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Early And Mid-Term Radiological Results of Isolated Pembersal Procedure in Cases of Developmental Dislocation of The Hip

Gelişimsel Kalça Çıkığı Olgularda İzole Pembersal Prosedürünün Erken ve Orta Dönem Radyolojik Sonuçları

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ÖZET

Amaç: Gelişimsel Kalça Displazisi (GKD) olan hastalarda erken tanı ve erken tedavi önemlidir. Geç başvuran veya ihmal edilen hastalarda çeşitli osteotomi prosedürleri gerekebilir. Literatürde GKD cerrahisinde Pembersal osteotomi ile ilgili sınırlı sayıda makale bulunmaktadır. Çalışmamızın amacı GKD'li 18 aylıktan büyük çocuklarda izole Pembersal osteotominin sonuçlarını değerlendirmektir.
Gereç ve Yöntemler: Bu retrospektif çalışmada 2014-2021 yılları arasında kliniğimizde GKD nedeniyle Pembersal osteotomi uygulanan hastaların sonuçları incelendi. Çalışmaya açık redüksiyon ile birlikte izole periasetabular Pembersal osteotomi uygulanan, en az 2 yıllık takibi olan ve yaşları 19 ile 36 ay arasında değişen 9 çocuk (7 kız, 2 erkek) dahil edildi. Ameliyat öncesi, ameliyat sonrası erken dönem, ameliyat sonrası 6. hafta ve son kontrol radyografileri değerlendirildi ve Wiberg'in orta kenar açısı (CEA), asetabular indeks (AI) ve Tönnis dereceleri not edildi.
Bulgular: Hastaların ortalama yaşı 28.75 ay ve takip süresi 50.33 aydı. CEA ve AI ameliyattan sonra erken dönemde düzelme görüldü ve bu düzelme daha sonraki dönemlerde de devam ettiği görüldü. Tönnis evrelemesi tüm hastalarda ameliyattan sonra iyileşme gösterdi ve bu iyileşme de ameliyat sonrası erken dönemde ve 6. hafta kontrol grafilerde de devam etti. Ancak, son kontrol radyografilerinde 3 kalçada CEA<20º, AI>20º ve Tönnis evresi ≥2 idi ve bu üç kalça radyolojik kötü sonuç olarak değerlendirildi.
Sonuç: Bu çalışma, izole Pembersal osteotominin gelişimsel kalça displazisinin tedavisinde asetabular indeks ve diğer radyolojik parametrelerde iyileşme ile birlikte etkili ve güvenli bir seçenek olduğunu göstermiştir.
Anahtar Kelimeler: Gelişimsel kalça displazisi, periasetabular osteotomi, Pembersal osteotomi, merkez kenar açısı, asetabular indeks

ABSTRACT

Aim: Early diagnosis and timely care is important in patients with Developmental Hip Dysplasia (DDH). Late presenting or neglected patients may require various osteotomy procedures. There is a limited number of articles in the literature on Pembersal osteotomy in DDH surgery. The aim of this study was to assess the outcomes of isolated Pembersal osteotomy in children over 18 months of age with DDH.
Materials and Methods: A retrospective analysis was made of the outcomes of patients who underwent Pembersal osteotomy for DDH at our clinic from 2014 to 2021. The study included 9 children (7 girls, 2 boys) aged between 19 and 36 months with at least 2 years of follow-up who underwent isolated periacetabular Pembersal osteotomy with open reduction. Preoperative, early postoperative, 6 weeks postoperative and final follow-up radiographs were evaluated and Wiberg's centre-edge angle (CEA), the acetabular index (AI) and Tönnis grades were noted.
Results: The mean age of the patients was 28.75 months and the follow-up period was 50.33 months. CEA and AI showed improvement in the early postoperative period and this improvement continued in the later periods. Tönnis staging showed postoperative improvement in all patients, and this improvement continued in the early postoperative period and on the 6-week follow-up radiographs. At the final follow-up examination, 3 hips had CEA <20º, AI >20º and Tönnis stage ≥2 and these 3 hips were considered as a radiologically poor outcome.
Conclusion: This study demonstrated that isolated Pembersal osteotomy is an effective and safe option for the treatment of developmental dysplasia of the hip, with improvement in acetabular index and other radiological parameters.
Keywords: Developmental dysplasia of the hip, periacetabular osteotomy, Pembersal osteotomy, centre-edge angle, acetabular index

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INTRODUCTION

Although significant advances have been made in the early diagnosis and treatment of developmental dysplasia of the hip (DDH), cases of delayed DDH are sometimes encountered. Delayed cases require advanced surgical procedures such as periacetabular and/or proximal femur osteotomies (1). These procedures are associated with lower success rates, higher complication rates and higher cost. Balanced and complete formation of the acetabular and triradiate cartilage and proper positioning of the femoral head within the acetabulum are essential for normal development of the hip joint (2). In children older than 18 months with DDH, it is not possible to treat the hip with closed reduction due to elongated and thickened ligamentum teres, upward displacement of the capsule, and narrowing of the acetabular entrance of the iliopsoas tendon (hourglass deformity) and inverted labrum, and in these cases open reduction methods are preferred (3). The goal of open reduction is to achieve and maintain concentric reduction, prevent damage to the femoral head, and provide an optimal environment for growth of the proximal femur and acetabulum. Open reduction can be performed using various techniques. The goal of acetabular osteotomies is coverage of the femoral head by the acetabular roof. The most used techniques include Salter, Pemberton and Dega osteotomies (4). The Pembersal osteotomy was described by Morissy (5) and is a combination of the Salter and Pemberton procedures (6). This osteotomy technique avoids damage to the triradiate cartilage plane and involves an osteotomy line that extends from the ilium to the ischium along the posterior ilioischial branch of the triradiate cartilage. The method not only tilts the acetabular roof to cover the femoral head but also allows for some rotation (7). Although there are some studies in the literature of Pembersal osteotomy in the treatment of DDH, most of those studies have presented the results of the patients who underwent proximal femoral osteotomy, femoral shortening, and autograft use in conjunction with Pembersal osteotomy (5, 6).

The aim of this study was to evaluate the radiological results of patients who underwent isolated Pembersal osteotomy with open reduction for DDH.

MATERIALS AND METHODS

Ethics committee approval was obtained from the Ethics Committee of our institution for this retrospective study (Date: 21.11.2023; No: 20). A retrospective screening was conducted on patients diagnosed with Developmental Hip Dysplasia (DDH) who underwent periacetabular osteotomy in our clinic from 2014 to 2021. Of the 22 patients who underwent periacetabular osteotomy without femoral osteotomy for DDH, 9 patients who underwent isolated Pemberton osteotomy and continued regular follow-up, were included in this study. The age of the patients at the time of surgery ranged from 19 to 36 months, and the follow-up period ranged from 26 to 81 months. Patients without regular follow-up (n=4), who underwent revision surgery (n=2), or other (n=7) periacetabular osteotomies (e.g. Salter, Dega) (13 patients in total) were excluded. Patients who underwent proximal femoral shortening and derotation osteotomy in addition to Pembersal osteotomy were also excluded.

Radiographic evaluation included measurements of the Wiberg centre-edge angle (CEA), acetabular index (AI), and classification of the hip according to Tönnis staging on preoperative (PrO), early (immediate) postoperative (EPO), late (6 weeks) postoperative (LPO) and last control (LC) radiographs (Figure 1).

The operative success was gauged by the approximation of these values to the normal range postoperatively, while long-term surgical success was assessed by deviation from the normal range, particularly in the mid-postoperative period. The influence of gender on surgical outcomes was also examined. There was also evaluation of the impact of preoperative values on immediate postoperative and final control measurements.

AI, defined as the angle between the line joining the base of the acetabulum to its upper outer ossified edge and the Hilgenreiner line, is the preferred metric for assessing acetabular development in children under the age of eight years (8). A normal AI is expected to be around 20 degrees after two years of age, with an increase indicative of hip dysplasia (9). Wiberg's centre-edge angle (CEA), representing the angle between the line connecting the centre of the femoral head and the Hilgenreiner line and the line to the acetabulum's outermost point, has a physiological range of 20-40 degrees (10). Values below 20 degrees suggest dysplasia, with less than 17 degrees indicating severe dysplasia. Tönnis staging categorizes hips based on the femoral head position relative to

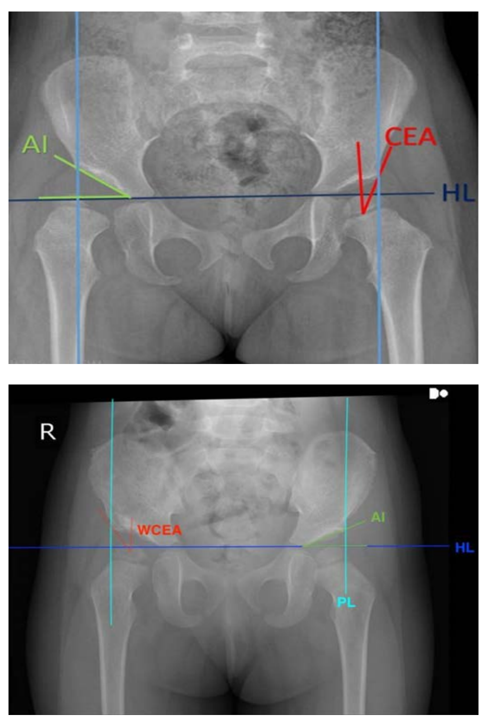

Figure 1. Preoperative (a) and postoperative (b) radiological evaluation.

the Perkins line, divided into four stages (11).

Surgical technique

All the operations were performed by the same surgeon. Pembersal osteotomy was used according to the technique described by Perlik et al. (7). The ilium was exposed subperiosteally using the iliofemoral approach. At the level of the triradiate cartilage, an iliopsoas tenotomy was performed. Arthrotomy was routinely performed in all cases to examine the joint to debride the pulvinar and to evaluate the reduction. The labrum was preserved in all cases. A pelvic osteotomy was performed 1-1.5 cm above the anterior inferior iliac spine to the body of the ischium, parallel to the acetabular dome and remaining anterior to the sciatic notch. Care was taken to avoid damage to the joint. The osteotomy opening results in a greenstick fracture of the remaining ischial body, causing the lower quarter of the body to move forward and downward. This leads to anterolateral rotation of the acetabulum around an axis that passes through the ischial fracture and symphysis pubis. In addition, the acetabular roof was tilted inferiorly and laterally, with the triradiate cartilage acting as a hinge. The osteotomy was performed in the visible part of the ilium near the sciatic notch, ending at the ilioischial line just superior to the medial end of the triradiate cartilage (TRC), without damaging the TRC. This was a total osteotomy and the inferior part of the pelvis was displaced forward and downward. Simultaneously, the roof of the acetabulum was laterally rotated, and the orientation of the acetabular cavity was repositioned. To avoid posterior displacement of the acetabulum, external rotation of the distal portion was not performed. Acetabular deepening was performed as in Pemberton's osteotomy, and reorientation as in Salter's technique. A curved bone graft in a triangular shape was harvested from the iliac crest on the same side as the surgery and then placed at the site of the osteotomy. No fixation material was employed along the osteotomy line. Patients underwent a six-week follow-up period in pelvipedal casting, after which the gradual discontinuation of abduction devices was initiated.

Whether or not a proximal femoral osteotomy was necessary was decided on the basis of clinical assessment during surgery. After the periacetabular osteotomy, the hip was assessed for joint stability by moving the hip in all directions while the hip joint was reduced, and proximal femoral osteotomy was not performed in hips that were stable in all directions, especially in extension and adduction. If the hip dislocated during this examination, a proximal femoral osteotomy was performed in addition to the Pembersal osteotomy.

Statistical Analysis

Data obtained in the study were analyzed using SPSS version 27 (IBM Corp., Armonk, NY, USA).

Descriptive statistics were computed to summarize the basic features like central tendency and overview of the data distribution. Normality of the data was assessed using the Shapiro-Wilk test.

RM ANOVA was utilized to evaluate the temporal changes in CEA, AI, and Tönnis grades. Mauchly's Test of Sphericity assessed the assumption of sphericity, with Greenhouse-Geisser correction applied where necessary. Spearman's Rho correlation analysis was used to explore the relationships between CEA, AI, Tönnis grades and age, as it is ideal for assessing associations between ranked variables.

Preoperative and postoperative measurements for CEA, AI, and Tönnis grades were compared using the Wilcoxon Signed Ranks Test as this test was suitable for paired samples to identify changes over time within subjects.

In line with standard statistical practice, p-values less than 0.05 were considered statistically significant. This threshold was used to determine the presence of significant differences or correlations in the data.

RESULTS

Evaluation was made of 12 hips of 9 patients, over a mean follow-up period of 50.33 months (SD= 11.04). Descriptive statistics for preoperative and postoperative CEA and AI measurements revealed a range of distribution patterns, with CEA measurements showing both symmetric and skewed distributions, and AI measurements varying from slightly skewed to leptokurtic. The patients comprised 7 (78%) females and 2 (22%) males with a mean age of 28.75 (SD= C) months (range, 19 -36 months) with a slightly negatively skewed distribution. The surgeries were performed in 9 (75%) left hips and 3 (25%) right hips (Table 1).

According to the Shapiro-Wilk tests, normal distribution was seen most variables in the study, including CEA (PrO, EPO LC) and AI (PrO, EPO, LPO) preoperatively and postoperatively, and patient age, and significant deviations from normality were determined in the CEA on LPO and AI on LC (Table 2).

Repeated measures ANOVA revealed no significant overall time effect on CEA measurements, but a significant quadratic trend ($F(1, 11) = 5.698$, $p = .036$) suggested a complex relationship between time and CEA values; Greenhouse-Geisser correction was applied due to the violation of sphericity ($W = 0.344$, $p = 0.067$).

Repeated measures ANOVA on AI measurements indicated a significant time effect with significant linear, quadratic, and cubic trends over time (Greenhouse-Geisser $F(1.939, 21.329) = 30.990$, $p < 0.001$; Huynh-Feldt $F(2.347, 25.820) = 30.990$, $p < 0.001$), after corrections for sphericity violations

Repeated measures ANOVA on Tönnis grade revealed

Table 1. Demographic characteristics and basic patient information

Number of patients	Hips	Side R/L	Age range, month (mean+SD)	Gender F/M	Follow-up period range, months (mean+SD)
9	12	3/9	19-36 (28.75±11.04)	7/2	26-81 (50.33±24.013)

SD: standard deviation

Table 2. Results of the descriptive statistics analysis.

	N	Range	Min.	Max.	Mean	SD
CEA PrO	12	37	15	52	32.58	12.688
CEA EPO	12	19	14	33	24.75	5.864
CEA LPO	12	22	10	32	25.58	6.186
CEA LC	12	13	22	35	27.00	4.156
AI PrO	12	24	27	51	36.25	6.524
AI EPO	12	10	18	28	24.00	2.796
AI LPO	12	12	18	30	23.25	3.388
AI LC	12	22	18	40	24.00	5.800
Age	12	17	19	36	28.75	6.412
Valid N (listwise)	12					

CEA PrO: preoperative centre-edge angle; CEA EPO: centre-edge angle immediately after surgery; CEA LPO: centre-edge angle at postoperative week 6; CEA LC: centre-edge angle at the last control; AI PrO: preoperative acetabular index, AI EPO: acetabular index immediately after surgery, AI LPO: acetabular index at postoperative week 6, AI LC: acetabular index at the last control, N - number of patients. Min: minimum, Max: maximum. SD: standart deviation. Std: standart, Stat: statistic.

Table 3. Spearman's rho correlation analysis of CEA, AI, Tönnis grades and age

		CEA PrO	CEA EPO	CEA LPO	CEA LC	AI PrO	AI EPO	AI LPO	AI LC	Tonnis PrO	Tonnis EPO	Tonnis LPO	Tonnis LC	Age
CEA PrO	C.C.	1.000	0.218	0.037	-0.059	-0.599	-0.349	-0.496	-0.379	-0.682*	0	0	-0.755**	-0.496
	Sig.	0	0.497	0.908	0.857	0.040	0.266	0.101	0.225	0.014	0	0	0.005	0.101
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
CEA EPO	C.C.	0.218	1.000	0.572	0.349	-0.302	-0.585	-0.391	-0.326	-0.492	0	0	-0.197	0.562
	Sig.	0.497	.0	0.052	0.266	0.340	0.046	0.209	0.302	0.104	0	0	0.540	0.057
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
CEA LPO	C.C.	0.037	0.572	1.000	0.293	-0.007	-0.230	-0.728	-0.389	-0.135	0	0	-0.368	0.301
	Sig.	0.908	0.052	.0	0.356	0.982	0.472	0.007	0.212	0.675	0	0	0.239	0.342
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
CEA LC	C.C.	-0.059	0.349	0.293	1.000	0.229	-0.679	-0.287	-0.005	0.000	0.	0.	0.113	0.456
	Sig.	0.857	0.226	0.356	.0	0.474	0.015	0.366	0.987	10.000	0.	0.	0.727	0.136
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
AI PrO	C.C.	-0.599	-0.302	-0.007	0.229	1.000	0.208	0.253	0.127	0.763**	0.	0.	0.621*	0.384
	Sig.	0.040	0.340	0.982	0.474	.0	0.518	0.427	0.695	0.004	0.	0.	0.031	0.218
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
AI EPO	C.C.	-0.349	-0.585	-0.230	-0.679	0.208	1.000	0.296	0.046	0.553	0.	0.	0.338	-0.221
	Sig.	0.266	0.046	0.472	0.015	0.518	.0	0.350	0.886	0.062	0.	0.	0.282	0.490
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
AI LPO	C.C.	-0.496	-0.391	-0.728	-0.287	0.253	0.296	1.000	0.769	0.468	0.	0.	0.655*	0.124
	Sig.	0.101	0.209	0.007	0.366	0.427	0.350	.0	0.003	0.125	0.	0.	0.021	0.700
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
AI LC	C.C.	-0.379	-0.326	-0.389	-0.005	0.127	0.046	0.769	1.000	0.358	0.	0.	0.366	0.057
	Sig.	0.225	0.302	0.212	0.987	0.695	0.886	0.003	.0	0.253	0.	0.	0.243	0.860
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
Tonnis PrO	C.C.	-0.682*	-0.492	-0.135	0.000	0.763**	0.553	0.468	0.358	10.000	0.	0.	0.707*	0.343
	Sig.	0.014	0.104	0.675	10.000	0.004	0.062	0.125	0.253	0.	0.	0.	0.010	0.275
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
Tonnis EPO	C.C.	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sig.	0	0	0	0	0	0	0	0	0	0	0	0	0
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
Tonnis LPO	C.C.	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sig.	0	0	0	0	0	0	0	0	0	0	0	0	0
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
Tonnis LC	C.C.	-0.755**	-0.197	-0.368	0.113	0.621*	0.338	0.655*	0.366	0.707*	0	0	10.000	0.591*
	Sig.	0.005	0.540	0.239	0.727	0.031	0.282	0.021	0.243	0.010	0	0		0.043
	N	12	12	12	12	12	12	12	12	12	12	12	12	12
Age	C.C.	-0.496	0.562	0.301	0.456	0.384	-0.221	0.124	0.057	0.343	0	0	0.591*	10.000
	Sig.	0.101	0.057	0.342	0.136	0.218	0.490	0.700	0.860	0.275	0	0	0.043	
	N	12	12	12	12	12	12	12	12	12	12	12	12	12

CEA Pro: preoperative centre-edge angle; CEA EPO: centre-edge angle immediately after surgery; CEA LPO: centre-edge angle at postoperative week 6; CEA LC: centre-edge angle at the last control; AI PrO: preoperative acetabular index, AI EPO: acetabular index immediately after surgery, AI LPO: acetabular index at postoperative week 6, AI LC: acetabular index at the last control, Tonnis PrO: preoperative Tonnis grade, Tonnis EPO: Tonnis grade immediately after surgery; Tonnis LPO: Tonnis grade at postoperative week 6, Tonnis LC: Tonnis grade, at the last control

significant differences as indicated by significant multivariate tests (e.g., Pillai's Trace: $F(2, 10) = 43.333$, $p < .001$) and within-subjects effects (Greenhouse-Geisser: $F(1.307, 14.381) = 59.667$, $p < .001$).

Spearman's rho correlation analysis revealed significant relationships between preoperative and postoperative measurements of CEA and AI, with significant negative correlations between preoperative CEA and preoperative AI ($\rho = -0.599$, $p = 0.040$), Tönnis preoperative grade ($\rho = -0.682$, $p <0.05$), and the Tonnis LC angle (Tonnis LC; $\rho = -0.755$, $p <$

Table 4. Wilcoxon Signed Ranks Test Results for Postoperative and Preoperative Measurements

	CEA EPO-CEA PrO	CEA LPO-CEA PrO	CE LC-CEA PrO	AI EPO-AI PrO	AI LPO-AI PrO	AI LC-AI PrO	Tonnis EPO-Tonnis PrO	Tonnis LPO-Tonnis PrO	Tonnis LC-Tonnis PrO
Z	-1.961[b]	-1.778[b]	-1.415[b]	-3.065[b]	-3.061[b]	-3.059[b]	-3.095[b]	-3.095[b]	-3.140[b]
p value	0.050	0.075	0.157	0.002	0.002	0.002	.002	.002	.002

b. Based on positive ranks. Z: Wilcoxon test statistics value; CEA Pro: preoperative center edge angle; CEA EPO: centre-edge angle immediately after surgery; CEA LPO: centre-edge angle at postoperative week 6; CEA LC: centre-edge angle at the last control; AI PrO: preoperative acetabular index, AI EPO: acetabular index immediately after surgery, AI LPO: acetabular index at postoperative week 6, AI LC: acetabular index at the last control, Tonnis PrO: preoperative Tonnis grade, Tonnis EPO: Tonnis grade immediately after surgery; Tonnis LPO: Tonnis grade at postoperative week 6, Tonnis LC: Tonnis grade, at the last control, Z: Wilcoxon test statistics value

0.01), and the Tonnis LC grade. The test also showed a positive correlation between CEA EPO and AI EPO measurements ($\rho = -0.679$, $p = 0.015$), and positive correlations between different AI measurements and Tönnis grades with age, indicating both inverse and direct associations (Table 3).

Wilcoxon Signed Ranks Tests revealed significant reductions in AI and Tönnis grades from preoperative to postoperative, while changes in CEA measurements were not consistently significant ($Z = -1.961$, $p = 0.050$ for the CEA in EPO) (Table 4).

DISCUSSION

The short and mid-term results obtained in this study of patients who underwent isolated Pembersal osteotomy for DDH showed a significant improvement in radiological AI values.

The treatment of delayed DDH presents significant challenges for both surgeon and the patient. Achieving femoral head acetabular alignment is crucial for extending hip joint longevity. In this study, the intermediate radiological results are presented of patients undergoing isolated Pembersal osteotomy for DDH. A study by Agarwai et al. of 16 patients over 54 months reported similar significant improvements in AI and CEA (5). The AI improvements observed in the current study were consistent with the findings of Agarwai et al., although the long-term CEA differences were not statistically significant. Li et al. reported that AI was statistically superior in specificity, sensitivity, and diagnostic accuracy post-closed reduction in DDH compared to the CEA and Reimer index (8). In the current study, improvements in AI were noted postoperatively, and Tönnis staging revealed an improvement from stage 4 to stages 1 and 2 in three patients.

The study by Bursalı and Tonbul (6) had a longer follow-up period and a larger number of patients compared to the present study. However, in the present study, isolated Pembersal osteotomy was performed, whereas in the Bursalı study, proximal femoral osteotomy was performed together with Pembersal osteotomy. While Bursalı and Tonbul (6) observed long-term improvements with a mean follow-up of 10.5 years, the shorter mean follow-up of 50.33 months in the current study may not capture the full extent of long-term skeletal maturation and stability after osteotomy. Nevertheless, the application of robust statistical methods such as Shapiro-Wilk and repeated measures ANOVA in this study revealed complex, time-dependent changes in CEA and AI, suggesting a nuanced trajectory of radiological improvement that parallels the clinical and radiographic improvements noted by Bursalı and Tonbul. In evaluating the outcomes of Pembersal osteotomy for DDH in this patient cohort, with a mean age significantly lower than that reported by Bursalı and Tonbul, it is acknowledged that there is the limitation of the ability to fully capture long-term complications such as premature closure of the triradiate cartilage and postoperative avascular necrosis. Although the findings of Bursalı and Tonbul on these complications provide an important context for interpreting the current study results, the relatively short mean follow-up of 50.33 months may not be sufficient to detect such late-onset complications, which are critical considerations for a comprehensive assessment of surgical outcomes.

Another study evaluated the effectiveness of interventions targeting only the acetabular side in the surgical treatment of Legg-Calvé-Perthes disease. That study involved twelve patients undergoing acetabular osteotomies including Pembersal, with significant improvements observed both clinically and radiologically. This complements the current study findings, suggesting the efficacy of acetabular-side surgeries in specific hip conditions without requiring femoral intervention (12).

Bortulev et al. compared different pelvic osteotomy techniques in the treatment of hip dysplasia in children and divided their patients into 3 groups. The first group included patients with Tönnis type 1 and AI ≤ 35º, who underwent a modified Salter osteotomy. The second group included patients with Tönnis type 2 and AI >35º, on whom Pemberton osteotomy was performed. Patients with Tönnis type 3 and 4 and AI > 35º were designated as the third group and Pembersal osteotomy was performed. It was reported that all three osteotomies successfully corrected acetabular dysplasia without causing hemipelvic deformity. However, considering that the third group of patients had a higher dislocation and acetabular index than the other groups, the Pembersal osteotomy seems to correct acetabular dysplasia better. The mean AI values of the patients in the current study were above 35º and satisfactory postoperative results were obtained. These findings are consistent with the emphasis in the current study on the efficacy of specific osteotomy techniques, such as Pembersal surgery, in the treatment of hip dysplasia, and highlight the importance of tailored surgical approaches based on individual anatomical variations (13).

Limitations

The main limitations of this study can be said to be the small sample size and retrospective design, which may limit the generalizability of the findings. The absence of a control group makes it challenging to draw direct comparisons with other treatments. Furthermore, the focus on a specific surgical method may not encompass the variety of cases encountered in clinical practice. Long-term follow-up data was not extensively analyzed, which is crucial for understanding the durability of the surgical outcomes. In addition, the study did not account for variables such as patient lifestyle or comorbidities, which could influence recovery and results. Previous studies have shown that patients with bilateral developmental dysplasia of the hip have a higher risk of avascular necrosis and worse outcomes (14). Therefore, the fact that 3 of the 9 patients included in the study had bilateral developmental dysplasia of the hip can also be considered a limitation of the study.

CONCLUSION

The results of this study demonstrated that Pembersal osteotomy is an effective and safe option for the treatment of DDH with improvement in acetabular index and other radiological parameters. Significant improvements were noted in the Acetabular Index and other radiological parameters, indicating the efficacy of this surgical approach in correcting hip dysplasia. However, long-term outcomes need further investigation. The study underscores the importance of individualized surgical techniques based on specific anatomical variations in managing DDH. These findings can be considered to contribute to the growing body of evidence supporting tailored surgical interventions for optimal patient outcomes in pediatric orthopedics.

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