


**THE USE OF OZONE THERAPY IN MUSCULOSKELETAL DISEASES:
PHYSICAL THERAPY INTERVENTION** <https://doi.org/10.56238/sevened2024.037-069>

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ABSTRACT

Ozone therapy has been established as an innovative therapeutic approach, especially in the treatment of musculoskeletal diseases. This technique consists of applying a mixture of oxygen (O₂) and ozone (O₃), generated by specific equipment, which has analgic, anti-inflammatory and antioxidant effects, and is minimally invasive. This chapter discusses the mechanisms of action and application of ozone therapy, its indications and contraindications, and compares it with other treatment modalities used in the physical therapy approach to musculoskeletal diseases.

Keywords: Ozone therapy. Musculoskeletal diseases and physiotherapy.

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INTRODUCTION

Musculoskeletal injuries, which include a wide range of conditions affecting bones, muscles, joints, and connective tissues, are a leading cause of chronic pain, physical disability, and reduced quality of life worldwide. These conditions not only directly impact the health and well-being of patients, but also entail high indirect costs for society, such as prolonged absences from work and loss of productivity (WHO, 2022). Given this scenario, the search for effective, accessible, and minimally invasive treatments has intensified, especially in the field of physical therapy, which plays a key role in the rehabilitation and management of musculoskeletal disorders.

In recent years, ozone therapy has emerged as a promising and innovative therapeutic approach, standing out for its anti-inflammatory, analgesic, and antioxidant properties. Using a controlled mixture of oxygen (O_2) and ozone (O_3), ozone therapy has been gaining increasing acceptance in clinical practice, especially among physiotherapists, who seek to integrate new technologies and techniques to optimize the recovery of their patients. This minimally invasive therapy acts directly on inflammatory and degenerative processes, promoting tissue regeneration and pain relief, essential factors in the treatment of musculoskeletal injuries (FERREIRA, 2020).

The relevance of ozone therapy for physiotherapy is justified not only by its direct therapeutic effects, but also by its complementarity with other traditional rehabilitation techniques, such as kinesiotherapy and muscle strengthening. By being applied in an integrated way to these approaches, ozone therapy enhances the results, promoting a faster return to daily activities and improving the patient's functionality. Studies have shown that, in addition to its effectiveness in relieving pain, ozone therapy also accelerates the healing and tissue regeneration process, which makes it a powerful ally in the therapeutic arsenal of physical therapists (ANZOLIN; BERTOL, 2018).

In Brazil, the use of ozone therapy was recently regulated by Law No. 14,648, of 2023, allowing physiotherapists to use this technique in their clinical practices legally and safely (COFFITO, 2023). This represents an important milestone for the profession, expanding the possibilities of intervention and offering patients an effective and innovative alternative in the treatment of musculoskeletal diseases.

In this context, this e-book aims to explore the fundamentals of ozone therapy, its mechanism of action, forms of application, indications and contraindications, in addition to discussing its integration with other therapeutic modalities in the field of physiotherapy. In the end, it is hoped that the reader will understand the benefits of this intervention and how



it can be effectively incorporated into the treatment of patients with musculoskeletal injuries, promoting faster and more efficient rehabilitation.

THEORETICAL FOUNDATION

MECHANISM OF ACTION

The mechanism of action of ozone is still a subject of debate, and most studies focus on the dosage and applicability of the therapy, s

in a conclusive definition of its interaction with biological structures (BOCCI, 2018). Ozone therapy works mainly by offering oxygen to the affected areas, which improves infections, ischemia, and oxidative stress (PASEK et al., 2022).

The therapeutic action of ozone occurs through three main mechanisms: oxidation of the bacterial cell membrane, peroxidation of the viral capsid, and increased production of 2,3-diphosphoglycerate in red blood cells, which improves the supply of oxygen to tissues (SHETE et al., 2016). In addition, ozone stimulates the production of prostacyclins, reducing the action of free radicals and promoting vasodilation and vascular neoformation, which favors tissue recovery (LEHNINGER, 2013).

In pathologies such as osteoarthritis, ozone stimulates the production of antioxidant enzymes and reduces the production of inflammatory prostaglandins (ANZOLIN; BERTOL, 2018). In the case of herniated discs, ozone acts by denaturing the nucleus pulposus, reducing its volume and promoting nerve decompression, relieving pain (SEYAM et al., 2018).

HOW OZONE THERAPY ACTS AT THE CELLULAR LEVEL

Ozone therapy has a series of mechanisms of action at the cellular level that are responsible for its therapeutic effects. Below are some of the key mechanisms that explain how ozone, when applied in a controlled manner, interacts with cells and tissues:

Modulation of Oxidative Stress

Ozone, when administered in adequate doses, induces a light and controlled production of reactive oxygen species (ROS), such as hydrogen peroxide (H_2O_2). This generates an adaptive response in the body, stimulating the production of antioxidant enzymes, such as superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx). In this way, the body's endogenous antioxidant system is strengthened, protecting cells from severe oxidative damage and reducing oxidative stress in injured tissues (PASEK et al., 2022).



Increased Tissue Oxygenation

Ozone, when it comes into contact with tissues, quickly decomposes into oxygen. This increases the supply of molecular oxygen (O_2) in the treated areas, improving local oxygenation. In addition, ozone stimulates red blood cells to produce 2,3-diphosphoglycerate, a compound that decreases hemoglobin's affinity for oxygen, facilitating the release of O_2 into tissues (SHETE et al., 2016). This is particularly useful in areas with hypoxia, such as chronic musculoskeletal injuries, where low oxygenation impairs healing.

Anti-inflammatory Action

Ozone modulates the inflammatory response by inhibiting the production of pro-inflammatory mediators, such as tumor necrosis factor alpha (TNF- α), interleukin-1 (IL-1), and interleukin-6 (IL-6), which are responsible for amplifying inflammation (PAOLUCCI et al., 2021). By reducing these mediators, ozone therapy decreases the intensity of the inflammatory response, which translates into less pain and edema in the affected tissues. In addition, ozone promotes the release of prostacyclins, which act as vasodilators and anti-inflammatories, improving blood flow and healing (LEHNINGER, 2013).

Immunomodulatory Action

Ozone therapy can have immunomodulatory effects, stimulating the activity of immune cells, such as macrophages and lymphocytes. Ozone can increase the production of anti-inflammatory cytokines, such as interleukin-10 (IL-10), which helps balance the local and systemic inflammatory response (PAOLUCCI et al., 2021). This is especially important in chronic inflammatory diseases, where the immune system is overactive and needs to be regulated.

Antimicrobial Action

Ozone has a potent antimicrobial action, due to its ability to oxidize and destroy the cell membranes of pathogenic microorganisms, such as bacteria, fungi, and viruses.

In the case of bacteria, ozone destroys the cell envelope by lipid oxidation, leading to their death. In viruses, ozone acts by oxidizing the viral capsid, preventing its ability to replicate (SHETE et al., 2016). This mechanism makes ozone therapy a useful tool for the treatment of infections associated with chronic lesions.



Neangiogenesis and Tissue Regeneration

Ozone stimulates the production of growth factors and promotes the formation of new blood vessels (neangiogenesis). This improves blood perfusion in the injured areas, contributing to tissue regeneration (ANZOLIN; BERTOL, 2018). In addition, ozone promotes the proliferation of fibroblasts, essential cells in the healing process, and accelerates collagen synthesis, which favors the repair of musculoskeletal injuries.

Nerve Decompression

In cases of herniated discs, ozone can be injected directly into the nucleus pulposus of the intervertebral disc. Ozone denatures the proteins of the nucleus pulposus, reducing their volume and, consequently, the pressure on the nerve roots. This relieves nerve compression and associated pain (SEYAM et al., 2018).

ENFORCEMENT MECHANISMS

The application of ozone therapy can be carried out locally or systemically, depending on the route chosen. The main forms of systemic administration include autohemotherapy, rectal or vaginal insufflation, and ozonated saline solution (FERREIRA; DICK; ANDRADE, 2021). Local routes include intramuscular, intra-articular, paravertebral, and intradiscal injections, which are widely used for the treatment of musculoskeletal pain (JEYARAMAN et al., 2024).

In cases of musculoskeletal injuries, the preferred routes are intramuscular, intraforaminal and intradiscal, which have shown promising results in reducing pain and recovering patients' functionality (AKKAWI, 2020).

INDICATIONS AND CONTRAINDICATIONS

Ozone therapy has been widely used in the treatment of various musculoskeletal conditions, such as osteoarthritis, tendonitis, ligament injuries, and herniated discs (SEYAM et al., 2018). Its anti-inflammatory and analgesic action makes it an effective alternative for pain relief and for accelerating tissue recovery (FERREIRA, 2020).

However, there are some relevant contraindications. The therapy is not recommended for pregnant women, patients with active autoimmune diseases, individuals with glucose-6-phosphate dehydrogenase (G6PD) deficiency, and people with bleeding disorders or who use anticoagulants (SANTOS et al., 2021). In addition, ozone inhalation is completely vetoed due to its toxicity in this application method (ISCO3, 2020).



COMPARISON WITH OTHER PHYSICAL THERAPY TREATMENTS

Ozone therapy can be associated with other physical therapy practices, such as kinesiotherapy, which involves active mobilization, muscle strengthening and the use of biomechanical devices (SEYAM et al., 2008). The combination with traditional physical therapies enhances the rehabilitation effects, modulating symptoms and accelerating the functional recovery of patients (FERREIRA, 2020).

Although ozone therapy is very effective in isolation, its association with other techniques, such as kinesiotherapy, tends to generate more consistent and long-lasting results, especially in cases of chronic and degenerative lesions (SEYAM et al., 2018).

Ozone therapy, as a complementary or alternative treatment, has gained prominence in several areas of health, especially in the management of musculoskeletal diseases. By comparing it with other conventional treatments, such as traditional physiotherapy, pharmacotherapy, and surgical interventions, it is possible to identify its advantages and limitations. The following are the main comparisons between ozone therapy and other therapeutic approaches.

Comparison with Kinesiotherapy and Conventional Physical Therapy

Kinesiotherapy, which involves therapeutic exercises and active mobilization, is one of the main pillars of physical therapy for the treatment of musculoskeletal diseases. This approach aims to improve muscle strength, flexibility, joint mobility, and physical endurance.

Rapid anti-inflammatory effect: Ozone therapy is able to reduce inflammation more immediately than therapeutic exercises, especially in acute inflammatory conditions such as tendonitis and bursitis (SEYAM et al., 2018).

Quick pain relief: In many cases, the analgesic effect of ozone therapy is observed soon after the first sessions, which can be helpful for patients who experience high levels of pain and have difficulty performing exercises (FERREIRA, 2020).

Complement to physiotherapy: Ozone therapy can be used as an adjuvant treatment to kinesiotherapy, enhancing the results. While kinesiotherapy helps to rehabilitate motor function and strengthen muscles, ozone relieves pain and reduces inflammation, making it easier to perform exercises without discomfort (SEYAM et al., 2008).

While ozone therapy helps relieve symptoms, such as pain and inflammation, it does not replace the need for active rehabilitation, which is essential for restoring muscle strength, flexibility, and overall functionality (FERREIRA, 2020).



Studies indicate that ozone therapy presents better results when used in conjunction with other therapeutic approaches, such as exercise and mobilization, than when used alone (ANZOLIN; BERTOL, 2018).

Comparison with Pharmacotherapy (Anti-inflammatories and Analgesics)

Pharmacotherapy commonly involves the use of nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroids, and analgesics for the control of pain and inflammation in patients with musculoskeletal injuries.

Fewer side effects: Long-term use of medications, especially NSAIDs and corticosteroids, is associated with several adverse effects, such as gastric ulcers, liver damage, and kidney failure. Ozone therapy, on the other hand, has a low complication rate and rarely causes serious adverse effects (STEPPAN et al., 2010).

Non-pharmacological treatment: For patients who have contraindications to the use of medications or who prefer to avoid excessive use of drugs, ozone therapy offers an effective alternative for the control of pain and inflammation (SEYAM et al., 2018).

Regarding the limitations, we can mention:

Localized action: While anti-inflammatory drugs can act in a systemic manner, ozone therapy usually has a more localized effect, depending on the route of administration (AKKAWI, 2020). This may limit its applicability in generalized or systemic conditions.

Need for multiple sessions: Although ozone therapy can offer quick relief, several sessions are usually needed to achieve lasting results, while medications can provide immediate pain relief with a single dose (FERREIRA; DICK; ANDRADE, 2021).

Comparison with Surgical Interventions

In severe cases of musculoskeletal diseases, such as herniated discs, fractures, or severe ligament injuries, surgery may be indicated to correct the structural problem that is causing pain and dysfunction.

Less invasive: Ozone therapy is a minimally invasive technique and usually does not require general anesthesia or hospitalization, unlike surgical interventions (SEYAM et al., 2018). This makes it an attractive option for patients who prefer to avoid the risks and complications associated with surgeries.

Shorter recovery time: After surgery, recovery time can be prolonged, including restrictions on activities and postoperative physical therapy. Ozone therapy, as it is less invasive, allows for a faster recovery, with less downtime (STEPPAN et al., 2010).



Reduction in the volume of the nucleus pulposus: In cases of herniated discs, ozone therapy can be used to reduce the volume of the nucleus pulposus, promoting nerve decompression without the need for surgery (SEYAM et al., 2018).

Regarding the limitations, the following can be verified:

Limited effectiveness in advanced cases: In very advanced musculoskeletal conditions, such as severe fractures or injuries requiring surgical repair, ozone therapy cannot replace surgery. In these cases, surgical intervention is inevitable to restore structural function (AKKAWI, 2020).

Does not correct structural deformities: While ozone therapy can relieve pain and reduce inflammation, it does not correct significant structural deformities, such as severe misalignments or complete ruptures of tendons or ligaments (FERREIRA, 2020).

Comparison with Other Complementary Therapies (Acupuncture, Manual Therapy, Laser Therapy)

Complementary therapies such as acupuncture, manual therapy, and laser therapy are widely used in the management of musculoskeletal conditions, often in conjunction with conventional physical therapy.

Anti-inflammatory and regenerative effects: Ozone therapy not only relieves pain but also promotes tissue regeneration and the creation of new blood vessels (neoangiogenesis), something that not all complementary therapies can do as effectively (ANZOLIN; BERTOL, 2018).

Versatility in applications: Ozone therapy can be applied in several ways, including local injections, rectal insufflation, and auto-hemotherapy, which makes it a very versatile therapy in different conditions and needs (FERREIRA; DICK; ANDRADE, 2021).

Among the limitations are:

Less popular acceptance: Despite its effectiveness, ozone therapy is still not as widely accepted or available as other complementary therapies, such as acupuncture or laser therapy, which may limit its use in some regions (FERREIRA, 2020).

Need for specialized equipment: Ozone therapy requires the use of specialized equipment for the generation and administration of ozone, which can increase costs and limit access in places where these resources are not available (COFFITO, 2023).

COFFITO'S OPINION

The regulation of ozone therapy in Brazil was sanctioned by Law No. 14,648, of August 4, 2023. According to this legislation, ozone therapy can be practiced by higher-



level health professionals, including physiotherapists, as long as they are registered with their respective councils and using equipment approved by Anvisa (COFFITO, 2023).

The Federal Council of Physical Therapy and Occupational Therapy (COFFITO) has authorized, since 2010, the use of ozone therapy by physical therapists, reaffirming the importance of this technique as a valid and effective therapeutic tool in the rehabilitation of patients with musculoskeletal diseases (COFFITO, 2022).

FINAL CONSIDERATIONS

Ozone therapy is consolidated as a relevant therapeutic modality in the treatment of musculoskeletal pathologies, offering an effective, safe and minimally invasive approach. Its ability to reduce inflammation and pain, coupled with the promotion of tissue regeneration, makes it a viable option for patient rehabilitation.

The practice of ozone therapy by physiotherapists is supported by Brazilian legislation and COFFITO, being an important alternative within rehabilitation strategies. However, to maximize its effects, the association with other therapeutic modalities, such as kinesiotherapy, is highly recommended.

The mechanisms of action of ozone therapy at the cellular level are diverse and complex, involving the modulation of oxidative stress, the improvement of oxygenation, the reduction of inflammation, the regulation of the immune system, as well as antimicrobial and regenerative actions. These mechanisms make ozone therapy a valuable therapeutic tool, especially in the field of physical therapy, where it can be used to treat a wide range of musculoskeletal conditions, promoting pain relief, accelerating healing, and improving patients' functionality.

Ozone therapy, when compared to other treatments, offers a number of advantages, mainly because it is a minimally invasive technique, with a low risk of side effects and with proven effectiveness in relieving pain and inflammation. However, it does not completely replace other therapeutic approaches, especially in cases that require structural correction or active rehabilitation. The combination of ozone therapy with traditional techniques of physiotherapy, pharmacotherapy and, in necessary cases, surgical interventions, can offer better results for patients with musculoskeletal diseases.

In summary, ozone therapy stands out as a valuable complementary tool in the arsenal of treatments available to physiotherapists, especially when integrated with more conventional approaches, enhancing functional recovery and symptom relief.



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