½ in. in dia., and with a 1/16-in.-thick wall are attached to the iliac plates, one for each side, in the manner shown in Figure 17. Note the screws which can be tightened to temporarily maintain a desired position. This type of attachment allows A-P and M-L motion during the adjustment phase; when the orthotist has achieved the position that he desires, he fixes that position by tightening the screws. c. Two threaded steel bars, 3 in. long, of ⅜ in.-14 (thread size), are similarly attached to the oval plates shaped for the thoracic area. A nut is applied to each of these as shown in Figure 17.

10. The Prenyl components are strapped to the patient. (A replica is shown in Fig. 18.)

11. The metal struts are aligned on the Prenyl bands slightly posterior to the mid-axillary line (Fig. 19) and, when placed in position, they will fall into place. The screws are tightened to lock the position, and the locations of the oval plates on the Prenyl are marked out.

12. The metal parts are brazed solid and the plates are riveted to the Prenyl bands in the predetermined positions. The nuts are ad-

FIGURE 17.—The metal components. See text.

FIGURE 18.—Coutil apron. This illustrates an earlier model than that of Figure 16. Note that there is a single upper strap and that the anterior bands are more widely separated.

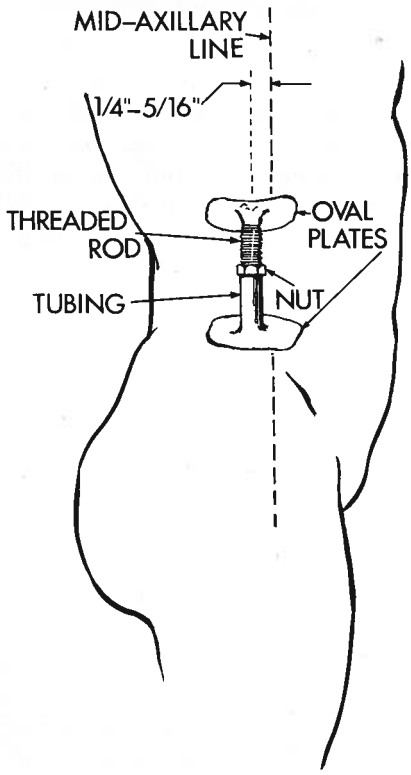

FIGURE 19.—Sketch of placement of threaded rod and tubing.

justed to provide sufficient separation so that the patient senses the upward pressure (Fig. 3, 14, and 16).

13. A separate apron of gray coutil is fabricated to fit the patient (Fig. 16). This is attached to one side of the brace with Velcro to avoid slippage. It is anticipated that the coutil aprons will be available in prefabricated form at a later date.

SUMMARY

Followup case histories of a new low-back brace and fabrication technique have been presented. The response of the patients who have used this brace has been uniformly positive and frequently enthusiastic. The design of the brace introduces what the authors considered to be maximum modularity for a brace of this type. Fabrication is relatively simple and the clinical results are very satisfactory.

ACKNOWLEDGMENT

The authors wish to state their indebtedness to Mr. Eugene Lamberty, Orthotist, for his contributions to the design of the metal components, his original viewpoints, and his enthusiastic cooperation.

Addendum: S.L. (Case No. 6) was examined at followup clinic, 3 months after issuance of the orthosis, and he demonstrated the ability to dorsiflex his foot against mild resistance and to walk without a drop-foot gait. He had noted this improvement during the preceding month.

REFERENCE

1. Rubin, G. and W. Greenbaum: A Spring-Loaded Low Back Brace. Bull. Prosthetics Res., BPR 10–15:123–128, Spring 1971.