Current Management and Rehabilitation in Legg-Calvé Perthes Disease

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The hip plays a pivotal role in providing mobility for our everyday life activities. Hip disorders in children, such as Legg-Calvé-Perthes Disease (LCPD), can adversely affect a child’s mobility and activity level. LCPD is a hip disorder that involves avascular necrosis of the proximal femoral head. It is a relatively self-limiting disorder, in that some activities may need to be modified to ensure that excessive forces are not placed on the femoral head; however, failure to treat the condition may adversely affect regeneration of the femoral head. Because the etiology of LCPD is not completely understood, the best way to treat the condition is debated. Limitation of high-impact activities and rehabilitation that focuses on restoration of range of motion (ROM) is usually recommended.

**Etiology**

Deficiency in proteins C and S, interruption of blood flow in the artery of the ligamentum teres femoris, and trauma that results in the loss of intraosseous or extraosseous blood supply have been proposed as etiologic factors. Other factors that may contribute to the development of LCPD include abnormal venous drainage, abnormal growth and development, and coagulation abnormalities. Because the mechanism responsible for development of the condition is not clearly understood, there is no known preventive measure.

LCPD is manifested in four pathological phases: synovitis phase, osteonecrosis phase, fragmentation phase, and revascularization phase. The synovitis phase usually presents decreased movement of the hip. This phase can last from six months to one year. During the osteonecrosis phase, interruption of blood supply to the femoral head occurs, and the bone tissue begins to die. Symptoms become more pronounced in the fragmentation phase. Affected individuals begin to lose more ROM, they begin to have more pain with activities, and they display more prominent gait deviations during this stage, which can last up to one year. During the last stage, new bone formation occurs over a period that lasts from one to three years. Some individuals may not demonstrate radiographic abnormalities initially, but MRI may demonstrate decreased blood supply to the femoral head. Most individuals can be diagnosed by x-ray when the femoral head demonstrates an increase in density.
**Signs and Symptoms**

The most common signs and symptoms that develop with LCPD include hip, groin, or anterior knee pain, decreased ROM (usually restriction of internal rotation and abduction), gait abnormalities, and muscle atrophy.\(^1\)\(^-\)\(^3\) It is usually more common in boys than girls and typically occurs in children between the ages of 4 and 8 years of age, but can occur up to 12 years of age.\(^1\)\(^-\)\(^5\)

LCPD is often confused with Slipped Capital Femoral Epiphysis (SCFE), which presents the same signs and symptoms. SCFE typically is seen in the adolescent population (11-15 years of age), the individual is commonly overweight, and pain is often experienced in the thigh or knee, rather than in the hip only.\(^1\)

Hip pain in young children should be taken seriously. Any child with hip or groin pain, a decrease in hip ROM, or gait abnormalities should be referred for medical evaluation. Depending on the severity of the condition, some individuals with minimal pain and good ROM can continue normal activities.\(^6\)

**Treatment**

Treatment for LCPD may vary according to the age of the individual and the extent to which the femoral head is damaged. The age of onset of the disease is usually a prime determinant in the prognosis of the individual, regardless of the treatment (operative or non-operative). Some physicians have noted that children over 8 years of age will usually have a poorer outcome than those who are younger.\(^1\)\(^-\)\(^2\)\(^,\)\(^5\)\(^,\)\(^6\) Kruse et al.\(^7\) reported two cases that were treated non-operatively, both of which involved patients who were older than 8 years of age. Neither patient had a positive outcome. Containment is the method of treatment for LCPD that maintains the femoral head within the acetabulum, thereby allowing the natural curve of the acetabulum to reshape the femoral head.\(^3\) The available evidence suggests that children older than 8 years of age do not benefit from containment treatment.\(^4\)\(^,\)\(^6\) Children who are less than 6 years of age usually have a better outcome and fewer residual problems, regardless of the chosen method of treatment.\(^3\)\(^-\)\(^6\) Kamhi and MacEwen\(^8\) reported that approximately half of children treated with containment had a good result (48 %) and approximately half had a good result without containment (49 %). Although age is a strong predictor of the outcome, the extent of the deformity to the femoral head and hip ROM are important factors.

The main goal of LCPD treatment is to maintain (or restore) a spherical femoral head and to prevent loss of hip ROM.\(^1\)\(^-\)\(^2\)\(^,\)\(^5\) A nonsteroidal anti-inflammatory drug and crutches for relief of pain associated with walking, traction, and rehabilitation help improve ROM.\(^1\)\(^-\)\(^3\)\(^,\)\(^8\) Depending on the severity of the condition, other methods of treatment may include containment or surgical intervention. Containment involves the application of a Petrie plaster cast or brace that maintains the hip in a position between 30 and 45 degrees of abduction for several weeks. Because containment requires several weeks of immobility, hip ROM must be restored before it is initiated.\(^1\)\(^,\)\(^4\)

Surgical management of LCPD is generally recommended. The extent of the femoral head that is involved and the age of the client are criteria that influence the likelihood of surgical intervention success, including the extent to which the femoral head demonstrates abnormality and the age of the patient. A variety of surgical methods are used, but outcomes have not been found to be significantly different.\(^2\)\(^,\)\(^5\)\(^,\)\(^6\)

Because the pathophysiology of LCPD is unclear, expert opinions about best practices for its management differ. The goals of LCPD rehabilitation are essentially the same as for other hip disorders: decreasing inflammation, decreasing pain (through reduction of weight-bearing activity), and increasing hip ROM. Restoration and maintenance of hip ROM is believed to be the most important aspect of LCPD rehabilitation.\(^6\)

**Aquatic Exercise vs. Land-based Exercise**

Incorporation of aquatic exercise as a component of LCPD rehabilitation will be fun and beneficial for the child patient. Aquatic exercise may increase ROM to a greater extent than land-based exercises alone, and the buoyant environment has other benefits. Reduction of compressive force on the joints of the lower extremity facilitates restoration of normal movement patterns in patients who are unable to perform normal weight-bearing activities or are unable to walk without a gait abnormality. Although research evidence for aquatic exercise benefits for LCPD patients do not exist, several studies have demonstrated benefits for individuals with rheumatic diseases. Templeton et al.\(^9\) reported that 94 % of patients with rheumatic disorders experienced a decrease in pain and improved their functional abilities. Hinman et al.\(^10\) reported that 72-75 % of patients with hip and knee osteoarthritis who participated in a 6-week aquatic program experienced pain reduction,
whereas only 17% of comparable patients realized the same degree of benefit from a program that did not include an aquatic exercise program. Silva et al.\textsuperscript{11} compared an aquatic exercise program to a conventional rehabilitation program for knee osteoarthritis and reported that patients in the aquatic group realized significant pain reduction. One study that involved children with juvenile idiopathic arthritis documented improvement in physical function, but the results were not statistically significant.\textsuperscript{12} 

Although aquatic exercise is definitely beneficial and fun for children, conventional therapeutic exercises should be included in the rehabilitation program. Patients with osteoarthritis who were compliant in performance of a conventional exercise protocol have been reported to realize reduced pain and disability versus patients who did not participate in such a program.\textsuperscript{13} Self-directed home exercise programs have been reported to reduce pain by 12%.\textsuperscript{14}

**LCPD Rehabilitation Protocol**

Swimming ability will affect the type of exercises chosen for an aquatic therapy program, and exercise volume will be affected by a patient’s pain level and movement tolerance. Exercises should be fun for a child patient. Some deep water exercises may require the use of a flotation device. A water temperature of 30–31 degrees Celsius (86–88 degrees Fahrenheit) is recommended.\textsuperscript{12}

Children have demonstrated greater gains in knee extension strength with low-repetition/heavy-load than high-repetition/moderate-load resistance training.\textsuperscript{15} The same number of repetitions of the same exercise produce a significantly greater amount of muscle activation in water than on land.\textsuperscript{16} We advocate the Daily Adjusted Progressive Resistance Exercise (DAPRE) approach to progression through the initial stage of the rehabilitation program (Table 1).\textsuperscript{17} As the child patient becomes more tolerant of exercise, a progression may be made from endurance exercise (12-20 repetitions for 1-3 sets) to strength exercise (6-12 repetitions for 1-3 sets), and finally, to power/explosive exercise (≤6 repetitions for 1–3 sets).\textsuperscript{18}

Progression through phases is not based on time intervals, but requires attainment of performance criteria. Minimal or no pain and 80–100% of normal hip ROM should be exhibited before progressing from the initial phase. When progressing from the second to the third phase, the patient should not have any strength deficits and should be able to bear full body weight with minimal or no pain. Individuals will progress at different rates depending on the severity of the condition.

The first phase of the program is focused on ROM improvement through low-impact exercises. Deep water exercises may include aqua-jogging (Figure 1), flutter kicks (Figure 2), tracing ABCs with the lower extremity (Figure 3), or performance of a cycling motion. Shallow water exercises may include the use of a kickboard for swimming from one end of the pool to the other. Treasure diving is a fun game to play with child patients. Place objects or toys on the pool floor and have the child swim to retrieve them. Buoyancy-assisted flexion/extension, abduction/adduction, and internal/external rotation of the hip should be empha-

### Table 1. LCPD Protocol

<table>
<thead>
<tr>
<th>Phase I (Range of Motion)</th>
<th>Phase II (Strength, balance, proprioception)</th>
<th>Phase III (Sport-Specific)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deep Water Aquatic Exercises</strong></td>
<td>Aqua-jogging</td>
<td>Flutter kicks</td>
</tr>
<tr>
<td></td>
<td>Flutter kicks</td>
<td>Shuttle run</td>
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<td></td>
<td>ABCs</td>
<td>Backward running</td>
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<td></td>
<td>Bicycle</td>
<td>Scissors</td>
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<td></td>
<td>Knee highs</td>
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<td></td>
<td>Cross-country ski</td>
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<tr>
<td><strong>Shallow Water Aquatic Exercises</strong></td>
<td>Kickboard</td>
<td>Rocking horse</td>
</tr>
<tr>
<td></td>
<td>Treasure diving</td>
<td>Pad jumping</td>
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<td></td>
<td>Lateral shuffle ball toss</td>
<td>Washing machine</td>
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<tr>
<td></td>
<td>Buoyancy-assisted abduction/ internal/external rotation</td>
<td>Dips</td>
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<td></td>
<td></td>
<td>Standing jumps</td>
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<td></td>
<td></td>
<td>Standing abduction (with resistance)</td>
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sized during the initial phase (Figure 4). The difficulty level of these exercises can be increased through progression to a standing position (no resistance other than water), followed by progression to augmented resistance or by increasing rate of movement through the water.

The second phase is focused on development of strength, balance, and coordination. Both deep water and shallow water exercises are used, and some land exercises are introduced. Having the child patient stand on one leg while the therapist runs around the child creates a water current that can improve postural balance. Other shallow water exercise options include placing pads of different colors on the pool floor and having the child jump from one to another (Figure 5), jumping over or into objects such as a hula hoop, performing dips (Figure 6a and 6b), and doing standing hip abduction/adduction exercises (Figure 7a and 7b).

The last phase of the program is focused on restoration of sport-specific skills or skills that relate to daily activities. To prepare for a return to sports, basic plyometrics can be performed in the shallow end of the pool. Aquatic plyometric exercise intensity can be adjusted by changing the water depth. To increase the intensity of an exercise, have the progress toward the more shallow end of the pool; if the intensity is too great, the exercise should be initiated a few steps further back into the deeper end of the pool. Hip ROM exercises should not be eliminated from the more advanced phase of the program, because complete healing of the femoral head can take up to 4 years.6
Orthopedic surgeons generally recommend avoidance of running or participation in any high-impact sport or activity, based on the concern that excessive loading to the epiphysis of the femur can negatively affect the normal growth process. Usually, sports that do not elicit symptoms are allowed. Physical activities that do not impose impact loads on the hip joint, such as swimming, are recommended. A slow progression to normal activity and participation in sports is important to avoid overloading. A physician must ensure that proper regeneration and revascularization of the femoral head has occurred before the patient is allowed to return to normal weight-bearing activities.

Summary

LCPD is a self-limiting hip disorder that involves avascular necrosis of the femoral head. Restoration of hip ROM and strength are key components of LCPD rehabilitation. Aquatic exercise can be fun for the child patient, and progressive exercise may help patients return to normal activities at a faster rate. Long-term follow-up is essential for patients with LCPD.

References


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