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## **Inflammation as a target for treatment in hand osteoarthritis**

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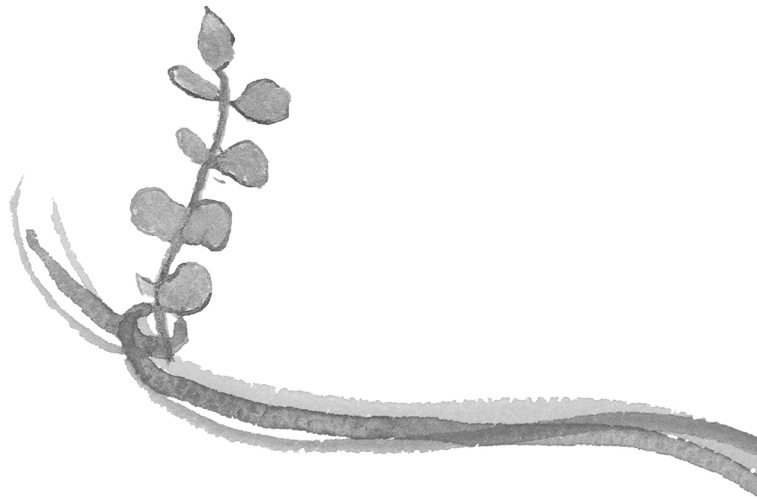
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# CHAPTER 15

## Atlas for the OMERACT thumb base osteoarthritis MRI scoring system (TOMS)

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## ABSTRACT

This paper presents an atlas for the Outcome Measures in Rheumatology Clinical Trials (OMERACT) thumb base osteoarthritis MRI scoring system (TOMS). The atlas includes reference images of each grade of each feature that is assessed in TOMS (synovitis grade 0-3, subchondral bone defects grade 0-3, osteophytes grade 0-3, cartilage assessment grade 0-3, subluxation and bone marrow lesions grade 0-3) in the first carpometacarpal and scapho-trapezio-trapezoid joint. The presented reference images can be used to guide scoring of thumb base MRIs in patients with hand osteoarthritis according to the OMERACT TOMS.

## ATLAS

Hand OA affects the interphalangeal and thumb base joints, including the CMC-1 and STT joints. Much is still unknown about the pathophysiology of thumb base OA. Although MRI studies have led to more insights in interphalangeal OA, thumb base MRI studies are still lacking. To facilitate this, recently the first MRI scoring system for thumb base OA was developed by the OMERACT MRI Working Group, the TOMS.<sup>1</sup>

Representative examples of each grade of the different features that are assessed in the TOMS are presented (see table 1 for definitions and scaling of each feature). Images from patients with hand OA were obtained from the Hand Osteoarthritis in Secondary Care (HOSTAS) study at Leiden University Medical Center (Leiden, The Netherlands). Images were acquired on a 1.5 T extremity MRI unit (ONI, GE, Wisconsin, USA). Examples of synovitis evaluated on contrast-enhanced images were obtained from patients with hand OA from the Nor-Hand study at Diakonhjemmet Hospital (Oslo, Norway), and were acquired on a 1.5 T MRI unit (Siemens Aera, Germany) after administration of gadolinium contrast. Example images were selected by a single reader with experience in using the TOMS and subsequently approved by three experienced radiologists (of which one is also experienced in using the score).

**Table 1.** Definitions and scaling of features in proposed OMERACT TOMS.

MRI feature	Definition	Scaling	Advised plane and MRI sequence
<b>Synovitis*</b>	Thickened synovium with enhancement after Gd injection.	0= normal, 1= mild (1%-33%), 2= moderate (34%-66%), 3= severe (67%-100%). Based on thirds of the presumed maximum thickness of enhancing tissue in the synovial compartment.	Coronal and axial. T1w pre- and post-Gd with fs. In absence of post-Gd images, T2w-fs/STIR/PD-fs can be used.
<b>Subchondral bone defects*†</b>	Subchondral bone loss, including erosions (sharply marginated bone lesions with cortical break), cysts (sharply marginated bone lesions without cortical break), and bone attrition (diffuse loss of bone contour).	0= no bone defects; 1= mild ( $\leq 25\%$ of bone volume or joint surface affected), 2= moderate (26%-50% of bone volume or joint surface affected), 3= severe ( $> 50\%$ of bone volume or joint surface affected).	Coronal and axial. T1w and T2w-fs/STIR/PD-fs.
<b>Osteophytes†</b>	Abnormal bone protuberance at joint margins or surfaces.	0= no osteophytes, 1= mild (1-2 small osteophytes), 2= moderate ( $\geq 3$ small osteophytes and/or $\geq 1$ moderate osteophyte(s)), 3= severe ( $\geq 1$ large osteophyte(s)).	Coronal (and sagittal if available). T1w.

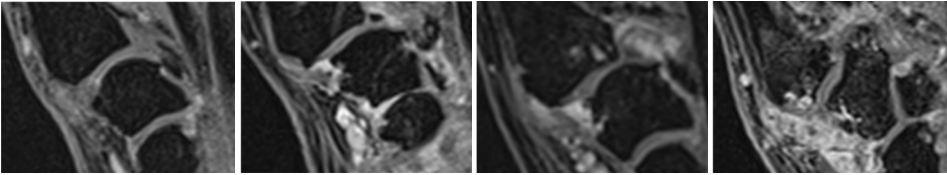
**Table 1.** Continued.

<b>MRI feature</b>	<b>Definition</b>	<b>Scaling</b>	<b>Advised plane and MRI sequence</b>
<b>Cartilage assessment</b>	Loss of cartilage, or loss of cartilage space based on the inter-bone distance.‡	0= no loss of cartilage or cartilage space, 1= mild (cartilage loss without complete denuding, or cartilage space loss without bone-to-bone contact), 2= moderate (cartilage loss with denuding ≤50% of joint surface or focal complete cartilage space loss with bone-to-bone contact ≤50% of the articulating area), 3= severe (cartilage loss with denuding >50% of joint surface or complete cartilage space loss over >50% of the articulating area).	Coronal. T1w-fs-3D-GE, otherwise use T1w-fs, T2w-fs or PD-fs.
<b>Subluxation§</b>	Subluxation of the CMC-1 joint in the frontal plane.	0= MC-1 subluxed 0%-25% of the MC width, 1= MC-1 subluxed ≥26% of the MC width.	Coronal. T1w.
<b>Bone marrow lesions* †</b>	Lesions within the trabecular bone with signal characteristic consistent with increased water content¶ and with ill-defined margins.	0= no bone marrow lesions, 1= mild (1%-33%), 2= moderate (34%-66%), 3= severe (67%-100%). Based on thirds of assessed bone volume.	Coronal and axial. T2w-fs/STIR/PD-fs.

Table was reprinted with permission from Kroon *et al.*<sup>1</sup> All rights reserved. \*In longitudinal studies, 0.5 increments may be used for synovitis, subchondral bone defects, and bone marrow lesions. †Proximal and distal parts of a joint are scored separately for subchondral bone defects, osteophytes, and bone marrow lesions. ‡If assessment of cartilage and cartilage space are in conflict, direct visualization of the cartilage should be prioritized. §Only the CMC-1 joint is evaluated for this feature. ¶High signal intensity on STIR/T2w-fs images. CMC-1, first carpometacarpal joint; fs, fat saturated; Gd, gadolinium; GE, gradient echo; MC-1, first metacarpal; PD, proton density; OA, osteoarthritis; OMERACT, Outcome Measures in Rheumatology Clinical Trials; STIR, short-tau inversion recovery; STT, scapho-trapezio-trapezoid; TOMS, thumb base OA MRI scoring system; w, weighted.

### Synovitis CMC-1

*T1 weighted fat-saturated postcontrast images*



Normal

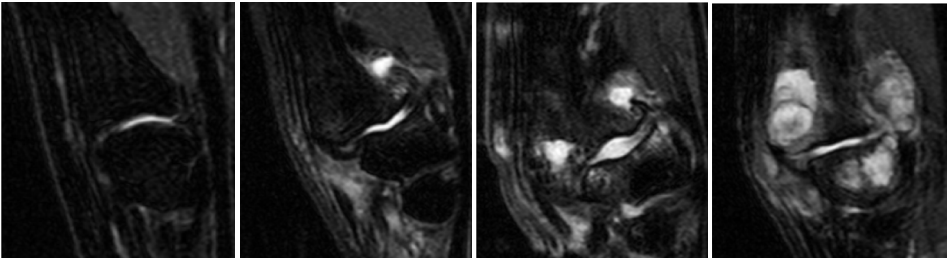
Grade 1

Grade 2

Grade 3

### Synovitis CMC-1

*T2 weighted fat-saturated images*



Normal

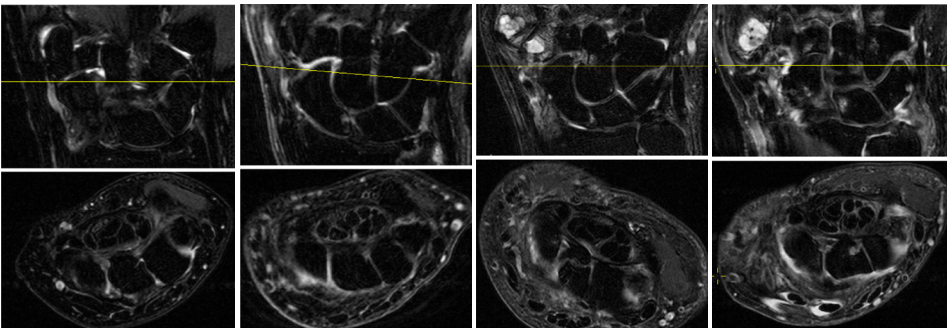
Grade 1

Grade 2

Grade 3

### Synovitis STT

*T2 weighted fat-saturated images*



Normal

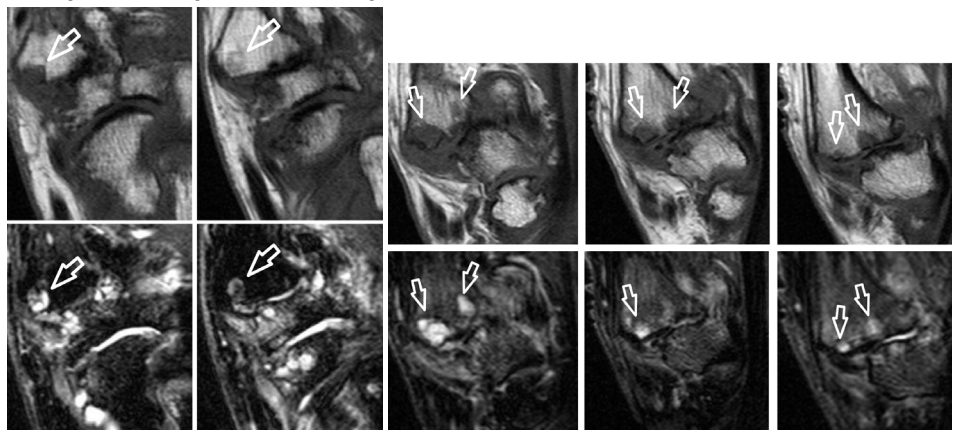
Grade 1

Grade 2

Grade 3

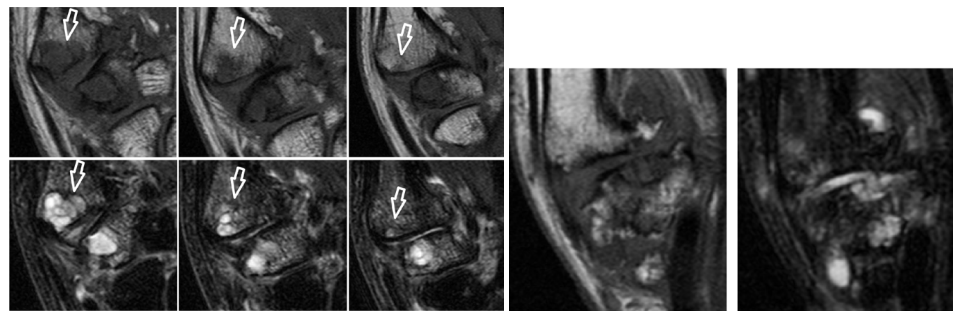
**Subchondral bone defects CMC-1: proximal first metacarpal**

*T1 weighted and T2 weighted fat-saturated images*



Grade 1

Grade 2

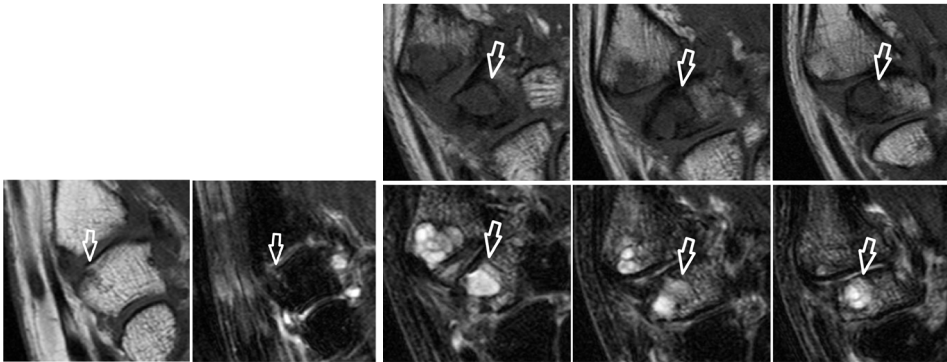


Grade 3

Grade 3 (attrition)

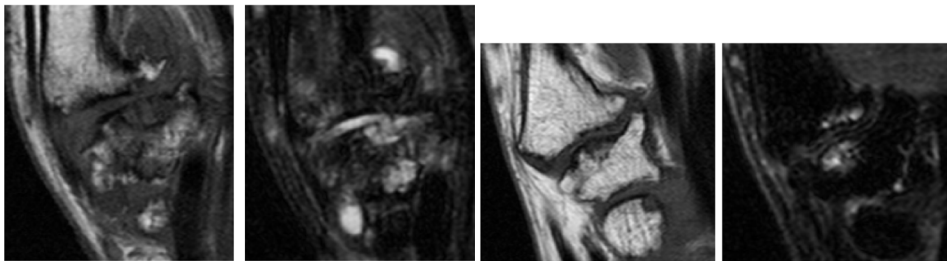
### Subchondral bone defects CMC-1: distal trapezium

*T1 weighted and T2 weighted fat-saturated images*



Grade 1

Grade 2

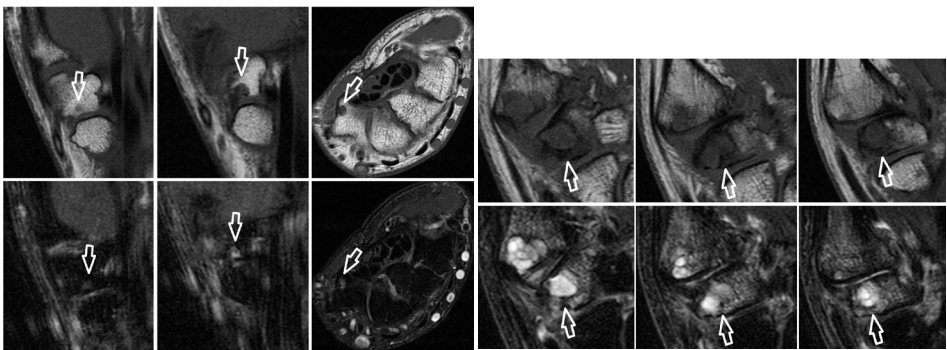


Grade 3

Grade 3 (attrition)

### Subchondral bone defects STT: proximal trapezium

*T1 weighted and T2 weighted fat-saturated images*

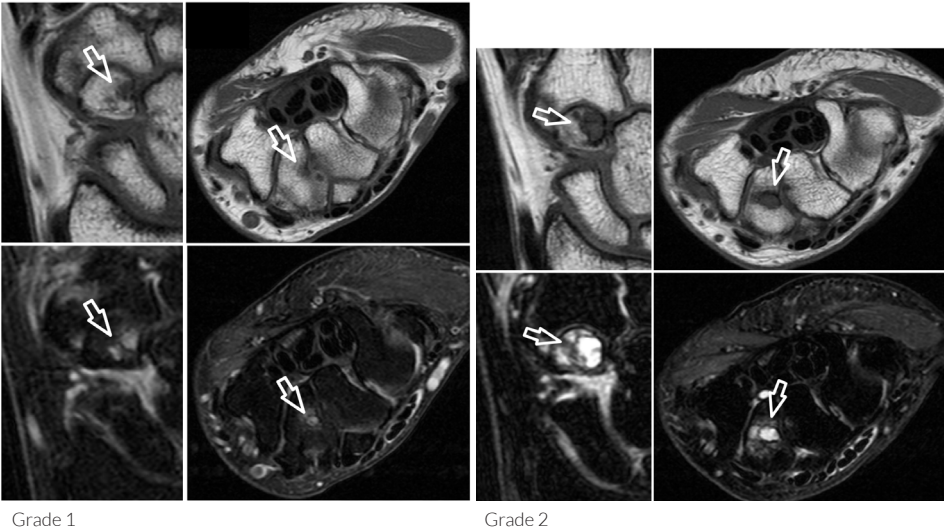


Grade 1

Grade 2

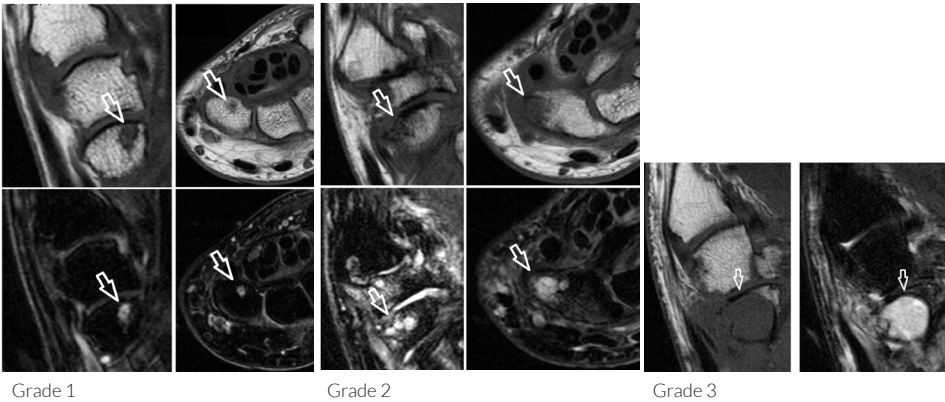
**Subchondral bone defects STT: proximal trapezoid**

*T1 weighted and T2 weighted fat-saturated images*



**Subchondral bone defects STT: distal scaphoid**

*T1 weighted and T2 weighted fat-saturated images*



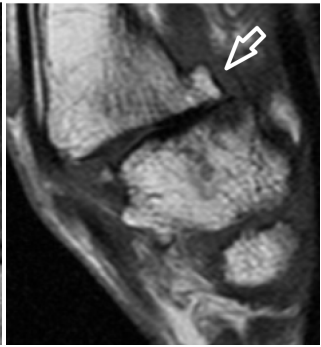


### Osteophytes CMC-1: proximal first metacarpal

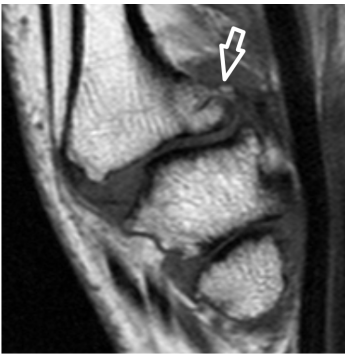
T1 weighted images



Grade 1



Grade 2



Grade 3

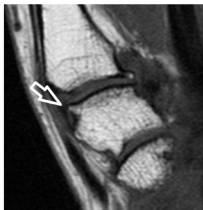


### Osteophytes CMC-1: distal trapezium

T1 weighted images



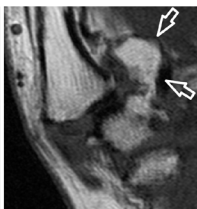
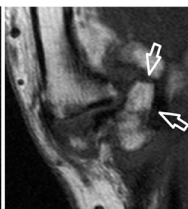
Grade 1



Grade 2



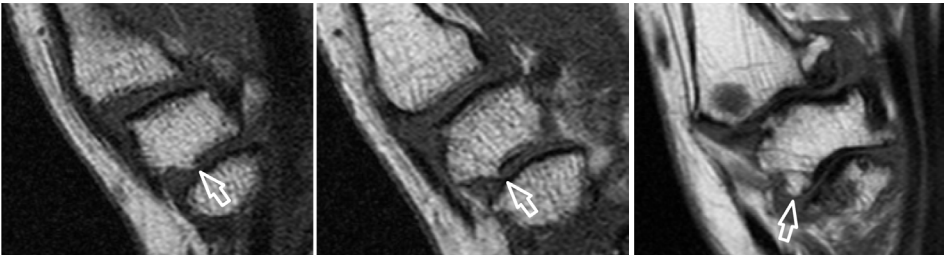
Grade 3





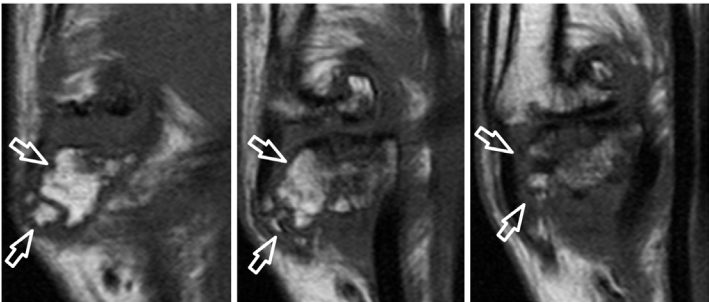
**Osteophytes STT: proximal trapezium**

*T1 weighted images*



Grade 1

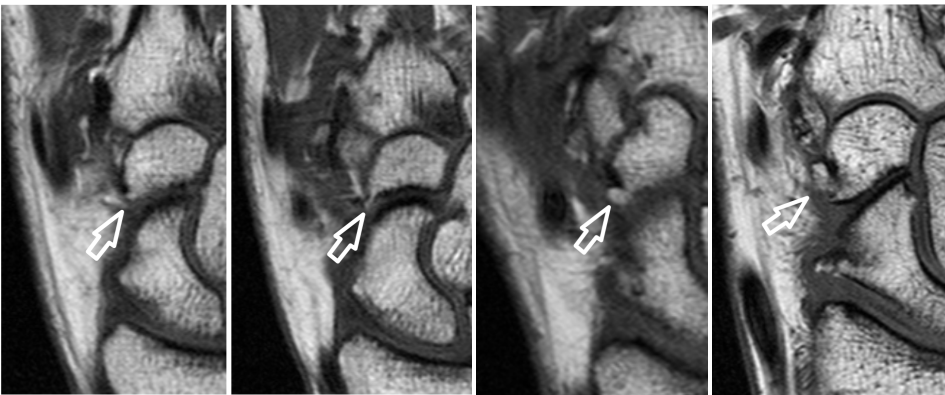
Grade 2



Grade 3

**Osteophytes STT: proximal trapezoid**

*T1 weighted images*



Grade 1

Grade 2

Grade 3

# **Osteophytes STT: distal scaphoid**

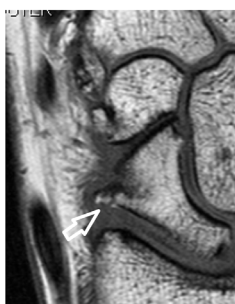
*T1 weighted images*



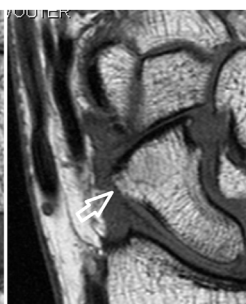
Grade 1



Grade 2



Grade 3



**Cartilage assessment CMC-1**

*T1 weighted images*



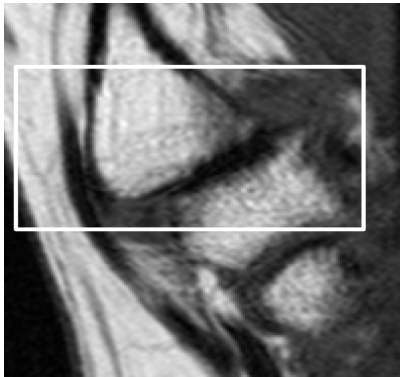
Normal



Grade 1



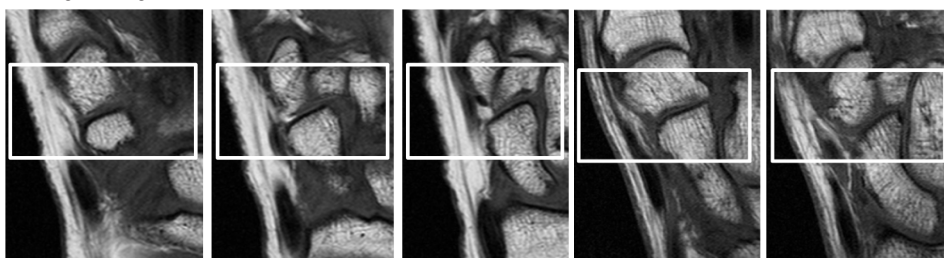
Grade 2



Grade 3

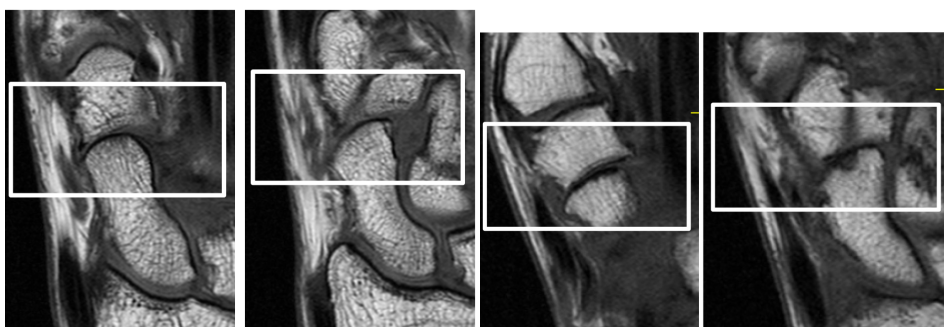
# **Cartilage assessment STT**

*T1 weighted images*



Normal

Grade 1

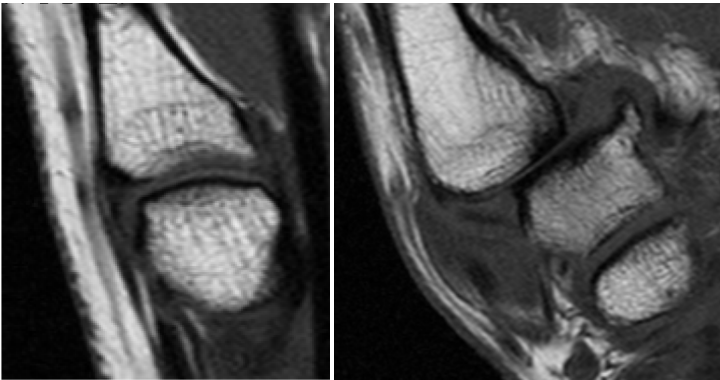


Grade 2

Grade 3

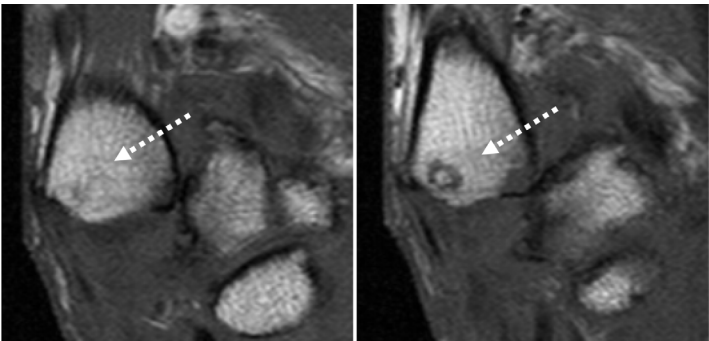
**Subluxation CMC-1**

*T1 weighted images*



Normal

Subluxation present

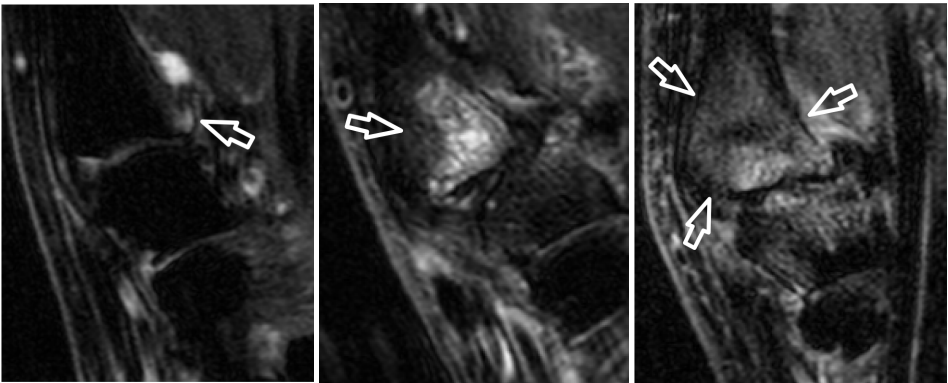


Subluxation present (severe)

[arrow points into direction of subluxation]

**Bone marrow lesions CMC-1: proximal first metacarpal**

*T2 weighted fat-saturated images*



Grade 1

Grade 2

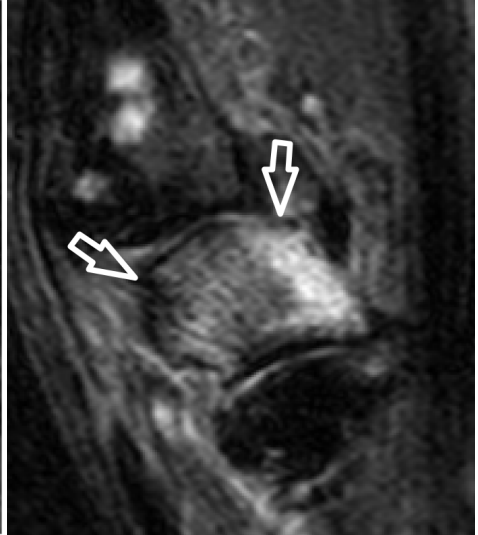
Grade 3

**Bone marrow lesions CMC-1: distal trapezium**

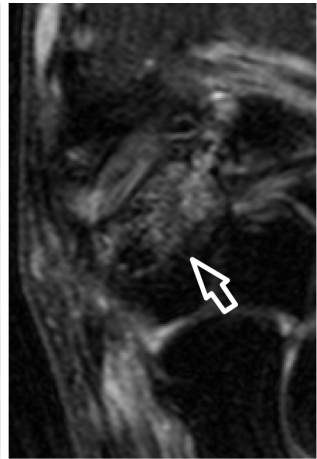
*T2 weighted fat-saturated images*



Grade 1



Grade 3

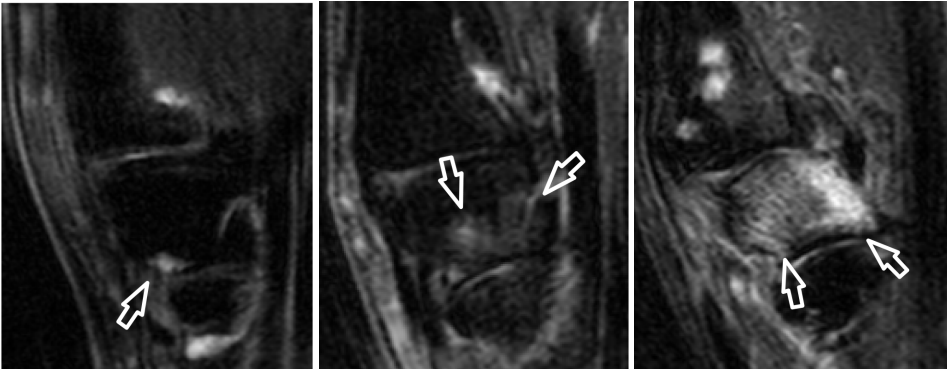


Grade 2



**Bone marrow lesions STT: proximal trapezium**

*T2 weighted fat-saturated images*



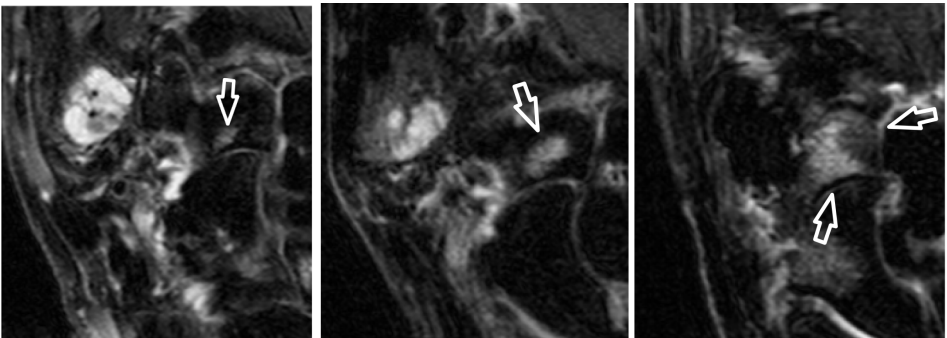
Grade 1

Grade 2

Grade 3

**Bone marrow lesions STT: proximal trapezoid**

*T2 weighted fat-saturated images*



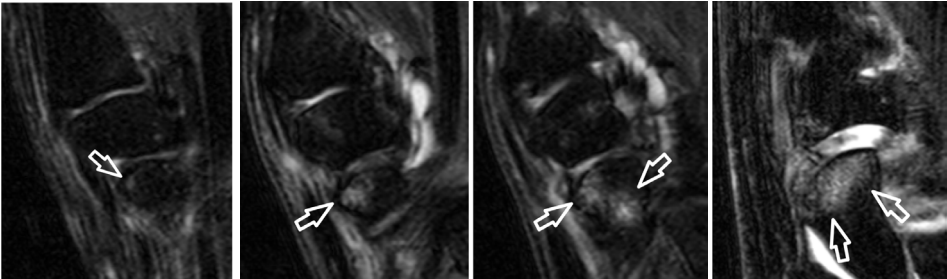
Grade 1

Grade 2

Grade 3

**Bone marrow lesions STT: distal scaphoid**

*T2 weighted fat-saturated images*



Grade 1

Grade 2

Grade 3

## REFERENCES

1. Kroon FPB, Conaghan PG, Foltz V, et al. Development and reliability of the OMERACT thumb base osteoarthritis magnetic resonance imaging scoring system. *J Rheumatol* 2017;44:1694-8.