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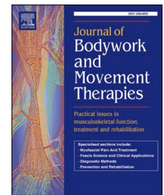

Paravertebral intramuscular and rectal insufflation oxygen-ozone therapy for modic 1- related low back pain: a case report

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A R T I C L E I N F O

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A B S T R A C T

Introduction: Modic type 1 changes on MRI are increasingly recognized as a source of chronic low back pain (cLBP), often resistant to conventional therapies. Oxygen-ozone (O2–O3) therapy (OOT) has emerged as a minimally invasive treatment option due to its analgesic, anti-inflammatory, and immunomodulatory properties.
Case presentation: A 68-year-old woman presented with bilateral cLBP and right leg pain, exacerbated in the morning and after inactivity, associated with Modic 1 changes at the L5-S1 level. Previous treatments with analgesics, steroids, and physical therapy were ineffective. From May 2024, the patient received weekly bilateral paravertebral intramuscular O2–O3 injections (10 mL per side, 10 μg/mL) and rectal O2–O3 insufflation (25 μg/mL, 150 mL/session) for twelve weeks. Significant symptom improvement was noted by the fourth session, with complete resolution by the tenth. Analgesic medications were discontinued after the fourth session. MRI at six months post-treatment showed complete resolution of inflammatory edema and restoration of bone trabeculae, with persistent Modic 2 changes and resorption of a median disc protrusion at L4-L5.
Conclusion: This integrated OOT approach (paravertebral intramuscular injections plus rectal insufflation) may represent a promising conservative option in selected patients, but these findings are preliminary and require confirmation in controlled studies before any treatment recommendations can be made.

1. Introduction

Low back pain (LBP) is a leading global cause of disability, absenteeism, and healthcare utilization. Approximately 22% (range 12–37%) of patients with nonspecific LBP exhibit Modic Type 1 or mixed Modic Type 1/Type 2 changes on Magnetic Resonance Imaging (MRI). Numerous large cohort studies have consistently demonstrated a strong association between Modic Type 1 changes observed on MRI and LBP. Specifically, the presence of Modic changes on MRI is linked to nonspecific chronic LBP (cLBP) and functional disability (Czaplewski et al., 2023).

Modic changes refer to a vertebral pathology arising from dynamic alterations of the vertebral endplates, representing pathological changes in the vertebral body boundaries and adjacent bone marrow. Modic changes are classified into three distinct types, each representing a stage in the progressive evolution of the pathology. MRI is the optimal diagnostic modality for visualizing the distinct pathological stages of Modic changes. Modic Type 1 changes on MRI indicate acute inflammation and bone edema, causing pain and functional impairment. Modic Type 2 changes show fatty infiltration, potentially reducing mechanical resistance. Modic Type 3 changes signify bone remodeling with calcification,

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Abbreviations

Low back pain LBP
Chronic low back pain cLBP
Oxygen-ozone O2–O3
O2–O3 therapy OOT
Magnetic Resonance Imaging MRI
Visual Analogue Scale VAS
Oswestry Disability Index ODI

leading to structural reorganization and potential biomechanical disruption (Espeland et al., 2023).

Modic changes, particularly Type 1, cause localized fascial pain, spinal stiffness, muscle contractures, and pain upon lying down. These changes, likely representing an underlying pathology, warrant therapeutic attention for cLBP. Currently there is no specific treatment protocol for Modic changes. Ultimate goal is to alleviate symptoms, address underlying causes, and promote spinal recovery through movement, posture restoration, and muscle elasticity improvement (Migliorini et al., 2025).

Oxygen-ozone (O2–O3) therapy (OOT) is being explored as an alternative treatment for cLBP due to O3 analgesic and anti-inflammatory effects.

O3, particularly when administered systemically (e.g., via rectal insufflation), and at low doses, dissolves in plasma and rapidly reacts with polyunsaturated fatty acids (PUFAs), generating secondary messengers such as hydrogen peroxide (H_2O_2) and 4-hydroxynonenal (4-HNE), a byproduct of lipid peroxidation. These molecules subsequently activate endogenous antioxidant defense systems. O3 itself disappears within seconds and acts as a biological regulator without following the conventional pharmacokinetic principles of absorption, distribution, metabolism, and excretion. Therefore, O3 functions as a primary and transient messenger; H_2O_2 exhibits a plasma half-life of approximately 2 minutes, whereas 4-HNE is more stable and persistent. Consequently, 4-HNE is considered a key mediator capable of delivering transient signals to multiple tissues. Both H_2O_2 and 4-HNE can activate the Nrf2 signaling pathway through indirect mechanisms. In the nucleus, Nrf2 dimerizes and induces transcription of antioxidant response elements (AREs) (Malatesta et al., 2024). AREs transcription regulates the expression of several antioxidant enzymes, including superoxide dismutase (SOD), glutathione peroxidase (GPx), glutathione S-transferase (GST), catalase (CAT), heme oxygenase-1 (HO-1), NAD(P)H quinone oxidoreductase 1 (NQO1), and heat shock proteins (HSPs). HO-1 catalyzes the degradation of heme into carbon monoxide (CO), free iron, and biliverdin, which is subsequently converted into bilirubin. CO, an important modulator of the NF-κB (nuclear factor kappa B) signaling pathway, contributes to the regulation of pro-inflammatory cytokine expression. In addition, bilirubin acts as a lipophilic antioxidant (Inguscio et al., 2023). Overall, HO-1 plays a pivotal role in modulating inflammation by down-regulating pro-inflammatory cytokines and promoting anti-inflammatory mediators. Furthermore, casein kinase 2 functions as a negative regulator of NADPH oxidase. Recent studies indicate that ozone influences CK2 expression levels via the Nrf2 signaling pathway (Elmounedi et al., 2024). O3 also plays a role in immune system modulation by increasing leukocyte counts and enhancing granulocyte phagocytic capacity. It promotes monocyte formation and T-cell activation, while stimulating the release of cytokines such as interferons and interleukins, thereby triggering antibody-dependent cellular cytotoxicity (Sharma and Hudson, 2008; Zeng et al., 2020).

Minimally invasive intramuscular paravertebral ozone injections have demonstrated safety and efficacy in reducing pain and disability. Recent evidence suggests the potential of OOT for cLBP unresponsive to conservative management. While some studies investigate intradiscal/intraforaminal O2–O3 injections, intramuscular paravertebral injection appears to be the most prevalent technique in current clinical practice (Latini et al., 2024).

The aim of this paper is to report a case of a patient with cLBP associated with Modic 1 changes, treated with a combination of paravertebral intramuscular injections and rectal insufflation OOT, and to evaluate the therapeutic effects and potential benefits of this novel approach in managing Modic-related LBP.

2. Case report

A 68-year-old woman with a Body Mass Index of 30.4, controlled hypertension, and hyperlipidemia despite statin therapy, presented with bilateral cLBP and right leg pain. Her symptoms worsened in the morning and after inactivity, with severe muscle contracture and pain when lying down, especially soon after assuming a supine position. Patient's symptoms led to work disability and impossible heavy lifting. Table 1 summarizes the main chronological events of this case.

For approximately one and a half years from late 2022, the patient underwent conservative treatment for her condition. According to the patient's medical history, previous management included several courses of oral analgesics (over-the-counter and prescription), nonsteroidal anti-inflammatory drugs, intramuscular steroid injections, and physiotherapy, all with insufficient symptom relief. As these interventions were administered by other clinicians, exact treatment schedules and dosages could not be retrieved.

Lumbar spine MRI two years into conventional treatment, compared to a scan at symptom onset, revealed an increase in inflammatory edematous changes within the trabecular bone of the L4-L5 endplate (Modic 1). Conversely, the adipose degeneration/replacement at the L5-S1 endplate (Modic 2) remained stable. Similarly, the median disc

Table 1
Main chronological data of the case.

Time Period	Clinical Events & Interventions	Imaging Findings	Outcome Measures
Late 2022	Symptom onset: Bilateral cLBP + right leg pain with morning exacerbation and positional aggravation	Initial MRI: Modic 1 changes (T1 hypointense/T2 fat-suppressed hyperintense) at L4-L5, Modic 2 at L5-S1	Work disability certification issued
2022–2024	Conservative management: Analgesic drugs, physiotherapy, steroid injections	MRI at 2 years: Progressive Modic 1 inflammatory edema at L4-L5, stable Modic 2 at L5-S1	Persistent ADL impairment
May 2024 (T0)	Initiation of OOT: Weekly bilateral paravertebral injections (10 mL - 10 μg/mL) + rectal insufflation (150 mL - 25 μg/mL)	Pre-treatment MRI: Extended Modic 1 changes at L5 superior endplate, stable median L4-L5 disc protrusion	VAS: 9 ODI: 58%
June 2024 (Session 4)	Partial symptom relief Analgesic discontinuation	/	Subjective functional improvement
August 2024 (Session 10)	Complete symptomatic resolution	/	Full return to ADLs
September 2024 (T1)	1-month follow-up	MRI: Resolution of Modic 1 edema Residual posterior wall inflammation Complete L4-L5 disc protrusion resorption	VAS: 5 ODI: 25%
February 2025 (T2)	6-month follow-up	MRI: Complete Modic 1 resolution Minimal adipose degeneration Stable L5-S1 Modic 2	VAS: 0 ODI: 0%

protrusion at the L4-L5 level showed no significant change. In particular, at symptoms onset, an evident Modic 1 alteration was present with signal hypointensity on T1 sequences and hyperintensity on fat suppression sequences at the spongy component level, adjacent to L4-L5 somatic bodies. After the treatment, on T1 images and even more evident in fat suppression images, an extension of the intraspongious inflammatory component, in particular on the superior somatic limitation of L5 was observed. The alteration with L5-S1 adipose intraspongious replacement remained unchanged (Modic 2).

The patient came to authors' attention in May 2024 for symptoms persistence with severe pain and functional impairment. Considering this as a failure of previous interventions, after signing an informed consent and sharing perspective on the treatment, the patient underwent OOT with bilateral paravertebral intramuscular O_2–O_3 injections (10 mL for each side at the affected level, with a O_3 concentration of 10 μg/mL, using a 27G x 25mm needle) associated with O_2–O_3 rectal insufflation (O_3 concentration of 25 μg/mL and gas volume of 150 mL/session). The injections and insufflation were performed weekly, for a total of twelve weeks. Before the injection, the locus dolendi was confirmed through the segmental semeiotic with an axial and lateral pressure of the lumbar vertebrae. No complications were recorded during the treatment protocol.

All procedures were conducted in accordance with established clinical practice guidelines, with the Helsinki Declaration of 1975 (as revised in 1983) and with the written informed consent of the patient. Chlorhexidine-soaked gauze and sterile, single-use needles and tools were used for skin disinfection and procedures to maintain aseptic conditions. The case is reported according to the 2013 Case Reports (CARE) checklist for case reports.

Two validated outcome measures, the Visual Analogue Scale (VAS) and the Oswestry Disability Index (ODI), were used to assess pain and disability. VAS is a pain rating tool, while ODI is a questionnaire assessing disability and functional impairment in individuals with LBP. These outcome measures were administered before OOT (T0), at one month (T1) and at six months (T2) following the final injection, alongside MRI examination.

The patient exhibited a notable reduction in symptoms starting from the fourth OOT session, with complete resolution by the tenth session. Following the fourth session, the patient discontinued all analgesic medication. Three months post-treatment, the patient reported significant symptom resolution, improved functional capacity and work performance, and an enhanced QoL. Accordingly, a reduction in VAS scores was observed from 9 at T0 to 5 at T1 and 0 at T2. Similarly, the ODI score decreased from 58 at T0 to 25 at T1 and 0 at T2.

Patient experienced improved spinal flexibility and posture after OOT, with pain relief and increased mobility. No major adverse event was recorder during OOT; patient reported only minor pain during the first sessions at the moment of injection.

At T1 Fat suppression images on the sagittal plane MRI revealed a resolution of the inflammatory condition (Modic changes type 1), with a subtle persistence of signal intensity alteration in the posterior wall, indicating residual inflammatory edema and an initial transition towards Modic 2 changes due to the presence of adipose tissue. At T2 Fat suppression and T1 images on the sagittal plane MRI showed complete resolution of the intraspongious inflammatory edema, along with a restoration of the bone trabeculae with minimal adipose degeneration. The adipose degeneration/replacement at the L5-S1 endplate (Modic 2) remained unchanged across all the study time points. At T2 Fat suppression images on the sagittal and axial plane MRI also demonstrated complete resorption of the median disc protrusion at the L4-L5 level. Fig. 1 shows patient's lumbar spine during the course of the case. More figures are provided as Supplemental Digital Content (Figure S1 to figure S5).

3. Discussion

This case report explores the potential of OOT administered through combined paravertebral intramuscular injection and rectal insufflation in the management of cLBP associated with Modic changes. A 68-year-old woman with bilateral cLBP and right leg pain experienced significant symptom relief and resolution of Modic 1 changes after 12 weeks of weekly paravertebral O_2–O_3 injections and rectal insufflation.

Intramuscular paravertebral OOT appears as an emerging promising therapeutic approach in the treatment of cLBP (Latini et al., 2024). In published series, paravertebral OOT has been associated with clinically meaningful reductions in VAS scores (often by 3–5 points) and substantial ODI improvements over 1–6 months of follow-up in patients with cLBP pain refractory to conventional conservative treatment (Llombart-Blanco et al., 2024). This case supports this notion: OOT was associated with the resolution of pathological alterations consistent with Modic 1 changes on MRI, accompanied by symptom relief. OOT appeared to have no evident effect on the trabecular fat replacement characteristic of Modic 2 changes observed on MRI. In this case, OOT was also associated with the resolution of disc protrusion, although a causal relationship cannot be established. MRI at T2 indicated that OOT was associated with the reconstruction of bone trabeculae.

The mechanism by which O_3 acts on disc protrusions and herniations, involving disc dehydration and subsequent reduction or resolution

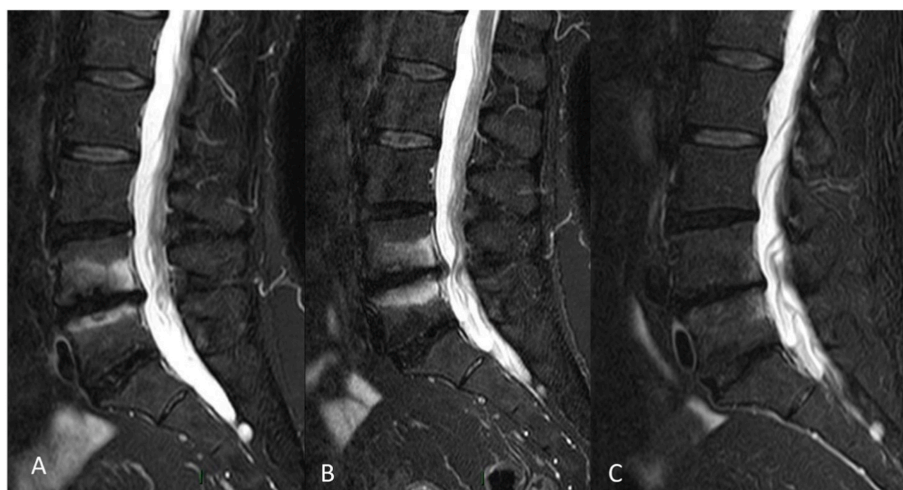

Fig. 1. Fat suppression on the sagittal plane MRI examination, before (A), 1 year after pharmacological treatment (B) and at six month after oxygen-ozone therapy (C).

of nerve compression, is well-supported in international literature for both intradiscal and paravertebral intramuscular ozone injections (Biazzo et al., 2018). In this specific case report, the median disc protrusion, while indenting the dural sac, did not appear to cause nerve root compression and was therefore considered an incidental finding related to disc degeneration rather than the primary source of the patient's symptoms. Notably, a growing body of research is validating the efficacy of paravertebral intramuscular ozone infiltration for treating herniated discs in comparison to chemonucleolysis via intradiscal injection (Latini et al., 2024; Biazzo et al., 2018; Özcan et al., 2019).

A consensus on optimal treatment for Modic changes in patients with cLBP is lacking. Most clinical studies on Modic changes have focused on the short-term efficacy of non-surgical approaches like intradiscal steroid injections, anti-TNF-α antibodies, antibiotics, and bisphosphonates, with long-term benefits being largely unknown (Anderson and Shaheed, 2022). Current pharmacological management of LBP in adults typically involves paracetamol, opioids, nonsteroidal anti-inflammatory drugs, muscle relaxants, antibiotics, and antidepressants (Mu et al., 2022). O3, through OOT, with its multifaceted properties, may offer a therapeutic advantage by potentially addressing various underlying mechanisms contributing to Modic 1 changes, including mechano-immunological, autoimmune, and infectious pathways, whether acting independently or concurrently.

According to the potential pathophysiological basis of the Modic 1 changes and on the properties and mechanisms of action of O3, OOT appears to play a peculiar role. Rectal insufflation, as well as paravertebral injections, are well-recognized systemic and local (respectively) routes of OOT administration, with standardized protocols regarding concentrations and volumes defined in international guidelines such as the Madrid Declaration; both rectal insufflation and paravertebral injections are used to harness the anti-inflammatory, immunomodulatory, and potential antimicrobial effects of O3 (Schwartz et al., 2020). In the context of Modic 1 changes, which may involve mechano-immunological, autoimmune, and low-grade infectious mechanisms, this dual local–systemic approach (i.e. local effects by paravertebral intramuscular OOT plus systemic effects by rectal insufflations) appears pathophysiologically plausible, although its specific contribution and comparative efficacy still need to be confirmed in controlled studies. The double approach has the aim of treating the patient both locally and systemically, enhancing the effect of the two methods of administration and acting not only as an anti-inflammatory and local repair agent, but also as an immunomodulator of the immune system and as a systemic antibacterial; thus, both approaches cover all possible causes hypothesized at the basis of Modic 1.

While Bruno et al. (2017) showed no change in Modic alterations after OOT for LBP with paravertebral intramuscular O2–O3 injections, the current approach involves paravertebral intramuscular O2–O3 injections and rectal insufflation, potentially affecting paravertebral tissues, vertebral bodies, and providing systemic effects.

3.1. Limitations

This case report has inherent limitations that must be acknowledged. First, the single-case design precludes any causal inference and limits the generalizability of the findings. Second, the absence of a control group prevents discrimination between true treatment effects and alternative explanations such as natural disease progression, placebo response, or regression to the mean. Third, spontaneous conversion of Modic 1 to Modic 2 changes has been described in the literature and therefore cannot be excluded as a contributing factor to the radiological evolution observed in this patient. Lastly, the combined intervention does not allow disentangling the individual contribution of each modality and the lack of specifics about previous treatment didn't allow to make further speculations. Thus, while OOT appears as a promising therapy, these limitations underscore the need for controlled studies with larger cohorts to confirm and extend the preliminary observations reported here.

4. Conclusion

In conclusion, the combined use of paravertebral intramuscular injections and rectal insufflation OOT appeared to be a safe conservative approach in this patient with cLBP associated with Modic changes and was associated with rapid and sustained clinical improvement as well as MRI changes compatible with reduced inflammatory edema and disc protrusion. However, given the single-case design and lack of a control group, these observations must be considered preliminary and hypothesis-generating. Rather than supporting any first-line treatment recommendation, these findings highlight the potential of this dual OOT approach and underscore the need for prospective, controlled studies with larger cohorts to clarify OOT efficacy and safety profile in Modic 1-related LBP.

Informed consent statement

Written informed consent for the procedures performed, participation in this study, and publication of the case details was obtained from the patient. In accordance with the Journal of Bodywork and Movement Therapies author guidelines ("Written consents must be retained. They should not be provided to this journal unless this is specifically requested in exceptional circumstances, for example, when a legal issue arises. Only then should you provide copies of the consents, or evidence that all relevant consents were obtained."), the consent form is held by the authors and available upon request.

Author disclosures

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CRediT authorship contribution statement

Valeria Fiaschetti: Conceptualization, Data curation, Investigation, Visualization, Writing – original draft. **Nicola Manocchio:** Methodology, Visualization, Writing – review & editing. **Helga Cosolo:** Writing – original draft. **Sofia Dell'Anna:** Writing – original draft. **Giuseppe Porcari:** Investigation. **Mauro Di Roma:** Writing – original draft. **Vincenzo Dell' Anna:** Conceptualization, Investigation, Methodology. **Calogero Foti:** Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

Authors have nothing to disclose about competing interests, funding, grants or equipment and financial benefits. The research has not been previously presented in any form.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbmt.2026.03.026.

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