CONCISE REPORT

Imaging of tophaceous gout: computed tomography provides specific images compared with magnetic resonance imaging and ultrasonography

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Ann Rheum Dis 2002;61:52–54

Objective: To determine the usefulness of computed tomography (CT), magnetic resonance imaging (MRI), and Doppler ultrasonography (US) in providing specific images of gouty tophi.

Methods: Four male patients with chronic gout with tophi affecting the knee joints (three cases) or the olecranon processes of the elbows (one case) were assessed. Crystallographic analyses of the synovial fluid or tissue aspirates of the areas of interest were made with polarising light microscopy, alizarin red staining, and x ray diffraction. CT was performed with a GE scanner, MR imaging was obtained with a 1.5 T Magnetom (Siemens), and ultrasonography with colour Doppler was carried out by standard technique.

Results: Crystallographic analyses showed monosodium urate (MSU) crystals in the specimens of the four patients; hydroxyapatite and calcium pyrophosphate dihydrate (CPPD) crystals were not found. A diffuse soft tissue thickening was seen on plain radiographs but no calcifications or ossifications of the tophi. CT disclosed lesions containing round and oval opacities, with a mean density of about 160 Hounsfield units (HU). With MRI, lesions were of low to intermediate signal intensity on T₁ and T₂ weighting. After contrast injection in two cases, enhancement of the tophus was seen in one. Colour Doppler US showed the tophi to be hypoechoic with peripheral increase of the blood flow in three cases.

Conclusion: The MR and colour Doppler US images showed the tophi as masses surrounded by a hypervascular area, which cannot be considered as specific for gout. But on CT images, masses of about 160 HU density were clearly seen, which correspond to MSU crystal deposits.

In previous studies we have shown that MSU crystal deposits in chronic gout may be identified by CT in the knee joints,¹ in the tendons,² and in subcutaneous tissues.³ They appear as round and oval opacities having a CT attenuation in the range of 150–200 HU. This study aimed at comparing CT with magnetic resonance MR imaging and

Identification of crystals

Needle aspiration of synovial fluid (patients 2, 3, 4) or tophaceous material (patient 1) was made in the area which was imaged. The aspirates were examined with polarising light microscopy and a first order red filter, then they were coloured with alizarin red stain, according to the technique of Paul *et al* for detection of apatite.⁴ The samples were analysed with powder diffraction x ray by standard methods.⁵

Imaging technique

Conventional x ray examinations were made in all the cases. CT examination was performed with a 9800 high speed advantage scanner (GE), MR imaging was obtained with a 1.5 T magnetom (Siemens), and ultrasonography with colour Doppler was carried out with a high frequency pulse (Acuson 128 XP/10 or an ATL HDI 5000).

RESULTS

Identification of crystals

Polarising light microscopy disclosed MSU crystals; CPPD crystals were not seen. Alizarin red staining did not show calcium containing compounds in any of the patients. x Ray powder diffraction analyses identified MSU crystals in the samples of all four patients. Apatite crystals were not found.

Results of imaging techniques

Plain radiographs showed soft tissue thickening; there were no calcifications or ossifications within the tophi. Bone erosions in contact with tophi were seen in patients 2, 3, and 4. CT images disclosed round and oval opacities in the tophi, 2–6 mm in diameter, with a mean density of about 160 HU (figs 1A and 2A). On MR imaging, the tophi were of intermediate intensity on T₁ weighting and of intermediate to low intensity on T₂ weighting (figs 1B and 2B). A gadolinium injection was made in patients 1 and 2; there was no enhancement in case 1 and in case 2 the signal was enhanced around the tophus (fig 1B). On gray scale ultrasound images, the tophi were hypoechoic with bright spots in the periphery and some shadowing (figs 1C and 2C). With colour Doppler, there was no obvious vascularity in case 1. However in cases 2, 3, and 4 increased vascularity was seen around the tophi (figs 1C and 2C).

DISCUSSION

An imaging technique which could specifically demonstrate MSU deposits within tissues would be very helpful, especially in patients presenting with a tumour of soft tissues of

PATIENTS AND METHODS

Four men with chronic tophaceous gout were examined. Their mean age was 56.3 years and the mean duration of gout 18 years. Associated disorders were hypertension and type II diabetes (patient 1), obesity and gonarthrosis (patient 2), allergy to allopurinol (patient 3), and hypertension (patient 4). Imaging of the left olecranon was carried out in patient 1, the left knee in patient 2, and the prepatellar bursa in patients 3 and 4.

Abbreviations: CT, computed tomography; CPPD, calcium pyrophosphate dihydrate; HU, Hounsfield units; MRI, magnetic resonance imaging; MSU, monosodium urate; US, ultrasound

unknown cause⁶ or in patients with subcutaneous nodules—which might be related either to gout or to rheumatoid arthritis.⁷ As we have shown in previous studies, MSU deposits within a tophus can be clearly defined with CT. The opacities have a CT attenuation of about 160 HU, which is clearly inferior to that of deposits of calcium containing crystals, which have an attenuation of about 450 HU. Apatite crystals can be seen in old tophi. This is shown by plain x rays, which sometimes disclose calcifications or ossifications in the centre of some tophi^{7 8}; in some cases anatomopathological studies have also disclosed calcifications in necrotic centres of tophi.⁹

However, there were no radiological or crystallographic data supporting the idea that apatite crystals might have been present in our cases. Unlike the results of Chen *et al*,¹⁰ our data do not sustain the hypothesis that apatite crystals mixed with MSU crystals may explain the opacities seen on CT images. Moreover, pure MSU crystal deposits have been proved to have the same CT attenuation in vitro as in tissues.¹

On ultrasonographic images, the tophi appeared as hypoechogenic structures of high attenuation with shadowing and hyperechogenic surrounding, images which cannot be clearly

differentiated from rheumatoid nodules.¹¹ MR imaging showed the tophi as structures of intermediate to low signal intensity, as already reported in previous papers.^{6 10 12} These findings cannot be considered specific to gout.¹² The post-gadolinium injected images showed a peripheral enhancement of the tophus (fig 1B), which is a sign of hypervascularity in patient 2 (fig 1B) but not in patient 1; likewise images with colour Doppler showed hypervascularity in patient 2 as well as in patients 3 and 4. It can be asked whether hypervascularity as demonstrated on injected MR and colour Doppler images is a sign of inflammatory reaction. Indeed, hypervascularity could favour bone erosions and destruction in close contact with the tophi, as in the three cases in which images of hypervascularity were seen; bone erosions were absent in the patient without signs of hypervascularity.

ACKNOWLEDGMENT

The authors thank L Calame, chief technician, for synovial fluid analyses, and P Thélin, of the University Institute of Mineralogy of Lausanne for supervising x ray diffraction analyses.

Figure 1 (A) Patient 2, left knee, lateral tophus. Two dimensional reconstruction coronal CT: lateral soft tissue thickening containing nodular opacities of 150–200 HU in density (a smaller medial tophus lesion is seen). (B) Coronal T₁ MRI with fat saturation after injection of gadolinium. The lateral tophus is intermediate in signal intensity. The periphery of the tophus is stained with contrast. (C) Colour Doppler view of the lateral aspect of the knee: the tophus is hypoechogenic with an hyperechogenic rim. Vessels are seen all around the tophus (coloured spots).

Figure 2 (A) Patient 3, left knee, prepatellar tophus. CT showing prepatellar soft tissue thickening and small nodular opacities of 150–200 HU in density. There are erosions with overhanging edges of the patella. Nodular opacities are also seen in the posterior part of the knee. (B) Transverse T₂ MRI with fat saturation. The soft tissue is intermediate in signal intensity. The nodular lesions are clearly seen. There is also joint fluid. (C) Colour Doppler transverse view of the medial aspect of the knee. The tophus appears as a hypoechogenic nodule surrounded by a hyperechogenic rim. Some vessels are visible within and around the nodule.

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Accepted 14 May 2001

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