



Research article

Violation of molecular structure of intracellular water as a possible cause of carcinogenesis and its suppression by microwave radiation (hypothesis)



Vitali Kalantaryan^{a,*}, Radik Martirosyan^a, Yuri Babayan^b, Voldemar Petrosyan^c

^a Yerevan State University, Department of Radiophysics and Electronics, Yerevan, Armenia

^b Yerevan State Medical University, Department of Medical Physics, Yerevan, Armenia

^c Saratov State Medical University, Saratov, Russia

ARTICLE INFO

Article history:

Received 22 January 2023

Received in revised form 6 June 2023

Accepted 11 June 2023

Available online 15 June 2023

Keywords:

Non-ionizing medical radiation

Microwaves

Tumor suppression

Hexagonal and cubic water structure

"Therapeutic" and "pathogenic" frequencies

ABSTRACT

The manuscript discusses a possible hypothesis about the transformation of healthy cells into cancer cells as a result of modification of the molecular structure of intracellular water from normal hexagonal to abnormal cubic phase (which may be caused by radiation, chemical, viral, mechanical and microbiological factors) and the possibility of returning to its original state under the influence of microwave radiation. The authors are not aware of any relevant experimental and theoretical support for this hypothesis in other literature. Our hypothesis is based on a completely unexpected experimental fact that we have received. It turned out that the radio spectra of cancer-affected tissues and the cubic phase of water are identical which confirms that these tissues really contain a cubic phase of water. It should be expected that the use of radiation of "therapeutic" frequencies may lead to regression of tumor growth. This assumption is based on another experimental fact confirming the possibility of the transition of the molecular structure of water from the cubic phase to the hexagonal phase (which is contained in healthy tissues) when irradiated with therapeutic frequencies. The conducted experiments demonstrate the real possibilities of structural-phase and spectral mutual transformations of the water medium under the influence of extremely low intensity flows of microwaves at "therapeutic" frequencies of 1000 MHz and 985 MHz or "pathologic" frequencies of 990 MHz and 51 GHz. The aim of this study was to experimentally verify a possible causal relationship between the violation of the molecular structure of intracellular water in healthy tissues and carcinogenesis.

© 2023 Published by Elsevier B.V. on behalf of Research Network of Computational and Structural Biotechnology. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

As is well known, low-intensity millimeter and centimeter electromagnetic waves of selective frequencies have a specific therapeutic effect and are therefore widely used in medicine and, in particular, in oncology [1–13]. Unlike the currently widely used traditional methods of treating tumors with ionizing radiation and chemotherapy, the use of non-ionizing and low-intensity microwaves is devoid of toxic side effects. In Kalantaryan, V.P., et al. (2011) [14] it was shown that irradiation of Sarcoma-37 tumor cells with low-intensity non-ionizing and non-thermal millimeter waves at a frequency of 42 GHz suppresses cell growth by 33% and lowers the

level of methylation to almost normal. In Kalantaryan, V.P., et al. (2020) [15], on the basis of experimental and theoretical studies, it is concluded that irradiation of tumor tissue at the resonant frequencies of natural vibrations of the molecular structures of water (triads and hexagons) can significantly increase the degree of binding of anticancer drugs to tumor DNA. This will allow for traditional treatment to significantly reduce the dose of drugs and the cost of a general course of therapy. In addition, some patients develop intolerance due to side toxic effects and the course of treatment is forced to be interrupted. With a reduction in the dose of drugs, the course of therapy can be successfully completed. After exposure by microwaves without anti-cancer drugs, the irradiated animals show inhibition of tumor growth compared to the control group and a sharp suppression of the level of DNA methylation, which becomes close to the corresponding value for healthy DNA. It should also be noted that microwave generators are much smaller

* Corresponding author.

E-mail address: vkalantaryan@ysu.am (V. Kalantaryan).

and cheaper than traditional expensive and bulky devices for radiation therapy of patients, which require large areas with appropriate shielding for safe operation. Applications of non-ionizing and non-thermal medical radiation can be considered as a potentially new, promising and safe method for early diagnostics, prevention and therapy in oncology. In studies with non-ionizing low-intensity radiation, it is necessary to take into account the following fundamental difference. In the case of ionizing radiation, the amount of energy received by the sample is very important. In the case of non-ionizing extremely low energy radiation, as in our case, the energy given to the sample is so small that it ceases to play an essential role and the information phenomena become predominant. The conditions of manifestation of the effect of the "information" actions are determined by the competition of energy (ΔU) and entropy (ΔS) expressed at a given a temperature (T) formula for the free energy of Helmholtz: $\Delta F = \Delta U - T\Delta S$. Hence the criterion of distinction between informational and energetic influences, which can also be interpreted as the boundary between strong and weak interactions: $f = \Delta U/T\Delta S$. Thus, with strong effects $f > 1$, energy processes prevail, and the accompanying "entropy-information" effects are secondary, with weak effects $f < 1$, the processes are controlled by "entropy-information" mechanisms, and energy is assigned the role of a translator of "information".

2. The resonant state of water

The resonant-wave state consists in the volumetric resonant-wave vibrational state of molecular water structures and the formation of an internal electromagnetic (EM) field at selective frequencies of natural oscillations, generation, reception and transmission of extremely weak ($\sim 10^{-16}$ - 10^{-15} W/cm²) EM waves in the millimeter (Extremely High Frequencies 30–300 GHz, wavelength 1–10 mm) and microwave (Ultra-High Frequencies 0.3–30 GHz, wavelength 1–10 cm) ranges. In the resonant-wave state, water-containing media, including biological ones, are "radio-transparent" for extremely low-intensity "resonant" EM waves. There is an effect of resonant radio transparency of water and biological tissues at extremely low power levels of EHF EM waves, as a threshold effect of an extremely low power level. These are translational resonances corresponding to the frequencies of natural, selective vibrations of molecular and supramolecular structures of water and the aquatic component of the biological environment. At these frequencies, radio waves are generated, transmitted, received, converted, emitted, and re-emitted in water environments. The frequency spectra of the resonant radio transparency of water are caused by the vibrations of molecular oscillators: hexagons and triads with magnetic j and electric p dipole moments. The spectral composition determines the molecular structure of the water medium. A model of the molecular structure of the basic water oscillators: triads, hexagons, and fractal clusters of the first and second

order is shown in Fig. 1. Based on the fractal-cluster model of water, such molecular fragments are mono molecules of H₂O triads with natural frequencies of 64.5 and 65.5 GHz, and hexagons (H₂O)₆ with natural frequencies of 50.3 and 51.8 GHz. Doublets are determined by transverse and longitudinal vibrations of the dipole moments of structures that excite transverse and longitudinal EM waves in water-containing media.

3. Violation of the molecular structure of intracellular water leads to the formation of cancer?

As noted above the main sources of radiation of the resonant electromagnetic waves are the basic molecular fragments of the water structure: triads H₂O, hexagons (H₂O)₆, clusters [(H₂O)₆]₆, generating resonant doublets of radio waves in the millimeter and microwave bands at frequencies of molecular vibrations own: 64.5 GHz and 65.5 GHz; 50.3 GHz and 51.8 GHz in millimeter band and 985.0 MHz and 1000 MHz in microwave band (Fig. 1). At these frequencies takes place the radiation and the interaction of internal and external resonant EM waves in water molecular systems and the water component of the biological media. The hypothesis is proposed about the **possible** transformation of normal cells into cancer cells as a result of modification in them of the normal hexagonal molecular structure of water to abnormal cubic structure. As is well known, foci of the cubic phase of the water structure can occur with various types of damage to the intracellular molecular structure of water caused by the influence of various external and internal factors such as radiation, chemical, viral, mechanical and micro-biological.

Obviously, with a local change from a hexagonal water matrix to a cubic one, a "program failure" occurs, and as a result, the cells begin to reproduce "abnormal" water, which leads to a change in the biochemical mechanisms of their vital activity Petrosyan, V.I., et al. (2014a,2014b) [16,17]. With dysfunction and pathology, the intensity of the resonance lines change and the resonance frequencies of biological tissues of the patient's body are preserved. A change in resonance frequencies is observed only in oncology as a result of a radical restructuring of the molecular structure of the water medium: the transformation of the hexagonal phase into a cubic one. The outcome of the competition between growth processes or regression of tumor formation is decided from the position of the balance of intensities of counter flows radio waves of conflicting phases. Since the counter flows have different resonant frequencies, their mutual penetration into the foreign phase occurs with attenuation within their skin layer. As a result, the wave boundary between the phases is blurred into an interlayer: the wave zone, which in this model is represented as an intermediate "wave" layer that captures the boundary skin zones of the abnormal and normal phases on both sides of the tumor border. At the same time, in the penetration zone, each of the phases "tries to impose" its own

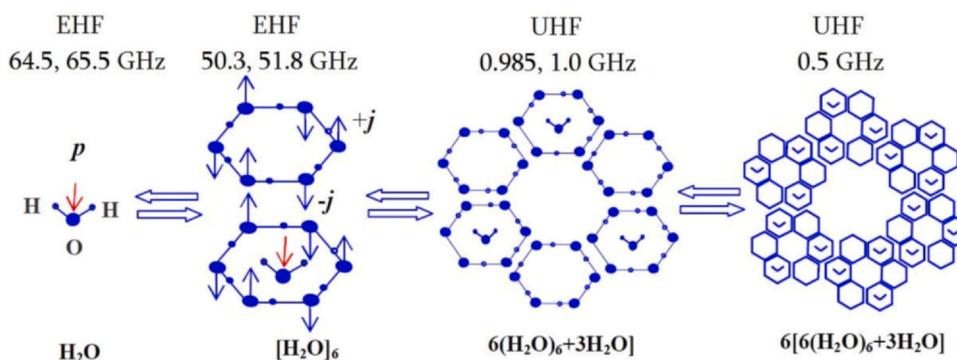


Fig. 1. Basic molecular fragments of the water structure. Natural resonances frequencies are indicated above the fragments, $\pm j$, p are the magnetic and electric dipole moments.

frequency in order to expand the boundaries of its influence. The tumor process is controlled by the balance of counter resonant wave flows of "conflicting" phases and tumor formation is possible only under conditions of redistribution of the balance in favor of "carcinogenesis", and in other cases, when the wave flow of healthy surrounding biological tissue predominates, the occurrence of an abnormal phase in such conditions becomes unrealistic. With increased wave activity of the anomalous phase or when the wave flow of the normal hexagonal phase of the surrounding biological tissue is weakened, conditions for the formation and growth of the embryo of the "anomalous" phase arise. This trend of tumor growth can be counteracted by including additional external therapeutic flow. If the total internal and external wave counteraction is inferior to the tumor one, then the tumor growth rate is positive, which corresponds to the stage of tumor growth, if the total internal and external wave counteraction exceeds the tumor, then the tumor growth rate is negative, which corresponds to the stage of tumor regression, if the combined internal and external wave action is comparable to tumor, the rate of tumor growth is close to zero, which corresponds to the stages of stabilization or inhibition of tumor growth. So, the outcome of the development of a carcinogenic tumor process is determined by the balance of counter internal intrinsic and introduced conflicting resonant radio wave flows of the norm and oncological pathology in the border zone of the malignant neoplasm. The use of an external source of therapeutic wave flows provides real possibilities for managing the development of a malignant neoplasm.

4. Experimental study of influence "pathologic" and "therapeutic" electromagnetic waves in oncology

Irradiation of water samples was carried out for 30 min by streams of extremely low intensity resonant radio waves with a power density of ~ 1 nW/cm² at a therapeutic resonant frequency of 1000 MHz or at a pathological resonant frequency of 990 MHz from a sweep generator of the panorama YA2R-74 and a broadband horn microwave antenna P6-2 with an opening of 25 × 35 cm² at a distance of 30 cm from the water sample. The microwave spectra were taken with the frequency tuning of the generator in the range of 960–1020 MHz in increments of 5 MHz and a shutter speed of 5 s at the same power (Fig. 2). To register the spectrum of resonant frequencies of water-containing objects, a modulation microwave

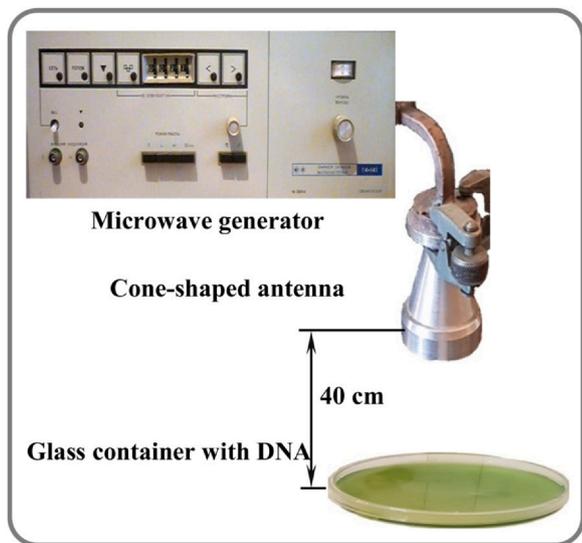


Fig. 2. The generator of microwave oscillations with cone-shaped antenna. Measurements were done at a far-field zone.

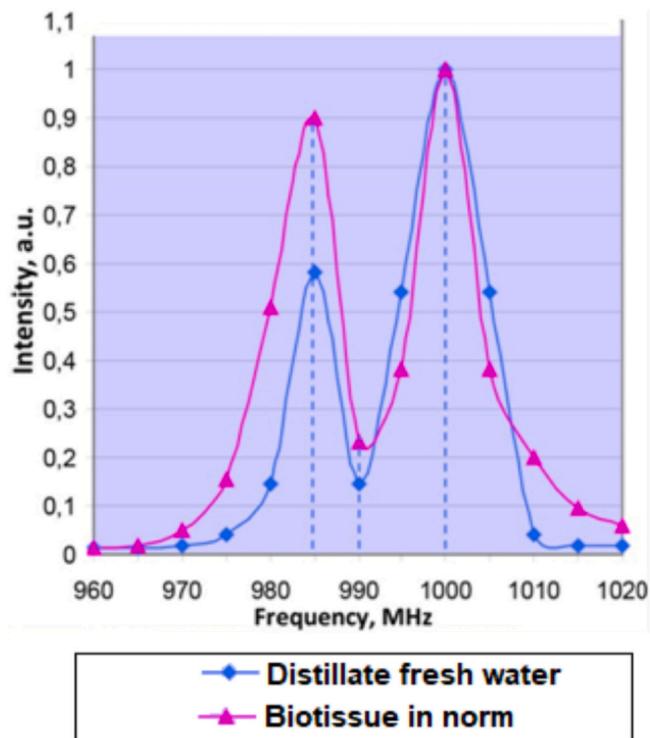


Fig. 3. Radiation spectra of normal (hexagonal) structure of distillate water and biological tissues of the human body in norm.

radiometer with a fluctuation sensitivity of 0.5 K (~10⁻¹⁷ W) was used as an ultra-sensitive radio receiver at a fixed resonant frequency of 1 GHz in the 25 MHz reception band and a signal integration time of 1 s Fig. 3 shows microwave spectra of the distilled water (normal hexagonal structure) and healthy biological tissues. There are two resonance peaks at 985 MHz and 1000 MHz and one minimum at 990 MHz (two-frequency resonance). As can be seen, these two spectra are identical, which indicates direct responsibility of the hexagonal water component of the biological environment of the body for processes in healthy biological tissues. Fig. 4 shows the spectra of normal hexagonal and "gamma-modified" abnormal cubic structure of water. The cubic phase of water was experimentally obtained under normal conditions by treating the distillate of the hexagonal phase of water with a classical carcinogenic factor - radiation gamma irradiation. The water distillate was treated with gamma quanta with an energy of 1.2 MeV and a dose of 15 Gy at the LUER-20 M accelerator. As can be seen, the spectrum of the cubic structure of water has only one resonant peak (single-frequency resonance), namely at the frequency of 990 MHz, where there was a minimum in the spectra of healthy tissue and hexagonal water. Fig. 5a shows spectra of prostate cancer and healthy biological tissues, Fig. 5b shows examples of resonance spectra of breast pathology: benign and malignant tumors. As can be seen, the single-humped resonance spectrum of the cubic structure of water (Fig. 4) is completely identical to the resonance spectrum of prostate cancer (Fig. 5a) and breast cancer (Fig. 5b), which means that in both cases the affected tissues contain cubic (carcinogenic) water. It is worth paying special attention to such an interesting fact that the resonance spectrum of a benign tumor in Fig. 5b does not coincide with the resonance spectrum of cubic water, but coincides with the spectrum of hexagonal water, which can serve as another experimental confirmation of our hypothesis. Fig. 6 shows the generalized microwave and millimeter spectra for healthy (1,2) and cancerous (3) biological tissues. The results obtained give reason to consider resonance at a frequency of 1000 MHz and 985 MHz as antitumor or

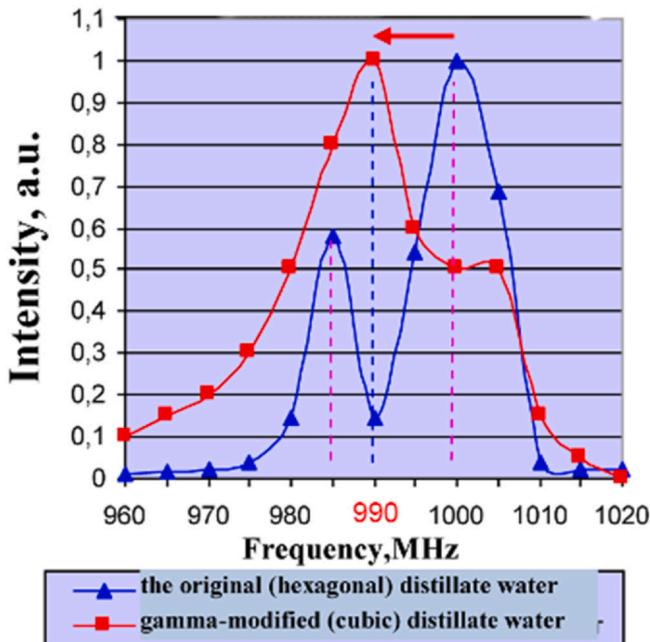


Fig. 4. Radiation spectra of normal and "gamma-modified" cubic structure of water.

"therapeutic", and abnormal resonance at a frequency of 990 MHz and 51 GHz as malignant or "pathogenic". Preliminary experimental studies show that acting on the water of the cubic structure with a flow of therapeutic microwaves with a frequency of 1000 MHz or 985 MHz, it is possible to change its structure to a normal hexagonal one, which corresponds to a healthy tissue. Conversely, the "pathogenic" frequency of 990 MHz really transforms the normal hexagonal molecular structure of water into an abnormal cubic modification

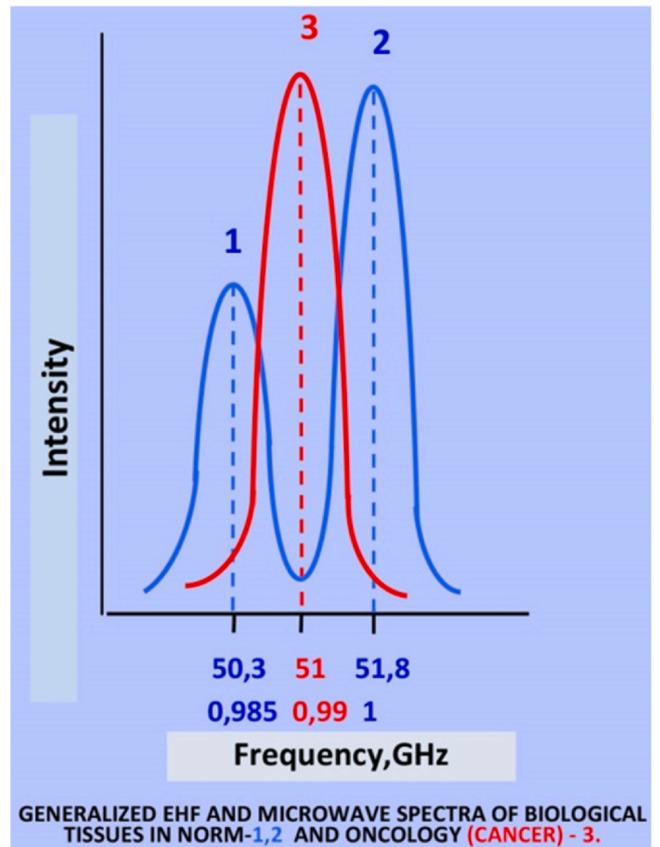
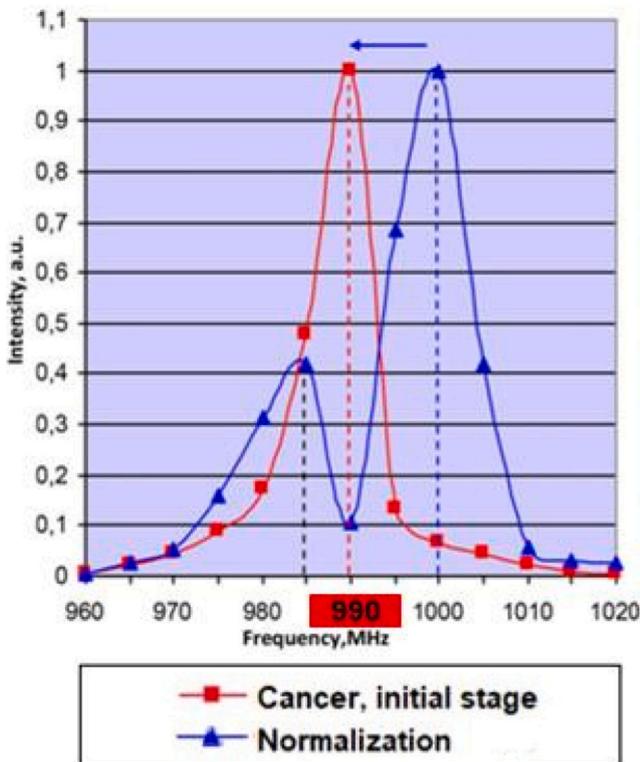
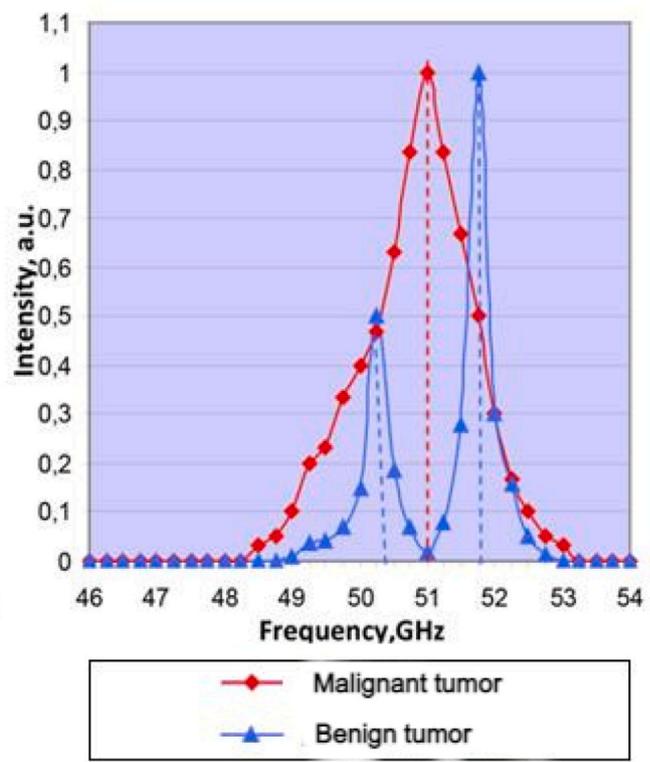


Fig. 6. Generalized microwave and millimeter spectra for normal (1,2) and tumor (3) biological tissues.



a



b

Fig. 5. (a) Resonance spectra of prostate cancer and biological tissues in norm. (b) Resonance spectra of breast pathology: benign and malignant tumors.

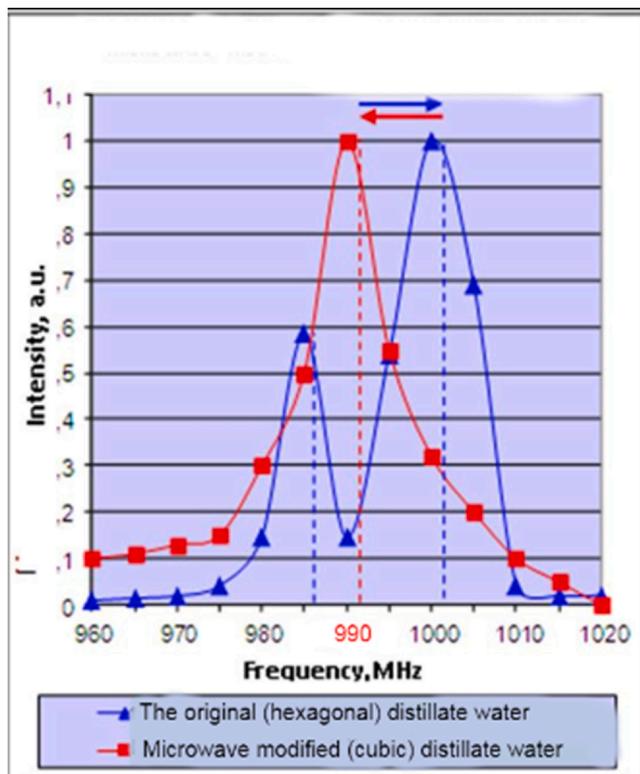


Fig. 7. Mutual phase transformations of the molecular structure of water under irradiation with microwaves of pathological and therapeutic resonant frequencies.

(Fig. 7). Therefore, it can be expected that the application of the new medical technology of non-ionizing and non-thermal microwave electromagnetic radiation therapy should lead to the recovery of the body. The above is the basis for the development of a radiophysical model and biophysical technologies for the diagnosis, prevention and therapy of cancer.

5. Conclusion

The possible determining role of the violation of the molecular structure of intracellular water in the occurrence of malignant neoplasms is discussed. This is indicated by the experimental fact of the complete coincidence of radio spectra from tumor tissues and the cubic phase of water. As you know, healthy tissue contains water, which has a hexagonal molecular structure. By affecting the cubic phase of water with therapeutic microwave radiation with a frequency of 1000 MHz or 885 MHz, its reverse transformation into a hexagonal phase is possible, which leads to regression of the disease. The destructive effect of microwaves on “pathological” resonant frequencies and their restorative effect on “therapeutic” resonant frequencies were studied. Therapeutic microwaves have a direct effect on the source of dysfunction or pathology and activate the body’s own resources, stimulating the restoration of the normal functional state of the affected organs and body systems. Use of the external source of therapeutic wave flows gives real control to the process of development of malignant neoplasms.

It is assumed that during the development of the tumor process, a change in the resonant frequency of the biological tissues of the patient’s body occurs following a radical restructuring of the molecular structure of the aqueous medium, the transformation of a normal hexagonal molecular structure into an abnormal cubic one.

Antitumor effect of low power non-ionizing microwaves obtained without drugs shows promising development of microwaves electromagnetic therapy for clinical oncology in the treatment of

malignancies. As an advantage of this method, it should also be noted that generators of microwaves are much smaller and cheaper than the traditional expensive and bulky devices for radiotherapy of patients, which require large areas for safety of work with appropriate shielding. Based on the above, the application of non-ionizing medical radiation can be considered as a potentially new, promising and safe medical technology for early diagnostics and therapy in oncology.

The presented original data demonstrate the potential clinical application of low power coherent microwaves. These preliminary results open up a very interesting line of research, which is associated with the possible application of low-power microwave radiation against tumor cells. The antitumor effect of microwaves indicates the prospects for the development of microwave therapy for clinical oncology in the treatment of malignant neoplasms without damaging other tissues, without antitumor drugs and harmful ionizing radiotherapy.

CRedit authorship contribution statement

Vitali Kalantaryan: Writing – original draft, Investigation. **Radik Martirosyan:** Supervision, Resources, Project administration. **Yuri Babayan:** Writing – review & editing. **Voldemar Petrosyan:** Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- [1] Peter Wust, Paraskevi DVeltsista, Eva Oberacker. Radiofrequency electromagnetic fields cause non-temperature-induced physical and biological effects in cancer cells. *Cancers* 2022;14(21):5349. <https://doi.org/10.3390/cancers14215349>
- [2] Tuszyński JA, Costa F. Low-energy amplitude-modulated radiofrequency electromagnetic fields as a systemic treatment for cancer: review and proposed mechanisms of action. *Front Med Technol* 2022;4:869155. <https://doi.org/10.3389/fmed.2022.869155>
- [3] Jimenez H, Blackman C, Lesser G, et al. Use of non-ionizing electromagnetic fields for the treatment of cancer. *Front Biosci, Landmark* 2018;23:284–97.
- [4] Zimmerman JW, Pennison MJ, Brezovich I, et al. Cancer cell proliferation is inhibited by specific modulation frequencies. *Br J Cancer* 2012;106(2):307–13.
- [5] Costa FP, de Oliveira AC, Meirelles R, et al. Treatment of advanced hepatocellular carcinoma with very low levels of amplitude-modulated electromagnetic fields. *Br J Cancer* 2011;105(5):640–8.
- [6] Barbault A, Costa F, Bottger B, et al. Amplitude-modulated electromagnetic fields for the treatment of cancer: discovery of tumor-specific frequencies and assessment of a novel therapeutic approach. *J Exp Clin Cancer Res* 2009;28(1):51–60.
- [7] Chidichimo G, Beneduci A, Nicoleta M, et al. Selective inhibition of tumor cells growth by low power millimeter waves. *Anticancer Res* 2002;22:1681–8.
- [8] Logani MK, Szabo I, Makar VR, et al. Effect of millimeter wave irradiation on tumor metastasis. *Bioelectromagnetics* 2007;27:258–64.
- [9] Pakhomov AG, Murphy M. Low intensity millimeter waves as a novel therapeutic modality. *IEEE Trans Plasma Sci* 2000;28:34–40.
- [10] Makar VR, Logani MK, Bhanushali A, et al. Effect of Cyclophosphamide and 61.22GHz millimeter waves on T-Cell, B-Cell, and macrophage functions. *Bioelectromagnetics* 2006;27:458–66.
- [11] Hovnanyan K, Kalantaryan VP, Trchounian AH. The distinguishing effects of low-intensity electromagnetic radiation of different extremely high frequencies on *Enterococcus hirae*: growth rate inhibition and scanning electron microscopy analysis. *Lett Appl Microbiol* 2017;65(3):220–5.
- [12] Tadevosyan HH, Kalantaryan VP, Trchounian AH. Extremely high frequency electromagnetic radiation enforces bacterial effects of inhibitors and antibiotics. *Cell Biochem Biophys* 2008;51(2–3):97–103.
- [13] Kalantaryan VP, Vardevanyan PO, Babayan YS, et al. Influence of low intensity coherent electromagnetic millimeter radiation (EMR) on aqua solution of DNA. *Prog Electromagn Res Lett* 2010;13:1–9.
- [14] Kalantaryan VP, Martirosyan RM, Nersesyan, L. Effect on tumor cells of low intensity electromagnetic waves. *Prog Electromagn Res Lett* 2011;20:98–105.
- [15] Kalantaryan VP, Martirosyan RM, Babayan Yu S, Khazaryan RS. On the possibility of using non-ionizing electromagnetic radiation (Millimeter waves) in oncology. *Prog Electromagn Res Lett* 2020;91:49–57.

- [16] Petrosyan VI, Chesnokov BP, Brill GE, et al. Cancer frequency of electromagnetic waves in the biosphere: AQUA-phase wave model of development of malignant new growths, Part 1: radiophysics basics of modeling. *Biomed Radioelectron* 2014(No 1):3–13.
- [17] Petrosyan VI, Chesnokov BP, Brill GE, et al. Cancer frequency of electromagnetic waves in the biosphere: AQUA-phase wave model of development of malignant new growths, Part 2: micro morphological and clinical trials, aqua-phase wave model. *Biomed Radioelectron* 2014(No 2):19–29.