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The prevalence of a prominent anterior inferior iliac spine

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Abstract

Introduction Impingement of the prominent anterior inferior iliac spine (AIIS) against the femoral neck has recently been described as another type of impingement. The purpose of this study is to provide a distribution of AIIS types using the classification proposed by Hetsroni and thus report on the prevalence of prominent types.

Materials and methods A total of 400 patients were included in the study with an average age 27.3 ± 6.9 years (range 18–40). All patients received a whole-body polytrauma computer tomography (CT) scan in the emergency room (ER) upon arrival. The classification of AIIS proposed by Hetsroni et al., which describes three morphological types, was used. Type II and III were grouped as prominent types. The measurements were performed in all three planes by two examiners.

Results Male to female ratio was 71:29. Type I was observed in 367 (91.7%) patients. Type II was observed in 31 (7.8%) patients and type III was observed in 2 (0.5%) patients, unilaterally. Prominent types were much more prevalent in men (10.5%) than in women (2.6%). The CT assessment demonstrated excellent intra- and interreliability (overall: 0.926, I/II: 0.906, III: 1.000).

Conclusion A young population demonstrates a prevalence of a prominent AIIS of 11.5%. Prominent AIIS is more common in men than in women.

Keywords Anterior inferior iliac spine · Impingement · Prevalence · CT

Introduction

In recent years, research has increasingly shown that femoroacetabular impingement causes pain [1], labral tears [2] and could even be responsible for early-onset osteoarthritis [3]. In newer studies, other types of impingement have emerged, such as impingement of a prominent anterior inferior iliac spine [4–8] (AIIS) against the femoral neck, the subspine hip impingement [9], psoas impingement occurring after arthroplasty [10] and os acetabuli [11]. Anatomically speaking, the direct head of the AIIS is the origin of the rectus femoris and the indirect head originates from the acetabulum [12]. Improvement in hip flexion, decreased pain and overall improvement in hip function have been reported after resection of the AIIS prominence [5]. Amar et al. [13] described the anatomical variant of AIIS as a mean length of 31.5 mm (range 23–39.5 mm), a mean height of 6.4 mm (range 3.5–10 mm) and a mean width of 11.9 mm (range 8.5–16.1 mm); the mean distance from the base of the AIIS to the acetabular rim was 21.8 mm (range 10.4–32.3 mm). Based on the radiographic morphology and clinical correlation to the range of motion (ROM), a classification system has been proposed by Hetsroni et al. [5]. This classification system has been developed on a cohort of 53 patients with symptomatic hips.

The purpose of this study is to provide a distribution of AIIS types in a young population and to account for any gender-related differences.

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Fig. 1 3D reconstructions of Hetsroni [5] AIIS classification; **a** Type I defined as a smooth ilium wall between the caudal level of the AIIS and the acetabular rim; **b** Type II, defined as bony prominences on the ilium wall extending from the caudal area of the AIIS to the acetabular rim or sitting directly at the rim; **c** Type III defined as an extension of the AIIS distally from the anterosuperior acetabular rim

Patients and methods

The patient cohort was collected using a retrospective search of patients primarily admitted and treated in the authors' university hospital emergency room between January 2013 and January 2018. It is a consecutive series of 95% Caucasian and 5% Middle Eastern patients. Inclusion criteria were age between 15 and 40 years at the date of admission and a whole-body polytrauma CT scan at admission. A total of 56 patients with pelvic or proximal femoral fractures were excluded. In total, 400 patients were included and analyzed in the study. There were 115 female (28.8%) and 285 (71.2%) male patients. The authors' institutional ethical board approved the study (0711/2017).

The CT images were collected using a scanner in a 64-slice mode, 1 mm scans (Siemens Somatom Definition AS; Siemens Healthineers, Erlangen, Germany). The measurements were performed independently by two observers (an orthopedic surgeon and a doctoral student trained in the radiological department specifically for this task) using Agfa Impax EE (Agfa-Gevaert N.V., Mortsel, Belgium).

All three planes of plain CT scans were used for the determination of the presence of AIIS. Three-dimensional reconstructions (3D) were available only in the minority of the cases and were therefore not used for the morphological assessment.

Hetsroni [5] variants of AIIS are shown in Fig. 1a–c. Type I variant of the AIIS was defined as a smooth ilium wall between the caudal level of the AIIS and the acetabular rim (Fig. 2). Type II was defined as bony prominences on the ilium wall extending from the caudal area of the AIIS to the acetabular rim or sitting directly at the rim (Fig. 3). Type III was defined as an extension of the AIIS distally from the anterosuperior acetabular rim (Fig. 4). Type II and type III were defined as prominent types, since they were shown to have clinical relevance, with type III being of greater relevance [5]. The presence of os acetabuli was defined as a bone fragment located at the acetabular rim, not originating from the AIIS [13].

Data were collected in Microsoft Excel 16 (Microsoft Corporation; Redmond, Washington, U.S.). Difference between groups was calculated using Chi-square analysis and *t* test in SPSS 24 (IBM, Armonk, N.Y., U.S.).

Fig. 2 CT scan of Type I variant of the AIIS—defined as a smooth ilium wall between the caudal level of the AIIS and the acetabular rim

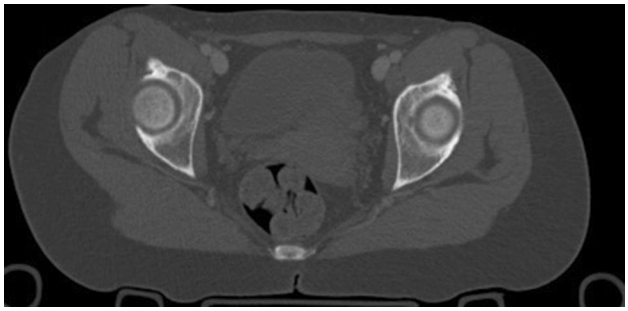

Fig. 3 CT scan of Type II variant of the AIIS—defined as bony prominences on the ilium wall extending from the caudal area of the AIIS to the acetabular rim or sitting directly at the rim

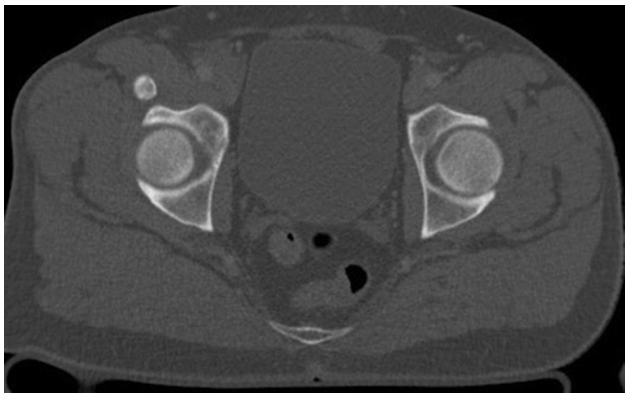

Fig. 4 CT scan of Type III variant of the AIIS—defined as an extension of the AIIS distally from the anterosuperior acetabular rim

Continuous data are shown as mean ± standard deviation (SD). The interobserver variability was tested using the weighted Kappa (wKappa) coefficients.

Table 1 Results (mean ± SD)

	AIIS type 1	AIIS type 2	AIIS type 3	Total
N patients (%)	367 (91.7%)	31 (7.8%)	2 (0.5%)	400 (100%)
N hips (%)	739 (92.3%)	59 (7.3%)	2 (0.25%)	800 (100%)
Age (years)	27.3 ± 6.8	27.2 ± 6.2	23.0 ± 5.5	27.3 ± 6.9
Men (%)	255 (89.5%)	28 (9.8%)	2 (0.7%)	285 (100%)
Age, men (%)	27.4 ± 6.9	27.4 ± 6.25	23.0 ± 5.5	27.3 ± 6.8
Women (%)	112 (97.4%)	3 (2.6%)	0 (0%)	115 (100%)
Age, women (%)	27.3 ± 6.7	25.2 ± 6.9		27.3 ± 6.7

Results

Average patient age in the cohort was 27.3 ± 6.9 years. Results showing the distribution of AIIS types are reported in Table 1. Of the 400 patients scanned, 367 patients had type I (91.7%). Of the prominent types, type II was observed in 31 patients (7.8%) with 28 patients having bilateral type II. Type III was observed in two patients, both unilaterally. These two patients had type I on the second hip.

Gender analysis showed a significant difference in the distribution of types ($p = 0.009$). Prominent types were more common in men than in women, 10.5% vs. 2.6%. Type III was only observed in men. There was no difference in age distribution between the types ($p = 0.721$). Os acetabuli was not observed.

Overall interobserver agreement was 92.6% (w κ 0.926). Type III interobserver reliability was 100%. Type I/II interobserver reliability was 90.6%.

Discussion

A young trauma population demonstrates a prevalence of prominent AIIS of 11.5%. The prevalence of the most prominent Type III AIIS is 0.5% in this population. Plain CT scan can be used reliably to determine the morphological type of AIIS.

Data on prevalence in the symptomatic population is scarce, and data on the prevalence in the general population is entirely lacking. A study by Nawabi et al. [14] showed some abnormality of the AIIS in 84% of soccer players. However, this was a symptomatic cohort and therefore does not represent the general population.

Screening for prominent AIIS has been proven difficult by literature. Krueger et al. [15] determined that AIIS morphology using plain radiographs was impossible, but the projection of AIIS below the anterior acetabular rim represented a hypertrophic AIIS in all cases. Conversely, Schindler et al. [16] showed that plain radiographs could be used

for screening AIIS impingement. Reliable data using plain radiographs was missing.

These limited attempts probably motivated Hetsroni [5] to create a classification based on 3D CT imaging. Patients with a variety of femoroacetabular symptoms were used to create a morphological and clinical classification. They have shown that prominent subtypes need to be critically assessed as significant contributors to hip impingement. They point out in their study, though, that their classification system may be of limited applicability in other institutions, because it was created with 3D scans which are necessary to differentiate between the subtypes. Our study shows that plain CTs can be a very reliable tool for assessing the morphological types of AIIS.

The literature on diagnostics and treating of prominent AIIS is limited to case studies and studies with a low number of symptomatic individuals or AIIS avulsions [17]. Hetsroni et al. [5] used 53 patients with various femoroacetabular symptoms to develop their classification system, with the distribution of the types being 17% type 1, 75% type 2 and 8% type 3. However, this is a purely symptomatic cohort with other pathology, such as femoroacetabular impingement. A previous study by Hetsroni used a case series of ten symptomatic patients [4]. Larson et al. [18] included three patients, while Pan et al. [7], Amar et al. [13], Rajasekhar et al. [19] and Matsuda [20] described one patient, the latter two as a result of fractured apophysis. Our study shows that prominent AIIS occurs in 10% of the population and a very prominent AIIS in 0.5%. A recent study on a lower number of hips in all age groups found an increased prevalence, compared to our study [21]. This could be due to different age distributions and racial differences. Another recent study compared AIIS distribution between symptomatic and asymptomatic hips and found no difference [22]. The study groups were 54 and 35 hips, respectively, and the classification proposed by Hetsroni et al. [5] was not used.

Though this study addresses the data on the prevalence in the largest cohort reported in the literature up to date, it is not without limitations. Firstly, this is a predominantly male and predominantly Caucasian cohort, typical of a general trauma cohort. Data shows that trauma population is very similar to the general population [23]. Furthermore, the demographics of our cohort matches the symptomatic cohorts in previous studies, which was the reason for targeting this age group. Hetsroni described the classification system on a predominantly male cohort, aged 15–30 years [5]. In his other study, he uses a consecutive series of ten male patients with an average age of 24.8 years [4]. Larson used three males, aged 21, 17 and 31 years [18]. The targeted younger population and predominantly male population in our study make the results of the study even more relevant. Another limitation is the lack of data on potential symptoms in this cohort, but the purpose of this study was only to report on the distribution of morphological types. In his study, Hetsroni [5] utilizes 3D CT reconstructions, which were not utilized in this study. In the limitations of his model, the authors state that their model could have limited applicability, if 3D CT was not used routinely which is partially observed in this study. Due to a single measurement per observer, an intraobserver analysis was not performed, potentially skewing the distribution; however, this difference should be minimal.

Conclusion

A young population demonstrates a prevalence of a prominent AIIS at 11.5%. Prominent AIIS is more common in men than in women.

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Compliance with ethical standards

Conflict of interest Antonio Klasan has received research support from Implantcast, unrelated to this study. Thomas Neri has no conflicts of interest. Susanne Fuchs Winkelmann has no conflicts of interest. Swen Putnis has no conflicts of interest. Philipp Dworschak has no conflicts of interest. Karl Friedrich Schüttler has no conflicts of interest. Markus Schofer has been paid for presentations for Depuy and Smith & Nephew. Thomas Heyse has been paid for presentations for Smith & Nephew, Zimmer Biomet and Implantcast. He has received research support from Smith & Nephew, Zimmer Biomet and Implantcast. He is a consultant to Smith & Nephew.

Ethical approval The authors' university board of ethics reviewed the study and approved the study (0711/2017). The study was performed at the University Hospital Marburg, Center for Orthopedics and Traumatology, Baldingerstrasse, 35043 Marburg, Germany.

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