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POLYPROPYLENE IN SPINAL ORTHOTICS

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For several years the thermoplastic material, Orthoplast[3], has been in use for the fabrication of certain spinal orthoses, particularly for the pelvic girdle of the Milwaukee Brace. However, Orthoplast, a synthetic balata, has limitations with respect to durability. We have found it to be quite acceptable for about a year and, in some cases, it has served adequately for as long as two years as the pelvic girdle for a Milwaukee Brace. However, body chemicals and time usually join forces soon after the first year to accelerate the deterioration of Orthoplast, causing the patient to face a rather expensive and time-consuming replacement process.

This problem led us to search for a more durable material, while recognizing the advantages of Orthoplast and similar thermoplastic materials —cosmesis, light weight, and better "total-contact" fit than has been possible with more conventional materials. Thermoplastics such as Kydex[4] and Vitrathene[5] have been tried as a substitute for Orthoplast with varying degrees of success. Both Kydex and Vitrathene are difficult materials to work compared with polypropylene.

The following is a summary of our experience with polypropylene, including the techniques for casting and molding it in the fabrication of pelvic girdles for the Milwaukee Brace and scoliosis jackets. A new application using polypropylene in the construction of a spinal flexion orthosis is also described.

Our initial experience with polypropylene was in the construction of ankle-foot orthoses (AFO) for drop-foot, where it proved to be resistant to repeated stress, easy to work, and remarkably durable. We have used polypropylene for AFOs for about a year and a half with no replacements required due to breakage or deterioration. We, therefore, naturally turned to polypropylene for trials in the construction of spinal orthoses. At this point, polypropylene has been used in the construction of over 30 spinal orthotic devices with equally rewarding results.

CASTING CONSIDERATIONS

Casting for the pelvic girdle portion of the Milwaukee Brace is carried out in the currently accepted way.

Casting for the postoperative scoliosis jacket is done in the same manner as for the Milwaukee Brace but with the patient standing in cervical traction straps to give stability during casting.

Casting for the scoliosis jacket for nonambulatory patients is done by lifting the patient into a sitting position until as much of the curve is corrected by gravity as is possible. A second person or a sling suspension must be used. An alternate technique for the wheelchair patient is to apply the cast in two sections, the anterior portion taken with the patient supine and the posterior portion with the patient prone. Plaster splints are used, and the two halves are joined together to form a negative mold.

Casting for the flexion jacket is performed by positioning the patient to eliminate as much lumbar lordosis as possible. Generally, this is best accomplished with the patient sitting partially on the mid portion of the thighs with the hips in about 20-25 deg. of flexion, and the patient's trunk erect with the arms resting on a support.

FABRICATION CONSIDERATIONS

Polypropylene is relatively easy to work. Once a cast has been taken of the patient, filled, modified and smoothed, a sleeve of cotton stockinette is pulled over it. A piece of polypropylene is cut to the circumference and length of the cast and both

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sides are sprayed with a silicone parting agent to prevent sticking. The material is then placed on an aluminum or stainless-steel tray for approximately 10-15 min. in an oven at a temperature of 400 deg. F. Oven time will vary with its thickness. When the material becomes clear, it is ready to be removed from the oven. It is imperative that polypropylene not be left in the oven too long.

Generally the molding process requires two people. The heated material is lifted slowly from the metal tray (Fig. 1) and placed on top of the prepared cast. When the seam is to be on the anterior aspect, the cast should be facing down. When a seam on the posterior aspect is required, the anterior part of the cast should be facing up. One person molds the top of the cast for total contact between the polypropylene and the cast, paying particular attention to modified areas. At the same time, another person molds the seam, working underneath the cast to insure total contact (Fig. 2). Excess polypropylene is trimmed off to prevent its weight from causing the material to sag and thus interfere with total contact (Fig. 3).

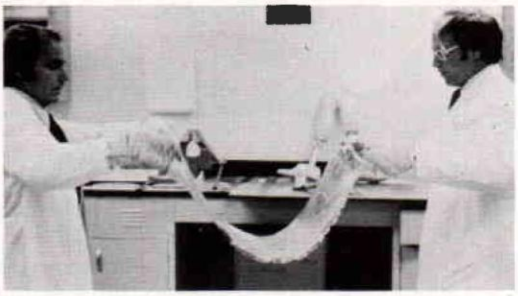

Fig. 1. The heated polypropylene sheet is lifted slowly from the oven.

Fig. 2. One person molds the sheet over the upper surface while the other molds the sheet over the lower surface.

Fig. 3. Excess polypropylene is trimmed off to prevent it from pulling the heated sheet away from the cast.

Polypropylene shrinks as it hardens and, unless molded constantly, it will pull away from the mold, particularly in modified areas. It is necessary for one person to continually mold the material lightly, by hand, against the cast until completely hard. The working time varies with the thickness; material 1/16 in. thick has approximately 45 seconds of working time, and 3/32 in., about two minutes.

CASE ILLUSTRATIONS

Case No. 1: C.J. is a 14-year-old girl with a 35-deg. right thoracolumbar scoliosis. She is shown in Figure 4, fitted with a Milwaukee Brace that has a polypropylene pelvic girdle. The thoracolumbar pad is made of Plastazote (expanded polyethylene) which provides comfort comparable to standard pads with much greater durability. These pads are backed with aluminum sheet as in the standard pads (Fig. 5).

Case No. 2: M.S. is a 13-year-old boy postoperative to a Harrington fusion procedure for a right thoracic scoliosis. Figure 6 shows him in his postoperative polypropylene scoliosis jacket which was fabricated from a positive mold six months after insertion of the Harrington instrumentation.

Case No. 3: P.M. is a 20-year-old girl with severe scoliosis, measuring 120 deg. as a result of arthrogryposis (Fig. 7). She was nonambulatory and confined to a wheelchair, but her activities were limited because of trunk instability and the necessity to use her upper limbs for support while sitting. She was unable to transfer. Figure 8 shows her fitted with a polypropylene scoliosis jacket which served to enhance her trunk support and

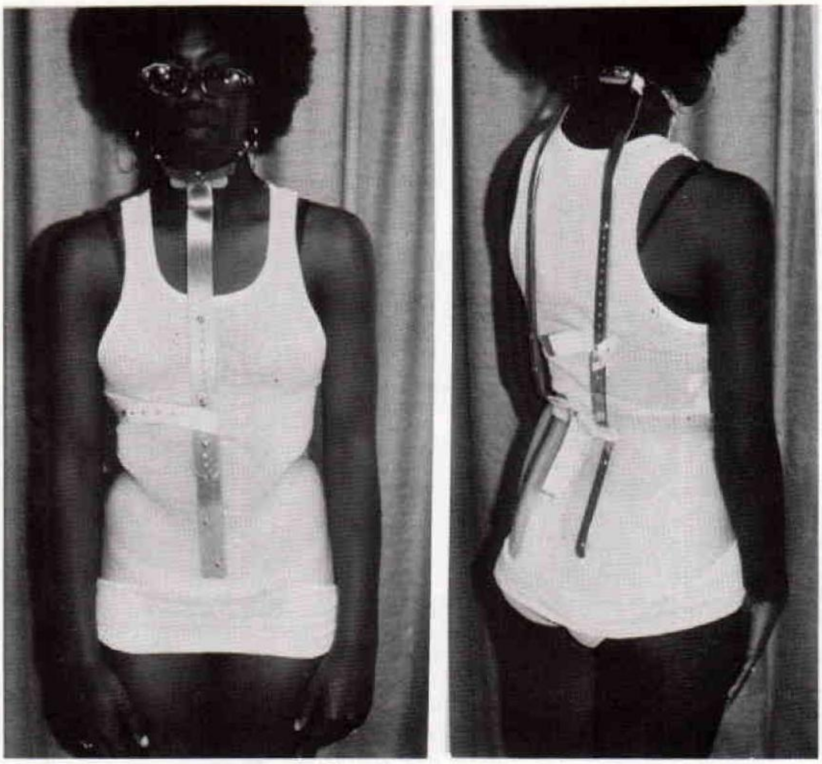

Fig. 4. Case No. 1.

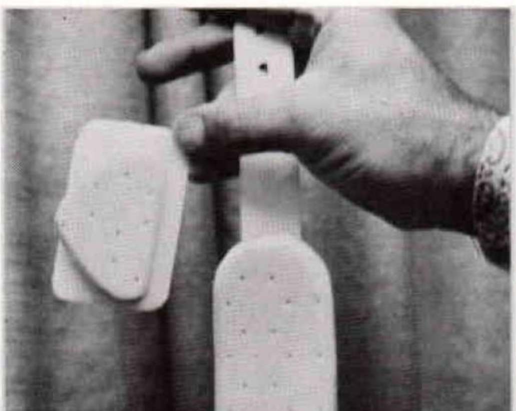

Fig. 5. Close-up view of thoracolumbar pads made of Plastazone backed with aluminum sheet.

made transfer activities possible. Correction of 20 deg. of the scoliosis was obtained.

Case No. 4: N.S. is a 12-year-old girl with Grade I spondylolisthesis and right sciatic pain. Figure 9 shows the rather marked degree of lordosis present in the standing position. Figure 10 shows the patient fitted with polypropylene flexion orthosis which decreases her lumbar lordosis considerably and serves to eliminate her sciatic-nerve root pain completely. This patient later came to spine fusion, and the same orthosis was used for her ambulatory postoperative management.

Case No. 5: N.H. is a 16-year-old girl with muscular dystrophy, who experienced low-back pain as a result of excessive lumbar lordosis. Figure 11 shows the degree of lordosis in the standing position. Figure 12 shows the patient fitted with a polypropylene flexion jacket which eliminated her low-back discomfort. In this particular case, the lordosis had to be controlled rather than eliminated because it was essential to her standing balance and ambulation.

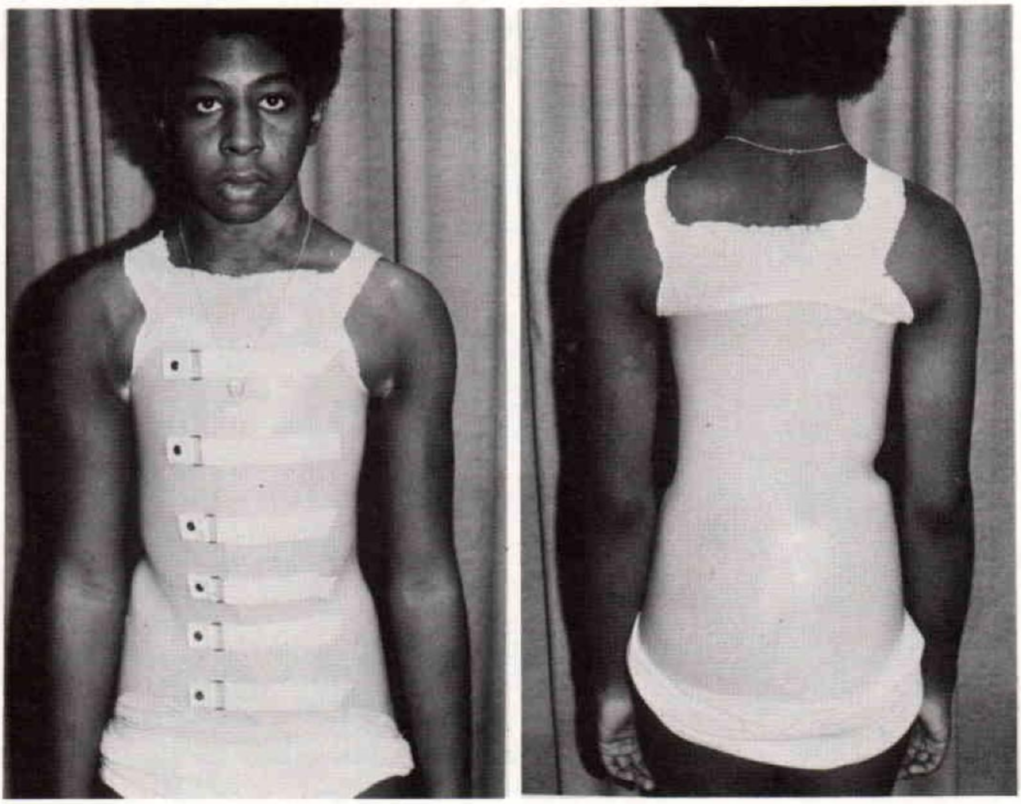

Fig. 6. Case No. 2.

Fig. 7. Case No. 3 without scoliosis jacket.

Fig. 8. Case No. 3 wearing scoliosis jacket fashioned from polypropylene.

Fig. 9. Case No. 4 without correction.

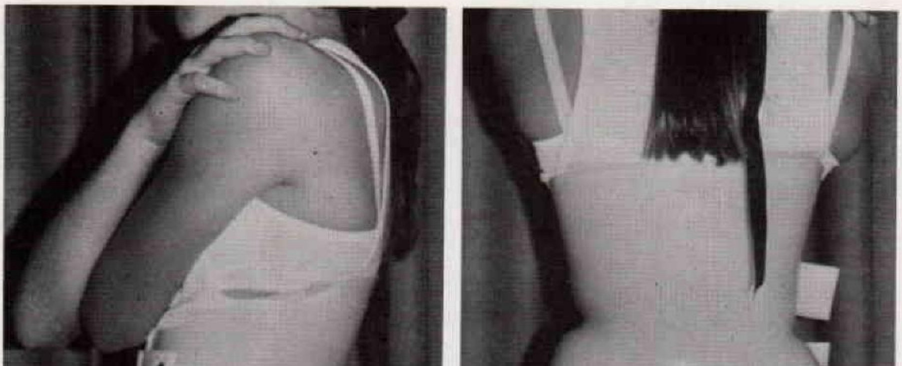

Fig. 10. Case No. 4 wearing a flexion orthosis fashioned from polypropylene.

Fig. 11. Case No. 5 without correction

Fig. 12. Case No. 5 wearing a flexion orthosis fashioned from polypropylene.

SUMMARY

Polypropylene has proven to be an excellent material for use in certain spinal orthotic designs. To date, it has been used for the pelvic girdle of the Milwaukee Brace, for scoliosis jackets, and for flexion jackets. It is useful for the nonoperative management of spinal deformity as well as for postoperative care. Light weight, comfort, superior durability, and relative ease of fabrication are all highly desirable features of this material.

REFERENCE

1. Blount, Walter P., and John H. Moe, *The Milwaukee Brace*. Williams and Wilkins, Baltimore, 1973.