Diffuse Idiopathic Skeletal Hyperostosis and Ankylosing Spondylitis: A Challenging Case and Review of the Literature

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ABSTRACT

Background: Diffuse idiopathic skeletal hyperostosis and spondyloarthritis share similarities in clinical and radiological findings. In this article, we report a case of overlapping of these two hyperostotic diseases followed by an extensive narrative review of the literature focusing on the gray areas in the diagnosis of diffuse idiopathic skeletal hyperostosis. Case description: We report the case of simultaneous diffuse idiopathic skeletal hyperostosis and ankylosing spondylitis in a 57-year-old man. The diagnosis was made after many collegial meetings based on solid radiological arguments. Conclusion: Review of the literature reveals many uncertainties in the diagnosis of diffuse idiopathic skeletal hyperostosis, especially in the radiological evaluation of sacroiliac joints. Diffuse idiopathic skeletal hyperostosis and ankylosing spondylitis frequently overlap in important radiological features leading to diagnostic ambiguity and they can also co-exist in the same patient.

CASE REPORT

CASE REPORT

A 57-year-old male patient presented to the rheumatology outpatient clinic for a 4-year history of widespread continuous pain as well as a dull inflammatory buttock pain mostly on the left side for the preceding year.

His past medical history is significant for a sudden onset of hoarseness and dysphagia that appeared a year earlier to presentation and that is progressive in nature and intensity. This was followed by an episode of aspiration pneumonia that led to the diagnosis of left vocal cord paralysis on Ear-Nose-Throat evaluation. Relevant medical history includes uncontrolled type 2 diabetes, hypertension and medically treated dilated cardiomyopathy with an ejection fraction of 40%. There was no personal or family history of uveitis, psoriasis or inflammatory bowel disease.

Physical examination revealed significantly decreased mobility of the lumbar spine (Fingertip-to-floor test of 40 cm), severe limitation of the range of motion of both hips (internal rotation: 0 degrees, flexion: 90 degrees) and a moderate right knee effusion. Subsequent right knee arthrocentesis retrieved a non-inflammatory synovial fluid with no crystals and the cultures were sterile. On laboratory evaluation, HLA-B27 was negative and CRP was 5 mg/dL.

Radiological evaluation of the hoarseness and dysphagia included routine cervical conventional radiographs as well as cervical and thoracic computed tomography (CT) scans (Figures 1, 2, 6). In addition to multilevel degenerative changes of the cervical spine on cervical films, the patient had exuberant osteophytes involving the bodies of C3 to C6 forming an elongated ossification of the frontal planes of the cervical vertebral bodies especially at the level of C4 markedly displacing the hypopharynx anteriorly. The latter was further confirmed by a CT of the neck that showed a mechanical obstruction and compression of the esophagus along with an anterior displacement of the larynx by the anterior ossified cervical mass. The CT of the chest, initially realized as part of the initial workup for his ENT symptoms, showed a complete ankylosis of all the costovertebral and costotransverse joints.

A complementary cervical magnetic resonance imaging (MRI) ruled out cervical myelopathy. Radiological evaluation of the back and buttock pain included thoracolumbar spine and pelvic films (Figures 3-5). Anterolateral flowing ossifications were present along multiple contiguous thoracic and lumbar levels with a predilection for the right side on anteroposterior (AP) films and the intervertebral disc height at involved vertebral segments was preserved. Exuberant beak-like bridging osteophytes were present on lumbar films as well as apophyseal joint osteoarthritis. On the AP radiograph of the pelvis, sclerosis of joint margins and irregularities of the subchondral bone cortices were visible at the right sacroiliac joint (SIJ). The left sacroiliac joint appeared fused. At the hips, we could see joint space narrowing with subchondral cysts and overgrown osteophytes of the acetabuli. We completed the SIJ evaluation with a complementary MRI of the sacroiliac joints (Figures 7-8) that showed bone marrow edema on both sacral and iliac sides of the right SIJ on fat saturation sequences along with irregular margins that were best visible on the T1 sequence. On the left, the articular surface was barely visible confirming the aspect of partial ankylosis on conventional radiographs. Bilateral sacral fat metaplasia of the subchondral bone was present. In addition to that, paravertebral soft tissue inflammation surrounding the intervertebral ossifications at the level of L3-L4 was visible on both axial and coronal STIR sequences of the pelvis. The CT scan of the pelvis (Figure 9) shows partial ankylosis of the synovial part of the left SIJ as well as subchondral sclerosis, erosions, ankylosis and joint irregularities of the synovial part of the right sacroiliac joint. In addition, changes found in DISH such as and para-articular bridging and ankylosis of the entheseal part of the SIJ are also seen.

Radiological evaluation also included conventional radiographs of affected joints (Figures 10,11,12) and showed degenerative changes of the shoulders, hands and knees as well as bilateral ossified patellar enthesopathies.

In addition to DISH, the diagnosis of AS was retained based on the following features: Along with the typical anterolateral flowing ossifications of the spine characteristic of DISH in an elderly male patient with type 2 diabetes and obesity, there is a pattern of cervical facet joint involvement (partial ankylosis), complete ankylosis of all the costovertebral and costotransverse joints with obliteration of the articular surfaces, paravertebral inflammation at the level L3-L4 and bilateral chronic sacroiliitis confirmed on both MRI and CT scan of the SIJ, all of which favor the diagnosis of concomitant spondyloarthritis. The patient's initial Ankylosing Spondylitis Disease Activity Score with CRP (ASDAS-CRP) score was 4.6 indicating a very high disease activity.

He underwent an uneventful operative resection of the cervical ossified mass followed by a one level instrumented cervical fusion of C4-C5 (Figure 13). Post-operative X-rays show normalization of the anatomic structures of prevertebral tissues and the patient reported improvement in swallowing one month after surgery. He was started on Secukinumab, an interleukin-17 inhibitor, 150 mg subcutaneously every month after a loading dose of 150mg weekly. On a follow-up visit 6 months after the start of treatment, the patient noticed a major clinical and functional improvement. Fingertip-to-floor test went from 40 cm on the initial clinical evaluation to 20 cm at the 6-months evaluation. His ASDAS-CRP was 2.6, indicating a major clinical response (change ≥2.0 units). In addition to a sustained clinical and functional improvement, MRI of the pelvis performed 11 months after start of Secukinumab (Figures 14 and 15) showed a decrease in SIJ subchondral bone marrow edema. MRI of the lumbar spine showed degenerative changes (Figure 16).

Moreover, the patient underwent an uncomplicated bilateral total hip arthroplasty. On his last follow-up visit, the patient had been on Secukinumab for twenty months and continued to notice clinical and functional improvement. His ASDAS was 1.7 indicating low disease activity with major improvement from baseline.

DISCUSSION

Etiology, Risk factors (Table 1):

Diffuse Idiopathic Skeletal Hyperostosis (DISH) and AS (Ankylosing Spondylitis) are two entirely separate hyperostotic diseases involving the axial skeleton and peripheral entheses. While they can share clinical manifestations, they present many differences including genetic predisposition, metabolic background, age at onset, radiological manifestations and treatments [1]. Contrarily to axial spondyloarthritis (ax-SpA) that witnessed many advances in disease understanding in the past decade [2], DISH is still not sufficiently investigated nor fully understood [3]. It is more likely seen in men, affects older adults especially after the age of 50 and is strongly associated with insulin resistance, diabetes mellitus and obesity. Given the lack of deep understanding of disease and imaging characteristics of DISH, the clinician often encounters difficulties in the diagnosis and hence the management of this disease.

History and Classification criteria (Table 2):

DISH was described in the literature under a variety of names since the 19th century. It was not until 1950 that Forestier and Rotes-Querol [4] first introduced the entity of senile ankylosing hyperostosis of the spine characterized by the anterior and lateral ossification of the vertebral column with a predilection to the thoracic segment. This entity was later modified to ankylosing hyperostosis of the spine since it also involved the middle-aged population [5]. In 1975, after having described distinctive extraspinal manifestations of Forestier's disease in 21 consecutive cases, Resnick proposed a more appropriate description of the disease in order to underline its widespread character: Diffuse Idiopathic Skeletal Hyperostosis [6]. The criteria proposed by Resnick and Niwayama [7] for conventional radiographs are still nowadays the most widely used classification criteria for DISH. They comprise three major criteria; 1) flowing anterolateral bony bridges of at least four contiguous vertebrae, 2) the absence of extensive degenerative disc disease and 3) the absence of sacroiliitis, with the thoracic spine being the predilection site for spinal involvement in DISH. Extra-articular manifestations can be present but are not required for diagnosis. In 1985, and similarly to Harris [8], Arlet and Mazieres allowed the classification of patients with at least three contiguous interconnected vertebrae in the lower thoracic spine as DISH [9]. At this point, it was becoming clear that DISH manifestations were not limited to the spine and that peripheral involvement can be observed. But it wasn't until 1985 that Utsinger [10] allowed the extension of the classification criteria to include peripheral enthesopathies as a major criterion. Moreover, using these criteria, a diagnosis of possible DISH can be made in the absence of spinal involvement if suggestive peripheral entheseal involvement is present. Also, for the first time, SIJ surface involvement does not exclude the diagnosis of DISH. Conversely, all the previously mentioned criteria allowed the presence of para-articular bony fusions in the vicinity of the SIJ but surface involvement was always set as an exclusion criterion.

With the aim of improving the inter-observer agreement for the diagnosis of DISH based on computed tomography, Oudkerk et al [11] proposed a modification to the original Resnick and Niwayama criteria that were intended to be applied to conventional radiographs [7]. One of the main reasons for disagreement was the definition of a relative intervertebral disc preservation in the involved areas initially proposed by Resnick. It was therefore advised to attach less importance to degenerative disc disease as an exclusion criterion and to allow the establishment of the diagnosis of DISH in the presence of mild to moderate disc changes when other criteria are met. Another definition that warranted discussion was the flowing ossifications which are the hallmark of DISH. In order to differentiate them from bridging osteophytes, it was suggested that the angle of each bony bridge should be at least 90 degrees for it to be considered flowing. While these modifications significantly improved inter-reader agreement for CT-based diagnosis of DISH, they are still awaiting validation.

All of the previously mentioned criteria are dichotomous as they were designed to include patients with established disease overlooking patients in the early stages of DISH. In the recent years, there has been an increasing interest in the understanding of the natural course of DISH which was not taken into account by any of the previously proposed classification criteria [12-13]. In particular, Kuperus et al. conducted a retrospective longitudinal analysis of chest CT scans from patients with DISH fulfilling the Resnick criteria and with at least two chest CTs with a minimal interval of 2.5 years between both scans [14]. A new scoring system was used to evaluate the progression of bone formation. It was based on the completeness of the intervertebral bone bridge, its degree of flow as well as its circumferential extent in relation to the disco-vertebral unit. During a mean follow-up period of 5 years, there was an ongoing process of measurable bone formation and remodelling in both early and established disease, underlining the need for new criteria with a low threshold for the detection of early phases of DISH. As a result, the cohort of patients of the aforementioned study [14] was used to develop a new set of criteria that could distinguish between absence of DISH, early phases and advanced disease. The developed criteria were validated afterwards in another large-scale retrospective cohort and yielded high sensitivity and specificity for predicting the development of DISH as well as for detecting early phases of the disease [15].

<u>*Sacroiliac joint involvement in DISH (Table 3):*</u>

The original Resnick DISH criteria firmly lay stress on the difference in SIJ involvement between DISH and ax-SpA. They exclude patients with erosions, sclerosis or intra-articular ankylosis of the SIJ. In a more recent set of criteria, Utsinger did not emphasize on the absence of SIJ fusion to differentiate the two entities [10]. A few studies from the 1980's describing SIJ involvement in DISH showed conflicting results [16]. However, it is becoming clearer that the SIJ can be affected in DISH and this finding should not be mistaken for SpA. A work worth mentioning is that of Leibushor et al. [17] who studied the pelvic CT of 104 patients known to have spinal DISH and 106 matched controls. Ax-SpA and other inflammatory arthritis were excluded. They found that SIJ fusion (intra-articular joint bridging) and entheseal bridging (fusion within the ligamentous portion of the SIJ) were significantly more frequent in DISH patients than in controls ($p < 0.001$). These CT findings also had a high specificity and were discriminative for the diagnosis of DISH. Additionally, there was a nominal increase in erosions of SIJ surface in DISH patients compared with controls, without specifying the number of erosions found in each patient (4 patients DISH+ vs 2 patients DISH-, $p < 0.269$). These findings stand against the notion that SIJ fusion and erosions rule out DISH and that they can differentiate it from SIJ involvement of ax-SpA. Differentiating between these two hyperostotic diseases of the spine is surely not a straightforward task and the contribution of MRI in this context is still unclear. To answer this question, a group of rheumatologists from Cochin University Hospital in Paris [18] aimed to describe MRI findings of patients diagnosed with DISH and to assess the discriminative capacity of this imaging technique. In their recently published paper on Spine and SIJ radiographic and MRI findings suggestive of ax-SpA in 53 symptomatic DISH patients without concomitant ax-SpA, Latourte et al. [18] found that nearly half of the patients fulfilled the Assessment of Spondyloarthritis International Society (ASAS) criteria for spinal MRI [19-20] while only 15.8% fulfilled the ASAS criteria for active sacroiliitis on SI joint MRI [19-21]. Also, 19% had SIJ radiographs fulfilling the modified New York criteria for ax-SpA [22]. In addition, patients seldom had erosions of T1-weighted sequences of the spine and SIJ and none had more than 3 erosions. This might be an indication of the high specificity of erosions for the diagnosis of ax-SpA in the elderly population suffering from DISH. In contrast to the study of Leibushor [17], SIJ ankylosis was a rare finding in this DISH population (2% vs 23%). All these findings suggest that the MRI findings of the SIJ may be more helpful than those of the spine in discriminating between DISH and ax-SpA, thus corroborating the findings of two previous studies on the contribution of whole-body MRI in differentiating between these two conditions [23-24].

In light of these contradicting results, Yahara et al. [25] conducted a retrospective analysis of bony fusion of SIJ in CT of 86 patients with DISH and 86 controls who underwent a lumbar surgery for lumbar spine disease, essentially spinal stenosis. Similar to the findings of Leibushor et al [17], anterior and posterior para-articular bridging were significantly more frequent in patients with DISH compared to non-DISH controls with the former being more prevalent than the latter in both groups. Also, intra-articular joint fusion was more commonly observed in the DISH population while vacuum phenomenon was more prevalent in non-DISH patients.

Moreover, an entity worth mentioning in the differential diagnosis of sacroiliits is osteitis condensans ilii. It predominantly affects the ilium, but sacral involvement is present. It is characterized by sclerosis contiguous to the inferior sacroiliac joint, typically of triangular shape. The sclerosis is well demarcated from the rest of the bone. The joint space is preserved and erosions are not seen [26].

What can finally be retained is that entheseal ankylosis and para-articular bridging particularly of the anterior SIJ are somewhat characteristic of DISH. Intra-articular ankylosis can be found in DISH and should not be used as an argument to rule out the diagnosis. As for erosions, they can be observed on SIJ of DISH, however, they are not characteristic of the disease and they are seldom numerous. Bone marrow edema and subchondral sclerosis are also found in SIJ of DISH and their presence does not necessarily indicate an inflammatory disease as they can be found in situations of increased mechanical stress such as in young athletes [27] and in the post-partum period [28].

<u>Facet and costovertebral joint involvement in DISH:</u>

Looking back at the classification criteria of DISH along the years (Table 1), it was an accepted fact that facet and costovertebral joints are preserved in this hyperostotic disease differentiating it from ax-SpA where these synovial joints undergo inflammatory erosive changes and ultimately ankylosis [29]. Resnick and Niwayama first mentioned that apophyseal joints are relatively preserved in DISH as they can undergo mild degenerative changes in some patients characterized by sclerosis and osteophyte formation, but are never fused [7]. Arlet and Mazieres noted that in DISH, facet joints can be the site of ligamentous ossifications and hyperostosis with joint preservation [9]. Kuperus et al indicated in their new classification criteria that facet joints are not fused [15]. Moreover, in a study of Weiss et al. realized by whole body MRI to differentiate between DISH and AS [23], facet joint ankylosis constituted a good and better discriminatory argument than facet joint inflammatory lesions for discerning between the two conditions (4 patients with DISH vs 49 patients with AS).

Slonismky described facet and costovertebral degenerative changes on CT from the first dorsal to the first lumbar vertebrae [30]. He noticed a significantly higher prevalence in DISH patients than in controls of degenerative changes of facet joints in the first two intervertebral spaces of the thoracic spine as well as mid to lower thoracic changes in costovertebral joints. In addition, these changes were mostly found on the right side. This can be partly explained by an increased mechanical stress on these synovial joints by the asymmetric development of bone bridges. Also, these discrepancies in the description of facet and costovertebral joint involvement along the years can be explained by the fact that CT and MRI permit a better evaluation of these small joints than conventional X-rays where this description can be challenging.

Furthermore, in addition to degenerative changes, many authors previously described hyperostosis at the head of the rib in the costovertebral joints [31]. While Resnick mentioned this ossification in his work, he found it challenging to differentiate it from bony growths from adjacent vertebrae [32]. Sawakami et al. described the morphological features of the costovertebral joints on computed tomography in a subpopulation of 50 DISH patients who required surgery for a cervical injury. Costovertebral joint osseous outgrowth and rib hyperostosis were recorded in 94% and 82% of the patients respectively, especially at the mid-thoracic level and with a predilection for the right side [33]. This predominant right-side involvement goes in line with that of vertebral ossifications and is also thought to result from the inhibitory effect of the pulsation of thoracic aorta on bone formation.

We now know that facet joint in DISH can undergo degenerative changes. As for costovertebral joints, in addition to undergoing degenerative changes, they can be the site of entheseal ossifications (radiate and costotransverse ligaments) and rib hyperostosis. Ankylosis of both joints constitutes an argument for discerning it from ax-SpA even though some DISH patients were found to have intra-articular fusion of these joints.

A question worth asking is whether this costovertebral osseous outgrowth can be misinterpreted as costovertebral joint ankylosis seen in ax-SpA.

<u>Biologic treatments in DISH:</u>

There is no rationale behind using biologic agents in DISH since it is not considered to be an inflammatory disease [3]. Interestingly, an Australian observational study [34] supported the efficacy of Tumor Necrosis Factor Inhibitors (TNFi) in the majority of patients with clinically active DISH based on a sharp reduction in Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) score during the first few years of treatment compared to untreated controls. These results should be carefully interpreted as this study has many limitations with the small number of included patients being the most important. To date, no studies exist on Il-17 inhibitors in DISH.

<u>Coexistence of DISH and ax-SpA in the literature:</u>

There have been many published reports on the concomitant occurrence of DISH and ax-SpA [35-37]. A recent systematic literature review was conducted on 39 cases described to have both conditions [35]. All patients had radiographic abnormalities on spinal and/or pelvic imaging corresponding to DISH and ax-SpA, but not every region was simultaneously affected by both conditions. 82% of SIJ radiographic changes were attributed to AS, while nearly 65% of spinal involvement were attributed to DISH. Even though it is conceivable that younger subjects with AS could develop DISH afterwards, particular care should be taken with radiological interpretation of hyperostotic diseases. As we have seen earlier, ankylosis can affect the SIJ in DISH patients and can lead to a misdiagnosis of ax-SpA, especially before the era of CT scan and MRI. This could lead to overtreatment since treatment strategies differ between SpA and DISH.

Moreover, most case reports on concomitant DISH and ax-SpA raise the question of an association of these two hyperostotic diseases mainly on the basis of SIJ involvement on pelvis X-ray and/or SIJ findings on MRI. It is very clear that there is still a misconception that SIJ are normal in DISH and that their involvement still leads the physician to believe that the patient has an associated sacroiliitis and therefore a diagnosis of co-existent ax-SpA.

Back to our case report:

Our patient had bilateral articular obliteration of all costovertebral and costotransverse joints, a finding that can only be seen in ax-SpA. Also, there were no signs of osseous outgrowth of these joints that are typical of DISH and that could be confused with ankylosis. As for bilateral chronic sacroiliitis confirmed on both MRI and CT, we have also seen in the aforementioned narrative review that DISH patients were reported to have sacroiliitis fulfilling the ASAS criteria for ax-SpA on MRI [18]. Furthermore, vertebral corner bone marrow edema was a frequent finding on spinal MRI of DISH patients in the proximity of vertebral bony bridges. Using the same rationale, we could hypothesize that paravertebral soft tissue inflammation surrounding the intervertebral ossifications at the level of L3-L4 could be seen in DISH by irritation of bony bridges of the surrounding soft tissues. However, all these findings taken together favor the diagnosis of ax-SpA associated with DISH rather than DISH alone. Finally, we believe that in addition to these solid radiological arguments, the patient's major clinical response to treatment with Il-17 inhibitors (ASDAS-CRP major response: change ≥2.0 units at 6 months compared to baseline as well as the sustained clinical improvement leading to a state of low disease activity at 20 months), functional response (improvement in the fingertip-to-toe score) and radiological improvement (decrease of SIJ BME on repeat pelvis MRI at 11 months), constitute a supporting argument for co-existent AS.

CONCLUSION:

This is a very challenging clinical case of simultaneous occurrence of DISH and AS supported by a complex radiological armamentarium, that warranted both national and international discussions. Unfortunately, there are still many uncertainties surrounding the pathogenesis, diagnostic criteria and radiological features of DISH. While the Resnick and Niwayama classification criteria are still the most used, they do not account for the natural history of the disease nor peripheral involvement. Very strict, they only include patients with severe disease. Many propositions to modify the outdated classification criteria have been voiced and to adapt it to CT and MRI. Recent evidence supports the presence of SIJ changes in DISH. Intra-articular bone fusion was found to be significantly more prevalent in DISH than in controls. Erosions, while present in DISH, are still more characteristic for AS. The radiological diagnosis of DISH should be less strict regarding SIJ involvement as a substantial percentage of DISH patients fulfilled the ASAS criteria for sacroiliitis. As for the costovertebral and costotransverse joints, similar to the facet joints, they can be the site of degenerative changes. Moreover, DISH is characterized by extra-articular ossifications of these joints with preservation of the articular surface. Despite it being found in DISH patients, ankylosis of these small synovial joints is still a strong argument for AS when found with other characteristic radiological features. Finally, DISH and ax-SpA frequently overlap in important radiological features leading to diagnostic uncertainty. To make things more challenging, they can also so-exist in the same patient. In doubtful cases, a collegial meeting should be held in order to retain either diagnosis or eventually in some cases, both. Further studies are warranted to better understand the pathogenesis, diagnosis and radiological features of DISH.

TEACHING POINT

Recent evidence supports the presence of sacroiliac joint articular changes in Diffuse Idiopathic Skeletal Hyperostosis (DISH), thus challenging the long accepted fact that sacroiliac joint are normal in DISH. (Intra-articular bridging, joint space narrowing but seldom erosions). Costovertebral joints, in addition to undergoing degenerative changes in DISH, can be the site of entheseal ossifications (radiate and costotransverse ligaments) and rib hyperostosis.

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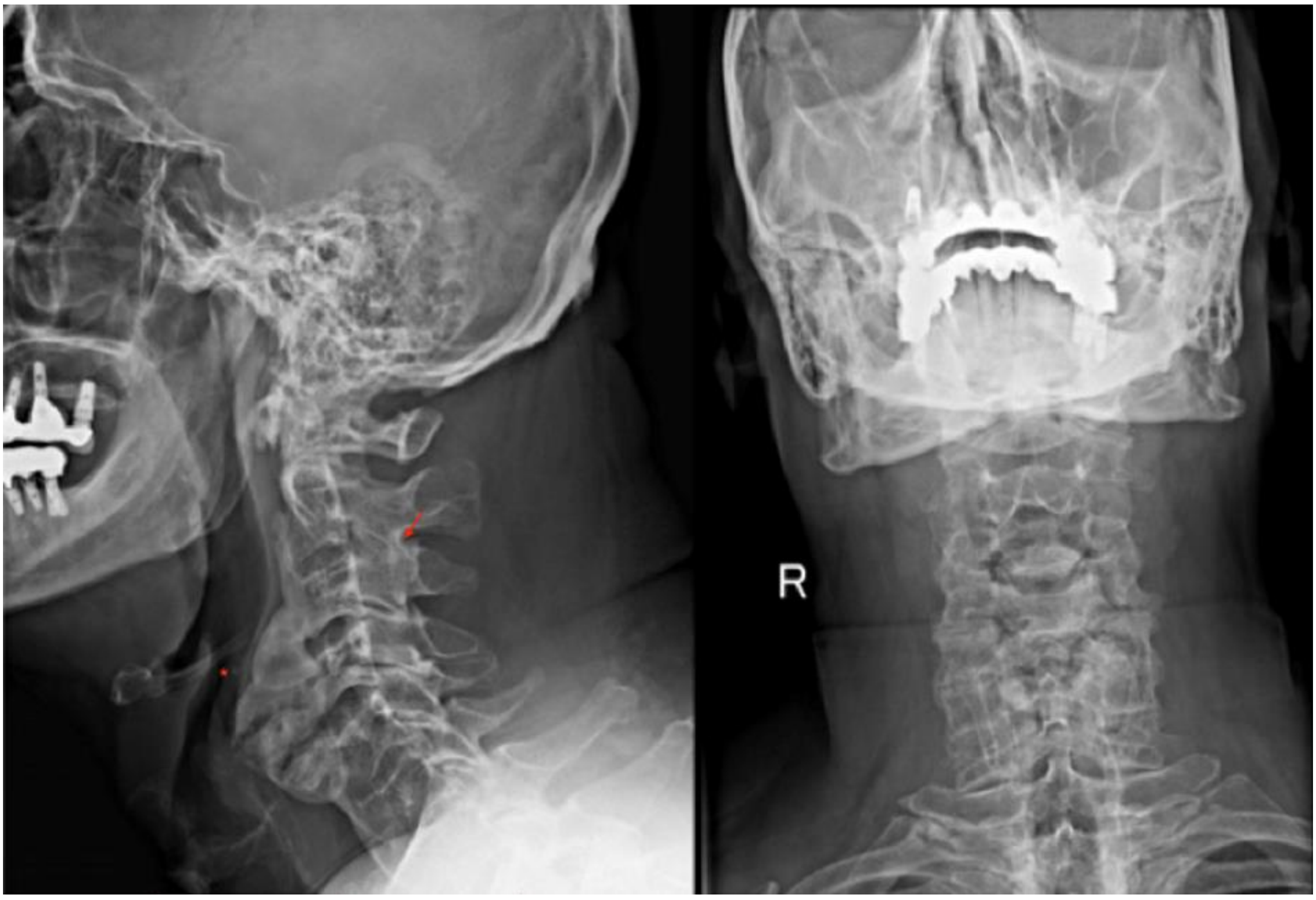
FIGURES

Figure 1 (bottom): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Lateral and Antero-Posterior X-rays of the cervical Spine

Findings: Multilevel degenerative changes, partial ankylosis of facet joints at C2-C3 (Arrow). Exuberant and prodigious osteophytes involving the bodies of C3-C4-C5-C6. Elongated ossification of the frontal planes of the vertebral bodies especially at the level of C4 responsible of a marked displacement the hypopharynx anteriorly (Asterisk).



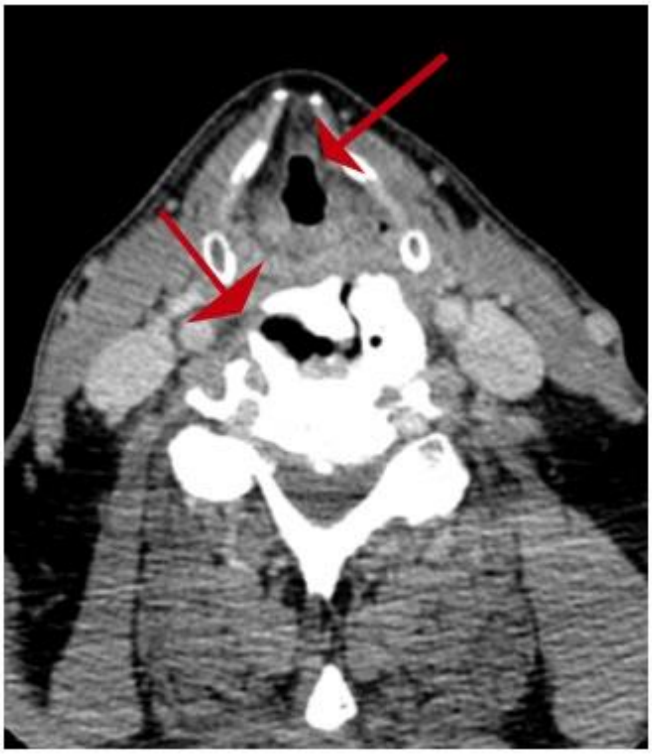


Figure 2 (left): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Axial contrast enhanced CT scan of the neck (300 mA, 120 kV, 2 mm slice thickness, 100 ml of Xenetix 350, biphasic injection technique)

Findings: Confirmation of the radiographic findings on cervical films. Anterior ossified cervical mass responsible for a mechanical obstruction and compression of the esophagus (narrow arrow) and an anterior displacement of the larynx (bold arrow).

Figure 3: 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Lateral and Antero-Posterior (AP) X-rays of the thoracic Spine

Findings: Flowing ossifications involving the anterior longitudinal ligament along multiple contiguous thoracic levels with preservation of the intervertebral disc height at the involved vertebral segments on the lateral film as well as calcifications of the annulus fibrosus

Figure 4: 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Lateral and Antero-Posterior X-rays of the lumbar Spine

Findings: Flowing ossifications along the anterolateral aspects of the lumbar spine. Exuberant beak-like bridging osteophytes. Apophyseal joint osteoarthritis.

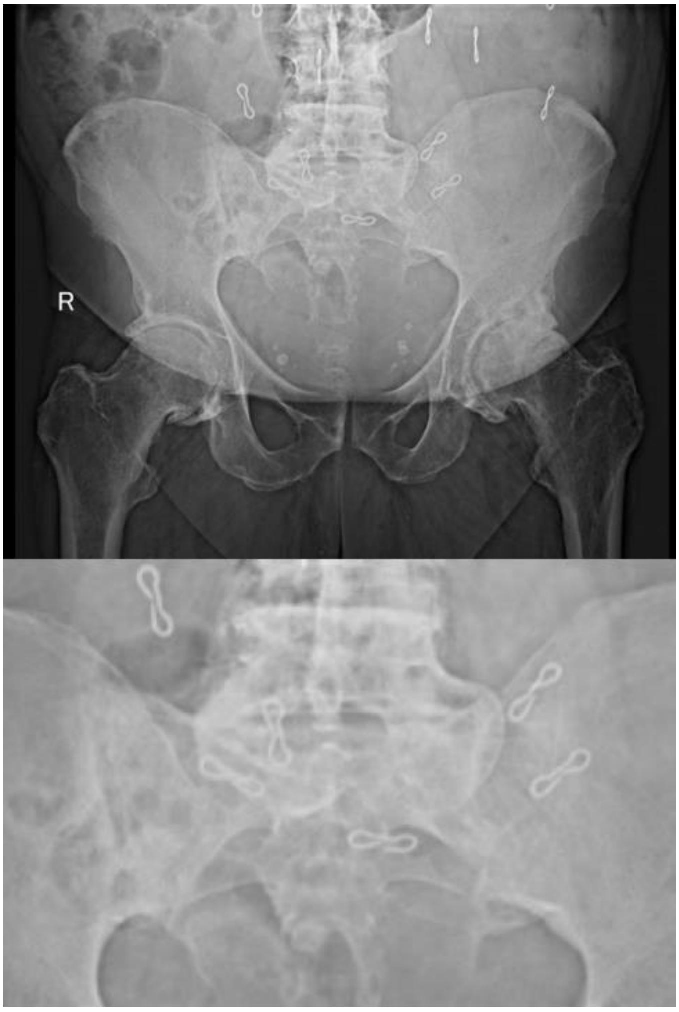


Figure 5 (left): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis. (Magnification is seen below)

Technique: Antero-Posterior X-ray of the pelvis

Findings: Left sacroiliac joint fusion. Sclerosis of the joint margins. Irregularities of the subchondral bone cortices are visible despite the projection of the gas within the overlying bowel making the interpretation of erosion and variation in joint width more difficult. Hip joint changes: joint space narrowing with subchondral cysts and overgrown osteophytes of the acetabuli.

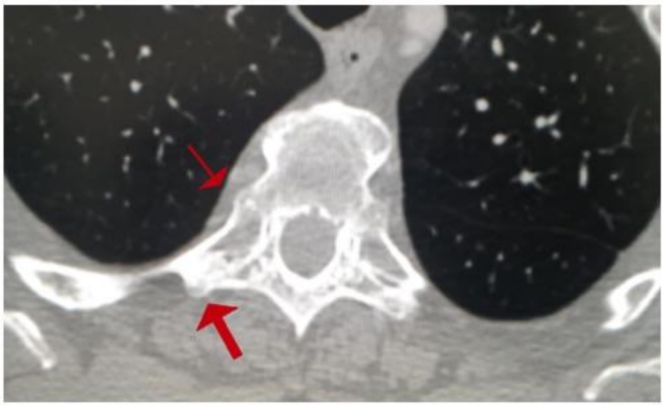


Figure 6 (left): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Axial view of the contrast enhanced CT scan of the chest CT scan of the neck (300 mA, 120 kV, 2 mm slice thickness, 100 ml of Xenetix 350, biphasic injection technique)

Findings: Narrow arrow points at a complete ankylosis of the costovertebral joint with a complete obliteration of the articular surface. Wide arrow points at a complete ankylosis of the costotransverse joint with a complete obliteration of the articular surface

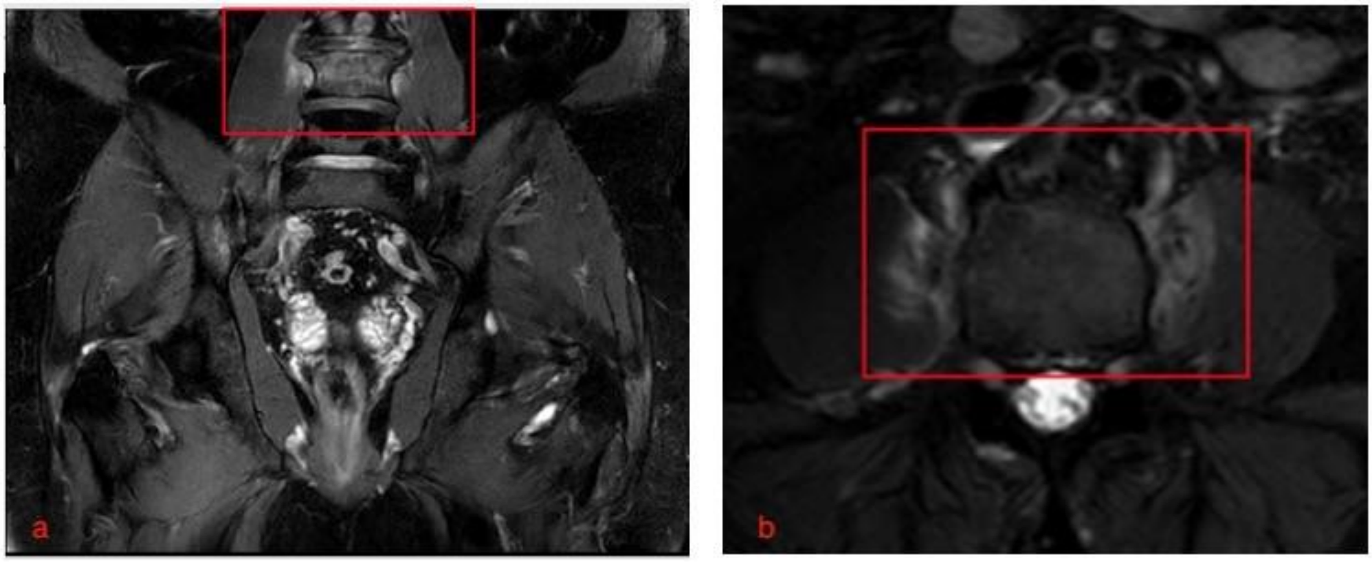


Figure 7: 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: MRI 3 tesla, Sagittal view, T2 weighted fat suppression sequence showing the lower spine.

Findings: Paravertebral soft tissue inflammation surrounding the intervertebral ossifications at the level of L3-L4.

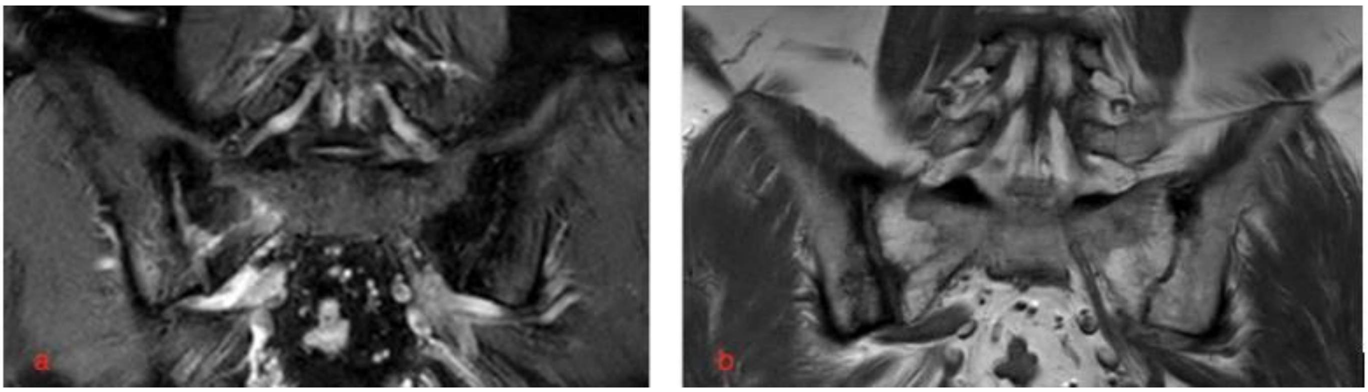


Figure 8: 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: MRI 3 tesla of the sacroiliac joints, coronal view.
a. T2 weighted sequence with fat suppression on the left.
b. T1 weighted sequence of the right.

Findings: Bilateral chronic sacroiliitis is present. Bone marrow edema is present on both sacral and iliac sides of the right sacroiliac joint. Irregular margins of the right SI joint. On the left, the articular surface is less visible confirming the aspect of partial ankylosis on conventional radiographs. Bilateral fat metaplasia predominant on the sacral subchondral bone bilaterally.

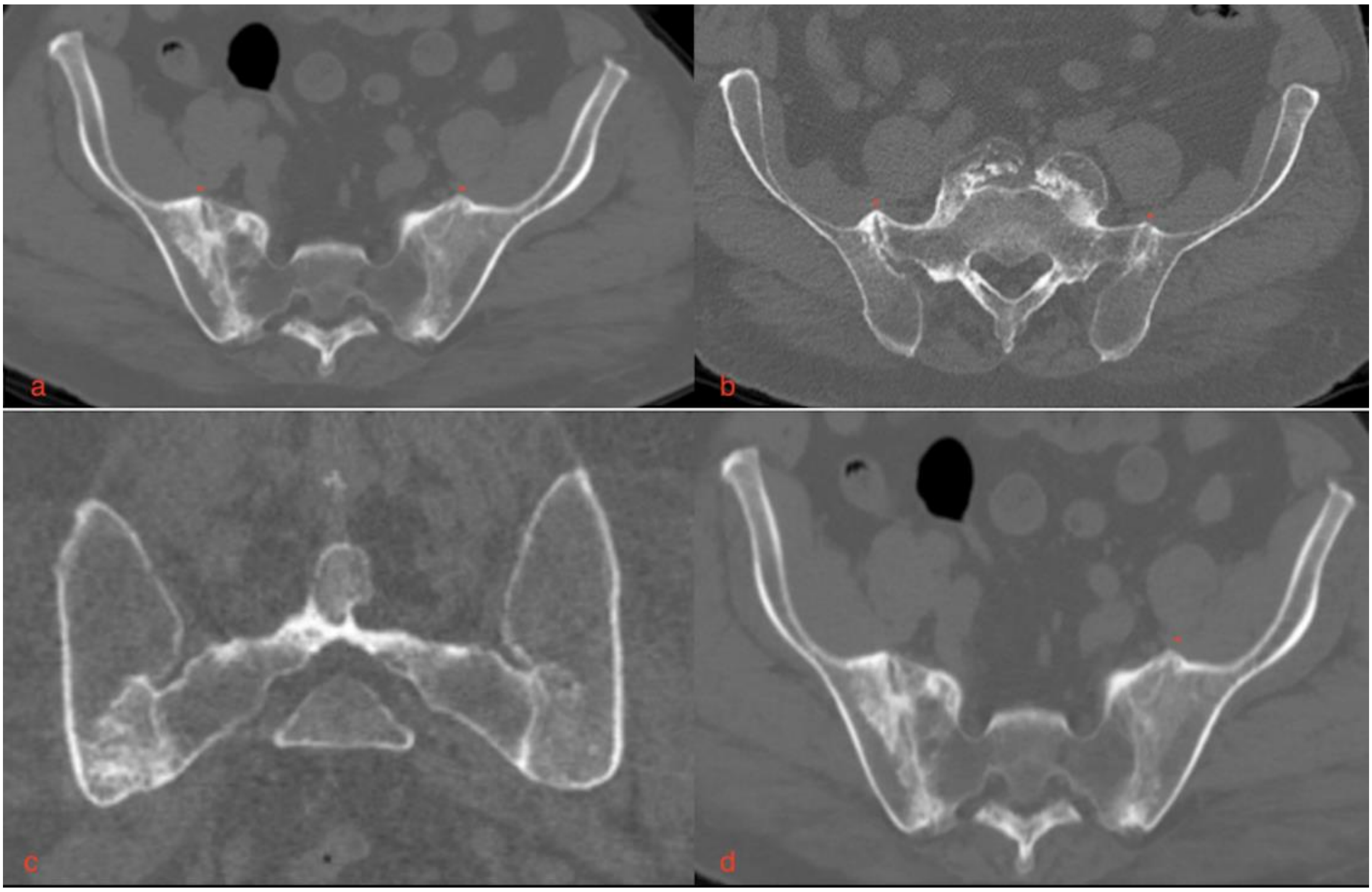


Figure 9: 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: CT scan of the pelvis (275 mA, 120 kV, 3 mm slice thickness)
a. Axial view of the sacroiliac joint
b. Axial view of the sacroiliac joint
c. Coronal view of the sacroiliac joint
d. Axial view of the sacroiliac joint

Findings: In addition to changes found in DISH such as para-articular bridging (asterisk in images a,b,d) and ankylosis of the entheseal part of the SIJ (as shown in image b), there is partial ankylosis of the synovial part of the left SIJ (best shown in image c) as well as subchondral sclerosis, erosions, ankylosis and joint irregularities of the synovial part of the right sacroiliac joint (best shown in images a and d).

Figure 10 (left): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Anteroposterior views of the shoulders

Findings: Bilateral degenerative changes of the glenohumeral joints more prominent on the left. Loose osteocartilaginous bodies in the left glenohumeral joint.

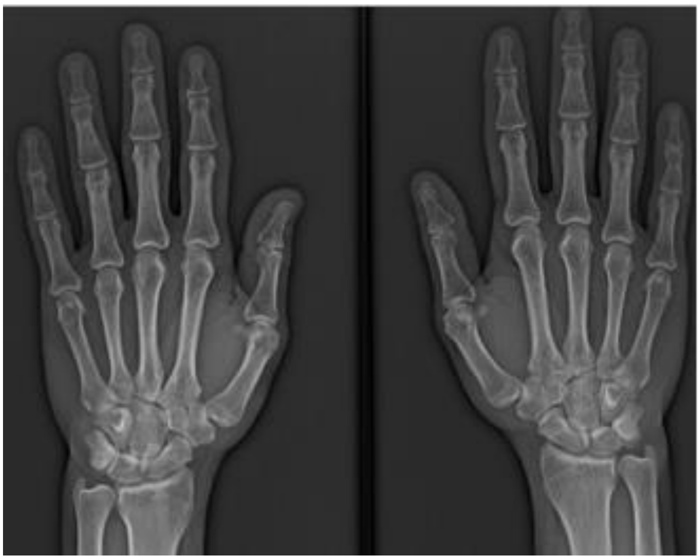


Figure 11 (left): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Anteroposterior views of the hands

Findings: Degenerative changes of the interphalangeal joints bilaterally.

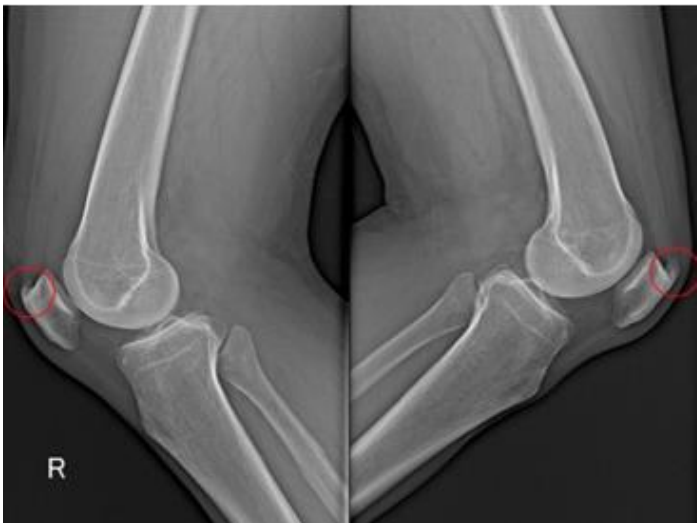


Figure 12 (left): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Lateral views of the knees

Findings: Bilateral ossified patellar enthesopathies (circles).

Figure 13 (left): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Post-operative lateral film of the cervical spine

Findings: Operative resection of the cervical ossified mass followed by a one level instrumented cervical fusion of C4-C5

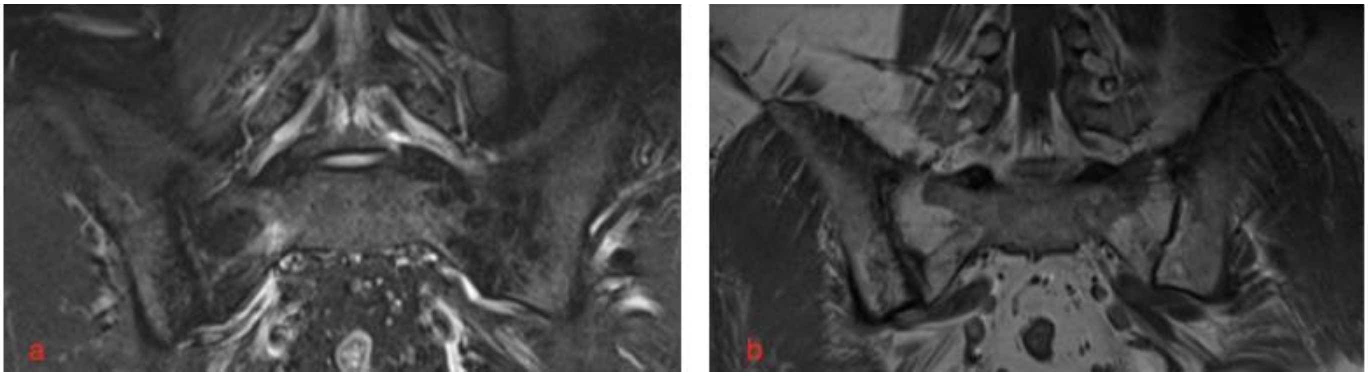


Figure 14: 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: MRI 1.5 T of the sacroiliac joints after treatment, coronal view.
a. T2 weighted sequence with fat suppression on the left
b. T1 weighted sequence of the right

Findings: Notice the decrease in bone marrow edema of the right sacroiliac joint before and after treatment

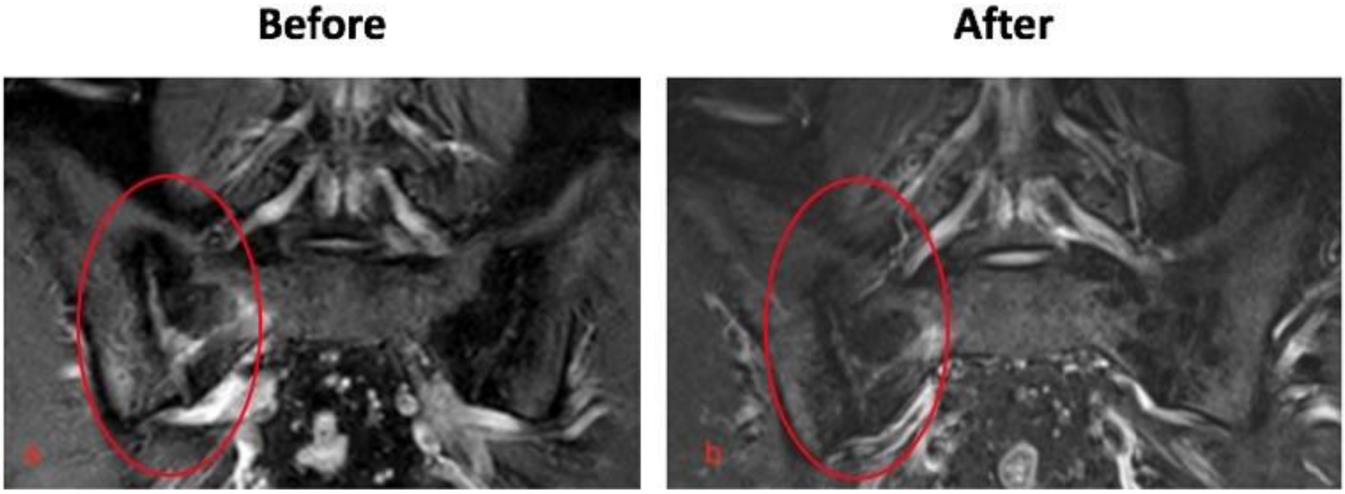


Figure 15: 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: Comparison of T2 weighted sequence, coronal view, MRI of the sacroiliac joints (1.5 Tesla)
a. Before treatment on the left
b. 11 months after Secukinumab on the right

Findings: Notice the decrease in bone marrow edema of the right sacroiliac joint before and after treatment.

Figure 16 (left): 57-year-old male patient diagnosed with both Diffuse Idiopathic Skeletal Hyperostosis and Spondyloarthritis.

Technique: MRI of the lumbar spine, sagittal view (1.5 Tesla)
a. T1 weighted sequence of the left
b. T2 weighted sequence with fat suppression on the right

Findings: In addition to the anterior ossifications of the lumbar spine, we can see degenerative changes especially at the level of L3-L4

Etiology	Idiopathic
Incidence	Unknown (depending on classification criteria used)
Gender ratio	More likely to be seen in men with a ratio of 1.5-2:1
Age predilection	Older adults, especially in people > 50 years old.
Risk factors	Obesity, Insulin resistance, Diabetes Mellitus (Strong association) Long-term used of retinoids
Treatment	Symptomatic treatment Surgery may provide relief of severe symptoms
Prognosis	Variable disability (Loss of range of motion and stiffness, swallowing difficulty). Spinal fractures.
Findings on imaging	Entheseal bridging, Intra-articular bridging (partial ankylosis), Para-articular bridging, Subchondral sclerosis. Erosions can be seen but are seldom numerous. No vacuum phenomenon.

Table 1: Summary table of Diffuse Idiopathic Skeletal Hyperostosis.

Definition	Year	Imaging modality	Number of adjacent connected vertebrae affected by ankylosis	Preferential Level	Intervertebral disk	Apophyseal joints	Costovertebral joint	SIJ surface	Peripheral involvement§§
Forestier	1950	Conventional radiograph	Not mentioned	Thoracic	Preservation	Not involved	Not involved	Not involved	Not involved
Julkunen	1971	Conventional radiograph	≥ 3-4 vertebrae (2 levels) Adjacent or not	Thoracic	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned
Harris	1974	Conventional radiograph	≥ 3 vertebrae (2 levels) **Major**	Thoracic	Not mentioned	Not mentioned	Not mentioned	Not involved* **Major**	Present **Not required for diagnosis**
Resnick and Niwayama	1976	Conventional radiograph	≥ 4 vertebrae (3 levels) **Major**	Thoracic	Relative preservation** **Major**	Relative preservation*** **Major**	Not involved	Not involved § **Major**	Present **Not required for diagnosis**
Arlet and Mazieres	1985	Conventional radiograph	≥ 3 vertebrae (2 levels) **Major**	Lower thoracic	Relative preservation** **Major**	Ligamentous ossifications, hyperostosis	Not mentioned	Not involved **Major**	Present **Not required for diagnosis**
Utsinger	1985	Conventional radiograph		Thoracolumbar				**Not an exclusion criterion**	
Possible DISH (1st scenario)			≥ 2 vertebrae (1 level) **Major**						Absent **Major**
Possible DISH (2nd scenario)			No spinal involvement **Major**						Present **Major**
Probable DISH			≥ 2 vertebrae (1 level) **Major**						Present **Major**
Definite DISH			≥ 4 vertebrae (2 levels) **Major**		Preservation **Major**	Not involved **Major**	Not mentioned		Present **Not required for diagnosis**
Rogers and Waldron	2001	Not applicable ¥	≥ 3 vertebrae (2 levels) ¥¥ **Major**	Thoracic **Right side**	Preservation **Minor**	Not involved **Minor**	Not mentioned	Not mentioned	Present **Major**
Oudkerk	2017	Chest Computed tomography	≥ 4 vertebrae (3 levels) Condition: The outer contour of the flowing ossifications intersects the vertebral body at >90° respecting the globally flowing character of the bridging ossification.	Thoracic	Mild or Moderate degenerative disc disease is allowed.	Not mentioned	Not mentioned	Not evaluated	Not evaluated
Kuperus	2019	Chest Computed tomography	**Early DISH:** ≥ 4 vertebrae (3 levels) Condition: 3 segments with near-complete bridging † OR 1 segment complete bridging †† + 1 segment at least near-complete bridging + 1 segment with at least presence of newly formed bone ††† **Definite DISH:** ≥ 4 vertebrae (3 levels) Condition: complete bridging	Thoracic	Relative preservation*	No fusion	Not mentioned	Not evaluated	Not evaluated

Table 2: Main diagnostic features of Diffuse Idiopathic Skeletal Hyperostosis (DISH).
*: absence of sacroiliitis, spurs at the lower end of sacroiliac joints
**: absence of extensive radiographic changes of degenerative disc disease (intervertebral osteochondrosis) in the involved areas, including vacuum phenomena and vertebral body marginal sclerosis
***: normal apophyseal joints or mild sclerosis; occasional osteophytes, absence of ankylosis
§: absence of erosion, sclerosis or intra-articular bone fusion. Para-articular bone fusion can be found
§§: para-articular osteophytes; ligament calcification and ossification, hyperostosis
¥: macroscopic evaluation of excavated skeletons
¥¥: hyperostosis with or without ankylosis
†: anterior bone formation with a distance of less than 2 mm between two bony structures or a full connection between adjacent vertebrae that is visible in a maximum of two sagittal or coronal CT sections (CT sections thickness of 1mm).
††: complete bridging between the adjacent vertebral bodies visible in more than two sagittal or coronal CT sections (CT sections thickness of 1mm).
†††: anterior bone formation that is either connected or not to the above or below vertebral body with a distance of at least 2 mm between two bony structures (could be a nodular soft-tissue calcification) OR a connection between two adjacent vertebral bodies without abundantly formed bone.

	X-rays	CT	MRI
Diffuse Idiopathic Skeletal Hyperostosis	- Bridging (Entheseal, intra-articular or partial ankylosis, para-articular) - Subchondral sclerosis - Erosions can be seen but are seldom numerous - No vacuum phenomenon	Similar to X-rays but more sensitive.	- Subchondral bone marrow edema - Fat metaplasia - Subchondral sclerosis - Entheseal bridging - Para-articular bridging - Intra-articular joint bridging
Spondyloarthritis	- Joint space narrowing - Blurry joint space margins - Subchondral sclerosis - Erosions - Joint ankylosis	Similar to X-rays but more sensitive.	- Active inflammatory lesions: Bone marrow oedema, Capsulitis, enthesitis, synovitis (Low T1 signal, High T2 signal, contrast enhancement). - Structural lesions: Erosions (better seen on T1-weighted sequences). Fat metaplasia (High T1 and T2 signals, Low on T2 fat saturation sequences). Subchondral bone sclerosis (Low on T1 and T2 signals. Ankylosis (better seen on T1-weighted sequences).
Osteitis Condensans Ilii	- Predominantly iliac sclerosis contiguous to the inferior sacroiliac joint. Typically, it is triangular but can have other shapes. The sclerosis is well demarcated from the rest of the bone. - Preserved joint space. - No erosions	Similar to X-rays but more sensitive.	- Predominant anterior localisation of sclerosis. Well demarcated. - Bone marrow oedema is predominantly anterior and less extensive than in inflammatory sacroiliitis. - Fat metaplasia could be present but less extensive than in inflammatory sacroiliitis. - Erosions are absent.
Degenerative changes	- Uniform joint space narrowing - Osteophytes at joint margins - No ankylosis - Minimal subchondral sclerosis - Subchondral cysts - Vacuum phenomena - Erosions are rare. If present, localized and very superficial.	Similar to X-rays but more sensitive.	- Subchondral bone marrow oedema is less extensive than in inflammatory sacroiliitis. - Subchondral fatty changes are a common feature. - Osteophytes at joint margins - Joint space narrowing better seen on T1 sequence - Erosions are rare

Table 3: Differential diagnosis table for sacroiliac involvement of Diffuse Idiopathic Skeletal Hyperostosis.

ABBREVIATIONS

AP = Anteroposterior
AS = Ankylosing Spondylitis
ASDAS-CRP = Ankylosing Spondylitis Disease Activity Score with CRP
ax-SpA = Axial spondyloarthritis
CT = Computed tomography
DISH = Diffuse Idiopathic Skeletal Hyperostosis
MRI = Magnetic resonance imaging
SIJ = Sacroiliac joint

KEYWORDS

Diffuse idiopathic skeletal hyperostosis; ankylosing spondylitis; spondyloarthritis; co-existence; co-occurrence

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