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BRIEF REPORT

The first report of diffuse idiopathic skeletal hyperostosis (DISH) in the Parthian cemetery of Liyarsangbon, Guilan, Iran

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Abstract

DISH is a systemic noninflammatory condition with unknown causes, closely linked to factors such as sex, age, environmental influences, genetic predisposition, and changes in medication. In addition, certain medical conditions, including gout, metabolic disorders like type 2 diabetes as well as particular populations have significant effects on the frequency of this disease. The individual examined here was unearthed from Liyarsangbon cemetery in Amlash city, situated in the Guilan, Iran. The individual is estimated to be around 35 to 40 years old. In total, the remains of 48 adults and one child were uncovered, with only one specimen showing evidence of the condition known as DISH. On the basis of preliminary typology of the artifacts discovered and grave types, the site was dated to the Parthian (247 BCE–224 CE) and in few cases to the Sassanid period (224–651 CE). Based on the paleopathological analysis of the sample under investigation, indications of pathological changes in the spine, ribs, sternum, and sacroiliac region were detected. While various potential differential diagnoses like spondyloarthropathies, Paget's disease, metabolic diseases, and POEMS syndrome could apply to the individual, through the utilization of advanced radiological imaging technique and the established criteria related to the aforementioned conditions, the ultimate diagnosis was determined to be either DISH or eDISH.

Keywords Forestier and Rotès-Querol · Ankylosing hyperostosis · EDISH · Palaeopathology · Ancient disease · Parthian period · Amlash

Introduction

Diffuse Idiopathic Skeletal Hyperostosis (DISH) is a systemic noninflammatory ailment. It has been referred to under different names such as Forestier-Rotes-Querol by Resnick et al. (1975, 1978). However, what seems certain is that DISH is closely related to sex and aging (Mata et al. 1995) and certain medical conditions, including gout, and metabolic disorders like type 2 diabetes (Navarro and Buckberry 2022; Denko and Malemud 2006; Kiss et al. 2002) as well as contact with environmental factors like retinol and fluoride in humans (Forestier and Rotès-Querol 1950; Julkunen et al. 1971; Cassim et al. 1990; Hannallah et al. 2007; Navarro and Buckberry 2022). The prevalence of this disease among different populations/ethnic groups shows that genetic factors play a role in the etiology of this disease (Julkunen et al. 1981; Kim et al. 2004; Kiss et al. 2002a; Vaishya et al. 2017). The occurrence of DISH in the Eastern Mediterranean and Middle Eastern areas is uncommon, as indicated by the limited statistical data available.

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A prevalence of 10% was observed among the elderly in Omani recent population (Sirasanagandla et al. 2018).

According to the paleopathological studies of ancient remains, it appears that this disease is not a recent disorder. Signs of DISH have even been observed in dinosaurs (Rothschild 1987). It has also been reported as early as the Middle Paleolithic on one of the Neandertal skeletons discovered at Shanidar Cave in Iraq (Shanidar 1)(Crubézy and Trinkaus 1992). The Neandertal skeleton, Kiik Koba 1 (Crimea), might also have been affected by DISH (Trinkaus et al. 2008).

Additionally, DISH has been documented in various archaeological populations across the globe and throughout different time periods, including in contemporary populations (Waldron 1985; Mays 1991, 2016; Rogers and Waldron 2001; Müldner and Richards 2007; Patrick 2014; Verlaan et al. 2007; Paja 2010; Arriaza et al. 1993; Hukuda et al. 2000; Oxenham et al. 2006; Mosothwane and Steyn 2009; Kim et al. 2012; Smith et al. 2013; Saleem and Hawass 2014). Limited information is available regarding prehistoric Near Eastern post-Paleolithic data, specifically pertaining to the excavation report of three identified individuals. These individuals include an adult male from Mallaha and two adult males from Hayonim cave in Israel, all belonging to the Natufian (13000−9500 BC, calibrated) population (Bocquentin 2003). According to the published manuscript, only one study has been carried out in the Middle East region over the past thirty years (Bloom 1984). The present manuscript aims to achieve an accurate diagnosis regarding the individual under study by utilizing non-invasive and non-destructive methods. This endeavor seeks to demonstrate whether the application of interdisciplinary approaches can help overcome existing obstacles in the analysis of ancient sources.

Materials and methods

A total of 49 human skeletons, including 48 adults and one child, were discovered from a funerary area situated in Liyarsangbon Amlash, Guilan, Iran as a result of two seasons of excavation during the years 2015 and 2016. The skeletal remains were gathered and conveyed to the biological anthropology facility situated at the Research Institute of Guilan Studies (RIGS), University of Guilan, Rasht, Guilan, Iran. Upon conducting initial studies, it was discovered that some of the exposed bones exhibited signs of infectious and chronic diseases (Eghdami et al. 2023). One of the most interesting examples that caught the attention of relevant researchers was the remains of an individual with the changes in the spine. The sex and age, both metric and nonmetric traits, of this individual were determined by standardized criteria established by Rudolf Martin (Martin 1928) and other researchers (Buikstra 1994; Brothwell 1963; Martin and Saller 1957; Meindl et al. 1985; Walker 2008; Stewart 1979). Among the individuals discovered, there were 18 men and 23 females ranging in age from 25 to over 55 years. The age and sex of 8 individuals could not be determined due to environmental degradation.

The use of basic and more advanced imaging techniques for investigating of the pathogenesis and differentiation of DISH from other diseases with similar imaging properties and lesions was argued (Mader et al. 2017). To identify the lesions of DISH in the subject of this study, two specified criteria were employed: those outlined by Resnick and Niwayama in 1976 and by Julkunen et al. in 1975. Non-instrumental observation can lead to higher rates of misdiagnosis in differential diagnoses. Therefore, the use of common methods and multidisciplinary tools in medical sciences can greatly improve the ability to accurately diagnose ancient diseases. Hence, the individual under study underwent radiological assessment, a typical diagnostic approach for DISH (Scholz et al. 2019). The diagnosis of DISH is established by analyzing chest and spine radiographs, along with CT scans, to detect underlying factors contributing to bone disorders like hyperostosis, joint ankylosis, or pseudoarthrosis (Scholz et al. 2019). The skeletal samples were subsequently transported to Golsar Hospital in Rasht, Guilan, for CT scanning to uncover any concealed factors. The imaging procedure was carried out utilizing a Philips Brilliance 16 Slice CT scanner, third generation, ultra-high resolution (up to 24 Lp/cm spatial resolution); flexible slice acquisition modes including 16 × 0.75 mm and 16 × 1.5 mm and sub-second 360° rotation time. Subsequently, the acquired images underwent enhancement using Maximum Intensity Projection (MIP) to enhance clarity and precision for improved diagnostic capabilities. Furthermore, to facilitate further analysis, the enhanced images were reconstructed in three dimensions (3D) using Valum Rendering (VR) software. To prevent errors in interpretation due to overlapping lesions, the refined images were meticulously examined and analyzed with colleagues utilizing with picture archiving and communication system (PACS) Infinitt radiology PACS version 7.0 software. This comprehensive approach ensured a thorough evaluation of the images and facilitated accurate diagnosis and treatment planning for patients with DISH disease.

To determine the soil matrix's acidity, samples were initially collected from various areas of the excavated site of Liyarsangbon and examined on-site. Sodium bicarbonate and acetic acid were employed for this purpose. Additionally, in the laboratory, a Milwaukee Mi 151-m with ±0.01 pH accuracy was utilized for further analysis (Table 1). This experiment enabled the observation of how environmental

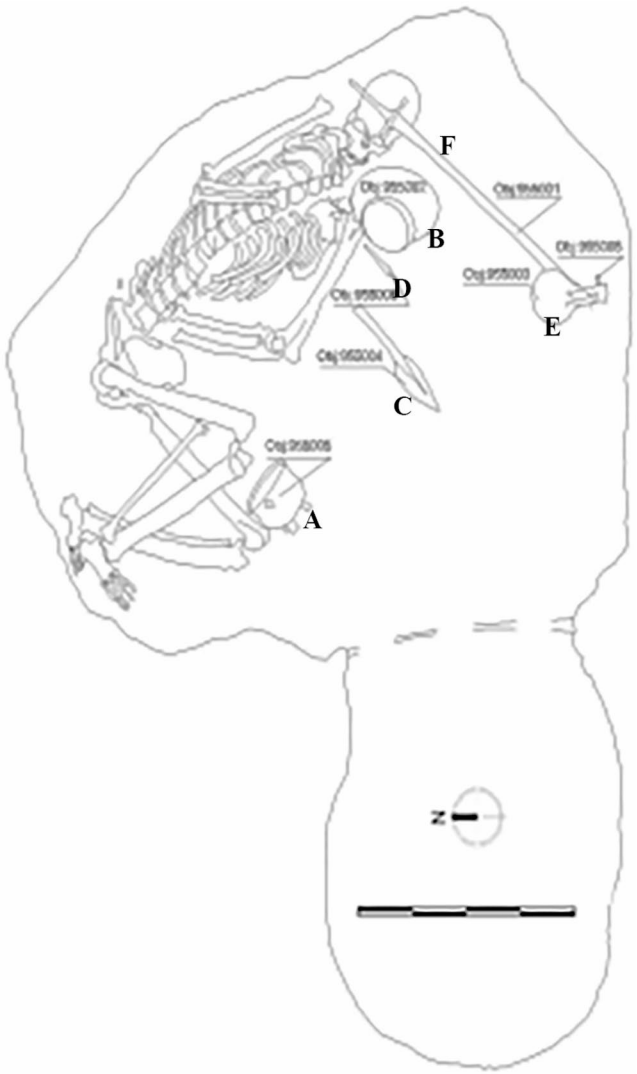


Fig. 1 Showing a flexed burial type accompanied by various grave goods, including a **A**: bowl, **B**: jar, **C**: bayonet, **D**: knife, **E**: unidentified metal and bronze objects, and an **F**: iron sword. This individual burial was uncovered in trench 9501 within crypt grave 95,501. Drawing by Reza Shiargar

factors, such as soil type, can impact the degree of destructive effects on bones.

Archaeological site

The archaeological site of Liyarsangbon is located in Amlash city, Guilan province (UTM 36° 55′ 50.85″ N, 50° 02′ 09.86″ E). The expansive ancient complex, spanning around 27 hectares at altitudes of 1311 to 1751 m above sea level, is divided into two main sections: a cemetery on the eastern slope (sloping approximately 14 degrees from east to west) and the remains of stone-built structures in the middle slope of Mount Ahīn bar-Talleh, indicating past residential activity in the Liyarsangbon region. The surface is covered with rubble stone deposits. Surrounding the complex are Shirchak summer village with nomadic residents about 2 km northwest, Siyahkouh village with permanent residents 1 km northeast, and Shieh village 1.8 km south at a lower altitude. The buildings construction of the mentioned villages is generally based on domestic materials, with more stone, wood and thatches. By conducting an initial typological examination of artifacts and burial practices (Fig. 1), the archaeological site has been identified as originating from the Parthian period (247 BCE–224 CE) and at times from the Sassanid era (224–651 CE) (Eghdami et al. 2023; 2025). The discovered individuals had been buried in various ways. Apart from one jar burial, which belonged to a child, adults were interred in two distinct types of graves: crypt graves and pit graves. Almost all of the graves contained objects crafted by humans placed alongside the bodies (Fig. 1). Analysis of the soil samples collected from different strata - from the surface to the location of the skeleton - reveals pH values that vary between 7.70 and 8.67, with an average pH of 8.23, suggesting a soil composition that is moderately to strongly alkaline in nature (Table 1) which itself is a reason to protect the bones.

Results

The individual under study is reported to be a male between 35 and 40 years old (Eghdami 2025). Studies have shown, extensive hyperostosis is observed at the sites where tendons attach to various points on the bones. In addition to the fusion observed in vertebrae C6 to C8, all thoracic vertebrae (T1 to T12) and lumbar vertebrae (L1 to L5) are affected by

Table 1 Showing all the individual information obtained from the excavated skeleton

Individual Information, Trench No. 9501 Cave No. 95501						
Date of Excavation: Summer, 2015				Site Director: V. Jahani		
Sex	Age	Soil pH	Burial Type	Burial Direction	Grave Type	Buried Goods
Male	~35–40	μ 8.46	Flexed	Northeast to Southwest	crypt	Bowl, Jar, Bayonet, Knife, Scissors, unknown metal and bronze object, an iron sword

hyperostosis. During the examination of the analyzed stock, unusual findings such as ossification and calcification were identified. These included the presence of syndesmophytes and atypical calcification within the paravertebral ligaments (Fig. 2).

Skeleton description of the lesions visible with the naked eye

An ambiguous intravital round hole with smooth margin has been identified on the left parietal side of the skull. The outer surface dimensions measure 5.7 × 5.7 mm, while the inner surface dimensions are 1.7 × 4.7 mm. There are no signs of vascular involvement observed on the outer surface (Fig. 2: A & Al). An average pH of µ 8.46 suggests a reduced likelihood of environmental degradation in this context. Complete ossification of the thyroid cartilage is also observed (Fig. 2: L). Complete bridging, ossification in the lower cervical spine right between C6 to C8 vertebrae body was noticed (Fig. 2: B – B2). Costal cartilage of the right first rib is completely ossified and fused to the sternal manubrium (Fig. 2: C). Bilateral hyperostosis can be seen in the supracondylar line of the humerus (Fig. 2: D). Severe syndesmophytes, paravertebral anterior and lateral ligament calcification appeared throughout the spine without any skip lesion and caused increased kyphosis in the thoracic vertebrae and lordosis in the cervical vertebrae C6 to C8 (Fig. 2: E). Throughout the spinal disc, space is well preserved and the posterior portion of the vertebral bodies is less involved and no evidence of gross pre-mortem destructive in the vertebral bodies is observed (Fig. 2: E). Appearance of candle flowing wax calcification is seen in all of the thoracic (T1 to 12) and lumbar (L1 to L5) vertebrae (Fig. 2: F). Bony attachments of the sacroiliac joint with bilateral hyperostosis in the tendinous attachment sites of iliac and bridging osteophytes in the right sacroiliac joint, caused the appearance of ankylosis (Fig. 2: G). In addition, Hyperostosis is identified as irregular bony outgrowths in areas such as the posterior iliac spine (Fig. 2: G1), the superior pubic margin (Fig. 2: G2), and the ischial tuberosity (Fig. 2: G3). Bilateral hyperostosis is seen in intertrochanteric line and lateral medial the edge of the linea aspera of femur (Fig. 2: H & H). Prominent tibial tuberosity (right side) is also evidenced (Fig. 2: J). Further, an unusually large coarse osteophyte is seen at the proximal end of the fibular notch of the right tibia (Fig. 2: J1). Sign of severe hyperostosis on the patella anterior surface (left side) can be perceived (Fig. 2: M). The appearance of overly prominent and coarse bone protrusions, along with noticeable visibility of the calcaneal tuberosity on both sides (Fig. 2: N), are among the distinct lesion symptoms that can be observed with the naked eye.

Fig. 2 The excavated skeleton shows lesions on the affected bones, which are marked in red on the accompanying graphic. Missing bones are represented in gray, providing a clear visual distinction. **A** & **Al**: an ambiguous intravital round hole of the skull; **L**: complete ossification of the thyroid cartilage; **B** – **B2**: ossification in the lower cervical spine C6 to C8 vertebrae; **C**: ossification of the right first rib to the sternal manubrium; **D**: Bilateral hyperostosis of the humerus; E: Severe syndesmophytes caused increased kyphosis in the thoracic vertebrae and well preserved throughout the spinal disc; **F**: appearance of candle flowing wax calcification; **G**: ankylosis from sacroiliac joint bony attachments and bilateral tendinous hyperostosis; **G1**: irregular outgrowths on the iliac spine; **G2**: the superior pubic margin; **G3**: the ischial tuberosity; H & H1: bilateral hyperostosis in intertrochanteric line and lateral medial the edge of the linea aspera; **J**: prominent tibial tuberosity; **J1**: unusually large coarse osteophyte of the right tibia; M: sign of severe hyperostosis of the patella anterior surface; **N**: Prominent bone protrusions and visible calcaneal tuberosity. Images and drawing by Mohammad Reza Eghdami

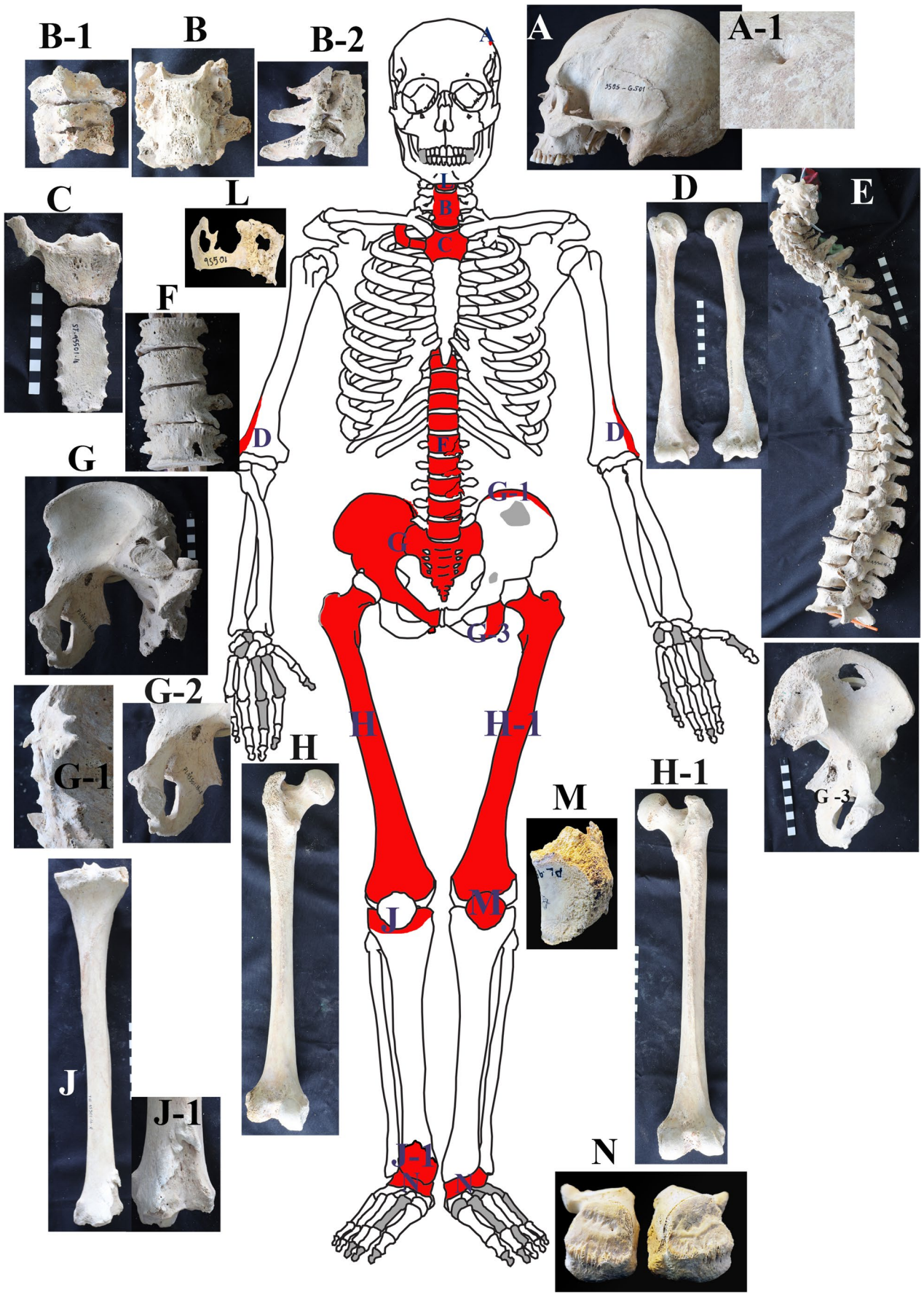
Overall, the bones do not show any evidence of osteoporosis, and there is also no evidence of premortem destruction and no evidence of destruction was observed in the cartilage surface of the joint in general.

Radiologic/CT scan finding of the visible lesions

Ankylosis/near fusion associated with bridging ossification in the anterior, posterior, and bilateral vertebral bodies leading in neuroforaminal narrowing and degenerative joint disease (DJD) in end-plates and subchondral sclerosis and irregularity and marginal osteophytes in C6 to C8 levels, as well as DJD in the right uncovertebral joint/near ankylosis in T1-T2 level is observed (Fig. 2. A1, A3, A5, A4, A6). Marginal osteophytes and schmorl's nodes (Schmorl 1927) in thoracic and lumbar vertebral bodies can be seen in Fig. 3 (A2 & A5).

Joint space narrowing, the presence of bridging osteophytes, and partial fusion observed in the anterosuperior portion of the right sacroiliac joint, along with hyperostosis and ossifications at the posterior tendinous attachment site of the ilium (predominantly on the right side), are indicative of enthesopathy (Fig. 4: B1, B2).

Cartilage ossification at the attachment site of the right first rib to the sternal manubrium resulting in ankylosis is observed (Fig. 5: E1 & E2). In addition, Hyperostosis is observed at the lateral supracondylar region of both humeri, specifically at the site where the common extensor tendon attaches to the bone, as evident in both 2D and 3D imaging (Fig. 5: C1 & C2). Furthermore, hyperostosis and ossification in the superior part of the fibular notch of the right tibia at the interosseous ligament attachment site (R/O enthesopathy) is also seen (Fig. 5: D1 & D2).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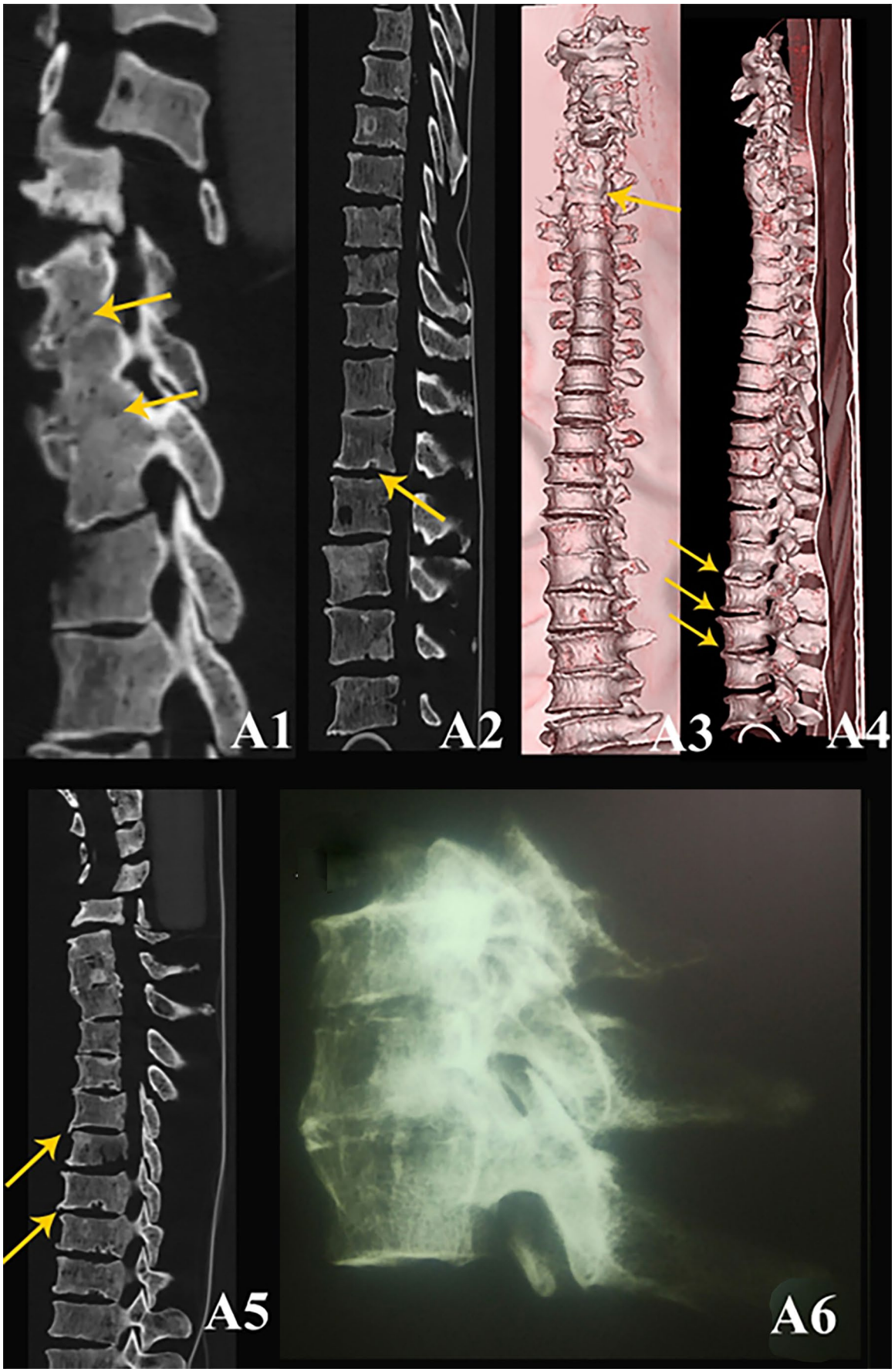
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Fig. 3 Radiological findings (CT scan & X-ray) are used to obtain a precise diagnosis of the pathological changes both in 2 and 3 dimensional views. The yellow arrows show the relevant part of the bone in the vertebrae. **A1**: fusion in C6 to C8 levels; **A2**: schmorl's nodes; **A3**: 3D model of fusion in C6 to C8 levels; **A4**: 3D model of marginal osteophytes; **A5**: marginal osteophytes. Imaging by Maryam Bozorgnia

Discussions

After conducting initial inquiries and thorough examinations, it seemed probable that the hyperostosis condition in the individual could be linked to the existence of several comparable diseases, such as DISH, spondyloarthropathies like Ankylosing Spondylitis (AS), and possibly psoriatic arthritis (PsA) and Reiter's Syndrome (ReS). Furthermore, other potential causes were also taken into account, including Paget's disease, metabolic disorders like gout, primary and secondary hyperparathyroidism, and POEMS (Polyneuropathy, Organomegaly, Endocrinopathy, Monoclonal Protein, Skin changes) syndrome. Table 2 outlines the various similarities and differences among the diseases mentioned above.

Using the data derived from the images in the literature, the differential diagnosis of Disch disease can be compared and analyzed alongside other potential differential diagnoses. As outlined and numbered in Table 3, certain symptoms can help distinguish DISH disease from other differential diagnoses. These symptoms are listed alongside Roman numerals next to the relevant indicators in the table. I: Most commonly involves this part rather than other area. II: ReA tend to affect the joint in lower extremities mor than upper. III: PsA tend to affect the joint in upper limb more than lower. IV: Common sits of spinal brucellosis are in the lower thoracic and lumbar vertebrae. V: Common sits of spinal TB in the adults are in the lower thoracic and upper lumbar vertebrae. VI: more common of other SpAs.

Diffuse idiopathic skeletal hyperostosis (DISH)

As it is shown in Table 3, DISH emerges as the most conspicuous diagnosis for the case under examination. DISH disease is primarily characterized by the development of new bone in the anterolateral longitudinal ligaments of the thoracic spine, with this being the most prominent feature of the condition. Yet, the lumbar and cervical vertebrae frequently experience the effects of the process (Forestier and Lagier 1971). The study revealed that not only the most significant level of participation was observed in the cervical vertebrae, but signs of engagement in the lumbar and thoracic vertebrae were also noted in the examined case.

Usually, the posterior longitudinal ligament is not involved. In this case, apart from C6 to C8, the rest of the posterior longitudinal ligament in the spinal area is not implicated. The DISH condition is characterized by the development of a flowing wax candle shape at the anterior aspect of the vertebrae, as described by Jacques Forestier and Rotès-Querol in 1950. A recent case study reported on a 60-year-old diabetic man from Rasht, Iran, who experienced chronic neck pain, restricted cervical mobility, and lower limb paresthesia. Imaging findings showed DISH alongside ossification of the anterior and posterior longitudinal ligaments, as well as the Ligamentum Flavum. This condition caused cervical stenosis at C1-C2, C2-C3, and C6-C7 levels, along with thoracic canal stenosis at T1-T2 and T2-T3. Additional findings included ligament calcification, osteophyte formation, and compressive effects on the spinal cord and nerves, resulting in symptoms affecting the right arm. A pelvic radiograph further confirmed the presence of DISH (Alijani et al. 2018). Another study involving a 72-year-old patient in Iran diagnosed with Diffuse Idiopathic Skeletal Hyperostosis (DISH) revealed that the posterior longitudinal ligament remained unaffected. However, significant ossification was detected in the anterior longitudinal ligament between the C2 and C4 levels, which led to esophageal compression (Davoodi et al. 2023). As it is represented in Fig. 2 (F), this characteristic is similar to the observation made in the vertebral regions of the studied sample in this research. In the research carried out by Holton and colleagues (2011), it was noted that DISH disease results in the formation of extraspinal entheseal ossification. Strikingly, the individual being studied also displayed a similar extraspinal entheseal ossification (Fig. 2).

The calcification of ligament insertion sites may result in pseudo-fusion within the sacroiliac joint, particularly involving the sacroiliac ligaments. This occurrence is detectable using various imaging modalities (Kiss et al. 2002b). The sacroiliac joint of the sample under investigation exhibited an exact comparable event (Fig. 2. G & Fig. 3. B1-2).

Scholars utilize a principle or criteria to evaluate or determine a specific issue. Various researchers have presented different criteria in relation to the diagnosis of DISH disease. The prevailing criteria set by Resnick and Niwayama describe DISH by various features know as, continuous ossification of the anterior longitudinal ligament, involving at least four adjacent vertebrae in the thoracic region; maintenance of vertebral disc space as a result of the ossification process and absence of inflammation affecting the apophyseal and sacroiliac joint (Resnick and Niwayama 1976). Another criterion has been described by(Julkunen et al. 1975). According to their criterion, bridging ossification occurs between two adjacent thoracic vertebrae.

Furthermore, a separate study conducted by Schmidt et al. (2002), revealed that the fusion of vertebrae occurs with fewer affected in number when compared to the criteria outlined by Resnick and Niwayama (1976). According to them,

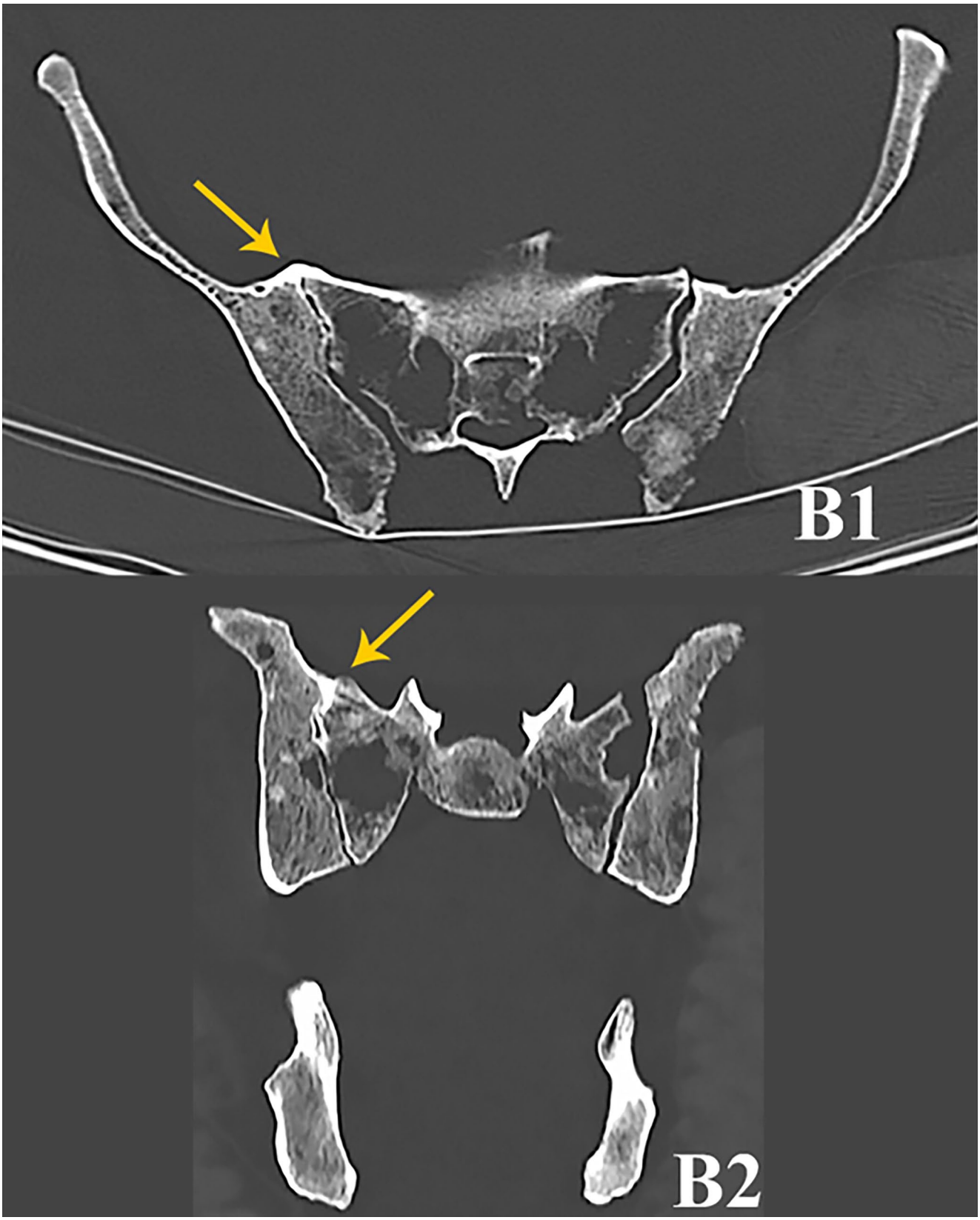

Fig. 4 **B1**: partial fusion in the right sacroiliac joint; **B2**: bridging osteophytes. The yellow arrows show the relevant parts in the right sacroiliac joint. Imaging by Maryam Bozorgnia

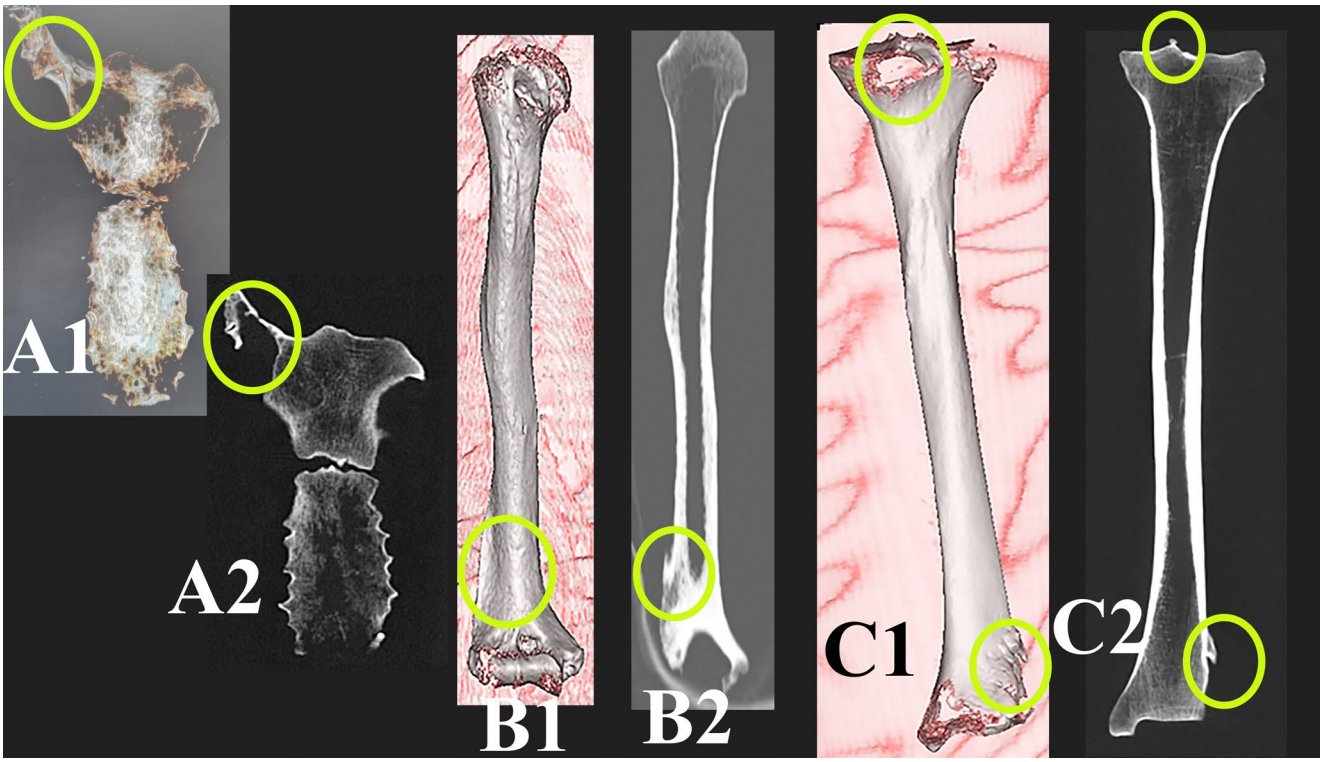

Fig. 5 E1: VR and E2: MIP and cartilage ossification of the first right rib to the sternal manubrium; C1 & 2: 2D and 3D images of hyperostosis at lateral supracondylar of the both sides of humerus at the site where the common extensor tendon attaches to the bone.; D1 & 2: the interosseous ligament attachment site ossification in the anterolateral tibia; Imaging by Maryam Bozorgnia

there is a possibility of reducing the number of fused vertebrae at the early stage of DISH disease, which they refer to as "eDISH".

Upon examination of the CT scan images, it was observed that the intervertebral space within the fused area, identified by the ossification of the longitudinal ligaments, remains unaltered. Moreover, analysis of the apophyseal and sacroiliac joints using diagnostic imaging did not show any indications of involvement (Fig. 4. B1). This specification is consistent with most of the characteristics mentioned in Resnick and Niwayama (1976) and Julkunen et al. (1975) criteria. However, the number of three fused vertebrae in the present research is different from the criteria of Resnick and Niwayama (1976) and corresponds to the count criteria provided by Julkunen et al. (1975). Alternatively, in cases where diagnosis is required according to the criteria established by Resnick and Niwayama (1976), individuals with less than four fused vertebrae may be classified as being in the initial phase of DISH disease (eDISH).The sole difference observed between the results of the examined case and the set standards, relates to the specific site of fusion. Here, fusion is observed in the three cervical vertebrae, while the established criteria mainly focus on fusion in the thoracic vertebrae (Fig. 3. A7). The demographic and biological features of the individual in the present study are in line with DISH disease, such as age (over 50 years) and sex (male), indicating a greater probability (Van der Merwe, Maat, & Watt, 2012) when compared to other potential diagnoses listed in Tables 1 and 3.

The etiology of DISH can be related to obesity and consequently type 2 diabetes (Inamasu et al. 2006; Hajkova et al. 1965; Julkunen et al. 1966). Therefore, a study was carried out on the signs of diabetes in the recovered individual. After evaluating the integrity of the skeletal system, there was no evidence of limb amputation due to diabetes. Instead, the individual displayed satisfactory bone density, suggesting the lack of substantial issues related to malnutrition and decreased bone density linked to advanced diabetes. As a result, the present sample does not correspond with the identification of severe type 2 diabetes, although the chance of mild type 2 diabetes and initial phases of the condition cannot be entirely dismissed.

Conclusion

The pattern of lesions, sex (male), and age over 40 years indicates a diagnosis of DISH disease as more likely compared to other differential diagnoses. The analysis of the sample highlights multiple defining features consistent with

Table 2 Illustrates a comparison of the differential diagnosis of symptoms in related diseases with DISH. The diagnosis most probable is DISH disease in comparison to other conditions

Disease Signs	Sub-Groups	Coarse Syndesmophytes	Sex	Age	Fusion in the Sacrum	Fusion in the Lumbar vertebrae	Fusion in the Thoracic Vertebrae	Fusion in the Cervical Vertebrae	Preser-vence of Disc Space	Destruction in Vertebral Bodies	Increased Vertebral Kyphosis and Lordosis	Skip Lesion in Spine	Sacroiliac Joint Fusion	Extra Spinal Hyperostosis	Unusual Cartilage Ossification	Bambo Spine	Extraxial Arthropathy	Sym-metrical Conflict
Spondyloar-thropathies	(AS)	Yes	M>F	**15-35Y**	Yes	Yes[I]	Yes	Yes	Yes	No	Yes	No	Yes	Unusual	No	Yes	No	Yes
	ReS	Yes	M=F	**18- 40Y**	Yes	Yes	Yes	Yes	Yes	**No**	maybe	Yes	Yes	Rare[VI]	**No**	No	Yes[II]	No
	(PsA)	Yes	M=F	Young adults	Yes	Yes	Yes	Yes[I]	Yes	No	maybe	Yes	Yes	Rare	No	Rare	Yes[III]	No
Metabolic Disease	Gauty Arthritis	No	M>F	Adult-s	No	No	No	No	Yes	No	No	NO	-	Rare	Maybe	No	Yes	No
	Primary & Secondary Hyperparathy-roidism	No	Variable	Variable	No	No	No	No	Yes	Maybe	Maybe	No	No	No	Yes	No	No	Yes
POEMS Syndrome	-	No	M>F	30-80Y	No	No	No	No	Yes	Maybe	Maybe	No	No	No	Yes	No	No	No
Paget's Disease	-	No	M>F	50-60Y	No	No	No	No	Yes	Yes	Yes	No	maybe	Yes	No	No	Yes	No
Infectious Disease	Brucellosis	No	M=F	Any age	Rare	Yes	Yes[IV]	Yes	Yes	No	Rare	Yes	Yes	No	No	No	Rare	No
	Tuberculosis	No	M=F	Any age	Rare	Yes	Yes[V]	Yes	No	Yes	Yes	Yes	Yes	No	No	No	Rare	No
DISH	-	Yes	M>F	>45 Y	No	Yes	Yes	Yes	Yes	No	Yes	maybe	No	Yes	Yes	Yes	No	No

I: Most commonly involves this part rather than other area. II: ReA tend to affect the joint in lower extremities mor than upper. III: PsA tend to affect the joint in upper limb more than lower. IV: Common sits of spinal brucellosis are in the lower thoracic and lumbar vertebrae. V: Common sits of spinal TB in the adults are in the lower thoracic and upper lumbar vertebrae. VI: more common of other SpAs

Diffuse Idiopathic Skeletal Hyperostosis (DISH). These include the characteristic candle wax-like appearance of ossification along the spine, calcification of the paravertebral ligaments, exaggerated thoracic kyphosis, absence of vertebral skip lesions, and hyperostosis at tendon attachment sites, particularly in the ilium. Further observations identify diffuse bilateral extraspinal hyperostosis and sternal ankylosis caused by ossification of cartilage extending from the right first rib to the sternal manubrium. Although hyperostosis involving the anterolateral longitudinal ligaments of the cervical, rather than thoracic, vertebrae is noted, this does not exclude a likely diagnosis of DISH.

Radiographic and clinical findings strongly support a diagnosis of diffuse idiopathic skeletal hyperostosis (DISH). Key indicators include flowing spinal osteophytes, extraspinal entheseal ossifications, pseudo-fusion in the sacroiliac joint, and the absence of inflammatory or infectious involvement that typically seen in other conditions such as ankylosing spondylitis or tuberculosis. The preservation of intervertebral spaces and ossifications in non-axial regions further reinforce DISH as the most plausible explanation. The evidence suggests the patient may be in early-phase DISH (eDISH) characterized by progressive vertebral fusion.

Table 3 Illustration of a comparison of the differential diagnosis of lesions in diseases related to DISH. The diagnosis is most probably DISH disease in comparison to other conditions

Disease Signs	Sub-Groups	Coarse Syndesmophytes	Sex	Age	Fusion in the Sacrum	Fusion in the Lumbar vertebrae	Fusion in the Thoracic Vertebrae	Fusion in the Cervical Vertebrae	Preservence of Disc Space	Destruction in Vertebral Bodies	Increased Vertebral Kyphosis and Lordosis	Skip Lesion in Spine	Sacroiliac Joint Fusion	Extra Spinal Hyperostosis	Unusual Cartilage Ossification	Bambo Spine	Extraxial Arthropathy	Symmetrical Conflict
Spondyloarthropathies	Ankylosans Spondylitis (AS)	Yes	M>F	**15-35Y**	Yes	Yes[I]	Yes	Yes	Yes	No	Yes	No	Yes	Unusual	No	Yes	No	Yes
	ReS	Yes	M=F	**18-40Y**	Yes	Yes	Yes	Yes	Yes	**No**	maybe	Yes	Yes	Rare[VI]	**No**	No	Yes[II]	No
	(PsA)	Yes	M=F	Young adults	Yes	Yes	Yes	Yes[I]	Yes	No	maybe	Yes	Yes	Rare	No	Rare	Yes[III]	No
Metabolic Disease	Gauty Arthritis	No	M>F	Adult-s	No	No	No	No	Yes	No	No	NO	-	Rare	Maybe	No	Yes	No
	Primary & Secondary Hyperparathyroidism	No	Variable	Variable	No	No	No	No	Yes	Maybe	Maybe	No	No	No	Yes	No	No	Yes
POEMS Syndrome	-	No	M>F	30-80Y	No	No	No	No	Yes	Maybe	Maybe	No	No	No	Yes	No	No	No
Paget's Disease	-	No	M>F	50-60Y	No	No	No	No	Yes	Yes	Yes	No	maybe	Yes	No	No	Yes	No
Infectious Disease	Brucellosis	No	M=F	Any age	Rare	Yes	Yes[IV]	Yes	Yes	No	Rare	Yes	Yes	No	No	No	Rare	No
	Tuberculosis	No	M=F	Any age	Rare	Yes	Yes[V]	Yes	No	Yes	Yes	Yes	Yes	No	No	No	Rare	No
DISH	-	Yes	M>F	>45 Y	No	Yes	Yes	Yes	Yes	No	Yes	maybe	No	Yes	Yes	Yes	No	No

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Declarations

Competing interests The authors declare no competing interests.

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