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Computed tomography study of Femoro-acetabular Impingment features in asymptomatic hip joints.

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Abstract

Femoroacetabular impingement (FAI) was discovered 15 years earlier and it was well known clinical condition. It is a mechanical or structural disorder of the hip. It is identified as common cause of hip pain and predisposing factor for osteoarthritis. There are three types of FAI: (A)-CAM type, (B)-PINCER type, (C)–combined (both CAM and PINCER) are present. In CAM type, non-spherical shape of femoral head secondary to excessive bone formation at junction of head and neck results in abatement against the acetabular rim. In PINCER type, because of deep acetabulum, acetabular protrusion or acetabular retroversion, acetabular over coverage of the femoral head limits the range of motion in the hip joint and leads to abnormal stresses on acetabular rim.

Aims: The aim is to evaluate the imaging features on computed tomography thought to be associated with femoroacetabular impingement.

Materials and methods: This study was carried out in the Department of Radiodiagnosis, Dr. Pinnamaneni SIMS & RF for a period of 2 years from November-2019 to October-2021.

Results: A total of 100 cases were taken. Most of the patients were seen in the age group of 36-50 years and 51-65 years age group i.e, 36. Among the 100 patients, 35 members had CAM, 20 members had PINCER and 5 members had COMBINED characteristics. Sensitivity and Specificity is good for the study and positive likelihood ratio <1.41, negative likelihood ratio < 0.55 which reveals diseased probability was decreased.

Head-neck offset, α-angle and acetabular angle were more in males compared to females. α-angle were seen most in age group of 51-65 years, Acetabular angle and Head-neck offset were seen in 20-35 years age group.

Conclusion: From statistical analysis, it was determined that the prevalence of CAM and PINCER type impinge Ment is more in males than females.

The study suggests that the CT imaging features which were associated with Femoro-acetabular impingment can be taken as a identical finding which helps in assessment as a pre disposing factor for developing osteoarthritis.

Keywords: cam, pincer, femoroacetabular impingment, ct, α-angle.

Introduction

Femoro-acetabular impingement (FAI) was discovered 15 years earlier and it was well known clinical condition. It is a mechanical or structural disorder of the hip. It is identified as a common cause of hip pain and pre disposing factor for osteoarthritis. (1)

In this condition, bone overgrowth develops around the femoral head and/ or along the acetabulum. Genetic factors are important in the etiology of osteoarthritis of the hip and may have a role in femoroacetabular impingement. (2)

Generally, it presents with symptoms of pain in hip, frequently in young people (20 – 45 years) and most important symptom is groin pain anteriorly. On examination, motion is limited during adduction in flexion and internal rotation (anterior impingement test). (3) Locking or clicking sensation within the joint.

There are three types of FAI

(A)-CAM type,

(B)-PINCER type,

(C)–combined (both CAM and PINCER) are present.

In CAM type, non-spherical shape of femoral head secondary to excessive bone formation at junction of head and neck results in abutment against the acetabular rim.

In PINCER type, because of deep acetabulum (coxa profunda), acetabular protrusion (4-6), or acetabular retroversion, acetabular over coverage of the femoral head limits the range of motion in the hip joint and leads to abnormal stresses on acetabular rim.

It is one of the leading causes of most leading disease among the hip joints, i.e osteoarthritis (7). But some patients with femoroacetabular impingement are asymp to matic. Ganz et al. investigated the hip morphology, which is the key variable in the formation of FAI. FAI is discovered as a result of hip OA activation.

In association with clinical examination, radiological tests using conventional x rays (8) have been assessed in different views comprising anteroposterior view (AP) (9), frog-leg lateral view, and Dunn view.

In addition, other imaging features such as elevated alpha angle, reduced head-neck offset, reduced acetabular version angle, (10) and elevated Centre edge angle on CT images can be considered these are mostly observed asympto matic individuals. To identify features which are likely to be associated with Femoro-acetabular impinge Ment, 3D images which were obtained on CT images are helpful.

Aims and objectives

The aim is to evaluate the imaging features on computed Tomo graphy thought to be associated with femoroace tabular impingement.

The objective of this study is to determine the presence of radio logic parameters associated with Femo Ro acetabular impingement such as:

A. Alpha angle.

B. Femoral head-neck offset.

C. Angle of Acetabular version.

To also evaluate the CAM and PINCER morphological imaging features on computed tomography of hip joints.

Materials and methods

This study was carried out in the Department of Radio diagnosis, Dr. Pinnamaneni SIMS & RF, Gann avaram, Andhra Pradesh.

Population and study subjects

Inclusion criteria

Patients who are referred for CT evaluation of abdomen, CT evaluation of KUB and CT evaluation of Pelvis.

Exclusion criteria

- Patients who are diagnosed with osteoarthritis or any other traumatic hip injuries.
- Patients with any known symptoms of hip.

Mode of selection of subjects

- Patients >18 years of age groups

Equipment, materials used

Materials will be collected from images of hip joints obtained using siemens- 16 slice Somatom CT with slice thickness of 1.5 mm by using bone window with coronal and oblique-axial reconstructions in the department of radio diagnosis from November 2019.

Technique used

Tube voltage: kVp 130, mA 60, 1.5mm contiguous axial slices. The CT images were analyzed using bone win Dow settings on OsiriX software.

Statistical analysis

Data was entered in MS-Excel and analyzed by using SPSS software. Descriptive statistics was represented with frequencies and percentages. If data follows normal distribution parametric tests will be done otherwise non-parametric tests will be done. We calculated p-value and interpreted the results. Excel has been used to generate graphs, tables etc.

Observations and results

Hip joints of a total of 100 patients were examined. Maximum patients i.e, 36 were in 36-50- and 51-65-years age group and minimum patients i.e, 1 in <20 years age group (Table/ figure 1). Out of 100 cases 65 were males and 35 were females (Table/figure 2). Among the study 35 patients have CAM, 20 have PINCER and 5 have COMBINED characteristics. (Table/figure 3)

This study is significant and the P-Values are less than 0.05. Sensitivity and Specificity is good for the study and positive likelihood ratio <1.41, negative likelihood ratio < 0.55 which reveals diseased probability was decreased. (Table/ figure 4). α-angle is more in males compared to Females and in 51-65 years age group. In this study Head-Neck offset is more in males and maximum observed in 20-35 years age group. In this study Acetabular angle is more in females and in 20-35 years age group. In our study Prevalence reveals diseased conditions in patients. In our study maximum prevalence is observed in CAM and minimum pre valence observed in COMBINED. (table/ figure 5)

Discussion

Impingment detection

However, diagnosing FAI is a difficult process, and surgeons have mistaken it with other hip muscle illnesses, and FAI detection takes a long period. Various articles introduce clinical exams and radiographic examinations in order to appropriately and precisely detect FAI.

Radiological parameters

Physicians can use a solid understanding of FAI bio mechanics to assist them create therapies that lower the risk of osteoarthritis progression. However, future research investigations should concentrate on two points: the etiology of diseases and the nature of impinging joint motions that cause tissue degeneration. There are numerous factors that can be used to identify impinge ments.

On an AP hip radiograph, the CEA (Centre edge angle) can be calculated (11). It's the angle formed by the line drawn from the acetabulum's edge to the central section of the femur's head. The main cause of this condition has been discovered to be an increased acetabulum depth.

Alpha angle (Table/figure 7a)

When compared to a normal hip, the alpha angle shows any abnormality of the head-neck joint. As indicated in the figure, this angle exists between the axis of the femur's neck and the axis of the femur's neck.

1. A line drawn from the Centre of the femoral head to the point where the peripheral osseus contour of the anterior femoral head intersects the extrapolated circle of the femoral head.
2. A line drawn from the femoral head's Centre to the femoral neck's longitudinal axis. (12)

The normal alpha angle should not be more than 55°(13). The head of femur is a sphere in a normal hip, but it is not totally sphere in a hip with impingement. The pistol grip deformity (14) is one parameter which is used to determine whether the femur is spherical. The alpha angle, on the other hand, is more commonly utilised to determine if the femur is a sphere (15).

Acetabular version (Table/figure 7b)

1. It's done on an image that was obtained during the axial reconstruction.
2. Retroversion occurs when the angle between the anterior and posterior borders of the ipsilateral aceta bulum is less than or equal to 15°, as measured by drawing a line from the anterior to the posterior border of ipsilateral acetabulum and another vertical line from posterior edge of the acetabulum that is tangent to the horizontal line that connects the posterior margins of the acetabulum.

Femoral head-neck offset (Table/figure 7c)

The distance d between lines b and c, which are parallel to the anterior aspect of the femoral neck (16) cortex and the anterior cortex of the femoral head, is the anterior offset. At its narrowest dimension, lines b and c are parallel to the midpoint of the femoral neck. The term "reduced offset" was defined as an offset of less than 8mm.

In a study by jihang kim et al (17), the CT findings of the 473 asymptomatic hip joints we investigated for male and female individuals. The median age of the hips that were assessed was 31 for 292 male hips and 34 for 181 female hips. In our study, the median age group in which the CAM and pincer type were more common was 36-50 years, among these males were more in number who presented with typical features of Femoro-acetabular impingement. The p value was significant (0.01), hence the prevalence of FAI features were more in males than females.

In study by jihang kim et al, asymptomatic male and female hip joints, the mean alpha angle was 48.0° and 45.6°, respectively. Male hip joints had a femur head-neck offset of 10.6°, while female hip joints had a femur head-neck offset of 10.2°. In 59 of 292 male hip joints (20.2%) and 26 of 181 female hip joints, an abnormal alpha angle (> 55°) was discovered (14.4%) (Table/ figure 11). Male hip joints had a mean femur head-neck offset of 10.6 mm, while female hip joints had a mean femur head-neck offset of 10.2 mm. In 33 of 292 male hip joints (11.3%) and 15 of 181 female hip joints, an aberrant femur head-neck offset (less than 8 mm) was discovered (8.3%) (Table/figure 12).

In male and female hip joints, the mean acetabular version angle was 16.2° and 16.8°, respectively; an abnormal acetabular version angle (15°) was observed in 91 of 292 male hip joints (31.2%) and 40 of 181 female hip joints (22.1%) (Table/ figure 13). In a study done by chakraverty et al, the overall number of cam-type abnormalities, the total number of parameters tested in the sample population was 81. Sixty-six hips out of sixty (60%). At least one anomaly associated with cam FAI was seen in men, and two or more were seen in men.

At least one CAM abnormality was found in 35% of the women, and four out of 40 (10%) had two or more. In our study, The median age group in which the CAM and pincer type were more common was 36-50 years, among these males were more in number who presented with typical features of Femoro-acetabular impingement. Among 100 patients ,55 cases (55%) showed aberrant CT features related to Femoro-acetabular impingement. The p value was significant (0.01), hence the prevalence of FAI features were more in males than females.

In a study by hack et al (18), 79% (n=22) of the 28 people with a raised alpha angle were men, and 21% i.e., 6 of the 28 people with an elevated alpha angle were women. Breakdown of alpha angles by sex for all 400 alpha angles at the 3:00 position hips. The same tendency was seen when the 1:30 position was used. 75.3 % i.e., 67 of the 89 males were visible. In comparison, 35.1% i.e., 39 women of the 111 women had >50.5° alpha angle (p 0.001), and 51.7 % i.e., 46 of eighty-nine men compared to 18.9% i.e., 21 of women (p 0.001). The alpha angle of 111 women was greater than 55° (p 0.001).

In our study, mean alpha angle among male patients was 48.72° and among female patients was 47.02°. Abnormal alpha angle was seen in total 8 cases out of 100 examined patients. Abnormal alpha angles associated with FAI were common in male than female patients (p<0.01). In a study by kang et al (19), the alpha angles ranged from 30° to 70°, with 45.57 being the average (median, 43). Male joints had a mean of 44.02° (median 41), while female joints had a mean of 46.89°. (Median, 44). Ten of the 100 joints (5 female, 5 male) had an alpha angle of greater than 55. The average femoral head-neck offset was 9.49 mm, with a range of 6.2 to 14.7 mm (median, 9.3 mm). Male joints had a mean of 10.08 mm (median 9.9 mm), whereas female joints had an average of 8.99 mm (median, 8.9 mm). The femoral head-neck offset (head-neck offset less than 8mm) was reduced in 12 of the 100 joints (8 female, 4 male).

In our study, the mean alpha angle among male patients was 48.72° and among female patients was 47.02°. Abnormal alpha angles associated with FAI were more common in male than female patients (p<0.01). The mean value of head-neck offset is 8.17mm among male asymptomatic hip joints and 8.0mm among female

asymptomatic hip joints. Abnormal offset values were seen in a total of 38 (22 male and 16 female) cases.

In a study by Beaule PE et al (20), the symptomatic group had a substantially higher mean alpha angle: 66.4 (39-94) SD +/- 17.2 compared to 43.8 (39.348.3) SD +/- 4.46 in the control group (p = 0.001). The age and the alpha angle had no connection (p = 0.268). In the symptomatic group, males showed substantially larger alpha angles than females (p = 0.009), but not in the control group (p = 0.22).

In our study, minimum alpha angle was observed in age group less than 20 years. Maximum alpha angle was observed in age 51-65 years age group with a mean of 49.08°. The correlation is not significant (p < 0. 1). Abnormal alpha angle was seen in total 8 cases out of 100 examined patients. Among these 7 (87. 5%) were male patients and 1 (12. 5%) were female patients. Abnormal alpha angles associated with FAI were common in male than female patients (p<0.01). In a study by Fatma bilge ergen et al (21), The mean age of the 68 patients was 32. 9± 7.70 years. Overall, 20. 0%, 26. 8%, of hips had cam morphology, 25. 8%, 10. 2%, and 11.7% and pincer morphology.

In our study, maximum number of patients (36) were in 36-50- and 51-65-years age group. 7 patients in >65 years age group. Males were 65 in number, whereas females were 35 in number. Among these 65 males ,22 were presented with CAM type deformity and 13 were presented with PINCER type deformity with a sensitivity of 62.3 % and specificity of 33.8% and the prevalence of CAM type in more in males than females with p value (p=0.01). In the combined type seen in 5 patients, 4 in males and 1 in female the sensitivity is of 80% and specificity of 35% with a positive likelihood ratio of 1.4 and p value (p=0.03) making the study significant. Among the 35 female patients ,13 patients were presented with CAM type,7 patients were presented with PINCER type and 1 with combined type. The prevalence of these features were less in females than males.

In a study done by Jung et al (22), included 215 hips from 108 males with an average age of 62.5 years (26.6 to 92.6), and 540 hips from 272 women with an average age of 59.5 years (25.5 to 90.9). The 755 hips had a mean-angle of 49.3° (SD 12.8°). Gender differences were found to be statistically significant, with men having a higher-angle than women (p 0.001). Men had a statistically larger incidence of problematic and borderline alpha-angles than women (chi-squared test, p 0.001).

Within each gender group, there were no significant differences in – alpha angles between the age ranges. In our study, With a sensitivity of 62.3% and specificity of 33.8%, and a prevalence of CAM type in more males than females with p value (p=0.01), 22 of these 65 males were presented with CAM type deformity and 13 with PINCER type deformity. Females had a lower prevalence of these characteristics than males. Male patients had a mean alpha angle of 48.72°, whereas female patients had a mean alpha angle of 47.02° in our study.

Out of 100 patients evaluated, abnormal alpha angles were found in 8 (seven male and one female) cases. Male patients had more abnormal alpha angles linked with FAI than female ones (p0.01).

In a study by Jun Zhou et al, results compatible with FAI were found in 1145 patients (60.5%; 1371 hips; 374 male and 771 female; mean age, 28.8 8.4 years). Cam-type hips made up 139 (10.1%), pincer-type hips made up 245 (17.9%), and mixed-type hips made up 987

(72.0%). A pistol grip deformity and an alpha angle >55° were found in 577 (42.1%) and 1069 (78.0%) people, respectively. 66.9° 10.5° was the average alpha angle.

In our study, the greatest alpha angle was detected in the age group 51-65 years old, with a mean value of 49.08. Males accounted for 65% of the population, while females accounted for 35%. 22 of the 65 males were diagnosed with CAM type deformity and 13 with PINCER type deformity, with a sensitivity of 62.3% and specificity of 33.8%, and a prevalence of CAM type in more males than females with p-value (p=0.01).

Radiographs, computed tomography (CT), and magnetic resonance imaging (MRI) are useful in verifying the diagnosis of FAI in a patient with an acceptable history and clinical symptoms with positive anterior and/or posterior impingement tests. Radiographs, CT and MRI are the optimal imaging combination in facilities with a lot of expertise in this condition. There will be some discussion of potential pitfalls to be aware of, as well as some background on current surgery for radiologist knowledge. Radiographs, CT, and MRI imaging can confirm the diagnosis of femoroacetabular impingement in clinically suspected cases with symptoms and positive impingement tests. The diagnostic radiologist's job is to look for signs that confirm the diagnosis, describe the degree and severity of the labral avulsion and cartilage lesion, rule out other diagnoses, and rule out advanced osteoarthritis, which is linked to poorer post-operative results.

Jihang kim et al (17). concluded that imaging chara cteristics on computed Tomo graphy established with the femoroacetabular impingement are widespread in asymptomatic adult hip joints, especially in men, with a high degree of coexistence among the studies.

According to Fatma Bilge Ergen et al. (21), larger alpha angle values were obtained from radial reformatted images in asympotmatic people, notably in the Antero superior area of the femoral head-neck junction. The alpha angle (AA) is a measurement of focused femoral epiphyseal overgrowth that shows inadequacy of the anterolateral femoral head-neck offset as well as femoral head a sphericity. The AA measurement is a popular way to assess osseous deformities at the femoral head-neck junction. Initially, the AA measures were exclusi vely utilised to characterised cam-type ab nor malities on the femoral head and neck's anterior surface.

According to the defined measuring parameters, Alan C.L. Kang et al (19) demonstrated the bony features leading to femoroacetabular impingement in asympto matic patients.

Conclusion

From statistical analysis, it was determined that the prevalence of CAM and PINCER type impingement is more in males than females. The study suggests that the CT imaging features which were associated with Femoro-acetabular impingment can be taken as a identical finding which helps in assessment as a predisposing factor for developing osteoarthritis. The prevelance of bony abnormalities predisposing to FAI in asymptomatic hip joints was calculated according to the established measurement parameters. This study showed not only the prevalence of CT features thought to be associated with FAI that are easily measured on routine hip CT, but also the association among those findings

Imaging findings on CT known to be associated with FAI are common with high coexistence of features in asymptomatic adult hip joints, especially in males, so these features should be interpreted with much caution and clinical correlation.

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