Conservative versus surgical treatment of late-onset Legg-Calve-Perthes disease: a radiographic comparison at skeletal maturity

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Abstract

Background Late-onset Legg-Calve-Perthes disease (LCPD; i.e., disease onset after 8 years) has been associated with a more aggressive course and poorer long-term outcomes. The optimal treatment method of LCPD is still controversial, especially in this late-onset patient population. The purpose of this study was to evaluate the radiographic outcomes at the end of skeletal maturity in a cohort of patients with late-onset LCPD, comparing the results between conservative and surgical treatment.

Methods We performed a retrospective comparative study of all 371 patients with LCPD seen at a single institution during a 30-year period. Children younger than 9 years of age at disease onset, bilateral cases, and children that had not reached skeletal maturity at last follow-up were excluded. Clinical data was collected from chart review and radiographs were staged according to the Waldenstrom and Catterall classifications. Patients treated conservatively (adductor tenotomy, bracing and physical

therapy, or physical therapy alone) were compared to those treated with more extensive surgery (varus femoral osteotomy or Chiari pelvic osteotomy [CPO]). Final radiographic outcomes were based on a modified Stulberg criteria.

Results Forty-three patients with an average age of 10.8 years and a mean follow-up of 10 years were identified. Twenty-one children received conservative treatment (15 underwent adductor tenotomy, followed by abduction cast or brace and physical therapy; six had only physical therapy) and 22 underwent surgery (16 underwent femoral varus osteotomy and six had CPO). Based on the modified Stulberg criteria, there was no significant difference in radiographic outcome between the surgical and the conservative treatment groups, but there were twice as many patients with a poor result in the conservative group.

Conclusion Late-onset LCPD presents with an extensive head involvement and shorter disease course. While there was no statistical difference between surgical and conservative treatment, there was a trend toward better radiographic outcomes when varus derotational osteotomy was performed early in the disease process.

Keywords Legg-Calve-Perthes · Perthes disease · Hip osteochondrosis · Late-onset

The authors certify that their institution has approved the publication of this study, that all of the investigations were conducted in conformity with ethical principles of research, and informed consent was obtained. None of the authors received financial support for this study.

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Introduction

Legg-Calve-Perthes disease (LCPD) is a self-limited condition of the immature hip characterized by aseptic necrosis of the femoral head, followed by a subchondral fracture, fragmentation, revascularization, and remodeling [1–4]. LCPD most commonly affects boys, between the ages of 4 and 8 years [5–7], and is considered as late-onset whenever

the initial symptoms occur after this age. Age is an important prognostic factor: children older than 8 years of age at the time of diagnosis are more likely to have a poor outcome compared to children presenting at a younger age [7–9].

The treatment options for late-onset LCPD vary significantly. Conservative treatment includes rest, physical therapy, bracing/casting, and, sometimes, adductor tenotomy [8, 10–12]. Surgical treatment includes femoral [13–15] and/or pelvic osteotomy [11, 16, 17]. The short-term goal of treatment is the maintenance of hip range of motion and containment of the femoral head [5, 18, 19]. The ultimate goal is the preservation of hip congruency and sphericity of the femoral head [1, 20, 21]. In spite of the various treatment options, uncertainty persists as to the optimal treatment method for children with late-onset disease.

The purpose of our study was to compare the long-term radiographic outcomes of a large cohort of patients with late-onset LCPD following conservative treatment and surgical treatment. We hypothesized that more aggressive initial surgical treatment would result in better radiographic outcomes at final follow-up.

Materials and methods

After obtaining approval from the Institutional Review Board, the pediatric database at a major research orthopedic hospital was queried to find all children diagnosed with LCPD during a 30-year period. Only children older than 9 years of age at disease onset were included. We excluded all bilateral cases and children that had not reached skeletal maturity at last follow-up.

Medical charts were retrospectively reviewed for sex, laterality, age, clinical presentation, treatment, complications, and clinical outcome. Based on a review of all of the available radiographs, the disease was initially staged according to the Waldenstrom and Catterall classifications [1, 4, 22].

Depending on the treatment, the patients were grouped into *conservative* (physical therapy, abduction cast/brace, +/- adductor tenotomy) or *surgical* (femoral varus derotational osteotomy [VDRO] or Chiari pelvic osteotomy [CPO]).

The final radiographic outcome was based on a modification of the Stulberg criteria [21]. Considering that a spherical and congruent hip are the goals of the treatment, the Stulberg classes 1 and 2 (spherical and congruent hip) were grouped as type I, classes 3 and 4 (congruent but non-spherical hip) were grouped into type II, and Stulberg class 5 (non-congruent and non-spherical hip) was called type III.

Statistical analysis included the direct comparison of variables (i.e., initial staging vs. radiographic outcome based on the treatment group), univariate analysis, chi-square, and Fisher's test, where appropriate. The significance level was set at $P < 0.05$.

Results

We identified 371 children diagnosed with LCPD during a 30-year period. Of those, 47 met the inclusion criteria. Forty-three had appropriate clinical and radiographic follow-up and, therefore, represent the final study group. All patients had reached skeletal maturity at the time of final radiographs, and our average follow-up was 10 years (range, 5–22).

There were 39 (90%) boys and four (10%) girls; the right side was involved in 23 children (53%). The average age at onset of symptoms was 10.8 years (range, 9–14).

There were 21 (49%) children in the conservative group and 22 (51%) in the surgical group. Of the 21 children in the conservative group, 15 underwent adductor tenotomy due to hip abduction of less than 30°, followed by abduction cast or brace and physical therapy, while six had only physical therapy. Of the 22 children in the surgical group, 16 underwent VDRO and six had CPO (Fig. 1a, b).

Among the conservative group ($n = 21$), eight hips were in the necrosis phase, five in fragmentation, and eight in reossification. According to the amount of head involvement, there was one Catterall II, 15 Catterall III, and five Catterall IV. In the surgical group ($n = 22$), there were 16 hips in the necrosis stage, four in fragmentation, and two in reossification. There was one Catterall II, 19 Catterall III, and two Catterall IV. The differences between the conservative and surgical groups with regards to disease severity were not statistically significant.

Final radiographic outcome was based on a modified Stulberg classification (Table 1). Although there was no significant difference between the two treatment groups ($P = 0.43$), there were twice as many patients who were modified Stulberg type III in the conservative group compared with the surgical group.

Of the three patients with a poor result (modified Stulberg III) in the surgical group, two had undergone CPO. Only one of 16 patients that underwent VDRO (~6%) had a poor outcome; 2 of 6 patients that had CPO developed modified Stulberg III hips (~33%).

Stratifying our results in terms of disease severity (Catterall classification), we found no statistical difference in radiographic outcome between the conservative and the surgical cohorts ($P > 0.1$; Table 2). None of the patients initially classified as Catterall IV in either treatment group developed a spherical joint (modified Stulberg I).

Fig. 1 **a** AP pelvis radiograph of a 9-year-old boy with Legg-Calve-Perthes disease (LCPD) of the right hip; there is lateral head involvement and Catterall II. **b** Lateral pelvis radiograph showing the extent of head involvement. **c** AP right hip after VDRO with a blade plate. **d** AP pelvis radiograph at skeletal maturity after hardware

removal, showing congruent hip with mild coxa brevis and increased trochanteric height, consistent with Stulberg 2. **e** Lateral pelvis radiograph at skeletal maturity after hardware removal, showing congruent hip with mild femoral head flattening

Discussion

In children with LCPD, several authors have shown that age at disease onset is an important prognostic factor; children with disease onset after 8 years of age tend to have worse outcomes compared to younger children [4, 9, 23–28]. In children with late-onset LCPD, the disease stages are shorter and, sometimes, the necrosis phase is not visualized. In addition, there is a shorter remodeling period remaining [22, 29, 30]. Ippolito et al. described this more severe course with late-onset LCPD [6, 8]. They noted that

Table 1 Radiographic outcome based on the modified Stulberg classification

Modified Stulberg	Treatment group				Total	
	Conservative		Surgical		n	%
	n	%	n	%		
Type I	3	14.3	4	18.2	7	16.3
Type II	12	57.1	15	68.2	27	62.8
Type III	6	28.6	3	13.6	9	20.9
Total	21	100.0	22	100.0	43	100.0

Table 2 Correlation between initial classification and final outcome

Catterall classification	Modified Stulberg			
	Type I	Type II	Type III	Total
Conservative treatment ^a				
Grade 3	3	8	4	15
Grade 4	0	3	2	5
Total	3	11	6	20
Surgical treatment ^b				
Grade 3	3	13	3	19
Grade 4	0	2	0	2
Total	3	15	3	21

^a There was one patient Catterall 2 that developed a type III modified Stulberg

^b There was one patient Catterall II that developed a type II modified Stulberg

the majority of patients treated conservatively developed early degenerative arthritis, regardless of the amount of head involvement, and they recommended a more aggressive approach for this age group. In contrast, the majority of young patients have a good outcome with symptomatic and/or conservative treatment [2, 3, 6, 8, 31].

The goal of treatment is to obtain a spherical and congruent hip at skeletal maturity. The non-spherical but congruent hip should be seen as a fair result and an incongruent hip as a poor result. Although radiographic outcomes do not necessarily correlate with clinical results, the Stulberg classification has been shown to be reliable in predicting the likelihood of early degenerative arthritis and is, therefore, useful as a radiographic outcome instrument [21, 28, 32]. The final radiographic analysis should be done at the end of skeletal maturity [33].

Some authors believe that the earlier the treatment is initiated in the disease process, the higher the likelihood of obtaining a good outcome [1, 4, 27]. Conceptually, containment of the femoral head should be achieved before the development of a fixed deformity following femoral head fragmentation. However, when we compared outcomes based on the disease stage when treatment was initiated, we found no statistically significant difference between surgical and conservative management. Four of 8 (50%) patients in the necrosis stage treated conservatively developed a congruent hip, while 14/16 (87%) treated surgically (all with VDRO) achieved the same results. These numbers are small and preclude a statistical correlation; a higher powered study may reveal a true advantage of surgical treatment early in the disease process.

While several authors have described the amount of head involvement as an important prognostic factor [1, 4, 27], we did not observe a statistical correlation between the initial amount of head involvement (Catterall grading) and

the final outcome (modified Stulberg). Since most patients had extensive head involvement at presentation, this may reflect a more aggressive course in late-onset LCPD.

VDRO is often used in the treatment of LCPD. Significant remodeling occurs following VDRO, sometimes up to 60% of the preoperative angle [25, 29, 34, 35]. Some authors believe that remodeling will occur as long as the proximal femoral growth plate is open [29]. Others believe that remodeling occurs mainly in the first 2 or 3 years following surgery and only in younger children [35, 36]. Although we found no statistical difference between surgical and conservative treatment for late-onset LCPD, we did see a trend toward better outcomes in patients treated with VDRO early in the disease process. In our study, there were twice as many patients who were modified Stulberg type III in the conservative group as in the surgical group, and only one of 16 patients that underwent VDRO (~6%) had a poor outcome.

There are several limitations to our study. Our retrospective study could have limited power and may be of insufficient size to demonstrate an actual difference between surgical and conservative treatment. In addition, there is a potential selection bias, as more of our surgical patients were treated in the initial stage compared to our non-surgical patients who were treated roughly equally in the initial, fragmentation, and reossification stages. We did attempt to account for this potential bias by directly comparing those patients in the necrosis phase treated conservatively with those treated surgically, and, again, we found no statistical difference between these two groups.

Regardless of its limitations, our series is one of the largest reported in the literature on patients with late-onset LCPD and it represents a 30-year experience in the treatment of LCPD at a major referral institution. While we were unable to find a statistically significant difference between conservative and surgical treatment, we did see a trend toward improved radiographic results in children treated with VDRO early in the disease process.

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