Reverse transformation of Modic Type 2 changes to Modic Type 1 changes during sustained chronic low-back pain severity

Report of two cases and review of the literature


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✓ Modic Type 2 (MT2) neuroimaging changes are considered stable or invariant over time and relatively quiescent, whereas Modic Type 1 (MT1) changes are considered unstable and more symptomatic. The authors report two cases in which MT2 changes were symptomatic and evidently unstable, and in which chronic low-back pain severity remained unaltered despite a MT2–MT1 reverse transformation. Two women (41 and 48 years old) both presented with chronic low-back pain. Magnetic resonance (MR) images demonstrated degenerating discs at L5–S1 associated with well-established MT2 changes in adjacent vertebrae. Repeated MR imaging in these two patients after 11 months and 7 years, respectively, revealed reverse transformation of the MT2 changes into more florid MT1 changes, despite unaltered chronic low-back pain severity. Following anterior discectomy and disc arthroplasty, immediate abolition of chronic low-back pain was achieved in both patients and sustained at 3-year follow up. Modic Type 2 changes are therefore neither as stable nor as quiescent as originally believed. Each type can change, with equal symptom-generating capacity. More representative imaging–pathological correlates are required to determine the precise nature of MT changes.

KEY WORDS • low-back pain • Modic change • discectomy • arthroplasty

The pathological and anatomical causes of chronic low-back pain remain unclear. Despite isolated examples of histological correlates of chronic low-back pain with MR imaging, histological correlates with symptomatology have not been described. Modic et al. originally described two types of vertebral marrow and endplate changes found using MR imaging. Modic Type 1 changes were considered unstable, and were believed to transform over time into either MT2 changes or revert back to normal (MT0 changes). In contrast, MT2 changes were considered stable and invariant over time. We report two cases in which MT2 changes were evidently unstable with subsequent reverse transformation into florid MT1 changes within 11 months and 7 years, respectively.

Case Reports

Case 1

This 41-year-old woman initially presented with a 3-year history of chronic low-back pain and minimal radiation down the right leg. Results of her physical examination were normal. A T₂-weighted MR image revealed a degenerating L5–S1 disc of reduced height and hypointensity. The adjacent discs were of normal appearance. Extensive MT2 changes, such as hyperintensity on both T₁- and T₂-weighted MR images, were apparent in both adjacent vertebral bodies.
Despite a prolonged course of physiotherapy, the patient’s chronic low-back pain continued unabated, and although the leg pain resolved, she presented again 11 months later. New MR images revealed the complete conversion of previous MT2 changes to MT1 changes (hypointensity on T1-weighted MR imaging, but hyperintensity on T2-weighted MR imaging) at the same vertebral level. In addition, the L5–S1 disc height was significantly more reduced, and the previous prolapse had largely resorbed. During anterior discectomy, the L5–S1 disc was found to be degenerating but not infected, and a Maverick (Medtronic Sofamor Danek) disc was successfully inserted. There was immediate postoperative abolition of chronic low-back pain that was sustained for 3 years.

**Case 2**

This 48-year-old woman initially presented to another specialty clinic with chronic low-back pain without radiation down the leg. Her physical examination findings were normal. Magnetic resonance images of the lumbar spine revealed a degenerating L5–S1 disc of reduced height and signal intensity, along with a posterior anular bulge and nuclear herniation. Extensive MT2 changes were noted in both adjacent vertebral bodies. The adjacent discs were of normal appearance. She was advised that no surgery was required, and given a course of physiotherapy. The patient’s level of chronic low-back pain continued despite courses of physiotherapy. Seven years later she was referred to our clinic, presenting with chronic low-back pain without radiation down the leg. At this examination, MR imaging revealed the complete conversion of previous MT2 changes to MT1 changes (hypointensity on T1-weighted imaging, hyperintensity on T2-weighted imaging) at the same vertebral level. There was no change, however, in the disc signal intensity, nor in the extent of prolapse initially present. Like the patient in Case 1, during anterior discectomy, the L5–S1 disc was found to be degenerating but not infected, and a Maverick disc was successfully inserted. Postoperatively, there was immediate elimination of chronic low-back pain that was sustained for 3 years.

**Discussion**

Vertebral marrow and endplate changes related to degenerative disc disease (but unrelated to tumor or infection) were first noted by de Roose et al. using MR imaging. A formal classification was subsequently provided by Modic et al. based on 474 patients, most of whom had chronic low-back pain. Modic Type 1 changes (4%) were hypointense on T1-weighted MR imaging and hyperintense on T2-weighted MR imaging. Modic Type 2 changes (16%) were hyperintense on T1-weighted MR imaging and either iso- or hyperintense on T2-weighted MR imaging. Modic Type 3 changes (hypointense on both T1- and T2-weighted MR imaging) were also subsequently described; the absence of Modic changes (a normal anatomical appearance) has often been designated MT0.

Tentative radiopathological correlates to these changes were also provided by Modic et al. based on three rare operative specimens. Identical changes were noted in the endplates of both MT1 and MT2 changes; in both types, the endplates were fissured and associated with reactive woven bone deposition and vascular granulation tissue formation. Markedly different changes, however, were noted in the adjacent bone marrow. In MT1 changes, the adjacent marrow was completely replaced by fibrovascular tissue, whereas in MT2 changes, the adjacent red marrow was totally replaced by fat (yellow marrow), accounting for the signal change on MR imaging. The nature of MT3 changes remained undetermined.

Modic et al. also suggested a hierarchy of changes based on longitudinal follow up. In five of his six patients with MT1 changes there was at least a partial conversion of MT1 changes to MT2 changes within 3 years. Definitive MT1–MT2 conversion occurred in three of four patients previously treated with chymopapain. Because none of 10 patients with MT2 changed within 3 years, and “at least one patient” demonstrated reverse transformation from MT1 to MT0, Modic et al. considered MT2 changes to be stable and unchangeable over time, and MT1 changes to be unstable. This idea was supported by a greater prevalence of MT2 changes than MT1 changes in his study.

Support for this framework has subsequently been provided by other investigators. Mitra et al. found that most MT1 changes (52%) either converted (wholly or partially) into MT2 changes within 72 months, or instead became more extensive (40%); thus, only 8% of the MT1 changes in this study remained unchanged. More data were provided by Vital et al. who found that in 17 patients demonstrating clinical improvement 6 months after a postero-lateral fusion, no MT1 changes remained invariant; 77% of the MT1 changes converted to MT2 changes, whereas 23% reverted back to MT0. Such results therefore also provide support for the view that MT1 changes are more active changes, in accordance with the marrow changes originally reported by Modic et al. Toyone et al. found that arthrodesis was more frequently required in patients with chronic low-back pain with MT1 changes than with MT2 changes, whereas Chataigner et al. found better fusion outcomes in those patients with MT1 changes.

Clear evidence that MT2 changes might not always remain invariant was recently provided by Kuisma et al. In a longitudinal study documenting the natural history of Modic changes, these authors found, as we did, that reverse transformation of MT2 to MT1 changes occurred in two patients. Unfortunately, no clinical details were given in this study to permit a formal comparison with our cases, although MT2–MT1 transformation was noted to have occurred within 3 years. Moreover, in the only example that the latter authors provided, the initial MT2 change was significantly smaller and limited to the posterior vertebral body extremity, in contrast, in both our cases, the initial MT2 and subsequent MT1 changes were both florid and extensive (Figs. 1 and 2).

More importantly, in both of the patients in our study, there was essentially no change in chronic low-back pain severity over the entire MT2–MT1 transformation period. Furthermore, only the index discs were abnormal on MR imaging in each case, whereas a single-level discectomy produced immediate and sustained (3-year) symptomatic relief. Such results contradict a MT1 (active) versus MT2 (quiescent) dichotomy, and instead indicate that MT1 and
MT2 are interchangeable with equal symptom-generating capacity. Further support for this view can be derived from numerous studies demonstrating mixed Modic change transitions, as well as from studies that have demonstrated that MT2 changes are equally as likely as MT1 changes to be associated with concordant pain on discography in patients with chronic low-back pain. Such a view is also surprisingly compatible with the radiopathological correlates of Modic et al., because in both MT1 and MT2 changes, the endplates contained vascularized granulation tissue, a likely source of de novo pain afferents. Divergent adjacent bone marrow appearances may therefore be less important, and with MT2 changes, may even represent epiphenomena that mask potentially more important endplate changes.

Larger studies, with longer follow-up periods and more frequent MR images, would be required to determine the frequency with which MT interchangeability might occur. Additionally, more representative radiopathological correlates are required to determine the precise pathological nature of all Modic changes. Given the current evidence, however, it seems likely that a conversion from MT1 to MT2 is more likely than a conversion from MT1 to MT0, which is more likely than a conversion from MT2 to MT1, accounting for the observed MT2–MT1 ratio. Further, until a case of direct conversion from MT2 to MT0 or vice versa is described, and until study data demonstrates how patients with MT3 might change, it appears likely that MT1 changes represent the major transition point and link with normality.

Conclusions

Results from this study suggest that MT2 changes are neither as stable nor as quiescent as originally believed. Modic Types 1 and 2 are instead interchangeable and equipotent in symptom-generating capacity, a fact that may more accurately reflect their associated endplate changes rather than their associated adjacent bone marrow changes. More representative radiopathological correlates are required to determine the precise pathological nature of all Modic changes.

Acknowledgment

This paper has been significantly contributed to by all named authors.

References

Reverse transformation of Modic Type 2 changes


Manuscript submitted September 6, 2006.
Accepted November 6, 2006.

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