Legg-Calvé-Perthes Disease

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Abstract

Legg-Calvé-Perthes disease is a self-limited disease of the femoral head that presents in the first decade. The pathogenesis is thought to involve bone necrosis, collapse, and repair. The presenting complaint is often a painless limp or hip pain, with decreased abduction and internal rotation of the hip. Factors that are believed to correlate with a poor prognosis are onset of symptoms after age 8 years, lateral head subluxation, involvement of over 50% of the femoral head with collapse of the lateral pillar, and the combination of an aspherical femoral head and an incongruent joint. The current cornerstones of treatment are maintenance of hip motion, relief of symptoms, and containment. Containment may be achieved by bracing or surgical means. The literature remains inconclusive on the indications for and effects of treatment. A long-term study has suggested that disabling arthritis of the hip develops in the sixth decade of life in 50% of untreated patients.

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Legg-Calvé-Perthes disease was originally described independently in 1910 by Legg of the United States, Calvé of France, and Perthes of Germany. The condition is a disease of children in which the essential lesion is not simply ischemia, but also includes the resulting process of resorption, collapse, and repair, which may result in a painful, poorly functioning hip. The majority of patients do well into their fifth decade; however, in one long-term study of untreated patients, 50% had disabling arthritis by age 55.[1] Treatment is largely a matter of the physician's personal preference, as the literature offers little scientific evidence to suggest superiority of one treatment over another or even to conclusively establish the efficacy of any treatment over the natural history of the disease.

Pathogenesis

Biopsy studies have established that various stages of bone necrosis and repair are present in the femoral head in Legg-Calvé-Perthes disease. However, numerous experiments in which the blood supply to the femoral head was interrupted in a single event failed to produce the characteristic lesion of Legg-Calvé-Perthes disease. Other researchers have found that recurrent injury to the circumflex arteries in dogs mimics the appearance of the disease, suggesting that Legg-Calvé-Perthes disease occurs over time with repetitive injury. The dependence of the blood supply to the femoral head on retinacular vessels that course through a nondistensible intracapsular space makes the theory of ischemia secondary to tamponade persuasive. Nevertheless, although artificially elevated intracapsular hip pressure and increased intraosseous venous pressure have been shown to produce femoral head ischemia in animals experimentally, they have not been directly linked to Legg-Calvé-Perthes disease in humans. Furthermore, ultrasound evaluation of 4- to 8-year-old boys with early Legg-Calvé-Perthes disease manifested by groin pain and limited hip motion also failed to confirm the presence of capsular distention.[2]

More recently, clotting factors and increased blood viscosity have been implicated as potential causes. Gregosiewicz et al[2] examined the serum of 26 boys with early Legg-Calvé-Perthes disease and found a significantly greater level of α_1-antitrypsin than in control subjects, indicating a decrease in fibrinolytic activity and enhanced intravascular clotting.

A possible relationship between endocrine abnormalities, especially thyroid disorders, and Legg-Calvé-

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Perthes disease has also been studied. In a large recent study,[3] it was found that although children with Legg-Calvé-Perthes disease are euthyroid, they have significantly higher levels of free thyroxine and free triiodothyronine than control subjects. In addition, there was a statistically significant increase in free thyroxine levels with an increasing degree of femoral-head involvement. Earlier work by the same investigators had shown that plasma levels of insulin-like growth factor I were reduced early in Legg-Calvé-Perthes disease.

Histologic evaluation of femoral-head specimens from patients with Legg-Calvé-Perthes disease shows necrosis at different stages of repair. In specimens from 11 children, Catterall et al[4] found three stages of the disease process. In the initial stage, bone necrosis predominates from the physis to the subchondral cartilage-bone interface. Femoral-head ossification is stopped, while the articular cartilage, nourished by synovial fluid, continues to grow, resulting in the radiographic appearance of a small ossific nucleus with a widened cartilage space. In the second stage, resorption of necrotic bone and creeping substitution of the necrotic bone by vascular connective tissue occur slowly over a 1- to 3-year period. The third stage is characterized by the appearance of osteoblasts, followed by new-bone formation and healing. This stage is probably concurrent with revascularization.

Collapse of the necrotic subchondral bone leads to loss of femoral-head height, as well as hip pain and synovitis. After collapse, a renewed cycle of bone resorption and repair begins. Some authors believe there are no symptoms until a subchondral pathologic fracture occurs and that, without collapse, "silent" infarcts may result in nothing more than a growth-arrest line or a "head-within-a-head" radiographic appearance. However, in their study, Salter and Thompson[5] found that 77% of children with Legg-Calvé-Perthes disease did not have evidence of subchondral fractures on radiographs obtained at the time of diagnosis.

The collapse of a subchondral fracture can lead to flattening of the ossific region of the femoral head. The articular cartilage remains intact initially. Healing usually results, with coxa magna. Growth disturbances will occasionally occur if isolated areas of the physis are affected. Physeal involvement is variable, but the anterior portion of the physis is most commonly affected. As the disease is secondary to multiple infarcts of varying age, multiple stages of infarction or repair may be present at any one time. It is interesting that Catterall et al[4] also found that the unaffected hip demonstrates thickening of the articular cartilage with irregular staining, as well as thinner physeal cartilage with irregular cell columns, suggesting that some preexisting condition contributes to susceptibility to Legg-Calvé-Perthes disease.

We do not recommend routine laboratory tests for endocrine or hematopoietic disorders in otherwise healthy children with Legg-Calvé-Perthes disease.

Clinical Presentation

The usual age at presentation is 4 to 10 years. The condition is more frequent in boys than in girls, and affected children are often small for their age. The child usually has limped for a few weeks or months. There is often no pain; when present, pain is usually mild and can affect the knee. Because the hip is innervated by three nerves, the pain may be referred to the suprapatellar region (femoral nerve), the medial thigh (obturator nerve), or the buttock (sciatic nerve). In many cases, diagnosis is delayed due to failure to examine the hip when the patient complains of knee pain. Some patients report having suffered acute trauma when the pain started.

Limited internal rotation and abduction of the hip are the most consistent findings. Limitation of internal rotation is best tested with the hip in extension. Limited hip motion early in the disease is due to muscle spasm and synovitis; late in the disease, it may be due to bone impingement of the femoral head on the acetabulum. Gait may be antalgic and may exhibit a gluteus medius lurch. The Trendelenburg test is often positive, and quadriceps atrophy in the affected leg is common. The affected leg may appear significantly shorter due to an adduction contracture; however, significant shortening is not common unless severe coxa plana has developed.

Radiologic Evaluation and Staging

The diagnosis is generally made and the course of the disease is followed with anteroposterior and frog-leg lateral radiographs of the pelvis. The child often has a delayed bone age. When the condition is bilateral, which occurs in 10% to 20% of cases, the hips may be at different stages. The first radiograph should be obtained without the use of a shield, to exclude the presence of pelvic abnormalities.

The radiographic appearance of Legg-Calvé-Perthes disease may be mimicked by other conditions, including multiple epiphyseal dysplasia, spondyloepiphyseal dysplasia, thyroid disease, Gaucher's disease, and trichorhinophalangeal syndrome, as well as by corticosteroid usage. Numerous radiologic signs and classification systems have been described.

Waldenstrom classified radiologic findings on the basis of the evolutionary phase of the disease. Initially, the femoral head is radiodense and smaller, while the cartilage space of the hip is wider. The increased radiodensity occurs because the surrounding bone has a normal blood supply, thus appearing osteopenic compared with the avascular segment. After a subchondral fracture, the fragmentation stage follows. The radiographic appearance of lateral fragmentation of the femoral epiphysis is caused by ongoing necrotic bone resorption and new-bone formation. This leads into the healing phase, when further reossification occurs and radiodensity becomes normal. The residual deformity may be coxa magna, coxa plana, or coxa breva. The Waldenstrom classification demonstrates which stage of the disease is present, but has no predictive value for long-term outcome or treatment.

The Catterall classification (Fig. 1), which is the most commonly used, defines four groups, primarily on the basis of the amount of involvement of the femoral head and the presence of radiographic "at risk" signs.[6] Group I shows anterior central involvement of the head and no metaphyseal reaction. Group II shows about 50% involvement anterolaterally, with the medial and lateral-pillar portions of the femoral head intact, plus anterolateral metaphyseal lesions. In group III, about 75% of the head is involved, including the lateral column, with diffuse metaphyseal reaction. In group IV,

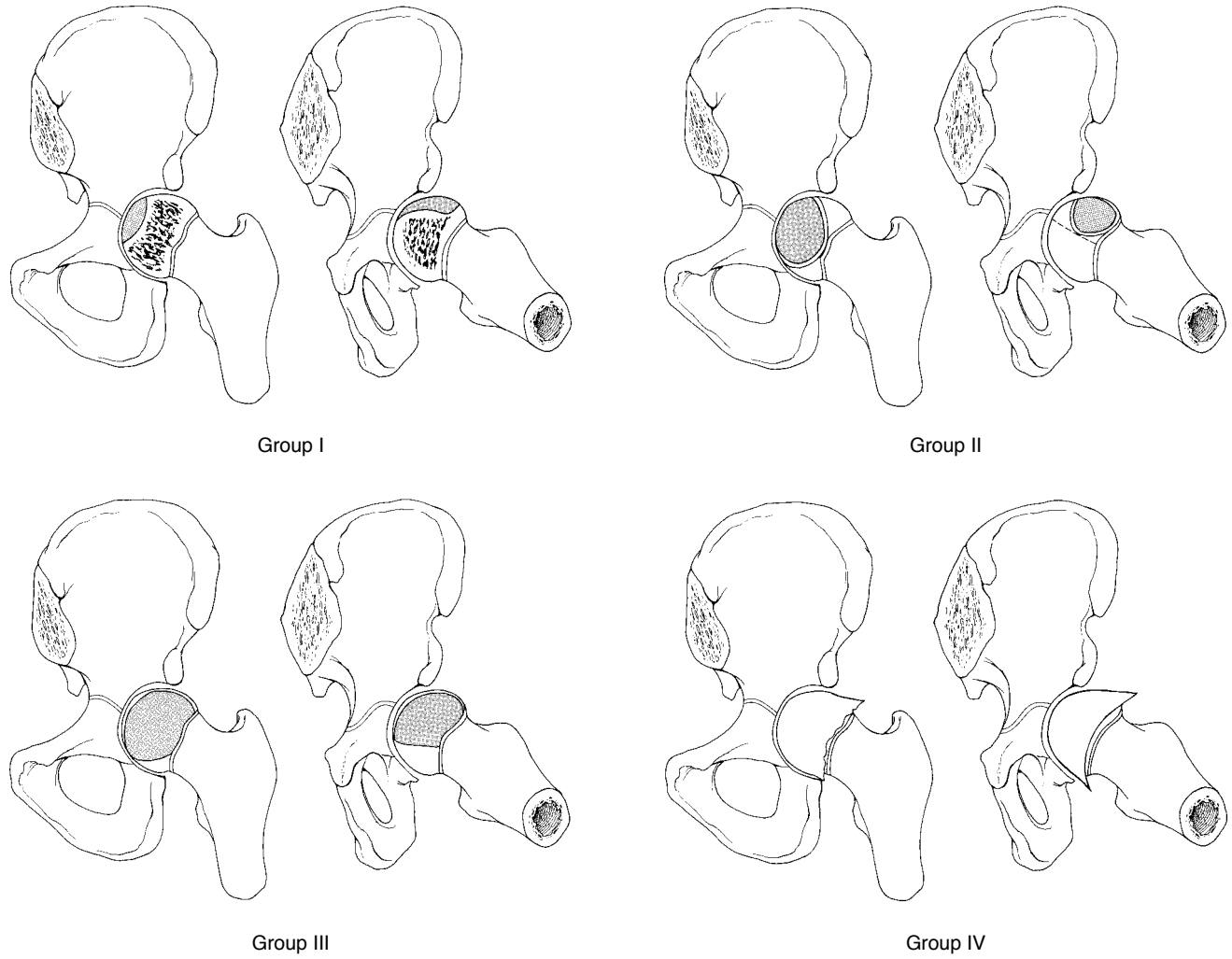

Fig. 1 The Catterall classification of Legg-Calvé-Perthes disease. In group I there is involvement (hatched areas) of the anterior head only, no sequestrum, and no collapse of the epiphysis. In group II, only the anterior head is involved, and there is a sequestrum with a clear junction. In group III only a small part of the epiphysis is not involved. In group IV there is total head involvement.

the entire head is involved, with diffuse or central metaphyseal reaction. Catterall suggested that groups I and II have favorable outcomes without treatment, while groups III and IV have a poorer prognosis and require treatment. Initially established from a retrospective review, the Catterall classification has the disadvantage that the appropriate group designation may appear to change as the disease proceeds.

After reviewing the radiographs of 1,264 children with Legg-Calvé-Perthes disease, Salter and Thompson[5] concluded that the extent of the subchondral fracture correlated precisely with the subsequent extent of maximum resorption, potentially providing an early means of predicting the eventual extent of femoral-head involvement. The subchondral fracture, or "crescent sign," is a transient phenomenon in the early stages of the disease, lasting 2 to 9 months. Radiographic visualization of such a fracture may herald the onset of symptoms in a previously asymptomatic process.

The Salter-Thompson classification is based on the extent of subchondral fracture. In group A, less than half of the femoral head is involved; in group B, more than half of the femoral head is involved. The advantages of this classification system are early applicability and simplicity. The major disadvantage of the Salter-Thompson classification is that 77% of the patients in their series did not have radiographs showing a subchondral fracture. As the study was retrospective, it was not possible to obtain replacements for poor-quality radiographs, which might have been more likely to show a crescent sign. Despite their drawbacks, both the Catterall and Salter-Thompson classifications seem to have prognostic value.[7]

A relatively new classification has been proposed by Herring et al[8] (Fig. 2). On an anteroposterior radiograph of the pelvis obtained in the early fragmentation phase, the height of the lateral epiphyseal pillar is compared with the height of the normal contralateral epiphysis. In group A, there is no collapse of the lateral pillar. In group B, the lateral pillar maintains at least 50% of its original height. In group C, there is collapse of the lateral pillar, with loss of more than 50% of its original height. In a retrospective analysis, no hip in group A had progressive femoral-head flattening, while only the oldest patients in group B (mean age at onset of disease, 10 years) had a flattened femoral head. Patients in group C were most likely to exhibit progressive flattening during reossification (incidence, 17%). This study also showed that, contrary to previous belief, the femoral head may continue to deform during the 3- to 4-year period of reossification.

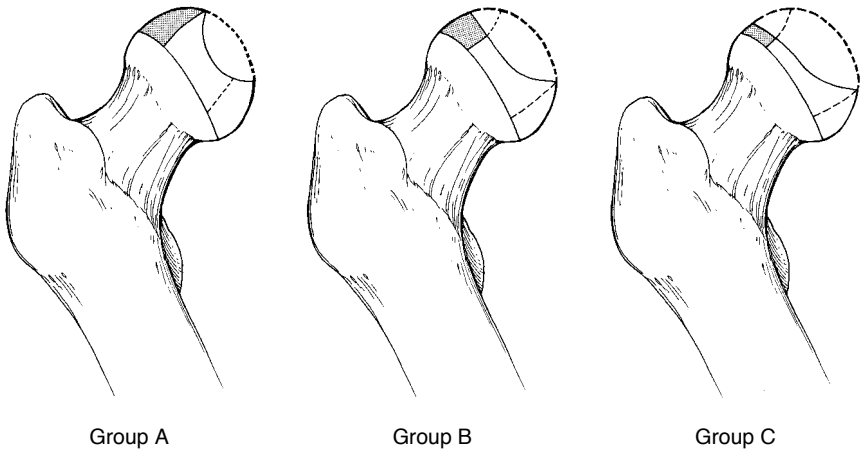

Fig. 2 The Herring classification of Legg-Calvé-Perthes disease. In group A, the lateral pillar retains its original height and shows slight radiographic changes. In group B, the lateral pillar may show density changes and height loss, but retains at least 50% of its original height. In group C, the lateral pillar is characterized by radiolucencies and collapse to less than 50% of its original height.

Ritterbusch et al[9] compared the Herring lateral-pillar classification and the Catterall classification and found that the lateral-pillar classification was a better predictor of long-term outcome and had greater interobserver reliability. We currently favor the lateral-pillar classification.

Other Imaging Studies

The initial radiographic changes of Legg-Calvé-Perthes disease may be absent at the onset of symptoms. Technetium-99m bone scanning with use of a pin-hole collimator may allow earlier diagnosis than radiography. Early in the course of the disease, a bone scan displays "cold spots," representing avascular areas that involve a significant part of the femoral head, while the femoral physis and acetabular rim show normal radioisotope uptake. During revascularization, the femoral head demonstrates increased isotope uptake. Revascularization of bone can occur by recanalization of existing vessels or by neovascularization through the development of new vessels. Recanalization occurs rapidly (minutes to weeks), whereas neovascularization is a prolonged process (months to years). The bone-scan

pattern of revascularization that begins with visualization of the lateral epiphyseal column appears to represent recanalization of the medial circumflex artery. This process occurs relatively rapidly and carries a good prognosis. A scintigraphic appearance of base filling, indicating extension of radioactivity through the growth plate into the base of the epiphysis by new vessels, represents neovascularization, which carries a poorer prognosis.[10]

Magnetic resonance (MR) imaging may depict bone infarction before radiography does. In addition, MR imaging provides direct visualization of articular and physeal cartilage and can be used to estimate femoral-head sphericity better than radiography. However, MR imaging has not proved advantageous over radiography for serially following the disease process and is certainly more expensive. As all studies to date are based on radiographic criteria, it is unclear at this time whether bone-scan or MR changes warrant treatment.

Arthrography is an excellent dynamic study in that it allows visualization of femoral-head shape and hip-joint congruency through the full range of motion of the hip. Arthrography can demonstrate the best position for containment if the femoral head is congruent and can depict the presence of hinge abduction if the femoral head is deformed.

Natural History

Most reviews of patients with Legg-Calvé-Perthes disease have the inherent problems of retrospective reviews, including grouping of various treatments and degrees of disease severity. However, in follow-up studies into late middle age of patients with Catterall group II, III, or IV disease, 70% to 90% were active and free of significant pain, with good range of motion, although their radiographs were often abnormal. Typical of these studies is that by Gower and Johnston.[11] They evaluated 36 patients (average age, 45 years) 36 years after the onset of symptoms of Legg-Calvé-Perthes disease. Of the 30 patients who were treated nonoperatively, 86% had scores on the Iowa Hip Rating Scale of more than 80 points, and 8% had been treated with arthroplasty.

This same group of patients was later reexamined by McAndrew and Weinstein,[1] when the patients had an average age of 55 years. The number of patients with Iowa hip scores over 80 points had fallen to 40%. Forty percent of the patients had undergone total hip arthroplasty, and an additional 10% had disabling osteoarthritis. A strong correlation between loss in width of the joint space (as seen radiographically) and the change in the Iowa hip score was noted. Other measurements of femoral-head and acetabular deformity and congruency had not changed over this follow-up period. It was concluded that the observed deterioration in function could be attributed solely to the onset of osteoarthritis.

It should be noted that these two studies evaluated the results of noncontainment treatment. No similar long-term studies after containment treatment have been published.

Prognosis

A number of radiographic at-risk signs that have been discussed deserve brief mention. Catterall proposed that patients are at risk for a poor prognosis if the following radiographic findings are present: Gage's sign (a radiolucent "V" on the lateral side of the epiphysis), calcification lateral to the epiphysis, lateral subluxation of the femoral head, a horizontal physis, and metaphyseal cysts. Some authors have considered "metaphyseal" cysts to be epiphyseal changes superimposed on the metaphysis by three-dimensional radiographic distortion.[12] While these authors also argue that there has never been clinical or anatomic confirmation of metaphyseal cysts, Catterall[6] found metaphyseal lesions consisting of nonossified cartilage in autopsy studies.

While "head at risk" signs have been thought to be prognostic indicators, two recent reports, each involving 100 patients, concluded that no head-at-risk sign other than lateral subluxation was important as a prognostic indicator.[7,13] In a long-term follow-up study, McAndrew and Weinstein[1] found that three radiologic measurements correlated with a poor clinical outcome: two or more Catterall head-at-risk signs, coxa magna (in which the femoral head is larger than normal by 10% or more, as described by Stulberg et al[14]), and a decrease in joint space in later life.[1]

Coxa magna, coxa breva resulting from growth arrest, coxa plana, and acetabular deformities are associated with healed Legg-Calvé-Perthes disease. Stulberg et al[14] correlated the radiographic deformity of the femoral head at skeletal maturity with the eventual functional outcome. Femoral heads that were flat yet congruent with the acetabulum were at risk for arthritis in the sixth decade of life. As the normal ball-and-socket joint deforms to a flattened cylinder, the hip loses abduction and rotation capability, while retaining flexion and extension potential. If the femoral head is flat and is not concentric with the acetabulum, early severe arthritis occurs. Hinge abduction and anterior impingement are known sequelae of a flat, incongruent femoral head.

One of the most important prognostic indicators is limitation of hip motion. In the initial stages of the disease, synovitis is responsible for

loss of hip motion. If the hip remains stiff for a prolonged period, deformation of the hip joint may develop. Long-term studies have shown that the earlier the onset of the disease, the better the long-term prognosis. The age of 6 to 8 years appears to be the dividing line,[1,14] perhaps because the acetabulum and femoral head lose some remodeling potential as the child ages.

Salter and Thompson[5] found no significant difference in outcome between Catterall groups I and II (satisfactory outcomes in 100% and 93% of patients, respectively) but noted worse results in group III hips (60% to 76% satisfactory) and group IV hips (41% to 61% satisfactory). This study appears to support the treatment of Catterall group III and IV hips but only observation of group I and II hips.

Another prognostic indicator involves the lateral pillar. Because the intact lateral column protects the epiphysis, it has been shown to be a favorable prognostic indicator.[5,8,9]

Treatment

Early treatment of Legg-Calvé-Perthes disease focused on relief from weight-bearing until the femoral head had reossified. Prolonged bed rest, traction, spica casts, and special frames and slings were used, but the results of treatment were difficult to assess accurately.

The results of current Legg-Calvé-Perthes treatment are difficult to evaluate. It is still uncertain who needs treatment and who does not. The most commonly used classification system, that of Catterall, may have high interobserver variation. In the studies published to date, there is a lack of uniformity of criteria for selection, treatment, and evaluation, and, more important, there are few control studies.[15] In addition, no studies reported to date have been prospective or randomized, although a multicenter prospective study is currently ongoing. In a recently published in-depth review of the literature on Legg-Calvé-Perthes management, Herring[15] cited the inconclusiveness of the findings.

Today, maintenance of hip motion and containment of the involved femoral head form the bases for treatment of Legg-Calvé-Perthes disease. However, the 80% good results in a 22-year follow-up at an institution where noncontainment treatment with a weight-relieving sling or harness was used[16] have been as good as any reported.

The initial goal of treatment is to restore hip mobility and relieve pain. The next step is to decide what percentage of the femoral head is involved and whether active treatment will be needed. Containment treatment should not begin until abduction and internal rotation have been restored to a near-normal state. Several days of bed rest at home or in the hospital may be needed to reduce the symptoms. Traction may be used to help keep the child off his or her feet. Physical therapy often is useful to help maintain hip motion. Adductor tenotomy or serial Petrie abduction casts may be necessary in more resistant cases.

Once hip mobility has improved, containment treatment can be considered. The theory behind containment is that development of a congruent joint is dependent on maximal contact between the immature femoral head and acetabulum. This theory has been proved clinically and in the laboratory in developmental dysplasia of the hips, although the results for Legg-Calvé-Perthes disease remain somewhat difficult to interpret. Before beginning any form of containment treatment, it is essential to make certain that the hips can be contained congruently and that there is no hinge abduction due to femoral-head flattening. Arthrography is particularly useful if abduction radiographs taken in the position of proposed containment are equivocal.

For the purpose of discussion, we will divide Legg-Calvé-Perthes disease patients into two categories on the basis of the extent of involvement of the femoral head. Children with less femoral-head involvement are those with Catterall group I or II, Salter-Thompson group A, or Herring type A or B disease. The majority of these patients have excellent results regardless of the type of treatment or lack thereof. Children with more femoral-head involvement (i.e., those with Catterall group III or IV, Salter-Thompson group B, or Herring type C disease) often have later disability if untreated. Maintenance of hip range of motion is probably all the treatment required for patients with less involvement, especially those under 6 years of age. No containment treatment is indicated unless there are poor prognostic indicators, such as persistent or recurrent synovitis, lateral subluxation, involvement of the lateral pillar, or involvement of nearly 50% of the femoral head. We recommend some form of containment treatment for most children aged 6 years or older in whom there are more than two poor prognostic indicators. Children with more involvement should receive containment treatment. Our preference is to use bracing for children under 7 years and surgical containment for those over 7 years.

Nonoperative Containment

Containment methods that prohibit hip motion, such as the use of spica casts, are not recommended. Motion is a prerequisite for containment treatment and cannot be overemphasized during the course of treatment. Petrie casts (two long-leg casts separated by an abduction

bar) have been used as a means of containment, although medial femoral condyle flattening has been described with prolonged use. These and other long-leg orthoses promote abduction while allowing motion at the hip and ambulation.

Petrie casts have been largely superseded by shorter orthoses. The most popular of these is the Scottish-Rite Hospital orthosis, which consists of two thigh cuffs connected by an abduction bar, with joints to allow motion at the hips and knees, promote ambulation, and contain the femoral head. It is generally well tolerated by patients under 7 years and well accepted by their parents. Deciding when to remove the brace is a problem, as there is no clear evidence showing when containment ceases to be beneficial. The patient is generally weaned off use of the orthosis when radiographs show that the disease is in the reparative stage, as shown by reossification of the lateral epiphysis.[15] Although two recent reviews of the use of the Scottish-Rite Hospital orthosis in patients with Catterall group III or IV disease (mean age at diagnosis, 6 and 7 years) failed to show any advantage over either no treatment or other means of treatment,[17,18] the possibility of avoiding surgery has led many pediatric orthopaedists to continue to use this device in younger children with Legg-Calvé-Perthes disease.

Operative Containment

The relative advantages of operative over nonoperative treatment are also unclear. Many have reported that operative treatment provides an improved outcome compared with the natural history in children with more extensive femoral-head involvement, although rigorous controls have been lacking. A comparative study of varus-derotation osteotomy and ambulation-abduction bracing in children over 6 years revealed no difference in results.[19]

Surgical containment can be achieved by proximal femoral varus osteotomy, innominate osteotomy, an acetabular-shelf procedure, or some combination of femoral and pelvic procedures. However, it must be remembered that in a normal hip the femoral head is only 63% "contained," as the femoral head is 120% of a hemisphere while the acetabulum is 75% of a hemisphere.[20] Furthermore, which 63% of the femoral head is in contact with the acetabulum is a function of the phase of gait as the joint changes position. One review of 72 patients treated with a femoral or innominate osteotomy disclosed no difference in results at follow-up.[21] There are the usual risks of surgery, and a second operation is often necessary to remove hardware. The advantages of surgery include definitive treatment, a short period of limited activity, and the avoidance of psychosocial issues arising from prolonged brace wearing.

Salter[22] recommends the innominate osteotomy for children 6 years or older with Salter-Thompson group B involvement and subluxation of the femoral head in a weight-bearing position. His recommended criteria for surgery are pain-free full range of motion of the hip and no deformation of the femoral head. While studies of the innominate osteotomy may have slightly better results than other surgical series, it is likely due to the above-mentioned selection criteria. The Salter innominate osteotomy provides a practical limit of 25 degrees of anterior coverage and a range in lateral coverage of 5 degrees at heel strike to 15 degrees at midstance, with an increase in anterior coverage at the expense of less posterior coverage.[20] To ensure preservation of motion, a psoas and partial-adductor tenotomy should accompany the procedure, a postoperative hip spica cast should be avoided, and physical therapy should be begun early.

Varus-derotation osteotomy of the proximal femur may provide containment if an abduction-internal rotation radiograph of the hip shows containment. A dynamic arthrogram is recommended to find the best position, as the osteotomy can correct for rotation, varus/valgus, and flexion/extension as needed. Varus correction should be limited to 20 degrees, because complications such as a short leg and abductor lurch are more pronounced with greater varus angulation, although both usually improve with time. One may expect 15 to 20 degrees of increased lateral coverage and about 10 degrees of improved anterior coverage from a 15-degree-varus, 15-degree-derotation osteotomy of the proximal femur. While this osteotomy theoretically doubles the shear force across the proximal femoral physis,[19] adverse clinical effects have not been reported.

As there are limitations to the amount of femoral-head coverage that can be obtained with both innominate and intertrochanteric osteotomies, a combined procedure may be indicated in severe subluxation. Theoretically, the potential lengthening and increased joint pressure resulting from an innominate osteotomy may be avoided by performing an intertrochanteric osteotomy, which provides both shortening and a decrease in joint-surface pressure. Both osteotomies may be performed through a single ilioinguinal approach or through separate incisions. Use of this combination has been reported in patients with Catterall group III or IV involvement; seven of nine patients had clinically good results after a mean follow-up period of 50 months.[23]

Shelf arthroplasty has been recommended for children over the age of 8 years who have Catterall group

II, III, or IV disease, to prevent subluxation and increase acetabular coverage. Compared with an age-matched control group treated nonoperatively, patients who underwent a shelf arthroplasty had better hip motion and coverage 2 years after surgery.[24] Hardware removal is not needed with this procedure.

Hinge abduction occurs later when an enlarged femoral head is laterally extruded and impinges against the lateral acetabular rim on abduction, causing pain. A medial dye pool is seen on arthrography. A valgus osteotomy is indicated if arthrography shows congruence of the medial femoral head with the acetabulum as the hip is adducted, provided a functional amount of adduction would remain after the osteotomy. Chiari osteotomies performed as salvage procedures in the older child with little remodeling potential serve to increase the load-bearing area, which may offer several years of pain-free hip function before further reconstructive surgery is needed.

Summary

Although the literature is inconclusive on indications for treatment and what type of treatment to use, some recommendations seem warranted. Regaining and preserving hip motion cannot be overstressed and is certainly indicated before any containment treatment. Poor prognostic factors include the onset of symptoms after age 8 years, lateral hip subluxation, involvement of more than 50% of the femoral head with collapse of the lateral pillar, and an aspherical femoral head with an incongruent joint. In the presence of any of these factors, it is unlikely that containment treatment will harm the patient, and it certainly may help. As long-term studies have shown that in 50% of untreated patients disabling arthritis of the hip develops in the sixth decade of life, it

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