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Basic Science

Femoral Morphology in Patients Undergoing Periacetabular Osteotomy for Classic or Borderline Acetabular Dysplasia: Are Cam Deformities Common?

Lucas A. Anderson, MD [a], Jill A. Erickson, PA-C [a], Russell P. Swann, MD [a, b], Ian P. McAlister, MD [b], Mike B. Anderson, MSc [a], Rafael J. Sierra, MD [b], Christopher L. Peters, MD [a, *]

[a] Department of Orthopaedics, University of Utah, Salt Lake City Utah
[b] Department of Orthopedic Surgery, The Mayo Clinic, Rochester, Minnesota

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ABSTRACT

Background: The primary purpose of our study was to determine the prevalence of Cam deformity in patients with symptomatic acetabular dysplasia (SAD) who underwent periacetabular osteotomy (PAO).
Methods: We retrospectively reviewed 164 SAD PAO patients from 2 institutions. Preoperative anteroposterior and frog-lateral radiographs were analyzed for lateral center edge angle (LCEA), retroversion, alpha angles, and anterior femoral head-neck offset. Hips were classified as dysplastic (LCEA <20°, group A, n = 142) and borderline dysplastic (LCEA 20°-25°, group B, n = 22). There were 128 females and 36 males with an average age of 29 years (range 13-56).
Results: The overall prevalence of Cam deformity was 10% (17 of 164) in SAD patients. There was no difference in the prevalence of Cam deformity between the groups ($P > .99$).
Conclusion: Prevalence of Cam deformities in our series of SAD patients having undergone PAO is less than prior reports. Careful radiographic measurement should be performed to avoid overtreating these hips with unnecessary osteochondroplasty procedures.

There are arguments for a less invasive periacetabular osteotomy (PAO) procedure from the standpoint of patient recovery and whether intracapsular interventions such as femoral osteochondroplasty are necessary. The need for femoral osteochondroplasty is supported by the reports of Steppacher et al [1] who suggested that acetabular dysplasia may promote asymmetric growth of the femur resulting in an aspheric femoral head. Furthermore, they propose that the combination of acetabular and femoral deformities may influence the results of acetabular reorientation procedures. Recent reports indicate potential benefits of hip arthroscopy for the treatment of intraarticular pathology and Cam-like deformity before and during PAO procedures [2,3]. In addition, Albers et al [4] reported that lack of femoral offset correction in aspherical femoral heads during acetabular reorientation procedures such as PAO increased the risk of failure, presumably due to secondary femoroacetabular impingement (FAI).

Although some evidence suggests the need to address intracapsular pathology when present at the time of PAO, controversy exists regarding the overall prevalence of femoral-sided morphology requiring intervention in hips undergoing PAO [5-8]. The aspheric femoral head in patients with classic dysplasia (excluding pincer and retroverted acetabula) may be a different morphologic abnormality than the classic Cam deformity of FAI. Often in dysplastic hips, there is lateral or anterolateral flattening of the femoral head-neck junction which can result in reduced head-neck offset (HNO) but may be quite different than the classic anterolaterally based protuberance seen in Cam-type FAI both from a morphologic and possibly pathomechanical standpoint. In our experience, with careful digital templating the lateral flattening of the head-neck junction is often actually "within" the sphere of the head suggesting that the pathomechanics may be quite different than a cam-like mechanism. Other authors have suggested that the

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* Reprint requests: Christopher L. Peters, MD, Professor, Department of Orthopaedics, University of Utah, 590 Wakara Way, Salt Lake City, UT 84108.

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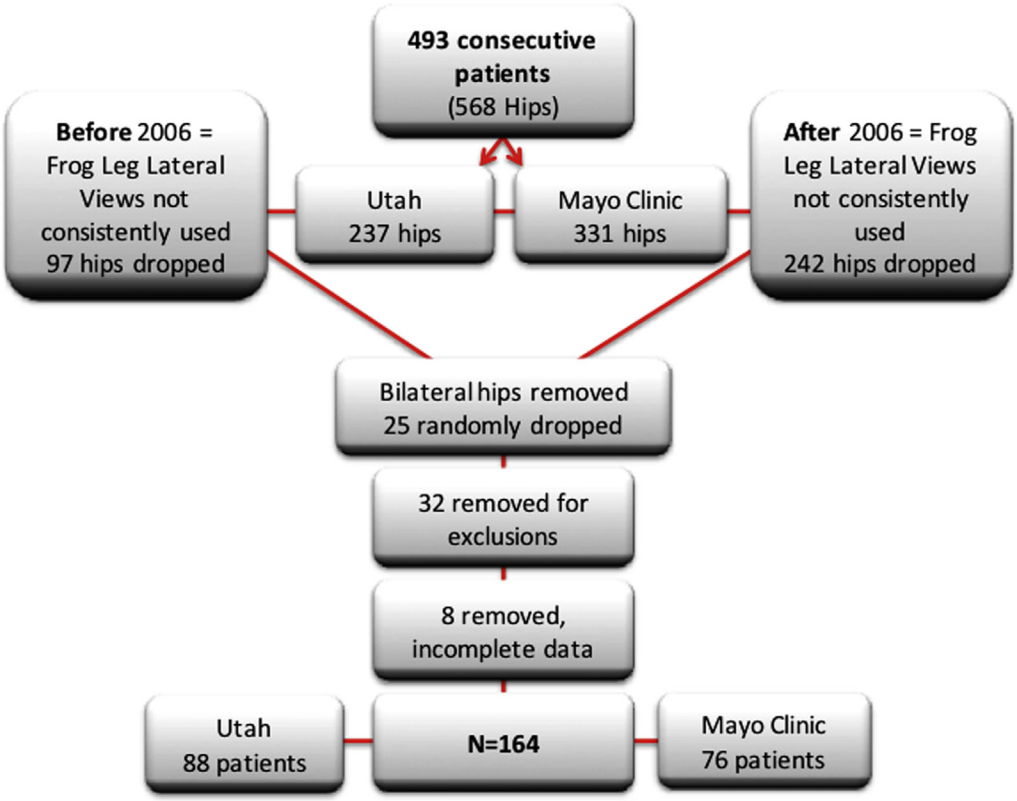

Fig. 1. This figure demonstrates the patient selection and attrition process.

anterolaterally based flattened femoral head abnormality may be secondary to remodeling that occurs in the unstable or dysplastic hip as the result of abnormal muscle forces [9].

The primary purpose of our study was to determine the prevalence of true femoral Cam deformity in patients with symptomatic acetabular dysplasia (SAD) who underwent PAO. A second purpose was to characterize femoral HNO in this population. We hypothesized that these patients would have a lower prevalence of Cam deformity than previously reported.

Materials and Methods

We retrospectively reviewed all SAD patients (n = 493, n = 568 hips, Fig. 1) that had undergone PAO from 2 institutions after exemptions from each institution's internal review board. Inclusion criteria included patients who underwent a PAO for classic (lateral center edge angle [LCEA] <20 degrees) or borderline (LCEA 20-25 degrees) and who had complete anteroposterior and lateral radiographs preoperatively and postoperatively. For patients with bilateral involvement, one hip was randomly selected (n = 25 excluded). Furthermore, patients with a retroverted acetabulum, coxa profunda, or prior surgery/trauma were excluded (n = 32). Eight patients with inadequate data were also removed. Of the 493 patients, a total of 164 patients who underwent PAO due to classic or borderline acetabular dysplasia qualified and were reviewed for this cross-sectional study. There were 128 females and 36 males with an average age of 29 years (range, 13-56). There was no difference in age, sex, or body mass index between the groups (Table 1).

Preoperative anteroposterior and frog-lateral radiographs were analyzed for LCEA, alpha angles, and femoral HNO [10,11]. LCEA was measured according to methods previously described [12-15]. Hips were classified as classic dysplasia (LCEA <20°, group A, n = 142) or borderline dysplasia (LCEA 20°-25°, group B, n = 22).

The alpha angle measurement was made by first finding the center of the femoral head on frog-leg lateral radiographs and fitting a statistical circle to match most of the femoral head articular surface. Second, from the center of the narrowest point of the neck, we extended the first arm of the alpha angle to the precise center of the head. Finally, the second arm of the angle was extended to the point at which the femoral head or neck exits (goes outside rather than inside) the statistical circle (Fig. 2) [11,16].

Anterior head-neck offset (AHNO) was defined as the difference between the radius of the head and half the neck width (Fig. 3) [17]. Head-neck offset ratio was measured by taking the AHNO measurement divided by the femoral head diameter (Fig. 4) [11,17]. To assess the osteoarthritic condition of each hip, we used the grading system, described by Tönnis and Heinecke [18].

Demographic data are reported as mean (range). A Shapiro-Wilk test was used to assess the distribution of the data, which was found to be nonparametric ($P < .001$). Data are reported as median (interquartile range [IQR]). A chi-square analysis or Fisher's exact test, when counts were less than 5, was used to assess binary data,

Table 1
Patient Demographics Between Groups.

Characteristic	Overall	Classic Dysplasia, n = 142	Borderline Dysplasia, n = 22	*P* Value
Age, mean (range)	29 (13-56)	29 (13-48)	30 (16-56)	.804
Gender, male (%)	36 (22%)	34 (24%)	2 (9%)	.167
BMI, mean (range)	25.3 (18-38)	25.2 (18-38)	25.8 (19-33)	.457

BMI, body mass index.