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# Knee Cylinder

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For a variety of reasons it is not uncommon to wish to hold the knee firmly in a position of maximum extension for an extended period of time. This may occur following surgery or after reduction of a severe flexion contracture. One way of doing this is to apply a plaster-of-Paris knee cylinder. In some instances a more attractive alternative, though, is the use of a thermoplastic knee cylinder, because it is lighter, more durable, easier to keep clean, and it can be removed periodically for skin care and therapy to the knee.

In some instances a knee orthosis of more conventional design, including knee joints and plastic shells, may be considered, but there are a number of factors that may weigh against its use. Unless the foot is to be included, suspension must come from points above the knee, mechanical joints are required, and the posterior opening necessary to permit flexion makes it difficult to obtain adequate suspension and rotary stabilization. The presence of an anterior opening about the bony prominences of the knee makes it difficult to control properly the pressure that must be distributed in this area to prevent flexion.

Spasticity in its severer forms not only makes it difficult to control pressure about all edges of the orthosis, but makes it difficult to lock the joints of the orthosis and keep them locked. In such cases a knee cylinder that totally encloses the knee will not only prove to be safer and more comfortable, but also will prove to be more effective. Lastly, the possibility of "window edema" about the openings of the knee cannot be overlooked.

## Orthosis Design

The orthosis (Figs. 1 and 2) consists of anterior and posterior sections that overlap medially and laterally and extend distally to about two inches proximal of the medial malleolus and proximally to a point about one inch distal of the ischial tuberosity. The proximal and distal edges should be rounded outward so as to avoid excessive pressure in these areas. Anteriorly directed forces will be created in the posterior proximal and distal areas and appropriate material should be removed to facilitate this. The posterior section should be of polypropylene to provide the stiffness necessary. The anterior section can be made of either polypropylene or polyethylene, and it can be padded, if desired, with closed cell polyethylene foam during the fabrication procedure.

About the knee, modification is best

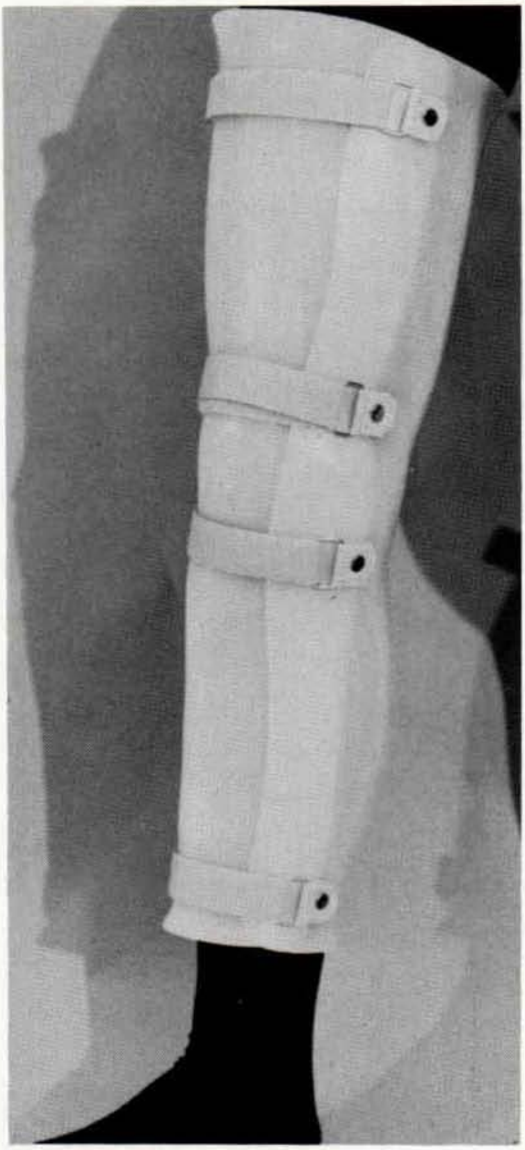

Fig. 1. Antero-medial view of the knee cylinder.

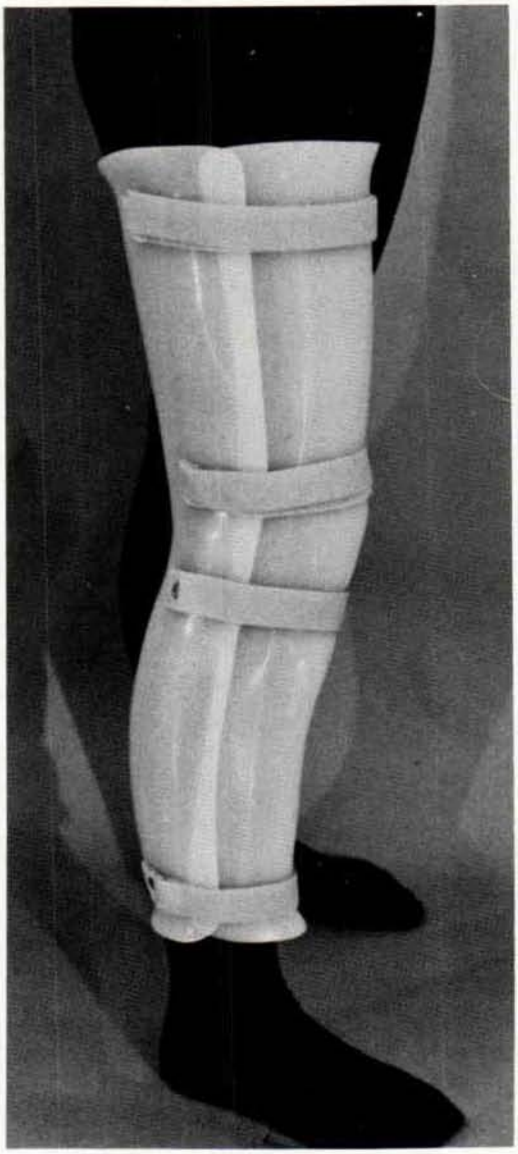

Fig. 2. Lateral view of the knee cylinder.

thought of as for a suprapatellar/supracondylar PTB prosthesis (Figs. 3 and 4). Material will be removed medially and laterally proximal to the bony structures of the knee to provide suspension, and, similarly, material should be removed from over the medial tibial plateau to "lock in" the orthosis and prevent pistoning. The posteriorly directed corrective force will be distributed over the quadriceps tendon, the patellar tendon, and to both sides of the tibial crest distal to the tibial condyles. Appropriate relief will be added over the patella, adductor tuber-

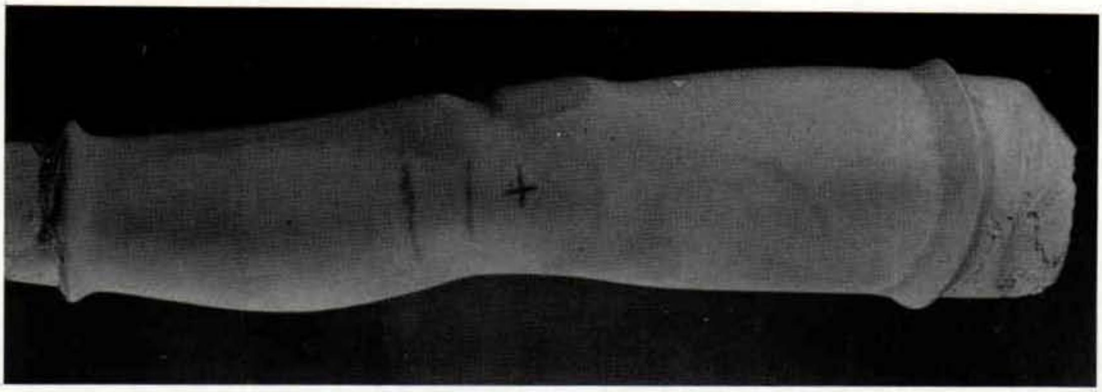

Fig. 3. Medial view of modified model showing proximal and distal buildups for flares, as well as the modification of the knee.

cle, lateral femoral condyle (if necessary), tibial tubercle, tibial condyles (if necessary), tibial crest, and fibular head. In addition, relief can be made posteriorly about the knee.

Four Velcro straps (Figs. 1 and 2) are attached to the anterior sections, two about the knee, one proximally and one distally. In applying the orthosis the strap immediately proximal to the knee should be fastened so that the orthosis settles into place properly relative to the bony prominences of the knee, and so that correct suspension is obtained. The strap immediately distal to the knee should then be fastened followed by the other two straps. Once all four are fastened, each strap should be readjusted individually in the same order to obtain maximum correction and proper pressure distribution. Once this is done the orthosis should be grasped about the knee and moved proximally and distally, and rotated from side to side. If the orthosis fits properly and has been applied properly, there should be no discernible motion between the orthosis and the skin and the two should move as one over the underlying bones. It is intended that the orthosis will be worn over a length of stockinet or hose, as is the case for all such orthoses.

## Casting

The patient is positioned supine on the edge of the table or bed with the limb

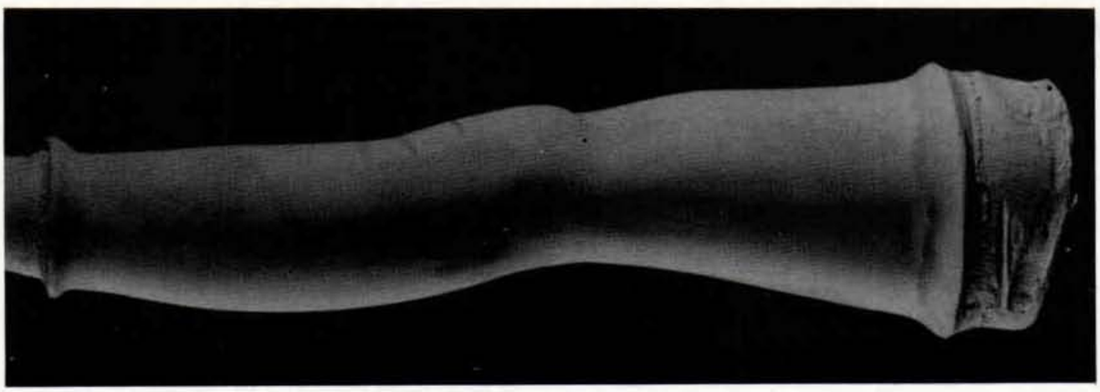

Fig. 4. Posterior view of modified model showing indentation proximal to the adductor tubercle.

Fig. 5. Antero-lateral view of the patient's knee showing the bony prominences outlined with indelible pencil.

supported by the assistant holding it about the ankle. The procedure should be explained to the patient to reassure him and elicit his cooperation and the orthotist and his assistant should practice the procedure and position with him. The assistant will provide firm sustained traction distally while the orthotist molds the contours about the knee for suspension and pressure distribution, and holds the knee in a position of maximum extension. Firm traction held over sustained periods will relax the muscles, thus facilitating correction. To prevent clonus, sudden and jerky movements of the knee should be avoided.

Cotton stockinet is applied to the leg from the ankle to the groin. A plastic tube or webbing is positioned underneath it for protection of the patient during subsequent removal of the cast. Some prefer to position this directly over the tibial crest on the theory that relief will be added here later while others prefer to position the tube in other more fleshy areas where the contours are less critical. Indelible pencil is used to mark the bony prominences of the knee (Figs. 5 and 6) and the proximal and distal edges. Some modifications can be avoided if felt strips, skived on one edge, can be positioned under the stockinet at the proximal and distal edges to facilitate formation of the radii later. The limb is wrapped with elastic plaster-of-Paris bandage and reinforced with rigid bandage. While the bandage sets, the orthotist and assistant hold the knee in extension and mold the contours as rehearsed (Fig. 7). Careful attention to detail at this point will save considerable trouble in subsequent modification of the positive model. Once set, the cast is split, removed (Fig. 8), closed, and filled with plaster of Paris.

Fig. 6. Antero-medial view of the patient's knee showing the bone.

Fig. 7. Cast on the patient, after it has hardened, showing the plastic tube anteriorly and strong finger indentations laterally.

Fig. 8. Medial view of the cast once it has been removed from the patient showing indentation proximal to the adductor tubercle.

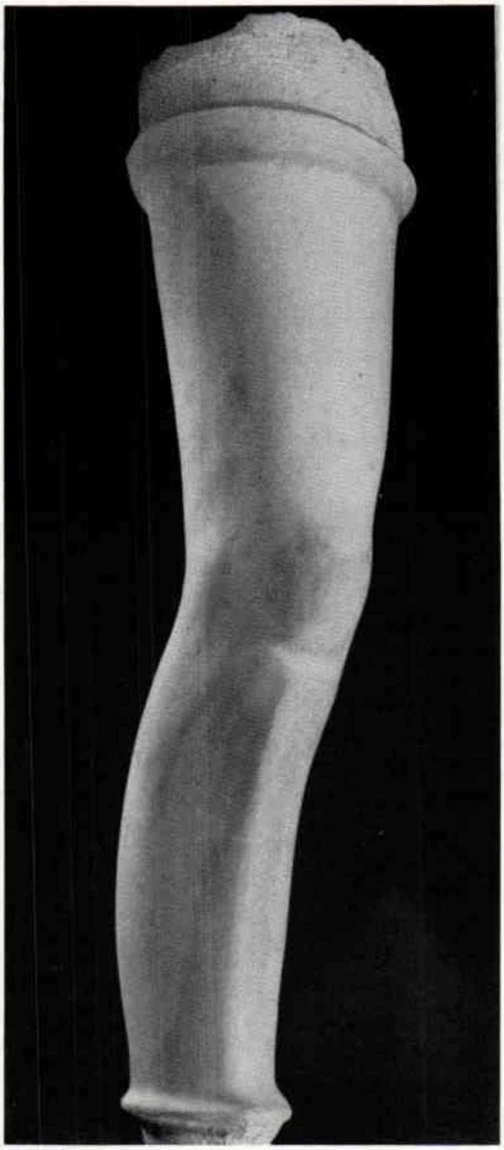

Fig. 9. Positive model ready for forming of orthosis.

## Fabrication

The positive model is smoothed up overall, modified as necessary for correction and suspension, and appropriate reliefs added (Fig. 9). Once the model is modified and smoothed it is dried and a nylon hose added for vacuum forming of the posterior section (Fig. 10), which can be done either by hand draping or in conjunction with a frame and platen. This is most commonly made with polypropylene, but in the absence of spasticity and in the presence of edematous changes it can be made with polyethylene for addi-

Fig. 10. Posterior section of the orthosis once it has been vacuum formed, trimmed, smoothed, and reapplied to the model for vacuum-forming of the anterior section.

Fig. 11. Anterior section vacuum formed, trimmed, and reassembled on the model with the posterior section.

tional circumferential flexibility. Padding can be added to the posterior section as well as to the anterior section if desired, but it must be borne in mind that padding makes an orthosis even warmer than it is without it. Once the posterior section has cooled and been trimmed, the anterior section is fabricated in a similar

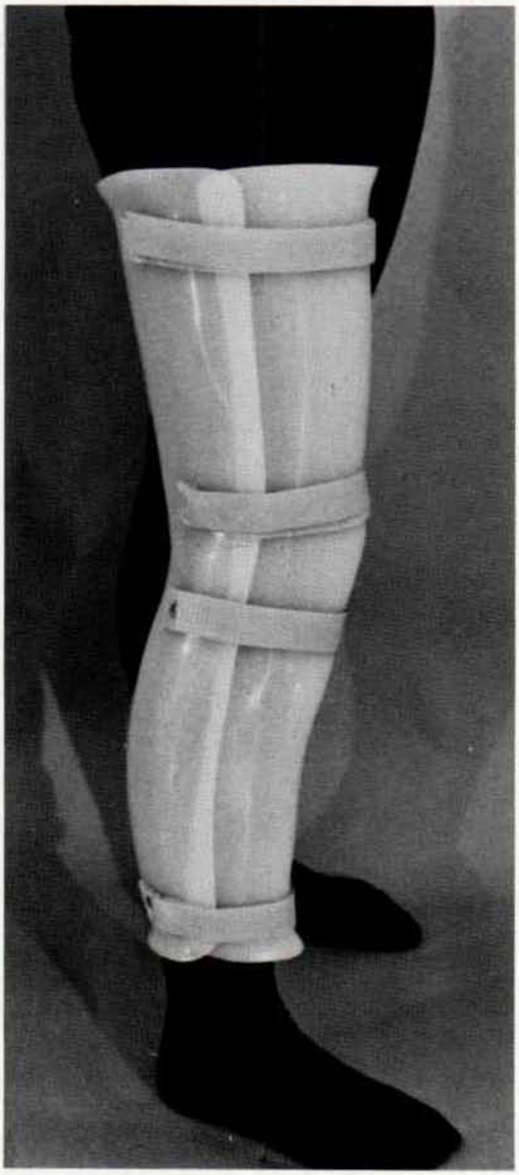

Fig. 12. Completed orthosis on the patient.

fashion (Fig. 11). Finishing of the orthosis proceeds in the usual way (Fig. 12). No specific instructions are given here for modification of the positive model or fabrication of the orthosis as it is believed that adherence to the design philosophy given earlier and general fabrication procedures described elsewhere, will prove sufficient and avoid needless time-consuming and condescending repetition of basic instructions. Attention in particular is drawn to *Lower-Limb Orthotics* (1).

**Summary**

Considerations for the prescription and design of a thermoplastic bivalved knee cylinder orthosis are given. In addition, the casting procedure is described and some general instructions for the fabrication of the orthosis are given.

**Footnotes**

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**References**

(1) Wilson, A. Bennett, Jr., David Condie, Charles H. Pritham, and Melvin Stills, *Lower-limb orthotics: a Manual.* First edition, Rehabilitation Engineering Center, Moss Rehabilitation Hospital, Temple University, Drexel University, 1978.