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ORIGINAL RESEARCH

Medicine Science International Medical Journal

Medicine Science 2019;8(4):963-6

Determination of correlation between alpha angle and herniation pit in healthy adults on hip MRI

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Received 16 April 2019; Accepted 17 May 2019
Available online 09.07.2019 with doi:10.5455/medscience.2019.08.9052

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Abstract

The purpose of this study was to investigate the association between alpha angle and herniation pit (HP) in healthy adults on hip magnetic resonance imaging (MRI). Between May 2016 and September 2018, 502 hip joint MRIs of 251 healthy adults (aged between 19 and 82 years) were retrospectively evaluated to determine the presence of HP of the femoral neck. Femoral neck alpha angles were also measured. Possible relationships between herniation pit and age, sex, sided-ness, and alpha angle were investigated. One hundred twenty-four males and 127 females were included, and the mean age was 40.96 ± 12.85. HPs were present in 20 of the 502 hips, a prevalence of 3.98 % (45 % at right and 55 % left hips). The herniation pit sizes were ranged from 2 to 9.6 mm; the average value was 5.1±2.2 mm. The average value of the alpha angle of 502 hips was 50.42 ± 5.91°. The alpha angle was ≥ 55 degrees in sixty-seven (13.35 %) of 502 patients. No correlation was found between herniation pit and age, sex, side (right or left hip) and alpha angle degrees. No statistically significant association was found between alpha angle ≥ 55 degrees and the actual size of the herniation pit. There is no correlation between age, sex, or alpha angle ≥ 55 degrees and the prevalence of herniation pit in healthy hips. HP formation is an incidental radiologic finding and unrelated to the alpha angle.

Keywords: Herniation pit, hip, alpha angle, magnetic resonance imaging

Introduction

The herniation pits (HPs) are benign oval or small round lesions seen in the proximal anterior superior quadrant of the femoral neck were first described by Michael J.Pitt [1]. Although HPs are felt to be synovial herniation through cortical defects at the femoral neck, the exact etiology is still unclear [2-4]. Mechanical forces between the anterosuperior femoral neck and the acetabulum were accused in the development of the HPs. The typical radiologic findings of HP on MRI is a round focal fibrocystic lesion in the proximal anterosuperior quadrant of the femoral neck less than 1 cm in diameter with T1-weighted low and T2-weighted bright signal with well-defined peripheral low signal intensity.

The association between the femoroacetabular impingement (FAI) and the development of HP were reported in some studies, but some studies reported that HP was incidental finding [3,5-7]. There are two types of FAI with the decreased head-to-neck ratio in the femoral head-neck junction (cam-type FAI) or over coverage of femur by acetabulum (pincer-type FAI) [8,9]. In cam-type FAI, because of morphological alterations in the femoral head and the acetabular rim result in cartilage damage, labrum tear and advanced hip osteoarthritis [3,10]. Although many imaging methods have been used to diagnose cam-type FAI, studies have underlined the importance of alpha angle in evaluating the femoral head-neck junction and accepted over 55 degrees as diagnostic criteria [5,11-15] Whereas some studies showed FAI might have a role in patients with HP, some studies reported HPs were irrelevant with FAI. Therefore, the presence of HP in the etiology of FAI remains still controversial [16-18].

Our purpose in this study was to investigate possible relationships between HP and age, sex, side, and alpha angle in healthy adults on MR images.

Material and Methods

This retrospective study was performed in healthy adults (aged 19 to 82 years) who were not diagnosed clinically as FAI and

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underwent hip MRI for trauma or medical purposes (e.g., gynecologic indications); the hip was included in the scan range. Exclusion criteria were as follows: avascular necrosis, history of hip surgery, osteoarthritis, malformation, fracture, or tumor in the proximal femur.

Our institutional review board approved this study. Written informed consent was not obtained from patients due to the retrospective design of the study. For this purpose, the picture archiving and communication system (PACS, General Electric, Chicago, IL, USA) was used. MRIs (Philips Best, 1.5 T Ingenia, Netherlands) were performed by using a phased-array coil with the following parameters: T1-weighted images in coronal and axial planes from the body of the pubis to the coxae (TR, 621msec; TE 7 msec), T2- weighted image in coronal plane from sacrum to pubis (TR, 3500 msec; TE 80 msec) and T2-weighted fat-saturated image in axial plane (TR, 3500 msec; TE 80 msec).

All MR images were evaluated by the same observer (experienced with musculoskeletal MRI for eight years). Firstly, all images were evaluated in terms of herniation pits that are described as having a diameter of ≥2 mm well circumscribed juxtacortical lytic lesion in the proximal upper quadrant of the femoral neck and size of herniation pit was measured on MR images (Figure 1). Alpha angles were measured by the radiologist twice for each patient using the method described by Nötzli et al. criteria on T1W axial sequences, and the average values were used for statistical purposes [9]. The alpha angle was defined as the angle between two intersecting lines at the center of the femoral head: first line from the center of the femoral head down to the long axis of the femoral neck and the second line from the center of the femoral head to the anterior point where the head extends beyond the margin of the circle (Figure 2). To assess the reliability of the alpha angle measurements, the same radiologist performed the measurements one month after the first evaluation.

Statistical Method

SPSS® version 17 (IBM Corp., Armonk, USA) was used for the statistical analysis. The continuous variables were expressed as mean ± standard deviation. Data were compared using the chi-square test and t-test. In all tests, a p-value of < 0.05 was statistically significant.

Results

124 male (49.40 %) and 127 female (50.60 %) patients with the mean age of 40.96±12.85 years (range, 19 to 82 years) were included for this study. HPs were present in 20 of the 502 hips, a prevalence of 3.98 % (9 of them (45 %) at the right side and 11 of them (55 %) at the left side). HPs were observed in 9 of 248 hips (3.63 %) in men and 11 of 254 hips in women (4.33%). The HP sizes were ranged from 2 to 9.6 mm; the average value was 5.1±2.2 mm. HPs were grouped into two groups; herniation pits smaller than mean value (< 5.1 mm) and larger than mean value (≥ 5.1 mm). Eleven of HPs were < 5.1 mm and 9 of them were ≥ 5.1 mm. The nostatistical difference was found between the presence of herniation pit and sex and side of the hip. The prevalence of HPs was higher in patients younger than 41 years when compared with patients older than 41 years but did not reach statistical significance (p=0.897). The alpha angle values were ranged between 33 and 69 degrees (50.25±5.89 ° in the right side and 50.58 ± 5.94 ° in the left side). The average value of the alpha angle was 50.42 ± 5.91 °. Sixty-seven out of 502 hips (13.35 %) showed alpha angle ≥ 55 degrees, and only 6 of them (8.96 %) had herniation pits. HPs were statistically common in patients had alpha angle <55 degrees (p< 0.05). Statistically significant difference was not detected between alpha angle ≥ 55 degrees and age, sex, side and size of the HP (p = 0.570, p = 0.582, p = 0.896, p= 0.913) (Table 1).

The intraclass correlation coefficient for intraobserver reliability was 0.88.

Table 1. The relationship between alpha angle and sex, age, presence of herniation pit, size and lateralization

		Alpha Angle				
		< 55		≥ 55		p[1]
		n	%	n	%	
Sex	Male	217	(49.89)	31	(46.27)	0.582
	Female	218	(50.11)	36	(53.73)	
Age	< 41 years	86	(19.77)	10	(14.93)	0.348
	≥ 41 years	349	(80.23)	57	(85.07)	
Laterality	Right	218	(50.11)	33	(49.25)	0.896
	Left	217	(49.89)	34	(50.75)	
Herniation pit(HP)	Absent	421	(96.78)	61	(81.82)	0.025
	Present	14	(3.22)	6	(8.96)	
Side of HP	Right	6	(42.86)	3	(50.00)	0.769
	Left	8	(57.14)	3	(50.00)	
Size	≥ 5.1 mm	6	(42.86)	3	(50.00)	0.769
	< 5.1 mm	8	(57.14)	3	(50.00)	

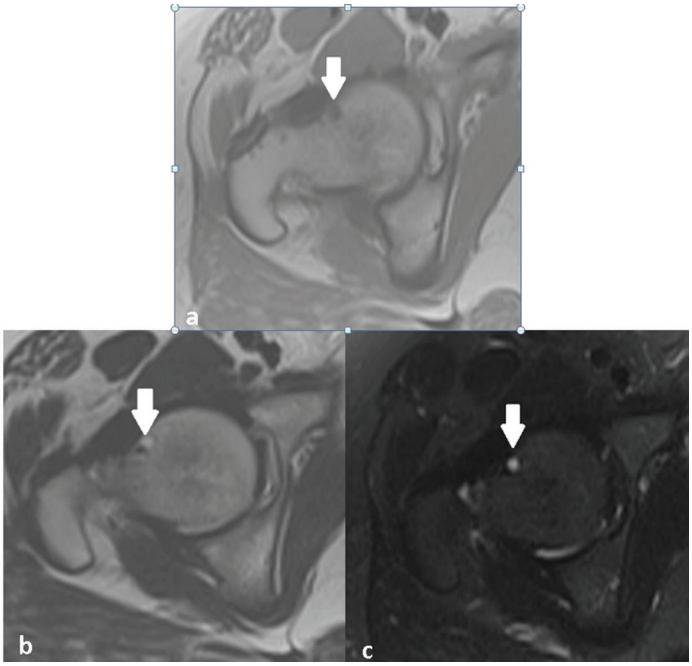

Figure 1a. Axial T1-weighted image of MR showing the herniation pit at the femoral head-neck junction with low signal intensity (arrow) **1b and 1c.** Axial T2-weighted and T2-weighted fat-saturated images of MR showing the herniation pit at the femoral head-neck junction with high signal intensity (arrow)

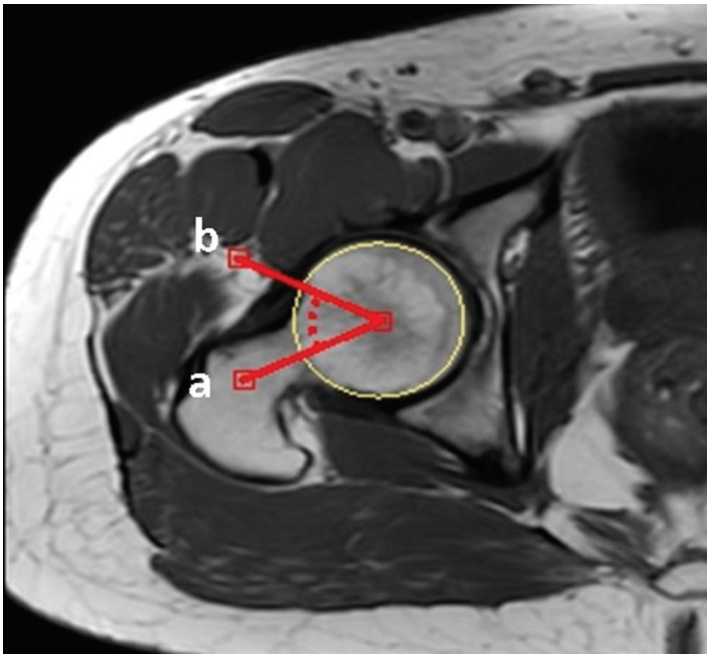

Figure 2. Measurement of alpha angle on oblique axial T1-weighted MR images parallel to the axis of the femoral neck. A circle, which was drawn out-lining the femoral head, the first line from the center of the femoral head down to the long axis of the femoral neck (line a) and the second line from the center of the femoral head to the anterior point where the head extends beyond the margin of the circle (line b)

Discussion

However, the exact etiology of HP is still controversial; these pits are felt to be secondary to the mechanical effects of the overlying hip capsule [17,19]. The prevalence of HPs differs because of different methodologies and selection criteria for participants in the literature. Pitt et al. reported a prevalence of 5 % using radiographic imaging in normal adults [1]. Daenen et al. found an HP frequency of 12 % and Hedvabny et al. described a prevalence of 6 % by X-ray [18,19]. Nokes et al. found a prevalence of 4 % on AP radiographs and MRI [20]. Lee et al. showed a higher prevalence of HPs with CT than those in previous studies [21]. In our study, we identified HPs in 20 of the 502 hips (3.98 %), which were slightly lower than the results of the previous studies. Although some studies reported the higher prevalence of HP in male patients when compared with the female patients due to having a more physical exercise [16]. We didn't find statistically significant differences in the prevalence of HPs among genders. This may be due to the increased participation of women in working life. In our study, the patients older than 41 years had a much greater prevalence of HPs than those younger than 41 years (12 out of total 20 herniation pits, 60 %) but it did not reach statistical significance. These results showed similar prevalence as compared to previous studies and blamed increased participation and physical exercise with age [17].

Several studies have revealed that FAI may be a predictor of HP [2,6,15-17]. In cam-type FAI because of morphological alterations in the femoral head and neck and repetitive mechanical contact between the superolateral quadrant of the femoral neck and the acetabulum or joint capsule result in cystic changes at the femoral neck [17]. The alpha angle is a commonly used parameter to measure the morphology of the femur head-neck junction [4,5,12]. In patients with cam-type FAI, the alpha angle increases because of disappearing off the normal offset of the femoral head-neck junction. Leunig et al. and Ganz et al. found a high prevalence of HPs in hips with FAI by X-ray [2,8]. Also, prior studies suggested that the alpha angles were greater in patients with HPs than in without HPs with CT [15,16]. The result of our study showed a lower prevalence of HPs in healthy population than those reported in FAI contrary to the previous studies. This result suggests that the presence of HPs is not related to the FAI. Our results showed a wide range of angle between 33 and 69 with a mean of 50.42 degrees in a healthy population, but the higher results were reported in previous studies [21]. We determined the prevalence of alpha angle ≥ 55° in a healthy population as 13.35 %. As found in our study, Kim et al. also indicated that the presence of HPs had no importance in the diagnosis of FAI [17].

The study has several limitations. First, the cases of this research were selected from just one hospital, the sample range was narrow, and the sample size was not much enough, there may be some bias. Second, this was a retrospective study. However, we selected asymptomatic patients from the medical records without known activity frequency that could lead to a risk factor for the presence of HPs. Third, we used only the alpha angle as a radiological measurement to assess the diagnosis of cam-type FAI and did not alter acetabular morphology into consideration. Although the normal value of the alpha angle is still controversial, we have accepted it pathologically to be above 55 degrees, as stated by Pfirrmann CW et al. Another limitation was the fact that we did not exclude the elderly patients that can affect the alpha angle and femoral head morphology secondary to osteoarthritis.

Conclusion

In conclusion, there is no correlation between age, sex, side of the hip joint or alpha angle ≥ 55 degrees, and the herniation pit in healthy hips. HP formation is an incidental radiologic finding and unrelated to the alpha angle.

Conflict of interest
The authors declare that there are no conflicts of interest.

Financial Disclosure
All authors declare no financial support.

Ethical approval
Consent of ethics was approved by the local ethics committee.

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