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Radiographic Structural Abnormalities Associated with Premature, Natural Hip-Joint Failure

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Background: Significant controversy exists regarding the causes of premature, natural hip-joint failure. Identification of these causes may guide future investigations targeting prevention of this disorder. The aims of this study were to: (1) determine and characterize structural abnormalities associated with premature, natural hip-joint failure, and (2) analyze disease progression in the contralateral hips of patients with femoroacetabular impingement deformities.

Methods: We analyzed 604 patients (710 hips) from three different medical centers who underwent primary total hip arthroplasty at or before fifty years of age (average age, forty years). Three hundred fourteen patients (52%) were male, and 290 patients (48%) were female.

Results: The diagnoses associated with premature hip failure varied, but osteoarthritis and osteonecrosis were most common. Radiographic abnormalities associated with developmental hip dysplasia and femoroacetabular impingement were associated with the majority of osteoarthritic hips. Hips with femoroacetabular impingement deformities demonstrated distinct structural anatomy relative to asymptomatic hips, with a high prevalence of bilateral deformities. In a subgroup of seventy patients with femoroacetabular impingement deformities, contralateral radiographic disease progression or the need for total hip arthroplasty was observed in 73% of hips.

Conclusions: Osteoarthritis and osteonecrosis are the major causes of premature hip-joint failure in young patients. Femoroacetabular impingement abnormalities are usually bilateral and are commonly associated with progression of the disease to the contralateral hip.

Level of Evidence: Prognostic Level IV. See Instructions to Authors for a complete description of levels of evidence.

A variety of disorders, including osteoarthritis, osteonecrosis of the femoral head, inflammatory arthritis, and posttraumatic conditions, can cause end-stage hip disease. For patients who are fifty years of age or younger, end-stage disease can be considered "premature" and treatment is challenging due to long life expectancies and potentially high activity levels. Thus, the concepts of early diagnosis and hip-joint preservation surgery have gained increased attention[1,2]. While previous studies have documented structural abnormalities associated with secondary osteoarthritis[3-6], there is a lack of comprehensive information regarding the causes of end-stage disease in the young patient.

Refinements in understanding the structural etiology of secondary osteoarthritis have highlighted developmental dysplasia of the hip and femoroacetabular impingement as possible precursors[1,2]. Femoroacetabular impingement has received recent attention due to improved methods of diagnosis and innovations in surgical treatment[7-12]. Nevertheless, the role of femoroacetabular impingement in osteoarthritis remains controversial because a cause-and-effect relationship has not been rigorously established. Additionally, the prevalence of femoroacetabular impingement abnormalities in hips with premature osteoarthritis is not known. The prevalence of bilateral disease, the fate of untreated femoroacetabular impingement deformities, and the prognostic factors for disease progression are topics of current controversy.

Our study was designed to analyze a large cohort of patients with premature, end-stage hip disease who underwent primary total hip arthroplasty at or before fifty years of age. We performed a series of investigations to (1) determine and characterize the

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structural abnormalities associated with premature, natural hip-joint failure and (2) analyze disease progression in the contralateral hips of patients with femoroacetabular impingement deformities.

Materials and Methods

Study Overview

A retrospective search was performed to identify all patients who were treated with primary total hip arthroplasty at fifty years of age or younger by any of five orthopaedic surgeons at three medical centers. Six hundred and four patients (710 hips) with available medical records and radiographs were identified and included. The total hip arthroplasties were performed between the years of 1975 and 2005. The study protocol was approved by our institutional review boards.

The average patient age at surgery was forty years (range, twelve to fifty); 314 patients (368 hips) were male, and 290 patients (342 hips) were female. All pertinent medical and surgical history information in conjunction with radiographic analysis of acetabular and proximal femoral anatomy were utilized to determine the apparent cause of natural hip-joint failure. The cases were initially classified into broad diagnostic categories, including osteoarthritis, osteonecrosis, inflammatory arthritis, posttraumatic disease, "other conditions," and "too far advanced" to determine. Osteoarthritis cases were further evaluated to determine associated structural abnormalities. These abnormalities were classified as developmental dysplasia of the hip, slipped capital femoral epiphysis, Legg-Calvé-Perthes disease, or osteoarthritis of "unknown etiology." Cases that were classified as having an unknown etiology underwent a comprehensive radiographic review to characterize the detailed structural anatomy and to identify deformities consistent with femoroacetabular impingement. A subgroup of seventy patients with femoroacetabular impingement abnormalities and serial radiographs over time was identified and studied to assess the prevalence of bilateral deformities and the risk of disease progression in the contralateral hip.

Clinical and Radiographic Disease Classification

Medical record review included outpatient clinic notes, inpatient charts, and operative notes. Radiographic evaluation used all radiographs available. If multiple radiographs existed that spanned an extended time period, the earliest were used to assess structural features of the hip so that any distortion caused by the presence of secondary osteoarthritis would be minimized. Alternatively, the radiographs of highest quality were utilized. All cases were reviewed by the senior author (J.C.C.) to provide consistency with regard to disease classification.

Cases categorized as osteoarthritis were further analyzed for the presence of radiographic structural abnormalities. Measurements made from the anteroposterior pelvic radiograph[13] included the lateral center-edge angle[14], the acetabular index[15,16], the neck-shaft angle[17], the acetabular depth (coxa profunda or protrusio)[13], and the Tönnis osteoarthritis grade[18]. A hip was classified as coxa profunda if the medial wall of the acetabulum abutted or traversed the ilioischial line and/or had a lateral center-edge angle of ≥40°, and it was classified as coxa protrusio if the medial aspect of the femoral head crossed the ilioischial line[13]. Femoral head sphericity was documented[19]. Characterization of acetabular version was accomplished by examining for the acetabular crossover sign[13,20]. This was recorded and analyzed only when the anterior and posterior lips of the acetabulum could be visualized and the pelvic radiograph demonstrated no pelvic rotation and tilt[17,20]. From the cross-table lateral projections, head-neck offset and head-neck offset ratio were measured with use of the technique described by Eijer et al.[21,22]. Head sphericity was also noted on the lateral projections[19]. For cases that had a false-profile radiograph[23], the anterior center-edge angle was measured[13,15,16]. All radiographic measurements were performed or supervised by one senior author (J.C.C.).

Specific radiographic features were considered indicators of associated structural hip disease. Developmental dysplasia of the hip was considered to be the primary diagnosis for hips with a lateral center-edge angle of <20° and an acetabular inclination of >15°. In the absence of structural features for developmental dysplasia of the hip, hips with decreased head-neck offset (<9 mm)[19,21,22], decreased head-neck offset ratio (<0.17), or aspherical femoral heads[19,21,22] were classified as having a cam impingement deformity. Similarly, retroverted acetabula, coxa profunda, or coxa protrusio were identified as pincer impingement deformities[1,8,10,12,13,24]. Hips exhibiting features of both cam and pincer impingement were considered "combined" impingement deformities[8].

Femoroacetabular Impingement: Prevalence of Bilateral Deformities and Disease Progression in the Contralateral Hip

Hips with radiographic findings of femoroacetabular impingement were studied in detail to determine the prevalence of bilateral femoroacetabular impingement deformities and the risk of disease progression in the contralateral hip over time. The 118 hips with femoroacetabular impingement were screened to identify patients who had adequate serial radiographs (at least two distinct time points) that spanned a minimum of four years. This yielded seventy hips for inclusion in this aspect of the investigation: fifty (71.4%) in men and twenty (28.6%) in women. The average age at the time of index arthroplasty was forty-four years (range, twenty-three to fifty years). The contralateral hip (not undergoing initial arthroplasty) was the focus of this portion of the study. Radiographic parameters analyzed included age, sex, type of impingement, alpha angle[25], head-neck offset ratio, "functional head-neck offset ratio," acetabular version, lateral center-edge angle, acetabular inclination, Tönnis osteoarthritis grade, and minimum joint-space width[26]. All radiographic measurements were made with use of established radiographic parameters with the exception of the measurement for "functional head-neck offset ratio," which was made as previously described for head-neck offset ratio[21] except that the most anterior or anterolateral aspect of the femoral head was determined by including osteophytes and/or reactive bone superimposed on a visible femoral neck cortex. The investigators who made the radiographic measurements were blinded to patient name, film date, and clinical status.

The clinical and radiographic disease progression was determined by objective end points, including subsequent total hip arthroplasty or the progression of radiographic osteoarthritis grade. The average time from the first radiograph to the last radiograph was 8.8 years (average, 0.3 to 30.5 years). Subjects were defined as having an "event" if they underwent total hip arthroplasty or showed progression of Tönnis osteoarthritis grade during the follow-up time period. Statistical analysis was performed to determine the factors associated with an event.

Structural Hip-Anatomy Comparison Group

A comparison group was established as previously described[22] and consisted of patients who were fifty years or younger who presented to one author's clinic (J.C.C.) with complaints of back or leg pain and had a complete radiographic hip series prior to clinical evaluation. History and physical examination revealed no signs or symptoms of intrinsic hip disease. Specifically, no patient had groin pain, hip-joint irritability, asymmetric or diminished range of hip motion, or a positive impingement test. The majority of these patients had signs and symptoms consistent with lumbar spinal disease in the absence of hip involvement. Thirty-five patients (forty-two hips) with an average age of 38.5 years (range, eighteen to fifty years) were identified and used as the comparison group. The radiographic data from twenty-two of these patients have been published previously[22]. Eleven patients (fourteen hips) were male and twenty-four patients (twenty-eight hips) were female.

Statistical Analysis

All data are reported as the mean plus the standard deviation for continuous variables and the number of patients (and the percentage of the group) for categorical variables. When the baseline characteristics and radiographic parameters were compared between the different groups separately (comparison group vs. combined groups, patients with subsequent total hip arthroplasty surgery vs. patients without subsequent total hip arthroplasty surgery), chi-square tests were used for categorical variables and unpaired t tests were used for continuous variables. Radiographic parameters of the comparison group and combined impingement groups were analyzed by sex. For categorical variables, if the cell count was too low ($n < 5$), the Fisher exact test was used instead. Among the seventy patients with femoroacetabular impingement, logistic regression models were used to determine if any predictors were associated with radiographic outcomes. Odds ratios and the corresponding 95%

TABLE I Diagnostic Categories and Patient Characteristics for 604 Patients (710 Hips) with Premature Hip-Joint Failure According to Sex

	Number of Hips*			Age of Patients† *(yr)*		
Diagnosis	Female (N = 342)	Male (N = 368)	Overall (N = 710)	Female (N = 342)	Male (N = 368)	Overall (N = 710)
Osteoarthritis	190 (55.6%)	147 (40%)	337 (47.5%)	40.9 ± 8.3	41.8 ± 7.6	41.3 ± 8.0
Osteonecrosis	63 (18.4%)	142 (38.6%)	205 (28.9%)	35.8 ± 8.9‡	40.3 ± 6.5‡	38.9 ± 7.6
Posttraumatic disease	32 (9.4%)	29 (7.9%)	61 (8.6%)	41.8 ± 6.8§	36.3 ± 8.6§	39.1 ± 8.1
Inflammatory arthritis	36 (10.5%)	19 (5.2%)	55 (7.7%)	36.4 ± 10.1	38.8 ± 6.9	37.2 ± 9.2
Too far advanced	14 (4.1%)	27 (7.3%)	41 (5.8%)	38.6 ± 10.7‡	44.2 ± 6.0‡	42.2 ± 8.4
Other	7 (2.1%)	4 (1.1%)	11 (1.5%)	31.0 ± 10.8§	45.8 ± 4.6§	36.4 ± 11.5

*The values are expressed as the number and percent of patients. †The values are expressed as years of age and the standard deviation. ‡A significant difference ($p < 0.01$) was seen between men and women within the same disease group. §A significant difference ($p < 0.05$) was seen between men and women within the same disease group.

TABLE II Radiographic Parameters of Hips According to Sex*

		Osteoarthritic Hips			
Variables	Asymptomatic Hips (Comparison Group)	With Cam-type or Combined Impingement Deformity	P Value	With Pincer-type or Combined Impingement Deformity	P Value
Sex = male	n = 14	n = 83		n = 26	
Age *(yr)*	41.4 ± 6.4 (n = 14)	44.4 ± 5.1 (n = 83)	0.049	43.3 ± 5.2 (n = 26)	0.300
LCE angle *(deg)*	31.4 ± 7.1 (n = 14)	26.9 ± 9.6 (n = 82)	0.099	36.9 ± 8.2 (n = 26)	0.041
Acetabular inclination *(deg)*	7.5 ± 7.0 (n = 14)	10.4 ± 7.3 (n = 82)	0.165	8.7 ± 7.0 (n = 26)	0.598
Neck-shaft angle *(deg)*	136 ± 5 (n = 14)	137 ± 7 (n = 82)	0.806	137 ± 8 (n = 26)	0.905
ACE angle *(deg)*	31.8 ± 9.9 (n = 9)	27.4 ± 15.9 (n = 12)	0.479	44.4 ± 9.3 (n = 3)	0.084
Head-neck offset ratio	0.18 ± 0.05 (n = 13)	0.09 ± 0.11 (n = 58)	<0.0001	0.11 ± 0.11 (n = 22)	0.014
Crossover sign	n = 14	n = 30	0.951	n = 13	0.054
No	9 (64%)	19 (63%)		3 (23%)	
Yes	5 (36%)	11 (37%)		10 (77%)	
Femoral head sphericity	n = 14	n = 55	0.007	n = 21	0.005
Aspherical	0	20 (36%)		9 (43%)	
Spherical	14 (100%)	35 (64%)		12 (57%)	
Sex = female	n = 28	n = 28		n = 17	
Age *(yr)*	37.0 ± 10.4 (n = 28)	43.5 ± 5.3 (n = 28)	0.005	43.2 ± 4.9 (n = 17)	0.010
LCE angle *(deg)*	31.2 ± 6.9 (n = 28)	31.8 ± 10.6 (n = 27)	0.817	39.7 ± 13.1 (n = 17)	0.022
Acetabular inclination *(deg)*	2.64 ± 5.80 (n = 28)	8.59 ± 5.92 (n = 27)	<0.001	7.18 ± 6.45 (n = 17)	0.019
Neck-shaft angle *(deg)*	136 ± 5 (n = 28)	134 ± 6 (n = 27)	0.484	133 ± 6 (n = 17)	0.231
ACE angle *(deg)*	32.2 ± 7.0 (n = 20)	35.1 ± 15.9 (n = 11)	0.570	41.0 ± 17.0 (n = 7)	0.225
Head-neck offset ratio	0.19 ± 0.05 (n = 26)	0.10 ± 0.09 (n = 23)	<0.001	0.11 ± 0.10 (n = 17)	0.009
Crossover sign	n = 28	n = 15	0.001	n = 11	<0.001
No	26 (93%)	7 (47%)		3 (27%)	
Yes	2 (7%)	8 (53%)		8 (73%)	
Femoral head sphericity	n = 28	n = 22	0.012	n = 13	0.027
Aspherical	0	5 (23%)		3 (23%)	
Spherical	28 (100%)	17 (77%)		10 (77%)	

*Unless otherwise indicated, the values are expressed as the mean plus the standard deviation for continuous variables and the number of patients (and the percentage of the group) for categorical variables. LCE = lateral center-edge, and ACE = anterior center-edge.

confidence intervals were reported. A p value of <0.05 was used to determine significance. All analyses were performed with use of SAS statistical software (Version 9; SAS Institute, Cary, North Carolina).

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This study was supported in part by a grant from the Curing Hip Disease Fund, which was utilized for research personnel salary and data analysis.

Results

Etiologies of Premature Degeneration of the Hip Joint

The diagnoses associated with premature failure of the hip joint varied, yet osteoarthritis and osteonecrosis were the dominant conditions associated with hip replacement surgery (Table I). Of the 710 hips, 337 (47.5%) had osteoarthritis, 205 (28.9%) had osteonecrosis, sixty-one (8.6%) had posttraumatic disease, fifty-five (7.7%) had inflammatory arthritis, and forty-one (5.8%) had disease too far advanced to allow accurate measurements or classification. Within the osteoarthritis group, 163 (48.4%) hips were classified as having developmental dysplasia of the hip, thirty-two (9.5%) as having Legg-Calvé-Perthes disease, twenty-one (6.2%) as having slipped capital femoral epiphysis, and 121 (35.9%) as having an "unknown etiology."

Radiographic Abnormalities Associated with Osteoarthritic Hips with "Unknown Etiology"

Detailed radiographic analysis of osteoarthritic hips with an unknown etiology demonstrated a high prevalence of structural abnormalities associated with femoroacetabular impingement. Analysis of the 121 hips in which the cause of disease was unclear revealed that seventy-six hips (62.8%) had radiographic features consistent with cam impingement; seven (6%), with pincer impingement; and thirty-five (30%), with combined cam and pincer impingement. These patients with femoroacetabular impingement deformities were more likely to be male (71.4%) compared with the total hip arthroplasty group as a whole (52% male) (p = 0.0001).

We analyzed the same radiographic parameters in reference to our comparison group of asymptomatic hips. To separately analyze cam and pincer abnormalities, all hips with cam deformities (cam only and combined cam and pincer cases) were grouped together (n = 111) as were all hips with pincer deformities (pincer only and combined cam and pincer) (n = 43) (Table II). Hips were also analyzed according to sex to control for sex-specific morphologies. Male patients with cam impingement deformities had structural differences when analyzed with the comparison group (Table II). These included a decreased head-neck offset ratio (p < 0.0001) and a higher percentage of hips with an aspherical femoral head (p = 0.007). Female patients with cam impingement deformities had an increased acetabular inclination (p < 0.001), a decreased head-neck offset ratio (p < 0.001), a higher percentage of hips with a crossover sign (p = 0.001), and a higher percentage of hips with an aspherical femoral head (p = 0.012). Male patients with pincer deformities demonstrated reduced head-neck offset ratio (p = 0.014) and a higher percentage of hips with an aspherical femoral head (p = 0.005; Table II). When analyzed with the comparison group, female patients with a pincer deformity demonstrated an increased lateral center-edge angle (p = 0.022), an increased acetabular inclination (p = 0.019), and a decreased head-neck offset ratio (p = 0.009) and composed a higher percentage of hips with a crossover sign (p < 0.001) and an aspherical femoral head (p = 0.027).

TABLE III Baseline Characteristics of the Seventy Patients with Femoroacetabular Impingement According to the Need for Subsequent Contralateral Total Hip Arthroplasty (THA)*

Variables	Patients without Subsequent Contralateral THA (N = 44)	Patients with Subsequent Contralateral THA (N = 26)	P Value
Age *(yr)*	43.5 ± 5.5	43.9 ± 5.7	0.815
Alpha angle *(deg)*	76.6 ± 17.8	94.4 ± 15.5	<0.001
LCE angle *(deg)*	28.3 ± 8.7	21.1 ± 7.3	<0.001
Acetabular inclination *(deg)*	7.74 ± 6.34	12.1 ± 6.9	0.009
Head-neck offset ratio	0.11 ± 0.04	0.08 ± 0.05	0.018
Functional head-neck offset ratio	0.07 ± 0.06	0.01 ± 0.07	0.001
Joint-space width *(mm)*	0.06 ± 0.01	0.03 ± 0.02	<0.001
Percent (no.) of female hips	25.0 (11)	34.6 (9)	0.390
Impingement type *(percent [no.])*			0.323
Cam	70.5 (31)	84.6 (22)	0.166
Pincer	6.8 (3)	0	
Both	22.7 (10)	15.4 (4)	

*Unless otherwise indicated, the values are expressed as the mean plus the standard deviation for continuous variables and the number of patients (and the percentage of the group) for categorical variables. LCE = lateral center-edge.

TABLE IV Odds Ratios of Risk Factors for Subsequent Contralateral Total Hip Arthroplasty in the Seventy Patients with Femoroacetabular Impingement

Variable	Odds Ratio (95% Confidence Interval)	P Value
Alpha angle*	1.98 (1.33, 2.95)	0.001
LCE angle	0.87 (0.79, 0.95)	0.002
Acetabular inclination	1.12 (1.02, 1.22)	0.012
Head-neck offset ratio*	0.23 (0.07, 0.82)	0.024
Functional head-neck offset ratio*	0.24 (0.10, 0.55)	0.001
Joint-space width	0.53 (0.38, 0.73)	<0.001
Both/pincer versus cam (cam was reference group)	0.43 (0.13, 1.51)	0.189

*The odds ratio of the alpha angle was based on a 10° increase; the odds ratios of the head-neck offset ratio and the functional head-neck offset ratio were based on a 0.1 increase. LCE = lateral center-edge.

Contralateral Disease Progression in Patients with Femoroacetabular Impingement

Screening of the 118 hips that had structural deformities consistent with femoroacetabular impingement identified seventy with adequate serial radiographs spanning a minimum of four years or until contralateral total hip arthroplasty. The average duration of radiographic monitoring of the contralateral hip was 8.8 years (range, 0.3 to 30.5 years). Structural abnormalities were found in the contralateral hips of all seventy patients with femoroacetabular impingement deformities. Of the seventy contralateral hips analyzed, fifty-one (73%) underwent subsequent total hip arthroplasty or demonstrated a progression in osteoarthritis grade. Twenty-six (37%) of the seventy hips underwent subsequent total hip arthroplasty at an average of 5.1 years (range, zero to nineteen years) after the initial total hip arthroplasty in the other limb. Twenty-five (36%) of the seventy hips demonstrated progression of the Tönnis osteoarthritis grade at an average of 8.4 years (range, 0.6 to twenty-one). Analysis of baseline characteristics (Table III) indicated that patients undergoing total hip arthroplasty had major differences in structural hip anatomy compared with the anatomy in patients who did not require surgery. Odds ratio analysis for subsequent total hip arthroplasty revealed that an increased alpha angle and acetabular inclination were the strongest predictors of subsequent total hip arthroplasty (Table IV). These findings indicate that a more severe cam deformity (increased alpha angle) and mildly increased acetabular inclination were predictors of disease progression in the contralateral hip.

Discussion

The current study was designed to analyze a large cohort of patients who had premature, end-stage hip disease and who underwent primary total hip arthroplasty at or before fifty years of age. Our goals were to determine and characterize structural abnormalities associated with premature, natural hip-joint failure and to analyze disease progression in the contralateral hips of patients with femoroacetabular impingement deformities. Our data are unique because we focused specifically on a young patient population, investigated all causes of end-stage disease, utilized contemporary techniques to measure the structural anatomy of the hip, examined a comparison group of patients without hip symptoms, and analyzed serial radiographs to determine predictors of progression of joint disease in the contralateral hip in patients with femoroacetabular impingement deformities.

Our findings demonstrate that osteoarthritis and osteonecrosis are the major causes of end-stage degeneration of the hip joint in young patients. In-depth radiographic analysis of osteoarthritic hips highlighted developmental dysplasia of the hip and femoroacetabular impingement as the predominant structural abnormalities associated with osteoarthritis. Hip deformities due to slipped capital femoral epiphysis and Legg-Calvé-Perthes disease commonly have the pathomechanical characteristics of hip-impingement disease and can be considered severe forms of femoroacetabular impingement[27]. When we combined the cases in which these disorders were present and the cases in which femoroacetabular impingement deformities were present, we found that secondary osteoarthritis was associated with developmental dysplasia of the hip and femoroacetabular impingement abnormalities in near equal proportions (48.4% and 50.7%, respectively) and that they collectively accounted for 99% of hips with premature arthritis.

In the third portion of this study, we investigated the fate of the contralateral hip in patients with advanced secondary osteoarthritis and associated femoroacetabular impingement deformities. Our data indicated that contralateral hip deformities were present in all cases and that progression of osteoarthritic disease was very common in the contralateral hip. Specifically, at an average of 8.8 years of surveillance, 37% of hips had undergone total hip arthroplasty and an additional 36% of hips demonstrated radiographic progression of disease. The need for surgical intervention was strongly associated with severity of the impingement deformity (Tables III and IV). These data suggest that femoroacetabular impingement deformities are commonly bilateral and that the long-range prognosis for the contralateral hip is guarded.

Other investigators have described structural deformities associated with osteoarthritis. In general, these studies analyzed patients of all ages and utilized less sophisticated radiographic measures to assess the structural anatomy. In 1965, Murray[5] studied 200 cases of primary osteoarthritis and reported that up to 65% had an underlying abnormality. Stulberg et al. reported on seventy-five cases of "idiopathic" osteoarthritis in all age groups and, using lateral radiographs, identified the "pistol-grip deformity" in 40% and acetabular dysplasia in an additional 39%[6]. Gosvig et al.[28] identified a deep acetabular socket and pistol-grip deformities as risk factors for osteoarthritis in a large-population study. These studies are consistent with our observations on young patients with premature osteoarthritis in that nearly all such patients have an associated structural deformity. A contrasting theory, as presented by Resnick[29], suggests that femoroacetabular impingement deformities of the femur are secondary to a remodeling phenomenon in the osteoarthritic hip.

More recent studies have further addressed the issue of bilaterality of femoroacetabular impingement in osteoarthritic hips in the early stages of disease. In their recent analysis of a cohort of patients with femoroacetabular impingement, Allen et al.[30] reported bilateral deformities in 78% and bilateral symptoms in 26% of patients. Similarly, we have recently reported on joint-preservation surgery with a combined arthroscopic and limited anterior approach[31]. In our series, 75% of patients had bilateral radiographic deformities and 34% had symptoms in the contralateral hip. The findings from these two recent studies emphasize that, in addition to hips with femoroacetabular impingement and end-stage disease, prearthritic hips and hips with early stage arthritis commonly demonstrate bilateral deformities and symptoms.

Although the current investigation presents unique data on a large group of young patients with end-stage hip disease, there are weaknesses. First, the patients presented over a thirty-year time interval and it is possible that the etiology of end-stage disease varied during this time frame. For example, the introduction of screening protocols for developmental dysplasia of the hip and the availability of antirheumatoid medications may have impacted the proportion of hips with end-stage arthritis that were attributed to those causes. Secondly, the radiographic protocols, the images obtained, and the quality of radiographs varied at the different institutions and over the time course of the study. We have obtained data from all radiographs for which positioning and image quality was adequate, but the dataset is imperfect in that all cases did not have the same adequate radiographs. Additionally, inadequate visualization of osseous landmarks due to secondary osteoarthritic changes occurred with some radiographs. Thirdly, we acknowledge that the femoroacetabular impingement cases in this cohort likely represent major impingement disease, as these patients all required total hip arthroplasty at a young age. Therefore, our findings of bilateral deformities in hips in all cases and the common observation of disease progression may not be applicable to patients with milder forms of femoroacetabular impingement. Finally, it should be noted that our data describe associations and do not present evidence of a true cause-and-effect relationship between structural deformities and end-stage disease.

Collectively, these data expand on previous observations regarding natural hip-joint failure. Findings indicate that femoroacetabular impingement deformities are associated with premature osteoarthritis; thus, investigations to enhance early diagnosis and analyze joint preservation treatments are appropriate. Additionally, femoroacetabular impingement should be approached as bilateral hip disease and patient monitoring and/or patient education regarding early symptoms and preventive treatments should be considered. ■

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