Duel Energy CT Imaging of Tophaceous Gout

Abstract:

Gout is characterized by an inflammatory response that is initiated by the precipitation of monosodium urate crystals within and surrounding the joints as well as the soft tissue. This is the most common form of inflammatory arthritis and has been showing increasing incidence over recent years in association with increased incidence of the metabolic syndrome. Arthritis Ireland believe the same increase is taking place in Ireland with up to 5% of the Irish population suffering from gout. Many associate alcohol consumption with gout but fructose in non alcoholic soft drinks and beers may also have a contributory role. Male patients who consume over 2 soft drinks daily are thought to have a 1.85 relative risk for developing gout.

Typical age of onset is 30-50 years old and the initial presentation is often with an acutely painful first metatarsophalangeal joint known as podagra. A diagnosis of gout is usually made on clinical grounds in combination with, serum urate levels and radiologic diagnosis. The presence of monosodium urate crystals in aspirated synovial fluid is definitive. Urate crystals are negatively birefringent under polarized light. Joint aspiration can be difficult in the acutely inflamed joint, the deformed joint and is not always performed for definitive diagnosis. Using these diagnostic tools gout is usually easily diagnosed, but in certain cases the clinical and biochemical picture is ambiguous. For example patients atypical site of disease, a prolonged rate of onset, or polyarthropathy. Serum uric acid levels may be normal in an acute gouty attack. Although there is hyperuricaemia there may be concomitantly an acute inflammatory process that imitates gout.

Plain film radiographs are invaluable in the diagnosis of gout demonstrating typical peripheral erosions, soft tissue swelling and calcific tophi in the hands and feet. Characteristic locations include the first metatarsophalangeal joint and the first metacarpophalangeal joint. The time erosions and tophi are present however this already indicates advanced disease and plain films are not the diagnosis or choice for early stage disease. Bone erosions take many years to develop and they may be seen on radiographs even in the absence of current active disease indicating a sequela of prior attacks of gout. Ultrasound of the joint is a widely available bedside non invasive technique. Ultrasonography is particularly useful to image the inflammatory nature of gouty arthropathy, revealing synovial and soft tissue inflammation, and can analyse the composition and vascularity of tophi. Ultrasound is considered less sensitive for osseous erosions than MRI but better than plain film. Monosodium urate (MSU) tophi are very echogenic when US is used. Typical US features of gout include a double-contour sign or “urate icing”.

MRI is used in the characterization of inflammatory arthropathies due to its excellent soft tissue characterization, detecting the presence and extent of synovial involvement. MRI can indicate activity of disease with increased T2 signal intensity in active tophi and enhancement with administration of intra venous gadolinium. MRI is not routinely used in the diagnosis of gout but can be particularly useful if the differential diagnosis is osteomyelitis. Bone oedema is not a typical feature of gout.

Dual energy CT was developed for the evaluation of uric acid content of renal stones. On standard non contrast CT calcific tophi and calcific deposits for other reasons cannot be differentiated. So renal stones composed of uric acid could not be distinguished from stones made of harder calcium oxalate or cysteine using standard CT as both appear as hyperattenuating deposits on non contrast CT. This modality is an important differentiation as softer stones such as uric acid stones are known to have a better response to lithotripsy than calcium oxalate stones. Dual energy CT evolved to allow characterization of the density of calcific deposits. This is possible due to acquisition of two images at different tube voltages with different attenuation characteristics by using two different kilovoltage potentials (80 and 135Kvp).

Different materials interact with the different kilovoltage potentials in a manner specific to their atomic density. The dual energy technique of dual energy imaging using a gout algorithm and colour coded images are produced reflecting differences in the composition of the material. Standard CT acquired simultaneously allows for high resolution depiction of bone and the extent of periarticular erosions.

Dual energy CT is not confined to use in the evaluation of renal stones and gout. It is also used for characterization of adrenal masses as well as cardiac imaging and vascular imaging. It can be used to create virtual non contrast images and thus reducing radiation doses. This technique, takes approximately 5 minutes to image the hands and feet. It is not associated with increased radiation doses over standard CT. Typical effective dose is in the region of 0.1-2mSv, standard two film series of one foot is 0.12mSv. DECT can be used to detect uric acid crystals with moderate sensitivity and high specificity according to several retrospective studies. Only one randomized control study has been performed confirming this. DECT can be used to problem solve in difficult cases where there are atypical sites of disease, significant soft tissue activity, acute gouty joint aspirates. DECT can be used to exclude other causes of an acutely inflamed joint. Cases with atypical presentations can delay diagnosis and treatment and have a consequence on patient outcome. To determine response to treatment, dual energy CT may prove to be the most sensitive method of quantitating tophus volume at baseline and following treatment.

With advancing imaging techniques we are provided with more sensitive techniques for detection of disease earlier in the disease process. Ultrasound and MRI are super sensitive techniques which were able to detect disease activity in the joints many years into the disease process. Currently, ultrasounds have been shown to detect early changes around the joint in patients with hyperuricaemia even in the asymptomatic setting. With the rising incidence of hyperuricaemia, it poses the question how aggressive should we be with new imaging techniques such as US and DECT to detect subclinical disease prior to onset of irreversible changes.

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References
5. McQueen PM, Doyle A, Dalbeth N. Imaging in gout—what can we learn from MRI, CT, DECT and US? Arthritis Res Ther;13:246
8. Poh YJ, Dalbeth N, Doyle A, McQueen FM. Magnetic resonance imaging bone edema is not a major feature of gout unless there is concomitant osteomyelitis: 10-year findings from a high-prevalence population. J Rheumatol;38:2475-2481
