Dual Energy CT for Gout

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Gout

• Deposition of monosodium urate crystals (MSU) in joints and soft tissues

• Body’s reaction to MSU leads to inflammation and symptoms

• Hallmark is hyperuricemia

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Diagnosis

- Clinical Findings

- Reference standard
  - ID of MSU crystals in joint fluid aspirate or soft tissue biopsy (thin, needle, negative birefringence on polarized microscopy)

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Diagnosis (Difficult/Elusive)

- Reliability of polarizing microscopy is poor
- Unusual manifestations, mimics, and disease coexistence
- Hyperuricemia may not be present in acute gout (42%)
- Joint aspiration and/or needle biopsy may not be feasible:
  - Physician experience/skill
  - Busy office setting/blind aspiration
  - Small joints, periarticular soft tissues
- Joint aspiration/biopsy complications
Gout

Ideal Imaging

✓ Accurate, non-invasive, early diagnosis
  ▪ Differentiate disease mimics
  ▪ Detect unusual manifestations
  ▪ Detect subclinical disease

✓ Evaluate severity and sequelae of disease

✓ Distinguish acute vs. chronic

✓ Quantify urate burden

✓ Monitor response to urate lowering therapy
  ✓ Outcome measures for clinical trials
Gout Imaging

- **Radiography (X-Ray)**

- **Advanced Imaging**
  - Magnetic Resonance Imaging (MRI)
  - High Resolution Ultrasound
  - Computed Tomography (CT)
    - Dual Energy CT
Gout
Radiography

- Marginal erosions with overhanging edges and sclerosis
- Preserved joint spaces until late
- Soft tissue nodules (tophi)
- Normal x-rays in early gout
  - 45-70% negative
- Latent period between first clinical symptoms and specific x-ray signs (5-10 yrs)

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MRI

- Comprehensive (soft tissue, bone, joint)
- *Not specific*, variable MR features
  - Tophi intermediate to low signal
  - Variable enhancement and marrow edema
- Location is key
Gout
High-Resolution Ultrasound

Joint features:
- Joint effusion
  - US more sensitive than clinical exam
- Synovitis
- Erosions
- Hyperechoic floating MSU crystals ("snowstorm")

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High-Resolution Ultrasound

Double Contour Sign

- MSU crystals on hyaline cartilage
- Specific (99%) for gout and asymptomatic hyperuricemia
- Not sensitive (44%)
- Sign can resolve with therapy

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High-Resolution Ultrasound

Synovitis

- Heterogenous, hyperechoic foci, hypoechoic rim
- Increased vascularity
- Nodular, mass-like
- Synovitis in RA:
  - Hypoechoic, arborizing, fingerlike
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High-Resolution Ultrasound

Erosions

- Intraarticular discontinuity of the bone surface seen in 2 perpendicular planes (Outcome Measures in Rheumatology Group)

- Caution:
  - Normal cortical variation
  - Degenerative changes
  - Post traumatic changes
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High-Resolution Ultrasound

Tophi

- Hyperechoic, anechoic rim, nodular, infiltrative
- Posterior shadowing
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High-Resolution Ultrasound

Tendons/Ligaments

- Most commonly envelops (45%) rather than occurs intratendinous

  ✓ Achilles Tendon
  ✓ Peroneal tendons
  ✓ Popliteus tendon
  ✓ Cruciate ligaments
  ✓ Patellar Tendon

Gout

CT

Tophi
- Discrete, hyperdense masses (160-170 HU)
- Within bone, around joints, in tendons, in soft tissues

Erosions
- Associated with tophi (82%)
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Dual Energy CT

- Two x-ray sources (80 and 140 kVp)
- Simultaneously acquires two data sets
- X-ray absorption is energy dependent
- Materials act differently at different energies depending on their chemical composition
- Creates a difference in attenuation (DEI)
- Each unique DEI makes classification of chemical composition of different tissues possible
- Computer algorithm software color codes different tissues based their unique DEI, and fuses with CT image

Desai MA, et al. Radiographics 2011; 31:1365-1375
Gout
Dual Energy CT

Urate-Positive

- Green, globular, focal, and confluent
- Adjacent to an erosion
- Ligaments, tendons, cartilage, menisci
- Minimum diameter 3 mm
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Dual Energy CT

• Sensitivity 78-100%
• Specificity 89-100%
• Good overall accuracy


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Gout
Dual Energy CT - Clinical Utility

- Establish/confirm diagnosis
- Unusual Clinical manifestations
- Distinguish gout from disease mimics
- Discordant Serum Urate
- Evaluate acute vs. chronic changes
- Detect subclinical disease
- Volumetric quantification of urate burden
DECT enables diagnosis of gout when the standard diagnostic approach fails (30%)

- False negative synovial fluid analysis
- Inability to aspirate fluid (synovitis, small joints)
- Unable to biopsy suspected tophus
  - Tendons, ligaments, entheses

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Dual Energy CT - Clinical Utility

- DECT can measure MSU volume
- Changes in actual MSU volume burden following treatment
- Prediction of gout flare risk
- Correlation with cardiac risk factors
- Research implications
  - Outcome measures
  - Gout score/biomarker
  - Gout distribution

Fitzgerald J, Levine BD, Raymond J, McMahon MA. Impact of Plasma Urate and Tophaceous Burden on Inflammatory Biomarkers of Cardiovascular Disease. *Arthritis Rheumatol*. 2016; 68 (suppl 10)
Gout

Dual Energy CT - Limitations

- **Artifacts**
  - Skin (calluses) and nailbeds
  - Motion and metal
  - Edges of cortical bone, linear
  - Subcutaneous tissue
  - Muscle

- **Ionizing radiation**
- **May have more limited sensitivity in acute gout**
- **May have limited specificity in advanced knee osteoarthritis**

Gout
Dual Energy CT

Ideal Imaging Technique

✓ **Highly specific**
  - Confirms diagnosis of gout
  - Distinguishes disease mimics/unusual manifestations
  - Detects subclinical disease

✓ **Non-invasive**
  - Alternative to joint aspiration/biopsy

✓ **Early disease detection**
  - To reduce morbidity

✓ **Quantifies** urate volume burden

✓ **Monitors** response to treatment
Gout

Do We Really Have to Aspirate the Joint?
Gout
Do We Really Have to Biopsy?
Dual Energy CT for Gout

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