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Imaging of gout: New tools and biomarkers?

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A B S T R A C T

While joint aspiration and crystal identification by polarizing microscopy remain the gold standard for diagnosing tophaceous gout, agreement among medical and ancillary health personnel examining synovial fluid using polarizing microscopy for the detection of monosodium urate (MSU) crystals appears to be poor. Imaging modalities, including conventional radiography (CR), ultrasonography (US), magnetic resonance imaging (MRI), and dual-energy computed tomography (DECT), have been found to provide information on the deposition of MSU crystals in tissues, and the consequences of such deposition. CR can demonstrate typical "punched out lesions" with marginal overhangs, but the sensitivity for erosion detection is better for DECT and US. US is inexpensive and can identify tophus deposition in and around joints, erosions, and tissue inflammation if power Doppler US is used. MRI can show tophi, bone marrow edema, and inflammation, but MRI findings of tophi may be nonspecific. DECT can identify and color-code tophaceous material, and provide an overview of the tophus burden of a joint area. Because of the lower number of available studies, the strength of evidence for the newer imaging can be improved through further research.

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Introduction

Gout is a common crystal-associated arthropathy, and epidemiologic data suggest that its incidence is increasing [1,2]. Gouty arthritis develops in the setting of hyperuricemia (serum uric acid > 6.8 mg/dl). Several risk factors are associated with gout, including dietary habits, use of alcoholic beverages, obesity, hypertension, hypertriglyceridemia, and renal impairment [2]. It manifests in both acute and chronic forms. Clinically, acute gout manifests as a recurrent, self-limiting severe inflammatory arthritis. In the chronic form, the aggregates of monosodium urate (MSU) crystals (also known as tophi) deposit in and around the joints, causing bone and joint destruction. If treated properly, flares of acute gouty arthritis can be prevented and joint damage due to tophi formation can be minimized. Therefore, a timely diagnosis of gout is essential to prevent patient morbidity [1–3].

Currently, the gold standard diagnosis of gout is based on the direct microscopic visualization of intracellular MSU crystals in the synovial fluid of affected joints. This requires performing an arthrocentesis of the affected joint, which sometimes is technically challenging and, in the case of periarticular inflammation, not feasible.

Advanced imaging techniques, such as ultrasonography (US), magnetic resonance imaging (MRI), and dual-energy computed tomography (DECT), have gained an essential role in the field of gout in recent years. The 2015 gout classification criteria developed by the American College of Rheumatology (ACR) in collaboration with the European League Against Rheumatism (EULAR) have included imaging modalities as a method to identify urate deposition in joints or bursa (US and DECT) or to identify gout-related joint damage conventional radiography (CR) [4]. The Outcome Measures in Rheumatology (OMERACT) gout working group has defined three domains for imaging in gout studies: urate deposition, joint inflammation, and structure joint damage [5], as shown in Table 1. Hence, imaging studies are not only important in helping to establish a diagnosis of gout, but they also play an important role in monitoring disease progression and response to treatment.

In this article, we will review the utility of conventional radiography (CR) as well as US, MRI, and DECT in gout and discuss the clinical and research utilities of the different imaging modalities.

Conventional radiography

CR has been used for the diagnosis and assessment of gouty arthritis for more than 120 years. In the early stages of the disease, during an acute gout attack, no osseous changes are present, but signs of joint swelling and effusion can be identified on plain radiographs by bulging soft tissue contours. Later in the course of the disease, tophaceous deposits may cause an increase in the radiodensity of periarticular tissues.

The most characteristic findings in the advanced stages of gouty arthritis are well-defined deep bony erosions with sharp overhanging edges and a sclerotic rim. This typical appearance is presumably caused by intra- or periarticular MSU deposits, leading to the activation of inflammatory cells, which in

Table 1
Gout working group prioritization of imaging modalities with the most potential for development in each of the three relevant domains. The highest priority is indicated as unshaded. Possible modalities are indicated in gray. Modalities not recommended for further development as darkshade.

Urate deposition	Structural damage	Joint inflammation
X-ray	X-ray	X-ray
Conventional CT	Conventional CT	Conventional CT
DECT	DECT	DECT
MRI	MRI	MRI
Ultrasound	Ultrasound	Ultrasound

DECT: dual-energy computed tomography.
CT: conventional computed tomography.
MRI: magnetic resonance imaging.
Adapted from: Imaging as an Outcome Measure in Gout Studies: Report from the OMERACT Gout Working Group. Grainger R et al., J Rheumatol 2015.