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Correlation between Femoral Neck Anteversion in Patients with Osteoarthritis of the Hip and Normal Controls

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ABSTRACT

Introduction: Alterations in Femoral neck Anteversion (FAV) ranges from 30–40 degrees at birth which dwindles throughout life due to several hereditary and environmental factors. FAV has been proposed to be engaged in the pathogenesis of several diseases among which hip osteoarthritis is a contradictory issue of study. It was aimed to evaluate the correlation between FAV and hip osteoarthritis in adults.

Materials and Methods: FAV was determined using Computed Tomographic Scanning (CT) in 36 patients with hip osteoarthritis and in 36 adults with normal hips. CT images of all cases were evaluated by an experienced radiologist and anteversion degree of femoral neck was studied from both limbs.

Results: Mean total FAV angle was 27.08 ± 8.80° and 23.43 ± 8.95° in patients group and control group, respectively. Total FAV angle did not show any significant difference between the two groups. Left FAV angle in osteoarthritic group was significantly increased compared with the control group. Mean osteoarthritis degree was 2.13 ± 0.99 in the patients. Osteoarthritis degree did not have any significant correlation with FAV angle of either right or left hip. No significant correlation was observed between different FAV angles and age in the whole study population.

Conclusion: Significant increased left FAV angle was reported among osteoarthritic patients compared with the control group and it was concluded that anteversion in femoral neck could be a contributing factor in the pathogenesis of osteoarthritis. Thus, in the management of hip osteoarthritis, anteversion of the femoral neck should be of importance.

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Introduction

Alterations in Femoral neck Anteversion (FAV), is defined as the angle between a conceived transverse line through the knee joint and an imaginary transverse line passing through the center of the femoral head and neck (1). On the average, FAV ranges from 30–40 degrees at birth which dwindles throughout life due to several hereditary and environmental factors (1). FAV has been proposed to be engaged in the pathogenesis of several diseases including slipped capital femoral epiphysis, knee and patella instability, and in or out-toeing gait patterns. There is controversial hypothesis that a persistent increase in FAV predisposes to osteoarthritis of the hip. Some previous studies have supported the hypothesis (2-4), whereas others have not (5,6). Osteoarthritis is a common degenerative joint disease and one of the leading causes of physical and psychological disability in the elderly that can affect any joint in the body, including hips (7). The pathogenesis of osteoarthritis involves process of progressive cartilage matrix degradation causing the cartilage to soften and lose elasticity and leading to surface integrity and resulting in loss of joint function and angular deformity or malalignment (8).

Osteoarthritis of the hip is classified into two groups.

Primary or idiopathic disease which its etiology is not completely understood and it has been suggested that it might be caused by unrecognized or mild hip dysplasia, previous slipped capital femoral epiphysis, Perthes' disease, or other morphological abnormalities around the hip; and secondary disease which is caused by hemochromatosis, hyperparathyroidism, hypothyroidism, acromegaly, hyperlaxity syndromes,

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Paget's disease, gout, chondrocalcinosis, etc. (9-14) .

FAV has also been hypothesized to be a predisposing factor in early osteoarthritis of the hip. Terjesen in an evaluation of 50 osteoarthritic patients and 30 normal controls by means of biplanar radiographies, reported no osteoarthritis in 3 of patients with increased anteversion and most of the patients with the osteoarthritis of the hip had normal anteversion angle, however, as there was a significant relationship between increased FAV angle and osteoarthritis of the hip comparing to control group, it was suggested that increased FAV in adults might contribute to later development of osteoarthritis of the hip as a predisposing factor (15).

Accurate and objective measurement of FAV is extremely consequential in selecting patients and treatment, as well as an accurate imaging technique.

Beside clinical examination, there are several imaging techniques for the measurement of FAV, including bi-plane radiography, fluoroscopy, ultrasound, Computed Tomographic Scanning (CT), and Magnetic Resonance Imaging (MRI) (16-18). Most femoral torsion problems are evaluated by CT, thus it is widely believed as the most accurate and the gold standard of diagnosis of FAV (19).

There are several CT methods employed in measuring FAV. The classic method defined by Weiner, which is based on a single CT image; another method introduced by Reikeras, in which the neck axis is defined by two superimposed images of the femoral head and neck. In the method of Murphy two proximal and one distal images and the angle in the transverse plane between the intersection of the plane of anteversion and the condylar plane defines the accorded angle. The latter method is the most popular CT method which is broadly used (20-22).

The purpose of this study is to evaluate the femoral neck anteverion angles in CT images of patients with hip osteoarthritis and in normal control group in order to illuminate the probability of its contribution to osteoarthritis of the hip.

Materials and Methods

This was a cross-sectional study on 36 patients with different degrees of hip osteoarthritis and 36 normal controls which was conducted during late-2013 to mid-2014, following obtaining confirmation from medical research ethics committee, Mashhad University of Medical Sciences, Mashhad, Iran.

Eligible patients were divided into two groups of hip osteorthritis and control, according to evidences of osteoarthritis of the hip in previous CT images and a thorough physical examination. The normal controls were selected from patients in whom CT of the pelvic region was indicated for various disorders other than hip joint problems. Objective data including age, gender, weight, prior surgeries and history of any background congenital or systemic diseases were collected and inputted in a predesigned form. Osteoarthritis of the hip were classified to five different grades according to severity of the disease (Table 1) (23).

Table1: Different degrees of osteoarthritis according to imaging criteria

Grade	Criteria
0	Normal
I	Doubtful narrowing of joint space, possible osteophyte development
II	Definite ostephytes, absent or questionable narrowing of joint space
III	Moderate osteophytes, definite narrowing, some sclerosis, possible joint deformity
IV	Large osteophytes, marked narrowing, severe sclerosis, definite joint deformity

CT images of all cases with 20 years of age or older who referred to radiology ward of Imam Reza hospital, Mashhad, Iran were evaluated by an experienced radiologist who was blind to the patients' group.

Sample size were calculated according to previous study of Reikeras and colleagues (24).

Images were obtained axially through the hip and femoral neck above the knee while patients were in supine position with slice thickness of 1.25-mm and 1.25-mm of reconstruction interval (120 kV; automatic dose modulation; pitch, 1.375:1) and finally they were reconstructed in the coronal, sagittal, and oblique axial planes. The CT imaging was done with GE VCT 64, GE LightSpeed 16, GE BrightSpeed 16, and GE Plus 8 (GE Healthcare Technologies, Waukesha, WI) scanners.

The CT measurements were performed by an expert radiologist blinded to patients' group and anteversion degree of femoral neck from was studied both limbs.

The technique for determining the version of the femoral neck was done in a systematic mode, and using the classic method, in every patient we chose a CT image containing the best scan of femoral head and neck, trochanter, and hip joint. Then, we measured the angle between an imaginary line passing through the chosen image and horizontal plane, and the angle between the imaginary line passing tangentially thorough both femoral condyles and horizontal plane.

The difference between these two measured angles defined the anteversion angle and the angular deviation from the normal range indicated the severity of the FAV in our study. The same procedure was done on the front hip and the obtained angles were studied in both osteoarthritic and control group. The anteversion angles were analyzed with respect to variables such as age, sex and severity of degenerative joint disease.

Inclusion benchmarks were restricted to all adult patients aging 20 years of age or more who filled and signed the written informed consent. Patients with any acquired or congenital musculoskeletal deformity of the hip and lower limb, any history of trauma leading to this situation or orthopedic surgery on lower limb, as well as patients with acquired or congenital infectious,

Immunologic, rheumatologic, and gastrointestinal conditions leading to degenerative bone disease were excluded from the study. Patients who could not be positioned correctly for imaging due to insufficient mobility of the hips (less than 90° of flexion or less than 20° of abduction with the hips flexed to 90°) as well as patients in which measurements were unreliable due to large osteophytes or deformation of the joints were also excluded from the study.

Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS Version $_{16}$, Chicago, IL, USA). One-Sample Kolmogorov-Smirnov test was done to evaluate the normal variables. Two Independent Sample T-Test and One Way ANOVA was performed to calculate the statistical differences between the various groups. The relationship between FAV and osteoarthritis of the hip was investigated by Pearson's correlation coefficient test and differences were considered significant at P-values below 0.05.

Results

FAV were studied in 36 patients (13 males and 23 females) with hip osteoarthritis and compared with 36 controls (17 males and 19 females). Mean age and weight in patients were 74.05±11.05 years and 51.86 ± 14.06 Kg, respectively, while in control group, 49.55±11.50 years 76.77±11.06 Kg, respectively (Table 2).

There was no significant difference neither in mean ages nor mean weights of the two groups.

Table2: Demographic values of 36 patients with hip osteoarthritis and 36 normal controls, Mashhad, Iran

	Osteoarthritic group			Control group			P value
	Mean ± SD	Variance	Range	Mean ± SD	Variance	Range	
Age (years)	74.05 ± 11.05	122.28	46	49.55 ± 11.50	156.25	51	0.06
Weight (Kg)	51.86 ± 14.06	197.83	58	76.77 ± 11.06	22.46	44	0.08

Mean left FAV angle was significantly higher in osteoarthritic group than in control group (p=0.04), however, mean total and right FAV angles showed no significant difference between the two groups. Table 3 shows FAV angles of the two groups in details.

Table3: Femoral neck anteversion angle values of right and left hip in 36 patients suffering from hip osteoarthritis and normal controls, Mashhad, Iran

	Osteoarthritic patients			Control group			*P* Value
	Mean	SD	Variance	Mean	SD	Variance	
Total FAV-angle	27.08	8.80	85.58	23.43	8.95	85.46	0.08
Right FAV-angle	27.33	9.97	99.54	24.58	9.45	89.45	0.23
Left FAV-Angle	26.83	9.42	88.88	22.27	9.89	97.97	0.04
Osteoarthritis degree	2.13	0.99	0.98				

In the study group, there was no significant correlation between the total FAV angle, as well as FAV angle of the either right or the left hip with gender. In control group, mean left hip FAV angle in men and women was 25.93 and 23.57 degree, respectively, which had not any significant difference.

In control group, mean right hip FAV angle in men was higher than women; however, the difference was not statistically significant.

There was no significant difference between FAV angle of either right or left hip with different osteoarthritis degrees in the study group. No significant correlation was observed between different FAV angles (total, right and left FAV angles) and age in the whole study population. Also no significant correlation was observed between weight and various FAV angle values in osteoarthritic group and control group.

Discussion

Increased anteversion of femoral neck and head have been suspected to predispose to osteoarthritis in previous studies. Some former investigations have been reported positive correlation (2-4), while others did not report significant correlation between them (5, 6).

According to contradictory results in the literature, we measured neck FAV angles in patients with primary hip osteoarthritis and in control group.

Secondary osteoarthritis is defined when a pre-existing abnormality cause the joint erosion. The most common causes of Secondary osteoarthritis are congenital dislocation and dysplasia, epiphysiolysis of the femoral head, Legg-Calve-Perthes disease, rheumatoid disease, infection and trauma (11-14). We excluded patients with any previous hip disease.

Acquired or congenital infectious, immunologic and rheumatologic conditions as well as history of previous trauma leading to possible degenerative bone condition were also excluded from the study. Thus, it is felt that all the osteoarthritic patients in this study represented primary osteoarthritis according to the recent knowledge, though; it could not be definitely proven.

We found a statistically significant increase in FAV angle of left hip in patients with hip osteoarthritis in comparison with a control group with matched age and weight. Kitaoka and colleagues evaluated FAV in sixteen subjects and eighteen controls by means of CT scanning technique. There was no significant difference in FAV between arthritic subjects and control population. Kitaoka stated that performing a derotational femoral osteotomy to prevent osteoarthritis is not indicated (5). A year earlier, Hubbard in a bi-plane radiography technique,

had been reported the same results (25).

Reikeras determined FAV in 44 patients with unilateral or bilateral idiopathic osteoarthritis of the hip. The mean anteversion angle and the neck-shaft angle were 20 and 131 degrees, respectively.

The anteversion was significantly larger in the patients, but no difference was found in the neck-shaft angle.

The results suggested that increased anteversion in adults may contribute to later development of hip osteoarthritis (4). Our results were in accordance with this hypothesis.

We reported total FAV angle of 27.08 ± 8.80° and 23.43±8.95° in patients with hip osteoarthritis and control group, respectively, by means of CT scanning method. The CT method for determination of FAV has been first described by Weiner (1978) and Hernandez (1981) (26, 27). The size of normal anteversion of the femoral neck has been previously described in the literature (28, 29), and the findings of this study are in agreement with these reports.

This study did not report any correlation between the age of the patients and the values of FAV angles. This result is in accordance with Reikeras study (3), but in contrast with Terjesen investigation.

Terjesen and colleagues stated that osteoarthritic patients below 70 years had a significantly increased FAV angle compared with patients above 70 years, and patients above 70 years had a significantly increased FAV angle compared to the control group (15).

In the present study, increased FAV was found in left hip among osteoarthritic patients compared with the control group. This is assumed to be a contributing factor in the pathogenesis of osteoarthritis due to poor adaptation of the femoral head to the acetabulum.

Conclusion

It is concluded that increased anteversion of femoral neck, which is likely to give long-lasting malfunction of the hip, is a predisposing factor for osteoarthritis, however, FAV is not the only factor. The cause of primary osteoarthritis is multifactorial and does not depend solely on preexistence of higher femoral anteversion. The interaction between anteversion and others, still unknown and should be studied in the future. Pathological femoral anteversion could produce a deformity that results in hip osteoarthritis. Therefore, it is possible that, correction of the anteversion may be considered necessary for such patients. In the management of hip osteoarthritis, anteversion of the femoral neck should be of importance, and if indicated femoral osteotomy should be considered to create optimal biomechanical conditions in the joint. Further studies with larger study population are needed to confirm the hypothesis.

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