

The Thoracic Suspension Jacket— Review of Principles and Fabrication

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Apparently, the first reference to the Thoracic Suspension Jacket was in an article by Siebens¹ in 1972. Since then, considerable experience with it has been amassed at Newington Children's Hospital and other localities as described by Siegfried Paul, C.P.O., (E),^{2,3} James C. Drennan, M.D.^{4,5,6} and others. Durr-Fillauer's involvement began in 1974, and over the years, simplified fabrication procedures using prefabricated components adaptable to wheelchair use or other sitting accommodations have been developed.

There have been frequent requests from orthotists for information relating to it. It is hoped that this article will at least partially fulfill the need.

DESCRIPTION

The Thoracic Suspension Jacket is a custom molded Thoraco-Lumbo Sacral Orthosis with an anterior opening and a PE-LITE* lining. The portions under the antero-lateral aspect of the costal margins are indented to provide shelves on which the ribs rest and the inferior edge is trimmed higher than usual for sitting comfort. Suspension lugs are secured to the right and

left sides of the jacket and hangers are secured to the back uprights of the wheelchair on which the jacket is suspended. Adjusting the height of the hangers and clamps permits the amount of weight borne by the thorax to be increased or decreased. By this means, the distractive effect of the lower portion of the body can be used to extend the spine and/or the buttocks, and other pressure sensitive areas can be relieved of superincumbent weight.

INDICATIONS AND CONTRAINDICATIONS

Drennan^{4,5} has described the orthosis as being indicated for individuals with paralytic spinal deformity for whom surgery, for whatever reason, (immature skeletal growth, life threatening complications, etc.) is not contemplated. He has described the objectives as:

- arrest or correction of spinal deformity
- improvement of sitting balance
- freeing of the arms from the role of trunk supports
- improved appearance and body language
- increased independence and mobility

- improvement of respiratory function
- relief of pressure and decubiti over the ischial tuberosities and sacrum
- relief of back pain

He cited prerequisites to success as being:

- willing patient and family cooperation
- presence of a skilled and experienced team including orthotist, physician, therapists, and nursing staff

Surprisingly enough, Drennan stated that anesthetic skin, with appropriate attention to detail and follow up, had not been a problem and that patients without sensation had developed tolerances of up to 10-12 hours. While adequate hip flexion for sitting is essential, it was found that fixed pelvic obliquities and dislocated hips could be accommodated.

Relative contraindications creating problems (and in some case failure) were listed as:

1. uncooperative family and patients.
2. hip joint stiffness with inability to sit.
3. severe athetoid cerebral palsy or severe involuntary movements.
4. gross obesity, as the underlying structures are difficult to grasp and the load imposed may be more than the skin can tolerate.
5. Cachexia (condition of general wasting marked by extreme thinness and muscular atrophy). Patients tended to

"slip through" the orthosis, especially those with muscular diseases and progressive weight loss and atrophy.

In a similar vein, Robin Black⁷ has listed as complicating factors:

1. severe spinal deformity leading to unequal loading on the rib cage and reduced tolerance time.
2. obese individuals.
3. patients with ileostomies.
4. poorly motivated patients.

FABRICATION

The negative impression is made in the usual fashion. The patient may either be positioned supine on a Risser table and wrapped circumferentially or positioned prone on the end of an ordinary fitting table with the knees flexed for casting in two steps with splints. In this latter instance, use of the Durr-Fillauer Pelvic Casting Fixture may prove helpful. Whatever technique is used, flexible curves should be corrected, and the space superior to the iliac crests and inferior to the costal margins should be indented in the usual manner. Before removal of the negative impression, the patient should be positioned straight, keeping in mind the eventual sitting posture, and anterior and lateral center lines drawn.

Following removal of the negative impression from the patient and closure, the suspension points are identified as depicted in Table 1. While the method of clamping the hanger rods to the wheelchair gives considerable adjustability, the suspension points should be located as accurately as possible, taking into account such things as decompensated curves and eventual sitting position. Once the suspension points are located, 1/4" holes are cut in the negative impression and the lubricated casting rod is positioned in them (Figures 1, 2). The negative impression is poured in the usual fashion, the rod is then removed (leaving a clear channel through the positive model), and the cast is removed from the positive model.

The positive model is smoothed and modified in the usual manner. Drennan⁴

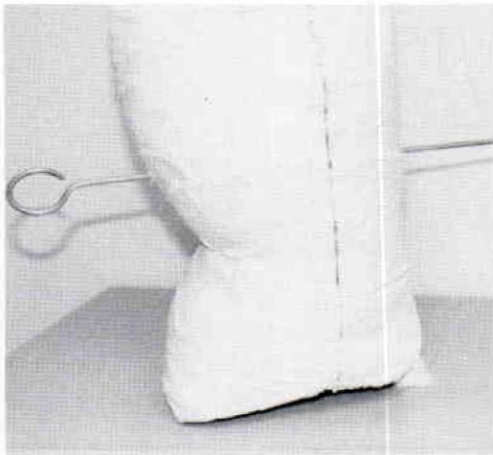
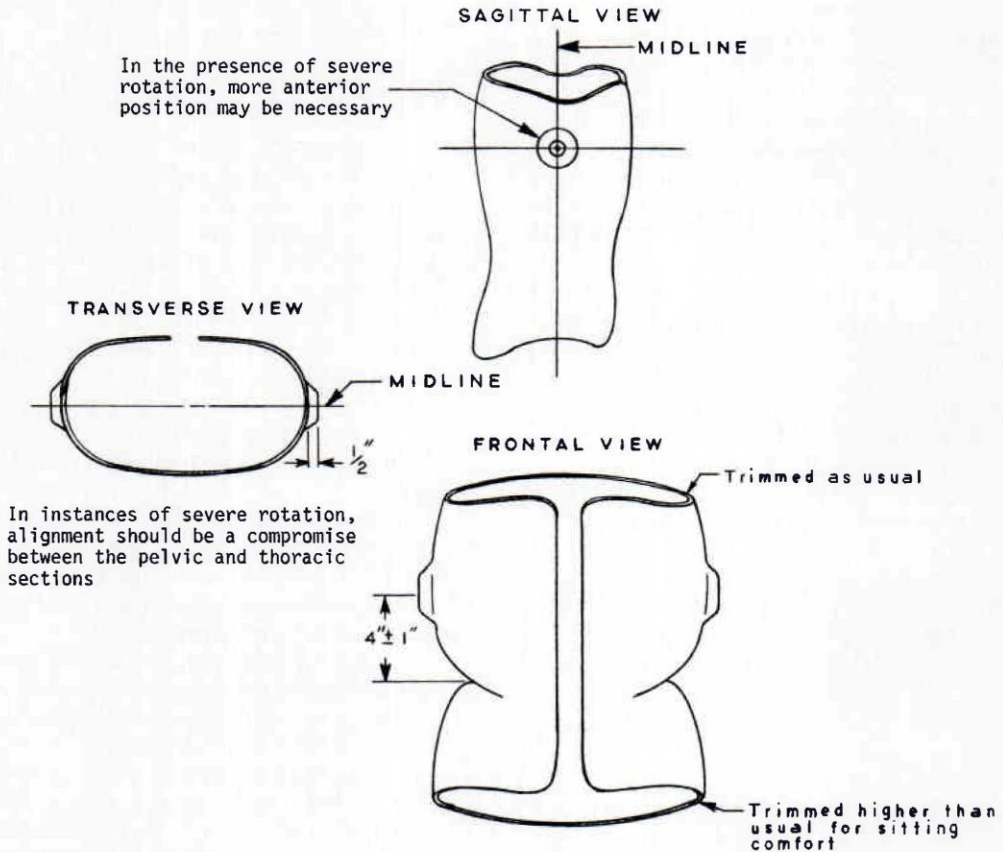


Figure 1. Cast with casting rod in place, posterior view.

TABLE I
LOCATION OF SUSPENSION LUGS



has recommended building up the areas superior to the costal margins to give room for chest expansion and respiration. Similarly, he has advised removal of plaster in the upper abdominal area to provide hydraulic resistance to contraction of the diaphragm and thus again aid chest expansion and respiration.

The modified positive model is prepared for vacuum forming and covered with a layer of 5mm A8 ventilated medium den-

sity PE-LITE (Figure 3) with an anterior opening. For several years the suspension lugs were mounted on anchor cups fabricated of aluminum and rigid polyurethane foam. Recently a quicker and more efficient means of mounting the suspension lugs has been devised.

The PE-LITE cup, adapter nut, and the rest of the components of the lug mount are assembled on the alignment rod as shown in Table 2.

TABLE II
EXPLODED VIEW OF ALIGNMENT ROD
AND LUG MOUNT COMPONENTS

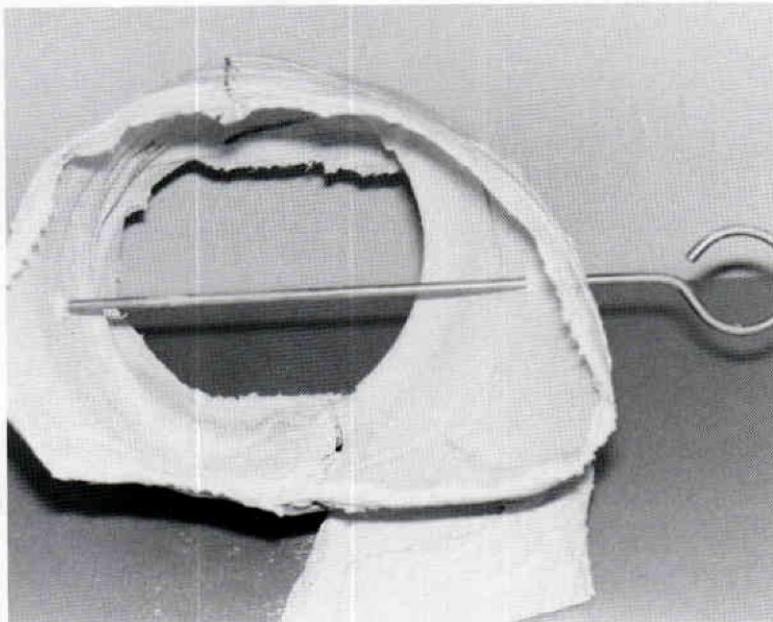
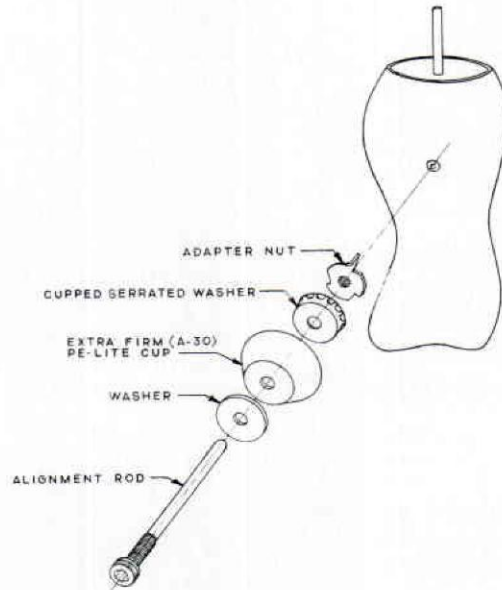


Figure 2. Inside view of cast and casting rod.

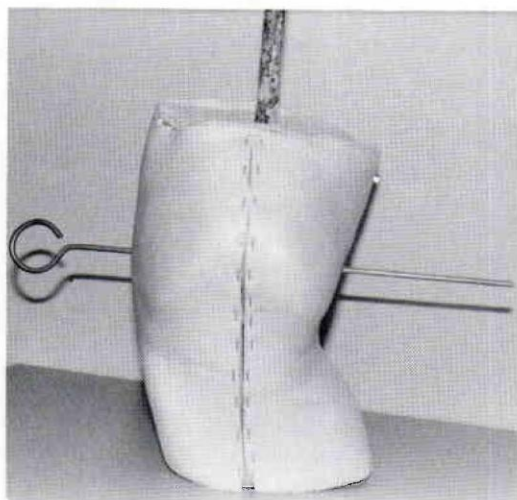


Figure 3. Anterior view of model with PELITE and casting rod in place.

The alignment rod is inserted in the hole previously provided by the casting rod (Figure 4) and the amount of PE-LITE to be removed is identified by measurement (Figure 5).

The PE-LITE cup is trimmed so that it makes even contact with the surface of the positive model and protrudes no more than $\frac{1}{2}$ ". When properly contoured, the PE-LITE cup (Figures 6, 7) is filled with Rapid-cure[†] and repositioned on the positive model in proper alignment (Figure 8). Once the acrylic compound reaches a stiff dough-like consistency, it is faired into the surface of the PE-LITE using a fingertip dipped in the methylmethacrylate catalyst. Once the lug mounts are properly shaped and secured in place, the alignment rod is removed (Figure 9) and the positive model is vacuum formed with $\frac{3}{16}$ " polyethylene.

When the polyethylene has cooled, the threaded holes in the lug mounts are exposed using a $\frac{3}{8}$ " drill (Figure 10) and a $\frac{5}{16}$ "-18 tap is used to clear the threads and properly align the hole (Figure 11) in the polyethylene.

The areas about the holes are heated (Figure 12) and the suspension lugs securely screwed into position (Figure 13) so that the plastic forms flat seats about them. Trimlines are drawn on the orthosis (Fig-



Figure 4. Lug mount assembly and alignment rod inserted in hole in model.

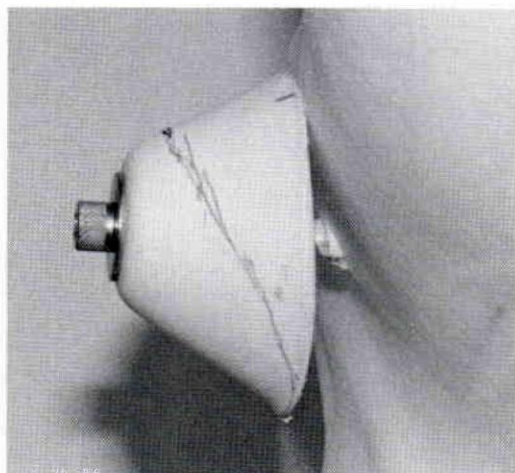


Figure 5. Amount of material to be removed is measured and marked.

ure 14) and it is removed from the positive model and finished as usual.

The clamp assemblies and hanger rods are secured to the chair horizontally (Figures 15, 16, 17) to provide appropriate positioning of the orthosis in the wheelchair. While rotation of the clamp assemblies on the uprights of the wheelchair provides considerable adjustability, modification of the hanger rods may be necessary. Although the thoracic suspension orthosis is generally adjusted so as to relieve the buttocks of the patient's

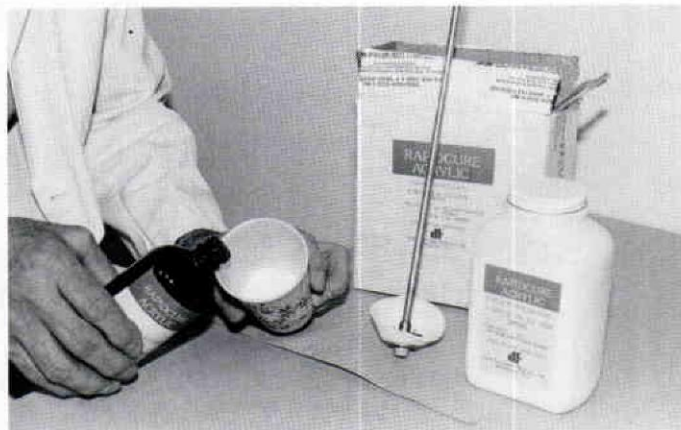


Figure 6. (Left) Mixing methylmetacrylate to fill the PELITE cup.

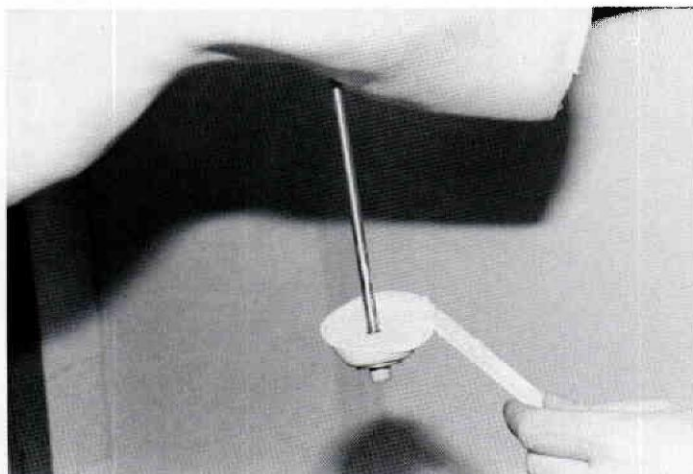


Figure 7. (Right) Cup filled with Rapid-cure. Model has been positioned upside down in pipe vise.

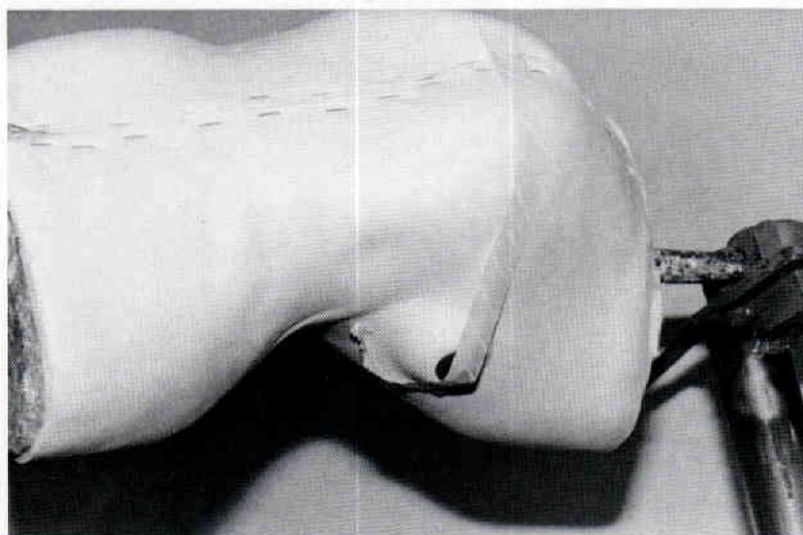


Figure 8. (Left) PELITE cup held in place until the methylmetacrylate sets.

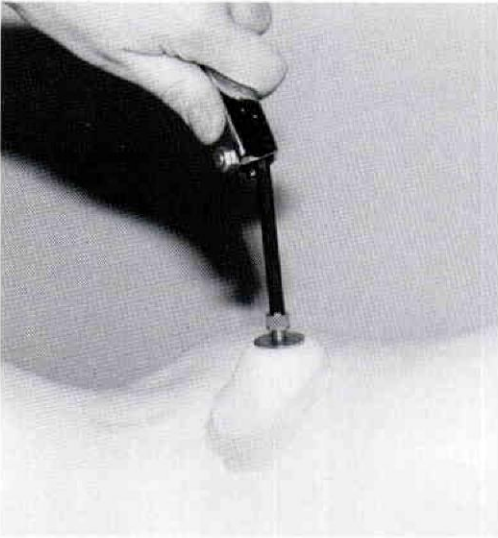


Figure 9. The alignment rod is removed from the lug mount after the edges are faired into the contours of the model.

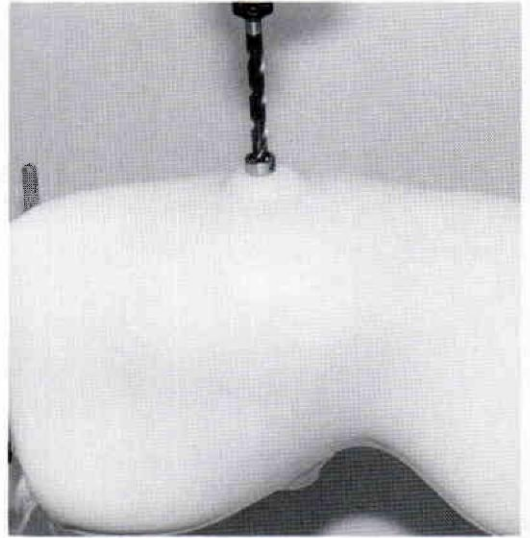


Figure 10. Drill used to open up the holes in the polyethylene over the lug mounts.



Figure 11. A tap is used to clear the threads and align the holes.

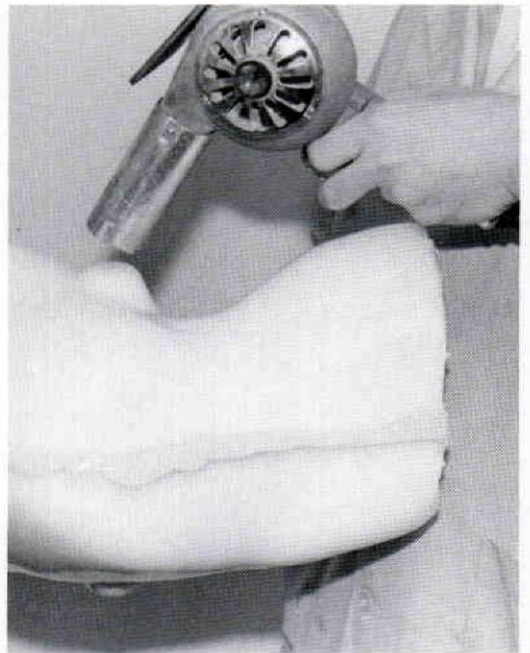


Figure 12. Heating the areas about the holes.

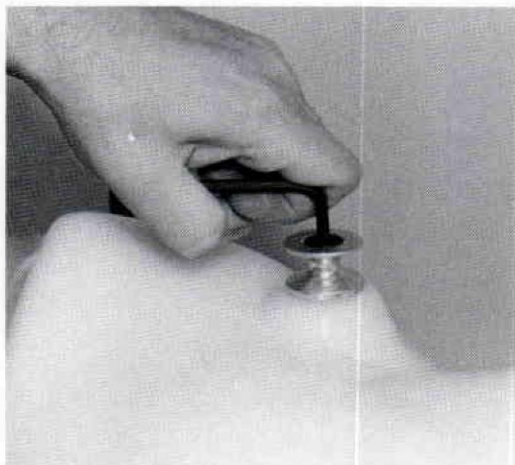


Figure 13. Securing the suspension lugs in place while the polyethylene is soft.

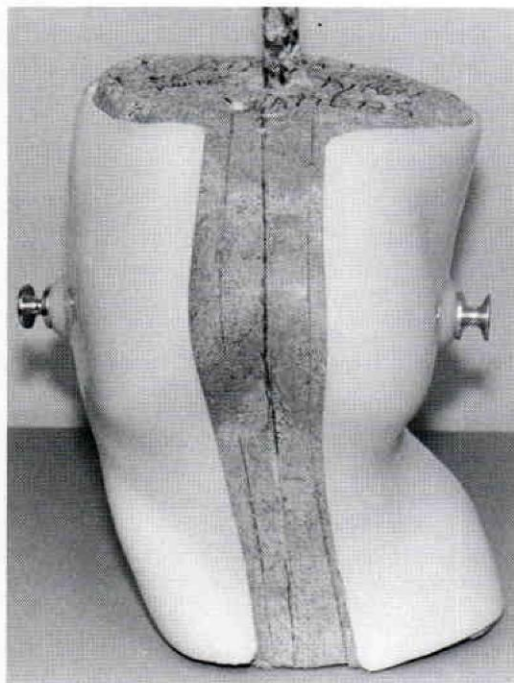


Figure 14. Orthosis with suspension lugs secured in place and initial trimlines cut and smoothed.

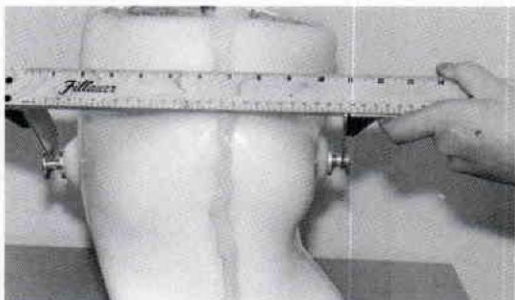


Figure 15. The distances between the two suspension lugs is measured.

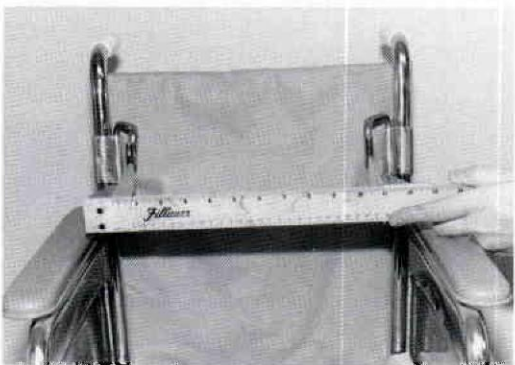


Figure 16. With that measurement as a guide, the clasp assemblies are installed on the chair.

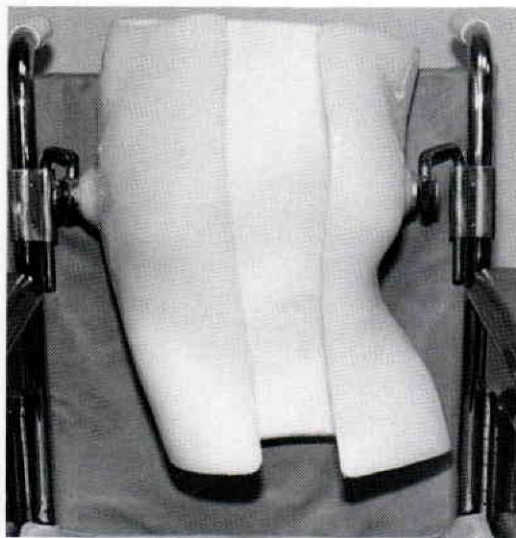


Figure 17. Finished orthosis mounted on the chair.

weight, it may also be used for stabilization of the torso without weight-bearing.

BREAK-IN PERIOD AND FOLLOW UP

Drennan and Black^{4,5,6,7} agree that wearing tolerance should be built up very gradually over a period of several weeks. The goal is that in 2-3 weeks time, the patient can use it for a full day with periods of relief from suspension. Drennan recommends hospitalization for this period of tolerance building and discharge once the patient can tolerate suspension for two hours out of four. Obviously, success depends on willing, intelligent cooperation of the patient and family.

The orthosis should be used daily to maintain tolerance, the skin should be inspected daily, and care should be taken to avoid wrinkles in undergarments worn. Areas of redness that do not clear after 20 minutes should be brought to the attention of the orthotist for appropriate action. Patients should not be transported in suspension, as the jarring motion can cause discomfort and skin breakdown. Drennan^{4,5} has reported that new orthoses were necessary on the average of 15 months after initial fitting, with a readmission to the hospital of about three days.

RESULTS

In 1979, Drennan⁴ reported the results of 62 patients fit since 1972. The suspension orthosis was prescribed most frequently for spina bifida, cerebral palsy, Duchenne muscular dystrophy, spinal muscular atrophy, trauma, and various other conditions. Patients ranged in age from 14 months to 26 years. Five instances of failure were described and attributed to: lack of cooperation, obesity, hip joint stiffness, severe athetoid cerebral palsy, and extreme and progressive cachexia.

Similarly in 1975, Robin Black⁷ described the results of fitting over a dozen children with spina bifida with suspension jackets over a period of two and one half years. Eight patients were identified as having benefited from use of the jacket, five of them remaining free of pressure sores for more than one year.

In addition, Karl Fillauer, CPO has fitted several patients with hemicorporectomy amputations with suspension orthoses and achieved good results.

CONCLUSION

The Thoracic Suspension Jacket has proven itself to be an efficient and practical means of handling individuals with severe scoliosis and decubitus ulcers. For the benefit of those who may not be familiar with the orthosis, indications, contraindications, fabrication, and follow up procedures are reviewed. It is hoped that this information will be of some assistance in meeting the needs of the severely deformed.

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*A closed cell Polyethylene foam

[†]Rapidcure, a methylmethacrylate plastic, is a product of Durr-Fillauer Orthopedic Division.