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The Polypropylene Single-Hip Spica

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The polypropylene hip spica described here is a marriage of former orthotic designs (1) (Fig.1) coupled with more recent polypropylene technology. A number of practitioners have used this design in the last couple of years (12, 13). Because the costs of the finished plastic hip spica are high, its application needs to be limited to those patients that can make proper use of it.

Description

The hip spica orthosis consists of a two-piece plastic shell design (Fig. 2). The upper shell features a girdle with its proximal border high on the contralateral side to the xiphoid level and just above the iliac crest on the ipsilateral side. The girdle is contiguous with the thigh section which extends distally to mid-knee of the affected leg. The one-piece shank/ankle shell (2) is of the familiar posterior leaf-spring design (Fig. 2). Aluminum fracture-cast type of polycentric knee joints[2] are used. Finally, both upper and lower shells employ anterior openings with flexible polyethylene tongues secured with Velcro closures.

Fig. 1. Dollinger brace, circa 1880. From *Atlas of Orthopaedic Appliances*.

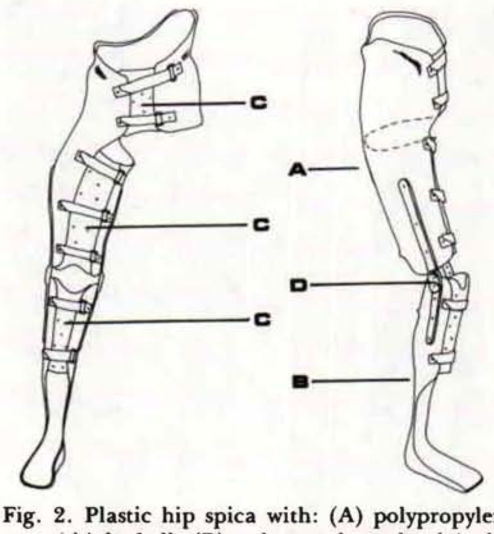


Fig. 2. Plastic hip spica with: (A) polypropylene torso/thigh shell; (B) polypropylene shank/ankle shell; (C) anterior polyethylene tongues at abdomen, thigh, pre-tibia, and (D) aluminum fracture cast polycentric knee joints.

The orthosis immobilizes the patient's hip in an attitude of abduction and slight flexion. Knee motion is free, whereas plantar flexion and dorsification are restricted.

Case Report

TMD is a 19-year-old black female with a history of sickle cell anemia. She sustained a transverse fracture of her right proximal femur (Figs. 3A and 3B). Osteomyelitis (Salmonella B and Myco fortuitum) had been confirmed by open biopsy prior to the fracture. She presented a 14 cm draining incision on her lateral right thigh (Fig. 4). Following three weeks of ten-pound traction with a tibial Steinmann pin, a plaster hip spica was applied. The wound required repacking daily and debridement weekly.

Application and removal of the spica cast on a bi-weekly basis was arduous and management of the draining would through the windowed cast could only be

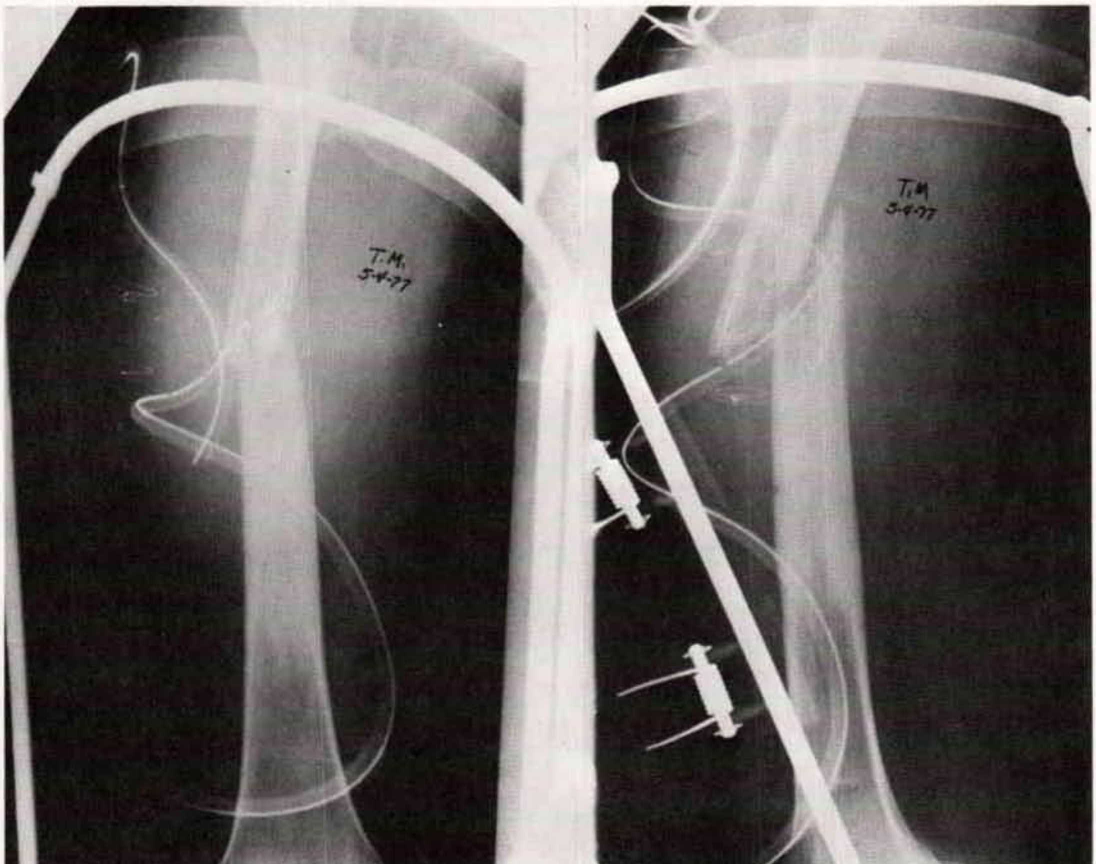


Fig. 3A. A – P view of right proximal ⅓ femoral fracture. Patient was x-rayed while in balanced traction.
Fig. 3B. Lateral view presents fractured femur with evidence of osteomyelitis at fracture site.

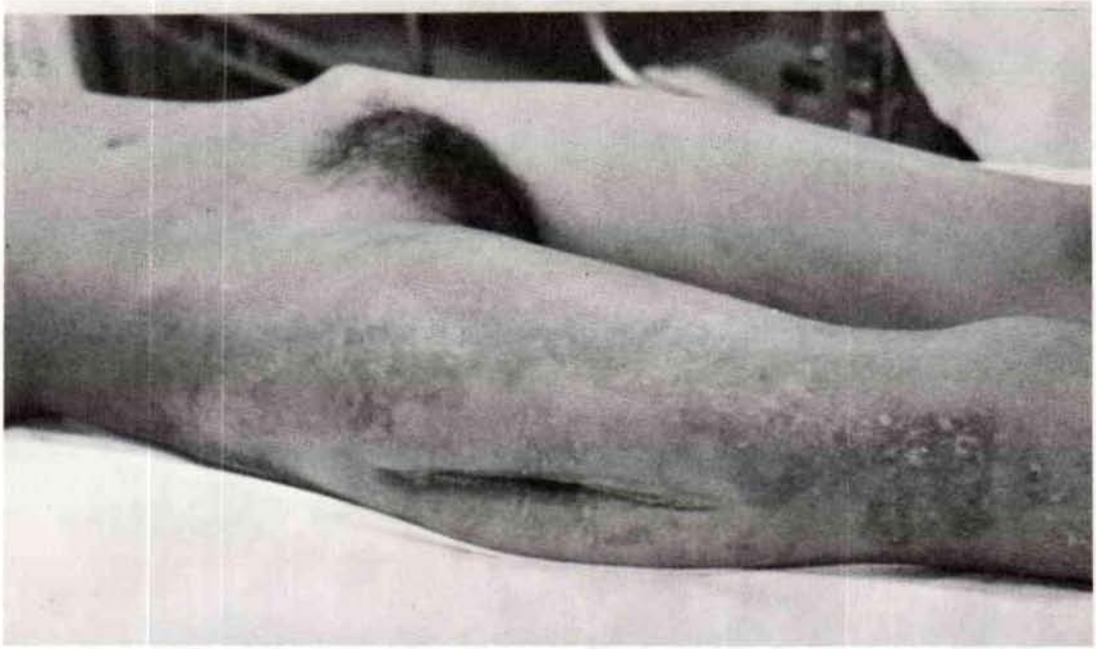


Fig. 4. The draining 14-cm long incision on patient's right lateral thigh at site of osteomyelitis and fracture.

less than optimal. One month after the first cast application, an orthotic design was requested that would be removable and washable so as to augment wound care while assuring maintenance of alignment.

Experience

The results of our first fitting of the plastic hip spica orthosis were quite pleasing. The patient's spirits brightened because of the greater mobility possible with the lightweight design (Figs. 5-9). Wound management was successfully facilitated (Figs. 10 and 11) with the orthosis, and the patient's hospital stay was shortened. Generous callous and control of the infection is apparent on X-ray (Figs. 12A and 12B) six weeks following fitting with the orthosis.

Casting

To obtain an impression for the polypropylene hip spica, the patient was placed supine[4] on a Stryker fracture table (7)(Fig. 13A) with both feet secured to the stirrups. A generous dry dressing was placed over the wound by the physician. The patient's abdomen and involved leg were wrapped with bias stockinette because application of the tubular stockinette was not feasible.

After suprailiac traction similar to the Risser casting approach (8) was established, the following landmarks were identified with a transfer pencil: anterior superior iliac spines, medial tibial plateau, pubis, and lower border of the breasts. Then measurements were taken of the following: ASIS-to-MTP and MTP-to-base of heel. A cast removal strip was applied anteriorly.

Fig. 5. Ant. view of patient wearing the plastic hip spica. Note that although patient is standing with her feet together, her right hip is actually abducted 15 deg.

Fig. 6. Anterior view of patient showing more detail.

Care was taken to assure that during the casting the ipsilateral hip was held in the position the physician requested, namely, 15° abduction and 15° flexion. The knee was maintained in extension and the ankle was kept in neutral.

To obtain a negative model, wrapping began with the abdomen and proceeded distally to the knee center. After a brief period to allow the plaster to set, the upper cast impression was removed. Meanwhile, the patient's right foot was freed and held with manual traction while the cast impression was taken of the lower leg, beginning with the knee center and

Fig. 7. Ipsilateral side, lateral view. Hip is flexed 15 deg for comfortable sitting. But because hip is flexed, knee must also be flexed for erect standing. A shoe with a heel wedge is indicated.

Fig. 8. Contralateral side, lateral view. Proximal trim is at xiphoid level. Distal trim is 2 in. above pubic level.

Fig. 9. Posterior view. Since patient complained of occasional pinching of right buttock, trim should be located more laterally for comfortable sitting.

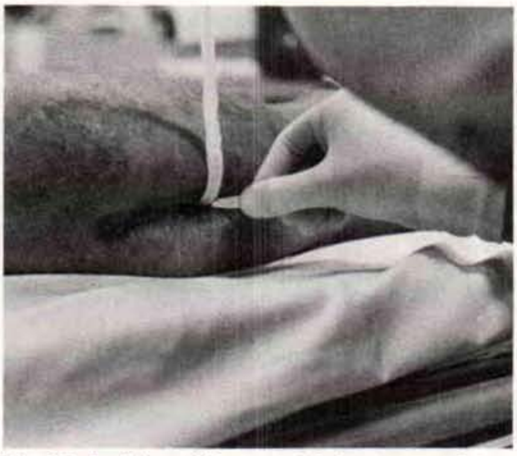


Fig. 10. Packing of the wound following careful removal of orthosis.

proceeding distally. Thus, the negative model was obtained in two sections (Fig. 13B). This facilitated its removal and permitted the physicians to more quickly begin reapplying a walking spica cast which was to be worn until the orthosis could be made and fitted.

Cast Modification

Positive model modification of the torso is similar to that of the Milwaukee cast. Following removal of the negative mold from the positive model (Fig. 14), the bony landmarks are re-identified. Plaster is added to the postero-lateral lumbar areas to provide symmetrically relief of muscle attachment at the iliac crests.

Anteriorly, the positive mold is modified, while the pelvis is maintained in a symmetrical position. Plaster is cut away to create a groove in the waistline to "provide a comfortable purchase on the soft tissues over the pelvis" (3), and to accommodate fulcrum action of the orthosis (Fig. 15). The iliac crests and the anterior

Fig. 11. After application of a dry dressing, bias stockinet is wrapped on leg to absorb any perspiration in the orthosis.

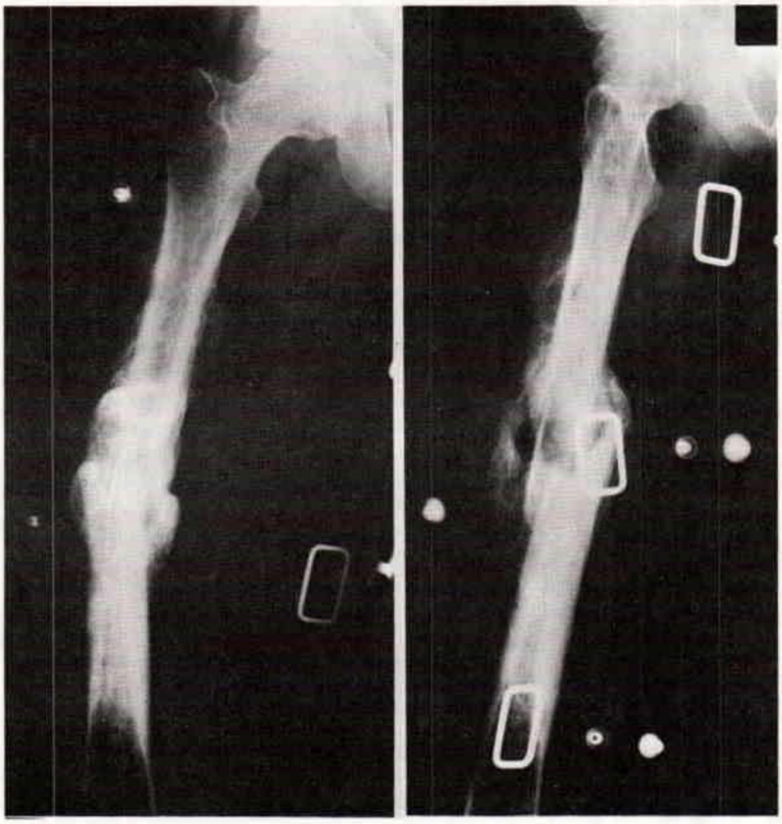
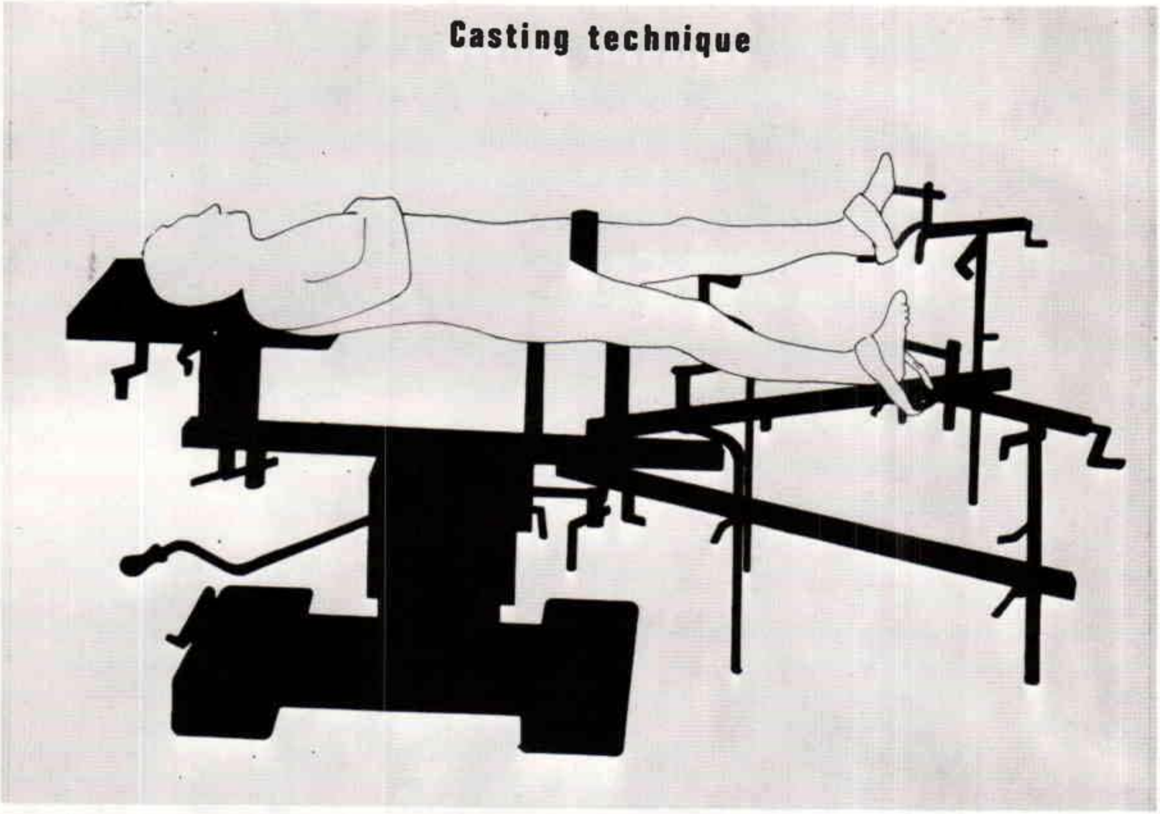


Fig. 12A. A-P view of fracture 6 weeks after fitting with the orthosis, 14 weeks post-injury. Note generous callous formation. Some varus angulation was accepted. Fig. 12B. Lateral view.



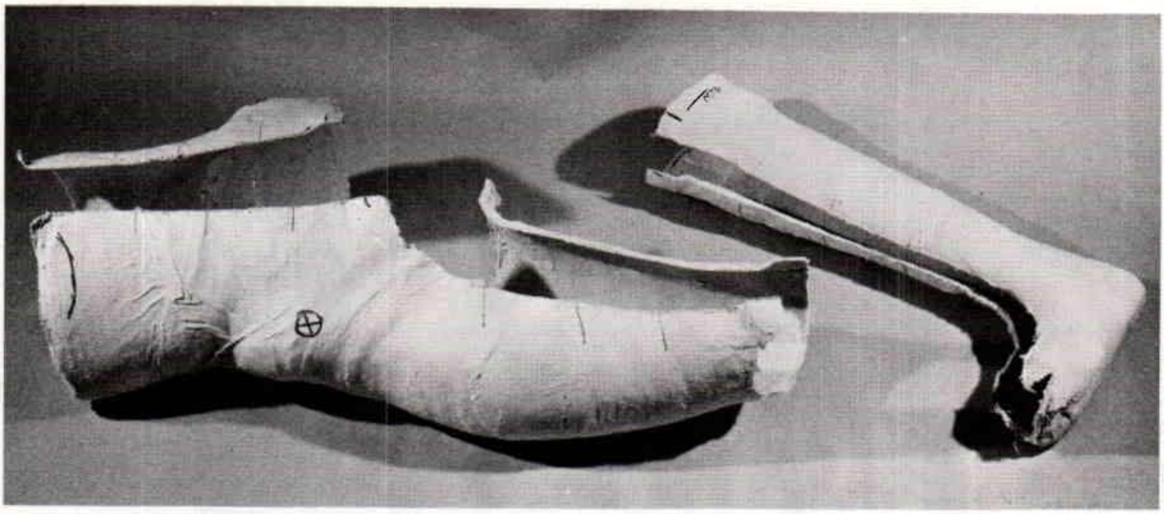


Fig. 13A. Patient is positioned on fracture table while the negative model is obtained. The fracture table shown above is the same as those commonly used in orthopedics for applying a conventional plaster hip spica. Fig. 13B. Negative model following removal from patient. Model was taken in upper and lower sections and the two sections were referenced to each other.

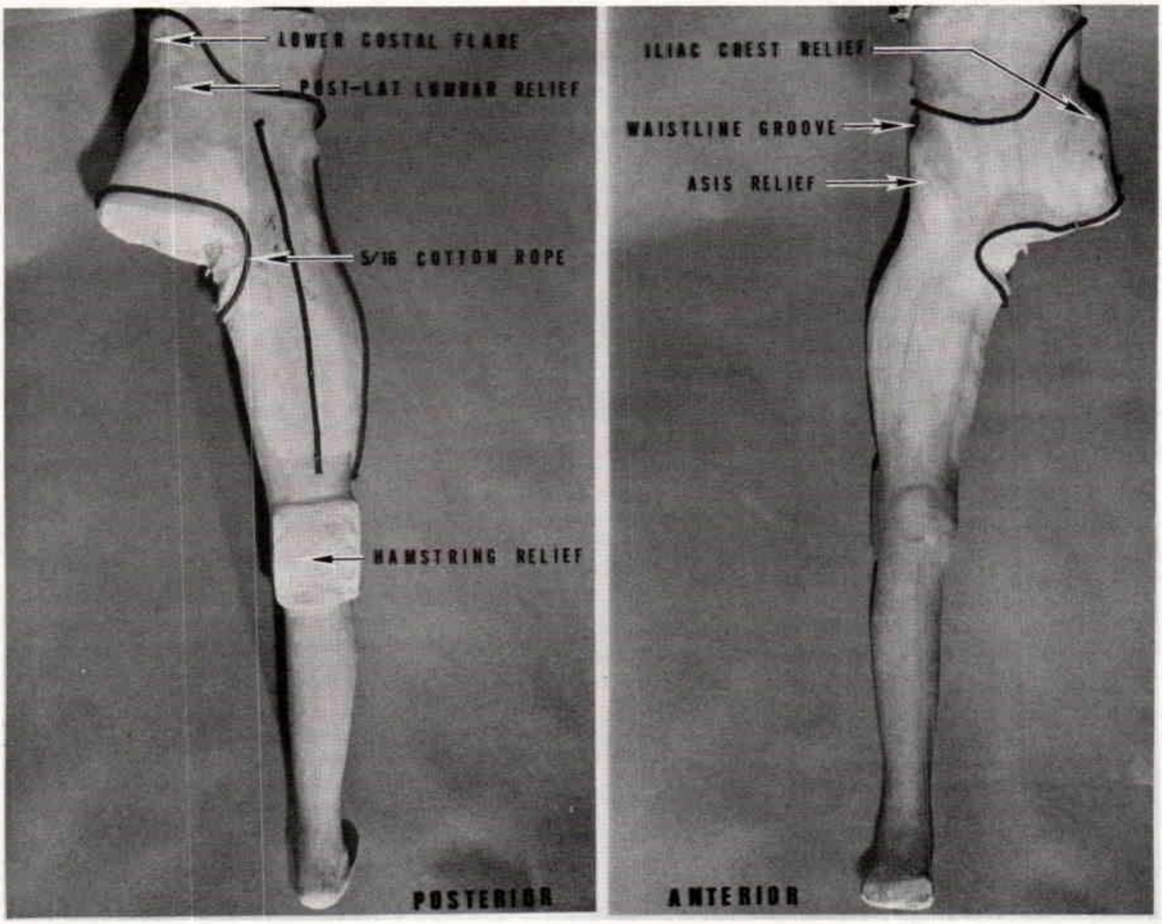


Fig. 14. Positive model modifications. Cotton rope (dyed for photographic contrast) provided a continuous flare of torso trim lines. The rope is also used on the posterior and lateral thigh to create corrugations for added strength.

superior spines are built up with a ¼-inch plaster relief which continues anteriorly and distally to the pubic level (Fig. 14). A flared plaster build-up is added just above the waistline groove to prevent impingement on the lower costal margin. Finally, provision for comfortable flexed-knee sitting is made by adding hamstring reliefs on the posterior knee area. Nylon-core cotton rope 5/16-inch in diameter nailed to the cast serves as an ideal method for providing a continuous flare at the torso trim lines, both proximally and distally. Moreover, the rope is used along the posterior aspect of the thigh and buttocks area to create corrugations in the plastic to provide additional resistance to buckling.

Fabrication

The initial stage of fabrication includes the construction of the anterior

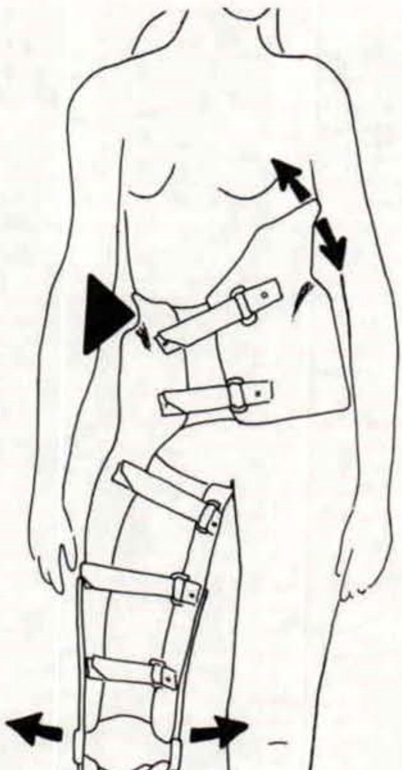


Fig. 15. The waistline grooves are recommended to prevent irritation of iliac crests due to any slight mediolateral fulcrum action of the orthosis.

tongues. Recommended is 1/16-inch polyethylene heated to 285°F and molded over the cast. The material is stretched completely around the cast and sealed to itself to assure good conformity to the patient's contours.

The fabrication of the lower polypropylene is at 410°F under vacuum in the usual manner (2) (11).

Molding polypropylene over the upper section, however, is far more difficult. The standard drape-molding technique for stretching an undersized piece of polypropylene over a large, irregular cast was repeatedly unsuccessful. The polypropylene could not be stretched sufficiently. To solve this problem, four pieces of aluminum angle stock were clamped together with the plastic sandwiched between (Fig. 16). These bars, fastened on the two long sides of the plastic, provided the fabricators with a means (Fig. 17) of stretching the polypropylene uniformly.[5] Just after sealing the polypropylene to itself, the bars were cut free from the molten plastic to avoid hindering the molding process. To compensate for the stretching of the plastic during molding, thicker polypropylene 3/16-inch thick was used.

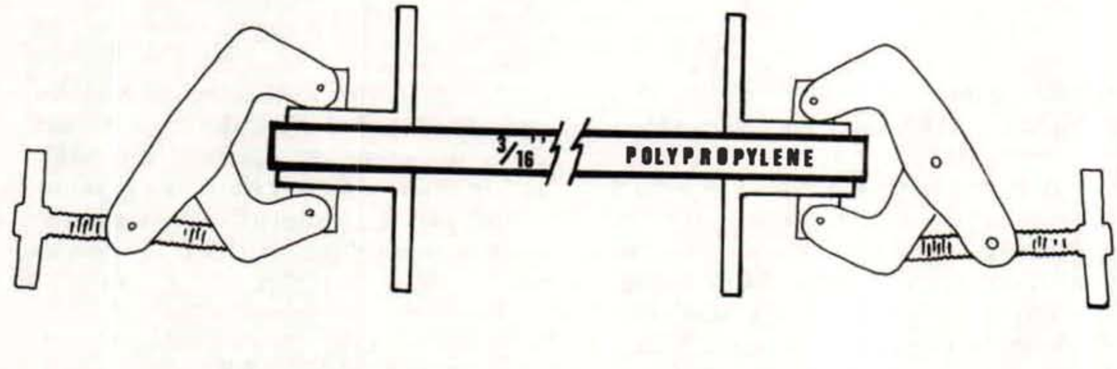


Fig. 16. Prior to heating the pastic in the oven, two pieces of angle aluminum are clamped together with the polypropylene sandwiched between on each long edge of the plastic.

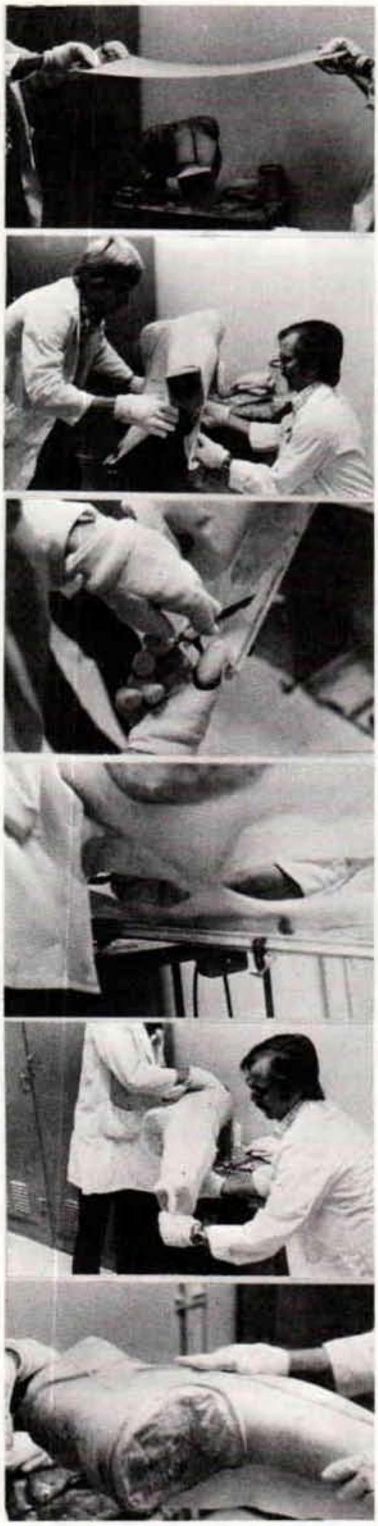


Fig. 17. Fabrication series, from top to bottom, illustrates: stretching of the plastic, drawing it around the cast, trimming the angle aluminum free, sealing the plastic, and finally obtaining vacuum.

Assembly

The polypropylene shells were trimmed and replaced on the positive model. Polycentric knee joints were aligned, contoured and riveted to the shells. The anterior tongues were trimmed and secured in position. Finally, Dacron-backed Velcro closures were attached to the finished orthosis (Figs. 18-20).

Special Considerations

The patient found it impossible to don a shoe independently on her affected side, owing to a very stiff knee initially, and to the fact that ipsilateral hip motion was prevented by the orthosis.

Alternate designs for the polypropylene hip spica orthosis have been used by Irons (6), Donaldson (4) and Voner (10). Specifically, one variation of the design described merely consisted of a "mini-spica" without the lower shell and knee joints (Fig. 21). In another case, the shank section *was* employed but using a polypropylene tibial fracture orthosis design that immobilized the lower leg and prevented rotational movements in the ankle. The latter effectively blocks ankle motion—a feature that our design at UCLA did not include. Furthermore, Irons et al. also report fabricating the plastic "mini-spica" orthosis from another patient's positive model that, with some modification, provided adequate fit and alignment of the bony segments. The casting procedure was thereby eliminated in that instance.

Fig. 18. Anterior view of completed orthosis.

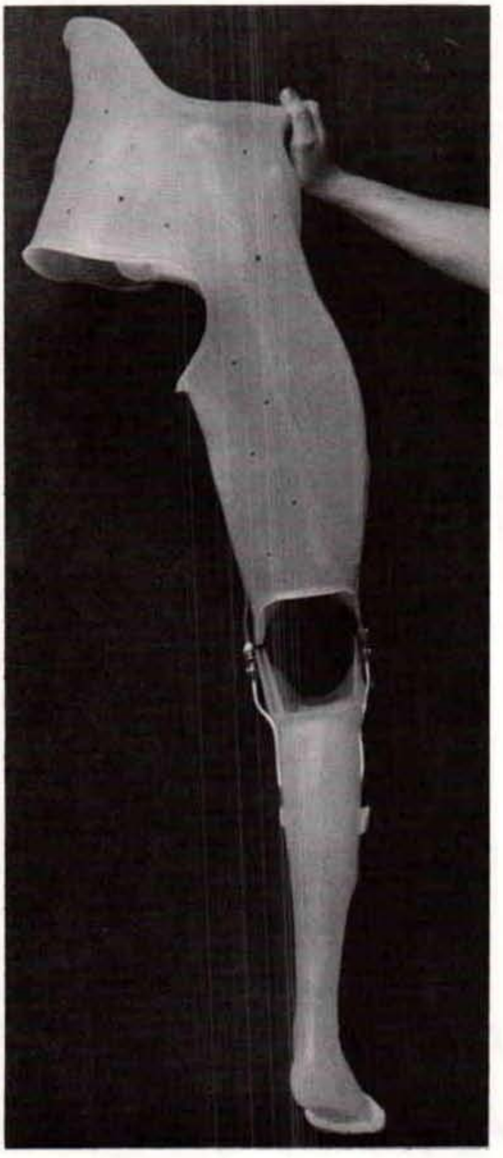


Fig. 19. Lateral view of completed orthosis.

Other Applications

Obvious uses of the plastic hip spica are numerous. Besides that of treating delayed union of proximal femoral fractures, other indications might include long term post-operative immobilization following hip fusion, and unstable hip arthroplasty. The "mini-spica" can be used to support the inflamed arthritic hip and thereby relieve pain (7). Older, debilitated patients, especially, can benefit from the lightweight feature of the orthosis and thus avoid disuse-osteoporosis.

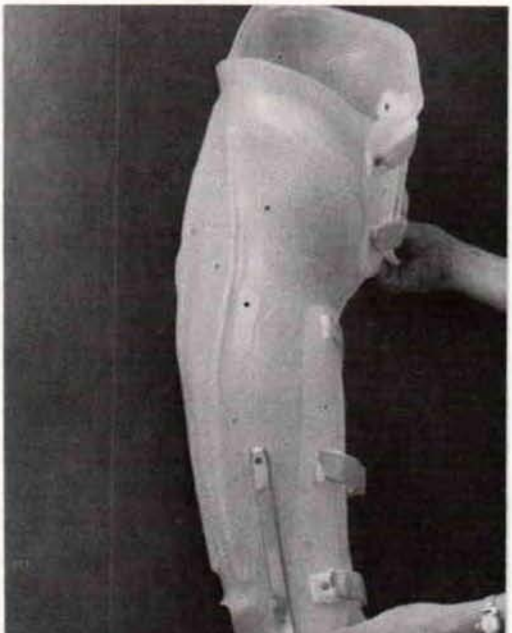


Fig. 20. Posterior view of completed orthosis.

Conclusion

A polypropylene single hip spica offers the patient and the physician many advantages. In certain cases, treatment with the orthosis is not only more convenient but far superior.

Summary

A molded single hip spica has been described. Its special features of being removable and washable were cited. Use of the plastic spica has been reported on a patient with a proximal femoral fracture, osteomyelitis and draining wound. All stages of the fabrication sequence were detailed. Variations of the design have been mentioned. A special drape-molding technique used in the fabrication has been introduced.

Acknowledgment

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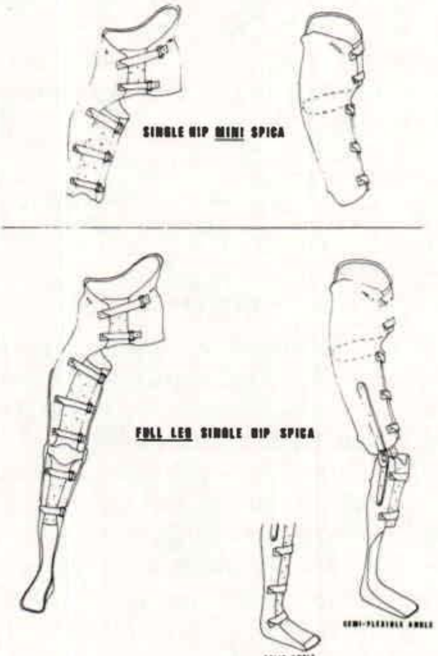

Fig. 21. The three variations of the polypropylene single hip spica orthosis.

Footnotes

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[2]United States Manufacturing, Glendale, California

[3]Slight hip flexion is advisable to provide comfort while the patient is sitting.

[4]Certain patient conditions may permit casting of the patient while the patient is standing (5).

[5]This special technique has proven to be indispensible in drape-molding items such as large body jackets where the circumferential dimension is appreciably greater than the size of plastic sheet the oven can accommodate.

[6]Assistant Professor, Division of Orthopedic Surgery, School of Medicine, University of California at Los Angeles.

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