

Modic Type 1 or Early Spondylodiscitis?

How Should We Approach Equivocal MRI Findings?

Differentiating Modic type 1 degenerative endplate changes from early spondylodiscitis is not always straightforward. Particularly in the early stages of infection, before obvious endplate destruction, paravertebral phlegmon, or abscess formation has developed, both conditions may demonstrate decreased T1-weighted signal intensity and increased T2/STIR signal intensity in the adjacent vertebral endplates.

In such cases, the goal is not to identify a single “diagnostic” finding, but rather to progressively refine the diagnostic probability by integrating the imaging pattern with clinical and laboratory data.

Fundamental approach:

Disc → Endplate → Paravertebral/Epidural Space → DWI Pattern → Clinical and Laboratory Findings

1. First Question: What Does the Disc Look Like?

Findings Favoring Modic Type 1

Modic type 1 changes are generally part of degenerative disc disease. Associated disc findings may include:

- Desiccation (loss of water content)
- Reduced disc height
- Disc bulging/protrusion
- Other degenerative changes

A predominantly degenerative disc appearance, without a conspicuous fluid-like signal abnormality suggestive of infection, is a supportive finding favoring Modic type 1 changes.

Findings Favoring Spondylodiscitis

The disc may demonstrate:

- Markedly increased T2/STIR signal intensity
- Fluid-like signal changes
- Contrast enhancement
- Progressive reduction in disc height

However, an important diagnostic pitfall must be recognized:

Increased T2/STIR signal intensity or contrast enhancement within the disc alone is not diagnostic of spondylodiscitis.

Degenerative discs may also exhibit signal abnormalities and enhancement. Therefore, disc findings must always be interpreted in conjunction with the vertebral endplates and surrounding soft tissues.

2. Reassess the Endplates: “Irregular” and “Destructive” Are Not the Same

Endplate morphology is one of the most useful morphological clues in differentiating Modic type 1 changes from spondylodiscitis.

Modic Type 1

The endplates may be irregular but remain intact.

In other words, the degenerative process may produce irregularity of the endplate contour; however, the structural boundary of the endplate remains identifiable.

Spondylodiscitis

The endplates may demonstrate:

- Blurring of their margins
- Disruption of endplate integrity
- Erosions
- Progressive destruction in more advanced stages

 Remember

Irregular but intact endplates → Favor Modic type 1

Blurred / disrupted / destructive endplates → Favor spondylodiscitis

The term “favor” is particularly important here.

Obvious endplate destruction may not yet have developed in early infection. Therefore, an absolute conclusion such as “intact endplates exclude infection” should not be made.

3. Look Beyond the Vertebrae: Evaluate the Paravertebral and Epidural Spaces

Because bone marrow edema may occur in both conditions, the diagnostic clue may sometimes lie not within the vertebral body but in the surrounding soft tissues.

In spondylodiscitis, the following findings may be present:

- Paravertebral inflammatory changes
- Paravertebral phlegmon
- Paravertebral abscess
- Epidural inflammatory changes
- Epidural abscess

The presence of these findings, particularly phlegmon or abscess formation, substantially increases the likelihood of infection.

A prominent paravertebral or epidural inflammatory component is not expected in Modic type 1 changes.



Radiologist's Reflex

When faced with uncertainty between Modic type 1 changes and infection, do not simply spend more time examining the endplates. Expand your assessment and systematically reevaluate the surrounding soft tissues.

4. On DWI, Do Not Simply Ask “Is There Restricted Diffusion?” — Look for the Pattern

DWI Claw Sign

The claw sign consists of well-defined, linear or curvilinear, typically paired bands of high signal intensity on DWI at the interface between normal and abnormal vertebral bone marrow in Modic type 1 degenerative endplate changes.

This appearance is a supportive imaging finding that strongly favors degenerative Modic type 1 changes.

Why Does the “Claw” Form?

Modic type 1 represents a relatively slowly progressive degenerative process. A sharply defined transition zone may develop between degenerative fibrovascular marrow changes and normal bone marrow.

The sharp, claw-like high-signal boundary on DWI reflects this transition.

Infection, in contrast, tends to spread through the bone marrow in a more diffuse and infiltrative manner. Consequently, rather than the same sharply defined boundary, a more diffuse, amorphous, and poorly margined DWI hyperintensity may be observed.

Key Point to Remember

Claw pattern → Favors Modic type 1

Diffuse/amorphous pattern → Favors spondylodiscitis

However:

Claw sign does not mean “low ADC, therefore restricted diffusion.”

The claw sign should primarily be assessed as a morphological distribution pattern on DWI.

ADC alone is not the basis for this differentiation.

Therefore, the key question when evaluating DWI should not be:

“Is there restricted diffusion?”

Instead, it should be:

“What is the distribution pattern of the DWI signal abnormality?”

5. If MRI Remains Equivocal, What Can Laboratory Findings Tell Us?

ESR and CRP: What Do They Mean for the Radiologist?

CRP

CRP responds more rapidly to an acute inflammatory response. It may begin to rise within hours after the onset of infection and generally decreases more rapidly than ESR following successful treatment.

Therefore, CRP is particularly useful for:

- Evaluating active inflammation/infection
- Clinically monitoring treatment response

However, elevated CRP is not specific for spondylodiscitis, and a normal CRP level does not independently exclude infection in an appropriate clinical context.

ESR (Erythrocyte Sedimentation Rate)

ESR changes more slowly and may remain elevated for a prolonged period even after other inflammatory markers have normalized.

Therefore, it may reflect a more prolonged inflammatory burden, although it is not specific for infection.

In suspected vertebral osteomyelitis/spondylodiscitis, ESR and CRP should be interpreted in conjunction with clinical assessment, while MRI should remain the primary imaging modality.

This is where the true value of CRP and ESR becomes apparent.

Laboratory findings are not intended to establish the diagnosis on behalf of the radiologist.

Rather, laboratory findings modify the diagnostic probability established through imaging.

How Should CRP and ESR Be Interpreted Together?

When MRI cannot clearly differentiate Modic type 1 changes from early spondylodiscitis:

Laboratory findings	Interpretation	Diagnostic reasoning
Normal CRP + normal ESR	No laboratory support for inflammation	The probability of infection decreases but is not completely excluded.
Elevated CRP + normal ESR	Supports active inflammation	Suspicion of spondylodiscitis increases in the appropriate clinical context.
Elevated CRP + elevated ESR	Both inflammatory markers are elevated	The probability of infection is further strengthened when clinical and MRI findings are concordant.
Normal CRP + elevated ESR	Isolated ESR elevation	Nonspecific. Other causes and timing should be considered.
Elevated CRP + elevated ESR + fever/bacteremia/risk factors	Clinical and laboratory findings are concordant	Spondylodiscitis becomes a major diagnostic consideration.
Decreasing CRP after treatment, while ESR remains elevated	Different marker kinetics	This should not be interpreted as treatment failure in isolation.

Golden Rule

CRP and ESR do not establish the diagnosis; they modify diagnostic probability.

Therefore, rather than thinking: “Elevated CRP → Infection”

A more appropriate radiological approach is to ask:

“How much does this CRP elevation change the probability of infection in the context of the current clinical and MRI findings?”

Equivocal MRI + Elevated Inflammatory Markers: What Should I Do?

This is one of the most important scenarios in real-world clinical practice:

Conventional MRI does not clearly differentiate Modic type 1 changes from early spondylodiscitis.

Furthermore, the patient has an unexplained elevation of CRP and/or ESR levels.

In this situation, rather than concluding “Modic type 1” and closing the case, the images should be systematically reevaluated for evidence of infection.

6. Interpret Contrast Enhancement Correctly

Spondylodiscitis

Contrast enhancement may be observed in the disc, endplates, and adjacent vertebral bone marrow.

Enhancement of paravertebral or epidural inflammatory tissue, particularly when accompanied by abscess formation, provides additional evidence favoring infection.

Modic Type 1

Contrast enhancement may also occur in the endplates and adjacent vertebral bone marrow.

Therefore:

The presence of contrast enhancement alone does not reliably distinguish spondylodiscitis from Modic type 1 changes.

The distribution of enhancement should be assessed together with disc appearance, endplate morphology, and associated soft-tissue findings.

7. Clinical and Laboratory Correlation

Clinical and Laboratory Findings Suggestive of Spondylodiscitis

- Persistent or progressive spinal pain
- Pain at rest or during the night
- Fever or signs of systemic infection
- Elevated CRP and/or ESR
- History of bacteremia
- An infectious focus or predisposing risk factors

However, the absence of fever or leukocytosis does not exclude infection.

Indeed, a substantial proportion of patients with vertebral osteomyelitis may have a normal white blood cell count.

Modic Type 1

The clinical presentation is more commonly associated with degenerative low back pain.

However, diagnostic decisions should not be based solely on assumptions such as:

“Mechanical pain = Modic changes”

or

“Night pain = Infection”

8. A Practical Approach for Radiologists

When Modic type 1-like vertebral endplate marrow changes are identified, consider the following sequence:

1. Disc

Is the disc simply degenerative/desiccated (showing loss of water content)?

Or is there a conspicuous fluid-like T2/STIR signal abnormality?

2. Endplates

Are the endplates irregular but intact?

Or are their margins blurred, disrupted, eroded, or destroyed?

3. Paravertebral Space

Is there subtle edema or inflammatory change?

Has phlegmon or abscess formation developed?

4. Epidural Space

Is epidural inflammatory tissue or an abscess present?

5. DWI

Is there a sharply defined linear/curvilinear claw sign?

Or is there diffuse/amorphous DWI hyperintensity?

6. Clinical Findings

Is fever present?

Is there bacteremia or a positive blood culture?

Is there a history of recent infection, surgery, or intervention?

Are risk factors for infection present?

What do CRP, ESR, fever, bacteremia, infection risk factors, and the pain pattern suggest?

7. Previous Imaging

Were degenerative endplate changes previously present at the same level?

How have the signal abnormalities and endplate morphology evolved over the years?

Demonstration of long-standing degenerative changes may provide an important contextual clue favoring Modic type 1 changes; however, it does not independently exclude a newly developed infection.

Golden Rule

Do not assign the responsibility of establishing a diagnosis to a single finding.

The most reliable approach is to recognize the imaging pattern and interpret it in conjunction with clinical and laboratory findings.

Diagnostic Confidence Increases When Findings Converge Constellation of Findings Favoring Modic Type 1

- Degenerative/desiccated disc
- Irregular but intact endplates
- Absence of paravertebral/epidural inflammation
- DWI claw sign
- No clinical or laboratory findings supporting infection

→ Modic type 1 changes are strongly supported.

Constellation of Findings Favoring Spondylodiscitis

- Abnormal fluid-like disc signal
- Blurred/disrupted/eroded endplates
- Paravertebral or epidural inflammation
- Diffuse/amorphous DWI pattern rather than a claw sign
- Unexplained CRP/ESR elevation with compatible clinical findings

→ Spondylodiscitis is strongly supported.

⚠ But Remember

In real-world practice, not all findings necessarily fall into the same diagnostic category.

Particularly in early spondylodiscitis:

- Obvious endplate destruction may be absent.
- An abscess may not yet have developed.
- The clinical presentation may be subtle.

This is precisely the group most likely to be confused with Modic type 1 changes.

An Important Pitfall After Treatment

Following initiation of treatment for spondylodiscitis, clinical and laboratory improvement does not necessarily occur simultaneously with improvement on MRI.

CRP may decrease and the patient may improve clinically, while the following abnormalities persist on MRI:

- Vertebral bone marrow edema
- Endplate changes
- Disc signal abnormalities

Some osseous/discal imaging findings may even temporarily become more conspicuous.

Routine follow-up MRI is generally not recommended in patients with spondylodiscitis who demonstrate a favorable clinical and laboratory response.

Therefore:

Persistent bone marrow edema ≠ Persistent infection

Treatment response should not be assessed solely on the basis of vertebral bone marrow or disc signal abnormalities.

When follow-up imaging is indicated, the evolution of paravertebral and epidural soft-tissue abnormalities may be more informative than changes in the bone and disc.

9. Example Radiology Report

At the L4–L5 level, T1-hypointense and STIR-hyperintense bone marrow signal changes are observed along the opposing vertebral endplates. The endplate contours are irregular but remain intact. No obvious endplate destruction, fluid-like signal abnormality within the disc, or paravertebral/epidural inflammatory soft-tissue component is identified.

The findings primarily favor Modic type 1 degenerative endplate changes.

If there is clinical suspicion of infection, correlation with laboratory findings, including CRP and ESR, is recommended.

10. High-Yield Differential Diagnosis Table

Feature	Modic Type 1	Early Spondylodiscitis
Disc	Usually degenerative/desiccated	Increased T2/STIR signal; fluid-like signal may develop
Endplates	Irregular but intact	Blurred, disrupted, eroded/destructive
Bone marrow	T1 ↓ / STIR ↑	T1 ↓ / STIR ↑
Paravertebral tissues	Prominent inflammation is not expected	Edema, phlegmon, or abscess may develop
Epidural space	Usually normal	Inflammation/abscess may develop
DWI	Claw sign favors this diagnosis	Diffuse/amorphous DWI pattern favors this diagnosis
Contrast enhancement	May be present	May be present; distribution and associated findings are important
ESR CRP	No specific association	Elevation increases suspicion in the appropriate clinical context
Clinical context	No specific association	Frequently elevated, but nonspecific and changes more slowly
Is any single finding diagnostic?	Degenerative pain	Infectious findings/risk factors may provide support
	No	No



RCD Radiology Pearl

The goal in differentiating Modic type 1 changes from early spondylodiscitis is not to identify a single “perfect” finding.

The disc, endplates, paravertebral/epidural soft tissues, and DWI pattern should be evaluated together. CRP and ESR then increase or decrease the diagnostic probability established by these imaging findings within the appropriate clinical context.

When MRI findings are equivocal, do not ask, “Which single finding establishes the diagnosis?” Instead, ask, “In which direction does the overall constellation of findings point?”

11. References

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