Technical Article

Dynamics and the L3 Through L5 Myelomeningocele Child

by John Glancy, CO*

Since 1970, the orthotic management of myelomeningocele children treated at Indiana University has focused primarily on musculoskeletal deformities that develop after birth. Much of our effort has been directed to children with L3 through L5 lesions, because of their potential to be community walkers.[1] The decision to direct our attention to the problems that these lesion levels present also relates to the fact that they constitute the majority group among the myelomeningocele population. The range of orthotic dysfunctions, in kind or degree, that children with these lesion levels are prone to today, are identical to the orthotic dysfunctions that like youngsters had to endure in 1970.

Myelomeningocele remains "the most complex, treatable congenital anomaly consistent with life."[2] What has changed, in the interim, is our understanding of the pathodynamics acting upon the musculoskeletal systems of children with L3 through L5 lesions. The introduction of thermoplastic materials, along with vacuum forming techniques, now allow orthotists greater freedom of design. Consequently, there is a gradual change occurring in orthotic management, from the traditional approach based upon statics, to a growing appreciation of dynamics as a means of preserving function by preventing the formation of secondary dysfunctions caused by gravity, growth, and time. How may one describe the benefits these changes portend for the L3 through L5 myelomeningocele child, present and future? It now appears that while present-day children with L3 through L5 lesions may have the same vulnerability to secondary dysfunctions as the children of 1970 . . . they may not have to endure them, in kind or degree.

Those concerned with the care of these children face the same dilemma today as was experienced in 1970—how to provide long-term protection from secondary dysfunctions without introducing unacceptable inhibitions to daily activities. Fortunately, some of the specific challenges within the makeup of this dilemma have been satisfactorily met:

- **The polypropylene Solid-Ankle Orthosis**[3] offers long-term protection to the foot/ankle complex. The Carlson, Berglund technique[5] adds to the efficiency of this orthosis.
- **Lightweight KAFO's** that utilize a unilateral upright with offset free knee joint, modified quadrilateral thigh cuff and dynamic knee extension assist[4] offer long-term protection to myelomeningocele knees.
- **A polypropylene thoracopelvic unit**[4] offers a promising foundation for achieving acceptable, long-term control of the trunk with L3 through L5 lesion levels, without having to extend the exoskeletal system below the anatomic hip joints (Figure 4).

Since the 1976 report on the dynamic orthotic system was published,[4] we have refined the modular aspects of the system for two primary reasons: (1) To ensure that each component meets the requirements for which it is designed, i.e., providing no more, nor no less control than needed, and (2) To encourage the night use of the daytime system by the utilization of quick releases, in order to remove any components unrelated to the areas requiring night-time dynamic control (Figure 1). These modular refinements were also prompted by our recognition of a correlation between early application and night-time dynamic control, to success in the

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*John Glancy, C.O., is Assistant Professor and Director of Orthotics in the Orthotics Division at James Whitcomb Riley Hospital for Children, Room 1100, Indiana University Medical Center, 702 Barnhill Drive, Indianapolis, Indiana 46223.

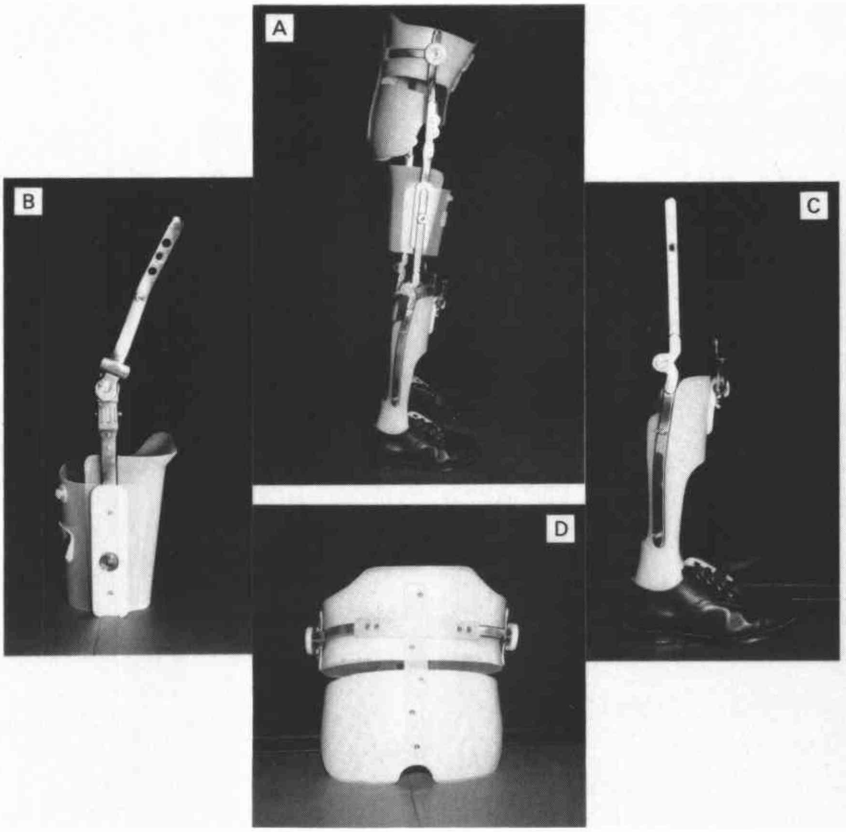

Figure 1. Features of modular system: (A) Assembled system for fitting: elastic components to knee and pelvic extension assist are not attached. (B) Modified quadrilateral thigh cuff; showing Nylon receptacle and locking nut for quick release of AK module. (C) Solid-ankle AFO with lateral off-set knee joint and pivotable attachment portion of knee extension assist assembly. Shockcord is not shown. (D) Thoracopelvic unit; receptacles for the quick release of the KAFO's and reinforcing horizontal bar are visible. Note: The combination polycentric and lateral motion joint shown in A. The lock joint shown in B is used for post-op cases.

prevention of secondary dysfunctions. Due to the complexities of the pathodynamics involved, particularly in the hip complex and lumbopelvic regions, an efficient night-time unit must be equally as functional as the day-time unit, hence the economic necessity that a single system provide both day and night protection against secondary dysfunctions.

The importance of night-time use became even more evident with an awareness of the startling amount of regression that often occurs during short periods of time when the system is not worn. Rapid regression occurs with discouraging frequency about the hips and lumbopelvic regions especially. Such 'down time' often is more frequent within the three-to-six month periods between orthotic checkup visits than we understood to be the case. For example, in addition to the usual childhood diseases, colds, etc, these children are subject to episodes of kidney and/or bladder infection and periodic revisions to their shunts. The success or failure of the dynamic orthotic system appears to be proportional to the frequency and duration of these occurrences. Without an appreciation for the circumstances just described, orthotists will experience constant frustration as they seek explanations for the gradual regression their patients present, because they will unintentionally attribute the cause to often non-existent weaknesses in the design of a given orthotic system.

The answer lies not only with better control of the hip and lumbopelvic regions, but also with constancy of control. We must be as persistent with our applications of biodynamics as nature is with the pathodynamics acting upon

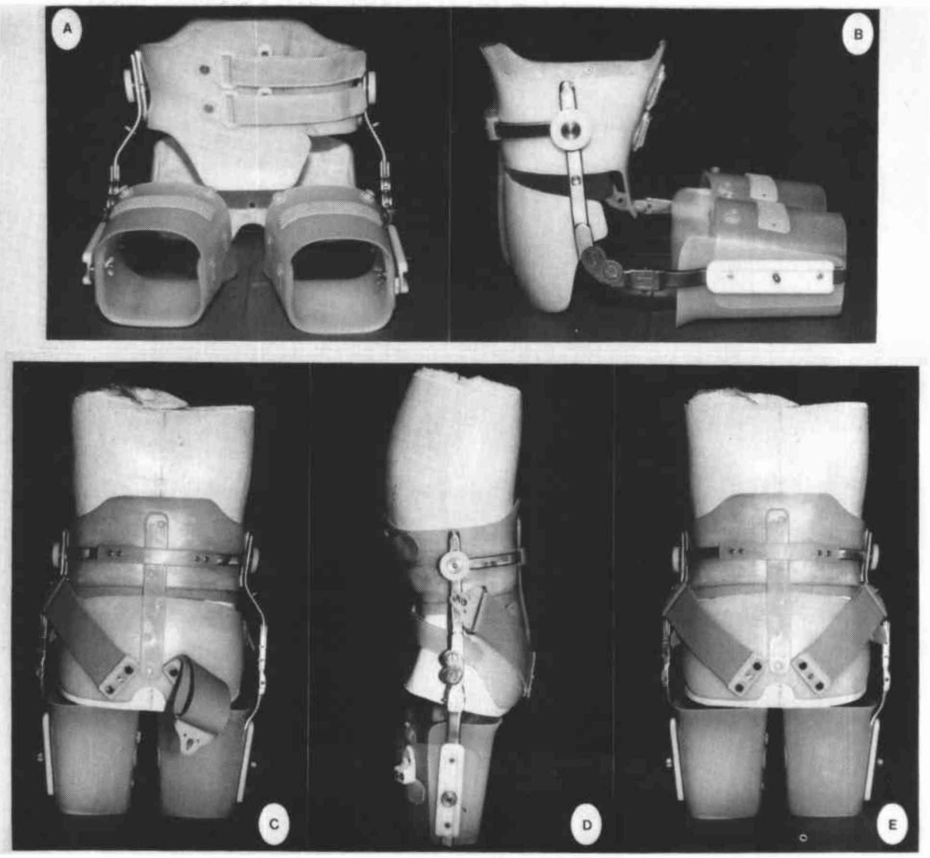

Figure 2. (A & B) Sitting stability and comfort is enhanced by the flat, posterior surfaces of the modified quadrilateral cuffs, abduction motion and polycentric feature of the hip joints. (C) Posterior view: Thoracopelvic unit on casts with the new pelvic extension assist showing right rubber strap detached from the upright. (Note how the model has dropped on the right side.) (D) Side view showing how rubber strap attaches to upright. AK and BK quick releases and Delrin fitting for shockcord of the knee extension assembly. (E) Posterior view with both rubber straps of the pelvic extension assist attached to the uprights. (Note the horizontally level suspension of the cast, demonstrating the force the rubber straps generate.)

these regions. There are three needs that must be considered, which hopefully can be met by a single dynamic thoracopelvic design. They are:

1. A reliable method of eliminating jackknifing of the trunk during ambulation without the use of locks.
2. Control of the lumbopelvic and hip regions in a manner which does not require extensions to the lower extremities. The need to protect the growing child's lumbar spine when his gluteous maximum muscles are paralyzed, but his hips and/or knees do not require protection (L4 and L5 levels), has yet to be met.
3. The controls in 1 and 2 above, must operate wtih the same efficiency during night-time wear as they do during the day, in order to reverse the inevitable regression resulting from unavoidable periods when illness prohibits wearing the orthosis.

Granted, these design criteria demand a major breakthrough in the state-of-the-art. Nevertheless, using our current thoracopelvic unit as a point of departure, an acceptable solution seems within our grasp. Figures 2, 3, and 4 show our progress to date. A resolution to this problem would have broad orthotic applications—it should be vigorously pursued. Our work on this project is ongoing, and we invite our readers' active participation.

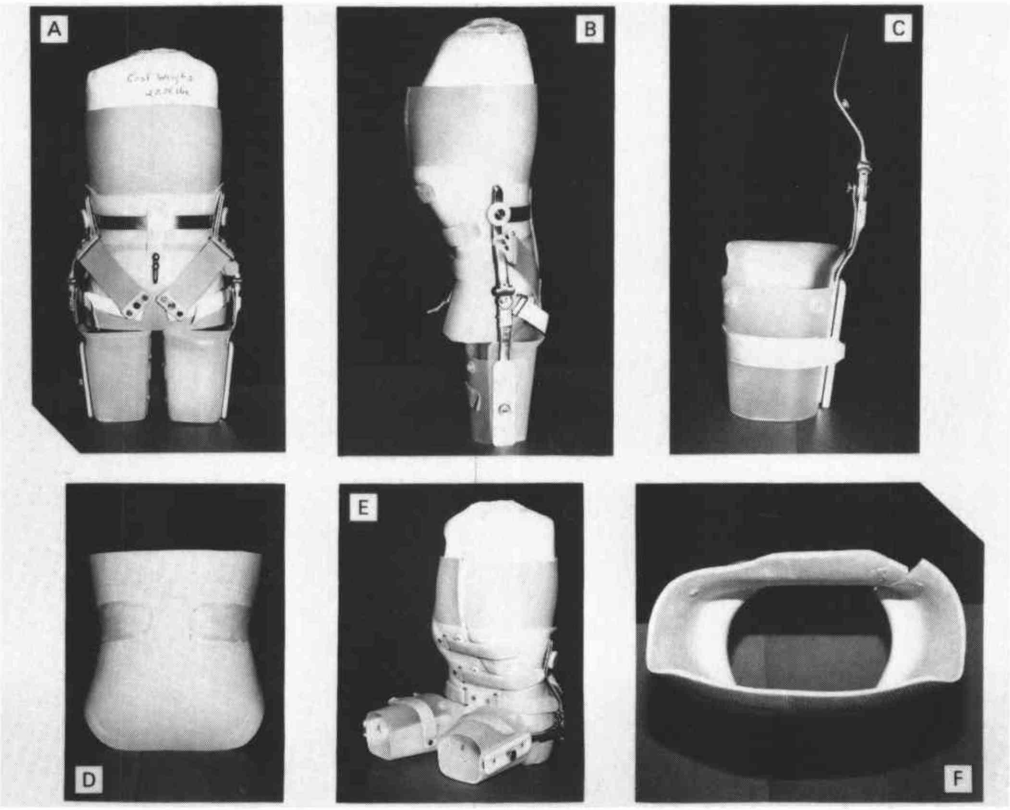

Figure 3. Most recent prototype: (A) Dacron straps with slide-bar buckles serve as a passive, adjustable 'pelvic band.' Puhient weighs 43 lbs. Each rubber strap is set to generate 14 force pounds equal to 62 inch pounds of extension moment which resists the first 20 degrees of forward flexion of the lumbar spine. Any voluntary forward flexion of the trunk beyond 20 degrees overrides the dynamic extension. (Note: Posterior polypropylene bar must be slotted at pelvic end (drawn in) to permit forward rotation of lumbar spine, as the dacron straps check unwanted forward rotation of the pelvis.) (B) Side view: Lock used for 2-3 months post-op. Dynamic extension is fully operative even with locks. Patient has 45 degree hip contractures, which explains posterior gap of thigh cuff in post-op alignment. (C) Anterior view: Note Nyloplex stud medial to hip joint which is the pivotal attachment point for slide-bar buckle. (D) Posterior view of Plastazote® lining showing the sealed 'pockets' at waistline level. Pockets are filled with #382 Elastomer. (E) Model shown in seated position. Although 28 force lbs. (both rubber straps) are acting to extend the lumbar spine when sitting, this force has no effect upon the lower extremities. (F) Bottom view: showing 'shelves' formed with the lining and filled with Elastomer via the pockets shown in photo D. Their effectiveness in transferring the weight of the thorax to the uprights is well demonstrated. This technique prevents pressure sores to insensitive skin.

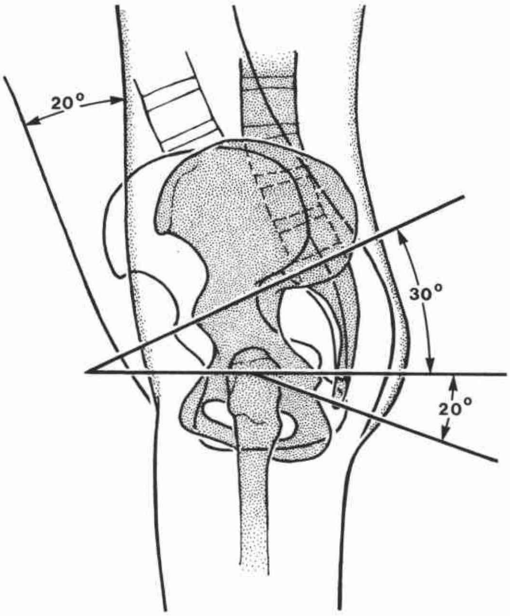

Figure 4. Schematic lateral view of normal lumbopelvic relationship to the horizontal. Shaded areas show the optimum sacral angle of 30 degrees, with respect to the center of the hip joint, during normal standing posture. The normal amount of postural lordosis resulting from the optimum sacral angle is also depicted. The unshaded outline shows the pelvis rotated 20 degrees about the hip joint in an anterior direction, taking the entire trunk with it, indicated by arrow in upper left. The downward oblique line, originating from hip center, indicates the maximum distal point (gluteal fold), relevant to the horizontal at hip level, which is feasible as an attachment point for passive pelvic control when fitting small children (see A & B, Figure 3). The arrow between the horizontal and oblique lines, to the right of the figure, demonstrates that beyond 20 degrees of forward rotation of the pelvis, the distal attachment point will rise *above* the horizontal. The contribution of the passive pelvic control, relative to forward rotation of the pelvis above the horizontal, is nil. However, the intimate fit of the thoracopelvic unit (especially the abdominal position) ensures that the optimum relationship between the lumbar spine and the rotating pelvis is passively maintained throughout the full range of pelvic A-P rotation. Consequently, any *involuntary* forward rotation of the trunk about the hips (within the first 20 degrees) can be controlled as a single body segment. The functional status of the abdominal and particularly the hamstring muscles, may be expected to be crucial contributors to the system's success. *Unless the pelvis and lumbar spine can be passively placed in a normal standing posture to begin with, neither can be controlled in an upright position without locks.*

REFERENCES

[1] Glancy, J. and R.E. Lindseth, "A dynamic orthotic system to assist pelvic extension: A preliminary report," *Orthotics and Prosthetics,* 29:1, pp. 3–9, March, 1975.

[2] Bunch, W.H., A.S. Cass, A.S. Bensman and D.M. Long, "Modern management of Myelomeningocele," Pub. Warren H. Green, Inc., St. Louis, 1972.

[3] Glancy, J. and R.E. Lindseth, "The polypropylene solid-ankle orthosis," *Orthotics and Prosthetics,* 26:1, pp. 14–26, March, 1972.

[4] Glancy, J., "A dynamic orthotic system for young myelomeningoceles: A preliminary report," *Orthotics and Prosthetics,* 30:4, pp. 3–15, December, 1976.

[5] Carlson, J.M. and G. Berglund, "An effective orthotic design for controlling the unstable subtalar joint," *Orthotics and Prosthetics,* 33:1, pp. 39–49, March, 1979.

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