Does Periacetabular Osteotomy Improve Hip Microinstability in Static postural change in Symptomatic Hip Dysplasia?

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INTRODUCTION: It remains poorly understood whether periacetabular osteotomy (PAO) improves hip microinstability in patients with symptomatic hip dysplasia. We aimed to assess the femoral head translation with static postural change, considered a potential indicator of hip microinstability, comparing dysplastic hips before and after PAO with normal hips.

METHODS: Twenty-seven patients (30 hips) with hip dysplasia underwent PAO and 18 healthy individuals (18 hips) were included. Hip joint kinematics were analyzed using 3D-2D model-image registration with static images (radiograph or fluoroscopic images) of each hip between supine and standing positions (Fig. 1). Femoral head translation was quantified as the displacement of the center of the femoral head relative to the center of the acetabulum in each image between supine and standing positions. Univariate logistic regression analysis was performed to identify preoperative morphological risk factors for lateral translation of the femoral head in the standing position before PAO in hip dysplasia. Variables with $p < 0.20$ were included in a multivariable model to identify the independent influence of each factor. Receiver operating characteristic (ROC) curves were plotted to calculate the sensitivity, specificity, and cutoff values of independent factors.

RESULTS: Femoral head translation decreased after PAO (1.5± 0.4 mm vs. 1.0 ± 0.4 mm, $p < 0.001$) but remained larger than in controls (1.0 ± 0.4 mm vs. 0.7 ± 0.3 mm, p=0.01). The more severe the hip dysplasia before PAO, the greater the femoral head translation. However, the femoral head translation improved after PAO with sufficient acetabular correction. Multivariate analysis identified the preoperative acetabular roof obliquity (ARO) (p=0.046) as an independent predictor for preoperative lateralization of the femoral head from the supine to standing position. Specifically, preoperative ARO of > 20.0° predicted lateral translation of the femoral head with static postural change (sensitivity 100%, specificity 57%, AUC 0.81).

DISCUSSION: This study demonstrates that the severity of hip dysplasia influences hip microinstability, that PAO mitigates hip microinstability with adequate acetabular correction, and that PAO does not normalize hip stability because of residual joint incongruity. In patients with a larger ARO, the femoral head has more lateral translation in the standing position. Therefore, weight-bearing postural radiographs are crucial for understanding hip biomechanics in hip dysplasia and refining surgical corrections during PAO.

SIGNIFICANCE/CLINICAL RELEVANCE: PAO can make the hip more stable in hip dysplasia, but not as stable as the normal hip. In hip dysplasia, pre-PAO standing radiographs should be evaluated due to accurately representing the femoral head position relative to the acetabulum.

IMAGES AND TABLES:

Fig. 1 : The surface models of the pelvis and femur are superimposed with radiographic images, using the three-dimensional-to-two-dimensional model-to-image registration technique. The edge of the three-dimensional models is image-matched to the pelvic radiograph while observing a user-adjustable view providing any aspect and zoom of the current joint configuration

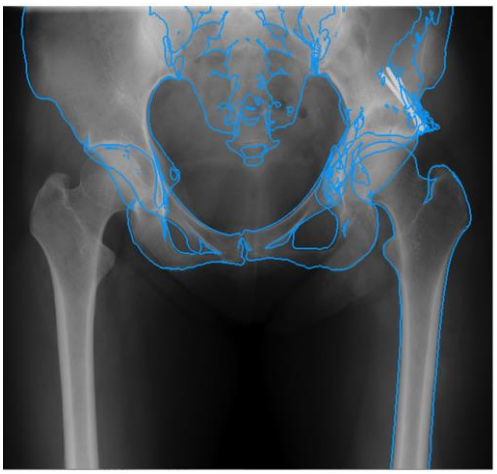

Table 1. Distance of the femoral head translation from supine to standing position between hip dysplasia before and after PAO and controls

	Before PAO	After PAO	Control	P value [a]	P value [b]	P value [c]
Distance	1.5 ± 0.4	1.0 ± 0.4	0.7 ± 0.3	P<0.001	P<0.001	P=0.01
x	-0.1 ± 0.8	-0.1 ± 0.4	0 ± 0.4	P>0.99	P>0.99	P>0.99
y	0.5 ± 0.5	0.2 ± 0.4	0.1 ± 0.4	P=0.15	P=0.02	P=0.65
z	1.0 ± 0.4	0.7 ± 0.5	0.2 ± 0.4	P=0.01	P<0.001	P=0.002

Table 2. Univariate and multivariate analysis of risk factors for lateral translation of the femoral head from the supine to standing position before PAO in patients with hip dysplasia

	Lateral translation (n = 7 hips)	Medial translation (n = 23 hips)	Univariate p value	Multivariate p value
LCEA (°)	8.3 (-13.8 to 22.1)	14.1 (-9.2 to 21.8)	0.06	0.15
ARO (°)	26.2 ± 6.0	19.2 ± 5.4	0.007	0.046
Sharp angle (°)	50.4 ± 2.9	47.8 ± 3.1	0.05	0.47
Extrusion index (%)	42.3 ± 12.1	34.3 ± 7.5	0.048	0.19
Anterior wall index	0.32 ± 0.07	0.34 ± 0.12	0.66	
Posterior wall index	0.80 ± 0.17	0.89 ± 0.19	0.22	
FEAR index (°)	10.7 ± 12.7	4.5 ± 7.8	0.12	0.88

PAO, periacetabular osteotomy; LCEA, Lateral center-edge angle; ARO, Acetabular roof obliquity; FEAR index, Femoro-epiphyseal acetabular roof index. Values are presented as the mean ± SD or the median (range).