

# IV CONGRESSO NAZIONALE



Maurizio Muratore

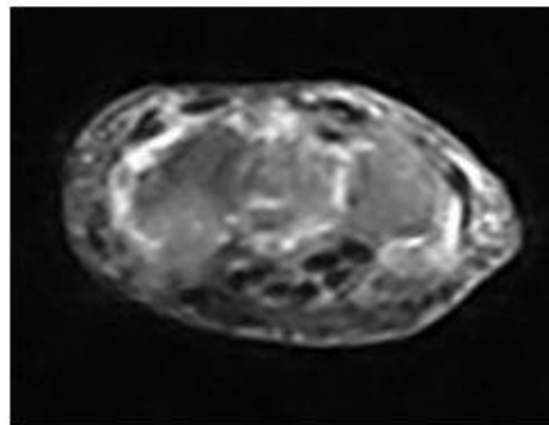
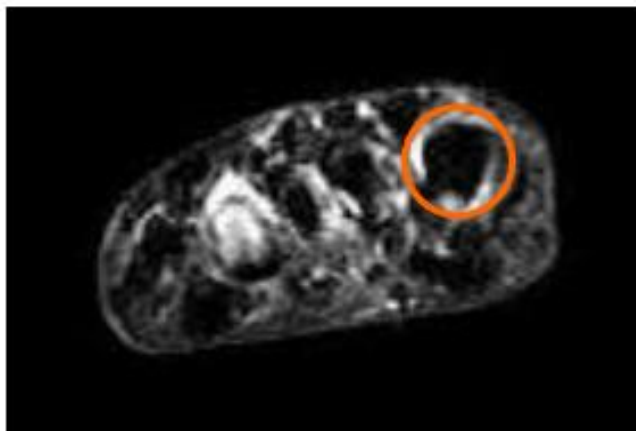
PERCHE' IL GRADING PER  
L'EDEMA OSSEO

Centro Congressi Unione Industriali  
TORINO 11-13 MAGGIO 2023



## Definizione di edema osseo alla RMN

- L'edema osseo si manifesta come diffusa iperintensità ossea trabecolare in sequenze T2 pesate o con soppressione del grasso, oppure come segnale irregolarmente diminuito in sequenze T1 pesate.
- Il segnale dell'edema osseo viene incrementato dopo l'infusione endovenosa di un mezzo di contrasto paramagnetico, ma in modo più sfumato ed irregolare di quello delle erosioni.





## Cos'è l'edema osseo?

### **BONE MARROW EDEMA**

*Area di aumentata intensità del midollo osseo, a margini sfumati/non ben definiti, nelle sequenze fluido-sensibili*

### **BONE MARROW LESION**

*Meccanismi fisiopatogenici:*

- *Edema «reale»*
- *Incremento della vascolarizzazione*
- *Infiltrato di cellule infiammatorie*
- *Infiltrato di cellule neoplastiche*
- *Sanguinamento (bone bruise)*
- *Necrosi trabecolare, fibrosi*

È un termine descrittivo che identifica un pattern RM che può essere osservato in uno svariato numero di entità cliniche, spesso caratterizzate da dolore quale sintomo principale comune, ma con differenze significative in termini di reperti istopatologici, meccanismi causali e prognosi

*Reumatismo, 2014; 66 (2): 184-196*

A clinical overview  
of bone marrow edema

M. Manara, M. Varenna



**TABLE 2** Classification of bone marrow oedema

## Primary

Bone marrow oedema syndrome without an identifiable underlying cause

## Secondary

Trauma (direct injury, ligamentous damage, complex regional pain syndromes, fracture)

Degenerative (e.g. OA)

Inflammatory (e.g. inflammatory arthritis, enthesitis)

Ischaemic (e.g. sickle cell disease, polycythaemia)

Infectious (e.g. septic arthritis, osteomyelitis)

Neoplastic (primary or secondary bone cancers, benign lesions such as osteoid osteomas)

Iatrogenic (e.g. after surgery or radiotherapy, drugs such as steroids or calcineurin inhibitors)

Metabolic (e.g. chronic kidney disease and its treatment)

Neurological (Charcot's joints)



# EDEMA OSSEO

- ◆ AR
- ◆ SPA (+ linfociti B; WNT )

**OSTEITE**

- ◆ OA

**BML**

*tardiva*

*precoce*

- ◆ OP Transitoria dell' anca
- ◆ OP migrante
- ◆ Algodistrofia (CRPS I )

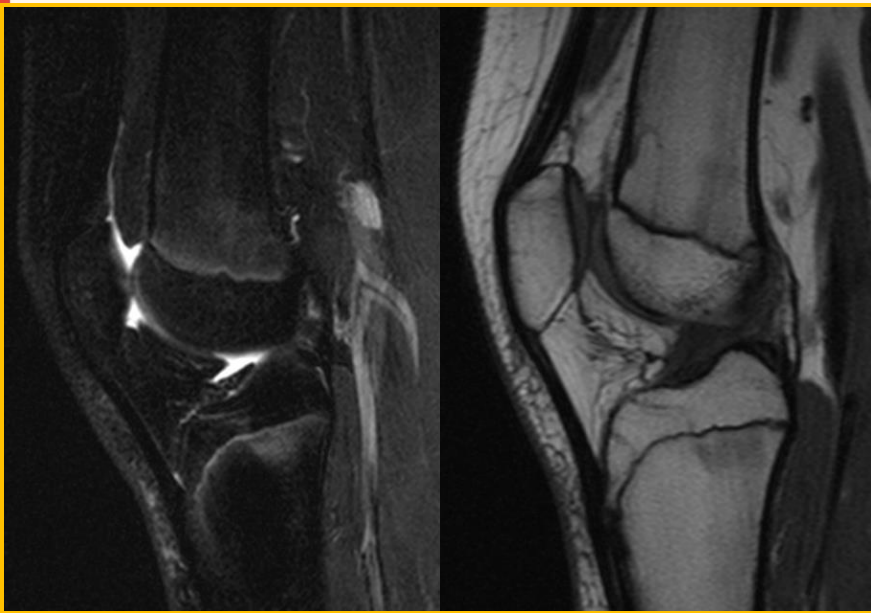
**BMES**

(ristagno venoso, edema, fibrosi, OM, perdita lining, non aumento osteoclasti)

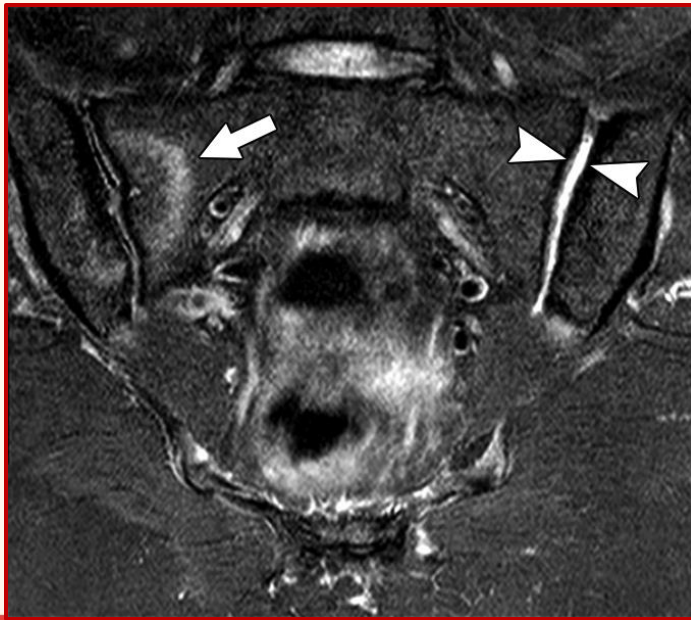


*Considerazione 1: Quale edema misurare?*

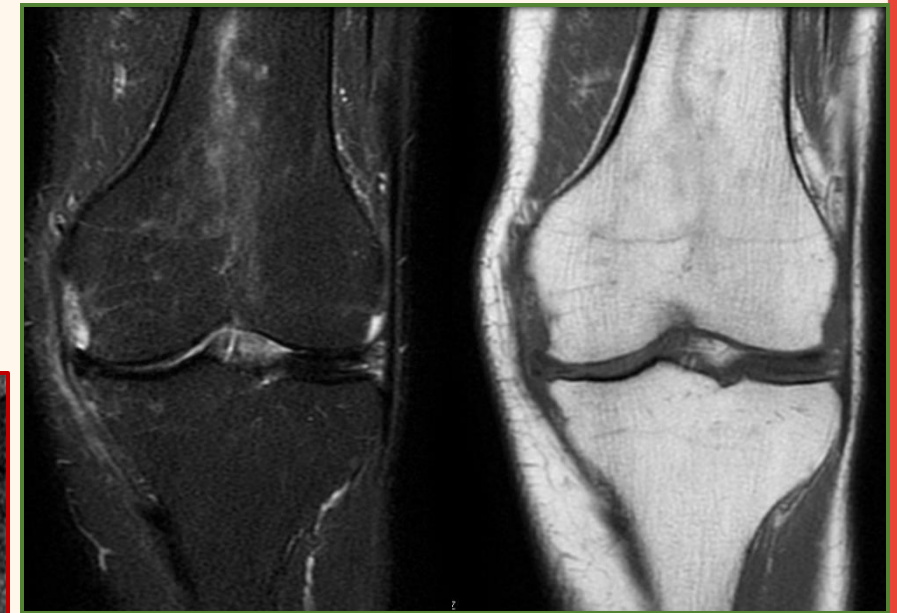
***Non tutto l'edema è patologico!  
Edema osseo come reperto fisiologico***



*Healthy children*



*SIJ in postpartum*



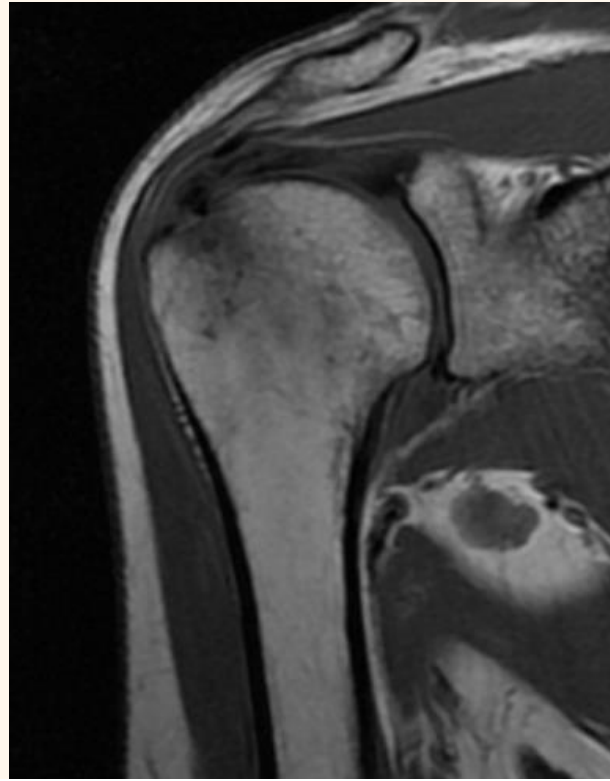
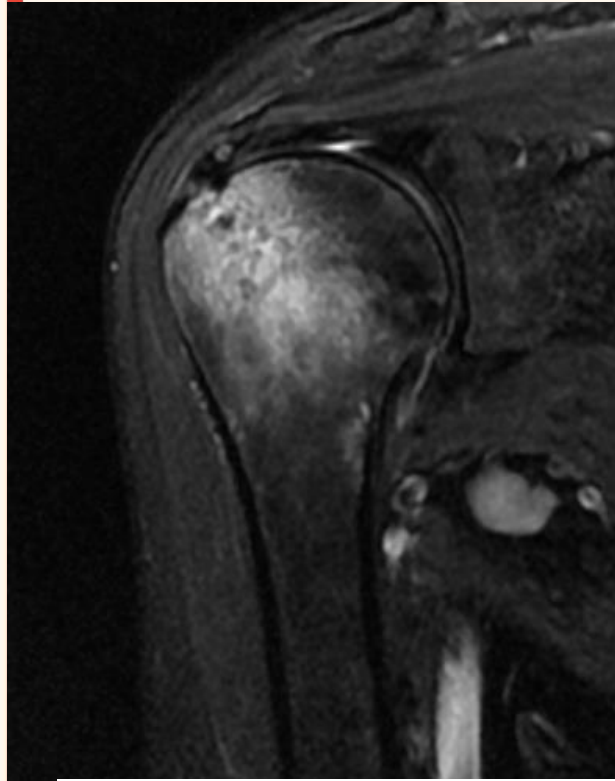
*Midollary reconversion*

## Considerazione 1: Quale edema misurare?

ZIONE

SOCIETÀ ITALIANA

**Non tutto l'edema va gradato**



### MR sequence

T1-W SE

PD-W/T2-W

STIR/fsT2-W/fsPD-W

T1-W-IV Gad

### Normal marrow or RMR

SI > muscle/disc

Minimally increased SI < fat

Minimally increased SI. Less commonly, focal islands of red marrow

<35 % Enhancement

### Pathologic marrow

SI = or < muscle/disc

SI approaching or similar to fat

Increased SI approaching vessels/epi-apophysis involvement/focal lesions/soft tissue mass

>35 % Enhancement

### **Edema osseo neoplastico**



# Si può parlare di intensità dell'edema osseo?



## L'intensità del segnale nell'osteite infiammatoria

- L'alterazione del segnale del midollo osseo è secondaria all'aumento della vascolarizzazione e alla presenza di infiltrato infiammatorio (linfociti, macrofagi)
- La presenza di edema riflette la presenza di osteite.
- Il grado di cellularità, l'intensità dell'edema e l'enhancement

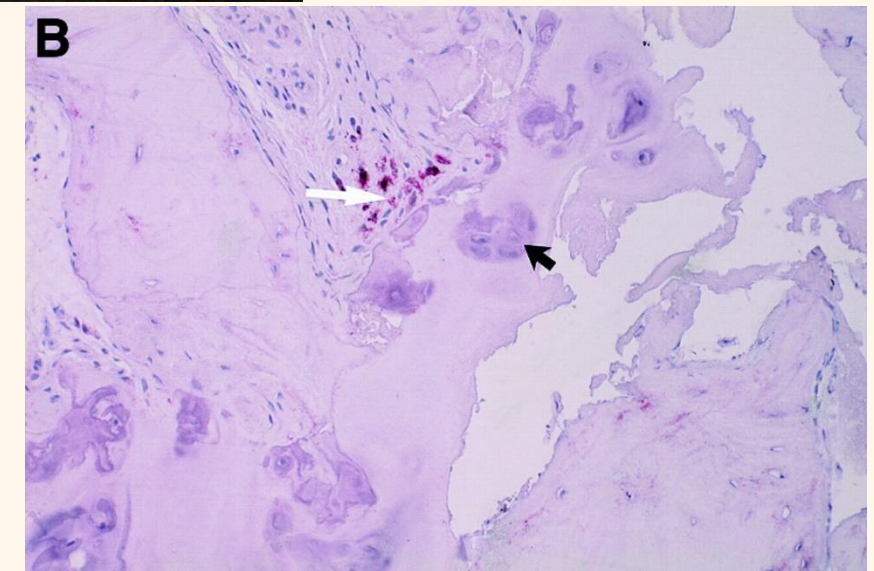
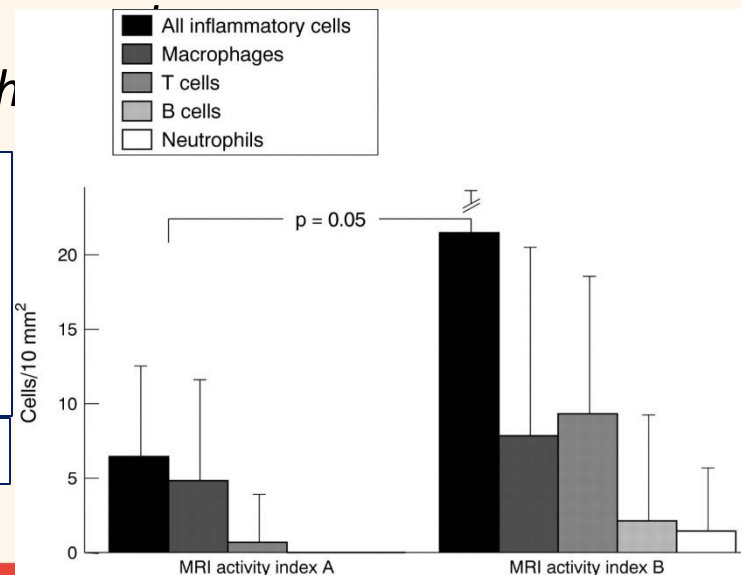
Quantitative analyses of sacroiliac biopsies in spondyloarthropathies: T cells and macrophages predominate in early and active sacroiliitis—cellularity correlates with the degree of enhancement detected by magnetic resonance imaging

Bollow M et al. Ann Rheum Dis 2000;59:135-140



Possibilità di distinguere l'edema infiammatorio dal non infiammatorio in base alla sua severità/intensità

H Marzo-Ortega et al. Ann Rheum Dis 2009;68:1721-1727





# Do knee abnormalities visualised on MRI explain knee pain in knee osteoarthritis? A systematic review

Erlangga Yusuf,<sup>1</sup> Marion C Kortekaas,<sup>1</sup> Iain Watt,<sup>2</sup> Tom W J Huizinga,<sup>1</sup>  
Margreet Kloppenburg<sup>1</sup>

**Conclusions** Knee pain in OA is associated with BML and effusion/synovitis suggesting that these features may indicate the origin of pain in knee OA. However, due to the moderate level of evidence these features need to be explored further.

Cartilage defects (level of evidence: conflicting)

Bone marrow lesion (level of evidence: moderate)

Osteophytes (level of evidence: limited)

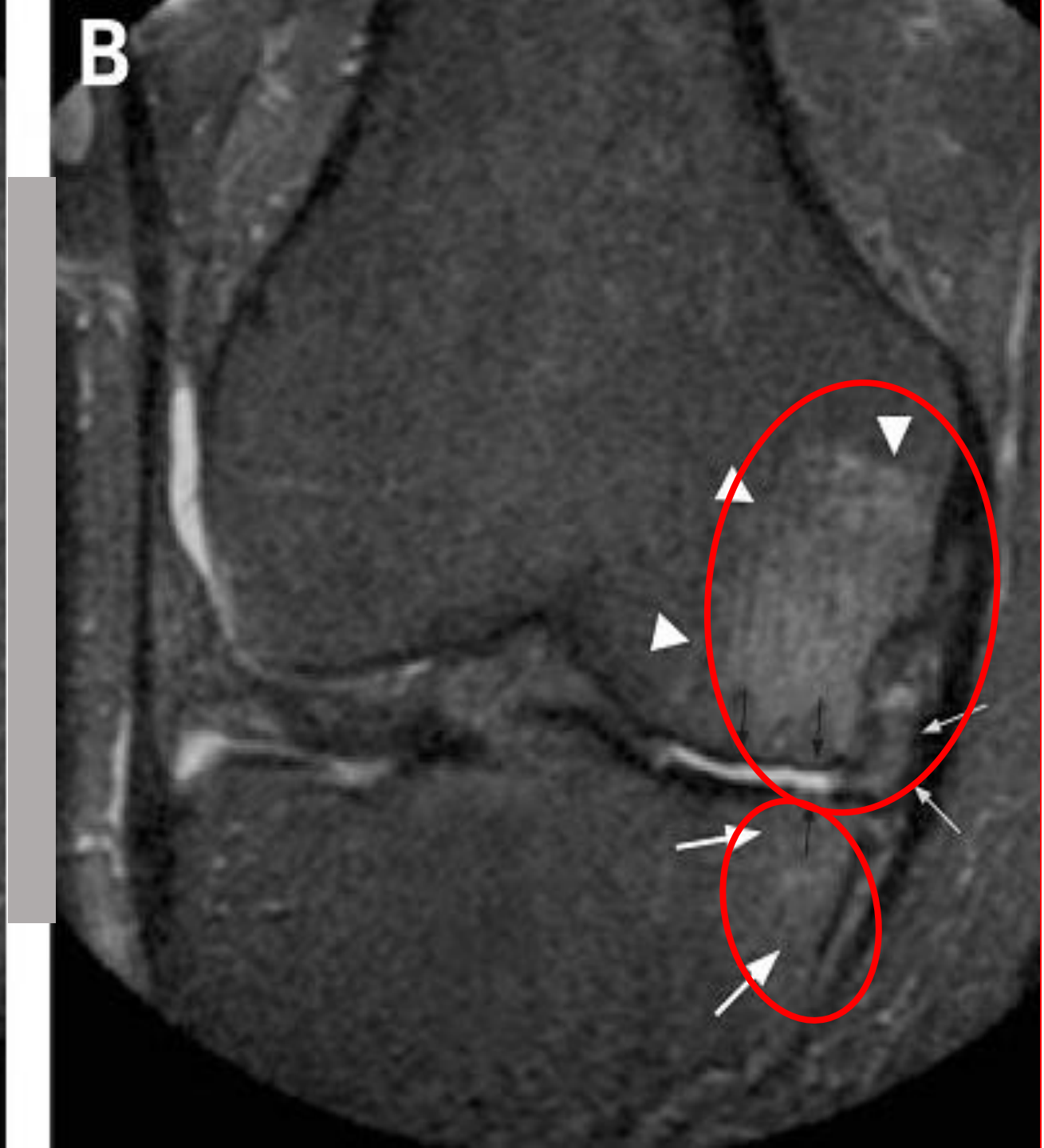
Meniscal lesion (level of evidence: conflicting)

Effusion and synovitis (level of evidence: moderate)

Knee ligament abnormalities  
(level of evidence: limited)

Subchondral cysts (level of evidence: limited)

Bone attrition (level of evidence: conflicting)



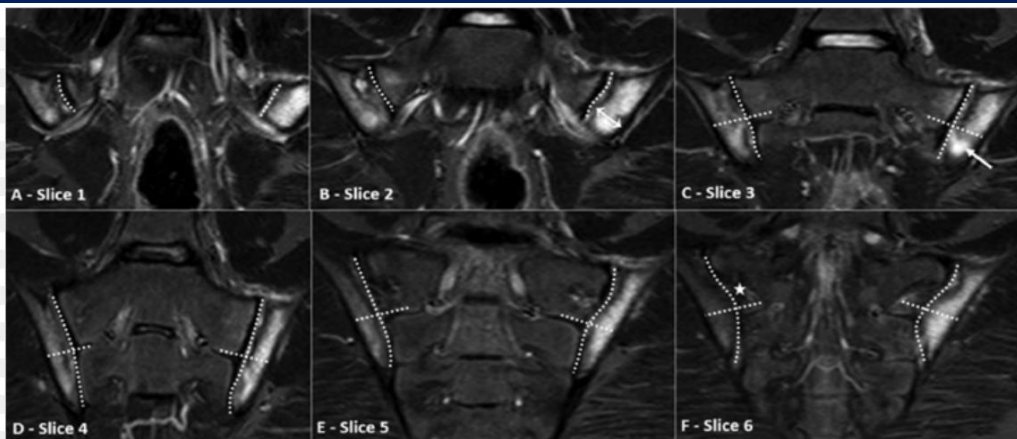


# Spondyloarthritis Research Consortium of Canada Magnetic Resonance Imaging Index For Assessment of Sacroiliac Joint Inflammation in Ankylosing Spondylitis

WALTER P. MAKSYMOWYCH,<sup>1</sup> ROBERT D. INMAN,<sup>2</sup> DAVID SALONEN,<sup>2</sup> SUHKVINDER S. DHILLON,<sup>1</sup>  
MARTIN WILLIAMS,<sup>1</sup> MILLICENT STONE,<sup>2</sup> BARBARA CONNER-SPADY,<sup>1</sup> JANICE PALSAT,<sup>1</sup> AND  
ROBERT G. W. LAMBERT<sup>1</sup>

## Quale Grading per edema osseo?

The Spondyloarthritis Research Consortium of Canada (SPARCC) and Sacroiliac Joint (SIJ) Structural Score (SSS) methodologies are the most popular imaging standards of active and chronic disease activity, with high accuracy and reproducibility [11]. This SPARCC score is an internationally recognized quantitative indicator used to evaluate the degree of sacroiliac joint inflammatory edema. SPARCC score is based on the semi-quantitative score obtained from the subjective visual examination of the doctor reading the film. It does not provide accurate and objective quantitative signal value of bone marrow edema.



G Patient: \_\_\_\_\_ Radiologist: \_\_\_\_\_ Total SPARCC score: 41 / 72

Right SI joint	Slice 1	Left SI joint	
(BME)	(BME)	(BME)	(BME)
(BME)	(BME)	(BME)	(BME)
(Intense)	(Intense)		7
(Extensive)	(Extensive)		12
	Slice 2		
(BME)	(BME)	(BME)	(BME)
(BME)	(BME)	(BME)	(BME)
(Intense)	(Intense)		8
(Extensive)	(Extensive)		12
	Slice 3		
(BME)	(BME)	(BME)	(BME)
(BME)	(BME)	(BME)	(BME)
(Intense)	(Intense)		9
(Extensive)	(Extensive)		12
	Slice 4		
(BME)	(BME)	(BME)	(BME)
(BME)	(BME)	(BME)	(BME)
(Intense)	(Intense)		8
(Extensive)	(Extensive)		12
	Slice 5		
(BME)	(BME)	(BME)	(BME)
(BME)	(BME)	(BME)	(BME)
(Intense)	(Intense)		5
(Extensive)	(Extensive)		12
	Slice 6		
(BME)	(BME)	(BME)	(BME)
(BME)	(BME)	(BME)	(BME)
(Intense)	(Intense)		4
(Extensive)	(Extensive)		12

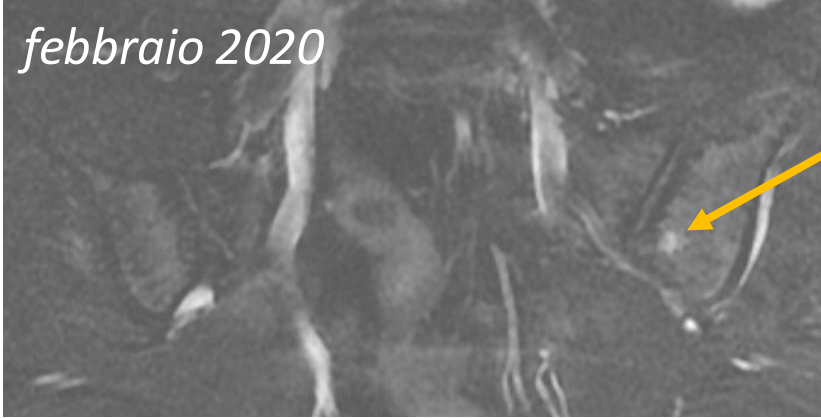
involves scoring BME on six coronal slices at the SIJ. BME is scored according to its presence, intensity, and depth. The depth of BME is defined as positive when 1 cm or more of continuous edema extends in a horizontal direction away from the articular surface. Each SIJ is evaluated as a whole. The depth associated with any part of a joint receives a score of 1. The depth of BME across six slices ranged from 0 to 12<sup>19</sup>. BME indicates the presence of acute inflammation, and increased density and depth indicate severe acute inflammation. We

*Scoring of depth and intensity.* The signal from pre-sacral blood vessels defined a lesion that was scored as intense. A lesion was graded as deep if there was a homo-

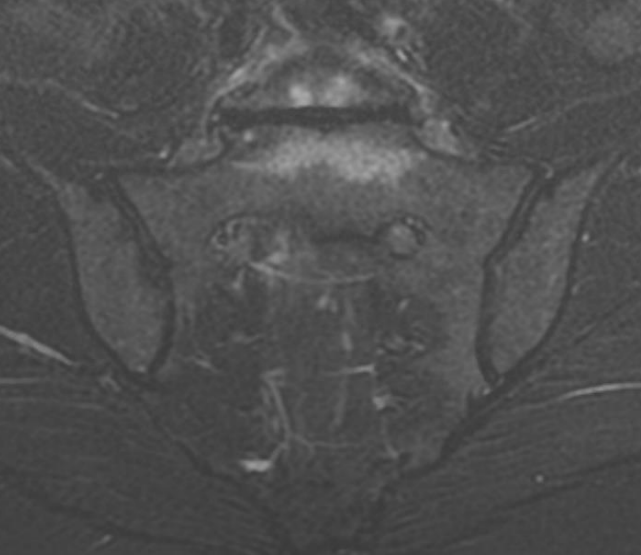
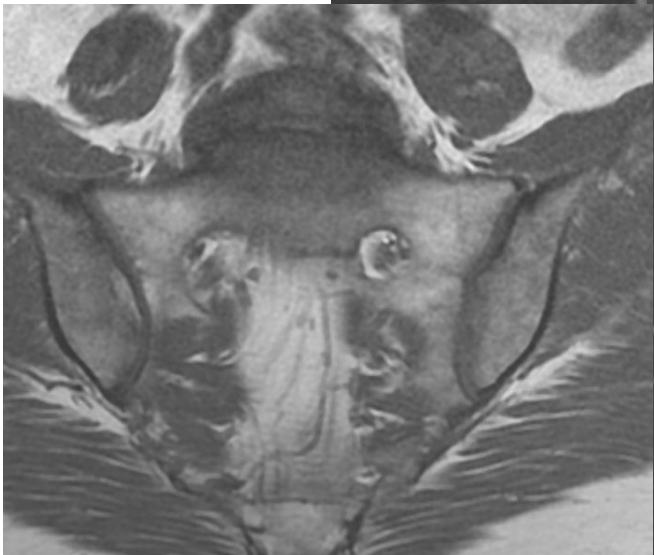
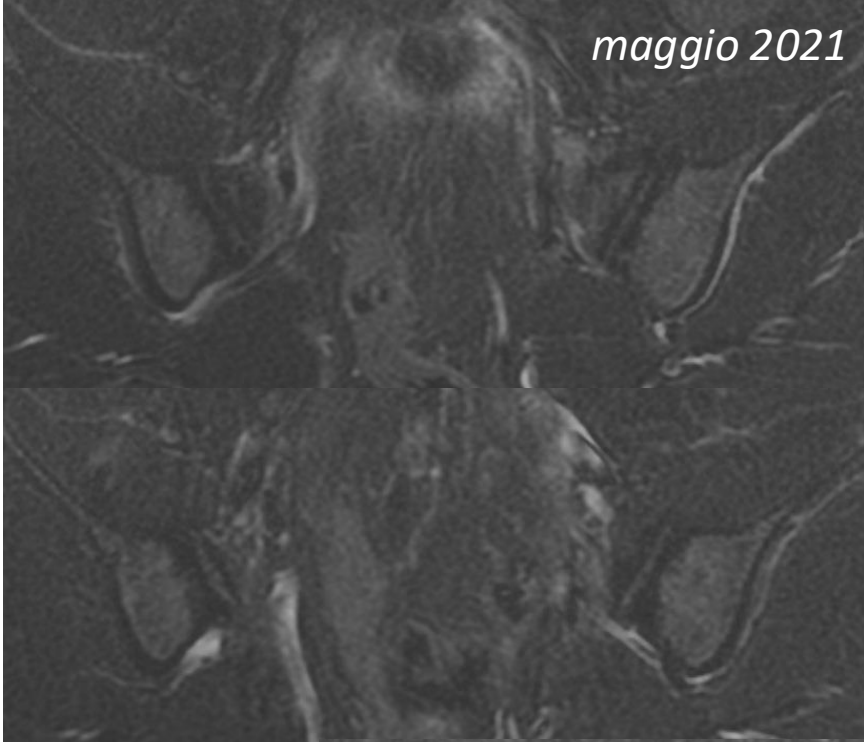
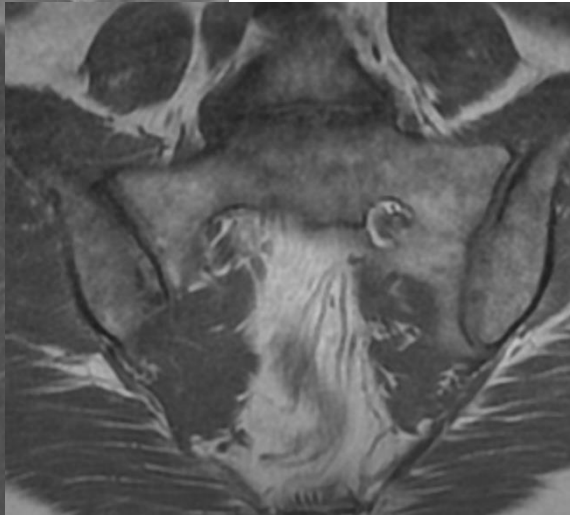
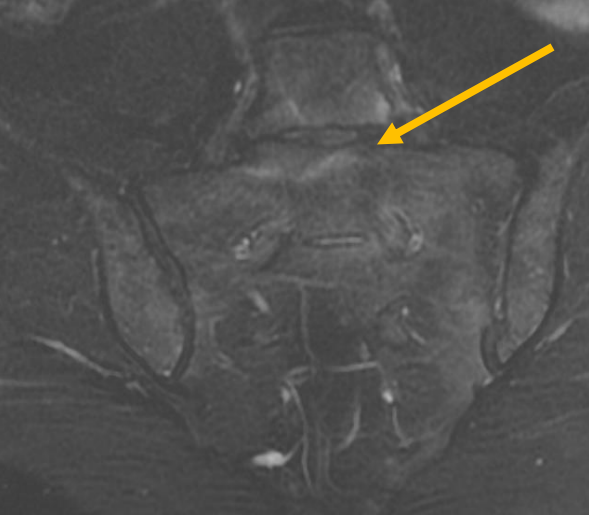
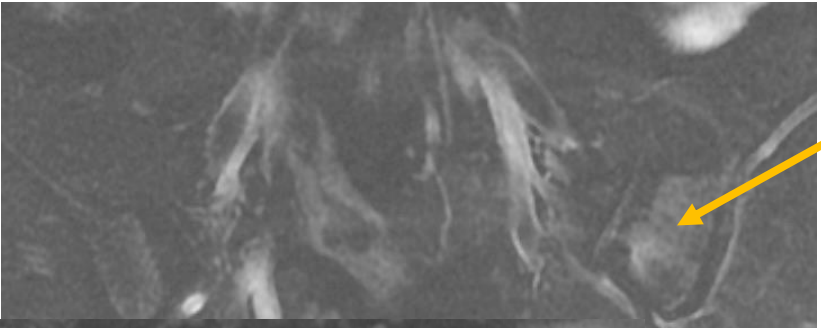
**Topografico/estensione/intensità**



*Michela, 43 aa, dal febbraio 2020 in terapia per spondiloartrite, iniziale miglioramento poi a maggio 2021 nuovo peggioramento*



*concordanza clinica-imaging*





*Perché il Grading RM per l' edema osseo?*

1. Utilità nella valutazione della risposta al trattamento

2. Correlazione tra intensità edema/gravità dell'infiammazione  
(valore prognostico)

**Bone Marrow Edema and Its Relation to Progression  
of Knee Osteoarthritis**

*Felson DT et al. Ann Intern Med. 2003;139:330-336*

**Value of MRI and ultrasound for prediction of therapeutic response  
and erosive progression in patients with early rheumatoid arthritis  
managed by an aggressive treat-to-target strategy**

*Sundin U, et al. RMD Open 2021;7:e001525.*

3. Correlazione tra intensità edema e possibili «complicanze»  
(perdita di massa ossea)

**Severe bone marrow edema on sacroiliac joint MRI increases the risk  
of low BMD in patients with axial spondyloarthritis**

*Kim HN et al. Sci. Rep. 2016; 6, 22158*



## *Efficacia Terapeutica: what does it mean?*

- *Controllo dei segni e dei sintomi*
- *Miglioramento della qualità della vita (Qof)*
- *Prevenzione del danno strutturale*
- *Mantenimento della capacità funzionale*

*Infiammazione  
(edema)*

*Relazione tra EDEMA-OSSEO e giudizio di EFFICACIA TERAPEUTICA?*





## Conclusioni

*L'edema osseo è un reperto comune ma associato a svariate condizioni cliniche.*

*Quasi sempre facile da identificare in RM (alta sensibilità), ma bisogna riconoscere le condizioni in cui è utile/necessario applicare un grading.*

*Conoscere la tecnica RM per applicare le giuste sequenze (problem solving) e per riconoscere un'indagine eseguita correttamente e diagnostica.*

# IV CONGRESSO NAZIONALE

SOCIETÀ ITALIANA  
**G.U.I.D.A.**  
PER LA GESTIONE UNIFICATA E INTERDISCIPLINARE  
DEL DOLORE MUSCOLO-SCHELETTRICO E DELL'ALGODISTROFIA







Ann Intern Med. 2003 Sep 2;139(5 Pt 1):330-6.

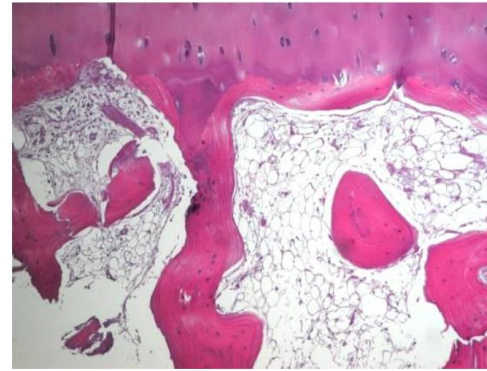
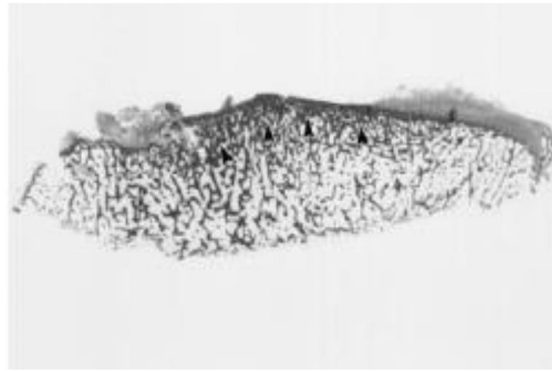
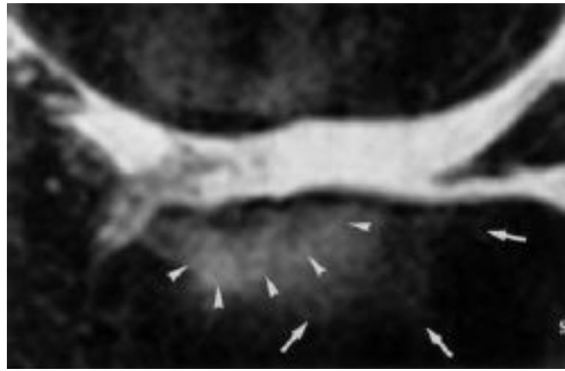
## **Bone marrow edema and its relation to progression of knee osteoarthritis.**

Felson DT, McLaughlin S, Goggins J, LaValley MP, Gale ME, Totterman S, Li W, Hill C, Gale D

### **CONCLUSION:**

Bone marrow edema is a potent risk factor for structural deterioration in knee osteoarthritis, and its relation to progression is explained in part by its association with limb alignment.

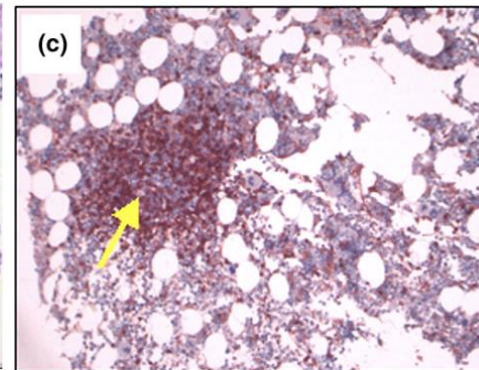
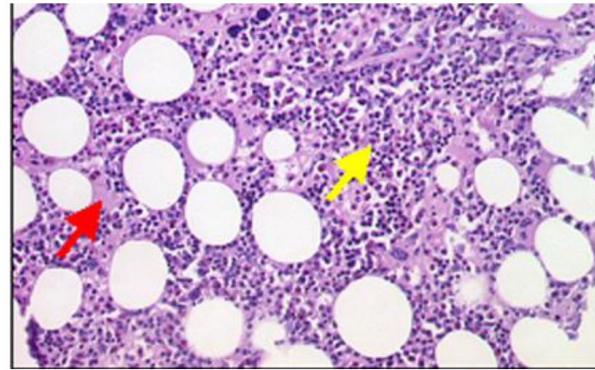
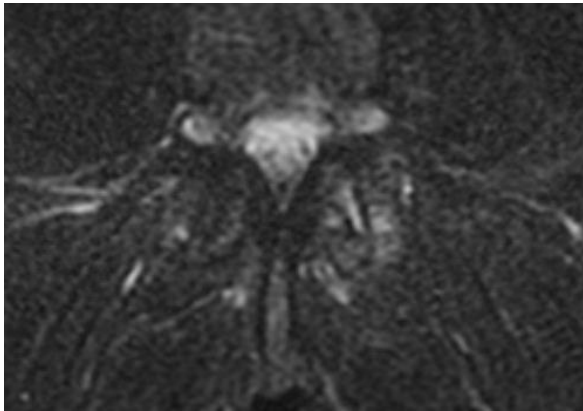
**OSTEOARTHRITIS**



Bergman AG, et al. Skeletal Radiol 1994;23:445–8. Zanetti M, et al. Radiology 2000;215:835–40.

In conclusion, the bone marrow edema pattern in osteoarthritic knees represents histologically noncharacteristic abnormalities that include bone marrow necrosis, bone marrow fibrosis, and trabeculae abnormalities but represents only a small amount of bone marrow edema. There-

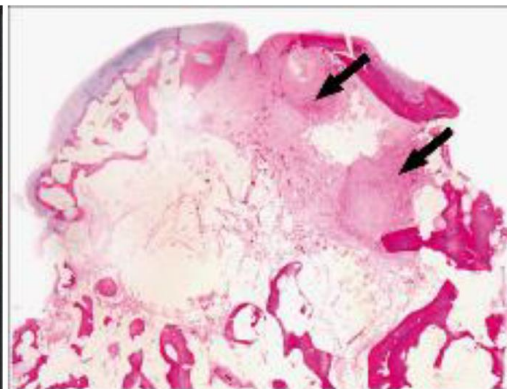
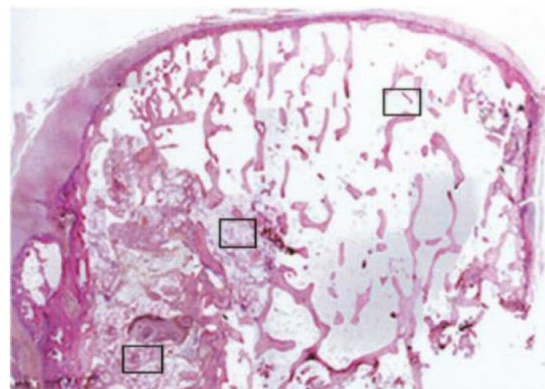
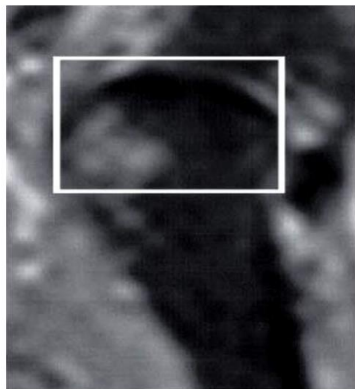
**ANKYLOSING SPONDYLITIS**



Appel H, et al. Arthritis Res Ther 2006;8;R143.

*infiltrations of mononuclear cells (yellow arrow) and interstitial bone marrow edema (red arrow)*  
**mononuclear cell aggregates CD3+ T (OSTEITE)**

**RHEUMATOID ARTHRITIS**

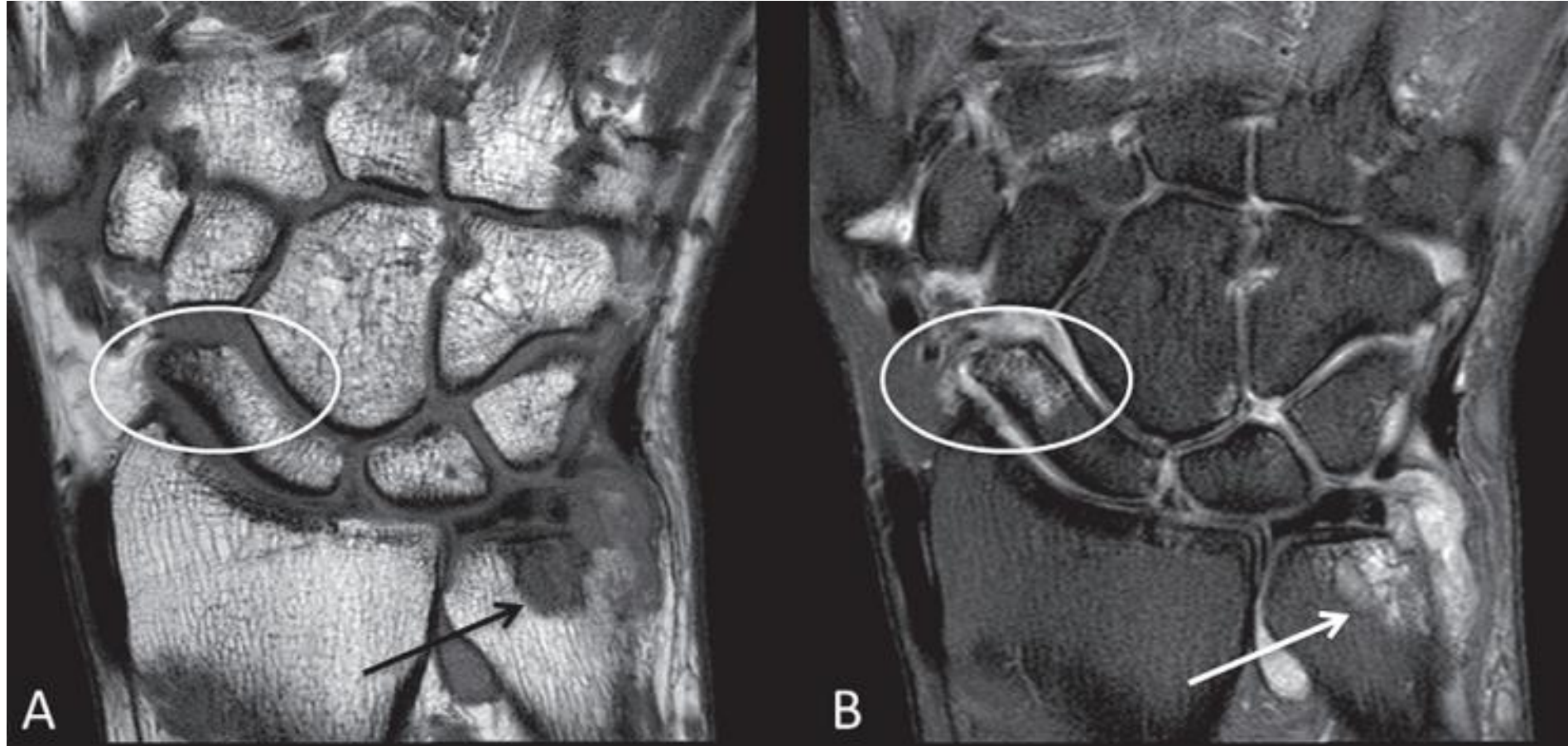


Jimenez-Boj E, et al. Arthritis Rheum 2007;56:1118-24. McQueen FM, et al. Ann Rheum Dis 2007;66:1581-7.

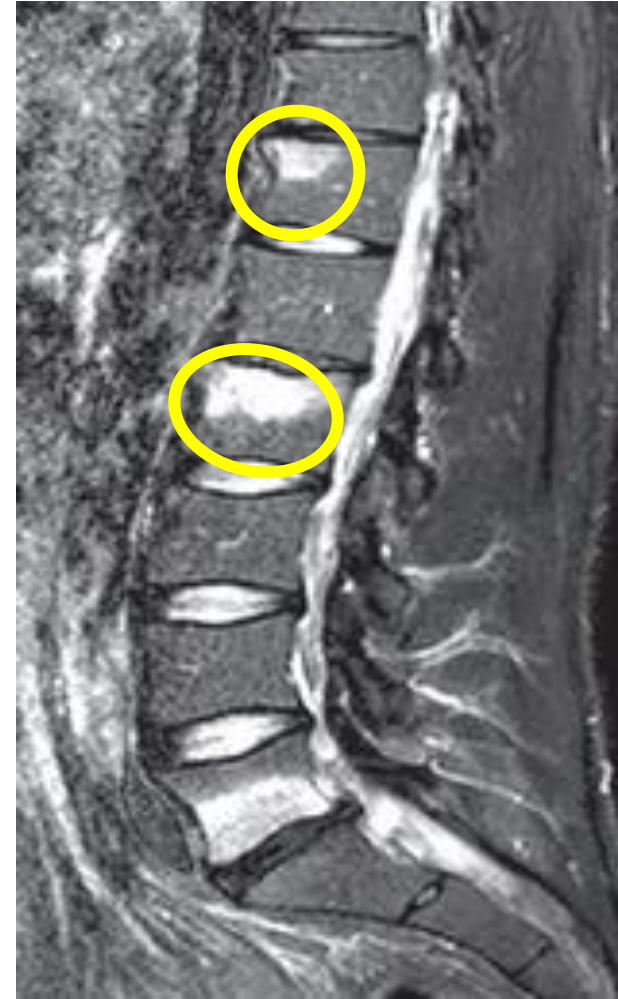
***B lymphocytes dominate subcortical bone marrow aggregates (OSTEITE)***



AR



SPA





### 3 Axial SpA: monitoring activity

9.2 (8.8–9.6) **1b**

MRI of the SI joints and/or the spine may be used to assess and monitor disease activity in axial SpA, providing additional information on top of clinical and biochemical assessments. The decision on when to repeat MRI depends on the clinical circumstances. In general, STIR sequences are sufficient to detect inflammation and the use of contrast medium is not needed.

#### *Recommendation 3: monitoring disease activity in axial SpA*

MRI of the SI joints and/or the spine may be used to assess and monitor disease activity in axial SpA, providing additional information on top of clinical and biochemical assessments. The decision on when to repeat MRI depends on the clinical circumstances. In general, short tau inversion recovery (STIR) sequences are sufficient to detect inflammation and the use of contrast medium is not needed.

Strength of recommendation: 9.2 (95% CI 8.8 to 9.6)

Thirty-four studies evaluated the utility of MRI in monitoring disease activity in axSpA.<sup>20 21 48–79</sup> Table 3 summarises and presents the results of longitudinal<sup>20 21 50 52–54 61 63 64 66–69 71 73 74 76</sup> as well as cross-sectional<sup>51 59 60 70 79</sup> studies evaluating correlation with accepted disease activity parameters (Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), Ankylosing Spondylitis Disease Activity Score (ASDAS), C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR)) or pain.

In addition, seven studies compared the utility of different MRI sequences (contrast-enhanced T1-weighted (T1Gd) and STIR), for monitoring disease activity in axial SpA,<sup>48 49 53 56 57 65 72</sup> six of which reported high levels of agreement or correlation between the two sequences.<sup>48 49 53 56 57 65</sup> A single longitudinal and two cross-sectional studies reported higher SE of STIR,<sup>49 53 65</sup> while a single longitudinal and two cross-sectional studies reported higher diagnostic confidence/reliability of the T1Gd-DPTA sequence.<sup>48 49 53</sup>

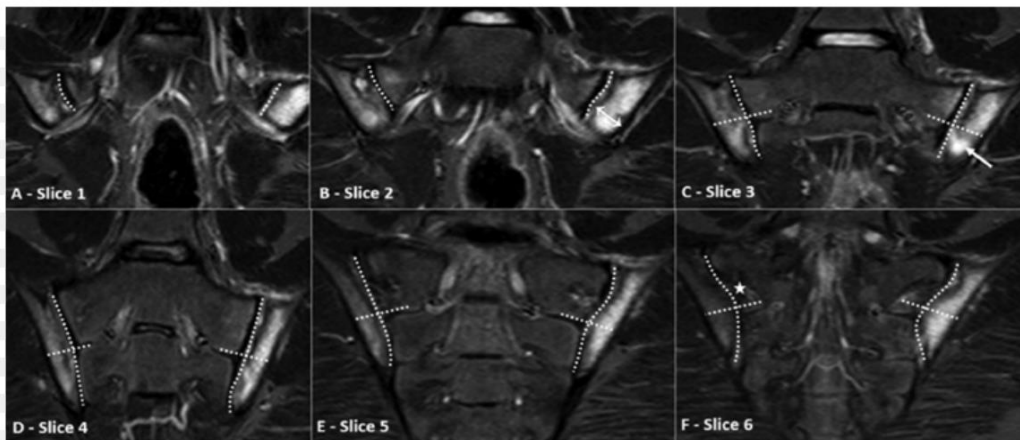
Regarding frequency of spinal MRI examination, two longitudinal studies reported significant changes detected already at 6

## Monitoring activity

*Riduzione edema = riduzione attività di malattia*

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G Patient: \_\_\_\_\_ Radiologist: \_\_\_\_\_ Total SPARCC score: 41 / 72

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(Extensive)	(Extensive)	(Extensive)	12
Slice 2		Slice 3	
(BME) (BME)	(BME) (BME)	(BME) (BME)	(BME) (BME)
(BME) (BME)	(BME) (BME)	(BME) (BME)	(BME) (BME)
(Intense)	(Intense)	(Intense)	(Intense)
(Extensive)	(Extensive)	(Extensive)	(Extensive)
8		9	
12		12	
Slice 4		Slice 5	
(BME) (BME)	(BME) (BME)	(BME) (BME)	(BME) (BME)
(BME) (BME)	(BME) (BME)	(BME) (BME)	(BME) (BME)
(Intense)	(Intense)	(Intense)	(Intense)
(Extensive)	(Extensive)	(Extensive)	(Extensive)
8		5	
12		12	
Slice 6			
(BME) (BME)	(BME) (BME)	(BME) (BME)	(BME) (BME)
(BME) (BME)	(BME) (BME)	(BME) (BME)	(BME) (BME)
(Intense)	(Intense)	(Intense)	(Intense)
(Extensive)	(Extensive)	(Extensive)	(Extensive)
Intense		Intense	
Extensive		Extensive	
4			
12			

## Quale Score per edema osseo?

The Spondyloarthritis Research Consortium of Canada (SPARCC) and Sacroiliac Joint (SIJ) Structural Score (SSS) methodologies are the most popular imaging standards of active and chronic disease activity, with high accuracy and reproducibility [11]. This SPARCC score is an internationally recognized quantitative indicator used to evaluate the degree of sacroiliac joint inflammatory edema. SPARCC score is based on the semi-quantitative score obtained from the subjective visual examination of the doctor reading the film. It does not provide accurate and objective quantitative signal value of bone marrow edema.

involves scoring BME on six coronal slices at the SIJ. BME is scored according to its presence, intensity, and depth. The depth of BME is defined as positive when 1 cm or more of continuous edema extends in a horizontal direction away from the articular surface. Each SIJ is evaluated as a whole. The depth associated with any part of a joint receives a score of 1. The depth of BME across six slices ranged from 0 to 12<sup>19</sup>. BME indicates the presence of acute inflammation, and increased density and depth indicate severe acute inflammation. We

*Scoring of depth and intensity. The signal from pre-sacral blood vessels defined a lesion that was scored as intense. A lesion was graded as deep if there was a homo-*

Topografico/estensione/intensità

# CONCLUSIONS: 3

- La valutazione dell'efficacia terapeutica deve necessariamente passare attraverso l'imaging?
- Abbiamo necessità di interpretare il BME residuo in pazienti sintomatici (infiammazione residua? altro?)

**11 novembre 2003 - Diploma di Specializzazione "cum laude" in Radiodiagnostica**, conseguito ai sensi del Decreto Legislativo 257/ 91, a seguito di un corso della durata di anni quattro, presso l'Università degli Studi di Siena in data 11/11/2003, e tesi sperimentale dal titolo: "Le sacroileiti nelle spondiloartropatie sieronegative: confronto tra Tomografia Computerizzata Multistrato e Risonanza Magnetica a studio dinamico con contrasto", relatore Chiar.mo Prof. Luca Volterrani.

Dynamic CE, DWI/ADC, T2 mapping, texture (radiomica)

- Dobbiamo dare un valore ad altre alterazioni del segnale (fat metaplasia, CIL B) (possibili fattori indipendenti di progressione di danno strutturale)

# Unmet needs

## **Entita' dell'edema:**

Quantificazione dell'edema in base all'aspetto

Quanto recente o remoto esso e'

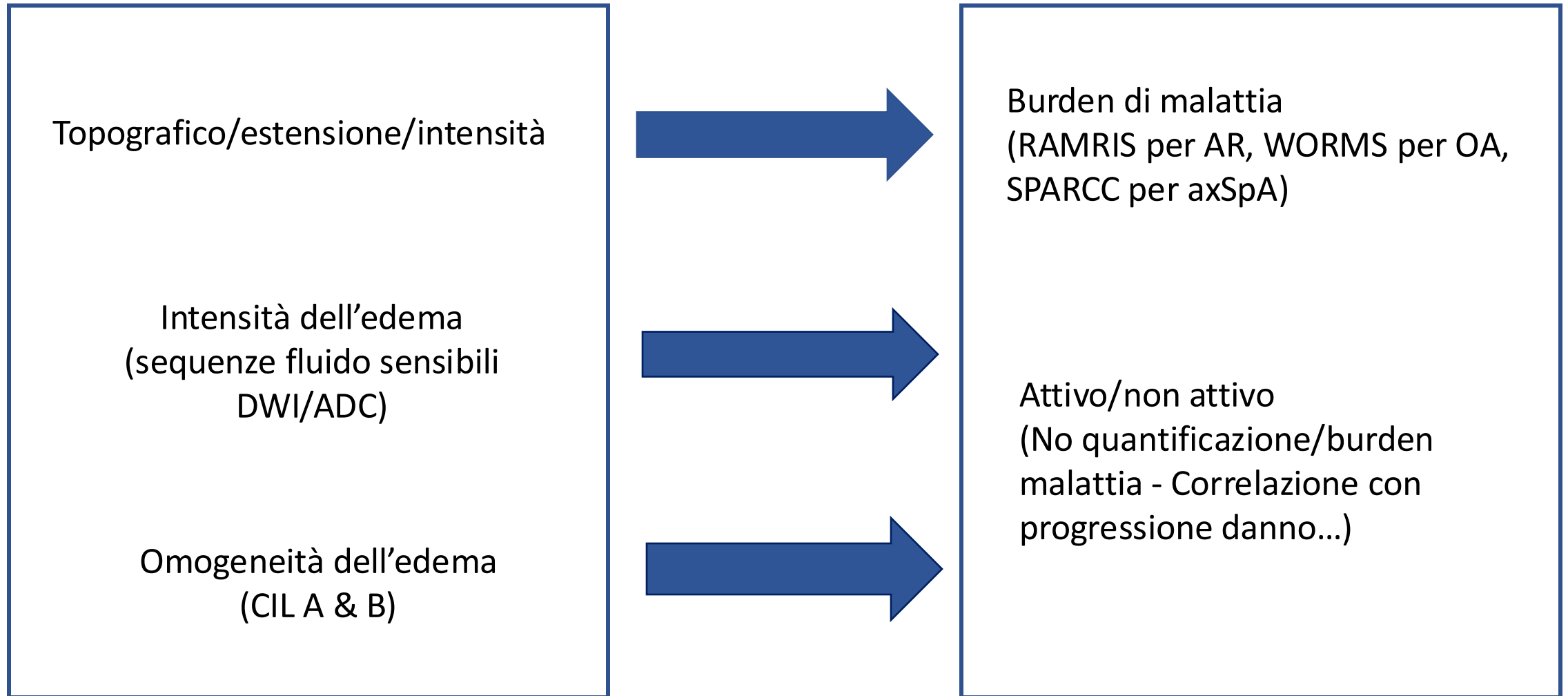
## **Le RM sono tutte uguali?**

**La prognosi:** legata solo alla patologia di base oppure anche all'entita' dell'edema

**Monitoraggio:** quando farlo,  
se farlo  
con che cosa farlo



## Quale Grading per edema osseo?



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