*Orthotics and Prosthetics*, Volume 39, No. 1, pgs. 62–69.


# Contemporary Trends in the Orthotic Management of Legg-Calve-Perthes Disease

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## INTRODUCTION

In 1895, the German physicist Wilhelm K. Roentgen discovered x-rays. The subsequent era saw an explosion of medical knowledge and many lively controversies over credit for various discoveries. Not the least of these was over who should receive credit for describing osteochondrosis of the hip and for differentiating it from tuberculosis of the hip. Echoes of the controversy can be found even today in its more popular name: Legg (1910), Calve (1910), Perthes (1910), Waldenstrom (1909) disease. This is more commonly shortened to Perthes disease or Legg-Perthes disease, or even abbreviated as LCPD.

To this day the etiology of LCPD is obscure, and over the years new treatment techniques have evolved. This paper is intended to explore some of these issues from the point of view of the clinical orthotist, with particular emphasis being given to ambulatory non-surgical treatment and to some of the various orthoses used.

## THE DISEASE

Legg-Calve-Perthes disease is described as self-limiting avascular necrosis of the epiphyseal center of the hip and of idiopathic origin.[1] It is said to affect four times as many boys as girls (it is said, however, to be more severe in girls), and while it may occur anytime between the ages of two and 15, the maximum incidence is between the ages of five and seven. Bilateral involvement occurs in 10-15 percent of the cases seen, and there is apparently a relatively low incidence among blacks.

It has been concluded that there is not a genetic factor in the majority of patients but that patients with LCPD in general are undersized and of delayed skeletal maturity for their age.[2, 3, 4]

LCPD is said to proceed in four phases:

- Following interruption of the blood supply, growth in the epiphyseal center ceases and bone dies. This period lasts a period of months or in some cases longer than a year, and is called the quiet phase, as

the child is pain-free and no deformity takes place.

- Blood supply to the involved area is reestablished and old bone is resorbed while new bone is deposited. The new bone is malleable and responds in shape to the forces exerted upon it. During this phase pathologic fractures of the subschondral bone or subluxation of the hip may occur. It is also during this phase that the child is seen. He may walk with an antalgic or painful gait and complain of pain or tenderness of the hip. In some instances, the pain may be referred to the knee. There is disuse atrophy of the proximal thigh and limitation of motion about the hip involving abduction and internal rotation. This period lasts from one to four years.
- Bone resorption ceases and bone deposition continues. The new bone is still malleable.
- The final phase is a residual period following healing. If the joint has been subjected to abnormal forces and joint incongruity has occurred, degenerated joint disease may eventually develop.

McAndrew and Weinstein evaluated the condition of 37 affected hips in 35 patients who had been diagnosed as having LCPD.[5] All patients had been seen at the University of Iowa Hospitals and the initial diagnosis was made between 1920 and 1940. At the time of follow up, the patients on the average were 56 years old and the authors concluded that 50 percent of the patients had disabling osteoarthritis. The authors also pointed out that the prevalence of pain and dysfunction in this patient group was ten times that in the general population in the same age group.

In two recent articles Salter, et. al., citing recent research, concluded that LCPD is a complication of avascular necrosis of the femoral head.[6,7] A painful subchondral fracture marks the initiation of LCPD, and resorption of bone occurs in the region under the fracture. The extent of the fracture, therefore, is of prognostic value in predicting the extent and course of the disease. In the absence of a pathological fracture, the authors concluded that an incidence of avascular necrosis resolved without the additional complication of LCPD.

# TREATMENT

In the past, a variety of treatment methods have been used with apparently indifferent results. In general these earlier schemes attempted by one means or another to put the hip at rest. Bed rest, slings to hold the leg off the ground, and Knee Ankle Foot Orthoses with patten bottoms and ischial weight-bearing brims have all been tried. Contemporary methods of treatment in general have been designed to exploit the Containment Theory of treatment.

This concept holds that if the diseased hip is held seated in the acetabulum with the femoral head covered as much as possible, then the plastic or malleable new bone will not be subjected to deforming forces. The result is that the child can be permitted full weight-bearing, and activity during the healing process and the femoral head will remain congruent. Interestingly enough, two authors attribute the concept involved to a gentleman by the name of A.O. Parker, and state that it was introduced in 1928–29.[7,8,9] The desired position involves abduction and internal rotation of the femur. A variety of techniques have been developed to maintain this position.

At least two different surgical techniques have been described to address the problem.[7] In one, the Salter innominate osteotomy, the pelvis is cut and wedged so as to reposition the acetabulum over the head of the femur. In the other, an osteotomy of the femur is performed and it is wedged to create a position of varus and internal rotation. While both procedures have their advocates, supporters of femoral osteotomy hold that it affects primarily the diseased segment, that it creates a more functional biomechanical relationship, and that the very fact that the femur is sectioned has favorable implications for the vascular supply, and thus the course of the disease.[10,11] Problems of complications secondary to surgery are apparently quite low, but, as with all surgery, must be considered. Advocates of surgery hold that once the osteotomy heals, the child is free to resume a normal life unencumbered with an orthosis. Some parents may prefer the

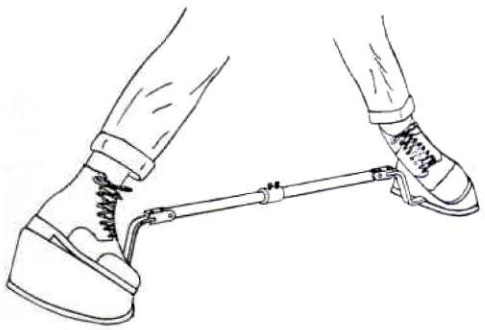

**Figure 1. Craig Bar.**

shorter treatment time of surgery, while others may fear the possibility of complication and prefer orthotic treatment. The ultimate decision is one to be made by the parents in consultation with the surgeon.

## ORTHOTIC TREATMENT*

One of the first of the various orthoses designed to exploit the containment principle is the Craig Bar.[12] This comprises a metal bar connected medially to the patient's shoes by stirrups and ankle joints (Figure 1). The ankle joints are modified to block external rotation and the shoes are wedged to hold the sub-talar joints in neutral. The bar is long enough to produce abduction of the hips and this fact, in combination with the alignment of the ankle joints, creates the position of containment. Writing in 1963, Craig and his colleagues described the orthosis as being used subsequent to casts used to create the same position. It would seem that the Craig Bar has never gained widespread use despite its extreme simplicity, and undoubtedly this is due in part to problems of ground clearance and cosmesis associated with a rigid bar attached to the shoes.

The name most commonly associated with casts for the treatment of LCPD is, of course, Petrie. Petrie and Bitenc described in 1971 their experience treating some 60 children using bilateral long leg casts and "broomsticks" to position the hips in abduction and internal rotation.[13] Treatment of an individual began with hospitalization and bed rest with traction, if necessary, to relieve the muscular spasm and obtain the desired position of correction. In cases of severe abduction contracture, traction was prolonged or abductor tenotomies were performed. When the desired position, 45° of abduction and five to 10° internal rotation in each hip was established, casts were applied and the patient was discharged home to walk with crutches.

Every three to four months, the patient was readmitted for removal of the casts, mobilization exercises, x-rays, and reapplication of the casts. The process was then repeated until healing was completed. The average course of treatment was 19 months, and Petrie and Bitenc's results in 60 cases of children over five years of age were 60.3 percent good, 30.9 percent fair, and 8.8 percent poor.

They compared* this to a series of 108 cases of children treated with recumbency (the phrase they use is "avoidance of weight-bearing," which, from the context in which it is used, is taken to mean bed rest). The results of this series were 48.1 percent good, 16.7 percent fair, and 35.2 percent poor.

This course of treatment with its great demands upon hospital resources and the need for rigid containment of the legs in heavy casts is obviously not particularly satisfactory. As a consequence, alternative means to achieve the same end have been developed.

One of the first of these was the Toronto Orthosis, initially developed in 1966–67.[14] This device held the patient's lower limbs in the desired position by means of thigh cuffs attached to the shoes by a metal framework (Figure 2). The frame was articulated with ball joints aligned to permit knee flexion and thus sitting. The soles of the shoes were mounted on wedged blocks at a 45° angle relative to the floor in the frontal plan. A commercial version of this

*The trilateral orthosis is not discussed as it was considered in some detail in: "Fabrication and fitting instructions: Trilateral Perthes Orthosis," *Orthotics and Prosthetics*, Vol. 37, No. 4, 1983, pp. 24–33.

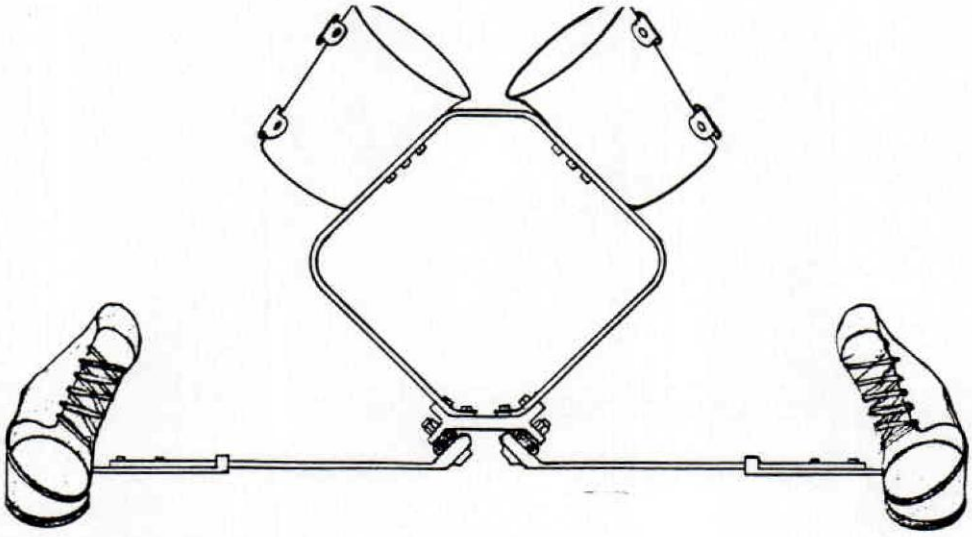

**Figure 2. Toronto Orthosis.**

orthosis, altered somewhat in structure to facilitate construction and post-fitting adjustments, have been available since about 1969 (Figure 3). This orthosis accomplishes the same end as the Petrie cast and is undoubtedly much easier for everyone to live with. However, the same objections as to cosmesis and use of crutches exist.

The Newington orthosis is very similar in design and was developed at about the same time (Figure 4). Curtis, et. al. apparently initiated their program of ambulatory treatment of LCPD in 1965 with Petrie casts, and very soon resorted to the use of the Newington orthosis.[15] King, et. al. gives the date for first use of the orthosis as 1968.[16] In any event, the orthosis comprised a non-articulated rigid metal framework with overlaps and multiple screw holes for adjustment. To this frame were attached Vitrathene medial shells to support the patient's knees and legs. Numerous cuffs and straps secured the patient to the orthosis. This orthosis was used during the day-time hours. For sleeping, simple lightweight plastic posterior shells were used to hold the legs in the desired position. Crutches were necessary for walking. Components for the orthosis were commercially available for a time, but have been discontinued.

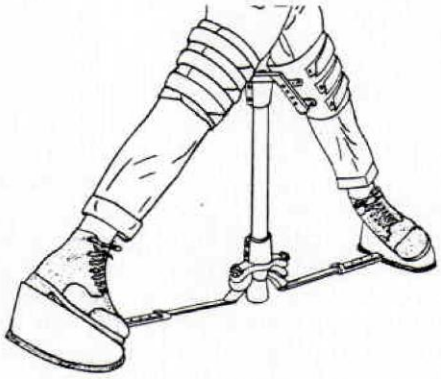

**Figure 3. Contemporary commercial version of the Toronto Orthosis.**

Curtis, et. al.* utilized an initial period of hospitalization and traction to establish the desired position of abduction and internal rotation. X-rays and arthrograms were used to determine coverage of the femoral head and the amount of angulation necessary to establish maximum coverage. In most instances 45° was necessary but in some cases proved to be too much. In all patients the hips were positioned not in

*In comparing these results of other authors cited in the article, due caution should be taken in drawing any conclusions. Various authors frequently differ in their assessment techniques and grading criteria. Therefore, direct comparisons are difficult and misleading.

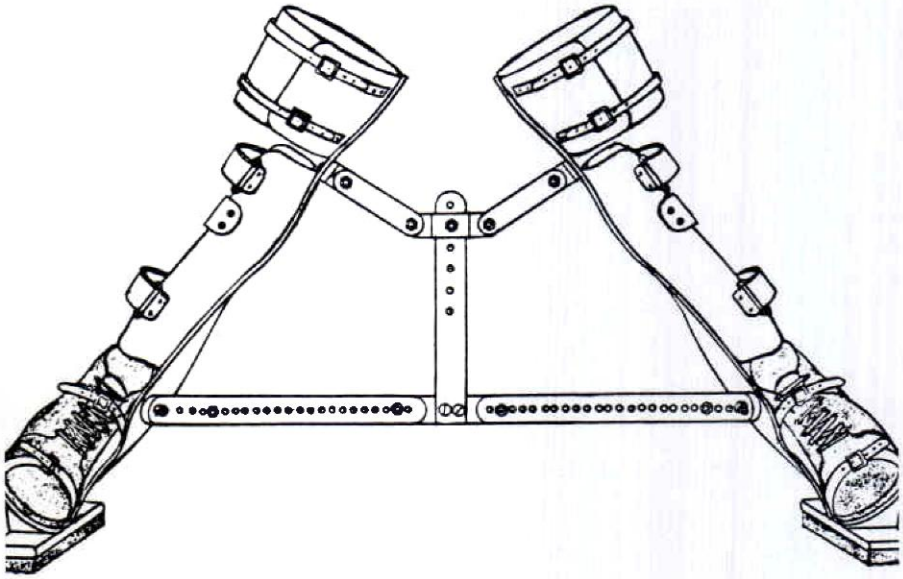

Figure 4. Newington Orthosis.

maximum possible abduction, but rather in ten degrees less in order to avoid pain and synovitis associated with the hips being positioned in maximum abduction.

The authors reviewed their results in nineteen cases. Sixty-three percent of the studies were classified as having good results, 21 percent were listed as fair, and 16 percent were poor. Mean age for onset of symptoms was eight years, one month. Mean age at time of hospitalization was eight years, six months. Course of treatment from hospitalization to removal of the orthosis averages about 20 months.

In 1980, King, et. al. reported on the results of ten years experience with the Newington orthosis.[16] Their sample group consisted of 56 patients (12 female, 44 male). Average age at the onset of symptoms was 7.1 years, with treatment initiated some 4.3 months later. After an initial period of bedrest, traction, and casts lasting on the average 2.2 months, orthotic wear commenced and lasted some 16.8 months. The mean follow-up period from onset of symptoms was 5.2 years, and on the average the children were 12.3 years old at the time of follow-up evaluation. Results were considered good in 32 percent of the cases, fair in 39 percent, and poor in 29 percent.

King and his colleagues also evaluated the results of treating some nine patients with the Scottish Rite Orthosis. Average age was 7.8 years, average time wearing the orthosis was 13.5 months, and time of follow-up was not given. Six hips were classified as good, two as fair, and none as poor. While suitably cautious in drawing any conclusions from such a small population, the authors felt that the Scottish Rite Orthosis gave superior results.

They attributed these superior results to the fact that while both orthoses maintained the position of correction, the Scottish Rite Orthosis was more conducive to active motion of the hip joints. Since anatomical studies have shown that any one time when less than 50 percent of the articular surface of the femoral head is contained in the acetabulum, areas of high pressure and deformity are likely to result from long periods of immobilization in one position. They felt that the Scottish Rite Orthosis with its increased motion, particularly transverse rotation, avoids these problems. In addition to the reasons cited by King and his colleagues, the effects of increased patient acceptance and compliance cannot be discounted.

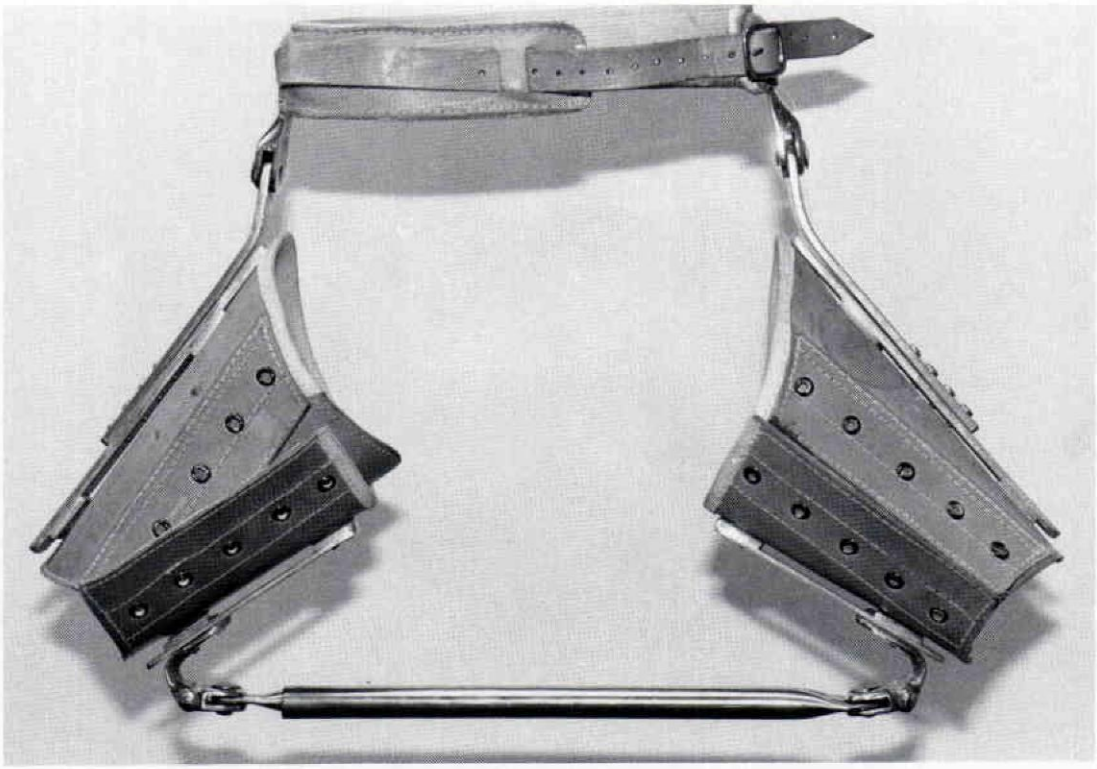

Figure 5. Original Scottish Rite Orthosis. Also known as the Lovell or Atlanta Orthosis.

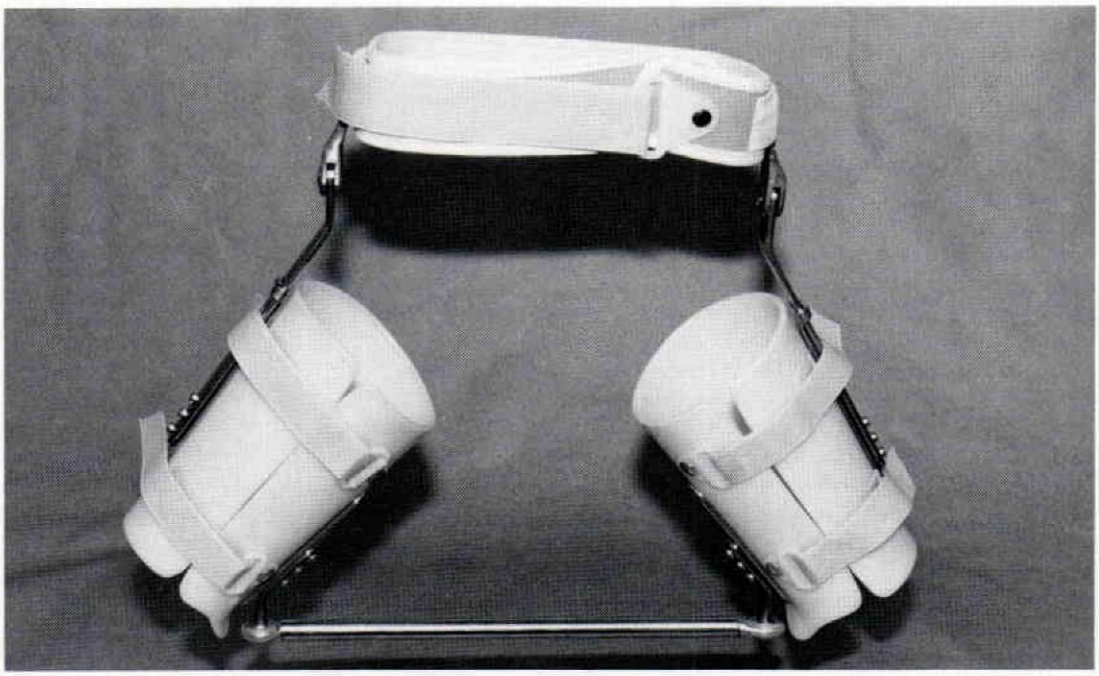

Figure 6. Commercial version of the Scottish Rite Orthosis with telescoping bar and universal joints at each end.

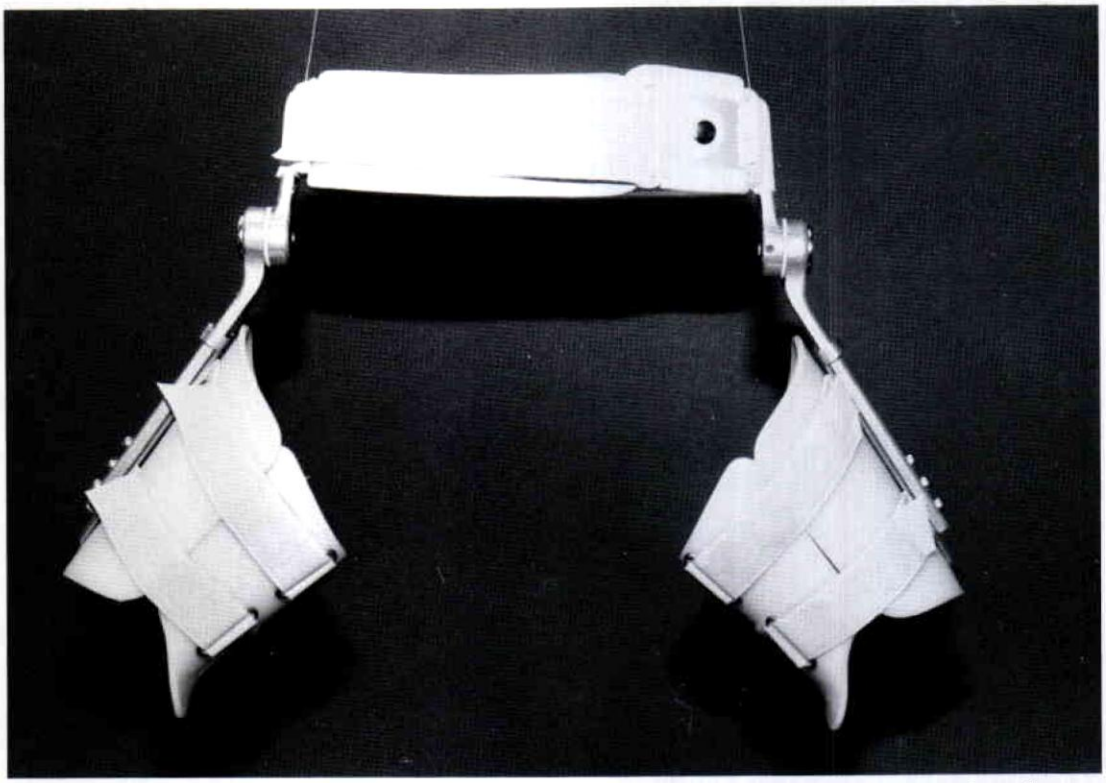

**Figure 7. Updated version of the Scottish Rite Orthosis with aluminum thrust bearing hip joints and no telescoping bar.**

The Scottish Rite Orthosis was developed initially in 1971 at the Scottish Rite Hospital for Crippled Children in Atlanta and revised in 1974.[17, 18] As used at the Scottish Rite Hospital, the orthosis is fabricated with a metal pelvic band and hip joints with the distal upright of the joints abducted (Figure 5). Medial uprights are connected to the lateral uprights with posterior bands and connected to each other by a telescoping rod with two way joints at each end. Leather thigh cuffs and a pelvic belt complete the orthosis.

A commercial version of the orthosis is essentially the same except that plastic thigh cuffs are substituted for the leather cuffs, eliminating the need for the four posterior bands (Figure 6). In addition, universal ball joints are used on the ends of the telescoping rod instead of the two-way joints used in the Atlanta version. Since its introduction, this version of the orthosis has attained a considerable measure of success with a minimum of reported breakage or failure.

In 1982, a new version with different joints was introduced (Figure 7). Aluminum hip joints in two sizes and with thrust bearings in the joints are utilized. In addition the initial abduction angles are milled into the distal upright, as is the offset angle in the proximal upright. This minimizes the amount of contouring to which the joints need to be subjected, and thus the amount of stress in them. The combination of the two factors, thrust bearings and milled contours, means that it is possible to eliminate the telescoping rod between the patients' knees. Consequently, the child can wear the orthosis beneath his clothing and the fabrication procedure is simpler. Maintenance and breakage have not been a problem since the introduction of this joint.

Purvis, et. al. reported on the results of their series in 1980.[15] Forty-one patients had completed treatment, with 78 percent reporting good or fair results. The average age at the state of treatment was six years, eight months, and the orthosis was worn for an average period of 18.9 months, which included a weaning period of some six months.

The authors stressed the importance of obtaining 40°-45° of bilateral hip abduction to provide coverage of the femoral heads, and stated that satisfactory treatment results could not be assured without adequate range of motion in the hips. As described by Petrie and Curtis, bed rest and traction are used to obtain the proper position and, if necessary, percutaneous adductor longus tenotomies. The authors noted further that while internal rotation control was not possible, the children treated tended to adopt a position of hip flexion which increased coverage of the femoral head.

## SUMMARY

The general features of LCPD and aspects of its orthotic management have been discussed. The contemporary period in the orthotic treatment of the disease can be said to have begun with the promulgation of the Containment Theory. Devices for the exploitation of this theory have evolved from the original Petrie casts of the 1950's to the Scottish Rite Orthosis of the 1970's. While a variety of different orthotic designs are used to treat LCPD, in general it would seem that the Scottish Rite Orthosis affords satisfactory correction, while still receiving better patient acceptance than some of the other designs.

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