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The Anterior Shell Orthosis: An Alternative TLSO

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INTRODUCTION

Postoperative spinal management has undergone progressive changes in recent years. The merits of early mobilization following spinal surgery are well documented[13] and it is now generally agreed that earlier mobilization leads to quicker and more successful patient recovery. The recent advent of DRGs and predetermined payment to hospitals, regardless of length of hospitalization, adds even more incentive to the concept of earliest possible mobilization.

Traditional approaches to postoperative spinal immobilization have been plaster body casts,[2,4,8,13] Jewett hyperextension orthoses,[3,5,6,7,8] and Knight-Taylor orthoses.[1,6,7] More recent approaches include the use of total contact TLSO's (body jackets), either with an anterior or posterior opening, or a bivalved, clamshell design.[4,5,6,7,8,9,11,12] Each of the above orthoses has inherent deficiencies with respect to very early patient mobilization attempts. Briefly, plaster casts lack total contact, lack volume adjustability, and do not promote or allow acceptable skin hygiene. Metal frame type orthoses such as a Jewett or Knight-Taylor do not control motion in all three planes, which is necessary for immediate postoperative mobilization. The ability of these orthoses to control lateral trunk flexion and/or rotary motion of the trunk is questionable. On the other hand, total contact TLSO's provide excellent control, but are very difficult to independently don and doff and, more important, they require rolling the patient into a prone position, or use of a Stryker frame, for molding. An additional deficiency of total contact TLSO's is they are too restrictive or confining, and actually slow the rehabilitation/recovery process by limiting range of motion necessary for independence.

DEVELOPMENT AND DESCRIPTION

In late 1977, Richard Rosenberger, C.P. (deceased March, 1985) and physicians with the Department of Orthopaedics and Rehabilitation at the University of Virginia Medical Center developed the "anterior shell" orthosis as an alternative TLSO, designed to address all of the above mentioned deficiencies found in these other orthotic approaches. As its name implies, the anterior shell orthosis is a TLSO that provides total contact coverage to the anterior three quarters of the trunk, with the anterior trimlines the same as those of any standard body jacket type TLSO, and the lateral trimlines just posterior to the lateral midline of the trunk (Figure 1). Suspension and immobilization are afforded by this total contact anterior section coupled with a Jewett type posterior pad with adjustable straps and a two inch wide Velcro® posterior strap across the sacral-coccygeal junction of the pelvis (Figure 2). Although quite flexible upon first impression, this TLSO becomes sufficiently rigid when properly tightened on a patient (Figures 3 and 4), deriving its strength and rigidity from the tubular principle. This orthotic design provides a three point pressure system which is effective from T5 to

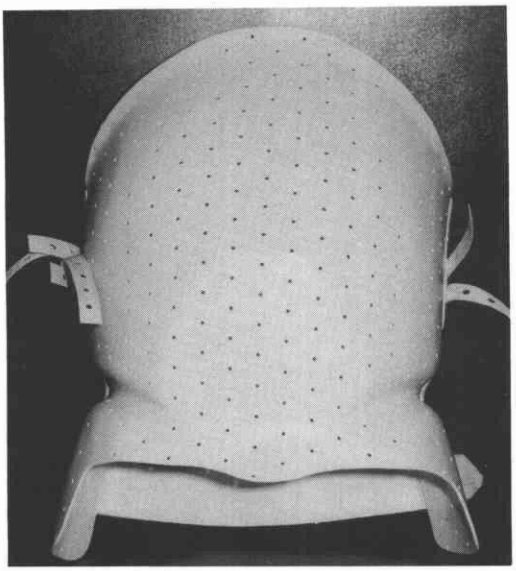

Figure 1. Anterior view of Orthoplast™ anterior shell orthosis.

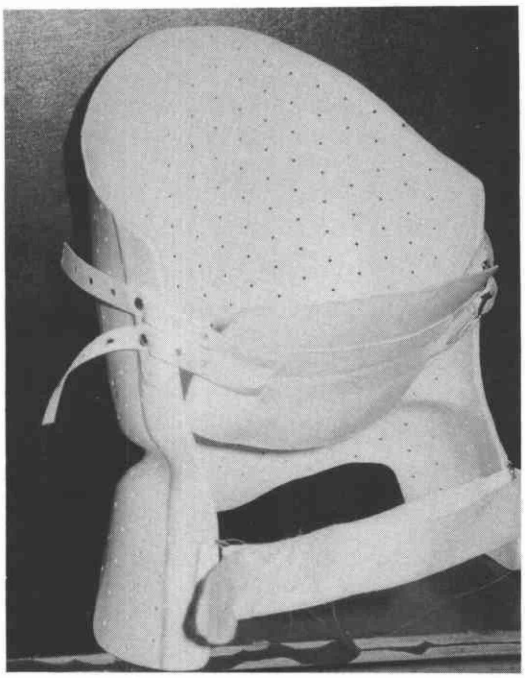

Figure 2. Posterior view of Orthoplast™ anterior shell orthosis.

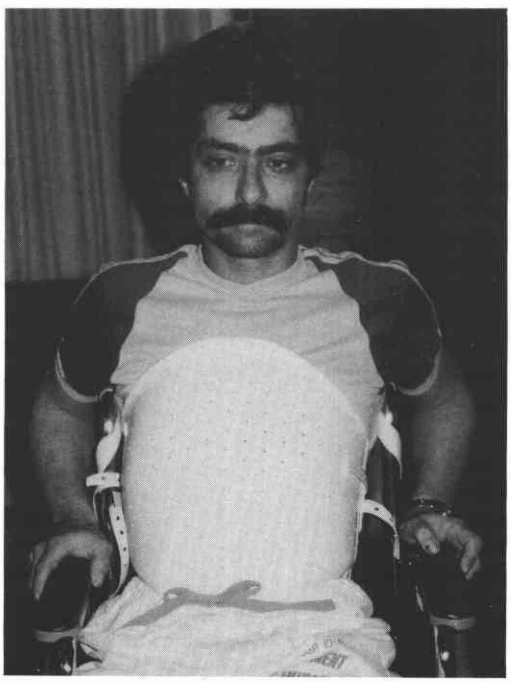

Figure 3. Anterior view of patient wearing orthosis.

Figure 4. Lateral view of patient wearing orthosis. Note Jewett type posterior pad and strap arrangement.

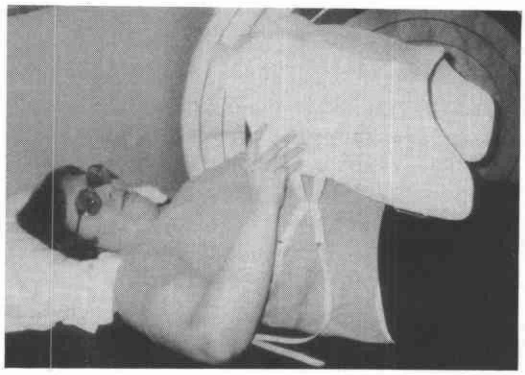

Figure 5. Patient in supine position donning orthosis.

Figure 6. Patient, lying down, rolls to side and fastens the posterior pad and strap. Allowing for the posterior pad and strap to fasten on the same side facilitates donning and doffing in the lying position.

L5; however, a cervical extension can be added to the orthosis to extend its support to the upper thoracic region. Originally designed for postoperative spinal management following Harrington rod instrumentation secondary to traumatic injury, the anterior shell orthosis permits the cast impression to be taken with the patient comfortably supine without the need for proning or other patient movement.

ADVANTAGES

In addition to the advantage of not having to move the patient while casting, the anterior shell orthosis is felt to be superior to the bivalved and circumferential TLSO designs for postoperative management in other respects. Additional advantages offered by the anterior shell orthosis include ease of donning and doffing the orthosis initially for the nursing staff and later, the ability to independently don and doff the orthosis by the patient while in the supine position (Figures 5 and 6), ease of inspection of the surgical wound site without having to doff the orthosis, increased air circulation to the surgical wound site, and more efficient cooling due to less body containment within the orthosis. The anterior shell orthosis provides anterior, posterior, lateral, and rotary control, however, because there is no posterior section, the lateral aspects are slightly more flexible than in a circumferential design. This quality of slight flexibility facilitates maneuverability during transfers and activities of daily living, yet the orthosis provides sufficient external stabilization to protect the Harrington rod instrumentation.

INDICATIONS

As the advantages of the anterior shell design were proven with experience with postoperative patients, opportunities were sought for its use with other spinal diagnoses (Table 1). Indications for use of the anterior shell orthosis now include various vertebral fractures, treated surgically or non-surgically; vertebral degeneration and pain due to diffused malignancy; progressive kyphosis due to osteoporosis, ankylosing spondylitis, and neurological conditions; degenerative joint disease; and postoperative management of spinal stenosis.

EXPERIENCE

Over a period spanning 1979–1985, 232 patients were treated orthotically with the anterior shell; 137 of these patients were treated postoperatively (Tables 2 and 3). Over this seven year period, no postoperative patients experienced failure of surgical instrumentation while in the orthosis. During the initial development phase in 1978, only one postoperative patient experienced failure of his surgical instrumentation while in the orthosis.

Etiology of Diagnoses	
motor vehicle accident	102
fall	39
cancer metastasis	23
unknown etiology	16
osteoporosis	8
spinal stenosis	7
industrial accident	6
ankylosing spondylitis	4
gunshot wound	3
osteomyelitis	3
spondylolisthesis	3
degenerative arthritis	2
pedestrian hit by moving vehicle	2
rheumatoid arthritis	2
systemic lupus erythematosus	2
tuberculosis of the spine	2
anterior spinal artery syndrome	1
discitis	1
herniated disc	1
histoplasmosis	1
intoxication	1
old fracture non-union	1
plane crash	1
rock slide	1
wood stacking accident	1

Table 1.

TREATMENT REGIME

Current treatment of thoracic and lumbar spinal cord injuries at the University of Virginia Medical Center includes molding and subsequent fit and delivery of an anterior shell orthosis within a few days post-surgery. Patients are usually maintained supine in bed until the orthosis is fit and delivered, with rehabilitation beginning immediately after fitting and delivery. At two weeks post-surgery, patients are allowed unlimited forward leaning in the orthosis for level and uneven surface transfers (wheelchair to bed, wheelchair to mat, etc.). Once the basic transfers are mastered, appropriately supervised advanced wheelchair transfers are permitted, including wheelchair to floor, floor to wheelchair, ascending and descending stairs in a sitting position, and in and out of a bathtub. At three to four weeks post-surgery, patients are taught independent donning and doffing of the orthosis in the supine position.

TECHNICAL INFORMATION

Material Selection

At the University of Virginia Medical Center, the anterior shell orthosis is normally fabricated utilizing Orthoplast™. This thermoplastic material offers quick and easy fabrication that permits removal from the mold immediately after cooling without risk of shrinkage or other distortion. This allows for quick fabrication and delivery of the orthosis. Other noteworthy advantages of Orthoplast™ include preventilation for air circulation, light weight, and due to its low temperature thermomolding properties, it is easily adjusted or modified in hospital and clinical settings. In cases where the orthosis is going to be used definitively, thermoplastics such as polyethylene or Vitrathene are used in lieu of Orthoplast™.

Patient Molding

To cast a patient for an anterior shell orthosis, a piece of 12 inch wide stockinette is split lengthwise and placed over the patient with the edges of the stockinette tucked under the patient to prevent shifting during casting. A piece of narrow stockinette is passed carefully under the patient in the lumbosacral region of the back and through to the other side. The two ends are pulled tight over the iliac crests, tied off, and placed under tension as for pelvic traction (Figure 7). Indelible anatomical markings are made and include the xiphoid process, sternal notch, costal margins, anterior superior iliac spines, and the superior border of the symphysis pubis. Plaster splints are then applied making sure to cover from the symphysis pubis to the sternal notch anteriorally and down to the surface of the table on the sides, being sure to follow the patient's contours. When hardened, the plaster cast impression is removed and sealed and the positive model is poured.

Model Modification

The positive model is modified in a normal TLSO modification fashion, including flattening the anterior lower thoracic and abdominal area for increased intraabdominal pressure and defining the area above the iliac crests for

Patients Treated With Anterior Shell Orthosis								
	1979	1980	1981	1982	1983	1984	1985	TOTAL
Post-surgically	7	19	25	19	15	23	29	137
Non-surgically	6	9	11	11	11	25	22	95

Table 2.

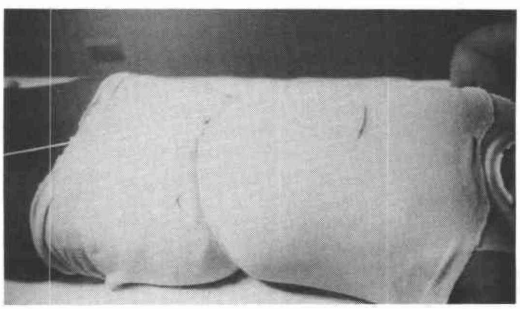

Figure 7. Patient, in supine position, is ready to be casted. Patient does not have to be rolled or turned to complete casting.

good suspension on the pelvis. Plaster build-ups are added over the anterior superior iliac spines if the patient is thin. The lateral posterior border is extended two inches in the posterior direction from the iliac crests inferiorally, to cover the gluteals laterally and increase lateral stability.

Because the anterior trimline of the orthosis extends to within an inch of the sternal notch, female patients require design variations in the model modification and the subsequent orthosis. For large busted female patients, an opening is frequently designed in the breast area to free the breasts. For smaller busted female patients, the breast area is built up on the plaster model to permit room for the breasts in the orthosis with the patient upright. In both situations, the area superior to the breast area is reduced on the plaster model to ensure good contact within the orthosis; also, the area superior to the breasts is reinforced in the fabrication process to ensure rigidity. When total contact for support and/or dispersement of pressure over a greater area is needed, as in cases of degenerative disease, such as osteoporosis, arthritis, and diffused cancer, the breast area is built up slightly on the plaster model and incorporated into a solid design in the orthosis.

Patient Population By Age		
Age	Males	Females
<20	29	10
21–30	47	13
31–40	20	12
41–50	16	11
51–60	22	17
61–70	6	9
71–80	7	10
>80	1	1
unknown	1	1
Totals	149	84

Table 3.

Fabrication Techniques

When molded with Orthoplast™, reinforcement is provided by a double thickness of Orthoplast™ in appropriate areas: the anterior superior and the lateral posterior edges. The metal anchor plates for attachment of the posterior pad straps are sandwiched in between layers of Orthoplast™ and later drilled and tapped for 8-32 screws.

If vacuum formed using a more durable thermoplastic, reinforcement can be provided with hybrid carbon composite inserts (available from Durr Fillauer). In this fabrication technique, the

metal anchor plates for the posterior pad straps can be mounted on the plaster model for incorporation into the vacuum formed shell.

In either case, the posterior pad is patterned after the Jewett orthosis posterior pad and has two sets of ½ inch dacron straps with 3/16 inch diameter holes, ½ inch apart in both ends for connection to the anterior shell. The posterior pad floats freely on the dacron straps, which are permanently attached to the metal anchorplate on the left side of the orthosis with 8-32 screws and have roller buckles on the right hand ends of the straps. The right side straps, which are attached under 8-32 screw studs, pass through the roller buckles and double back on themselves for adjustable tension control and attachment to the stud-heads of the 8-32 screw studs. The roller buckle system acts as a pulley system, thereby reducing the mechanical force needed to properly tighten the posterior pad.

The final component in the system is the two inch wide Velcro® sacral-coccygeal strap, which is permanently attached on the left side of the anterior shell, passes through a two inch stainless steel loop on the right, and doubles back on itself for a secure closure.

This adjustable closure system is described as was originally designed by Rosenberger, et al. It is not necessarily deemed to be the simplest. Any of the adjustable closure systems utilized in the available prefabricated spinal extension orthoses should provide a suitable alternative to the above closure system.

SUMMARY

The anterior shell orthosis provides quickly accessible orthotic support for early mobilization of patients with spinal cord injury and other diagnoses, allowing for independent donning and doffing with relative ease. Though sufficiently rigid to protect surgical instrumentation while boney fusion takes place, the anterior shell orthosis allows maximum maneuverability possible for a patient in a TLSO.

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