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Research Article

Correlation between borderline acetabular dysplasia and hip osteoarthritis: A retrospective cross-sectional radiographic study

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Abstract

Introduction: Hip osteoarthritis is one of the most prevalent diseases commonly affect older patients. It is also one of the most common causes of functional disability and musculoskeletal pain, but about half of the OA patients do not complain about these symptoms and remain undiagnosed. The aim of this study is to compare the radiological findings of OA with the acetabular dysplasia in patients who have not been diagnosed with OA before.

Methods: 365 patients (200 males, 165 females) aged between 40 and 65 were included in the study. Data were obtained retrospectively, among abdominal and pelvic Computerized Tomographies (CT) of patients consulted in urology department of our hospital with urological complaints. AP Topogram of each patient's CT's was evaluated. Center-Edge Angle (CEA), Acetabular Angle (Sharp Angle-SA) were measured and Tönnis Grading of each hip were calculated. Correlation between CEA and SA measurements and Tönnis Grading (grade 0, grade 1 and grade 2) of hip OA were evaluated.

Results: Overall, 8.63% (7.25% in males and 10.30% in females) of the patients had AD, based on at least one of the measurements (CEA<25° or SA>42°). Rate of hip OA was found as 8% in males and 6.36% in females (overall 7.26%). Mean CEA was 35.06° (± 5.58) in males and 34.71° (± 5.91) in females (overall 34.90° (± 5.73). Mean SA was 37.23° (± 2.92) in males and 37.75° (± 3.54) in females (overall 37.46° (± 3.22). There were no significant difference between Tönnis grades 0,1 and 2 groups, with respect to mean CEA and SA rates ($p<0.27$). The rate of Tönnis grade 2 OA was significantly higher in dysplastic group based on <25 CEA values, but there was no correlation between the hip OA and AD based on >42° SA values ($p=0.32$). So; unlike SA, CEA seems to have a role in etiology of the hip OA

Conclusion: This study has provided prevalence values of CEA and SA in patients with radiologic evidence of hip osteoarthritis. AD; based on CEA, but not SA is correlated with radiographic findings of hip OA.

Level of evidence: IV, retrospective series.

Keywords: acetabular dysplasia, hip osteoarthritis, CE angle, sharp angle, computerized tomography

INTRODUCTION

The burden of hip Osteoarthritis (OA) has been growing over the past two decades and is estimated to grow 174% by 2030; especially among the elders [1]. One quarter of 45-year-old adults are expected to develop symptomatic hip OA [2]. There is a wide variation of prevalence for mild hip OA between 0.9%-23% in different populations. Its prevalence is reported to be lower in Asian and African populations, and higher in European populations [3-9].

OA is considered to be a multifactorial disease. Both systemic and local factors affect the hip joint, but local factors play the final role [3]. Age, gender, ethnicity, body weight, physical activity, history of trauma, and also structure/alignment of the joint are some of the common risk factors [4]. There are several studies indicating that gross bone abnormalities; including Acetabular Dysplasia (AD) can play role in the formation of OA. AD is thought to cause OA; because in AD, two parts of the hip joint are not equally connected, by giving rise to higher contact pressure over a smaller surface on hip joint [10]. But especially, in mild forms of dysplasia, the relationship between AD and OA is not fully understood.

Although, pain is one of the major symptoms of OA, symptoms just as pain and stiffness are not always correlated with radiographic changes; and about 50% of patients with OA do not complain about related symptoms [11]. OA is usually classified according to radiographic criteria. Tönnis grading system is one of the classification systems, commonly used for evaluating hip OA radiologically. According to this system; degenerative changes of the hip are evaluated in three degrees radiologically, as; Grade 0: no degenerative changes; Grade 1: mild degeneration; Grade 2: moderate degeneration and Grade 3: Severe degeneration [12]

The aim of the present study is to compare the radiological findings of OA with AD in patients who have not been diagnosed with OA before.

PATIENTS AND METHODS

Study design

365 patients (200 males, 165 females) aged between 40 and 65 were included in this retrospective study. Patients with hip replacement and those with pelvic bone tumour and those with hip deformity due to a previous disease were excluded. Each patient had a pelvic or abdominal Computerized Tomography (CT) for an indication without orthopedic inducement. Lower abdomen and pelvic CT's were retrieved, and individual hip joints were assessed. CT topograms of each abdomen and/or pelvic CT (10 ma, 120 kv, GE Bright Spears; simple AP topogram) were evaluated. Tönnis grading for the radiographic OA was performed by two orthopedists blinded to study. 2 hips (0.27%) of 2 patients which classified by only one of two authors as Tönnis grade 3 and 2 hips (0.27%) who had undergone a contralateral total hip arthroplasty were excluded since the change in the loading pattern of the contralateral hip joint due to previous surgery may lead to the development of osteoarthritis. Level of agreement was qualified using kappa statistics. Acetabular Dysplasia (AD) was assessed by two observers blinded to the results of the Tönnis grading, using two measures: Center-Edge Angle (CEA) and Sharp Angle (SA). The CEA was defined as the angle between the line joining the center of the femoral head to the lateral margin of the acetabular roof and the line perpendicular to the line joining the centers of the femoral heads [13]. The centers of the heads were located and all angles were measured with the help of measurement function of Clear Canvas Software, Version 2.0.1272937986 SP1 by Synaptive Medical (Figure 1). Level of agreement was qualified using kappa statistics. The reproducibility of the radiological parameters was good to excellent, and the kappa values were all >0.8.

Statistical Analysis

R 3.6.1 (R Foundation for Statistical Computing, Viena, Austria) software was used for statistical analysis. Correlations between mean CEA-radiologic OA, mean SA-radiologic OA, and mean CEA-age groups (>55 and <55) were analyzed by two sample t-test. The rate of patients with dysplastic hips based on CEA and SA in patient groups with OA (Tönnis grade 0-1 and Tönnis grade 2) was compared using a proportion test. Two-sided p-values <0.05 were considered significant in all analysis.

RESULTS

A total of 730 hips of 365 patients were studied. 68 hips of 43 patients were found as dysplastic. 33 hips were dysplastic based on only >42° SA values. 23 hips were dysplastic based only on <25° CEA values. There were no patients with CEA<20°. Mean CEA values of right hips and left hips were 34.69 ± 5.55° and 35.11 ± 5.90°; respectively. Mean

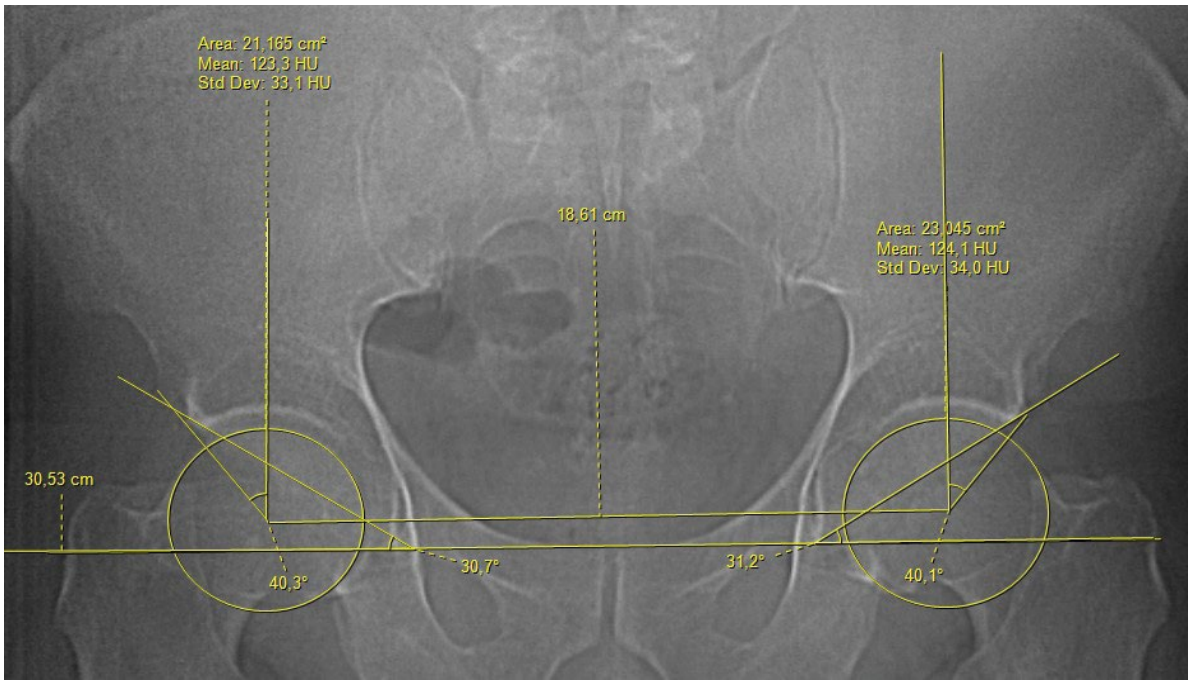

Fig. 1. Drawings and measurements of CEA and SA. CEA: Center-Edge Angle; SA: Acetabular (Sharps's) Angle

SA values of right hips and left hips were 37.36 ± 2.98° and 37.56 ± 3.46°; respectively. When men and women were analyzed separately, mean CEA values of males and females were 35.06 ± 5.58° and 34.71 ± 5.91°; mean SA values of males and females were 37.23 ± 2.92° and 37.75 ± 3.54°; respectively. Also, rate of AD was found 7.26% in men and 10.30% in women. Overall, 8.63% of the hips had AD based on at least one of the measurements (CEA<25° and/or SA >42°). There was a significant increase in mean CEA measurements in age>55 group (p=0.032). Tönnis grades 0, 1 and 2 OA were seen in 56.16%, 36.58% and 7.26% of the hips; respectively (Table 1).

There were no significant difference in terms of mean CEA and mean SA values, between groups of Tönnis Grade 0-1 and Tönnis grade 2 (p=0.29 and p=0.27; respectively.) The rate of Tönnis grade 2 OA was significantly higher in dysplastic hips, based on <25° CEA values (p<0.001), but there was no correlation between the OA and diysplastic hips based on >42° SA values (p=0.33). So, in contrast with SA, it seems that CEA has a significant correlation with the development of hip OA. There were moderate correlation between CEA and SA (Figure 2).

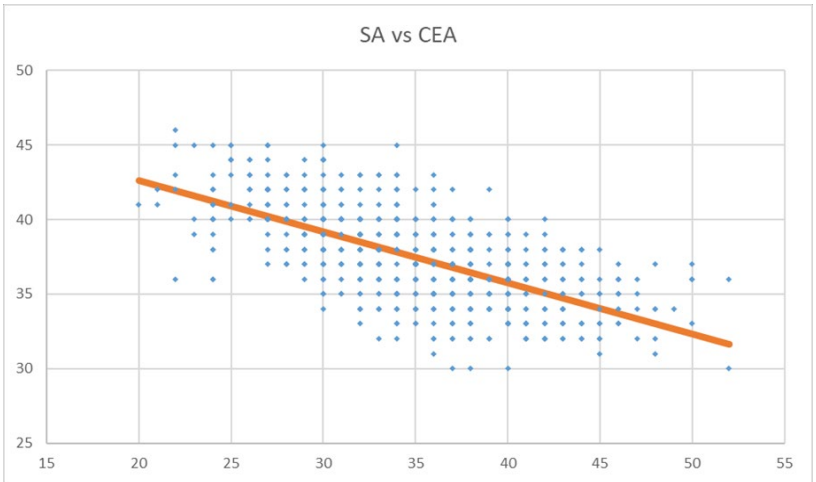

Fig. 2. The scatter plot and regression line between the CEA and SA. The line shows the fitted regression line between these two variables. The pearson correlation coefficient turns out to be 0.65 which yields a moderate relation between two variables

Table 1. Comparative evaluation of Tönnis Grading with SA and CEA measurements in male and female patients

	MALE	FEMALE	TOTAL
Number of joint	400	330	730
CEA			
Mean CEA R	34.83 (± 5.37)	34.53 (± 5.78)	34.69 (± 5.55)
Mean CEA L	35.30 (± 5.78)	34.89 (± 6.04)	35.11 (± 5.90)
Mean CEA (R+L)	35.06 (± 5.58)	34.71 (± 5.91)	34.90 (± 5.73)
SA			
Mean SA R	37.14 (± 2.82)	37.64 (± 3.14)	37.36 (± 2.98)
Mean SA L	37.32 (± 3.02)	37.85 (± 3.91)	37.56 (± 3.46)
Mean SA (R+L)	37.23 (± 2.92)	37.75 (± 3.54)	37.46 (± 3.22)
Tönnis Rates			
Right Hip Tönnis			
0-1 R	189 (47.25%)	158 (47.88%)	347 (47.53%)
2 R (Mean OA rate)	11 (2.75%)	7 (2.12%)	18 (2.47%)
Left Hip Tönnis			
0-1 L	179 (44.75%)	151 (45.76%)	330 (45.21%)
2 L (Mean OA Rate)	21 (5.25%)	14 (4.24%)	35 (4.79%)
R+L Hip Tönnis			
0-1 L	368 (92.00%)	309 (93.64%)	677 (92.74%)
2 L (Mean OA Rate)	32 (8.00%)	21 (6.36%)	53 (7.26%)
Prevalance of AD	29 (7.25%)	34 (10.30%)	63 (8.63%)
Tonnis vs CEA (Prevelance)			
CEA<25 in Tönnis grade 0-1	13 (1.78%)	8 (1.10%)	21 (2.88%)
CEA<25 in Tönnis grade 2	5 (0.68%)	3 (0.41%)	8 (1.10%)
Tönnis vs SA (prevelance)			
SA>42 in Tönnis grade 0-1	14 (1.92%)	22 (3.01%)	36 (4.93%)
SA>42 in Tönnis grade2	3 (0.41%)	1 (0.14%)	4 (0.55%)

CEA: Center-Edge Angle; SA: Acetabular (Sharps's) Angle; OA: Osteoarthritis; AD: Acetabular Dysplasia

DISCUSSION

In the present study; the prevalence of mild hip OA in Turkish population is found to be 7.26%, lower than some European countries but higher than some eastern populations. This rate varies among different populations between 5%-23% [5-9]. Radiological parameters of Tönnis grading were used to classify the hip OA [14-16]. AD was defined as the presence of measurements; CEA <25° or/and SA>42°. We demonstrated that, AD based on <25° CEA measurement is associated with mild hip OA and is thought to play a major role in development of hip OA. On the other hand; dysplasia based on >42° SA measurement is not found to be associated with hip OA. We observed 63 dysplastic hips (8.63% of all hips): 6 of these were dysplastic based on both CEA and SA measurements, remaining 57 hips were dysplastic based on one of the CEA (29 hips) or SA (40 hips) measurements.

OA of the hip is one of the main causes of functional disability and pain. For preventive and treatment strategies, understanding of the disease process is very important. Although mild AD suggested as initiator of subsequent joint degeneration due to stress loading on the supero-lateral border of the hip and assumed to be an etiological factor of OA [17], there is a controversy in the literature about correlation of AD and OA. Although the risk of hip OA is especially higher in younger subjects with AD, the cause/effect relationship between AD and hip OA in older subjects remains controversial. We aimed to investigate the potential effects of radiographic measurements of AD on this debate. In our study, AD prevalence was 8.63%. AD prevalence is reported between 1.8%-9.8% in various populations [5,6,18,19], compatible with the present study. There are also various studies reporting higher prevalence of AD in certain populations [7]. Jacobsen et al studied 4151 hips within a subset of the Copenhagen City Heart Study and showed that AD was significantly associated with OA [19]. Cooperman et al. reported that almost all patients with stable AD (CEA<20° and no sublux) will develop OA by 65 years of age, and unstable AD (CEA<20°, with subluxation) always leads to OA by 65 years of age [20]. Interestingly, Gosvig et al. used the same database with Jacobsen and concluded that AD was not statistically associated with OA [21]. The evidence for the influence of AD on the occurrence of hip OA, at ages of 50-60 or older, is limited [22]. Chitnavis reported that, up to 40% of hips of patients who underwent total hip replacement manifested AD [23]. The studies cited so far showed that AD and OA are correlated. On the other hand; some of the researchers claim that there is no relation between AD and OA. Some cross-sectional studies conducted with older subjects and utilized urography suggested no relationship between AD and OA [6,24,25]. Lane et al. [13] and Goker et al. reported that; AD did not seem to play a major role in the development of radiographic hip OA [18].

The term of CEA was developed by Wiberg [15] as a measurement of the degree of acetabular development and the degree of dislocation of the femoral head in children. Fredensborg reported that; CEA increases slowly until the age of 15 and after this age there is only a slight increase, the curve was reported to be almost identical in both sexes [26]. CEA values of 20°-25° is considered to be borderline dysplasia [26,27]. The normal values of CEA in adults are between 27±7° and 37.9 ± 5.6°, with slight differences among different populations [14,18,19,24,26,28-37]. In our study, mean of CEA values was 35.06° (± 5.58) in males, 34.71° (± 5.91) in females, overall 34.90° (± 5.73).

SA measurement was devised to assess the degree of a patient's hip dysplasia without considering the position of the femoral head [14]. SA describes the angle formed between the inter-teardrop-line and the line connecting the inferior tip of the teardrop to the lateral acetabular rim. It reflects the acetabular morphology and frontal deviation of acetabulum. It is not affected by pelvis position. The normal values for this angle are reported by Sharp as 33°-38°. Upper limit of SA is determined by Sharp as 42° and by Ozcelik et al as 45° in adults [38]. Mean SA values are found to be different in different populations [14,19,31,33,34,36,38-40]. In our study we found that mean SA value was 37.23° ± 2.92 in males, and 37.75°± 3.54 in females (overall 37.46°± 3.22).

Results of the present study indicate that; CEA is useful to detect the relation between femoral head and acetabulum and it is strongly correlated with mild hip OA. On the other hand; we could not observe any relation between SA and OA. SA only gave us information about structure of acetabulum. In the literature, there are many studies investigating the relation between CEA and OA [6-8,14,16,18,25,28,32,41-43] but there is limited information that reveal the relation between SA and OA. The results of these limited studies about SA-OA relationship are also controversial. Nakamura [36] reported that, SA values showed no significant difference between normal and hip OA groups. In their study by surveillance of 86 hips of 59 patients more than 10 years, Hasegawa et al. [44] reported that, SA is not correlated with OA. Ipach [45] found significant relationship between SA and OA. Jingushi [46] et al. reported that SA values >45° significantly increase odds ratios for OA in comparison to <40°.

Our study has many limitations. First of all, our study is retrospective in nature. We measured only CEA and SA which may not be enough to evaluate the three-dimensional structure of the hip joint. CEA does not indicate the shape or depth of acetabulum and does not assess vertical migration of femoral head. We were able to measure only SA and the lateral CEA on CT topogram. But in dysplastic hips CEA decrease significantly in all three directions 46. Hence measuring the lateral CEA might not be enough to predict the progression of OA. However, it is a retrospective study and we avoid to additional radiation exposure to our patients by extra XR and CT.

CONCLUSION

The results of the present study suggest that there is a significant relationship between OA and CEA however there is no evidence that shows an association between SA and OA. These results are comparable to other published data.

DISCLOSURE OF INTEREST

The authors declare that they have no competing interest.

AUTHORS CONTRIBUTIONS

Z Soydan had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design: Z Soydan, HH Ceylan, C Sen

Acquisition of data: Z Soydan, A Kasabaligil, M Mert,

Statistical Analysis and interpretation of data: Z Soydan, MG Guler, C Sen

All authors read and approved the final version of the manuscript.

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