# Die Rolle der Bildgebung bei Diabetischen Fussinfekten

10. Balgrist Symposium zum Diabetischen Fuss

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10. Balgrist Symposium zum Diabetischen Fuss
Prophylaxe und Praxis bei Diabetischen Fussinfekten

# Die Rolle der Bildgebung bei Diabetischen Fussinfekten

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Prophylaxe und Praxis bei Diabetischem Fussinfekt

YouTube: Chameleon Changing Color

# Radiology – Goals

- Detect or exclude osteomyelitis in patients with diabetic foot syndrome
- Assess location and extent of osteomyelitis
- Diagnose complications: soft tissue abscess, septic arthritis or tenosynovitis
- Differentials: bone infarction, charcot neuro-osteoarthropathy

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# Outline

- Imaging technique
- MRI – normal vs. abnormal
- Osteitis or Osteomyelitis?
- Value of contrast material
- Imaging challenges and differential
- New imaging technique

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# Diabetic foot – Imaging technique

- **Baseline imaging – Radiographs**




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# Diabetic foot – Imaging technique

## Baseline imaging – Radiographs – what can we see

- **Arteriosclerosis**


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# Diabetic foot – Imaging technique

## Baseline imaging – Radiographs – what can we see

- **Arteriosclerosis**
- **Resected bones**

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# Diabetic foot – Imaging technique

## Baseline imaging – Radiographs – what can we see

- **Arteriosclerosis**
- **Resected bones**
- **Osteolysis and osteopenia**


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# Diabetic foot – Imaging technique

## Baseline imaging – Radiographs – what can we see

- **Arteriosclerosis**
- **Resected bones**
- **Osteolysis and osteopenia**
- **Ulcer and emphysema**


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# Diabetic foot – Imaging technique

## Baseline imaging – Radiographs – what can we see

- **Arteriosclerosis**
- **Resected bones**
- **Osteolysis and osteopenia**
- **Ulcer and emphysema**
- **Fracture**

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# Diabetic foot – Imaging technique

## Baseline imaging – Radiographs – what can we see

- Arteriosclerosis
- Resected bones
- Osteolysis and osteopenia
- Ulcer and emphysema
- Fracture
- Osteodestruction

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# Diabetic foot – Imaging technique

## Baseline imaging – Radiographs

- Arteriosclerosis
- Resected bones
- Osteolysis and osteopenia
- Ulcer and emphysema
- Fracture
- Osteodestruction
- Bone marrow evaluation

Low sensitivity (43-75%) and specificity (75-83%) to detect pedal osteomyelitis

Detection of acute OM: 10-20 days after onset

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Calvo-Wright, M.d.M et al, J. Clin. Med (2023)

# Diabetic foot – Imaging technique

## Advanced imaging – CT

- \- **Bone marrow evaluation**

- \+ **Cross sectional anatomy**
- \+ **Soft tissue: abscess, ulcer, gas**
- \+ **bony changes in chronic osteomyelitis: sequestrum, involucrum, cloaca**

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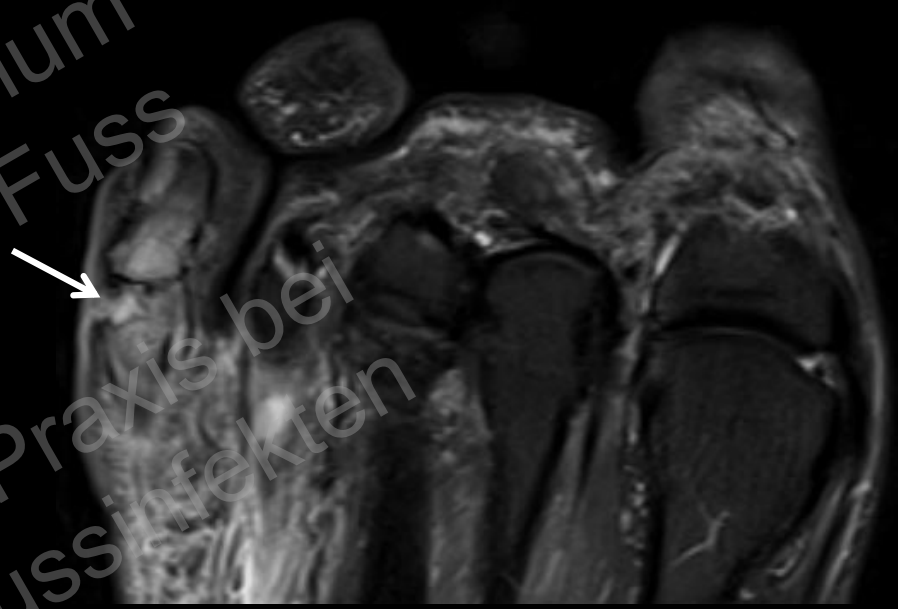
Simpfendorfer, CS, Infect Dis Clin N Am (2017)
Mandell, JC et al, Emerg Radiol (2018)

# Diabetic foot – Imaging technique

**Advanced imaging – MRI**

- **+ Bone marrow evaluation**
- **+ Cross sectional anatomy**
- **+ Soft tissue: abscess, gas, tenosynovitis**



**High sensitivity (90%) and specificity (79%) to detect pedal osteomyelitis**

**Detection of acute OM: 1-2 days after onset**

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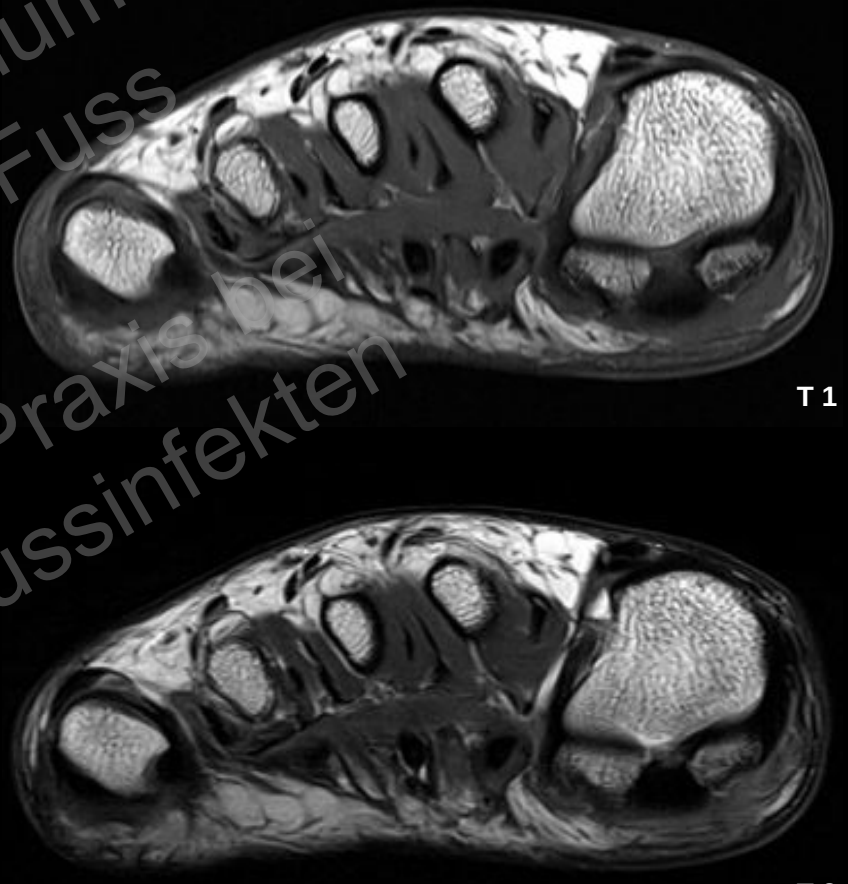
Simpfendorfer, CS, Infect Dis Clin N Am (2017)
Mandell, JC et al, Emerg Radiol (2018)

# Diabetic foot – Imaging technique

## MRI Protocol

STIR

T 1



T 1



T 2

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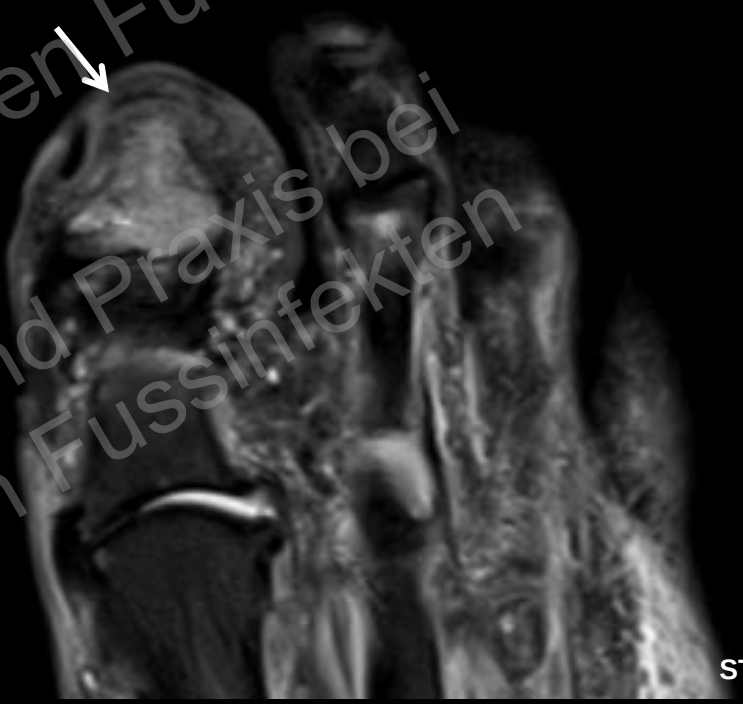
# Diabetic foot – MRI – Normal vs. abnormal

**Normal bone marrow**

STIR

**Bone marrow edema**



STIR

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# Diabetic foot – MRI – Normal vs. abnormal

**Normal bone marrow**

**Bone marrow replacement**

T 1

T 1

CT

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# Diabetic foot – MRI – Normal vs. abnormal

## MRI – Osteomyelitis

- **Fluid sensitive image (e.g. STIR): increased signal of bone marrow**

  **Alerts for presence of OM, BME non-specific finding**


- **T1-weighted image: decreased signal of bone marrow**
  - **Sensitivity 95%**
  - **Specificity 91%**


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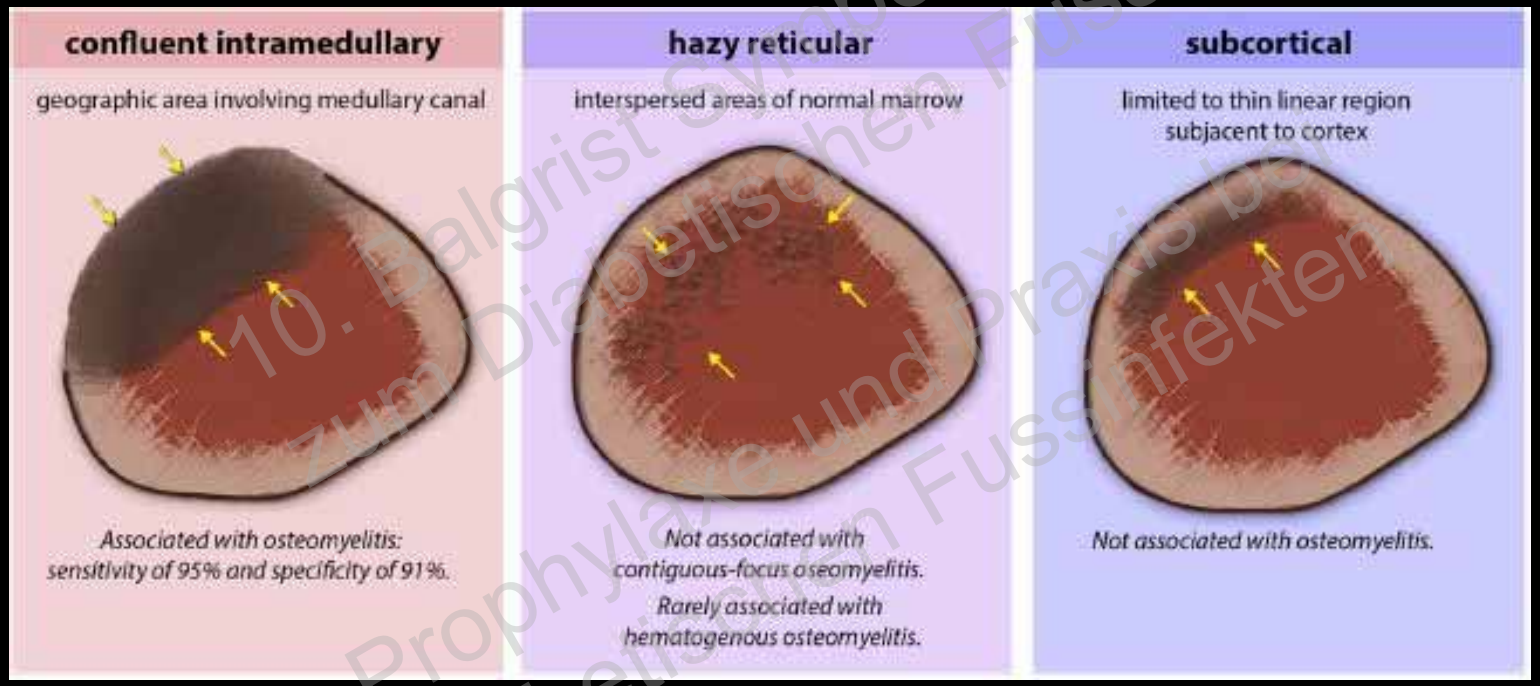
Mandell, JC et al, Emerg Radiol (2018)

# Diabetic foot – MRI – Normal vs. abnormal

## MRI – Osteomyelitis




**Patterns of T1 signal alteration**

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Mandell, JC et al, Emerg Radiol (2018)

# Diabetic foot – MRI – Normal vs. abnormal

## MRI – Osteomyelitis

**Table 3**
**MR Findings in Resected Bones with Negative Diagnosis at Pathologic Study**

| Patient No. | Bone Specimen | Signal Intensity: T1 | Signal Intensity: T2/Fat-suppressed T2/STIR/Fast STIR |
|---|---|---|---|
| 2 | Three phalanges | Normal | Normal on STIR, increased* on T2 |
| 10 | One phalanx, one metatarsal | Normal | Normal |
| 11 (second operation) | One phalanx, three metatarsals, two cuneiforms | Normal | Normal |
| | One navicular | Normal | Normal |
| 12 | Three phalanges | Normal | Normal |
| 13 | Two phalanges | Normal | Normal |
| | One phalanx | Normal | Increased† |

Note.—T1 = T1-weighted images, T2/Fat-suppressed STIR/Fast STIR = T2-weighted or fast fat-suppressed T2-weighted STIR or fast STIR images.
* Increased signal intensity attributed to nonuniformity of peripheral radio-frequency field.
† Increased signal intensity attributed to nonuniform fat suppression.

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**Normal bone marrow signal excludes osteomyelitis**

Craig, JG et al, Radiology (1997)

# Diabetic foot – Osteitis or Osteomyelitis?

**MRI – Osteomyelitis**

STIR

T 1

**MRI – (reactive) Osteitis**

STIR

T 1

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# Diabetic foot – Osteitis or Osteomyelitis?

**MRI – (reactive) Osteitis**

**!Caution!**

**STIR ↑ deep to ulcer and T1 normal**

- **61% developed OM**

**=> Carefully followed clinically**


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Mandell, JC et al, Emerg Radiol (2018)

# Diabetic foot – Value of contrast material

Not necessary for diagnosis of OM

- \+ delineation of soft tissue / intraosseous abscess
- \+ septic tenosynovitis
- \+ identification of necrotic bone

  (preserved T1 signal, fatty marrow)
- (+) demarcation of necrotic soft tissue

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Mandell, JC et al, Emerg Radiol (2018)

# Diabetic foot – Value of contrast material

## Intraosseous abscess

STIR T 1 T1 FS

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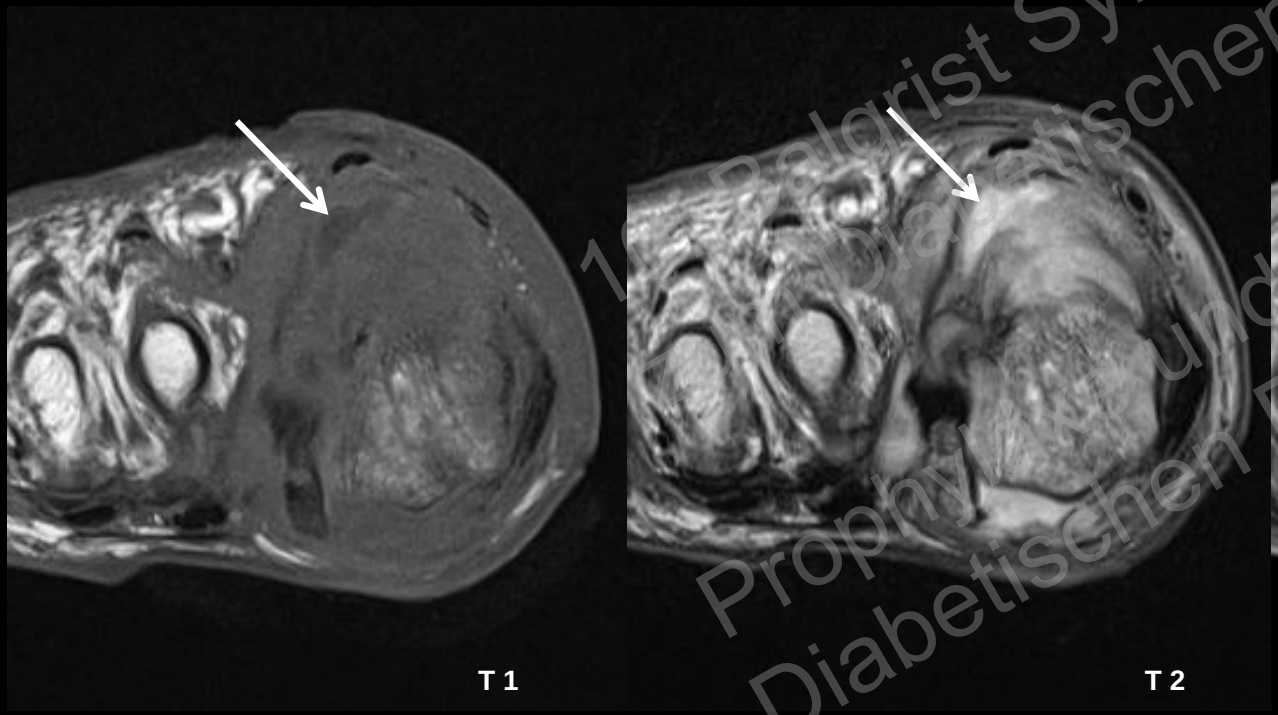
# Diabetic foot – Value of contrast material

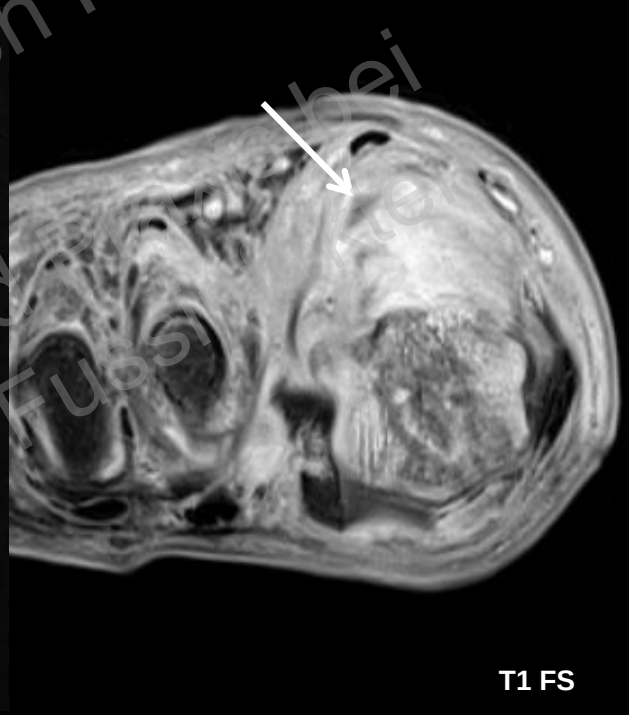
## Soft tissue abscess



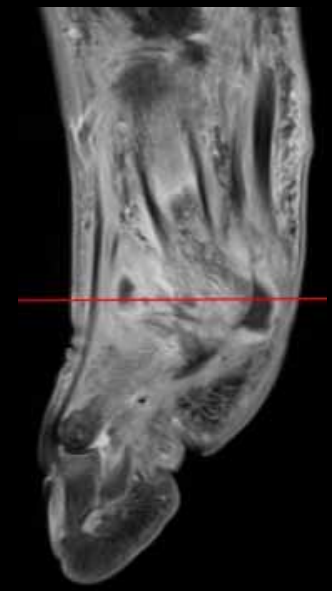
T 1



T 2



T1 FS



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# Diabetic foot – Value of contrast material

## Septic tenosynovitis

T 2

T1 FS

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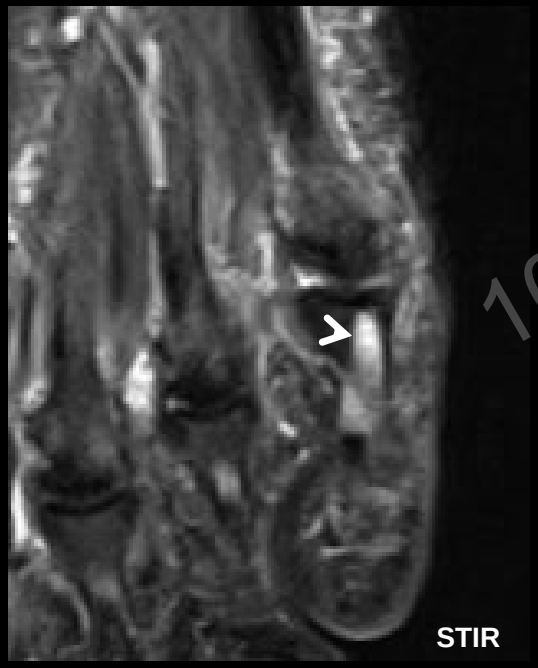
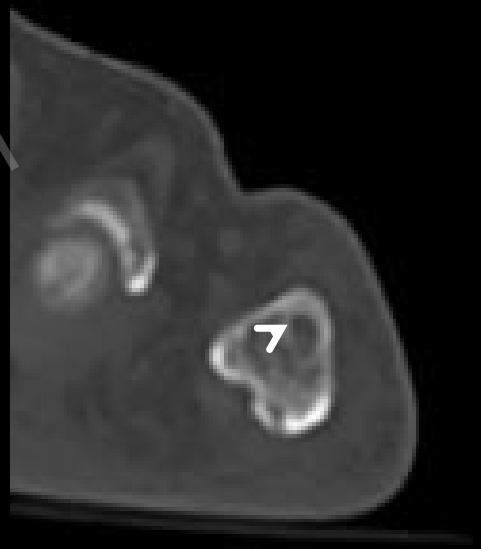
# Diabetic foot – Imaging challenges & differential

## K-wire channel


STIR


T 2


T1


CT

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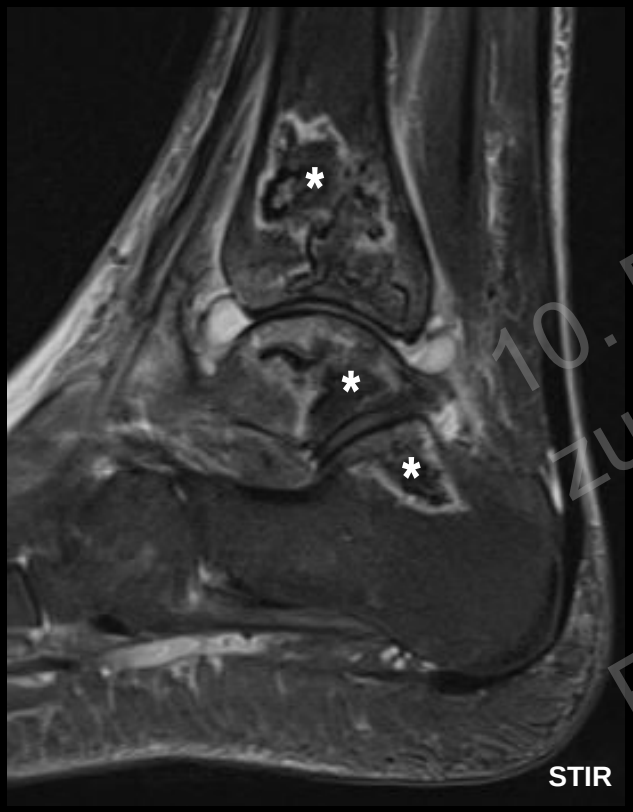
# Diabetic foot – Imaging challenges & differential

## Bone infarction



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# Diabetic foot – Imaging challenges & differential

## Charcot neuro-osteoarthropathy

STIR

T1

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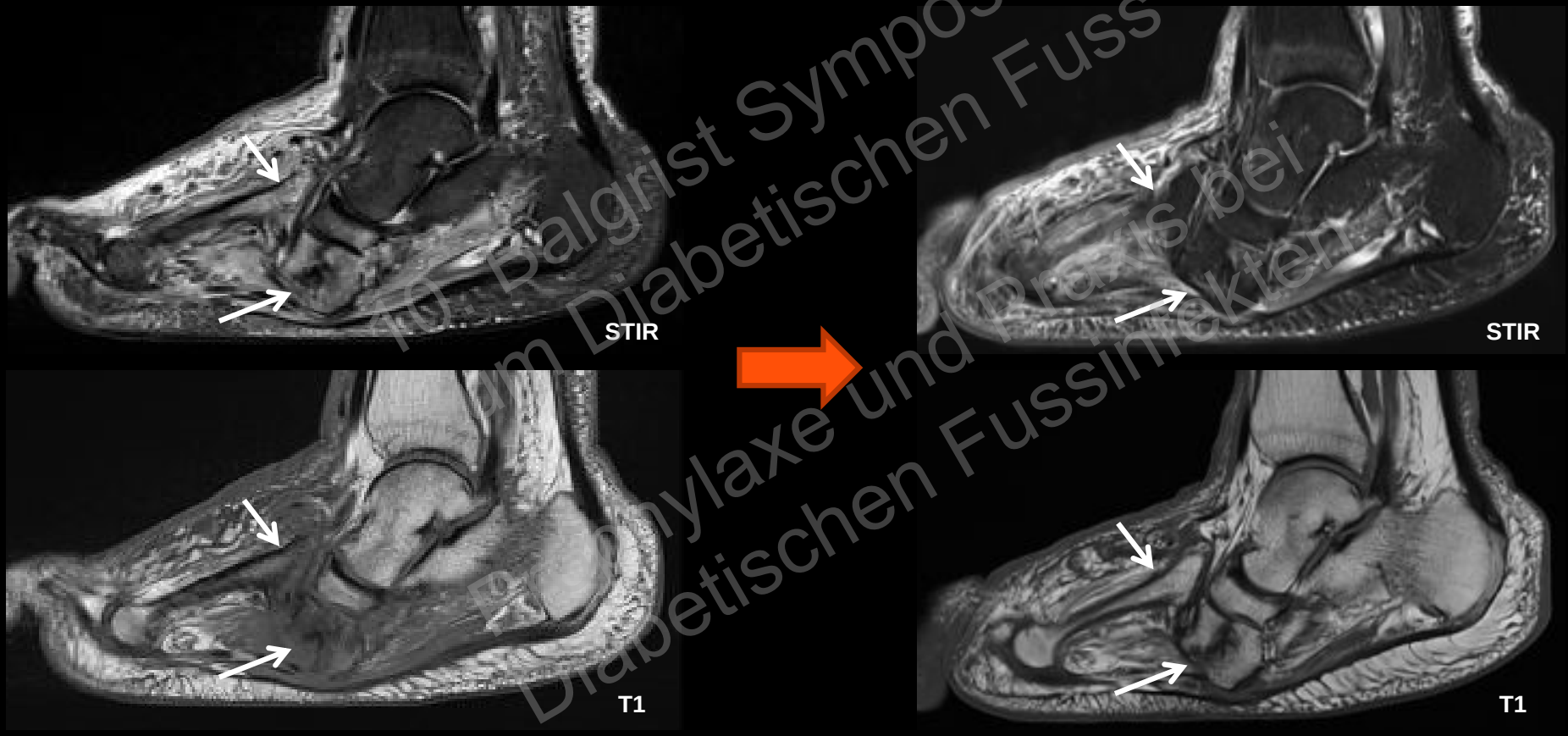
Diabetischen Infekten

# Diabetic foot – Imaging challenges & differential

## Charcot neuro-osteoarthropathy

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# Diabetic foot – new imaging technique

## Dual energy CT performance vs. MRI

- **Sensitivity 93%**
- **Specificity 83%**
- **Accuracy 87%**
- **NPV 94%**

⇒ **Potential as viable diagnostic alternative in patients who cannot undergo MRI (e.g. pacemaker)**

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Stern, C et al, unpublished data

# Take-home message

- **Normal vs. pathologic bone marrow**
- **Osteomyelitis (STIR ↑, T1 ↓) vs. Osteitis (STIR ↑, T1 →)**
- **Use of contrast material: soft tissue / intraosseous abscess, septic tenosynovitis**
- **Differentials: bone infarction, charcot charcot neuro-osteoarthropathy**
- **New imaging technique: DECT**

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# THANK YOU

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The Balgrist

# DD Charcot foot vs. superimposed OM

- **Sinus tract +/- soft tissue abscess**
- (Diffuse marrow signal abnormality)
- (Replacement of soft tissue fat)
- **Thick rim enhancement**
- (Joint erosion)
- **Ghost sign ( + OM, - Charcot)**

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