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CASE REPORT

# Case Report: Compassionate application of chlorine dioxide-based solution in a patient with metastatic prostate cancer

## Caso clínico: Aplicación compasiva de una solución a base de dióxido de cloro en un paciente con cáncer de próstata metastásico

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## ABSTRACT

Chlorine dioxide is a powerful and cost-effective oxidizing agent that has demonstrated anti-cancer activity both in vitro and in vivo. Its proposed mechanism involves the release of free radicals, which disrupt the delicate oxidative balance within cancer cells. In case report, the patient has voluntarily opted for compassionate chlorine dioxide therapy over continuing conventional chemotherapy and immunotherapy due to side effects and uncertain survival outcomes. The concentration of the chlorine dioxide solution was 1/100 times lower than the LOAEL threshold, ensuring that not compromise the patients' health. This is the first follow-up in patient diagnosed with metastatic prostate cancer, who shown tumor reduction at distant sites from the primary tumor with no side effects. This preliminary observation suggests that chlorine dioxide and its free radicals could be potential mediators of an anticancer response. However, it is imperative to emphasize the importance of conducting rigorous clinical trials to validate these initial findings.

**Keywords:** Chlorine Dioxide Solution; Cancer; Reactive Oxygen Species; Case Report.

## RESUMEN

El dióxido de cloro es un agente oxidante potente y asequible que ha demostrado actividad anticancerígena tanto in vitro como in vivo. Su mecanismo propuesto está relacionado con la liberación de radicales libres, que alteran el delicado equilibrio oxidativo de las células cancerosas. En este caso clínico, un paciente eligió voluntariamente la terapia compasiva con dióxido de cloro frente a la quimioterapia e inmunoterapia convencionales, debido a los efectos secundarios y la incertidumbre sobre el pronóstico de supervivencia. La concentración de la solución de dióxido de cloro fue 1/100 veces inferior al umbral LOAEL, lo que aseguró no comprometer la salud del paciente. Es el primer seguimiento en un paciente diagnosticado con cáncer de próstata metastásico, que mostró una reducción de la tumoración en lugares distantes del tumor primario sin efectos secundarios. Esta observación preliminar sugiere que el dióxido de cloro y sus radicales libres podrían ser mediadores potenciales de una respuesta anticancerígena. Sin embargo, es imprescindible destacar la importancia de realizar ensayos clínicos rigurosos para validar estos hallazgos iniciales.

**Palabras clave:** Solución de Dióxido de Cloro; Cáncer; Especies Reactivas de Oxígeno; Caso Clínico.

## INTRODUCTION

Chlorine dioxide solution (CDS) is a potent oxidant and a prodrug of HOCl that is widely used as a biocide.[1] CDS has cytotoxic effects on cancer cells.[2] The cytotoxicity of CDS on cancer cells appears to be associated with the induction of oxidation that disrupts the delicate and controlled redox balance of cancer cells, which

induces apoptosis, pyknosis, and necrosis.[3] Thus, CDS has the potential to prevent tissue invasion and cell transformation.[3,4] The cytotoxic effect of CDS was demonstrated by inhibiting the proliferation of human cancer cell lines and pancreatic adenocarcinoma.[3,5]

CDS does not appear to be toxic to normal cells, and it was shown that CDS does not have an apoptotic effect on human gingival fibroblasts and endothelial cells and does not decrease the viability of periodontal ligament stem cells.[6,7] Additionally, in the public health context, the oral use of CDS has been reported as a safe and effective therapy to treat COVID-19.[8]

Given the documentary evidence collected to date, we raised the possibility that CDS could potentially be an effective anticancer treatment. We report cases of patients with metastatic cancer treated with maximum daily doses of 3 mg/kg (0,003 % chlorine dioxide) given orally, enema, and/or intravenously.[2,9]

## CASE REPORT

*Metastatic prostate cancer*

In October 2019, a 64-year-old Mexican male patient with no relevant medical history underwent a routine prostate examination, which revealed abnormal prostate antigen values (> 10 ng/ml). Urinary and semen bleeding occurred promptly and was diagnosed by a biopsy of the prostate and positron emission tomography as metastatic prostate cancer. In February 2020, the patient refused chemotherapy and immunotherapy to choose metabolic therapy that consisted of 2,5 months of daily intravenous administration of the glucose analogue 2-deoxy-D-glucose (2DG). Additionally, the patient followed a ketogenic diet and 20 h of intermittent fasting. During therapy, the patient did not have significant side effects.

In March 2020, the patient started the oral CDS protocol by adding 1 ml of vehicle dimethyl sulfoxide (DMSO) 70 % to the solution and the enema CDS protocol by absorption. In 2021, the patient added 5 g of clinoptilolite zeolite to the diet during fasting and before each meal. In 2022, the patient balanced oral and enema therapy with the intravenous CDS protocol, which the patient administered monthly according to previously described doses. Currently, the patient is without deficits or alterations in the daily routine. The patient had normal (> 4 ng/ml) prostate antigen values and maintained periodic control, with a forty-four-month follow-up from diagnosis (Figure 1).

## DISCUSSION

When metastatic cancer patient pondered the risks and benefits of continued first-line treatment, by personal decision, he decided to suspend and started CDS protocols. This article describes the clinical course of the use of chlorine dioxide as part of second-line treatment.

The patient with metastatic prostate cancer started his therapy with the temporary administration of 2DG. In transformed cells, 2DG is a nonmetabolizable glucose analogue that interferes with glycolysis and induces apoptosis by promoting the expression of stress-related genes.[10] Treatment continued with oral CDS in combination with DMSO. DMSO has anti-inflammatory, analgesic and membrane-penetrating effects, and its primary use is as a vehicle for other co-administered agents.[11] Oral CDS therapy was supplemented with enemas and intravenous administration of CDS. Rectal administration has local and systemic effects, it has been described as a stable route due to gastric pH elution and hepatic first pass.[12] Additionally, possible systemic absorption via lymph nodes has been reported.[13] Likewise, the therapy was supplemented with intravenous chlorine dioxide therapy due to full availability in the bloodstream.[2] We suggest that multiple administration routes increased the range of action of chlorine dioxide throughout the system. CDS therapy was supplemented with clinoptilolite zeolite, which has been reported to have an anticancer effect.[14] This suggests that the induction of multiple redox changes may have a relevant role in destabilizing the intracellular environment of cancer cells, thus interfering with the Warburg effect phenotype. Additionally, intermittent fasting, a type of caloric restriction without malnutrition, was carried out, which promotes anticancer adaptations.[15] This suggests that the combination of chlorine dioxide with other therapeutic agents exhibits a synergistic anticancer effect, to this case and the following cases that share the same therapeutic approach.

Images confirm the diagnosis of metastatic cancer (A, B). Images after CDS treatment (C, D), an important reduction in bone metastasis is observed.

## CONCLUSION

The treatment with CDS protocols showed a consistent and clinically significant anticancer response, with no associated side effects. Chlorine dioxide-based treatment is safe and cost-effective. However, controlled clinical studies are proposed to determine the efficacy of the administration of CDS protocols. In addition, the question of long-term efficacy and toxicity in patients undergoing anticancer treatment is open.

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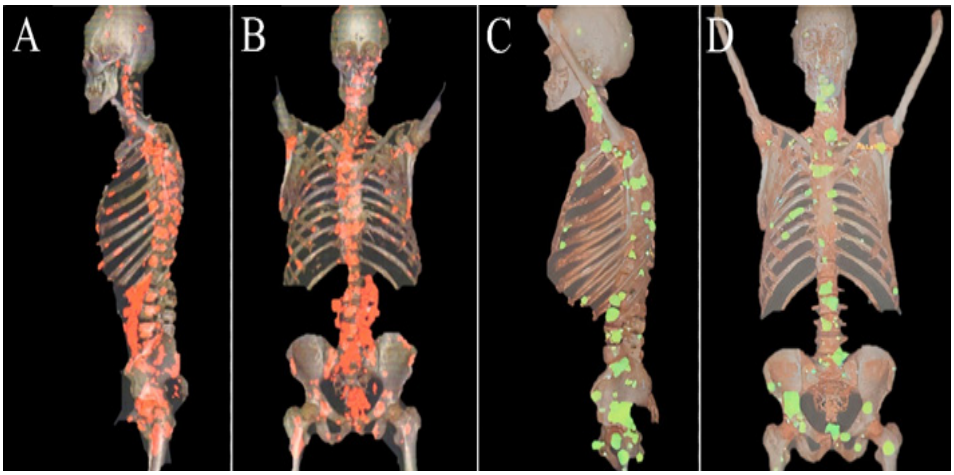


**Figure 1.** Positron emission tomography of a male patient with metastatic prostate cancer

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## AUTHORSHIP CONTRIBUTION

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