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Abdominal fat distribution in diffuse idiopathic skeletal hyperostosis and ankylosing spondylitis patients compared to controls

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AIM: To evaluate abdominal fat distribution (subcutaneous adipose tissue [SAT] and visceral adipose tissue [VAT]) in two enthesopathy-related diseases with known correlation to metabolic syndrome (MS): diffuse idiopathic skeletal hyperostosis (DISH) and ankylosing spondylitis (AS) compared with controls.

MATERIALS AND METHODS: Abdominal computed tomography (CT) examinations of 43 DISH (Resnick radiographic criteria) patients, 31 AS (Modified New York Criteria) patients and 42 age- and gender-matched (to DISH) controls (males: 29; 29; 27 and mean age: 71.7±7; 56.1±16; 72.7±8 years, respectively) were evaluated and compared for VAT and SAT surface areas on mid L3, L4, L5 levels.

RESULTS: AS patients were significantly younger compared to DISH patients and controls. No significant differences were observed between VAT and SAT of DISH and AS patients or between SAT values in all groups even after correction for age. VAT was higher in DISH and AS patients compared to controls on all three levels, but reached significance ($p<0.05$) only for DISH patients (L3: 24.34/23.6/18.43; L4: 23.85/22.21/18.05; L5: 19.09/18.94/14.24 mm^2, respectively). This did not change after correction for age. The VAT/SAT ratio was significantly larger in DISH and AS patients on all levels compared to controls.

CONCLUSION: The higher VAT surface area, a known marker for MS, which by itself is associated with bone proliferation, in DISH and AS patients compared to controls substantiates its role as a potential surrogate marker for MS as well as suggests a potential shared pathogenic pathway for enthesopathic excessive bone production in DISH and AS.

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Introduction

Diffuse idiopathic skeletal hyperostosis (DISH) is a poorly understood, systemic condition characterised by progressive calcification and ossification of ligaments and entheses with marked predilection for the axial skeleton (particularly the thoracic spine), but may also involve peripheral joints.[1,2] The disease is observed mostly in the elderly with a male preponderance. The disease is radiographically diagnosed mostly by the Niwayama and Resnick criteria, which include flowing ossifications along the anterolateral aspect of at least four contiguous vertebral bodies, preservation of intervertebral disc height in the involved areas, and absence of sacroiliac joint erosions or sclerosis.[2,3]

DISH is associated with metabolic risk factors, especially obesity, dyslipidaemia, hypertension, and type 2 diabetes mellitus.[4,5] These were also reported to appear in patients with ankylosing spondylitis (AS), the inflammatory counterpart of DISH also known to involve entheses of the axial and peripheral sites.[6–8]

Metabolic syndrome (MS) is a cluster of metabolic and cardiovascular risk factors including obesity and visceral adiposity, insulin resistance, dyslipidaemia, and hypertension. These factors contribute to cardiovascular mortality being a major cause of mortality worldwide.[9]

Body fat tissue is distributed into two main compartments with different metabolic characteristics: subcutaneous adipose tissue (SAT) and visceral adipose tissue (VAT). Visceral or central obesity is defined as increased adipose tissue surrounding the intra-abdominal organs. Body fat, mainly visceral, has been distinctly linked to impaired glucose and lipid metabolism, insulin resistance, and other MS components.[10–12] VAT was also shown as a major predictor for cardiovascular events.[13–16]

Currently, the reference standard for the quantitative assessment of VAT and SAT is by computed tomography (CT) and magnetic resonance imaging (MRI).[17] Indeed, VAT CT measurement and the ratio between VAT:SAT tissue have been associated with a greater cardio-metabolic risk regardless of body mass index (BMI) or race.[15,16,18] The most accepted and reliable method for CT measurement of VAT and SAT is by measuring the intra-abdominal fat surface area on a single CT transverse slice at mid L3, L4, or L5 vertebra's height.[19]

Body fat composition was shown to be altered in AS and DISH patients using methods such as waist circumference measurement and densitometry [20–22]; however, to the authors' knowledge visceral adiposity and fat distribution were not evaluated on CT in DISH or AS patients.

Due to the potential role of visceral adiposity as a surrogate biomarker for MS in DISH and AS patients, the aim of the present study was to evaluate VAT and SAT distribution on CT examinations of patients with DISH as compared to age- and gender-matched controls as well as to patients with AS.

Materials and methods

Institutional review board approval was obtained for the retrospective analysis of CT scans performed between 2000 and 2015. Patient consent was waived due to the retrospective nature of the study. The authors declare no conflicts of interest.

Patients

Archived records of patients with a radiographic diagnosis of DISH (Niwayama & Resnick criteria), were used as the primary cohort for the study. The institution's picture archiving and communication system (PACS) was searched for abdominal and chest CT examinations in these patients. Included in the study were patients who had both examinations and in which DISH was verified on the thoracic CT examination. Only patients who's abdominal or pelvic CT examination covered the entire pelvis between L1–L5 vertebral heights were evaluated. Patients whose pelvic CT examination did not include the entire subcutaneous fat area or patients with extreme subcutaneous fat oedema were excluded.

In addition, archived records of patients with known diagnosis of AS by the Modified New York Criteria[23] that had a pelvic CT examination adhering to the same inclusion CT criteria as DISH were included in the study. The CT appearance of the thoracic spine in DISH and ankylosing spondylitis is demonstrated in Fig 1.

Age- and gender-matched patients to the DISH study group who had CT examinations of the entire spine showing no evidence of DISH and had abdominal or pelvic CT examinations adhering to the same inclusion and exclusion criteria as DISH and AS formed the control group. In order to exclude patients who may potentially have DISH in early stages[24] a strict criterion of absence of two or more flowing osteophytes anywhere along the cervical, thoracic, or lumbar spine was chosen. Patients with more than two flowing osteophytes were excluded from the control group.

Medical indications for CT examinations were similarly distributed between the three study groups: surgical work-up: DISH n=15 (35%), AS n=10 (32%), controls n=14 (32%), oncological work-up: DISH n=20 (46%), AS n=15 (48%), controls n=18 (43%), follow-up: DISH n=8 (19%), AS n=6 (20%), control n=10 (24%).

CT technique and adiposity measurements

All CT studies were performed using the following CT systems: Mx8000 Quad 4-slices, Mx8000 IDT 16-slices, Brilliance 40, 64 and 128 (Philips Medical Systems, Eindhoven, The Netherlands), and 64-slice VCT LightSpeed (GE Medical Systems, Milwaukee, WI, USA). Slice thickness ranged between 0.6 and 2.5 mm. Images were evaluated using the soft-tissue algorithm in the axial orientation.

Adiposity measurements were evaluated on the pelvic CT examinations of all three groups by a single reader (a postgraduate, third-year resident), blinded to the patient's clinical data. A subgroup of 10% of all examinations in the three groups was re-evaluated by a second reader (a musculoskeletal radiologist with 16 years of experience) for reproducibility evaluation.