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Mobile Phone Radiation: Its Efficacy as Protoscolicidals

Cep Telefonu Radyasyonu: Protoskolisidal Olarak Etkisi

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ABSTRACT

Objective: There are different types of radiations, such as microwaves and mobile waves. Certain types of radiofrequency were evaluated in hydatid cyst ablation or as protoscolicidals. This study aimed to assess the influence of mobile waves on hydatid cyst protoscolices.
Methods: Hydatid cysts were collected from the slaughterhouse and transferred to the laboratory. The contents of the cysts were drained in sterile conditions and the protoscolices were rinsed three times with phosphate buffered saline. Equal volumes of protoscolex suspensions were aliquoted into similar tubes. Based on the distance of the samples from the mobile generation waves, the tubes containing the parasitic suspensions were classified into three groups, each of which was further categorised into nine subgroups according to the time of the radiation exposure. The subgroup with zero exposure time was considered the control.
Results: It was found that the mortality rate of the protoscolices increases as the distance of the sample from the wave-generation source decreases ($p<0.0001$). Increasing the time of exposure also improves the mortality rate of protoscolices.
Conclusion: The mortality rate of protoscolices was directly proportional to the time of exposure and inversely proportional to the distance from the mobile generation waves.
Keywords: Hydatid cyst, mobile phone, radiation, radiofrequency, protoscolex

ÖZ

Amaç: Mikrodalgalar ve mobil dalgalar, çeşitli radyo frekansı radyasyonudur. Bazı radyo frekansı türleri kist hidatik ablasyonu veya protoskolisidal olarak değerlendirilmiştir. Bu araştırmanın amacı mobil dalgaların kist hidatik protoskoliklere etkisini değerlendirmektir.
Yöntemler: Kist hidatik kesimhaneden toplandı ve laboratuvara nakledildi. Kist içeriği steril şartlarda boşaltılmış ve protoskolikler parazitik süspansiyonlar ile üç kez durulanmıştır. Protoscolex süspansiyonları benzer tüplere ve eşit hacimlere bölünmüştür. Örneklerin mobil üretim dalgalarından uzaklığı bazında, parazitik süspansiyon içeren tüpler, her biri radyasyon dönemine göre dokuz alt grupla sınıflandırılan üç sınıfa ayrılmıştır. Sıfır radyasyon süresi olan alt grup kontrol grubu olarak dikkate alındı.
Bulgular: Bu testin sonuçları, dalga üretim kaynağından örnek mesafesi azaldıkça protoskolik kaynaklı ölüm oranının arttığını gösterdi ($p<0,0001$). Ayrıca maruziyet süresinin uzaması, protoskoliklerin mortalite oranını artırmıştır.
Sonuç: Protoskoliklerin mortalite oranı maruziyet süresi ile doğru orantılı ve mobil üretim dalgalarından uzaklık ile ters orantılıdır.
Anahtar Kelimeler: Hidatik kist, cep telefonu, radyasyon, radyofrekans, protoskolex

INTRODUCTION

Radiofrequency (RF) radiation, which includes radio waves and microwaves, is at the low-energy end of the electromagnetic spectrum. Microwaves are at the higher frequency end of the radio wave band with frequencies between 300 MHz (0.3 GHz) and 300 GHz. Mobile phones are low-powered RF transmitters, working at frequencies in the range of 450 to 2.700 MHz with peak powers between 0.1 and 2 watts (1,2). Despite X-rays and gamma rays, RF rays are not able to break chemical bonds or lead to ionization in the human body. If RF radiation is absorbed in large enough amounts by materials containing water, it causes the water molecules to vibrate and generate heat (2).

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Heating is one of the main effects of the microwaves used in microwave therapy (3). The thermal effect of RF mobile has been studied on some infectious agents such as bacteria (3,4).

Hydatidosis is a disease induced by *Echinococcus* spp. parasite, which is considered as a hydatid cyst. Fertile hydatid cysts contain protoscolices which, if released, can form secondary hydatid cysts (5). Since hydatidosis is a severe illness with no proper medical treatment, the optimal treatment is currently the surgery which is related with the risk of protoscolices release and recurrence. Surgeons use scolicidal to decrease the risk of its reappearance disease (6). There have been multitudinous industrial and natural materials used as scolicidal; however, this is limited because of the inadequacy of removing all protoscolices and creating side effects (7). The recent consensus among international experts has indicated that effective cure of hydatid cyst requires a technically-complete method for all active steps of the cyst, implemented with few facilities to run safely, and proved by subsequence clinical trials (8).

Recently, many investigations has been performed to find and apply the non-invasive treatment of this disease (9). Hitherto, Innovative treatment methods are developed to ablate hydatid cyst, including cryoablation (9), and high-intensity focused ultrasound (10), nanosecond pulsed electric field (11), radio frequency (12) and microwave (13).

The current research was conducted to assess the effect of mobile waves on hydatid cyst protoscolices.

METHODS

The current research was carried out as an experimental study *in vitro*.

Protoscolices Preparation

In Arak, Iran, the liver hydatid cyst was collected from the slaughterhouse and transported to the laboratory of parasitology. The hydatid cyst contents were drained by syringe in sterile conditions. Then, the contents were located in a sterile glass container for thirty minutes until the protoscolices precipitate The supernatant was discharged and protoscolices were rinsed three times with phosphate-buffered saline (pH =7.2). Finally, a suspension of 9.000 to 10,000 protoscolices per ml was prepared. The suspensions, in which at least 90% of the protoscolices were alive, were transferred to the dark dish and stored until used at 4 °C.

Evaluating the Mortality Rate of Protoscolices

To evaluate the mortality rate of protoscolices, a 0.1% eosin staining method was used. In this method, viable and dead protoscolices are observed colorless and red, respectively (14).

Experiments

a) Specifications of Used Devices

To expose the protoscolices to RF electromagnetic waves, a commercial mobile device was used (3 G frequency, maximum power <1W, specific absorption rates 0.9 W/kg). The temperature alteration in the protoscolex suspensions was monitored prior and following the irradiation with a thermocouple (Tp-01, Lutron Electronic Enterprise Co., Taiwan) and the temperature difference was represented as ΔT. The temperature of the suspension was measured with an accuracy of 0.1 °C when the probe was introduced into the suspension.

b) Exposure of Protoscolices with Mobile Waves

Protoscolex suspensions were aliquoted into similar tubes and equal volume (50 µL). Protoscolex was exposed to mobile waves based on two variables; the distance from the source of wave production (mobile) and the duration of radiation. The radiation was exposed in repetitive mode, so the device was on for forty seconds and off for three seconds. In this condition, the temperature of the suspension did not drop.

Tubes containing parasitic suspension were classified into three groups as follows: Group I, samples were located at a distance of 2 cm from the mobile phone. Group II and group III, samples were placed from a mobile phone at a distance of five cm and ten cm, respectively. Each of the three groups was divided into nine subgroups on the bases of the period of the exposure. It should be stated that the subgroup with zero radiation time was considered as control.

Statistical Analysis

Analyzed by Excel and SPSS, the data were reported as average values in three separate experiments and expressed as mean ± standard deviation. To test the normality of the data from the Shapiro-Wilk test was used. Differences between the subgroups were analyzed with the Repeated Measures test. Statistical significance was considered as $p<0.05$.

RESULTS

Tables 1 to 3 shows the mortality rate of protoscolices in exposure to mobile waves because of the duration of radiation and the distance from the source of the wave. The outcomes of the Shapiro-Wilk test indicated that the obtained data were normal, so the Repeated Measures Test was utilized to assess the difference between the data.

The outcomes of this test showed that the mortality rate of protoscolices increases significantly with decreasing sample distance from a wave generation source (mobile phone),

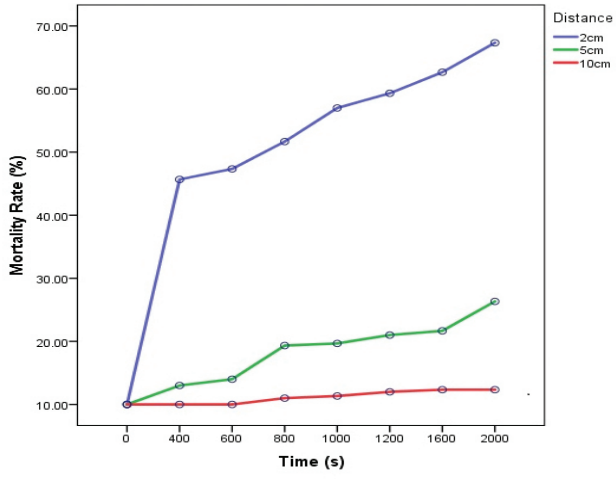

Figure 1. The mortality rate of hydatid cyst protoscolex on the bases of the distance of samples from transmitter radio waves (mobile phone)

($p<0.0001$) (Figure 1). Also, with increasing the time of mobile phone exposure, the mortality rate of protoscolices increases and in some radiation time exposure (Table 1, 2).

DISCUSSION

In the current research, protoscolices exposed to radiation of mobile phone had a higher mortality rate than non-exposed ones. The mortality rate of the parasite also depends on its distance from the mobile phone and the period of exposure to its radiation.

Today's world is constantly exposed to microwaves which induce by mobile phones and other devices. Most researchers are concerned about the dangerous effects of these waves, but some researchers have focused on using these waves to eliminate pathogenic organisms and treat diseases such as hydatid cyst and protoscolices. Lamonaca et al. (15) indicated that RF can be ablated the germinal layer of hydatid cyst by necrotizing. Then, Saricik et al. (12) observed that the RF method could damage the germinal layer of hydatid cyst (after 4-minute exposure) by raising the temperature of the cyst to 95 °C. Although extreme heat is required to damage the germinal layer of hydatid cysts, such heat may cause damage to other organs and blood vessels (16).

Our previous research showed that the RF microwave with the power of 1.550 W and frequency of 2.450 MHz had a fatal effect on both the continuous and repetitive modes on protoscolices. This kind of RF-waves (microwave) could increase the protoscolices mortality rate up to 100% after 200s exposure in repetitive mode and 50s in continuous mode. The purpose of using repetitive mode was to eliminate the heating influence of the microwave as much as possible since the heating effect of the waves was not eliminated in the continuous mode. In other words, the outcomes of earlier studies, the effect of the irradiation mode and the period of exposure to the microwave on the protoscolices proved (13).

In the current study, the mortality rate of protoscolex was inversely proportional to the distance of the parasite from the wave transmitter source (mobile phones) thus the highest protoscolices mortality was observed at the minimum distance (2 cm) from the mobile. As the investigation of the effect of microwave on protoscolex, in the current research, the effect of increasing mobile phone wave radiation time on protoscolex mortality is significant. This type of RF-waves (mobile phone wave) could increase the mortality rate of protoscolices up to 45% and 67% after 6.6 (400s) and 30 min (the 2.000s) exposure time. Considering that in the current study, the temperature does not return to its initial state in the interval between exposure to mobile waves, the outcomes are comparable to the continuous mode of our earlier work. These findings indicated that the highest ΔT was 1.5 °C at 6.6 min (400 s) exposure time with mobile phone waves. Unlike the previous findings, the effects of microwave radiation on the protoscolices showed that although microwave leads to 45% mortality of this parasite at 45s exposure time, ΔT was 25.7 °C (13). It is worth notable that as the maximum power of mobile RF waves, utilized in the current research, was <1W, compared with the earlier study that was using microwaves (power of 1.550 W), the period of mobile waves radiation on protoscolices was increased but the changes in temperature (ΔT) was very low.

Also, the present data clarified that RF exposure declines quickly with enhancing distance from mobile. The level of radiation exposure is inversely proportional to the square of the distance from the radiation source (17). This means that increasing the distance to two or five times from the radiation source can reduce the radiation exposure to $\frac{1}{4}$ and $\frac{1}{25}$, respectively. As the distance increases, the mortality rate is reduced, i.e., when the distance increased to 5 cm, the mortality rate dropped as much as 40%. Our data suggested that there was no important difference between the control group and the other treatment groups at ten cm intervals. Therefore, distance from the mobile source is a main factor for radiation therapy.

Table 1. The mortality rate of protoscolices exposed to mobile radiation in distance of 2 cm from mobile phone

Subgroups	Exposure time (s) Mean ± SD	ΔT (°C) Mean ± SD	Mortality (%) Mean ± SD
1	0 (control)	0±0	10±0
2	10×40s	1.43±0.11	45.67±1.53
3	15×40s	1.7±0.26	47.33±1.15
4	20×40s	2.43±0.06	51.66±3.79
5	25×40s	2.53±0.25	57±6
6	30×40s	2.47±0.38	59.33±2.52
7	40×40s	2.67±0.47	62.67±2.52
8	50×40s	3.1±0.1	67.33±1.53

SD: Standard deviation

Table 2. The mortality rate of protoscolices exposed with mobile radiation in distance of 5 cm from mobile phone

Subgroups	Exposure time (s) Mean ± SD	ΔT (°C) Mean ± SD	Mortality (%) Mean ± SD
1	0 (control)	0±0	10±0
2	10×40s	1.9±0.3	13±2
3	15×40s	2.1±0.3	14±2
4	20×40s	1.7±1.2	19±1.15
5	25×40s	1.6±0.8	19.6±2
6	30×40s	1.5±0.2	21±3
7	40×40s	1.87±0.97	21.67±2.08
8	50×40s	2.96±0.3	26.33±1.5

SD: Standard deviation

Table 3. The mortality rate of protoscolices exposed with mobile radiation in distance of 10 cm from mobile phone

Subgroups	Exposure time (s) Mean ± SD	ΔT (°C) Mean ± SD	Mortality (%) Mean ± SD
1	0 (control)	0±0	10±0
2	10×40s	0.7±0.39	10±1
3	15×40s	0.5±0.26	10±2
4	20×40s	0.8±0.36	11±1
5	25×40s	0.8±0.15	11.3±1.52
6	30×40s	0.8±0.06	12±2
7	40×40s	0.9±0.10	12±0.6
8	50×40s	0.9±0.15	12.3±1.53

SD: Standard deviation

CONCLUSION

Radiation of mobile phones are capable to kill protoscolices. This capability is directly proportional to the duration of exposure, but inversely proportional to the distance from source of the wave. However, the temperature changes caused by the radiation of mobile waves are very low compared to the microwave waves, so it seems that other potentials of this type of waves have led to the death of the parasite.

* Ethics

Ethics Committee Approval: Research project approved by the Ethics Committee of theArak University of Medical Sciences (approval number: 93-171-4).

Informed Consent: This study was not performed *in vivo* and it was done *in vitro*, so it did not need to informed consent form.

Peer-review: Internally peer-reviewed.

* Authorship Contributions

Concept: H.S., Z.E., Data collection and processing: R.H., H.S., Analysis or interpretation: H.S., Z.E., Literature search: R.H., Z.E., Writing: Z.E., H.S.

Conflict of Interest: No conflict of interest was declared by the authors.

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