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Prevalence of Femoro Acetabular Impingement in A Rural Population Presenting to A Medical College

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Abstract

The hip joint, scientifically known as the acetabulofemoral joint, is the joint between the femur and acetabulum of the pelvis and its primary function is to support the weight of the body in both static (e.g. standing) and dynamic (e.g. walking or running) postures. The study seeks to bridge this gap and to raise awareness of the existence and importance of asymptomatic FAI in rural settings among Orthopaedic surgeons, and ultimately to enable better hip health by diagnosing the condition in a timely manner and implementing preventive measures. This cross-sectional radiographic study was conducted at the Department of Radiodiagnosis, Annapoorana Medical College and Hospitals, among 211 asymptomatic adults aged 30–65 years from a rural population. Standard anteroposterior (AP) pelvis and frog-leg lateral radiographs were analyzed for radiological features of femoroacetabular impingement (FAI). Measurements included lateral center-edge angle (LCEA), acetabular index (Tönnis angle), pistol grip deformity, and crossover signs. Hips were categorized as cam, pincer, or mixed type based on standard angular cut-offs. Informed consent was obtained, and ethical clearance was secured prior to data collection. The mean age of participants was 50.3 ± 12.5 years; 54% were females. Cam-type features such as pistol grip deformity were present in 4.3% (right) and 5.2% (left), while circle sign was more frequent on the left (8.1%). Pincer-type indicators including medialized posterior wall sign were seen in over 21% of hips, and acetabular roof overlap (crossover sign) was observed in 33–40% of cases. The LCEA was significantly higher on the left (42.7°) compared to the right (39.6°), and the acetabular index showed a side difference ($p < 0.001$), suggesting asymmetrical hip morphology in this rural cohort. Orthopaedic clinicians should focus on the triad of symptoms, physical findings, and imaging before diagnosing FAI syndrome.

INTRODUCTION

The hip joint, scientifically known as the acetabulofemoral joint, is the joint between the femur and acetabulum of the pelvis and its primary function is to support the weight of the body in both static (e.g. standing) and dynamic (e.g. walking or running) postures^[1]. The articulation at the joint occurs via hyaline cartilage formed of mainly type II collagen and proteoglycans on the femoral head, that serves as a smooth surface for movement and absorbs shock^[2]. The socket of the joint is deepened and further supported by the acetabular labrum, a ring of fibrocartilage that supports the joint and is critical to maintaining the negative intra-articular pressure necessary to keep the joint properly seated^[3]. Disturbance of this complex anatomy, and biomechanics can contribute to pathologies, one of the most relevant being the femoroacetabular impingement (FAI) syndrome.

FAI syndrome is due to abnormal contact of the femoral head-neck junction with the acetabular rim with restricted normal hip motion^[4]. This can result in labral tears and articular cartilage damage, and in the long term, early-onset osteoarthritis^[5,6]. According to the morphology, FAI is classified into three distinctive types: cam, pincer, and mixed. Cam-type FAI occurs when the femoral head is not spherical or there is minimal head-neck offset, resulting in abutment against the acetabular rim, especially during flexion and internal rotation^[4]. In contrast, pincer-type FAI is caused by overcoverage of the acetabulum secondary to retroversion or a deep acetabulum and limits the normal range of motion of the femoral head. Mixed type like both cam and pincer type. Radiographic studies have shown that cam morphology can be detected in up to 25% of men and 10% of women and that pincer morphology has been observed in 6–7% of men and 10% of women^[7]. Nevertheless, the presence of such a morphological type is non-pathognomonic of FAI syndrome. It is essential to have clinico-radiological support in terms of groin pain and positive impingement signs with supportive radiological diagnosis for a concrete diagnosis.

The etiology of FAI is multifactorial, including congenital deformities, genetic predispositions, pediatric hip diseases, such as slipped capital femoral epiphysis or Perthes disease, and most notably, acquired developmental changes^[4]. High-impact physical activities or hyperflexion-related mechanical stresses during skeletal maturation are considered pivotal to the development of cam-type deformities. This suggests the potential impact of modes of living, including occupational habits and globally prevalent sitting and squatting postures, as significant factors in FAI^[4]. It is, therefore, reasonable to assume a potential ethnic and socio-environmental variation in FAI's

prevalence, supported by recent studies. Despite the growing body of literature on FAI, the majority of research publications have been urban and largely targeted at athletes and symptomatic patients^[4]. Comparatively, rural populations are vastly underrepresented, particularly asymptomatic individuals. This is an unfortunate gap in knowledge. Rural residents frequently engage in lifestyles involving squatting, floor-sitting, and other postural habits that could favour hip joint morphologies typical for FAI. Additionally, rural residents have weaker access to early diagnostic and rehabilitation services, leading to undiagnosed progression into hip osteoarthritis and disability due to reduced ability.

With the increasing awareness of FAI as a harbinger of hip joint degeneration and the relatively unexplored etiology of this condition in rural populations, there is an urgent need for the study of FAI in this population. Estimation of radiographic prevalence of cam and pincer morphology in asymptomatic rural population would give important clues to the subclinical disease load. These data would have significant clinical application for orthopedic clinicians in early screening strategy planning, preventive counseling, and selection of individuals who are in need of early intervention. In addition, this would help explain the epidemiology relating to ethnicity, environmental exposure and lifestyle in the context of the natural history of FAI. Against this background, the current study was conducted to evaluate the prevalence of femoroacetabular impingement morphology in asymptomatic adult population in a rural setup attending a medical college. We speculate that the rate of radiological FAI morphologies in a rural population might be different to that of urban or athletic populations, perhaps because of distinctive life style and occupational factors. The study seeks to bridge this gap and to raise awareness of the existence and importance of asymptomatic FAI in rural settings among orthopedic surgeons, and ultimately to enable better hip health by diagnosing the condition in a timely manner and implementing preventive measures.

MATERIALS AND METHODS

An observational, cross-sectional study in the Department of Radiodiagnosis at Annapoorana Medical College and Hospitals to assess the radiological prevalence of femoroacetabular impingement (FAI) in the hips of asymptomatic adults of a rural community. Study group The study group were 30–65 year-olds referred for reasons other than for hip-related complaints, to the radiology department from January 2024 to June 2024. All participants were consecutively recruited during the study period; none of them had typical symptoms and none were previously diagnosed

with hip disorders. The goal was to evaluate FAI-related morphology in a true asymptomatic rural population.

All subjects presented standardized anteroposterior (AP) pelvic radiography and frog-leg lateral pelvic view. Only radiographs that met quality criteria (adequate visualization of iliac crests and proximal femurs with symmetrical obturator foramina and centrally aligned symphysis pubis) were included in the analysis. It provided an excellent radiographic accuracy and reproducibility. Excluding poorly positioned and low-quality radiographs was performed to prevent misreading of the anatomical angles and structures.

The study protocol was approved by the Institutional Ethics Committee of Annapoorana Medical College and Hospitals, Faculty of Radiodiagnosis. Ethical and confidentiality issues throughout the collection and analysis of data and its deposit have been rigidly observed. Exclusion criteria were all patients with previous fractures in the pelvic ring or the lower extremity, any operative treatment of the hip joint, radiologically proven coxarthrosis and ligamentous damage in the lower extremity. These would be places where the FAI related radiological features might be confounded by conditions that change normal hip joint shape or function. To the best of our knowledge, there are no data describing the prevalence of FAI in populations native to rural areas and, as the reported prevalence of FAI in urban and athletic populations is varied, we performed a pilot survey in 400 healthy volunteers in whom we could document the absence of symptoms. This UOR was the first step to determine an estimated prevalence of FAI in the rural cohort and for further radiological investigation and description.

X-rays included measurements of physiological angular parameters that are commonly used in the diagnosis of FAI. The alpha angle was obtained on frog-leg lateral views to evaluate for cam deformity, with an angle $>55^\circ$ being diagnostic for cam-type FAI. Acetabular coverage was categorized according to the LCEA and TA, which were acquired from AP pelvic views, respectively. An LCEA $>39^\circ$ or TA 10° .

All measurements were obtained manually using angle-measuring tools after viewing the digital X-ray using Carestream Classic CR. Every measurement was conducted by two radiologists separately, and disagreement was reconciled by consensus to reduce interobserver variation. The data were compiled, processed and analyzed to determine the prevalence and patterns of the various forms of FAI morphology in this rural, asymptomatic cohort.

RESULTS AND DISCUSSIONS

The mean age of the study participants was approximately 50.3 years, suggesting a middle-aged

population. The mean lateral center-edge angle (LCEA) was higher on the left (42.7°) compared to the right (39.6°), indicating a possible side variation in acetabular coverage. The acetabular index, which reflects acetabular inclination, showed a slight asymmetry with a positive value on the right and a negative value on the left, suggesting potential pincer-type morphology or acetabular retroversion on the left side (Table 1).

Out of 211 participants, 54% were female and 46% were male. This nearly equal gender distribution allows for gender-based subgroup analysis of radiographic FAI features (Table 2).

Pistol grip deformity and femoral head-neck asphericity ('circle sign') were assessed bilaterally. Pistol grip deformity was present in 4.3% (right) and 5.2% (left) of cases, while abnormal circle sign was more common, particularly on the left side (8.1%), suggesting a higher frequency of cam-type morphology on the left hip (Table 3).

A lateralized posterior wall sign was found in approximately 78% of both hips, while a medially displaced posterior wall (indicative of acetabular retroversion) was present in 21–23% of cases. This suggests that a significant subset of the population may have subtle morphological predispositions to pincer-type impingement (Table 4).

This table indicates the location of the acetabular roof margins. Around 40% of cases demonstrated overlapping of the anterior and posterior margins (crossover sign), which is suggestive of acetabular retroversion and pincer-type impingement. This finding is consistent with the LCEA and Tönnis angle measurements (Table 5).

Paired t-test results indicate statistically significant differences ($p < 0.001$) between the right and left hips in both LCEA and acetabular index. The left hip consistently showed higher LCEA and lower acetabular index values, implying a trend toward increased acetabular coverage on the left side, which may contribute to pincer-type features (Table 6).

The current study focused on the radiographic prevalence of FAI morphologies in an asymptomatic rural population and found that mild-to-moderate cam and pincer morphologies are not rare in people with no symptoms of hip disease. Our results are in accordance with a number of studies showing high prevalence of FAI morphologies in asymptomatic adult population.

A systematic review by Frank *et al*^[8] reviewing $>2,100$ hips found that cam as well as pincer morphologies were identified on imaging in 37 and 67% of asymptomatic volunteers, respectively. In the same way, among 185 Brazilian asymptomatics, cam morphology was present in about 32% and 43% had pincer morphology. However, our population presented slight lower prevalence, 4-8% for cam type and 33-50% for pincer indicators (posterior wall

Table 1: Descriptive Statistics of Continuous Variables (N=211)

Variable	Mean	Std. Deviation
Age	50.32	12.48
LATERAL CENTRE ANGLE RIGHT	39.62	8.52
LATERAL CENTRE ANGLE LEFT	42.74	8.39
ACETABULAR INDEX RIGHT	1.31	6.88
ACETABULAR INDEX LEFT	-1.69	6.83

Table 2: Gender Distribution (N=211)

Gender	Frequency	Percent
Male	97	46.0
Female	114	54.0
Total	211	100.0

Table 3: Prevalence of Cam-Type Features (N=211)

S.No	Variable	Nil	Present
1	PISTOL GRIP DEFORMITY RIGHT	202(95.7%)	9(4.3%)
2	PISTOL GRIP DEFORMITY LEFT	200(94.8%)	11(5.2%)
3	CIRCLE RIGHT	200(94.8%)	11(5.2%)
4	CIRCLE LEFT	194(91.9%)	17(8.1%)

Table 4: Posterior Wall Sign (N=211)

S.no	Variable	Lateral	Medial
1	Posterior wall sign Right	162(78.6%)	49(23.2%)
2	Posterior Wall sign Left	165(78.2%)	46(21.8%)

Table 5: Acetabular Roof Morphology (N=211)

S.no	Variable	Lateral	Medial	Overlap
1	Acetabular roof Right	31(14.7%)	95(45%)	85(40.3%)
2	Acetabular roof Left	34(16.1%)	107(50.7%)	70(33.2%)

Table 6: Comparison of LCEA and Acetabular Index Between Right and Left Hips (N=211)

S.No	Variable	Mean±SD	P-value
1	LATERAL CENTRE ANGLE RIGHT	39.62±8.52	<0.001
	LATERAL CENTRE ANGLE LEFT	42.74±8.39	
2	ACETABULAR INDEX RIGHT	1.32±6.88	<0.001
	ACETABULAR INDEX LEFT	-1.69±6.83	

medialization or crossover), which are still included within the range observed in healthy, asymptomatic subject^[9].

The discrepancy found between sides (the left side having a higher LCEA and more negative AI) leads us to believe in the presence of a side-related hip predisposition for acetabular overcoverage^[10]. It is in agreement with earlier observations of lateralized geometric characteristics in healthy adults. The statistically significant differences (p<0.001) highlight the clinical fact that one hip may be more susceptible to the changes as a result of impingement. Our cam feature findings of 4.3-8.1% prevalence for pistol-grip and circle signs are less than the prevalence rates noted in athletic or urban cohorts. For instance, Hack *et al*^[11] found a cam prevalence of 25% in men and of 10% in women. These differences could be attributed to early-life mechanical loading and sport participation; individuals in rural settings are likely to perform routine non-aerobic tasks such as squatting or manual work, which may have an effect on acetabular rather than femoral remodelling.

The incidence of pincer morphology continues to be high (~40%) in our series. This promotes a level of awareness that acetabular overcoverage can develop as a result of loading conditions, race variations, or positional factors. Deformities, including high retroversion are easily identified in asymptomatic people and associated with benign pathology unless exaggerated by an accumulation of repetitive

impingement or joint stress^[12]. Other symptoms tenderness to palpation, pain with resisted range of motion, abductor weakness or fatigue, and imaging suggesting femoral acetabular impingement (FAI) are common in individuals without symptoms, clinical studies suggest that true impingement syndrome (i.e. symptoms plus exam findings) are much less common, occurring in around 3% of a general adult white population^[13].

Our findings support the clinical doctrine—not explicitly mentioned in the current consensus criteria—that FAI syndrome should be diagnosed only if morphological findings are associated with consistent clinical signs such as hip/groin pain and a positive impingement test. Additionally, the presence of morphological variants in asymptomatic patients is regarded to be more of normal anatomy than a reflection of early OA^[14].

This is a cross-sectional, radiographic-only study without clinical correlation, follow up functional assessment, or advanced imaging such as MRI, which may show labral injury. Previous research indicates that 68% of asymptomatic hips with FAI morphology have labral tears on MRI—a finding we were unable to evaluate¹³. In addition, our rural sample may not generalize to the biomechanics of other populations. In a study by Namboodikandy *et al*^[14] out of 1600 radiographs of the hips studied, 1353 were found to be normal and the remaining 247(15.4%), had features of FAI. 61 hip radiographs (3.8%) showed cam lesions and 9.2% showed pincer type of lesion. 38 hips (2.4%) showed mixed type of FAI.

CONCLUSIONS

While mild-to-moderate FAI morphology is common in asymptomatic rural adults, imaging alone should not drive diagnosis or management. Orthopaedic clinicians should focus on the triad of symptoms, physical findings, and imaging before diagnosing FAI syndrome. Longitudinal studies incorporating functional assessments and patient-reported outcomes should be prioritized to determine which individuals with morphological features will progress to symptomatic impingement or osteoarthritis.

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