# Femoroacetabular Impingement and Pelvic Incidence: Radiographic Comparison to an Asymptomatic Control

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**Purpose:** To investigate whether pelvic incidence (PI) in patients with symptomatic femoroacetabular impingement was different from that in a normal population. **Methods:** Retrospective analysis of 30 consecutive female and 30 consecutive male patients with computed tomography scans who underwent hip arthroscopy for FAI. PI was measured using scout lateral radiographs. The center-edge angle (CEA), acetabular version, and $\alpha$ angle were also measured. Each patient was subcategorized as having a cam-type deformity ($\alpha$ angle $>55°$), a deep socket deformity (CEA $>39°$), and/or a retroverted acetabulum (acetabular anteversion $<15°$). Our group and subgroups were compared with a historical control group from a previously published study of 300 volunteers. Each group was compared using a Student *t* test. **Results:** Our mean PI was $49.31° \pm 12.34°$ (range, 28.4°-79.5°), less than the asymptomatic historical control (n = 300) with a mean PI of $55.0° \pm 10.6°$ (range, 33°-82°) ($P < .001$). The subgroups for cam deformity, deep socket deformity, and acetabular retroversion have a mean PI of $48.89° \pm 11.81°$, $38.30° \pm 7.56°$, and $44.93° \pm 11.32°$, respectively. All had a significantly lower PI than the historical control ($P < .001$, $P < .001$, $P < .001$, respectively). **Conclusions:** We conclude that patients presenting with FAI may have a lower PI than the general population. The clinical significance of a 5.7° difference in PI remains unknown. **Level of Evidence:** Level III, retrospective comparative study.

Over the past 2 decades, there has been increasing recognition of the importance of sagittal balance to a normal functioning spine.[1-4] Sagittal balance facilitates upright posture such that minimal muscle exertion is required.[5] Inappropriately balanced spines are thought to cause muscle fatigue, back pain, and degenerative spinal conditions.[1,2,4,5] Spinopelvic parameters have been introduced to describe this relation and are closely associated with lumbar lordosis and overall sagittal alignment.[6]

Pelvic incidence (PI) is considered the key spinopelvic parameter because it is a fixed anatomic angle that is independent of the sagittal orientation of the pelvis.[6] It increases throughout childhood as the lumbar spine develops lordosis and then remains constant throughout adult life.[7] Abnormalities in PI have been associated with various spinal deformities, such as spondylolisthesis[8] and scoliosis.[1,9] Sacral slope (SS) and pelvic tilt (PT) are angles that change with position, reflecting the orientation of the pelvis relative to the sagittal plane. PI has been found to be the sum of sacral slope and pelvic tilt (PI = SS + PT).[6] When PI increases or decreases, the adaptability (range of motion) of SS and PT also increases or decreases.

Over this past decade, femoroacetabular impingement (FAI) has been gaining recognition as a major cause of nonarthritic hip pain.[10-12] It is a pathologic disorder characterized by abnormal contact of the hip joint secondary to abnormal morphology of either the femoral head-neck junction (cam-type) or the acetabular rim (pincer-type).[13] Bony and soft tissue

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*Investigation for the study was performed at Rush University Medical Center, Hip Preservation Institute, Chicago, Illinois, U.S.A.*

*The authors report the following potential conflicts of interest or sources of funding: M.J.P. receives consultancy fees from Smith & Nephew, MIS, SLACK Incorporated, Elsevier, Bledsoe, Donjoy, and Arthrosurface and grants from Ossur, Siemens, Smith & Nephew, and Vail Valley Medical Center. S.J.N. receives support from Stryker and Ossur as a paid consultant and receives research support from Allosource, Arthrex, Athletico, DJ Orthopaedics, Linvatec, Miomed, Smith & Nephew, Stryker.*

*Received September 14, 2015; accepted August 30, 2016.*

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*0749-8063/15851/$36.00*

*http://dx.doi.org/10.1016/j.arthro.2016.08.033*

impingement leads to hip pain and causes intra-articular damage.[14] Although great strides have been made to understand the pathomechanics of FAI,[11,14,15] static and dynamic factors from the spine and pelvis remain poorly understood.

Hip disorders concomitantly occurring with spinal disorders were first termed hip-spine syndrome in 1983.[16] Since then, little progress has been made to understand the pathophysiology associated with it. Although the true incidence of hip-spine syndrome is unknown, both hip and spine surgeons see patients quite frequently with pain in both their back and hips.[17] The relation between normal spinal sagittal balance, pelvic orientation, and hip kinematics has not been critically evaluated. Past studies have focused on removing pelvic orientation from measurements about the acetabulum.[18-20] Only recently has the effects of pelvic tilt on dynamic hip impingement been investigated using radiographs[21] and a 3-dimensional (3D) model.[22] PI, in the setting of symptomatic femoroacetabular impingement, is unknown.

The purpose of this study was to investigate whether PI in patients with symptomatic femoroacetabular impingement was different from that in a normal population. Our null hypothesis was that patients with symptomatic FAI have PI similar to that found in the general population.

## Methods

### Patient Selection

The study was performed under an institutional review board–approved protocol. We retrospectively identified a consecutive series of patients with symptomatic FAI who underwent preoperative computed tomographic (CT) scans and were treated with arthroscopic hip surgery between August 2011 and June 2012 at a single institution. We included patients with FAI diagnosed via symptoms and physical examination findings, and confirmed with corresponding radiographic findings (plain films and CT scan) and intraoperative findings. We excluded patients with evidence of osteoarthritis on plain radiographs (Tönnis grade $\geq$2),[23] evidence of childhood hip pathology on past medical history and plain radiographs (Slipped Capital Femoral Epiphysis, Perthes, and Developmental Dysplasia), and without a scout lateral radiograph accompanying their CT scan.

A historical control group was extrapolated from a previously published study that included volunteers that had no history of spinal disorders and had no radiographic abnormalities detected prior to or during the study.[24] Volunteers were also excluded if they had hip, knee, or ankle abnormalities found on clinical examination. In this study, PI was measured on a standing lateral spine radiograph as described by Legaye et al.[6]

### Measurements

PI was measured on a scout lateral radiograph as described by Legaye et al.[6] The $\alpha$ angle was measured on a 90° Dunn lateral hip radiograph as described by Nötzli et al.[25] The lateral center-edge angle was measured on an anteroposterior pelvis radiograph as described by Tannast et al.[26] Anteversion was measured on an axial CT cut where the femoral head was congruent with the acetabulum both posteriorly and anteriorly as described by Tönnis et al.[27] All measurements were determined using the measurement tools available in the MedVIEW Picture Archive Communication System (PACS) software (Aspyra, West Lake Village, CA). Two orthopaedic surgeons performed all measurements and were repeated 3 months later.

### Statistical Analysis

An a priori analysis was performed. Using results from previous studies,[9,24] the effect size was calculated by comparing normal PI with pathologic PI. We found that we needed 56 patients for adequate power ($[1 - \beta] = 90\%$, $\alpha = 0.05$). Our symptomatic FAI group was compared with the historical control group. All available demographic data and the PI was compared. Each hip was characterized as having cam deformity ($\alpha > 55°$),[25] deep socket deformity (center-edge angle >39°),[26] and/or acetabular retroversion (anteversion <15°).[27] Each subgroup was then separately compared with the historical control. A Student *t* test was used. An inter- and intraobserver agreement $\kappa$ statistic was performed, with 0.80 or greater being considered excellent agreement.[28] *P* values of <.05 were considered significant. All statistical tests were performed using PASW Statistics software for Windows, version 18.0 (IBM, Armonk, NY).

## Results

One hundred forty-three consecutive patients were considered for analysis in the symptomatic FAI group. Seventy-five patients did not have a lateral scout radiograph, 5 patients had Tönnis grade 2 arthritis on radiographs, 2 patients had Perthes disease, and 1 patient had a slipped capital femoral epiphysis, leaving 60 hips in 60 patients for evaluation. There were 25 right and 35 left hips in 30 men and 30 women. The mean age was 32.6 years (range, 18-63). Three hundred volunteers (110 women and 190 men) were included in the historical control group.[24] The mean age was 35.4 years (range, 20-70). Demographic data including age, sex, and BMI were all found to be similar between groups ($P = .088$, $P = .102$, $P = .095$, respectively) (Table 1).

The symptomatic FAI group's mean $\alpha$ angle was 62.29° (standard deviation [SD], 10.29°; range, 91.0°-37.7°), mean acetabular anteversion was 15.39° (SD, 5.95°; range, 1.0°-30.0°), and mean center-edge