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Infection Prevention and Tissue Repair in Skin Lesions Using Treatments Based on a Chlorine Dioxide Solution: Case Studies

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Abstract

Optimal regeneration of skin lesions needs to ensure protection against opportunistic infections that may hinder the healing process or increase the risk of infection. The use of antibiotics to avoid infection can, in some cases, interfere with tissue regeneration, and often fails due to resistant bacterial strains. Thus, there is a need to expand the arsenal of safe and effective treatment options available. Here, we document the prevention of infections and tissue repair in skin lesions using treatments based on a chlorine dioxide solution. We document four case reports, that include an abdominal burn by a chemical agent, a palpebral burn by extreme heat, limb ulceration due to vascular insufficiency, and a melanoma of the scalp. All lesions were treated topically with a chlorine dioxide solution, and systemically when necessary, according to previously proposed protocols. All four patients showed complete dermal regeneration, with aesthetic results, no side effects or any evidence of adverse effects or interactions with the concomitant treatments used. The results constitute evidence that a topical or systemic solution of chlorine dioxide is safe as an antiseptic treatment in the adequate and swift resolution of skin lesions.

Keywords: Chlorine dioxide solution; Oxidizing solutions; Skin lesions; CDS

Introduction

The inorganic compound chlorine dioxide (CD) is a powerful oxidant. Due to its size selectivity, when used at safe concentrations (<1000 ppm), CD prevents tissue damage and causes denaturation of microbial proteins through irreversible oxidation [1]. To date, and since 1995, due to its broad-spectrum antimicrobial effect, CD is part of the FDA's list of food additives for water treatment and vegetable washing [2].

In the field of human health in the face of the emergence of resistance to antibiotics, antivirals and antifungals, CD is an alternative antiseptic therapy for the prevention of infections in skin lesions [3-8]. In the dental field, the use of CD as an antiseptic is well known to help reduce gingival indices and lower the bacterial count in the oral cavity [9-11]. The use of CD has made it possible to establish that 1) it is safe for local application without risk of systemic intoxication, 2) it does not intervene in the healing process, 3) it is effective even at low concentrations and 4) it does not generate antimicrobial resistance [1]. Furthermore, CD appears to have a broad antimicrobial spectrum, with evidence of antiviral, antibacterial and antifungal effects in [12-19].

Other chlorine-based oxidizing solutions such as sodium hypochlorite (NaClO), hypochlorous acid (HClO) and hypochlorite (OCl -) have been used commercially to act as an antiseptic [20]. However, CD has shown greater biofilm removal compared to other chlorine derivatives, with lower risk of toxicity [21,22]. In the veterinary medical area, CD is also used as an antiseptic for post-surgical skin treatment, and for the prevention of bovine mastitis [6,23]. Similarly, in the area of human medicine, CD is used as an antiseptic in irrigation therapy and the treatment of keratosis pilaris [7,8].

Given the evidence that has been documented to date regarding its safety and broad antimicrobial properties, the possibility that a CD solution could have a beneficial effect as an antiseptic for skin lesions is pertinent to explore. The use of a CD solution could potentially prevent infection with potential pathogens and the proliferation of opportunistic microorganisms that can interfere with regeneration. We document four cases of patients with different skin lesions, all of whose treatment included the use of a CD solution. The resolution of the lesions, as well as the occurrence of adverse events and the manifestation of secondary lesions that could be associated with the use of CD were assessed.

Case Presentation

Case 1: Abdominal Burn by Chemical Agent

On August 25, 2022, a 64-year-old female patient with no relevant medical history suffered a chemical burn. The patient had abdominal discomfort and, despite not having a medical diagnosis, decided to apply a compress soaked with 1,500 ppm CD directly to the skin, over the painful area of the abdomen. The compress had been prepared by the patient using 5ml of CD at 3,000 ppm dilute in 5ml of a 0.9% NaCl solution. The patient covered the CD pad tightly by applying plastic film around her waist overnight. She reported burning pain, and when she removed the plastic film and compress, she noticed that she had suffered burns on her skin, for which she sought medical attention.

The lesion was diagnosed as a first-degree burn by a chemical agent (that involved the use of CD at 1,500 ppm), and was treated with protocol D (CD at 3,000 ppm diluted 1:3 in 0.9% NaCl; according to the protocols proposed by Andreas Kalcker and accepted by the medical doctors of Coalición Mundial Salud y Vida (COMUSAV). The 1,000 ppm CD solution was applied by spraying directly over the lesion every 2-3 h, without keeping it covered, until the recovery of healthy tissue (Figure 1). Abundant scar tissue was observed from the seventh day of treatment (Figure 1B) and treatment was discontinued on day 20 owing to the advanced stage of recovery observed. At day 34, the skin was completely healed (Figure 1D).

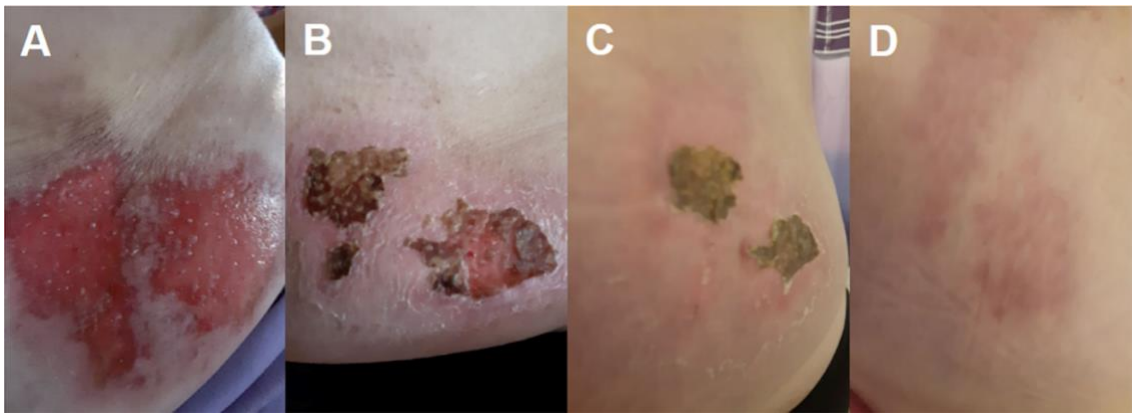

Figure 1: Follow-up of skin regeneration after abdominal burn by application of 50% DC. (**A):** Lesion observed on day zero, before the start of treatment; (**B):** Lesion on day 7 of treatment; (**C):** Lesion on day 11 of treatment; (**D):** Lesion on day 34 of treatment.

Case 2: Eyelid Burn by Extreme Heat

On December 7, 2021, a 15-year-old male with Down syndrome and astigmatism, suffered a burn from sudden exposure to the flame of a water heater, which affected the skin area on his upper and lower eyelids. The skin lesion was diagnosed as a second-degree burn caused by physical heat. Prior to antiseptic therapy with CD, the eye was treated for the first 48 hours with Besifloxacin 0.6% ophthalmic suspension every 8 h and a Tobramycin/dexamethasone ointment (3mg/1mg/g) every 12 h, as recommended by another physician. After 48 h, the antibiotic treatment was suspended and on December 9, 2021, treatment with CD began. The first day of CD treatment consisted of three F15 protocols (30ml CD at 3,000 ppm diluted in 1L of H_2O) taken orally every 3 h until finishing the liter, and on the application of protocol D (CD at 3,000 ppm diluted 1:3 in 0.9% NaCl) over the lesion every 2-3 h. The second day of treatment was a C20 protocol (20ml CD at 3,000 ppm diluted in 1L of H_2O) taken orally every hour during 10 h until finishing the liter, and the application of protocol D to the lesion every 2-3 h. Between days 3 to 7 of treatment, a C20 protocol was taken, protocol D was applied and an ophthalmic suspension was added according to protocol O (5ml CD at 3,000 ppm diluted in 50ml of 0.9% NaCl with 3ml of dimethyl sulfoxide, DMSO, at 70%) every 3-4 h. Between days 8 to 18 of the CD treatment, protocol D and O were followed. At the request of the parents, the CD treatment was supplemented with an ointment of Aloe vera and petrolatum topical on the skin. The skin was fully healed after day 22, and there was no change to the patient's astigmatism diopters.

Figure 2: Follow-up of skin regeneration after heat-induced eyelid burn. (**A):** Lesion on day zero of treatment; (**B):** Lesion on day 2 of treatment; (**C):** Lesion on day 4 of treatment; (**D):** Lesion on day 14 of treatment; (**E):** Lesion on day 22 of treatment.

Case 3: Limb Ulceration Due to Vascular Alteration

In August 2021, a 69-year-old male patient was diagnosed with chronic venous insufficiency. In March 2022, the patient reported a rash on the left lower limb that evolved into an open wound. He also reported pain, increased volume in the affected area, and a limited ability to walk. The diagnosis was ulceration associated with vascular insufficiency. The patient was taking a prescribed venotonic and vasoprotective agent, Diosmin and Herperidin 450mg/50 mg tablets every 24 h, for chronic vascular insufficiency. Without suspending his treatment for vascular insufficiency, the patient was given the C20 CD protocol (20ml CD at 3,000 ppm diluted in 1L of H_2O) and DMSO (70% in 50ml of H_2O) orally, divided in three volumes that were taken every 8 h before each meal, and 5g of clinoptilolite zeolite that was taken orally on an empty stomach and before sleeping. Meanwhile, locally, the ulceration was treated with a CD solution according to protocol D (CD at 3,000 ppm diluted 1:3 in 0.9% NaCl). The solution was applied by direct spray on the lesion every 2-3 h, without keeping the wound covered, until complete recovery of the tissue was evident. Complementary to the treatment described above, after each bath, the patient applied a clinoptilolite zeolite paste immediately after spraying with CD. The lesion resolved completely within two months of treatment (Figure 3). The patient did not report any local or systemic discomfort during oral and topical treatment.

Figure 3: Follow-up of the skin regeneration of the venous leg ulcer. (**A):** Lesion on day zero of treatment; (**B):** Lesion on day 5 of treatment; (**C):** Lesion on day 17 of treatment; (**D):** Lesion on day 28 of treatment; (**E):** Lesion in the second month of treatment.

Case 4: Possible Melanoma on The Scalp

A 51-year-old male patient, with no relevant medical conditions, reported the growth of a dark mole on the scalp, which showed signs of inflammation and accumulation of purulent exudate. A presumptive diagnosis of a possible melanoma with a specificity of 78% was made remotely on February 26, 2022 by another doctor, using the Skin Vision algorithm, with 95% sensitivity. The doctor suggested removal of the lesion. By his own decision, the patient refused the surgical approach and modified the prescribed treatment with protocol D, to include a pure CD solution at 3,000 ppm. The CD solution was applied by direct atomization on the lesion every 8 h, while leaving the area uncovered, and repeating until complete recovery of the skin, which occurred eight months after starting the treatment (Figure 4).

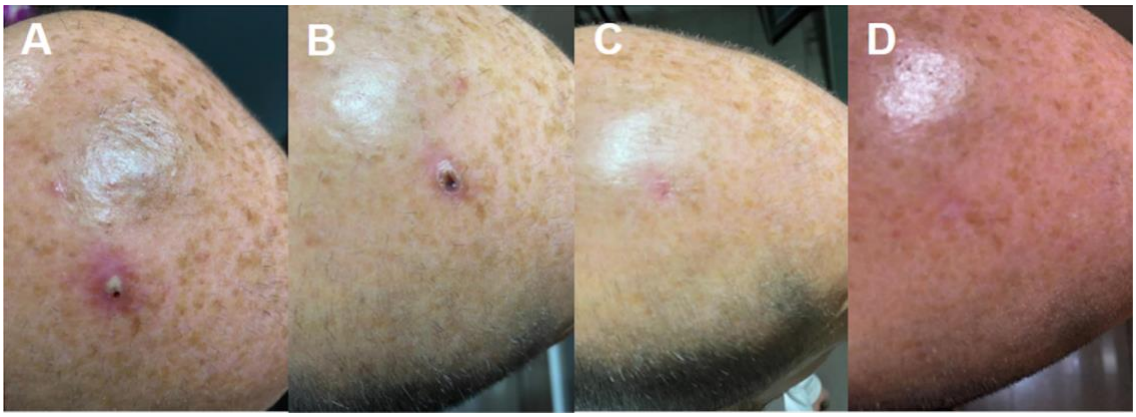

Figure 4: Follow-up of the skin regeneration of a possible melanoma on the scalp. (**A):** Lesion on day zero of treatment; (**B):** Lesion on day 5 of treatment; (**C):** Lesion on day 15 of treatment; (**D):** Lesion after 4 months of treatment.

Discussion

When there are lesions in the skin, there is a high risk of infection and spread of opportunistic infectious agents in the wound, which can interfere with healing and cause systemic problems. This paper reports the use of a chlorine dioxide (CD) solution as part of the treatment of four clinical cases with various skin lesions.

The first case described, which consisted of a self-inflicted burn due to misuse of the DC, was resolved without complications with the correct use of the DC skin protocol. The patient had used a concentration of 1,500 ppm of CD, applied directly to the skin and kept it occluded with a plastic bandage, which allowed the CD, which is a gas, to exert the effect of oxidative stress with a marked keratolytic effect. However, when used without occlusion, DC protected the tissue from opportunistic infections and allowed dermal regeneration, evidencing the phenomenon of hormesis [24].

In the second case, the F15 protocol for infections and the preventive C20 protocol was used systemically, to replace antibiotics with the main advantage of preventing the selection of populations of resistant microorganisms, currently considered one of the most pressing problems for public health [19,25,26]. Likewise, the dermal protocol and the ophthalmic protocol of CD were used with the addition of DMSO in the latter. Dimethyl sulfoxide is widely used in veterinary medicine and human medicine as a vehicle of other agents contained, and there is evidence that it has anti-inflammatory properties [27-29].

We suggest that its use increased the penetration of the CD by cell membranes, increasing the recovery rate due to ocular immune privilege, and that the ophthalmic application of CD had a specific antimicrobial effect [30,31]. It should be noted that the treatment included the use of Aloe vera, a plant with known anti-inflammatory properties that promote skin regeneration [32,33]. Also, the treatment included the topical application of mineral oil, that is thought to protect the skin of lacerations and dryness [34,35]. A future controlled study would allow to determine whether the resolution of the dermal lesion and the regeneration speed was due to the use of the CD+DMSO, to Aloe vera, to the topical oil, or to the three as a synergistic whole.

In terms of the ulceration due to venous insufficiency of the third clinical case, a double (local and systemic) intervention was required to treat the failure of blood vessels and skin ulceration. Since venotonic and vasoprotective agent have no antiseptic effect, the topical and systemic CD application was the only agent to which an antiseptic and antimicrobial effect can be attributed. Likewise, anti-inflammatory properties are attributed to the addition of systemic DMSO [27-29]. In this case, treatment was complemented with clinophylite zeolite, for which an antioxidant effect has been reported, one that impacts the adsorption capacity of microorganisms, removes toxins and helps reduce bad smell associated with tissue and cell breakdown [36-38].

Finally, the keratolytic effect of the fourth clinical case was achieved at a dose of 3,000 ppm. This property of CD suggests that when used against a possible melanoma, the solution could promote renewal of skin tissue, and thus reduce abnormal malignant cell development. Well, it has been shown that CD oxidizes proteins, by interacting with cysteine residues, tryptophan and tyrosine [39-42]. Therefore, doses of 3,000 ppm of CD have high oxidative stress indices and deplete reserves of the antioxidant glutathione, thus inducing selective apoptosis [1,43,44]. That is, CD has an apoptotic effect on microorganisms and epidermal cells [8,45].

Conclusion

For each case, total dermal regeneration was observed, with aesthetic results, without observable side effects or adverse interactions with any of the treatment used concurrently. That the observed results highlight that the systemic use of a CD solution at the concentration herein reported was safe for the patient. Thus, we conclude that a CD solution at concentrations between 1,000 ppm and 3,000 ppm, used topically or systemically according to the protocols used here, is safe as an antiseptic and tissue repair. The clinical cases described here provide relevant information that can aid future medical decisions to use and prescribe safe and economical antiseptic treatment of skin lesions without the need of antibiotics. Controlled clinical studies are proposed to determine the efficacy and safety of the F15, C20, D and O protocol as a treatment for skin lesions.

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