Lower-Extremity Surgery for Children with Cerebral Palsy: Physical Therapy Management
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Lower-Extremity Surgery for Children with Cerebral Palsy: Physical Therapy Management

The purpose of this article is to discuss physical therapy for children with cerebral palsy who undergo orthopedic surgery. Children with spasticity (increased tone) often undergo surgical procedures to increase the length of the hip, knee, and ankle musculature in an attempt to improve musculoskeletal alignment and functional abilities. Presurgical assessment of posture and movement to determine potential for change in function and postsurgical management are discussed. Intervention immediately following soft tissue surgery at the hips and knees and intervention at the time of cast removal for those children immobilized in a hip spica cast are reviewed. Specific postsurgical management protocols related to immobilization in splints/casts, positioning, and treatment activities are presented. [Harryman SE. Lower-extremity surgery for children with cerebral palsy: physical therapy management. Phys Ther. 1992;72:16-24.]

Key Words: Cerebral palsy, surgery; Lower extremity, hip/knee; Orthopedics, general; Orthotics/splints/casts, lower extremity; Pediatrics, treatment.

The clinical management protocols discussed in this article were initiated in 1971 and gradually modified and refined during the ensuing 20 years. The protocols were established in conjunction with orthopedic surgeons serving the Cerebral Palsy Clinic at the Kennedy Institute for Handicapped Children in Baltimore, Md, and are currently used with children receiving physical therapy services at this facility. Surgical procedures for these children are carried out at the Johns Hopkins Hospital or the Children's Hospital in Baltimore.

Numerous reports1-5 describe lower-extremity surgical procedures in children with cerebral palsy. The majority of these reports discuss surgical techniques or musculoskeletal status prior to and following surgery. Little has been written on presurgical physical therapy assessments or physical therapy management following orthopedic surgery. Recently, there have been reports describing specific physical therapy interventions following hamstring and gracilis muscle releases6 for children with spastic diplegia undergoing adductor tenotomy, psoas muscle transfer, femoral osteotomy, and hamstring muscle lengthening7; following surgery for knee dysfunction8 and following procedures at the hip or knee.9,10 In only one report4 is there a discussion of physical therapy management during the postoperative period. The objective of this article is to stimulate further clinical discussion and research related to the most efficacious treatment of children with cerebral palsy.

Soft tissue surgical procedures at the hip and knee that are commonly performed on children with cerebral palsy include adductor tenotomy, with or without anterior division obturator neurectomy3,11,12; adductor transfer to the ischium10,12; psoas muscle release or lengthening5,10; hamstring muscle lengthening, release, or transfer6; and distal rectus femoris muscle transfer or release.5,10 Following any of these soft tissue procedures, as well as following pelvic or femoral osteotomies, children with cerebral palsy should receive physical therapy.

The management protocol discussed in this article includes presurgical assessment, intervention in the period immediately following soft tissue surgery at the hip or knees, and intervention at the time of cast removal for...
those children immobilized in a hip spica cast.

Presurgical Assessment

Decisions regarding orthopedic surgical procedures in children with cerebral palsy should be made, in conjunction with the family, by a professional team who has known the child for a period of time.\(^5,6\) For some conditions, such as progressive hip subluxation, the timing and choice of procedures may be limited.\(^3\) Often, however, the potential for surgical intervention has been present for months before surgery is scheduled. This allows the therapist and family to plan for the procedure. In addition, important decisions related to postoperative management of positioning and therapy needs should always be open for discussion by the team and family.

Improved musculoskeletal alignment is the most obvious expected result of most surgeries on the soft tissues of children with cerebral palsy. Other areas of anticipated change include quality of posture and movement, function, access to the environment, and ease of management by caregivers. Postsurgical improvement in the quality of posture and movement frequently produces immediate improvement in skills such as sitting\(^5\) and serves as a basis for improved developmental function over an extended period of time. Functional changes in mobility may occur, not only in ambulation, but also in other areas such as in transfers to and from the wheelchair. Children with severe disabilities are likely to be easier to manage during daily care activities following orthopedic surgery. I believe that reduction in pain and deformity and increased tolerance to handling and positioning facilitate improvement in the general quality of family life. Children who are postoperatively able to be placed in and maintain more symmetrical postures in their seating system, as discussed by Hoffer,\(^3\) exhibit improved head, trunk, and upper-extremity control. This improved control may, in turn, lead to increased interaction with the environment through improved ability to use motorized wheelchairs, computers, augmentative communications systems, and environmental control units.

The evaluation techniques used in examining any patient with orthopedic problems, including analysis of walking patterns and documentation of passive and active range of motion (ROM), should be used with all children who have cerebral palsy. Instrumented gait analysis, if a gait laboratory is available, provides an assessment of muscle function to assist in planning surgical procedures.\(^5,8,14-16\) In the population of children with cerebral palsy, in order to delineate which factors interfere with function, the assessment should include analyses of developmental activities and underlying automatic movement reactions.

My experience suggests certain children with cerebral palsy respond particularly well to intensive physical therapy in the immediate postoperative period, showing more mature expression of equilibrium reactions. These responses may then serve as a basis for functional improvement. For children who stabilize in abnormal patterns utilizing increased flexor, extensor, or adductor tone prior to surgery, new means are needed for maintaining posture and coordinating movement following surgery. The presurgical analysis of rolling, sitting, and crawling activities, in addition to walking, assists in determining those patterns of movement that utilize increased tone and that may be interfering with freedom of movement.

Automatic movement reactions, particularly equilibrium, should be assessed during developmental activities and should include determination of the reactions' presence or absence, factors interfering with their expression, and potential for their improved expression following surgery. All components of equilibrium, including the positioning and movement of the head, shoulders, trunk, pelvis, and extremities, should be examined. Lower-extremity components, including weight shift through the pelvis, stabilization at the pelvis and hip, and countermovements against gravity of the pelvis and hip, can be analyzed during developmental activities such as rolling, reaching in the prone and sitting positions, sitting transitions, pulling to a standing position, and cruising (ie, walking sideways along a support). The important countermovement of hip abduction combined with extension should be assessed during both self-initiated and imposed weight shift in a variety of positions and, if necessary, in conjunction with handling techniques to reduce abnormal tone. For example, rotation of the pelvis relative to the trunk and of the femur relative to the pelvis immediately prior to facilitating weight shift may provide a temporary reduction in tone and allow optimal expression of hip abduction. Only with careful analysis of these components of equilibrium can the potential to facilitate improved function be explored.

The presurgical physical therapy assessment should provide sufficient information to determine potential for change in function, target areas for intervention, set postsurgical expectations, and determine treatment strategies. Those children in whom pelvic and lower-extremity components of equilibrium reactions can be elicited in a structured therapy session, but not spontaneously expressed in functional activities, should be considered as candidates for intensive therapy in the postsurgical period. I believe that children who show compromised expression of equilibrium reactions at the pelvis and hips secondary to increased tone, combined with abnormal postural alignment of the lower extremities secondary to muscle shortening, are particularly amenable to physical therapy intervention immediately following orthopedic surgery.

Once the physical therapist and the orthopedist have completed their respective evaluations, surgical procedures and definitive postsurgical expectations should be discussed. The physical therapy contribution related to potential for improved function in posture and movement will assist in selection and timing of procedures as well as in planning optimal postsurgically.
cal management. Recommendations should then be shared with the family and a postsurgical management plan formulated. The child's current seating systems should be assessed jointly by the orthopedist and the physical therapist with the expectation that surgery may necessitate equipment adaptations. Molded chair inserts that were adequate prior to surgery will probably no longer be satisfactory because of improved symmetry of the spine, pelvis, and hips. Seat depths often need adjustment following femoral varus osteotomy, and lateral supports for the trunk, pelvis, or femur may need repositioning following surgery at the hips. Following hamstring muscle surgery, the leg and foot supports may need to be replaced or adjusted because of a different position of the knee at rest in the chair. Specific steps must be taken to ensure that a plan is in place for appropriate adapted seating in the immediate postoperative period. The need for orthoses or other positioning devices following surgery must also be anticipated during the planning period.

**Postsurgical Management—Adductor Releases**

**Potential Areas for Improvement**

This management protocol assumes that surgery will be performed on the adductor muscles, with or without surgery to the psoas muscle. Surgical intervention to the psoas muscle is more variable. Hip adduction is one component of the tonic extensor pattern (which includes hip extension, adduction, and internal rotation; knee extension; and plantar flexion) and is frequently observed in children with cerebral palsy. The presurgical sitting posture on a flat surface often is characterized by a posterior pelvic tilt, with compensatory trunk flexion and a narrow adducted base of support. Many children habitually assume a spontaneous W-sitting posture, considered to be a compensation for increased extensor tone across the pelvis and hips, in which the legs are maintained in a flexed position by the weight of the body. Although W-sitting is a stable and functional posture, it limits the use of the pelvis and precludes the use of countermovements of the lower extremities to assist in maintenance of balance. Presurgical patterns of movement include limited or absent weight shifting through the pelvis; limited or absent countermovements of the lower extremities; limited or absent disassociation of movement between the trunk and the pelvis; between the pelvis and the femur; and between the lower extremities; and compensatory patterns of flexion and adduction in an attempt to maintain stability.

Surgical intervention to the adductor muscles appears to interrupt the tonic extensor pattern that is often present presurgically. This intervention allows the child to use more normal patterns of posture and movement at the pelvis and hips. Decreased extensor tone at the pelvis and hips allows the pelvis to be placed in a neutral position in sitting, that is, with the pelvis perpendicular to the supporting surface. This, in turn, allows the trunk to be extended over the pelvis. The child's ability to maintain hip abduction ultimately provides a more stable base of support than was possible prior to surgery. With postoperative treatment, increased mobility of the pelvis relative to the trunk and the femur relative to the pelvis, improved hip abduction, and a newfound ability to combine hip abduction with hip extension all may lead to functional improvements in sitting stability, sitting transitions (movement in and out of sitting), and mobility. Prior to surgery, standing and walking are usually compromised by a narrow adducted base of support, which may be accompanied by compensatory flexion at the hips and knees. In my experience, improved lateral stability at the pelvis and hips combines with improved hip extension to frequently lead to significant improvement in lower-extremity weight-bearing activities. In addition, the improved lateral stability of the hip combined with improved hip abduction is helpful in arresting or decreasing hip dysplasia.

**Figure 1. Abduction orthosis used with short, tone-inhibiting leg casts**

**Splints/Casts**

Children who are candidates for the type of early mobilization that is increasingly being reported in the literature are placed in orthoses that are removed only for daily physical therapy. The specific orthosis used is dependent for the most part on the choice of the orthopedic surgeon. All orthoses extend proximally over the pelvis to the midtrunk for maintenance of symmetry and are adjustable in relation to amount of hip abduction, hip rotation, and knee extension. The orthoses extend distally to the foot and are usually worn in conjunction with short, nonremovable, "tone-inhibiting" leg casts (Fig. 1). At the end of 6 weeks, the orthoses are removed during the day, but continue to be used at night for a minimum of 6 to 12 months. Children who are not candidates for early mobilization because of severity of involvement, marked hypertonicity, nonavailability of physical therapy services, or osteotomies in conjunction with soft tissue procedures are placed in a hip spica cast. Postsurgical management of these children is discussed at the end of this article.

**Positioning**

Structured positioning protocols are established for each child during the
6 weeks immediately following surgery.5,6,8,9,18 The prone position is used at night and initially during the day, except when the child is eating meals. In my experience, the abducted position of the hips following surgery often stimulates flexion of the hips and knees, particularly in the first few days following surgery. The accompanying abnormal flexor activity during this period is best controlled in the prone position, which, in conjunction with the orthosis, limits hip flexion. If necessary, tone-reducing medication may be used.14 If the psoas muscle has been lengthened or released, the tendency toward hip flexion may be reduced, but the prone position is still preferred for maintaining the improved range of hip extension.

A wheelchair that has been adapted for use with abduction orthoses is used for meals, usually beginning on the third postoperative day. The pelvis is positioned as close to neutral as possible in the chair. The back of the chair is reclined as necessary to seat the pelvis in contact with the chair and allow the trunk to be positioned directly over the pelvis. By the seventh postoperative day, the pelvis can usually be maintained in a neutral position, with the seat-to-back angle at 90 degrees (Fig. 2). By the end of the second week, during non-therapy-related activities, the chair is used most of the day, with 2 to 3 hours of prone positioning interspersed during the day. Children who exhibit increased hip flexor activity or limitations in hip extension may need increased time in the prone position or more frequent position changes.

Supported standing, with the child positioned with the hips in abduction and with the hips and knees in extension, is initiated with the use of the prone stander, on which the child can be secured in an optimal position. The prone stander is used for a minimum of 1 hour daily, usually beginning in the second week; the amount of daily use depends on the degree of influence of increased extensor activity. Orthoses are removed, but short leg casts are worn during use of the prone stander.

**Treatment Activities**

Treatment activities begin on the third postoperative day.6 The initial focus of treatment is to develop tolerance for supported movement without eliciting abnormal patterns. Normal movement patterns such as symmetrical hip flexion are encouraged, and therapeutic handling techniques are used to inhibit the abnormal movement patterns that are present presurgically and the abnormal flexor activity that is often seen postsurgically. The handling techniques, which reduce abnormal muscle activity, are not the primary focus or goal of treatment, but are used to prepare the child to maintain postures and to execute movements in the most normal manner possible.

I believe that all treatment should be based on the principle of the neurodevelopmental approach, with initial emphasis on weight-shifting activities in the prone position to assist the child in spontaneously using the movements of abduction with extension as part of the equilibrium reactions. These weight-shifting activities may be performed on a moving surface such as a therapy ball or during facilitated active movements such as when reaching in a prone position or rolling. During prone activities on the ball, the initial expected response is maintenance of hip abduction to oppose the presurgical adduction response. Weight shifting through the pelvis is encouraged to elicit a countermovement of the pelvis, which will later be accompanied by a countermovement of hip abduction with extension.

Handling techniques used during rolling from a supine to a prone position have the ability to facilitate disassociation movement between the lower extremities, between the femur and the pelvis, and between the pelvis and the trunk. For example, emphasis is placed on initiating movement with hip flexion of the leading lower extremity rather than bilateral hip flexion when rolling from a supine to a prone position. Weight shifting through the pelvis, requiring disassociation of the pelvis from the trunk, with active hip extension and abduction, requiring disassociation of the femur from the pelvis, is emphasized as the transition to a prone position is completed. During rolling from a side-lying or prone position to a supine position, hip abduction, hip extension, and active movement of the pelvis on the trunk are stressed.

Supported sitting is initiated on the third postoperative day. Initial emphasis is placed on achieving an erect trunk over a neutral pelvis and maintaining posture with trunk extension, hip flexion, and knee extension. To develop optimal control of the trunk over the pelvis, most children require considerable practice in this new posture. Weight-shifting activities in both a long-sitting position and a sitting position with the hips and knees flexed to 90 degrees are introduced as soon as a stable midline posture can be maintained. Weight shifting is usually encouraged through active reaching while the child is seated on a stable surface, I believe, because the various components of equilibrium can be more easily isolated on a stable surface than on a moving surface such as the therapy ball. Self-initiated movement is also more readily incorporated into functional activities in
the sitting position in contrast to maintenance of posture on a moving surface, which has minimal functional purpose in daily life. Emphasis during weight-shifting activities is placed on facilitating trunk elongation in contrast to lateral trunk flexion on the weight-bearing side, rotating the trunk relative to the pelvis, and achieving countermovement against gravity of the pelvis combined with hip abduction and extension. Movements into and out of a sitting position, especially from a prone to a sitting position, are used to obtain active rotation of the trunk relative to the pelvis, weight shift through the pelvis, disassociation of movement between the femur and pelvis, and active hip abduction and extension.9

Supported standing activities are introduced through use of the prone stander, usually during the second postoperative week. Children who were ambulatory prior to surgery will also begin standing activities with a walker. When hip abduction with hip and knee extension can be maintained while standing with a walker, weight-shifting activities are introduced. To facilitate weight shifting through the pelvis, emphasis is placed on reaching activities, trunk elongation in contrast to lateral trunk flexion on the weight-bearing side, maintenance of hip extension on the weight-bearing side, and hip abduction on the unweighted side. Weight shifting through the pelvis, disassociation of movement between the femur and pelvis, and active hip abduction in an extended position can also be encouraged through cruising. The therapist should ensure that the child's pelvis is parallel to the supporting surface to achieve hip abduction rather than hip flexion and that the trunk and pelvis are free from the supporting surface to achieve weight shift through the pelvis and hips without support of the pelvis and trunk. Moving between sitting and standing postures provides an opportunity for the child to control hip and knee extension while maintaining hip abduction. Assuming a standing posture through one-half kneeling requires disassociation of movement between the lower extremities as well as more refined pelvic stability.

Ambulation activities are initiated when hip abduction with relative hip and knee extension can be maintained during weight-shifting activities while standing at a support. In our facility, all children, even those who are freely ambulatory prior to surgery, begin ambulation with an assistive device to ensure the best postural alignment and control. Walking is usually initiated with the use of a posterior walker to facilitate hip extension.6 The use of quad canes, progressing to single-point canes if the child is able, is begun as soon as possible after surgery to improve lateral hip stability.

Six weeks following surgery, the orthoses are no longer used during the day, although their use is continued at night. Close monitoring of posture and movement patterns by the therapist is necessary for the next 2 to 3 weeks as the child gradually returns to a less structured therapy protocol; is free to move in the environment, and increases participation in school, play, and daily living activities. In my experience, a majority of the children who receive therapy in the immediate postoperative period will be functionally stable sitters when orthoses are removed during the day. I believe that children who were walking prior to surgery will usually be ambulatory with improved quality of posture and movement. Walking speed and distance, at this time, will usually be decreased in comparison with the pre-surgical status because of decreased endurance and the need to adapt to new patterns of movement, but should gradually improve as lateral hip stability continues to improve.

**Postsurgical Management—Soft Tissue Surgery at the Knees**

**Potential Areas for Improvement**

The management protocol outlined is designed for children who have surgical releases of the hamstring muscles, with or without surgery to the rectus femoris or psoas muscle. Before surgery, because of the tightness of the hamstring muscles, the child sits with posterior pelvic tilt and a resultant compensatory flexion of the trunk. The tilt is increased when the child is placed in a long-sitting position, but the posterior pelvic tilt usually is present in sitting with the hips and knees flexed to 90 degrees (ie, the “90/90” position) as well. The majority of children will have learned to habitually maintain a W-sitting posture in which the legs are maintained in a flexed position by the weight of the body. Although the child may have successfully used this posture to maintain a stable sitting position prior to surgery, this posture prevents the lower extremities from contributing to equilibrium reactions when the child sits or moves from the sitting position. Following surgery, the increased length of the hamstring muscles allows the child to achieve and maintain a neutral position of the pelvis during sitting. The trunk can then be extended over the pelvis. The lower extremities, as a result, are free to move separately from the hips, and there is increased ROM at both the hips and the knees. I find that children frequently demonstrate dramatically improved sitting posture after surgery, and this improved posture leads to independent sitting with increased stability and function within the first 2 to 3 weeks following surgery.6

Prior to surgery, standing is usually compromised by knee flexion with compensatory hip flexion or plantar flexion. I have observed that ambulatory children usually walk with short stride lengths and show knee flexion during mid-stance and terminal stance and decreased endurance attributable to inefficiencies in gait. During the normal gait cycle, the knee provides energy conservation throughout stance by minimizing the vertical excursion of the body's center of mass.14 This is accomplished by knee flexion during the loading response, with progressive extension during mid-stance and terminal stance. Maintenance of knee flexion in children with cerebral palsy, therefore, results in increased energy consumption.14
Flgure 3. Reclined sitting in long leg casts following hamstring muscle surgery

Lengthening of the hamstring muscles, combined with surgical intervention for the rectus femoris or psoas muscle, if necessary, allows for a qualitatively more normal posture with hip and knee extension. This improved posture, in turn, leads to improved stability, function, and efficiency in standing and walking.

Following surgery, children with quadriplegia and little or no equilibrium reactions will often be able to maintain the pelvis in neutral within their seating system, even when they cannot achieve unsupported sitting. The neutral position of the pelvis allows for improved trunk extension with potentially improved head and upper-extremity control.

Splints/Casts

Following surgery, children are placed in long leg casts or short, tone-inhibiting leg casts with knee-ankle-foot orthoses (KAFOs) for a period of 6 weeks. The immobilization method depends on the preference of the orthopedist. Those children whose knees cannot be fully extended during surgery are usually placed in plaster casts and may undergo serial castings during the initial immobilization period. The use of removable orthoses, whenever possible, is recommended to allow early mobilization and active involvement of the knee. Knee-ankle-foot orthoses continue to be used at night for a minimum of 6 to 12 months.

Positioning

Following hamstring muscle surgery, positioning should be designed to achieve the full length of the hamstring muscles, such as would be needed for long sitting with the pelvis in neutral. I believe alternate positioning should support combining hip extension as needed for standing activities with knee extension. Supported sitting for meals is usually initiated in an adapted wheelchair on the third postoperative day. Seating after surgery (Fig. 3) usually requires a reclined chair, so that the pelvis will be in contact with the chair back and the trunk will be directly over the pelvis. Within the limits of comfort, the angle of inclination is gradually reduced. In our experience, this reduction usually results in a neutral position of the pelvis within 7 to 10 days following surgery. The neutral pelvic position in the chair should be maintained either with pelvic straps (Fig. 4) or by securing the child in the chair using the foot plates (Fig. 5). Older children who have had longstanding contractures may require a longer period of time to achieve a neutral position.

The prone position is used at night. The prone position is also the initial primary position used during the day, and it is used for varying amounts of time, depending on the status of the hip flexors. If the hip flexors have been released or lengthened, or if they are tight, the maintenance of hip extension is important to allow for optimal positioning of the hips and lumbar spine when the child stands and walks. Positioning in the prone stander is usually initiated at the end of the first postoperative week. The angle of inclination should be reduced if the child is experiencing hip flexion spasms when attempting to maintain an antigravity position.

By the end of the second week, the long-sitting position, with the pelvis in neutral and the hips flexed and abducted, is used for a minimum of 6 hours daily. The prone position is used 1 to 2 hours daily, and the prone stander is used a minimum of 1 hour daily. The remaining hours are individualized for each child, depending on the factors mentioned.

Treatment Activities

Treatment activities begin on the third postoperative day, and, as with hip surgery, the initial focus is on increasing tolerance to supported movement without eliciting flexor spasms or abnormal patterns of posture and movement. Therapeutic handling techniques to inhibit abnormal movement patterns are used to prepare the child to maintain posture and execute movement in the most normal pattern possible. As with soft tissue releases at
the hip, however, handling techniques to reduce tone are not the primary focus or goal of treatment.

Children immobilized in long leg casts will participate in prone and rolling activities that emphasize hip extension to increase hip control and stability. This activity is similar to that discussed in the section related to soft tissue surgery of the hips. If the child is immobilized in orthoses that can be removed during daily physical therapy, graded knee flexion and extension are initiated as well. If surgery has not included the rectus femoris muscle, emphasis is placed on maintaining the length of this muscle; as increased spasticity (hypertonicity) is often observed in the rectus femoris muscle after lengthening of the hamstring muscles.\(^3\) This finding agrees with the finding of Reimers\(^4\) that, in the presence of spasticity, the antagonist functions more strongly following lengthening and weakening of the agonist. Controlled knee extension during movement transitions and in combination with hip extension during weight-bearing activities is stressed.

Achieving a neutral position of the pelvis in a sitting position is the focus of numerous activities during therapy. Flexion of the trunk, a habitual pre-surgical compensatory position for posterior pelvic tilt, usually continues in the immediate postoperative period. Trunk extension over a neutral pelvis must be continually encouraged.\(^6\) Many children require considerable experience in this new posture in order to develop the ability to maintain a midline position of the trunk over the pelvis. If splints can be removed during therapy, 90° sitting and movement from a prone to a sitting position can be incorporated into the treatment program. Following hamstring muscle surgery, a neutral pelvic position is more quickly obtained in 90° sitting than in long sitting. Sitting with hip and knee flexion, in turn, will allow earlier introduction of weight-shifting activities.

I have found that children who are ambulatory prior to hamstring muscle lengthening often experience considerable difficulty in adapting to a new standing posture with their knees extended. Prior to surgery, hip flexion has frequently been used as a compensatory posture. Following surgery, the child may attempt to use hip flexion in conjunction with knee extension and increased lumbar lordosis, which is a stable posture and precludes the need to grade movement between flexion and extension of the hips and knees.

With the child, standing activities are used to achieve and maintain hip extension, in combination with hip abduction and knee extension. Treatment activities focus on weight shifting through the pelvis to maintain hip extension on the weight-bearing side, use of the abdominal muscles to support the pelvis and thus decrease lumbar lordosis, and midrange control of the knee as during movement between sitting and standing positions.

Figure 4. *Neutral pelvic position maintained by foot pedals.*

Children who were ambulatory prior to surgery usually begin walking with their knees immobilized in extension.
within the first postoperative week. If the child uses KAFOs, the orthoses are unlocked during weight-bearing activities, once knee extension can be combined with hip extension during the stance phase of gait. As the ability to maintain midrange control of the knee improves, KAFOs are discontinued and ambulation continues in short, tone-inhibiting leg casts, which are also called “tone-reducing ankle-foot orthoses” (TRAFOs). All children in our facility use a walker or canes to facilitate hip extension until they are sufficiently secure in the new posture such that they do not revert to the presurgical flexion posture of the hips and knees while standing or walking.

At the end of the 6-week period of immobilization, children are usually placed in floor-reaction ankle-foot-orthoses (AFOs), which are rigid AFOs with an anterior shell extending over the proximal tibia. The floor-reaction AFO limits the forward progression of the tibia in mid-stance and assists with maintaining extension of the knee in the first few months following surgery. All children should be closely monitored to determine readiness for improved function with articulated AFOs. I believe that children who have used short leg casts with removable KAFOs during the previous 6 weeks adapt quickly to the floor-reaction AFOs and that children who were ambulatory prior to surgery resume some degree of functional ambulation after 6 weeks, with improved quality of both posture and movement. Children who were immobilized at the knee for the previous 6 weeks often need additional time to regain adequate knee control to return to their previous level of function. According to Gage, improvement can continue for a full year as the child incorporates new muscle length into the walking pattern. With all children, hamstring muscle length is maintained through long sitting, in KAFOs locked at the knees, each day at the time of night brace application.

**Postsurgical Management—
Immobilization in Hip Spica Cast**

**Rationale for Hip Spica Cast**

Children who are not candidates for early mobilization because of significant involuntary movement, marked hypertonicity, nonavailability of physical therapy services, or osteotomies in conjunction with soft tissue procedures are placed in a hip spica cast.

**Positioning**

The obvious concerns related to skin integrity, swelling, and circulation must be addressed as well as those more specific to children with cerebral palsy, such as abnormalities in muscle tone. The posture of the head, neck, and upper extremities should be controlled through positioning. Good alignment will help to decrease hypertonus, inhibit fixation patterns, and maintain ROM and function. Support of interaction with the environment for the child in a hip spica cast may require a special mobility device or adaptation of a communication system. Children with significant oral motor disability need ongoing assessment and management of nutritional needs during this period of prolonged immobilization. The presurgical position used for eating is usually not possible because of the hip spica cast, and alternative techniques for feeding the child frequently must be established.

**Splints/Casts**

Following cast removal, an abduction orthosis is used at night to maintain the surgical result. The orthosis should extend proximally to midtrunk level to control the position of the pelvis and hips. Extension of the orthosis below the knees or to the feet is optional and dependent on the ROM of the knees and feet.

**Treatment Activities**

Physical therapy is begun on the day of cast removal (ie, about 6 weeks postsurgically). Because increased flexor activity of the hips and knees is prevalent immediately following cast removal, medication to reduce increased muscle tone is frequently used as an adjunct to treatment and management. Initial emphasis is placed on reducing flexor spasms, establishing positioning, and achieving supported movement during position changes. The prone position, with the lower extremities abducted and extended, is the primary position in the first few days, alternating with supported sitting in an adapted chair for meals. The family or other caregivers must be instructed in handling techniques for controlled movement and postural transitions to reduce the possibility of sudden, uncontrolled flexion, because the supracondylar area of the femur is a common site of fractures in the osteoporotic, nonambulatory child. An appropriate chair is essential and can be temporarily adapted to provide the necessary support on the day of cast removal. The chair should support the improved position of the pelvis and hips and limit knee flexion to help prevent distal femoral fractures.

Approximately 7 to 10 days following cast removal, children usually show no signs of distress during supported movement and are able to tolerate supported sitting for several hours at a time. Children with limited motor development, for whom the goal is supported sitting, have usually at this point completed specific postoperative treatment activities and are ready to return to school. Children who were able to sit or walk presurgically, or have the potential to do so, should continue with therapy, as discussed in the section on adductor releases.

**Research Considerations**

Although the orthopedic literature is replete with articles related to children with cerebral palsy who undergo orthopedic procedures, little has been documented comparing presurgical function with postsurgical function. Postsurgical ROM, radiographic assessments of the hip joint, descriptions of weight-bearing posture of the lower ex-
tremities, and ambulatory status are frequently reported, but this population’s postsurgical functional status is less frequently compared with their presurgical functional status. As gait laboratories have become more available, comparative gait analysis has been used to document postoperative change in muscle function and joint angles, assess the surgical results, adjust bracing, and consider additional surgery.

Physical therapists providing treatment for children with cerebral palsy have an obligation to assist in establishing the most efficacious treatments for these children. A presurgical level of functional performance documented by the physical therapist and expressed in an objective manner provides a baseline for comparison following surgical intervention. Detailed evaluations, established baselines, well-defined treatment strategies, and monitoring of progress are necessary for determining the effectiveness of the therapeutic intervention. In addition to this systematic collection of data, therapists must be willing to share and report results of therapeutic intervention in order to establish the efficacy of physical therapy in children with motor impairment.

Summary

Under optimal conditions, decisions related to orthopedic surgery in children with cerebral palsy should be made, in conjunction with the family, by a team of health professionals who have known the child for a period of time. During a presurgical physical therapy assessment, the therapist should determine potential for change, target areas for postsurgical intervention, determine postsurgical expectations, and delineate initial treatment strategies. Structured positioning protocols and individualized treatment activities must be incorporated into the postsurgical intervention plan. Night splinting and continued monitoring with timely adjustment of the management plan, at least within the first 12 months after surgery, are necessary to support long-term maintenance of the surgical result.

References
