Evaluating the effectiveness of interventions targeting only the acetabular side in the surgical treatment of Legg-Calvé-Perthes disease

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Abstract. – OBJECTIVE: This study aims to show the effectiveness of only acetabular-side surgeries for hips affected by Legg-Calvé-Perthes disease.

PATIENTS AND METHODS: Twelve patients who underwent two different acetabular osteotomies –pembersal osteotomy and triple osteotomy – were evaluated retrospectively. Clinically, patients were examined for hip range of motion, flexion contracture, and hip extensor and abductor strength; the results were evaluated using the Harris hip score. Radiologically, the hips were assessed according to three different radiological parameters: lateral center edge angle, acetabular width, and acetabular head index at the preoperative, early postoperative, and last follow-up periods. The hips were classified according to Herring classification preoperatively and according to Stulberg classification at the last follow-up.

RESULTS: Statistically significant improvement was observed in patients both clinically and radiologically. It was observed that pembersal osteotomy significantly corrected the lateral center edge angle better than triple osteotomy while also correcting the other two radiological parameters, but no statistically significant difference was observed between these methods.

CONCLUSIONS: Only acetabular-side surgeries are effective and safe methods that do not require femoral intervention for hips affected by Legg-Calvé-Perthes disease and that do not show significant complications.

Key Words:
Legg-Calvé-Perthes disease, Pembersal osteotomy, Triple osteotomy.

Abbreviations

LCPD: Legg-Calvé-Perthes disease; ROM: range of motion; HSS: Harris Hip Scoring system; AP: anteroposterior; CEA: lateral center edge angle, AW: acetabular width; AHI: acetabular head index; PO: Preoperative mean values; EPO: Early postoperative mean values; LPO: Last follow-up mean values.

Introduction

In 1910, Legg-Calvé-Perthes disease (LCPD) was first described by Arthur Legg and Jacques Perthes[1]. LCPD is a pediatric hip disorder characterized by disruption of the blood supply to the femoral head, resulting in osteonecrosis and subsequent collapse of the femoral head. This condition affects approximately 1 in 1,200 children and is found more frequently in males[2]. The exact etiopathogenesis for LCPD is still unclear; however, certain contributory metabolic, genetic, and environmental factors have been identified[3,4].

Recent studies[5,6] investigating the etiology and treatment of LCPD have found a close relationship between LCPD and inflammation[5], along with diminished blood supply to the femoral head because of certain biomarkers[6]. Regardless of the cause, conservative treatment in the form of partial or full restriction of weight bearing is still the most widely used method; surgical interventions are aimed at safely containing the femoral head within the acetabulum. Existing surgical methods may target only the femoral side[7], the acetabular side[8], or both[9]. There is still no consensus on which surgical methods are the most effective. This study aimed to investigate the effectiveness of two different only acetabular-side surgeries – a triple osteotomy[10] and pembersal osteotomy[11] – in LCPD.

Patients and Methods

In the present study, we retrospectively analyzed 12 patients whose treatment began with conservative methods in the form of total non-weight bearing with two crutches and without a brace for at least three months but who underwent

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acetabular osteotomies (triple[10] or pembersal[11]) after the conservative treatment failed. The unaffected hips of each patient were used as the control. The principles in the Declaration of Helsinki were followed throughout the study. Informed consent was obtained from all patients and their parents or legal guardians. The patient data are given in Table I.

The clinical assessment involved an examination of various parameters, such as hip range of motion, flexion contracture of the hip, leg length difference, presence of Trendelenburg sign or limp, and hip extensor and abductor strength. Hip joint range of motion (ROM), which was quantified using a goniometer, was the most crucial clinical aspect; due to being the first clinical sign indicating deterioration in disease progression, in particular, as it is done in this study, abduction limitation should be closely monitored[12]. The strength of the hip abductors and extensors was evaluated on a scale ranging from 0 (no contraction) to 5 (normal power) based on the presence or absence of active movement against gravity and resistance. Evaluation of the clinical results was also done using the modified Harris Hip Scoring system (HSS), which has subheadings, including pain, activity (limping, walked distance, and stair climbing), and function (joint ROM and muscle strengths)[13].

Preoperatively, the patients were selected based on Herring (lateral pillar) classification[14] group A-B to achieve homogeneity within the study sample. Postoperatively, at the last follow-up, the patients' hips were classified based on Stulberg classification[15]. Five patients ≤ 6 years old had undergone pembersal osteotomy, while seven patients ≥ 7 years old had undergone triple osteotomy.

Anteroposterior (AP) pelvic radiographs of all patients preoperatively, in the early postoperative period, and at the last follow-up were evaluated. The lateral center edge angle (CEA), acetabular width (AW), and acetabular head index (AHI) for both hips were measured on pelvic digital radiographs (AP view) with Agfa Healthcare IMPAX PACS and then compared. CEA was measured as the angle in between, formed by a vertical line and a line connecting the femoral head center with the lateral edge of the acetabulum; the normal CEA should range from 20° to 39°[16] (Figure 1).

The AW was defined as the distance from the inferior teardrop to the lateral rim of the acetabulum[17] on the AP radiograph of the pelvis (Figure 2).

The AHI was calculated using AP pelvic radiography as follows: the distance (in mm) from the innermost surface of the head to a vertical line projected from the outermost surface of the acetabulum divided by the distance (in mm) from the innermost surface of the head to a vertical line projected from the outermost surface of the femoral head; the result was multiplied by 100[18] (Figure 3). An AHI ≤ 80 is abnormal and indicates lateral displacement of the femoral head[19].

Additionally, postoperative complications, such as implant failures, loss of correction, and limping with or without pain, were noted.

Table I. Data of the patients with preoperative and postoperative classification.

Gender	Age at operation time (year + month)	Age at the last follow up (year + month)	Osteotomy type	Preoperative herring classification	Postoperative stulberg classification
M	5 + 03	8 + 11	P	A	I
M	6 + 05	8 + 08	P	A	I
M	8 + 00	24 + 10	P	B	I
M	9 + 02	19 + 10	P	A	I
M	8 + 09	17 + 00	P	A	I
M	6 + 02	15 + 10	T	A	I
M	6 + 08	9 + 04	T	B	I
M	6 + 08	15 + 04	T	A	I
F	7 + 01	10 + 04	T	A	I
M	8 + 05	19 + 05	T	B	I
M	8 + 08	15 + 03	T	A	I
M	9 + 03	12 + 09	T	B	I

A: Herring Classification type; B: Herring Classification type; F: female; M: male; P: Pembersal; T: triple symbolized.

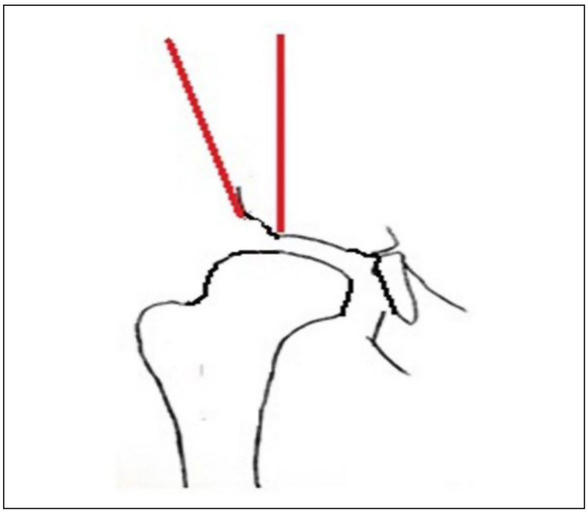

Figure 1. A diagram illustrating the measurement of lateral center edge angle (CEA). In this diagram the CEA is the angle between these red lines.

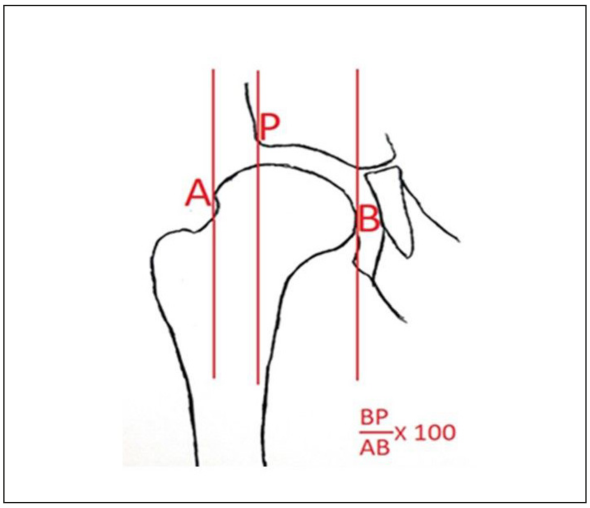

Figure 3. A diagram illustrating the measurement of the acetabular-head index (AHI).

Statistical Analysis

Descriptive statistics for numerical variables were reported as mean ± standard deviation, while categorical variables were presented as frequencies (percentages). The data distribution was examined using the Shapiro-Wilk test; accordingly, paired sample *t*-tests were used to compare two dependent groups with normal data distribution. Repeated measures ANOVA was performed to compare within- and between-group changes across different time points for variables with a normal distribution. All statistical analyses were performed using the Statistical Package for the Social Sciences version 26.0 (IBM Corp., Armonk, NY, USA). A significance level of $p \leq 0.05$ was used throughout.

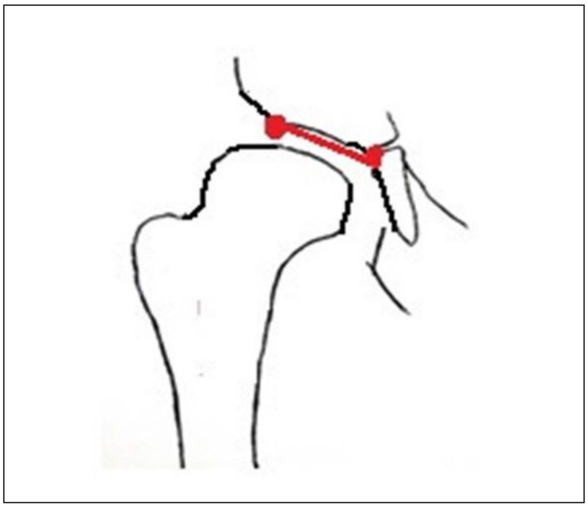

Figure 2. A diagram illustrating the measurement of acetabular width (AW). In this diagram the AW is the shortest direct distance between two red spots.

Results

Twelve patients (11 male, 1 female; all unilateral: 10 right-sided, 2 left-sided) with LCPD who were managed surgically with acetabular osteotomies were included. Seven patients received triple osteotomy, while five patients underwent pembersal osteotomy. The mean age of the patients at the time of surgery was 7.5 ± 1.3 years, while the follow-up period was 6.7 ± 5 years.

Regarding hip ROM, preoperatively, the affected sides showed abnormally reduced abduction and internal rotation ROM, with a mean difference of 15-20° when compared with the healthy sides. During the early postoperative period, ROM examination is not possible because of pain. At the last follow-up, although the ROM of the operated side was not comparable to the normal side, it was closer to it by at least 10-20º compared with the preoperative period.

Moreover, flexion contracture, which was seen in five of the patients, was resolved completely at the last follow-up. The leg length difference because of the presence of the Trendelenburg sign or limp was completely resolved in all patients.

Hip abductor strength did not change for any of the patients at the last follow-up, but in two pa-

Table II. Preoperative, early postoperative, and final follow-up values of hips.

N = 12	Operation side	Normal side	*p*-value[a]
CE			
PO	16.3 ± 7.2	28.9 ± 6.3	< 0.001
EPO	36.3 ± 8.3	31.3 ± 7.1	0.058
LPO	33.2 ± 6.8	36.2 ± 7.2	0.166
AW			
PO	40.5 ± 7.0	39.4 ± 5.9	0.078
EPO	51.8 ± 8.4	45.9 ± 12.1	0.160
LPO	60.3 ± 11.7	50 ± 10.1	< 0.001
AHI			
PO	69.3 ± 7.9	96.3 ± 7.4	< 0.001
EPO	88.1 ± 9.7	96.8 ± 7.6	0.010
LPO	82.8 ± 6.9	94.7 ± 7.5	0.001

[a]Paired Sample *t*-test. The data are presented as mean ± standard deviation. PO: Preoperative mean values; EPO: Early postoperative mean values; LPO: Values at the last follow-up.

tients with an extensor power of three, a one-degree increase was observed and became four, while there was no change in the values of those patients who had values of four and five preoperatively.

All patients, except for one patient with a score of 74, had HSS between 85 and 95.

Comparisons of the preoperative, early postoperative, and final follow-up values for the patients' affected and normal (nonaffected) lower limbs are listed in Table II.

Preoperatively, the mean CEA on the affected side was significantly low compared with that on the normal side ($p < 0.001$). However, postoperatively, the CEA was statistically comparable for both sides during both the postoperative first day ($p = 0.058$) and the last follow-up ($p = 0.166$). Regarding the AW, there was no statistically significant difference between the affected and normal sides during the preoperative ($p = 0.078$) and early postoperative periods ($p = 0.160$). However, at the last follow-up, the mean AW on the affected side was higher than that on the normal side, and this difference was statistically significant ($p<0.001$).

Finally, the mean AHI for the affected side was low compared with the normal side at all time intervals. Although the AHI did improve postoperatively, the mean value was still lower than that for the normal side, and this difference was statistically significant ($p < 0.001$).

Figure 4 a-c represent radiographic images of a seven-year-old male Perthes patient with left-side involvement who was treated with triple osteotomy surgery that was taken before surgery (4a), at the early postoperative period (4b), and at the third year postoperative period (4c). Preoperatively, the left side had a CE angle of 4°, an

Figure 4. a, Preoperative radiography of Perthes disease left side involvement. **b**, Early postoperative period radiography of the same patient with implants fixing the osteotomy. **c**, Radiography of the patient at the end of three years after operation.

AW of 41 mm, and an AHI of 36%. At the end of the third year postoperatively, the left side had a CE angle of 36°, an AW of 62 mm, and an AHI of 84%.

Comparisons of the preoperative, early postoperative, and final follow-up values for the patients' affected and normal (nonaffected) lower limbs based on the type of osteotomy are listed in Table III.

In the pembersal osteotomy group, the mean CEA on the affected side was significantly low compared with the normal side preoperatively ($p = 0.011$). After surgery, even though the mean CEA values were higher for the affected side than the normal side for both the early postoperative period and the last follow-up, the difference was not statistically significant. Regarding the mean AW values, both sides had comparable values in the preoperative period. In the early postoperative period, AW increased to reach a near-normal value; however, it was still lower than the normal side, but the difference was not statistically significant. At the last follow-up, the mean AW value increased significantly and was higher than on the unaffected side, which was a statistically significant difference ($p = 0.002$). Likewise, the mean AHI for the pembersal osteotomy group was lower than the normal side preoperatively, during the early postoperative period, and at the final follow-up visit. However, this difference was statistically significant only in the preoperative phase ($p < 0.001$).

On the other hand, in the triple osteotomy group, the mean CEA on the affected side was significantly lower than that on the normal side preoperatively ($p = 0.007$). Postoperatively (early postoperative and at the last follow-up), although the mean CEA values increased on the affected side compared with the normal one, this difference was not statistically significant (i.e., the correction was satisfactory). Similarly, this group had lower preoperative mean AW values on the affected side compared with the control group, but this was not statistically significant. Postoperatively (early postoperative period and at the last follow-up), the mean AW value for the affected side was significantly higher than that of the normal side ($p = 0.003$). Finally, the mean AHI value for the affected

Table III. Preoperative, early postoperative, and final follow-up values of hips based on the type of osteotomy.

Pembersal (n = 5)	Operation side	Normal side	*p*-value[a]
CE			
PO	18.4 ± 7.4	30.4 ± 6	0.011
EPO	41.6 ± 9.8	31.6 ± 7.1	0.053
LPO	37.2 ± 6.4	31.6 ± 7.1	0.050
AW			
PO	37.4 ± 8.4	37 ± 76.4	0.704
EPO	47.2 ± 8.0	49.2 ± 18.6	0.822
LPO	59.6 ± 9.3	50.8 ± 10.8	0.002
AHI			
PO	71.8 ± 5.3	100 ± 0	< 0.001
EPO	93.4 ± 9.8	100 ± 0	0.208
LPO	86.4 ± 7.9	95.8 ± 5.8	0.060
Triple Osteotomy (n = 7)			
CE			
PO	14.9 ± 7.2	27.9 ± 7	0.007
EPO	32.4 ± 4.5	31.1 ± 7.6	0.599
LPO	30.3 ± 5.8	31.1 ± 7.6	0.658
AW			
PO	42.7 ± 5.3	41.1 ± 5.2	0.052
EPO	55.1 ± 7.5	43.6 ± 4.5	< 0.001
LPO	60.9 ± 13.8	49.4 ± 10.3	0.003
AHI			
PO	67.6 ± 9.3	93.6 ± 9.0	< 0.001
EPO	84.3 ± 8.3	94.4 ± 9.6	0.038
LPO	80.1 ± 5.1	93.9 ± 8.8	0.013

[a]Paired Sample *t*-test. The data was presented as mean ± standard deviation. PO: Preoperative mean values; EPO: Early postoperative mean values; LPO: Values at the last follow-up.

side was lower than that for the normal side at all time points. Although the AHI improved postoperatively to reach normal values, it was still lower compared with the normal side, and this difference was statistically significant ($p < 0.001$).

Comparisons of the preoperative, postoperative, and follow-up mean values of three radiographic parameters of the affected hips for both osteotomy groups are listed in Table IV.

Although the mean CEA significantly increased after pembersal osteotomy at the last follow-up compared with the preoperative values ($p = 0.007$), the increase was not significant in the early postoperative period. Additionally, there was no significant difference between the values for the early postoperative period and the last follow-up, indicating that the correction was maintained postoperatively and that there was no loss of gained CEA values. On the other hand, mean AW values were significantly higher when it came to pembersal osteotomy both in the early postoperative period and at the last follow-up compared with the preoperative period ($p = 0.005$). In addition, the difference between the early postoperative phase and the last follow-up visit was statistically significant ($p = 0.007$), indicating that AW continued to increase with age after correction. Likewise, the pembersal osteotomy increased AHI postoperatively, with near-normal values both in the early postoperative and follow-up phases compared with the preoperative values. There was a statistically significant difference between the postoperative values, indicating that the correction continued over time ($p < 0.001$).

For the triple osteotomy group, the mean CEA, AW, and AHI values increased and returned to near-normal values in the postoperative period (either in the early postoperative period or at the last follow-up) compared with the preoperative period. In addition, there was no statistically significant difference between the two postoperative time points, indicating that the correction continued over time.

Figure 5 a-c represent the radiographic images of a 6-year-old male Perthes patient with right-side involvement who was treated with pembersal osteotomy surgery, taken before surgery (5a), at the early postoperative period (5b), and at the second year postoperative period (5c). Preoperatively, the left side had a CE angle of 9°, an AW of 38 mm, and an AHI of 62%. At the end of the third year postoperatively, the left side had a CE angle of 22°, an AW of 64 mm, and an AHI of 86%. Comparisons of the

Table IV. Preoperative, early postoperative, and final follow-up values of affected hips according to osteotomy type.

	PO	EPO	LPO	*p*-value[b]	Post-hoc *p*-value[c]
Pembersal					
CE	18.4 ± 7.4	41.6 ± 9.8	37.2 ± 6.4	0.007	1-2:0.054 1-3:0.022 2-3:0.390
AW	37.4 ± 8.4	47.2 ± 8.0	59.6 ± 9.3	0.002	1-2:0.005 1-3:0.007 2-3:0.045
AHI	71.8 ± 5.3	93.4 ± 9.8	86.4 ± 7.9	< 0.001	1-2:0.026 1-3:0.003 2-3:0.594
Triple Osteotomy					
CE	14.9 ± 7.2	32.4 ± 4.5	30.3 ± 5.8	0.006	1-2:0.004 1-3:0.019 2-3:0.436
AW	42.7 ± 5.3	55.1 ± 7.5	60.9 ± 13.8	0.014	1-2:0.004 1-3:0.042 2-3:0.609
AHI	67.6 ± 9.3	84.3 ± 8.3	80.1 ± 5.1	0.006	1-2:0.014 1-3:0.019 2-3:0.270

[b]Repeated Measures Anova; [c]Post-hoc Bonferroni test. The data were presented as mean ± standard deviation. PO: Preoperative mean values; EPO: Early postoperative mean values; LPO: Values at the last follow-up.

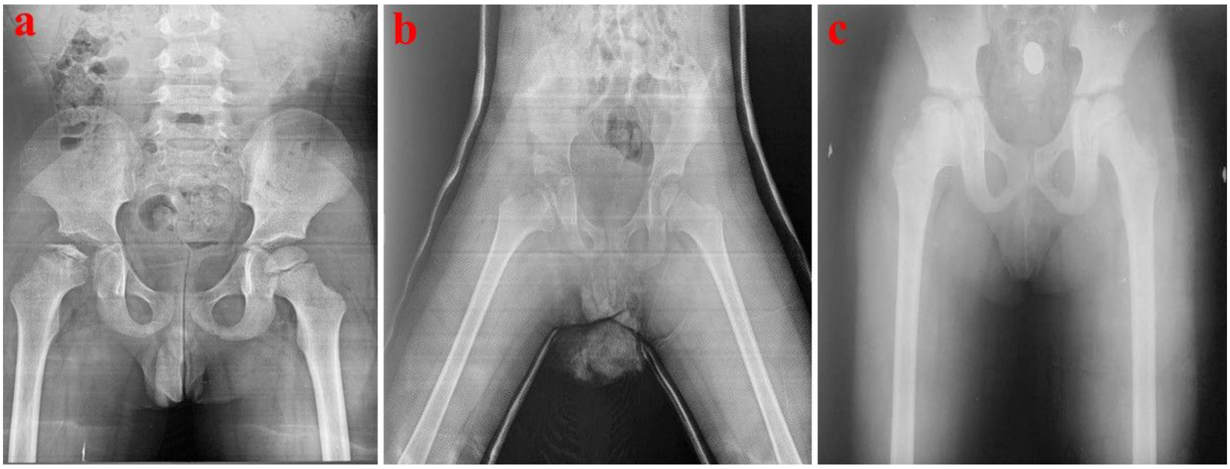

Figure 5. **a**, Preoperative radiography of Perthes disease right side involvement **b**, Early postoperative period radiography of the same patient in cast fixing the osteotomy without implants. **c**, Radiography of the patient at the end of three years after operation.

two osteotomy groups according to preoperative, postoperative, and follow-up changes in CEA, AW, and AHI mean values are presented in Table V.

Pembersal osteotomy corrected CEA better than triple osteotomy, but there were no statistically significant differences between the two osteotomies regarding the AW and AHI corrections. Radiologically, all hips continue their development within the acetabulum, and they remodel. At the last follow-up, all hips were in Stulberg Class I, but when their ages were considered, it was found that out of 12 patients, growth had stopped in seven and was still ongoing in five. We can expect that these hips will be further remodeled in a positive manner.

Discussion

The treatment approach for LCPD can vary depending on the timing of the diagnosis and natural progression of the disease and is either preventive, corrective, or salvage.

Preventive treatment may involve activity modifications, physical therapy, and sometimes bracing or casting to maintain the proper position of the femoral head within the acetabulum. In cases where LCPD has already caused deformity or damage to the femoral head, corrective measures may be required. This typically involves a surgical intervention to realign the hip joint, reshape the femoral head, or improve its blood supply. The goal is to correct any existing deformi-

Table V. Preoperative, early postoperative, and final follow-up values of affected hips and mean differences.

	Pembersal	Triple osteotomi	Mean difference	*p*-value[b]
CE				
PO	18.4 ± 7.4	14.9 ± 7.2	6.5	0.042
EPO	41.6 ± 9.8	32.4 ± 4.5		
LPO	37.2 ± 6.4	30.3 ± 5.8		
AW				
PO	37.4 ± 8.4	42.71 ± 5.3	-4.8	0.300
EPO	47.2 ± 8.0	55.14 ± 7.5		
LPO	59.6 ± 9.3	60.85 ± 13.8		
AHI				
PO	71.8 ± 5.3	67.57 ± 9.3	6.5	0.101
EPO	93.4 ± 9.8	84.28 ± 8.3		
LPO	86.4 ± 7.9	80.14 ± 5.0		

[b]Repeated Measures Anova. The data were presented as mean ± standard deviation. PO: Preoperative mean values; EPO: Early postoperative mean values; LPO: Values at the last follow-up.

ties and improve the overall function and stability of the hip joint. When LCPD has progressed to an advanced stage, significant damage occurs to the femoral head. In these cases, joint-preserving procedures or hip replacement surgery may be necessary to salvage the hip joint and alleviate pain and disability.

The significance of well-established treatment lies in recognizing the importance of adopting an approach that emphasizes the prevention and predictability of secondary arthritic degeneration in adult life. The risk of osteoarthrosis chiefly depends on the final degree of joint incongruence. Age at onset and lateral pillar classification are the two main outcome predictors[20].

Acetabular pembersal or triple osteotomies were performed to surgically contain the femoral head in the acetabulum for patients with LCPD. In all our patients, only acetabular-side surgery was concluded as being a safe and reliable method without performing femoral osteotomies because we achieved satisfactory results in all three measurements. Using this approach, disease extension and lateral subluxation of the femoral head from the acetabulum can be stopped without affecting the hip ROM. Radiographically, all patients achieved satisfactory outcomes.

Although surgical treatment is the typical first treatment for LCPD, conservative treatment comprising partial or full restriction of weight bearing has been the most popular approach in recent years. Stančák et al[21] stated that there is no difference between the results of conservative and surgical treatments for LCPD, both clinically and radiologically. Iwamoto et al[22] concluded that patients younger than 8.4 years old at onset, having a lateral pillar group A or B disease or Catterall group I or II showed good outcomes with a non-weight-bearing abduction brace for LCPD; patients who do not meet these criteria can be offered surgical treatment. Oh et al[23] stated that the prognosis of patients with LCPD onset before the age of 6 years treated with conservative methods is favorable. In our study, all patients were initially given conservative treatment in the form of total non-weight bearing without a brace for at least three months. Because none of them showed any improvement with conservative treatment, a decision was made in favor of surgical treatment.

Many studies[24-26] have reported findings in favor of surgical treatment over conservative management. Grzegorzewski et al[24] described that the lateral acetabular shape plays a very important role in the remodeling of the deformed proximal femoral epiphysis; unfortunately, only surgical treatment can improve the acetabular shape, which is impossible using conservative methods. Caldaci et al[25] revealed that surgical treatment in patients older than six years has excellent results in Herring B and B/C hips and poor results in Herring C hips. Furthermore, Kacki et al[26] revealed that the radiological parameters of femoral head coverage were better after operative treatment; in addition, the number of arthritic changes after conservative treatment was greater than that after surgery in this study. The present study revealed that surgical treatment of patients either with Herring A or B disease had satisfying results, culminating in Stulberg I, regardless of age.

In the current study, we used two different surgical methods to treat our patients. There is no consensus on the best technique or combination of techniques used simultaneously to guarantee treatment success. Madan et al[27] stated that the remodeling potential of the acetabulum decreases as the child grows older; therefore, containment procedures with femoral osteotomy can be opted for in younger children, whereas acetabular osteotomy may benefit older children. Multiple authors[9,28,29] claimed that surgical interventions performed on both the acetabular and femoral sides offer better results and must be used together. In our study, all patients underwent only acetabular-side surgeries, regardless of age, and we achieved satisfactory results without touching the femoral side.

Previous studies[30-32] have also reported good results with only acetabular-side surgery without intervening on the femoral side compared with femoral-side interventions. Papavasiliou et al[30] stated that acetabular surgery provided leg length equalization, restoring the working length of the abductors by maintaining the tip of the greater trochanter at the same level as the unaffected side; hence, it was not necessary to intervene on the femoral side. Moreover, Cahuzac et al[31] mentioned that after acetabular surgery, although the length of the acetabular roof did not change, the diameter of the acetabulum increased; consequently, the overall containment area also increased. Notably, Thompson[32] described that the main advantage of Salter osteotomy in LCPD is its effect on femoral head remodeling during the remaining growth because there is no need to touch the femoral side. Moberg et al[33] compared femoral osteotomies with Salter osteotomy, revealing that coverage of the femoral head by the acetabulum (checked only CEA) was better in the innominate osteotomy group. In our study, because femoral head remodeling is satisfactory enough for the remaining growth after acetabular osteotomies, there is no need to touch the femoral side. Moreover, whether it was Herring type A or B preoperatively, HSS scores between 85 and 95 were obtained in all hips, except for one patient with a score of 75; therefore, the results were considered good to excellent.

Numerous studies[34-37] have either defined or compared different surgical methods for LCPD, but a comparison between the effectiveness of two acetabular-side surgeries – triple osteotomy and pembersal osteotomy – has not been conducted. Freeman et al[34] concluded that shelf acetabuloplasty is a straightforward surgical procedure with good medium-term results in patients with severe LCPD and who have hinge abduction preoperatively. Additionally, Kumar et al[35] inferred that acetabular shelf operation and femoral varization osteotomies can be used as alternative treatment options for hips with LCPD. Villet and Laville[36] also favored shelf acetabuloplasty as a safe option to obtain satisfying results. Kuwajima et al[37] compared two acetabular surgeries – Salter's innominate osteotomy and augmented acetabuloplasty – and found better results with the latter.

When radiologic prognostic factors and prognostic data related to specific radiologic staging, classification, and groupings are set aside, the three main factors determining the prognosis of Perthes disease are age at disease onset, gender, and time at follow-up assessment. Although young patients with Caterall III and IV disease may have a poor prognosis, the general consensus is that the prognosis of the disease is better in those who start before the ages of 5-7 years compared with those who start after the ages of 8-9 years. In Perthes, which is more common in males (M:F = 4:1), the prognosis for female patients is worse: clinical symptoms become more pronounced after the ages of 50-60, while radiological deterioration starts earlier in the 40-50 range.[38]

Acetabular retroversion is another concern to be evaluated in LCPD because it alters the treatment results; however, there is conflicting evidence about this. Although Kawahara et al[39] revealed a high prevalence of acetabular retroversion in LCPD patients in both affected and unaffected hips, Sankar et al[40] noted that retroversion was very rare in patients treated for LCPD. Therefore, retroversion should be taken into consideration before surgical planning. In our study, retroversion was not taken into consideration before surgical planning, which can be considered a substantial limitation; nevertheless, both techniques significantly increased CEA, AW, and AHI in our patients, which are some of the radiological criteria that should be carefully followed in the treatment of LCPD to ensure that the hip remains within the acetabulum.

Limitations

The study sample was quite small, hence reducing the applicability of our results. Also, there were no data regarding acetabular retroversion in our patients, which is an important factor to be considered before surgery.

Conclusions

Despite having minor differences, both pembersal and triple osteotomies are effective techniques to ensure femoral head containment in LCPD patients. These techniques can be safely applied without the need for femoral intervention and do not result in significant complications.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Ethics Approval

The study was started after the approval of the Ethics Evaluation Committee of Kastamonu University Faculty of Medicine Clinical Research Ethics Committee, Kastamonu, Turkey (2023-KAEK-46 / 19.04.2023).

Informed Consent

Informed consent was obtained from all patients and their parents or legal guardians.

Availability of Data and Materials

The data and materials generated/analyzed in the present study are available from the corresponding author upon request.

Funding
None.

Authors' Contribution
Mehmet ALBAYRAK, and Fatih Ugur conceived and designed the study. Mehmet ALBAYRAK, and Fatih Ugur performed the experiments. Mehmet ALBAYRAK interpreted the data. Fatih UGUR, contributed reagents, materials, analysis tools. Mehmet ALBAYRAK and Fatih UGUR wrote the first draft of the manuscript. Both authors have read the final version of the article and take responsibility for its accuracy of data.

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