Technical Article

New Concepts in Post-Operative Scoliosis Management

by Robert D. Fitch, M.D.
Carrie Louise Beets, C.O.

As improved surgical techniques and stronger spinal instrumentation are developed, the need for external stabilization post-operatively and the design of post-operative orthotics have also evolved. The purpose of this article is to review the many recent advances in the surgical technique and spinal instrumentation, and the early results of a new management protocol (both surgical and orthotic) in the treatment of selected spinal deformities.

EVOLUTION OF SPINAL STABILIZATION

The goal in the surgical treatment of scoliosis is to correct the deformity and maintain correction until fusion of the spine occurs. It is the surgical technique of fusion that provides long term spinal stability. Until the fusion mass matures, we must rely on stability provided through surgical instrumentation (internal support) and casts or orthoses (external support). If the spine is not stabilized sufficiently internally and externally, then a non-union of the spine will occur similar to that which occurs with inadequate immobilization of long bone fractures. Once a non-union develops, the deformity may gradually recur.

Prior to the advent of the Harrington rod, correction of the spinal deformity was obtained through complicated casting techniques. Risser described the turnbuckle in 1927[6] (Figure 1). Later he developed the localizer cast.[5] A cast technique similar to this was perfected by Dr. Cotrel of France[1] (Figures 2 and 3). These casting techniques allowed correction of the deformity in the cast. The spine was then operated upon in the corrected position through the cast and the patient was maintained in a cast post-operatively for a period of nine to 12 months. With this form of treatment, there was a high incidence of failure, primarily due to the development of cast complications, or pseudoarthroses.[4] Many surgeons advocated routine exploration of the fusion mass six months post-operatively to identify any areas of non-union.

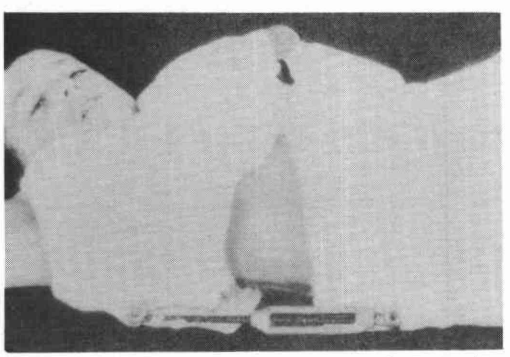


Figure 1. Turnbuckle cast as devised by Risser. Patient had to remain in bed for six months. (Photo reproduced with permission from *Scoliosis* by J.I.P. James, Williams & Wilkins Publishers, 1967.)

In 1960, Paul Harrington reported on the use of a stainless steel distraction rod for the correction and stabilization of spinal deformities.[2] The Harrington device has since become the mainstay of surgical treatment for scoliosis. It has shown to be of great benefit in experienced hands and has shortened hospitalization time, avoided the need for preoperative correction with casting, permitted early mobilization of

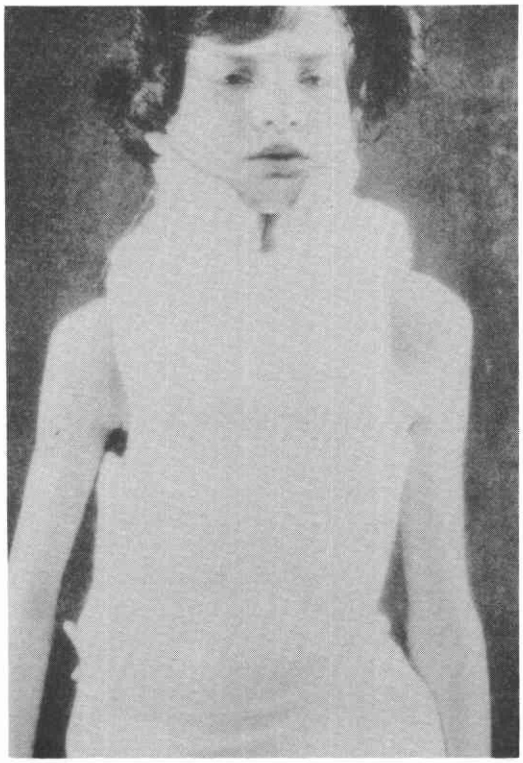


Figure 2. Localizer cast which extends up over the occiput and mandible. (Photo reproduced with permission from *Scoliosis*, ibid.)

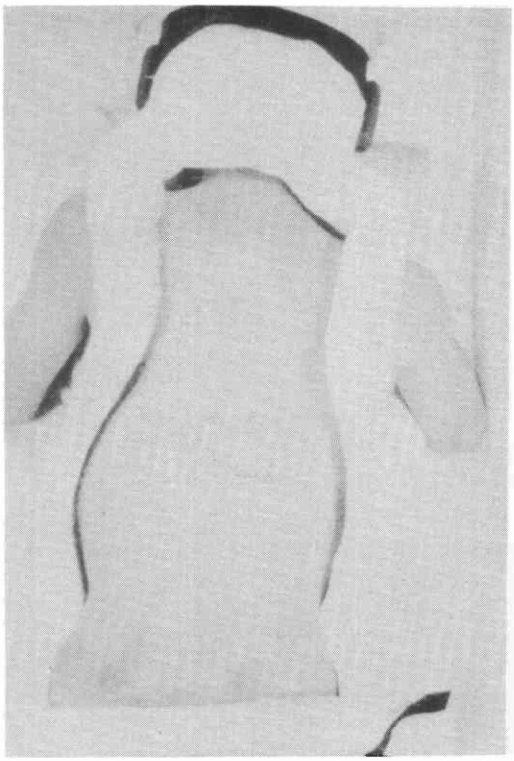


Figure 3. Posterior view of localizer cast showing window through which surgery was performed. (Photo reproduced with permission from *Scoliosis*, ibid.)

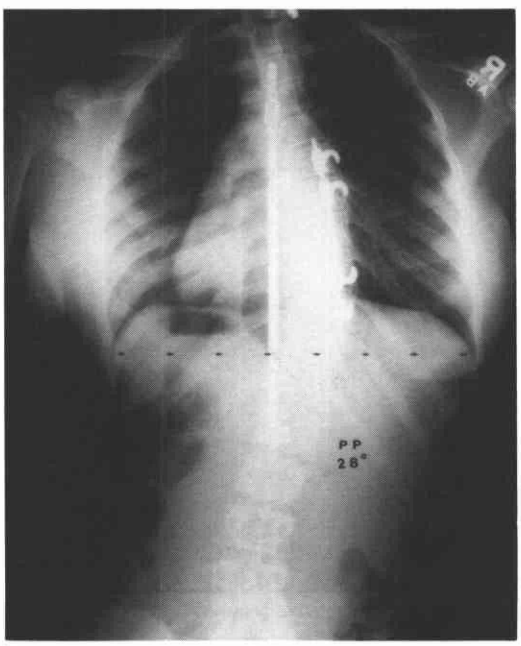


Figure 4. X-ray showing Harrington rod system.

Figure 5. X-ray showing Luque rod instrumentation.

the patient in a well-fitted cast or orthosis, and has markedly decreased the pseudoarthrosis rate following fusion. What it has not accomplished, however, is the ability to provide sufficient internal stabilization to allow the abandonment of external support either by cast or orthosis.

There are many instances in which external immobilization is undesirable. These include patients with insensitive skin, spasticity, or respiratory compromise. During the early 1970's, Edwardo Luque, M.D. from Mexico City was faced with many complex spinal deformities similar to those just mentioned. This led him to develop a new form of spinal instrumentation called segmental spinal instrumentation.[3] Unlike the Harrington rod, which uses distraction forces and is fixed to the spine at the top and bottom so that all the forces are concentrated at the bone-hook interface superiorly and inferiorly, segmental instrumentation provides corrective forces in a transverse manner at each spinal segment and, therefore, the distribution of forces is spread out over the whole length of the instrumentation. This has been shown to be much stronger biomechanically than the Harrington system and is extremely stable[7] (Figures 4 and 5).

Segmental spinal instrumentation has become the preferred method of treatment of complex spinal deformities, especially those associated with neuromuscular conditions such as muscular dystrophy, myelodysplasia and cerebral palsy. However, it has not replaced the Harrington rod for the management of idiopathic scoliosis. This is primarily because of the added neurologic risk that is involved when performing segmental spinal instrumentation. Wires must be passed sublaminarly within the spinal canal at every level to perform this technique. The potential for neurologic complications is related to invasion of the spinal canal with these wires and the potential for vascular compromise to the cord by correction of the deformity, which leads to elongation of the spinal canal and vascular stretch.

It must be kept in mind that segmental spinal instrumentation does not take the place of a meticulous fusion, and if fusion does not occur, then instrumentation failure in inevitable. In general, patients who have been treated with segmental spinal instrumentation are not placed in any cast or orthosis post-operatively. This is based on the assumption that the Luque instrumentation is so strong that no external support is needed. However, recently some surgeons have questioned the requirement for external support even with Luque instrumentation. Although the early instrumentation failures have been solved with segmental spine instrumentation, some surgeons have found increased loss of correction over the first few months in patients not treated with orthoses, compared to those who have been treated with orthoses post-operatively. Also, the question of late pseudoarthroses must yet be resolved; and if there is a significant incidence of pseudoarthroses with Luque instrumentation, would post-operative orthotic support decrease this incidence?

Because of the added neurologic risk, we have opted not to use segmental instrumentation in dealing with most idiopathic spinal deformities. Rather, we continue to use the Harrington rod with some recent modifications. The modified Harrington rod provides enough internal stability to allow us to use a post-operative orthosis that is comfortable, convenient, and cosmetic. Added stability to the Harrington system has been achieved by a simple modification of the Harrington hooks. This was devised by Dr. Bobechko of Toronto. The new hook has a cam placed inside a slot which allows two hooks, rather than one hook, to be utilized at the upper level. Since most of the early instrumentation failures with Harrington rods have been with the cut-out of the upper hook, two hooks allow the forces to be distributed over a larger surface area, and when the technique is properly performed, corrects that problem. At the bottom end, a specially designed hook with a longer shoe is used to prevent dislodgement of the hook in this area, which can occur when the patient flexes forward.

With the degree of stability provided by this method, post-operative cast immobilization is unnecessary. In addition, currently available orthoses such as the Greenville spinal orthosis, the SOS modular orthosis, or the Milwaukee brace also provide more external support than we feel is necessary. This has led us to adopt the use of a posterior plastic shell with corset front and shoulder straps.

CURRENT MANAGEMENT PROTOCOL

This post-operative orthosis is used in two situations: (1) in the patient with idiopathic scoliosis who has undergone Harrington rod instrumentation with modified hooks as described above, and (2) in patients with more complex

spinal deformities who have had segmental instrumentation and are at risk for loss of correction or late pseudoarthrosis.

Our post-operative regimen consists of taking a mold at the time of surgery. The patient is then mobilized quickly beginning on the first post-operative day. The patient is allowed to stand at the bedside twice a day until the orthosis is ready and applied, usually on the third post-operative day. At that point, the patient is allowed to begin ambulation and sit with the orthosis on. Following discharge, the patient is allowed to doff the orthosis at night and once a day for showering. The orthosis is worn for four months post-operatively.

ORTHOSIS DESIGN

The posterior shell orthosis used at Duke University Medical Center is based on an orthosis design that was originally used at the Texas Scottish Rite Hospital for Crippled Children in Dallas, Texas. At the Scottish Rite Hospital a Surlyn® posterior shell, with a special order Camp corset front riveted to the shell, is used. It is cast and delivered post-operatively, or sometimes on an outpatient basis.

At Duke, the design was modified by the addition of shoulder straps for provision of an anti-rotatory movement reminder. The shoulder straps and the corset front are removable for easy laundering. The Duke protocol is for its use as an immediate post-operative orthotic device.

CASTING

The Department of Prosthetics and Orthotics at Duke University Medical Center has the advantage of being located on site. This permits close coordination with the physician and his operating room schedule. The dates for which an orthotist is needed in the operating room are known in advance, as well as the time and estimated length of surgery. The surgeon notifies the orthotist as the surgical team prepares to close the case. The orthotist arrives in the operating room while the case is being closed. Adequate time is available to set up splints and water, inspect operative x-rays, and confirm the length of the instrumentation (helpful in determining proximal trimline of orthosis).

Following closure of the surgical site, a small temporary sterile dressing is placed over the suture line for protection. The orthotist places a split piece of cotton stockingette over the patient's back and buttocks. Using an indelible pencil, the axillary and proximal trimlines are marked, C-7 is marked for reference, the waist and the gluteal fold and a horizontal line across the top of the gluteal fold are also marked (Figure 6). Six inch wide plaster splints, three layers thick, are applied lengthwise starting with the center back and overlapping towards both sides. Attention is paid to apply the plaster splints as far anteriorly on the patient as possible to make sure the cast impression has been taken to midline or just beyond. If a patient appears large busted or overweight, the sides of the impression can be compressed while the plaster is setting up (Figure 7). This will afford a truer M-L measurement for the patient when standing and sitting. The cast impression is removed (Figure 8) and the post-operative bandages are applied.

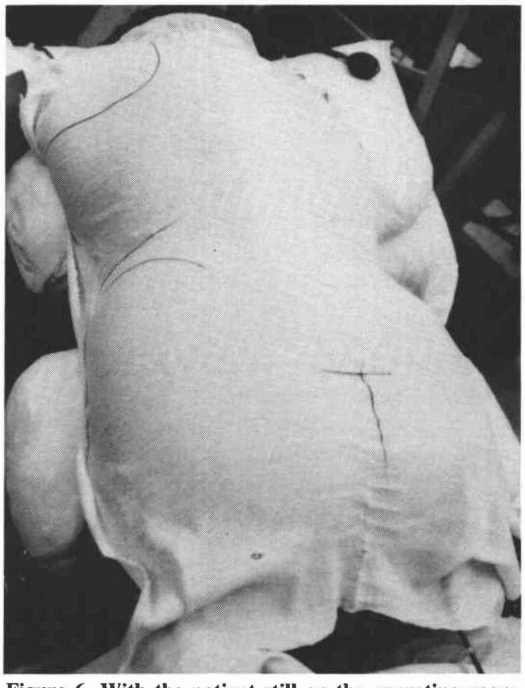


Figure 6. With the patient still on the operating room table, a split piece of stockinette is placed over the patient's back and landmarks and trimlines are marked.

FABRICATION

Any number of thermoplastics can be used to fabricate this orthosis, however, we have found Surlyn® to be sufficiently rigid and cos-

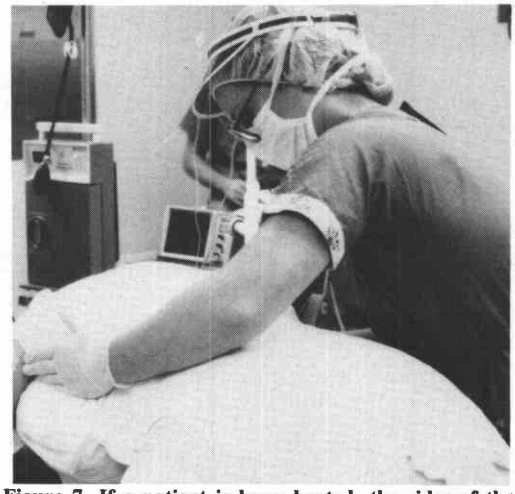


Figure 7. If a patient is large busted, the sides of the cast impression can be compressed while the plaster is setting, allowing a truer M-L dimension for when the patient will be sitting and standing.

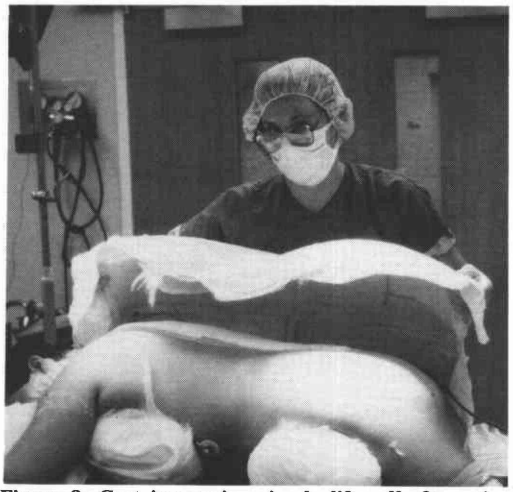


Figure 8. Cast impression simply lifts off. Operating room nurses replace temporary bandage, protecting the suture site with a regular post-op dressing.

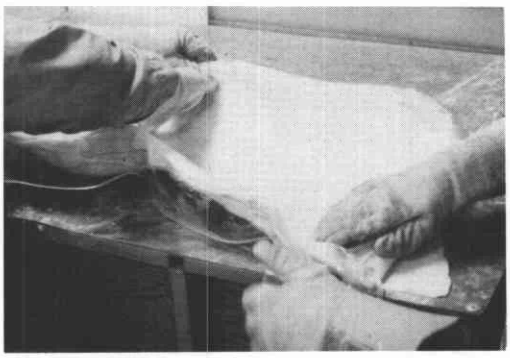


Figure 9. Surlyn®, heated just until pliable, is pressed into the contours of the cast impression.

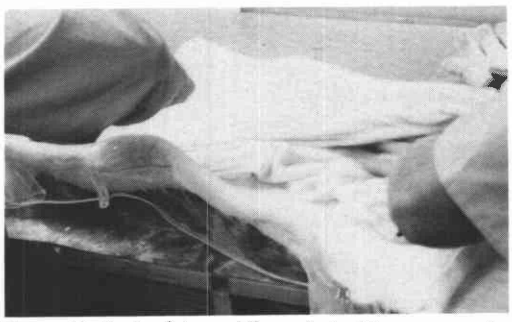


Figure 10. Surlyn® is rapidly cooled with a wet towel.

metic. The advantage of fabricating with Surlyn® is that the standard practice of pouring, stripping, and modifying a positive model can be completely eliminated.

In the fabrication lab, the cast impression is allowed to dry 30 minutes to an hour. The stockinette is then powdered. The impression is placed into an adjustable support to prevent any M-L spreading during the plastic molding. A piece of $^{3}/_{16}$″ thick Suryln®, large enough to cover the inside of the impression, is placed in the oven and allowed to heat just until it is pliable (about five minutes). The heated plastic is placed in the impression and pressed into the contours of the cast impression (Figure 9). The plastic is then rapidly cooled by a wet towel or air (Figure 10). When completely cooled, the plastic shell is lifted off the cast impression and the stockinette is stripped, exposing trimlines and reference marks made at the time of casting. The plastic shell is set back on top of the cast impression and the trimlines are transferred to the shell (Figure 11). The shell is trimmed and the edges finished (Figures 12 and 13).

The posterior shell is ready for the attachment of the corset front and shoulder straps. We use a standard corset front available from Truform in either a 9″, 10″, or 12″ abdominal length, depending on the patient's stature. Holes corresponding to the corset eyelets are drilled in the lateral edges of the posterior shell

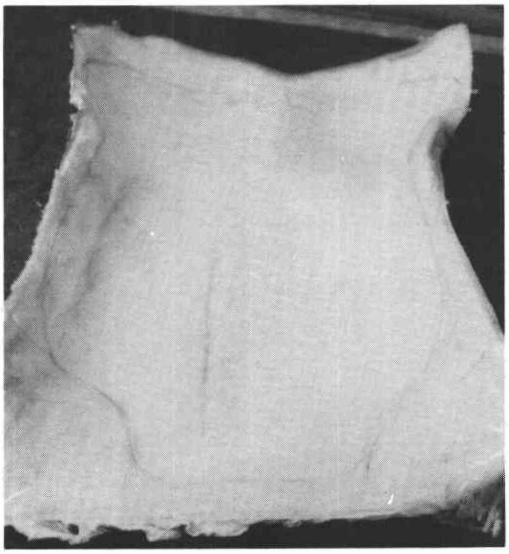
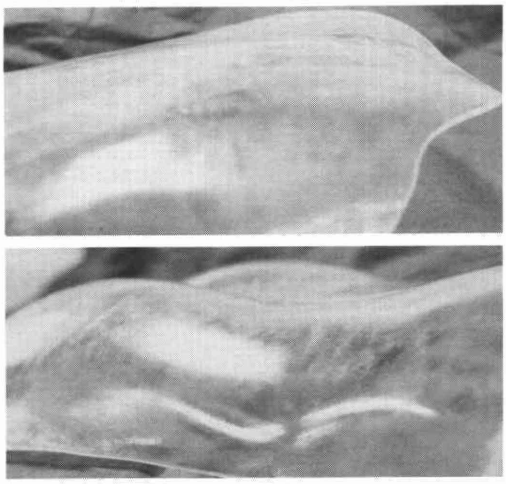


Figure 11. Trimlines are transferred from the cast impression to the Surlyn® shell.



Figures 12 and 13. Drape forming the Surlyn® to the cast impression without pouring a positive mold gives excellent contour detail to the resulting posterior shell.

and the corset front is laced onto the posterior shell (Figure 14).

The shoulder straps, which are also removable for laundering, are attached to the posterior shell via Velcro® on the ends which double back on themselves after slipping through loops permanently riveted to the posterior shell. The shoulder straps are attached to the shell just proximal to the interscapular level. They cross the shoulders and attach laterally several inches distal to the axillae via a standard corset style hook. Placement of the lateral hooks midway between the axillae and the waistline prevents binding in the axillae when the straps are tightened. Total fabrication time from casting to initial fit is approximately four hours.

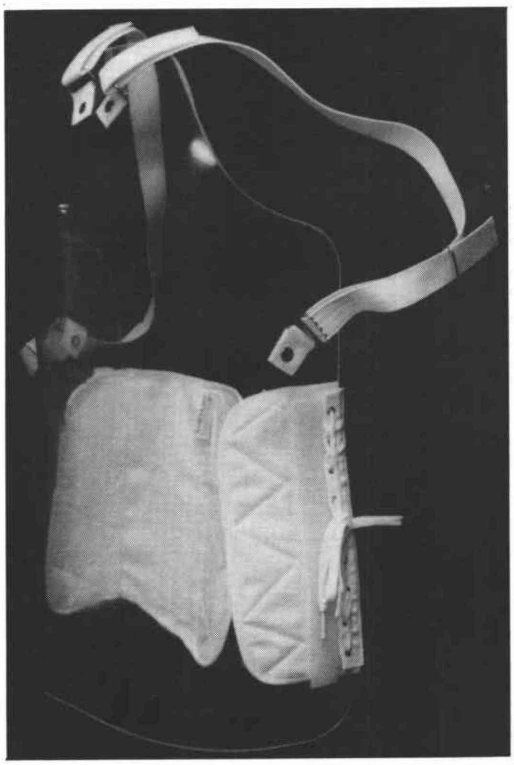


Figure 14. Finished posterior shell with corset front laced in place and shoulder straps also removable for laundering.

FITTING

Though the fabrication of the posterior shell orthosis is fast enough to permit fitting the same day as the cast impression is taken, the orthosis is usually delivered on the third post-operative day. This is done to allow post-operative illeus with accompanying abdominal distention to resolve. If the orthosis is fit too soon, the corset front invariably needs to be altered or the size of the front changed altogether. By the third day, the patient is alert and tolerant of being log-rolled, and the majority of abdominal distention has subsided. The posterior shell is tried for initial fit in bed and the patient is measured

for the corset front with the shell in place. The accuracy of the trimlines is noted and the shell is marked if any adjustments are needed.

After the corset front is attached, the orthosis is delivered to the patient, along with two pieces of stockinette to serve as in-hospital t-shirts and a written information/instruction sheet which covers care of the orthosis and basic "do's and don'ts."

When providing this orthosis for community physicians at nearby hospitals, rather than trying to coordinate with their operating room schedule since travel time is involved, we cast the patient several days post-operatively. The patient is log-rolled in bed to a prone position and the plaster impression is taken the same way as in the operating room. If thick bandages are still over the patient's surgical area, the impression will be slightly deeper than the final product. Trimlines must be adjusted accordingly. The community hospital patient is measured for the corset front at the same time as casting since he can be log-rolled back to a supine position for measuring. The M-L measurement for the corset front is taken midline to midline. The shell is then delivered in 24–48 hours. By either method, the patient is up and walking in the orthosis at four days post-operative and is usually discharged at 6–7 days post-operative.

SUMMARY

As of this writing, the protocol described above had been utilized in 44 patients over a period of 18 months. Diagnoses include adolescent idiopathic scoliosis, myelodysplasia, adult scoliosis, and adult spinal tumor. There has been one occurrence of instrumentation failure in a patient with adolescent scoliosis who had dislodgement of the upper hooks as a result of improper hook placement at the time of surgery.

We feel that with the increased internal support provided by the Bobechko hooks in the Harrington rod instrumentation that the modified bracing provided by the posterior shell (versus Milwaukee or Greenville orthosis) has provided satisfactory restriction of gross motions which might endanger the success of surgery. Forward bending and twisting are restricted and the shoulder straps add an upper torso anti-rotatory reminder for the patient. We have had no problems with lack of compliance in brace wearing, even though both the shoulder straps and the corset front are removable.

The orthosis has been well received by the patients. It is cooler and more comfortable than many of its counterparts. It is also cosmetically acceptable and is easily donned and doffed. Hygienic maintenance requires minimal time and effort. Finally, it has been well received by both adolescent and adult patients (Figures 15, 16, 17, and 18).

Figures 15 and 16. The orthosis is easily donned by the patient.

Figures 17 and 18. Posterior shell orthosis is very cosmetic.

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Technical Article

Dual Function Orthotic Ankle Joint

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This is a brief report of a simple mechanism which permits locking and unlocking of an orthotic ankle joint. It allows an individual who requires a locked ankle for ambulation to unlock the ankle, permitting plantar flexion of the foot for pedal control while driving a car.

We have found this to be a useful device for patients who have painful arthritic ankles which interfere with ambulation, but who find the discomfort tolerable when they are seated and the limb is unweighted. In such instances, an immobile ankle interferes with the smooth operation of the pedal while contributing little to the relief of pain when sitting.

The following cases illustrate the manner in which this problem was solved with two different types of AFO.

L.S. was 57 years of age when first seen by the VAPC Clinic Team in 1978. He had sustained a fracture of the right femur in WWII, which had healed in 20° of internal rotation of the distal fragment and with subsequent posttraumatic arthritis of the knee. A concomitant sciatic nerve injury indicated the need for a drop foot orthosis and the patient was provided with a light-weight shoe clasp orthosis.[1,2] Because of the internal rotation deformity, the patient was pushing off from the lateral aspect of the foot, and he developed callosities beneath the fifth metatarsal base. Subtalar, ankle, and mid-tarsal motion were painful. The shoe clasp orthosis did not adequately control the flexible equinovarus of the foot; a double bar orthosis with varus correction T-strap and spring loaded ankle was prescribed. The spring loading was permitted because the patient indicated that a solid ankle would interfere with the operation of the gas pedal of his car. The spring loaded ankle did not sufficiently relieve the pain and on October 10, 1984, the VAPC Clinic Team prescribed an AFO with an ankle joint which could be locked for ambulation and unlocked