Combined assessment of acetabular coverage and femoral head-neck shapes predicts osteoarthritis progression after periacetabular osteotomy

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INTRODUCTION: Good or excellent survival rates for acetabular redirection osteotomies have been reported, but at long-term follow-up, the rate of postoperative radiographic OA progression was high, ranging from 20% to 40% [1]. Recent study revealed that the high postoperative combined anterior center-edge and alpha angles (combined angle) were associated with femoroacetabular impingement after curved periacetabular osteotomy (CPO) [2]. Postoperative impingement might cause abnormal kinematics with increased joint contact pressure and adversely affects postoperative clinical outcome [3]. However, predictive anatomical parameters including the combined angle for radiographic OA progression after CPO are not well documented. In this study, we aimed to explore the anatomical parameters causing postoperative OA progression by comparing the patients with or without OA progression after CPO.

METHODS: We used a longitudinal cohort and identified 90 patients (13 men, 77 women, and 90 hips) who underwent CPO between March 2013 and March 2018. All patients were diagnosed as hip dysplasia with LCEA<20° and classified as having grade 0 or 1 OA according to the Tönnis classification system. Among them, 17 experienced OA progression at final follow-up and were included in the progression (P) group. The remaining 73 patients were included in the non-progression (N) group. OA progression was defined as an increase of at least one grade in the Tönnis classification system from 2 weeks postoperatively to the final follow-up. For all patients, X-rays and CT scans were performed preoperatively and 3 weeks postoperatively and the datasets were transferred to 3D software (ZedHip; LEXI Co, Tokyo, Japan). As anatomical parameters, the lateral (LCEA) and anterior center edge angles (ACEA), femoral anteversion, and acetabular anteversion were evaluated. For clinical evaluation, the modified Harris Hip Scores (mHHSs) were used for the evaluation of pre- and postoperative hip function. A postoperative anterior impingement was diagnosed if the patient had symptoms attributable to impingement and a positive anterior impingement sign. Comparisons between P and N groups were performed using the unpaired t-test for quantitative variables and Fisher's exact test for qualitative variables. Multivariate analyses were performed with postoperative OA progression as objective variables and parameters showing significant differences as explanatory variables. Cut-off values for explanatory variables were determined using receiver operating characteristic (ROC) curves. P-values < 0.05 were considered statistically significant.

RESULTS: There were no significant differences based on age, sex, BMI or follow-up period between the patients in the P and N groups (Table 1). Additionally, the preoperative LCEA and ACEA did not differ between the two groups, but P group had a higher frequency of preoperative OA compared to N group with an odds ratio of 9.32 (95% CI: 2.89 to 28.8, P = 0.002). In postoperative evaluations, patients in the P group had greater ACEA and the combined angle and less acetabular anteversion, even though there were no significant differences in other parameters (Table1). The ROC curve for the combination angle and acetabular anteversion demonstrated excellent discrimination between patients with or without postoperative OA progression (Fig.1). In multivariate analysis, postoperative OA progression was significantly affected by preoperative OA evidence (odds ratio 7.08, 95% CI 1.41-35.5, P = 0.017), acetabular anteversion < 5.0° (odds ratio 15.0, 95% CI 2.50-90.5, P = 0.003), and the combined angle >107.0 ° (odds ratio 18.2, 95% CI 1.45- 227.0, P = 0.025). Preoperative hip range of motions (flexion, abduction, internal rotation, and external rotation) were not significantly different between the P and N groups, but the mean hip flexion angle and internal rotation angle at final follow-up were significantly more limited in P group than in N group (flexion, 106.3° ± 11.9° vs. 113.2° ± 9.4°; P = 0.031, internal rotation 25.5° ± 11.3° vs. 32.0° ± 12.0°; P = 0.045, Table 3). Furthermore, P group had a higher frequency of postoperative anterior impingement (8/17, 47.1%) compared to N group (12/73, 16.4%, odds ratio = 4.52; 95% CI = 1.51 to 12.73, P =0.019, Table2). The preoperative mHSS did not differ significantly between the P and N groups, however, postoperative mHHS at the final follow up was significantly lower in the P group than in the N group (89.2 ± 7.1 vs. 94.4 ± 8.0, P = 0.017).

DISCUSSION: In this study, 17 out of 90 hips (18.9%) experienced radiographic OA progression after a minimum of 5 years follow-up subsequent to CPO. Furthermore, patients with OA progression after CPO had significantly negative clinical results as evidenced by poor mHHS, limited range of motion in flexion and IR, and anterior impingement sign. Most importantly, patients with higher combined anterior central edge angle and alpha angle postoperatively as well as postoperative reduced acetabular anteversion were more likely to have OA progression after CPO. To our knowledge, this is the first study to report that combined assessment of anterior coverage and femoral head shape predicts OA progression after CPO. Our results provide useful information to assist surgeons in deciding on the indication and preoperative planning for CPO.

SIGNIFICANCE/CLINICAL RELEVANCE: The current study demonstrated that hips experienced radiographic OA progression after CPO were associated with poor clinical results and high frequency of anterior impingement with a limited range of motions in flexion and IR. The surgeons need to focus on the potential adverse effect of specific parameters including the preoperative grade of osteoarthritis, postoperative reduced acetabular anteversion and postoperative combination of alpha angle and anterior coverage.

Reference: 1. Willey MC, J Am Acad Orthop Surg 2022. 2. Hayashi S et al. J Arthroplasty 2022. 3. Albers CE et al. Clin Orthop Relat Res 2013.

Table 1

	N group	P group	P value
LCE, °	30.0 ± 8.0	27.7 ± 6.8	0.21
ACE, °	54.7 ± 11.4	63.7 ± 9.7	0.014
Acetabular anteversion, °	14.2 ± 10.9	2.9 ± 12.8	<0.001
Femoral anteversion, °	26.5 ± 11.4	33.6 ± 11.1	0.252
Alpha angle, °	46.1 ± 6.0	48.6 ± 8.0	0.084
Combined angle, °	99.3 ± 9.7	111.2 ± 11.2	<0.001

Table 2

	N group	P group	P value
Postoperative flexion, °	113.2 ± 9.4	106.3 ± 11.9	0.031
Postoperative abduction, °	39.3 ± 6.4	40.8 ± 4.2	0.237
Postoperative IR, °	32.0 ± 12.0	25.5 ± 11.3	0.045
Postoperative ER, °	41.6 ± 10.6	39.5 ± 5.2	0.319
Anterior impingement (Yes/No)	12/61	8/9	0.019
Postoperative mHHS	89.2 ± 7.1	94.4 ± 8.0	0.011

Figure 1