ORIGINAL RESEARCH ORİJİNAL ARAŞTIRMA

DOI: 10.31609/jpmrs.2024-103096

The Common Pitfalls for Evaluation Sacroiliac Joint Radiography in Axial Spondyloarthritis: An Experience of Radiographic Examination from Single Center Cohort

Aksiyel Spondiloartritli Hastalarda Sakroiliyak Eklem Radyografisi Değerlendirirken Karşılaşılan Önemli Tuzaklar: Tek Merkez Kohortundan Radyografi Okuma Deneyimi

Abdulvahap KAHVECİ[a,b], Şebnem ATAMAN[b]

[a]Kastamonu Training and Research Hospital, Clinic of Rheumatology, Kastamonu, Türkiye
[b]Ankara University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Division of Rheumatology, Ankara, Türkiye

ABSTRACT Objective: This study aims to examine sacroiliac joint (SIJ) graphs (pelvic X-ray) of patients in axSpA cohort, and to present the common pitfalls as single center experience. **Material and Methods:** In this study, 1,123 SIJ graphs of 758 patients with axSpA from our cohort were obtained from the imaging database. Firstly, the X-ray images were evaluated by a blinded rheumatologist, and the images, which have mechanical SIJ disease (n=318), wrong radiographic technic (n=75) and infective joint disease/fractures (n=12) were excluded. Secondly, 718 pelvic X-ray/430 patients were investigated in terms of artifacts by two rheumatologists. The final 300 X-rays were graded according to the Modified New York criteria. The results of the study were presented by descriptive statistics, and chi-square test was used to compare the grades of right and left SIJ. **Results:** Totally, 430 axSpA patients; the mean age was 44.3±10.2 years, and 200 (46.5%) patients were classified as ankylosing spondylitis, and 230 (53.5%) as non-radiographic axSpA. Of the 718 radiographs, 258 (35.9%) had image artifacts, 117 (16.2%) had bowel superimposition artifact, and 43 (5.9%) had soft tissue calcification. The number of radiographs with Grade 0 on the left side (33% vs. 30.3%; p=0.042), and Grade 1 on the right side (21.0% vs. 26.0%; p=0.038) was significantly higher than that observed on the contralateral side. **Conclusion:** The study indicated that the most prevalent pitfalls encountered when assessing sacroiliac radiographs are image artifacts resulting from diverse etiologies and bowel superposition artifacts. The study suggested that during the evaluation of pelvic X-ray, to avoid clinical and/or radiological mis/over diagnose, the readers should know comorbidities, radiological technique, anatomy of SIJ, mimics, and artifacts.

Keywords: Axial spondyloarthritis; sacroiliac joint; pelvic X-ray; pitfalls; cohort

ÖZET Amaç: Bu çalışma, akSpA hastalarında sakroiliyak grafi (antero-posterior pelvis grafisi) değerlendirilmesini sırasında karşılaşılan tuzakları sunmayı amaçlamaktadır. **Gereç ve Yöntemler:** Çalışmaya akSpA kohortumuzdaki 758 hastaya ait, elektronik görüntü sistemindeki 1.123 sakroiliyak grafi dâhil edildi. Bu grafiler ilk olarak hasta verilerine göre kör romatolog tarafından değerlendirilerek, mekanik sakroiliyak eklem hastalığı (n=318), yanlış radyografik tekniğe sahip (n=75) ve enfektif eklem hastalığı/fraktür (n=12) olanlar dışlandı. Bunun sonucunda kalan 430 hastaya ait 718 pelvis grafisi artefaktlar yönünden iki romatolog tarafından birlikte değerlendirildi. Artefakt olan grafiler dışlandıktan sonra kalan 300 pelvis grafisi Modifiye New York Kriterlerine göre evrelendirildi. Çalışmanın sonuçları tanımlayıcı istatistik verileri ile sunuldu. Ayrıca, sağ-sol sakroiliyak evre karşılaştırılmasında ki-kare testi kullanıldı. **Bulgular:** 430 akSpA hastasının ortalama yaşı 44,3±10,2 yıl olup 200 (%46,5) hasta ankilozan spondilit, 230 (%53,5) hasta radyografik olmayan akSpA olarak sınırlandırıldı. 718 pelvis grafisinden 258'inde (%35,9) görüntü artefaktı, 117'sinde (%16,2) bağırsak süperpozisyon artefaktı ve 43'ünde (%5,9) yumuşak doku kalsifikasyonu tespit edildi. Sol sakroiliyak eklemde Evre 0 olan pelvis grafisi sayısı sağa göre istatistiksel olarak daha fazla iken (sol vs sağ; %33 vs %30,3; p=0,042), sağda Evre 1 olan pelvis grafisi sayısı sağa göre daha fazlaydı (sol vs sağ; %21,0 vs %26,0; p=0,038). **Sonuç:** Bu çalışma, sakroiliyak radyografileri değerlendirirken karşılaşılan en yaygın tuzakların, çeşitli etiyolojilerden kaynaklanan görüntü artefaktları ve bağırsak süperpozisyon artefaktları olduğunu göstermektedir. Bu doğrultuda pelvik grafinin değerlendirilmesi sırasında, klinik ve/veya radyolojik yanlış/aşırı tanıdan kaçınmak için okuyucuların komorbiditeleri, radyolojik tekniği, sakroiliyak eklem anatomisini, taklitçileri ve artefaktların bilinmesi önem arz etmektedir.

Anahtar Kelimeler: Aksiyel spondiloartrit; sakroiliyak eklem; pelvis grafisi; tuzak; kohort

Correspondence: Abdulvahap KAHVECİ
Kastamonu Training and Research Hospital, Clinic of Rheumatology, Kastamonu, Türkiye
E-mail: abdulvahap_kahveci@hotmail.com

Peer review under responsibility of Journal of Physical Medicine and Rehabilitation Science.

Received: 27 Mar 2024 ***Received in revised form:*** 21 Aug 2024 ***Accepted:*** 14 Oct 2024 ***Available online:*** 22 Oct 2024

Axial spondyloarthritis (axSpA) is a chronic rheumatic disease that mostly affects the sacroiliac joints (SIJ).[1] In clinical practice, the evaluation of SIJ is performed using X-ray (as means, conventional radiography) and the magnetic resonance imaging (MRI).[2] The computerize tomography (CT) is not recommended as a routine imaging method due to high ionizing radiation.[3] Therefore, although sacroiliac scintigraphy is a method of detecting inflammation, it is not preferred today due to the widespread use of MRI and the fact that it involves ionizing radiation like CT.[4]

SIJ radiography is an important method for classifying patients with axSpA and diagnosing ankylosing spondylitis (AS).[5] This modality shows chronic inflammatory changes in the articular structure including osteosclerosis, narrowing of the joint space, bony ankylosis and irregularities. Historically, the structural changes in SIJ radiography are graded by the Modify New York Criteria from Grade 0 to 4.[6] Radiographic sacroiliitis is defined with respect to the Modify New York Criteria describes as ≥ Grade 2 at both SIJ or ≥ Grade 3 at unilaterally.[6] On the other hand, early inflammatory signs of sacroiliitis (bone marrow edema, synovitis, capsulitis, enthesitis) have been detected using MRI. Th MRI facilitates early diagnosis and initiation of treatment and changes the nomenclature of axSpA. The current classification of axSpA consists of two subgroup including AS (with define radiographic sacroiliitis in X-ray) and non-radiographic (nr-axSpA; with sacroiliitis in MRI and without define radiographic sacroiliitis in X-ray).[1]

According to the European League Against Rheumatism and the Assessment of Spondyloarthritis International Society recommendations, the conventional radiographic evaluation of the SIJ is recommended as the first imaging method in case of suspicion of axSpA.[3,7] The SIJ radiography is cost and time effective for detecting radiographic sacroiliitis, which is present in more than half of the axSpA patients. However, is SIJ X-ray valid and reliable for evaluations of sacroiliac join, given its importance in diagnosis and classification? Undoubtedly, there are significant potential limitations when evaluating SIJ X-ray.[4,8]

One of the main limitations of evaluating sacroiliac radiography is the specific anatomy of the joint. Anatomical limitation may occur due to the three-dimensional position of the joint in the space. Additionally, the variations of SIJ become an anatomical limitation for examination SIJ X-ray.[9] Other limitations include imaging difficulties due to anatomical reasons, the use of different imaging techniques [standard antero-posterior (AP) view, Ferguson view, oblique projections, SIJ on lumbar spine radiographs] and imaging technique-related factors. Moreover, artifacts due to concomitant comorbid conditions (degenerative, infectious, etc.) can also affect the evaluation of SIJ radiography.[9]

Despite these limitations, SIJ radiography remains central to the diagnosis and classification of axSpA.[10] Conversely, these constraints represent a pitfall in the assessment of SIJ radiography. It is essential to identify and understand the pitfalls of SIJ radiography to ensure an accurate differential diagnosis in patients with low back pain, prevent overdiagnosis and misdiagnosis, and correctly categorize patients with axSpA. Accordingly, the aim of this study was to review the AP pelvic radiographs of patients in our axSpA cohort and present our experience with the pitfalls in terms of artifacts, radiological technique, anatomy of SIJ, mimics and comorbid conditions.

MATERIAL AND METHODS

STUDY DESIGN AND RADIOGRAPHIC FEATURES

In this cross-sectional study, sacroiliac joint radiographs (AP pelvis X-ray) of patients with axial spondyloarthritis (axSpA cohort) between 2010 and 2020 in Ankara University Faculty of Medicine, Department of Rheumatology were enrolled. A total of 1,123 pelvic X-ray/758 patients obtained from the electronic imaging system were evaluated by a rheumatologist (AK; 8 years of experience in AP pelvic X-ray evaluation). Within the 10-year cohort, all radiographs performed on the same patient at different times were included anonymously. During this evaluation, radiographs with incorrect shooting techniques, accompanying mechanical problems and infective pathologies were excluded and expressed. After that, 718 pelvic X-ray/430 patients radiographs

were scored by two rheumatologists (ŞA; over 25 years of experience in AP pelvic X-ray evaluation and AK) according to the Modified New York criteria (Table 1).[6]

Ethical approval was obtained from the Ankara University Ethics Committee for this study (protocol number of study and date: İ04-140-22-March 09, 2022). This study conducted between May 2023 and July 2023, and during the study period, the World Medical Association Helsinki Declaration and Good Clinical Practices Guidelines were followed.

CLINICAL AND DEMOGRAPHIC MEASUREMENTS

Clinical characteristics including of age, gender, body mass index, disease & symptoms durations, medications, comorbidities, and laboratory parameters (C-reactive protein, human leukocyte antigen; HLA-B27 positivity) were recorded from the axSpA cohort database.

EVALUATION SACROILIAC JOINT RADIOGRAPH AND OUR EXERCISES

Pelvic AP radiographs obtained from the digital PACs system were investigated together by two rheumatologists who were blind to patient clinical data. The evaluation process was completed in a total of eight periods, each of which lasted 60 minutes, for 718 graphs. Grading of radiographic sacroiliitis was performed according to the modified New York criteria for AS (Table 1).[6] Apart from grading, radiographs were evaluated in terms of artefacts (bowel, etc.) and soft tissue calcification.

STATISTICAL ANALYSIS

The results of the study were measured by descriptive statistics. Descriptive statistics were presented along with mean, standard deviation, and percentages. According to the Modified New York Criteria, the grades of right and left sacroiliac joint involvement in patients were compared using the chi-square test. The statistical significance was determined by a p-value below 0.05. All statistical analysis was performed by the SPSS V25.0 statistical software (IBM Corp.®, Armonk, NY).

TABLE 1: Grading of radiographic sacroiliitis.[6]

Grade 0	Normal
Grade 1	Suspicious changes
Grade 2	Minimal abnormality-small, localized areas with erosion or sclerosis, without alteration in the joint width
Grade 3	Unequivocal abnormality-moderate or advanced Sacroiliitis with one or more of: erosions, evidence of Sclerosis, widening, narrowing, or partial ankylosis
Grade 4	Severe abnormality-total ankylosis

RESULTS

In this study, 1,123 AP pelvic X-rays belonging to 758 patients in the Ankara University axSpA cohort were examined. Patients with concomitant mechanical joint disease (28.3%; 318/1123), wrong radiological technique (6.6%; 75/1,123) and SIJ infection or fracture (1.0%; 12/1,123) were excluded. A total of 718 pelvic X-rays of 430 axSpA patients were included in the detailed evaluation.

By the 430 axSpA (male/female ratio=1.32) patients; the mean age was 44.3±10.2 years, and 200 (46.5%) patients were classified as AS, and 230 (53.5%) as nr-axSpA. The mean duration of disease in patients was 10.5±5.1 years and the mean duration of symptoms was 15.2±6.1 years. 58.1% of patients used non-steroidal anti-inflammatory drugs, while 62.3% used biologic disease-modifying antirheumatic drugs. Other clinical data of the patients were shown in Table 2.

Of the 718 radiographs, 258 (35.9%) had image artifacts, 117 (16.2%) had bowel superposition artifact, and 43 (5.9%) had soft tissue calcification. There were an ideal of three hundred radiographs without any artifacts (Figure 1). Figure 2 presented examples of common artifacts.

In the evaluation of three hundred pelvic radiographs suitable for grading, the right and left grades determined according to the Modified New York Criteria were presented in Table 3. Of 300 axSpA patients, 125 (41.6%) had AS and 175 (58.4%) had non-radiographic axSpA. When comparison of grades between right and left SIJ, radiographs with Grade 4, Grade 3 and Grade 2 stages were similar on both sides. However, the number of pelvic radiographs with a Grade 0 score on the left side was higher than on the right (left vs right; 33% vs 30.3%; p=0.042), while the number of radiographs with a

TABLE 2: Patients characteristics of 430 patients with axial spondyloartritis.

	axSpA (430)	AS (200)	Nr-axSpA (230)
Age, years, $\bar{X}$±SD	44.3±10.2	44.5±9.3	43.9±8.9
Male, n (%)	245 (57.0)	116 (58.4)	129 (56.0)
Body mass index, $\bar{X}$±SD	28.8±5.2	28.6±4.3	29.2±4.2
Disease duration, years, $\bar{X}$±SD	10.5±5.1	10.4±5.1	10.5±5.0
Symptom duration, years, $X\bar{X}$±SD	15.2±6.1	15.1±7.6	15.2±6.9
Smoking, n (%)	130 (30.2)	60 (30.0)	70 (30.4)
Family history of axSpA, n (%)	112 (26.0)	50 (25.0)	62 (26.9)
HLA-B27, n (%)	245 (56.9)	112 (56.0)	133 (57.8)
Current use of medical therapy, n (%)	414 (96.2)	188 (94.0)	226 (98.2)
Current use of NSAIDs, n (%)	250 (58.1)	114 (57.0)	136 (59.1)
Current use of bDMARDs, n (%)	268 (62.3)	129 (64.5)	139 (60.4)
Comorbidity, n (%)			
-Hypertension	51 (11.8)	23 (11.5)	28 (12.1)
-Diabetes mellitus	58 (13.4)	24 (12.0)	34 (14.7)
Extraspinal manifestations, n (%)			
-Uveitis	77 (17.9)	35 (17.5)	42 (18.2)
-Psoriasis	7 (1.6)	3 (1.5)	4 (1.7)
-Inflammatory bowel disease	18 (4.2)	8 (4.0)	10 (4.3)
-Peripheral arthritis	18 (4.2)	8 (4.0)	10 (4.3)
-Enthesitis	292 (67.9)	120 (60.0)	172 (74.7)
-Dactylitis	4 (0.9)	2 (1.0)	2 (0.9)

AxSpA: Axial spondyloartritis; AS: Ankylosing spondylitis; nr-axSpA: Non-radiographic axial spondyloartritis; HLA-B27: Human leukocyte antigen B27; NSAIDs: Non-steroidal anti-inflammatory drugs; bDMARDs: Biologic disease-modifying antirheumatic drugs; SD: Standard deviation.

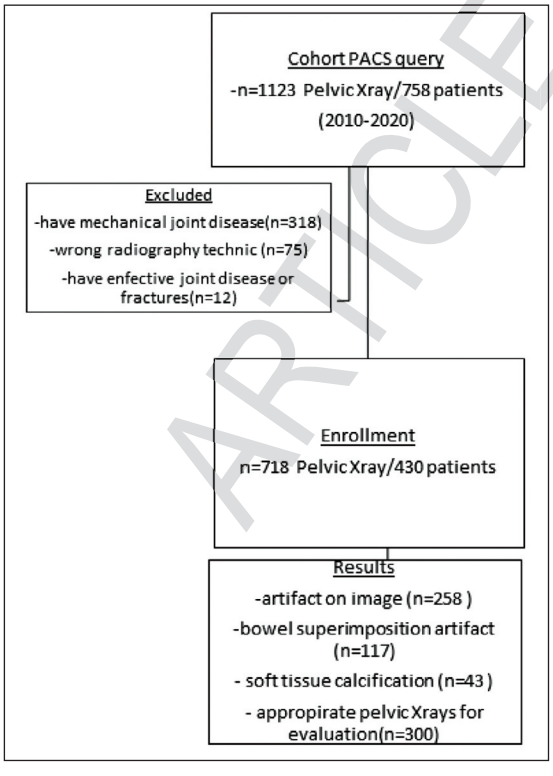

FIGURE 1: The study flow chart in line with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement.

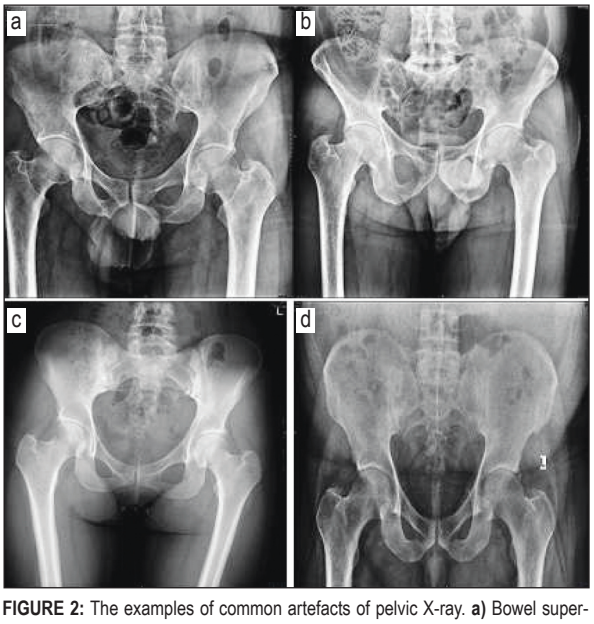

FIGURE 2: The examples of common artefacts of pelvic X-ray. **a)** Bowel superposition artefact; **b)** wrong radiography technic and bowel superposition artefact; **c)** Superposition artifact due to pelvis rotation; **d)** Superposition artifact due to abdominal fat tissue.

Grade 1 score on the right was higher than on the left (left vs right; 21.0% vs 26.0%; p=0.038).

TABLE 3: Results of grades of 300 sacroiliac radiographs with respect to Modify New York Criteria.

	Left side n (%)	Right side n (%)	p value
Grade 0	99 (33.0)	91 (30.3)	0.042
Grade 1	63 (21.0)	78 (26.0)	0.038
Grade 2	45 (15.0)	40 (13.3)	0.128
Grade 3	44 (14.7)	42 (14.0)	0.462
Grade 4	49 (16.3)	49 (16.3)	1.000

N: Number of SJ radiography; p values were obtained by comparing the number of radiographs with the corresponding grade on the right and left side for each sacroiliac grade using the chi-square test.

DISCUSSION

In this study, we presented the common pitfalls for evaluating the pelvic radiographs of patients in our axSpA cohort. 28.3% of the radiographs had mechanical joint disease. In addition, wrong radiological technique and concomitant infective and/or fracture were the other confounders, respectively. The important artifacts that affected the evaluation were artifact on image, bowel superimposition artifact and soft tissue calcification, respectively.

MECHANICAL JOINT DISEASE

Mechanical joint disease described as degenerative joint pathology that occurs in the SIJ. In the mechanical joint disease, the major difference from the inflammatory etiology was that the ligamentous part of the joint was involved earlier and more severely than the synovial component.[11] On radiography, it was characterized by the formation of osteophytes and ankylosis. It was often seen in the anterior and middle one-third of the joint. Concomitant degeneration of the symphysis pubis can also be seen.[9]

There were several special involvements in SIJ mechanical disease, which could occur due to various mechanical stress factors. Extensive sclerosis and osteitis condensans ilia in the postpartum period arise from increased physical overload on the SIJ during pregnancy and childbirth.[4] Extensive sclerosis was a condition that can be confused with axSpA by appearing on the sacral or iliac surface of the joint. Triangular shaped sclerosis of the iliac side of the SIJ manifests as osteitis condensans ilia, especially in women after pregnancy, although the condition may also occur in men.[4] In our study, we detected osteitis condensans ilia on thirty-two pelvic radiographs (Table 4).

The other disease associated with mechanical stress was diffuse idiopathic skeletal hyperostosis (DISH, Forestier disease). It is often characterized by the formation of rough syndesmophytes along the entire spinal vertebrae.[12] In the sacroiliac joint, similar in the spine, there were irregularly shaped, including some sclerosis mimicking sacroiliitis and also showing bony bridges crossing both sides of the joint.[4] In this study, we found that 18 patients had concomitant DISH when evaluated together with spinal radiographs (Table 4).

Another condition that could be seen in SIJ was exercise-related acute/subacute pathologies. The most common of these was sacral insufficiency fracture and was frequently seen with the anterior superior sacrum.[13] Sport-related iliac lesions were especially in the posterior lower ilium.[14]

The final condition in which there was mechanical load on SIJ was the congenital anomaly of the lumbosacral transitional vertebrae. This situation appeared as lumbalization and sacralization according to the position of the lumbar 5 and sacral 1 vertebrae.[15] It had an incidence in the range of 4% to 36% in the normal population.[15]

RADIOGRAPHIC TECHNIC

The SIJ, the largest joint of the axial skeleton, consisted of two compartments, ligamentous (posterior) and synovial (anterior). The synovial part was surrounded by chondral tissue, with more on the sacral

TABLE 4: The major pitfalls for examination sacroiliac joint radiography in our experience.

Pitfalls	Number of radiographs n=1,123 (%)
Mechanical joint disease	318 (28.3%)
-Osteitis condensans ilia	32 (2.8%)
-Diffuse idiopathic skeletal hyperostosis	18 (1.6%)
Wrong radiography technic	75 (6.6%)
Infective joint disease	8 (0.7%)
Fractures	4 (0.35%)
	n=718 (%)
Artifact on image	258 (35.9%)
Bowel superimposition artifact	117 (16.3%)
Soft tissue calcification	43 (6.0%)

face. SIJ involvement in axSpA often starts from the antero-inferior part of the synovial portion.[16] Different radiographic techniques including standard anteroposterior view, Ferguson view, oblique projections, SIJ on lumbar spine radiographs had been described to evaluate the SIJ.[3,6] In exist study comparing Ferguson X-ray and pelvic AP X-ray, there was no significant difference in their ability to indicate pathology.[17] The technique used in our practice and in this study was AP pelvic X-ray.

SIJ had a three-dimensional structure, and the sacral and iliac faces of joint were slightly superimposed in the AP graph due to the horizontal extension of the sagittal axis.[18] If this feature of the joint were not known on SIJ AP X-ray, it could be mistakenly evaluated as sclerosis. Other points to be considered regarding the radiological technique were that the patient was in the supine position or standing and upright during the shooting, his clothes were removed, and the X-ray is in sufficient dose. Although it had been stated in the literature that standing AP pelvic radiography recognizes hip pathologies early, it has not been shown to differ whether the X-ray is in the supine position or standing for SIJ.[18] In this experience, we detected 6.6% of pelvic radiographs (75/1,123) obtained with the wrong radiological technique. To prevent this, standardize the shooting technique (factors such as device, position, training of the technician) should be followed.

INFECTIVE, INFLAMMATORY JOINT DISEASE AND FRACTURES

There were two types of atraumatic fractures seen in the sacral region: sacral insufficiency fracture and sacral stress fracture. Sacral insufficiency fractures were often bilaterally in osteoporotic women, while sacral stress fractures were unilaterally in young athletes.[13,14] Although MRI was the ideal imaging modality in both cases, it should be known in the differential diagnosis when evaluating conventional radiography.[19]

Sacral and iliac fractures after major pelvic trauma were another limitation when evaluating SIJ. The callus tissue seen during the fracture process and hematoma and infectious involvement that may occur during this process were the clinical pictures that should be considered when reading the X-ray.[20] Infectious involvement of the sacroiliac joint was hematogenous origin, could be seen as osteomyelitis, and deep tissue abscess. Juxta-articular bone demineralization was in the initial period of infection while in the later stage, erosion and destruction of the joint are observed.[20] The hallmark of septic arthritis was that the tissues adjacent to the joint are affected and are often unilateral.

Brucella was one of the most important infective agents with SIJ affinity. SIJ joint involvement was seen in 35-37% of brucellosis cases and was often unilateral.[21] Brucellosis was an important zoonotic disease that was differential diagnosis of axSpA in rural areas and should be kept in mind when evaluating pelvic X-ray.

ARTIFACT ON IMAGE

Image artifacts were referred to by this term. There were several reasons under this item. To definitively reveal the causes of these artifacts, other imaging (such as MRI, CT) and laboratory methods were also needed. In our study, this group was the most common cause of X-ray artefact.

One of the important conditions causing image artifact in the pelvic graph was the anatomic variations of the SIJ.[22] These included iliosacral complex, paraglenoid sulci, ossification centers sacral wings, bipartite iliac bony plate, accessory iliac joints, semicircular defect articular surface, and isolated ankylosis.[11,23] Anatomical joint form variation was associated with sacroiliac joint disease and negatively impacted clinical decision-making.[24] The use of three-dimensional techniques such as CT and MRI as imaging methods in the presence of variation in the SIJ joint would be beneficial.[22]

Various syndromes/diseases could also cause artefacts in the SIJ on radiographic imaging. The most common were Tarlov cyst, spinal bifida occulta, intraosseous pneumatocyst.[9] In addition, bone tumors such as osteochondroma and giant cell tumors, multiple myeloma, plasmocytoma and metastatic tumors constituted artefact on the X-ray, making it difficult to evaluate the SIJ.[4,9] However, tumoral formations could be distinguished from inflammatory changes by being irregularly defined, atypical localizations

and the absence of other clinical manifestations.

BOWEL SUPERIMPOSITION ARTIFACT

One of the important pitfalls, which distorted the X-ray image especially in abdominal and pelvic imaging, was the superimposition of bowel. As a result of the intestinal gas shadow and/or fecality superimpose on the SIJ, the evaluation of the X-ray became exceedingly difficult. To prevent this artefact, it may be recommended to intestinal examination, an appropriate diet, especially for constipated patients, and to perform enemas when necessary. In our study, 16.3% (117/718) of the images we evaluated had bowel superimposition artifacts.

SOFT TISSUE CALCIFICATION

Soft tissue calcifications were another condition that made artefact when evaluating pelvic X-rays. The most common cause of soft tissue calcification in the pelvic region was intramuscular gluteal injections.[25] Other causes of soft tissue calcification included chronic renal failure, malignant metastatic calcification, crystalline arthritis, and metabolic diseases.[9,25]

As other results of these experience, we found a significant difference between the grades of the right and left SIJ (for Grade 0 and 1). According to the Modified New Criteria, demonstrating 'definite sacroiliitis' (bilateral Grade 2 or unilateral ≥ Grade 3) is central in pelvic X-ray radiographic axSpA (AS).[6] In the group defined as non-radiographic axSpA with pelvic X-ray (Grade 0; normal sacroiliac joint and Grade 1; suspicious changes), sacroiliac MRI is necessary for a definitive diagnosis.[5] Therefore, although there is a significant difference between the right and left, possibly due to conventional radiography's lack of sensitivity in distinguishing Grade 0 from Grade 1.

Pelvic radiography is a commonly used method in clinical practice. However, repeated radiographs due to insufficient quality can lead to misdiagnosis and increased costs.[26] According to European guidelines, an ideal radiograph should include the sacrum, intervertebral foramen, SIJ, pubic and ischial ramus, femoral neck, trochanters, and ensure pelvic symmetry.[27] In evaluating ideal pelvic radiographs, it is important to have knowledge of not only anatomical structures but also concepts such as lines (e.g. line of Klein), arcs (e.g. Shenton arc), and stripes (e.g. gluteal fat stripe).[28]

In this study, pelvic radiographs of axSpA patients were evaluated cross-sectionally. Other imaging (such as MRI) methods that could detect etiologies of patients had not been examined. Due to this situation, mechanical joint disease detected in the X-ray was expressed as the main title. There were many causes of mechanical joint disease, as mentioned in detail above. In the discussion section, while certain etiologies (such as osteitis condensans ilia, DISH) that could only be detected by X-ray were mentioned, other causes leading to degenerative findings were not specified as they require clinical, laboratory, and imaging assessment. This situation could be a limitation of the study.

Similarly, a second limitation of this study may be that image artifact was presented as a general topic because only X-ray was evaluated, although there were many different etiological causes that may cause image artifacts. Finally, this study analyzed only radiographs of patients diagnosed with axSpA to reveal pitfalls. However, AP radiography of the pelvis is a frequently preferred imaging method for different patient groups or healthy individuals. Therefore, the results of this study are valid for the evaluation of radiographs of axSpA patients. Examination of pelvic AP radiographs of other disease groups or healthy individuals may provide additional contributions to the literature.

CONCLUSION

In this study, we presented the common pitfalls while evaluating AP pelvic radiographs of patients in our axSpA cohort, which we followed for a period of one decade. We stated these pitfalls in order of frequency as image artifacts, mechanical joint diseases, intestinal superimposition artifact and incorrect radiological technique. Conventional radiography still plays a significant role in the diagnose and classification of axSpA despite advances in MRI. During the evaluation of radiography, to avoid clinical and/or radiological mis/over diagnose, readers should know comorbidities, mimics, and artifacts. For this purpose, it would be appropriate for clinicians and radiologists

to evaluate with a checklist for all possible pitfalls before, during and after X-ray examination.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

All authors contributed equally while this study preparing.

REFERENCES

1. Sieper J, Poddubnyy D. Axial spondyloarthritis. Lancet. 2017;390:73-84. PMID: 28110981.
2. Bodur H, Yurdakul FG, Ataman Ş, et al. Turkish league against rheumatism consensus report: recommendations for management of axial spondyloarthritis. Arch Rheumatol. 2018;33:1-16. PMID: 29900976; PMCID: PMC5864166.
3. Mandl P, Navarro-Compán V, Terslev L, et al; European League Against Rheumatism (EULAR). EULAR recommendations for the use of imaging in the diagnosis and management of spondyloarthritis in clinical practice. Ann Rheum Dis. 2015;74:1327-39. PMID: 25837448.
4. Baraliakos X, Hermann KG, Braun J. Imaging in axial spondyloarthritis: diagnostic problems and pitfalls. Rheum Dis Clin North Am. 2012;38:513-22. PMID: 23083752.
5. Rudwaleit M, van der Heijde D, Landewé R, et al. The development of Assessment of SpondyloArthritis international Society classification criteria for axial spondyloarthritis (part II): validation and final selection. Ann Rheum Dis. 2009;68:777-83. Erratum in: Ann Rheum Dis. 2019;78:e59. PMID: 19297344.
6. van der Linden S, Valkenburg HA, Cats A. Evaluation of diagnostic criteria for ankylosing spondylitis. A proposal for modification of the New York criteria. Arthritis Rheum. 1984;27:361-8. PMID: 6231933.
7. van den Berg R, de Hooge M, Rudwaleit M, et al. ASAS modification of the Berlin algorithm for diagnosing axial spondyloarthritis: results from the SPondyloArthritis Caught Early (SPACE)-cohort and from the Assessment of SpondyloArthritis international Society (ASAS)-cohort. Ann Rheum Dis. 2013;72:1646-53. PMID: 23139266.
8. Poddubnyy D. Radiographic evaluation of sacroiliac joints in axial spondyloarthritis - still worth performing? J Rheumatol. 2017;44:1-3. PMID: 28042123.
9. Caetano AP, Mascarenhas VV, Machado PM. Axial spondyloarthritis: mimics and pitfalls of imaging assessment. Front Med (Lausanne). 2021;8:658538. PMID: 33968964; PMCID: PMC8100693.
10. Kim Y, Chee CG, Kim J, et al. Diagnostic performance of plain radiography for sacroiliitis in patients with suspected axial spondyloarthritis: a systematic review and meta-analysis. Acta Radiol. 2021;62:500-9. PMID: 32536262.
11. Ziegeler K, Kreutzinger V, Diekhoff T, et al. Impact of age, sex, and joint form on degenerative lesions of the sacroiliac joints on CT in the normal population. Scientific Reports. 2021;11:5903. doi: 10.1038/s41598-021-85303-5
12. Merjanah S, Igoe A, Magrey M. Mimics of axial spondyloarthritis. Curr Opin Rheumatol. 2019;31:335-43. PMID: 31045950.
13. Rickert MM, Windmueller RA, Ortega CA, et al. Sacral insufficiency fractures. JBJS Rev. 2022;10. PMID: 35849657.
14. Dutton RA. Stress fractures of the hip and pelvis. Clin Sports Med. 2021;40:363-74. PMID: 33673892.
15. Tins BJ, Balain B. Incidence of numerical variants and transitional lumbosacral vertebrae on whole-spine MRI. Insights Imaging. 2016;7:199-203. PMID: 26873359; PMCID: PMC4805617.
16. Venerito V, Del Vescovo S, Lopalco G, et al. Beyond the horizon: Innovations and future directions in axial-spondyloarthritis. Arch Rheumatol. 2023;38:491-511. PMID: 38125058; PMCID: PMC10728740.
17. Omar A, Sari I, Bedaiwi M, et al. Analysis of dedicated sacroiliac views to improve reliability of conventional pelvic radiographs. Rheumatology (Oxford). 2017;56:1740-5. PMID: 28957558.
18. Alzyoud K, Hogg P, Snaith B, et al. Optimum positioning for anteroposterior pelvis radiography: a literature review. J Med Imaging Radiat Sci. 2018;49:316-24.e3. PMID: 32074059.
19. Urits I, Orhurhu V, Callan J, et al. Sacral Insufficiency fractures: a review of risk factors, clinical presentation, and management. Curr Pain Headache Rep. 2020;24:10. PMID: 32067155.
20. Habib N, Filardo G, Delcogliano M, et al. An algorithm to avoid missed open-book pelvic fractures. Eur Rev Med Pharmacol Sci. 2018;22:2973-7. PMID: 29863239.
21. Arkun R, Mete BD. Musculoskeletal brucellosis. Semin Musculoskelet Radiol. 2011;15:470-9. PMID: 22081282.
22. Ziegeler K, Hermann KGA, Diekhoff T. Anatomical joint form variation in sacroiliac joint disease: current concepts and new perspectives. Curr Rheumatol Rep. 2021;23:60. PMID: 34216295; PMCID: PMC8254711.
23. Ehara S, el-Khoury GY, Bergman RA. The accessory sacroiliac joint: a common anatomic variant. AJR Am J Roentgenol. 1988;150:857-9. PMID: 3258099.
24. Ziegeler K, Kreutzinger V, Proft F, et al. Joint anatomy in axial spondyloarthritis: strong associations between sacroiliac joint form variation and symptomatic disease. Rheumatology (Oxford). 2021;61:388-93. PMID: 33822902.
25. Hwang ZA, Suh KJ, Chen D, et al. Imaging features of soft-tissue calcifications and related diseases: a systematic approach. Korean J Radiol. 2018;19:1147-60. PMID: 30386146; PMCID: PMC6201973.
26. Parker S, Nagra NS, Kulkarni K, et al. Inadequate pelvic radiographs: implications of not getting it right the first time. Ann R Coll Surg Engl. 2017;99:534-9. PMID: 28682132; PMCID: PMC5697041.
27. "European Commission: Directorate-General for Research and Innovation, Carmichael J, Moores B, Maccia C. European guidelines on quality criteria for diagnostic radiographic images. Publications Office; 1996. Available from:bhttps://op.europa.eu/en/publication-detail/-/publication/d59ccc60-97ed-4ce8-b396-3d2d42b284be"
28. Yeap PM, Budak MJ. The pelvic radiograph: lines, arcs and stripes. Singapore Med J. 2021;62:333-40. PMID: 34409477; PMCID: PMC8801847