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Ozone Therapy and Pulsed Electromagnetic Fields Interplay in Controlling Tumor Growth, Symptom and Pain Management: A Case Report

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Abstract**—**Background: The immune system has evolved several mechanisms to protect the host against cancer, and it has now been suggested that the expansion of its functions may prevent tumor growth and control the symptoms of cancer patients. Two techniques, ozone therapy and pulsed electromagnetic fields (PEMF), are independently associated with an increase in the immune system functions and they maybe help palliative care of patients in these conditions. Case Report: A patient with rectal adenocarcinoma with metastases decides to interrupt the clinical chemotherapy protocol due to refractoriness and side effects. As a palliative care alternative treatment it is suggested to the patient the use of ozone therapy associated with PEMF techniques. Results: The patient reports an improvement in well-being, in autonomy and in pain control. Imaging tests confirm a pause in tumor growth despite more than 60 days without using classic treatment. These results associated with palliative care alternative treatment stimulate the return to the chemotherapy protocol. Discussion: This case illustrates that these two techniques can contribute to the control of tumor growth and refractory symptoms, such as pain, probably by enhancing the immune system. Conclusions: The potential use of the combination of these two therapies, ozone therapy and PEMF therapy, can contribute to palliation of cancer patients, alone or in combination with pharmacological therapies. The conduct of future investigations on this paradigm can elucidate how much these techniques contribute to the survival and well-being of these patients.

Keywords**—**Cancer, complementary and alternative medicine, ozone therapy, palliative care, PEMF Therapy.

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I. Introduction

CURRENTLY there is a scientific consensus on the importance of the immune system role in combating cancer, including those in an advanced stage [1]. There are countless immunological mechanisms involved to protect the host, controlling or suppressing growth tumor or eliminating the cancer [1]. It has been independently hypothesized that ozone therapy [2] and PEMF [3] can potentiate the immune system and maybe help to avoid tumor growth and to control the symptoms. This case report presents both techniques used for symptom control in a patient with stage IV adenocarcinoma of the rectum, with liver and lung metastases, who has decided to pause his classic treatment, such as the chemotherapy clinical protocol and radiotherapy.

II. Case Report

The selected patient is 53 years old with stage IV rectal adenocarcinoma with liver and lung metastases. Since his disease was first diagnosed in Stage IV, surgery was not considered as an option, and for this reason, he was directed to immediate treatment with chemotherapy.

The chemotherapy performed with Oxaliplatin + Fluorouracil + Calcium Folinate and Cetuximab was carried out in applications lasting 46 hours, the complete treatment cycle was registered by his oncologist, totaling 12 applications with an interval of 14 days. This therapeutic modality caused a series of significant side effects in this patient, such as fatigue, pain, nausea, vomiting, tooth fractures, paraesthesia, skin lesions, anorexia, alopecia and deep venous thrombosis of the left upper limb.

After 9 applications, the tumor had not shrunk in size, making the patient unsure about keeping the treatment, which, after all, he decided to pause. As a recommendation of his oncologist, he sought our research group to start a palliative care on an outpatient basis. After due explanations and clarifications, the patient and his family chose to start an alternative treatment using the ozone therapy and PEMF. Therefore, they invested in the purchase of an ozone generator from the USA and a Canadian PEMF equipment so that the therapy could start. There was a 30-day chemotherapy pause agreement with his oncologist, rather than a cancellation.

A. Equipments

The equipments used are:

a) O3ARC Standard Digital Ozone Generator (Promolife): According to its manufacturer, the O3Arc utilizes a specialized cell to produce ozone steadily [4]. Therefore, the ozone therapist can apply the exact amount defined in clinical protocol describe below.

b) PERL-M device (Resonant Light technology): The equipment chosen to be purchased was PERM-L produced by Resonant Light Technology, whose design is based on the patent for Bare CEMP emitting device [5], [6]. The electromagnetic field is emitted through the plasma by radiofrequency, generating frequencies of orders of magnitude higher than the best magnetic coils. Only the PERL plasma tube emits frequencies up to 300,000 Hz with 100% modulation [7]. The manufacturer proposes to expose the entire body of the patient to pulsed electromagnetic fields allowing total freedom of movement during the session.

B. Clinical Protocol

a) Ozone Therapy:

– Rectal route: 8 mg per day (one or divided into two applications) five times per week, applied by ozone therapist;

– Ozonated Olive Oil: innalatory, 40 minutes per day (divided into two applications) five times per week, applied by ozone therapist.

b) PEMF:

– 80 minutes per day with a specific oscillatory frequencies program, five times per week, applied by the patient himself.

c) Two days therapy free.

C. Follow up

After the first 2 days of application with pre-defined dosages, the patient no longer had the presence of pain, which used to be considered fluctuating between 7 to 10 points on the visual analog scale for pain, motivating the patient to frequently use oral morphine, which was no longer necessary. His well-being increased exponentially, with patient constantly claiming that he no longer felt sick. Patient also described that his constant pressure to go to the bathroom caused by the continuous feeling of tenesmus and the need to evacuate, caused by the presence of the primary tumor of 5.5 cm in the rectum, approximately 8 cm from the rectal ampoule, decreased 24 hours after the beginning of the treatment.

After 30 days using both technologies associated, and despite 60 days without chemotherapy or radiotherapy, it was possible to notice in the exams that there was a capacity to contain tumor growth and to control symptoms. This conclusion was confirmed by a set diagnosis tests. Table I functions as an objective reference to clinical use of both technologies combined using the control of liver metastases in the three exams as a reference, since the lesions are associated with the worst prognosis.

TABLE I
MRI DESCRIPTION OF THE UPPER ABDOMEN WITH HEPATOSPECIFIC CONTRAST OF THE PATIENT AT THREE DIFFERENT MOMENTS

A	B	C
Segment III: 2 cystic formation smaller than 0.3 cm;	Segment III: 2 cystic formation smaller than 0.3 cm;	Segment III: 2 cystic formation smaller than 0.3 cm;
Segment IV B: 1.4 cm nodular formation;	Segment IV B: 0.8 cm nodular formation;	Segment IV B: 0.8 cm nodular formation;
Segment V: 1.0 cm nodular formation;	Segment V: 0.6 cm nodular formation;	Segment V: 0.6 cm nodular formation;
Segment VI: 0.9 cm cystic formation.	Segment VI: 0.9 cm cystic formation.	Segment VI: 0.9 cm cystic formation.

Legend: A – At diagnosis; B – After 9 chemotherapy applications; C – Treatment suspension for 30 days + 30 days of exclusive alternative treatment.

The feeling of well-being is easily identified in the excerpts of the patient's interviews:

"After I started the alternative treatment, my life has changed significantly for the better. During the chemotherapy period I felt very fragile, exhausted, with a lot of pain, in addition to feeling practically all the side effects of chemotherapy medications... vomiting, diarrhea, nausea, tenderness in the extremities of the hands and feet, constant shocks, violent discomfort, among several other effects. That really sucked!! Very unpleasant!! Worst of all, after 9 sections of chemo, there was no improvement in my condition. I spent extremely unpleasant moments and there were no positive results, that is, the primary tumor did not regress, there was only a small reduction in liver metastases. This experience was very heavy, as I had the impression that the chemo was accelerating my end due to such intoxication caused by the drugs. This was confirmed with the tests performed after the chemo sections when compared with those performed before starting the chemotherapy treatment..."

"So, I was introduced to an alternative treatment based on electromagnetism that, after a lot of conversation, readings and guidance from a professional in the field, I decided to start instead of simply giving up chemotherapy."

"At first I was a little apprehensive, as it is not a common practice in the treatment of cancer..."

"However, after a month of treatment, I was amazed at the difference in my life condition and the physical predisposition, which did not exist in chemo. The side effects just disappeared... all of them, which gave me satisfaction and hope. And the previously constant pain stopped haunting me."

"The hope still increased when the results of the tests carried out after the first month of the alternative treatment were compared with the other different moments: before any treatment, after the chemo and after the alternative treatment. And I learned that the alternative treatment reduced the primary tumor and maintained the dimensions of the metastases".

"Perhaps, to be honest, not everything is perfect, because the session's frequency in this type of treatment

is "heavy", since they are daily, and that is tiring."

III. Literature Review

Ozone gas (O_3) is an unstable molecule discovered about 180 years ago that has been used and studied for about a century now, having several possible indications, from scar treatment of infectious wounds to rheumatic, oncological and infectious diseases. Its application is somewhat unusual due to its gaseous presentation. The most common applications are: local (spray over the area of interest), rectal route, innalation of ozonized olive oil, drink or wash of the area of interest by ozonized water, and transcutaneous by ozone gas bath [8]-[12].

The use of Ozone has an antimicrobial, immunomodulatory effect (in high concentrations it is an immunodepressive; in low concentrations, it is an immunostimulation), it reduces local hypoxia, it has a biosynthetic effect (increases ribosomes, mitochondria in cells) and antioxidant action, it potentiates bone remineralization, produces vasodilatation and stimulates angiogenesis [8]-[10], [13]. According to [14], there is an association between cytokine production and ozone rate in the blood, showing the ozone-inducing role in cytokine production and its cytotoxic potential at high concentrations. Cespedes-Suarez et al. [2] explain that HIV continues to be one of the biggest problems for the global public health. They conducted a research and concluded that the use of ozone boosted the immune system, increasing the number of CD4 and CD8 lymphocytes, reducing the viral load to the point of being identifiable for about two years.

In another study, [1] presents that the current main focus in cancer treatments is on the existing knowledge about the CD4 and CD8 T lymphocyte interplay that mediates the control of tumor growth. So, if there is an alternative therapy that increases C4 and CD8, it is possible to help that patient who feels like it is impossible to continue chemotherapy. In addition, [15] explains that the effects of electromagnetic fields on the immune system have received considerable interest in recent years, not only for investigating possible negative health impacts, but also for exploring the possibility of favorably modulating immune responses.

The potential use of PEMFs as modulators of immune responses alone or in combination with pharmacological therapies represents a new frontier of investigation with interesting clinical perspectives [16]. There seems to be a potential for the warning signs modulation by PEMFs, leading to the reduction of inflammation and the promotion of healing processes [15], [16]. According to [17], Ca^{2+} signaling processes are involved in mediating field effects on the immune system.

According to [18], low-frequency and low-intensity PEMF can be beneficial in reducing inflammation without possible side effects, indicating its value as a viable alternative for the treatment of inflammatory responses. The mechanisms are not well characterized, but they seem to include increased production of free radicals and increased expression of certain immune diseases for extreme low frequencies of PEMF, while electromagnetic fields seem to control inflammation through positive regulation of adenosine receptor pathways [19]. It is worth mentioning that these pathways are involved in any inflammatory condition and, therefore, can represent relevant therapeutic targets in several chronic inflammatory diseases. It is necessary to understand whether differences in effects depend on specific exposure parameters or more on the types of target cells, as well as on the underlying mechanisms, for the possible therapeutic purposes. The solution to this problem requires systematic and comparative studies, in which the dependence on waveforms, modulations, frequencies, flow densities and duration of exposure need to be investigated [15].

According to [20] and [21] the use of bioelectromagnetism is already recommended for pain relief in patients, whether oncological or not, as an alternative or complement to the use of opioids. Therefore, CEMP therapy has several potential advantages, including non-invasiveness treatment, safety, lack of toxicity for normal cells and the possibility of being combined with other available therapies [3], [22]. In fact, PEMF stimulation has even been used to deal with various types of cancer, including skin, breast, prostate, hepatocellular, lung, ovary, pancreatic, bladder, thyroid and colon cancer *in vitro* and *in vivo*. Thus, the use of PEMF as therapy for cancer treatment becomes a new emerging concept [23]-[25]. There is evidence on the benefit of this technology in the increase of well-being of oncologic patients, including clinical studies produced by Brazilian hospital research centers [26], [27].

IV. Discussion

According to [28], human civilization has preferably used chemical products for the treatment of diseases, based on the understanding that life itself is considered a purely biochemical process [29]. However, this perspective, in addition to being associated with the frustration of refractoriness in various clinical conditions, does not exhaust all therapeutic options historically available, since a number of other treatment methods do not use the principles of biochemical means as a basis for their therapeutic action. Such practices belonging to Complementary and Alternative Medicine (CAM) involve several different therapeutic modalities [30], [31], with an increasing trend in health care practices in Brazil [32], [33]. The beginning of the integration of CAM and conventional treatment, in diseases such as cancer, is occurring in several parts of the world [34]. In Brazil, the Ministry of Health updated, through Resolution Number 41, the incorporation of Palliative Care as part of the integrated continuous care offered under the Health Care Networks [35]. These guidelines are yet another incentive to incorporate the practice of CAM in the daily lives of patients, as integrative and complementary practices are directly associated with this type of care with apparent immediate benefit to the patient [36].

Although CAM is clinically relevant, there are many questions and lack of evidence about how and if its therapeutic actions actually occur. One of the possibilities to find such evidence is through Biophysics [37], which when directed to

the health area is associated with the study of the biomedical application of magnetic fields for both diagnoses and adjunct therapeutic techniques [2].

The reflections on the quality of care insert topics in the search process for the continuous improvement of the care and management processes of health institutions, focusing on patient safety and obtaining excellent services in order to affect the quality of care itself [38]. This, in turn, stimulates the motivation of many health professionals to search for solutions to increase the quality of care through innovation.

This case is an example of an alternative palliative care for tumor growth control despite more than 60 days without using chemotherapy or radiotherapy in a patient with control of previous refractory symptoms, such as pain. This favorable response of alternative treatment motivated the patient again and he decided to continue with the chemotherapy sessions after 4 months of absence. Thus, in this perspective, the therapeutic use of ozone therapy and PEMF can be very useful, especially as adjunct therapy.

V. Conclusion

Ozone therapy and PEMF therapy have been marred by conventional science for years due to many flawed experimental designs or small sample sizes of the population in which it intended to study. For this reason, many physicians have dismissed these two complementary options and limited funds have been delegated to furthering knowledge of its therapeutic effects. However, there starts to be evidence that suggests that ozone and PEMF do have various therapeutic effects, including the interplay in controlling tumor growth, symptom and pain management. Future research needs to be conducted to confirm those first impressions.

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