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The Development of a Molded Pelvic Girdle and the Pelvic Casting Fixture

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INTRODUCTION

The idea of a reciprocating gait orthosis originated at Ontario Crippled Children's Center as part of a total system directed towards meeting the needs of children with Spina Bifida and other spinal lesions. Since its original inception in Canada, work on the concepts involved has continued elsewhere.

A Swedish firm manufactures the components necessary for reciprocating hip joints, and such developments as the Shrewsbury "Clicker" (fundamentally a standing frame mounted on a swivel walker base) in England are outgrowths of the work in Toronto. Of crucial importance to its continued development and implementation in the United States have been the efforts of Roy Douglas, C.P., of Louisiana State University, and his interaction with personnel of Durr-Fillauer Medical's Orthopedic Division.

Mr. Douglas has, as a consequence of his great personal enthusiasm and energy, been responsible for not only establishing a successful program at L.S.U., but also for interesting countless others in pursuing the challenge. Durr-Fillauer became involved with the reciprocating gait orthosis in 1977, almost by accident, but since then, the interaction of the staffs of the Orthopedic Division and of L.S.U.'s Department of Orthotics and Prosthetics has been most productive.

Durr-Fillauer, with the resources of a large specialized manufacturing facility, and as a result of the objectivity that comes with geographical separation as well as indirect clinical involvement (as opposed to direct involvement), has been able to refine original concepts and procedures as well as pursue new developments and make them available to others. The results of this research and development effort have been continuously fed back to clinicians such as Roy Douglas for comment and continued improvement. Nonetheless, the reciprocating gait orthosis, no matter how important it is to the people who benefit from its use, remains a highly specialized device for a small segment of the total prosthetic/orthotic population. Far more important are the "spin offs" it has helped produce.

The L.S.U. Lively Orthosis was originally developed as an adjunct to the use of the reciprocating gait orthosis. Today it has been employed in meeting the needs of people who would by no stretch of the imagination be considered candidates for the reciprocating gait orthosis.

Carbon Fiber Composite sheeting with acrylic matrix was originally developed for use as inserts[1] for reinforcing or rigidifying the ankle sections of AFO's and KAFO's as used in the reciprocating gait orthosis. Since then it has been used as a reinforcing agent in a wide variety of prostheses and orthoses. Karl Bremer, C.O. has even been led to use it as a substitute for aluminum bands in conventional double upright AFO's and KAFO's.[2]

Lessons learned in the design of hip joints for the Reciprocating Gait Orthosis

are currently being applied to the design of a new hip joint for the Scottish Rite Orthosis.

The late William Svetz, C.P.O. as a consequence of experience with the Reciprocating Gait Orthosis, was led to utilize the same principles and pelvic joint assemblies to fill the prosthetic prescription aimed towards meeting the needs of a bilateral above knee amputee.[3]

In a more general sense, the Reciprocating Gait Orthosis program has been instrumental in reiterating and reemphasizing many of the lessons and experiences gained in the 60's and 70's as a result of the application of bio-engineering principles and sheet thermoplastic technology to the design and prescription of orthoses.[4] The present day design of the Reciprocating Gait Orthosis is, of course, a result of this process. Yet for some it is their first introduction to it. Lessons gained in the fabrication and fitting of Reciprocating Gait Orthoses are applied to a much larger patient population with less critical demands.

The topic of this paper, Molded Plastic Pelvic Girdle with Hip Joints, must be viewed in this context. It is, by an evolutionary process, the product of experience with one device and the precursor of new devices or applications.

ROLE OF THE PELVIC BAND

At its simplest, the pelvic band is merely a structural element tying together bilateral KAFO's. With reciprocating hip joints, such a structural element is necessary for the proper coordination of movement between the two distal sections. Far more critical, however, is its role as a fitting element or reaction point for the control of motion about a joint or joints.

An individual so involved as to need a reciprocating gait orthosis is going to need control of lumbar lordosis and hip flexion. In this instance, the pelvic band should fit as low distally across the sacrum and buttocks as is compatible with sitting comfort. So located, the band is properly located to work at best advantage as a component of a three point pressure system (or systems) in coordination with other reaction points both proximal and distal.

For a pelvic band used in conjunction with hip joints to achieve proper results, the following criteria must be met:

1. Broad surface area pressure distribution,
2. Accurate contouring for proper pressure relief and pressure application,
3. Accurate alignment of the hip joints for maximum congruence of anatomical and mechanical axes during flexion so as to provide sitting comfort (no inadvertent increase in pressure) and maximum cosmesis (no gapping).

While it is, of course, possible to achieve these criteria using conventional methods and materials, considerable time and effort is necessary to do so. In the past, little incentive existed to spend the effort necessary to insure proper results. The advent of the reciprocating gait orthosis made it, to our minds, imperative.

The crucial element is criterion number three. It must be conceded that individuals needing bilateral KAFO's with hip joints and a pelvic band will spend the majority of their time sitting, no matter how sophisticated the orthosis is. If sitting comfort is compromised, then the orthosis will be removed and once removed, little incentive exists to reapply it. The orthosis, therefore, is relegated to the role of exercise equipment, and is not integrated into the patient's total lifestyle. In recognition of this fact, and in an attempt to fulfill the three criteria set forth, we developed the molded plastic pelvic girdle and the fabrication technique involved.

THE MOLDED PLASTIC PELVIC GIRDLE

Obviously, we feel the molded plastic girdle (Figure 1) meets the criteria. A plaster of Paris positive model is obtained by which proper trimlines, surface contours, and hip joint alignment can be established. Hip joints suitably modified for strength

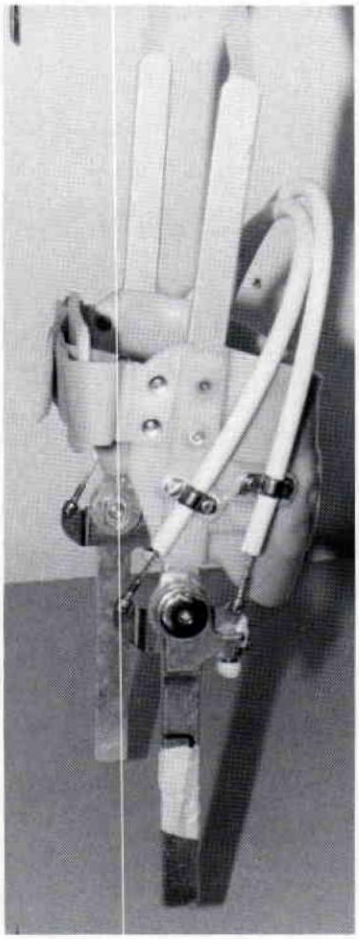

Figure 1. Molded plastic pelvic girdle.

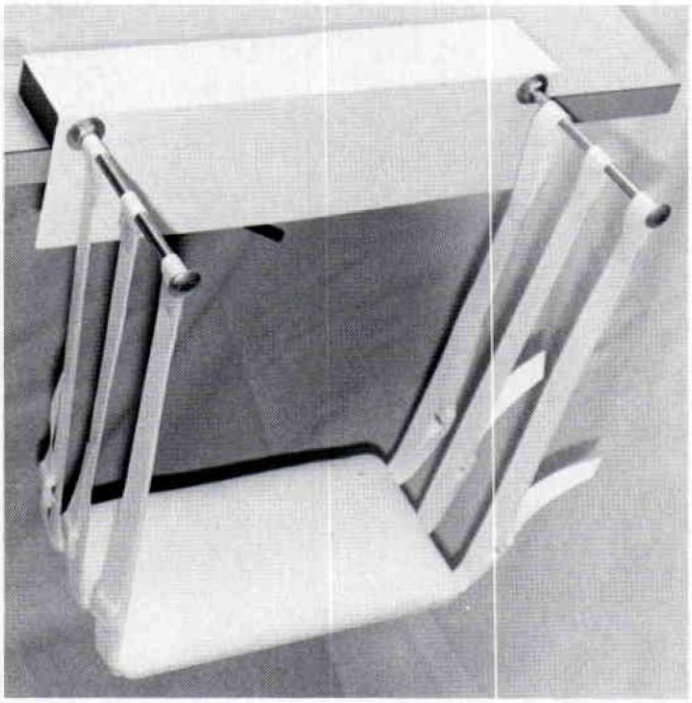

Figure 2. Casting fixture in place.

and stability are laminated inside two layers of co-polymer polypropylene, along with a third narrow strip of co-polymer. This strip of co-polymer ties the posterior outriggers of the two hip joints together and creates a corrugation.

The result is a pelvic girdle that is rigid enough for its intended purpose, yet has a measure of give, or flexibility, to it. This give or flexibilty seems to increase the comfort level of the orthosis and serves to protect the mechanical hip joints, as do the plastic thigh and shin sections of a polypropylene KAFO.

Vertical channels are formed on each side of the pelvic section for inclusion of thoracic extensions. These metal thoracic extensions provide for the incorporation of Velcro® straps or even, if necessary, of a molded plastic thoracic band for control of spinal curvature (In the presence of a preexisting CTLSO or TLSO, we have in the past recommended use of a metal pelvic band on top of the existing orthosis).

We have been quite pleased with the results achieved with these molded plastic girdles. Experience, however, soon showed the need for specialized casting techniques and equipment to achieve satisfactory results.

THE CASTING FIXTURE

A special casting fixture has been designed, which clamps to the end of most casting tables (Figure 2). An integral part of the fixture is a platform, adjustable in height, which supports the patient's knees. The top surface of the casting fixture stands above the surface of the table and supports the patient's pelvis. By this

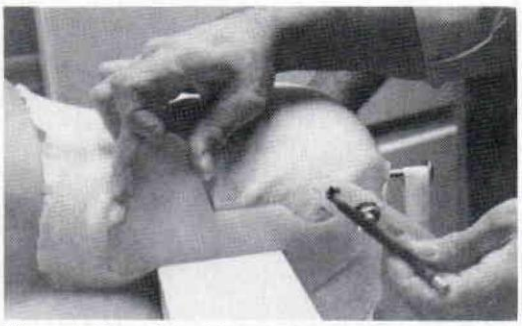

Figure 3. Use of the hip joint gauge.

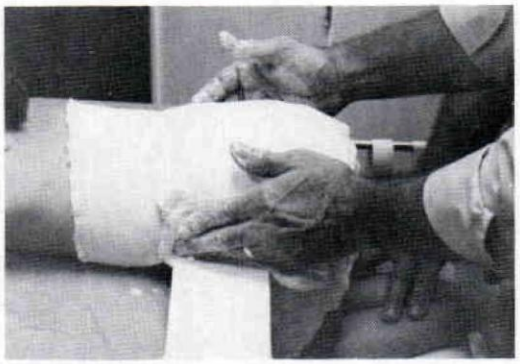

Figure 4. Molding the splint to the patient.

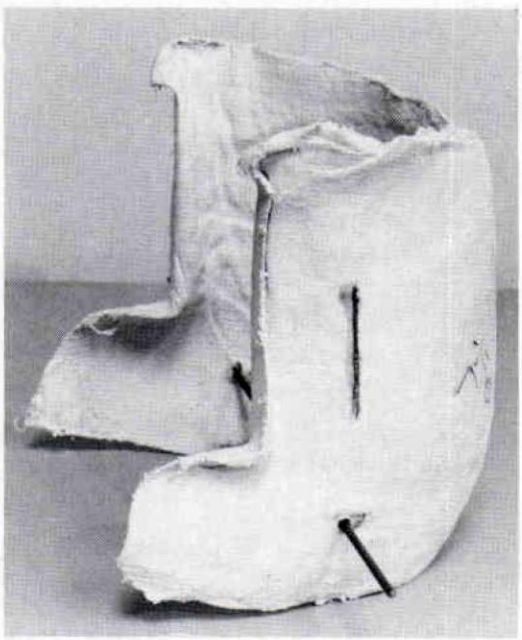

Figure 5. Finished cast.

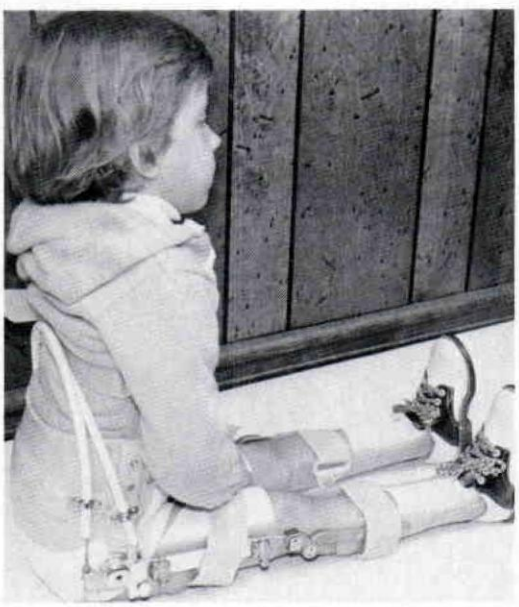

Figure 6. Completed molded pelvic girdle on the patient, showing the close fit during sitting.

means, and by adjusting the support afforded by the knee platform, the desired degree of lordosis is achieved.

The vertical and horizontal surfaces of the pelvic support provide reference planes for an adjustable hip joint gauge which rests on the two surfaces. This hip joint gauge is set for proper location of the hip joint axis by comparing it to first one hip joint and then to the other, and is used to mark the location of the axis on the outside of the cast (Figure 3). In use, one splint of nine layers of eight-inch wide plaster of Paris bandage is used, simplifying the process (Figures 4 & 5).

Use of this special casting fixture, the gauge, and the technique involved has eliminated our earlier problems, when instructions are followed carefully (Figure 6). This is quite gratifying in and of itself, but what is truly interesting are the implications for further use.

FUTURE IMPLICATIONS

While we have not had experience with all of the following suggestions, we consider them quite feasible and commend your attention to them. We, of course, realize that other uses exist and invite your suggestions:

1. Use of molded plastic girdles with bilateral HKAFO's without reciprocating gait.
2. Use of molded plastic girdles with bilateral above knee prostheses with or without reciprocating gait.
3. Use of a molded pelvic girdle, thigh cuff, and hip joint especially modified to prevent unwanted motions in cases of recurrent dislocation of total hip joints.[5, 6]
4. Use of the casting fixture to cast for the posterior section of a two stage cast for a TLSO orthosis.[7]
5. Use of the casting fixture to cast for a "sitting orthosis" either with splints or with a vacuum dilatency casting bag.[8]

CONCLUSIONS

Few techniques or devices can be called revolutionary. Rather, they are the result of an evolutionary process through which experience refines existing approaches and suggests new ones for the same problem or similar ones. It is through this process that the field progresses and it is one that all prosthetists/orthotists participate in. In this article, some suggestion of the process in general is given, and specifically the evolution of the molded plastic girdle and other "spin offs" of the reciprocating gait orthosis program are traced, and possible future developments of the molded plastic girdle are suggested.

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