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## Biomarkers of natural alpha particles in cancerous tissue of Iraqi patients

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**Abstract** : This research focuses on the emission of alpha particle rate in cancerous tissue in humans using nuclear track detector (CR-39, UK)in different areas of Najaf and Basra cities. This new study shows that the pollution in the environment from the emission of alpha particles. The highest emitting alpha particle rate found to be 0.198 mBq cm<sup>-2</sup> in a tissue uterus, while the lowest rate of emission of alpha particles (0.122 mBq cm<sup>-2</sup>) is found in the pelvic muscle. This study concludes that the emission of alpha particles is a regular rate is radioactivity naturally presented in the human bodies, which are no clear increase in these measurements by comparison conducted by global research, so the cancerous tissue samples are not caused by radioactive contamination. Overall, concluded that the emission of alpha particle rates is low. This means that the samples are free of environmental pollution from the alpha particles in human tissue studied.

Keywords: Naturalalpha particles, CR-39, cancer, biomarkers.

#### Introduction

Uranium is an element found everywhere on Earth and it's used as the fuel for nuclear reactor andraw material for nuclear weapons. Natural uranium consists of threeradioisotopes: <sup>238</sup>U (99.28%), <sup>235</sup>U (0.711%), and <sup>234</sup>U (0.005%) with different half-life. The nucleus of radioactive is unstable, meaning transformed into other elements either emitting or absorbing particles. This processis radioactive decay and results in the emission of alphaparticles from the nucleus, it's accompanied by emission of gamma rays as electromagnetic radiation. These types have different properties in some respects but are all ionizing radiation with energetic enough to break chemical bonds, then possessing the ability to damage or destroy living cells. The unstable nucleus of this radioactive isotope loses energy by emitting ionizing particles (stable state). It undergoes  $\alpha$ decay by radiating aparticles with decay energy (4.679 MeV). TheHelium (<sup>4</sup>He) is representing one alpha ( $\alpha$ ) particle. The radioactive properties of this isotope are used to determine the age of objects including fossils and rocks. The long  $T_{1/2}$  of this metal helps to find out the correct age of objects. This radioactive substance can enter the human body through inhalation or ingestion of food or water. Most of the inhaled or ingested <sup>235</sup>U leaves the body (biological  $T_{1/2}=15$  d) excepting a small part which stays accumulated in the kidney or teeth, and bones undergoing decay. The effect of ionizing alpha particles when entering or colliding with blood cells lead to the occurrence of leukaemia, the alpha particle reaction mechanismis direct with external electrons of the constituent atoms and if the provision of sufficient energy, they can throw external electrons away from the atoms. Then it will be producing free electrons and positively charged ions. This process was called ionization of blood cells<sup>1</sup>. Biological effect starts with the ionization of atoms. The mechanism that causes the radiation damage to human tissue is through the ionization of atoms in the material. Radiation ionized absorbed by human tissues have enough energy to remove electron from the atom that make up the molecules of tissues <sup>2</sup>. The alpha particle levels in teeth are 10 to 15 times greater than elsewhere in the body. The distribution of activity shows considerable structure. Studies on autopsy tissue have mainly aimed at determining level for the principal alpha emitters present, namely <sup>210</sup>Po, <sup>226</sup>Ra, and <sup>238</sup>U. These nuclei are found in human tissues with activity values. Considering <sup>210</sup>Po occurs at the end of the <sup>222</sup>Rn decay chain, <sup>222</sup>Rn exposure is considered another potential source of increased <sup>210</sup>Po and <sup>210</sup>Pb in the body. The retention of <sup>226</sup>Ra in bone is high and accumulates under conditions of chronic intake. Where human exposure or living organism to radiation leads to the risk resulting from two sources of radiation, one naturally resulted from the dissolution of unstable nuclei in self-transformation into a stable nucleus, and the other industrial produced by the bombing of the nuclei of stable isotopes with different types of nuclear particles. Wounds create a path for entry of radionuclides deposited on the skin, after entering through this path, the parts of this radionuclide can reach the blood, or move to the lymph nodes. Cancer defined as a kind of turbulence in the control of the process cell division resulting in cell proliferation in non-controlling by the body. This turbulence is the result of the event of changes in the cell nucleus because of the effect of radiation in the chromosomefor cells. It leads to a change in the number of chromosomes or occurred leukaemia cancerous diseases. Radiation causes of this disease of the connective tissue of the bones and result from this disease, excessive increase in the numbers of blood cell and affectsonchildren more than adult<sup>3</sup>. Some statistics indicate the emergence of cancer within a period ranging from 5-30 y from the time of exposure to radiation. Leukaemia is the first species that appear in the population after exposure, followed by breast cancer and cancer of the thyroid gland. There are many researches on alpha emission in biological samples using a technique-counting track by a nuclear particle detector, because it is a high resolution and the ability to detect very low-lying concentrations. CR-39 detectoris used in radon and alpha-particle detection to measure the natural alpha radioactivity in human, animal tissue, and human blood<sup>4-</sup> <sup>10</sup>.Nuclear track detector (CR-39) is organic detector, the scientific name (Polyallyldiglyol carbonate) and commercial name (CR-39). It has a chemical composition ( $C_{12}H_{18}O_7$ ), a density of 1.31 g cm<sup>-1</sup>, and contains general composition of the monomer on two groups' allele ( $CH_2 = CH - CH_2$ ).CR-39 detector has a high sensitivity and analysis ability to record the tracks of protons, alpha particles, and fission fragments, because it contains the bonds of weak carbon that breaks easily when exposed to radiation.<sup>226</sup>Ra is expected to be present in bone tissue because radionuclide tends to be moderately transferable in the physical environment. <sup>226</sup>Ra is taken by vegetation's from the soils and assimilated efficiently from the gut, when ingested by animal<sup>11</sup>. Aaim of present study is assessed the uptake of natural alpha radioactivity in human tissues and determines how measured level can be used as markers of exposure to alpha radioactivity.

#### **Materials and Method**

An alpha emission rate in the tissue is determined using  $\alpha$ -sensitive plastic track detectors (PADC-TASTRACK CR-39, Bristol, UK).Nuclear track detectors technology is one of the important techniques in determining the concentrations of radioactive substance due to the availability, accuracy, not requiring complex electrical equipment, and knows track detectors as electric materials ranging qualitative resistance 106-1020 Ohm cm that generated narrow paths of radiation damage called tracks when alpha particles pass through <sup>12</sup>. The tissues are collected by doctors who also recorded information on each tissue sample, such as the age, gender, and town of the donor (Table 1). Fivetissue samples are collected from Al Sadr Hospital in Najaf city. All tissue samples are sealed in vials Fig. 1. The tissue samples areplaced in a petri dishwhich its high resistance to thermal and dried at the 70  $^{\circ}$ C for 6 h using an oven.



Fig. 1Vial sample

SC	Gender	Scientific Name
T262	Female	Ovarian
T195	Male	Thyroid
T190	Female	Thyroid
T182	Female	Bone
T179	Male	Gluteus

**Table 1**Information about the tissue from study area

The tissuepowders are homogenized by mortar and sifted through a 0.5 mm sieve. All samples are weighted and the tissuepowders are placed on the sheets of the high-purity plastic  $\alpha$ -detector, with about a 2 × 2 cm<sup>2</sup> area. The detectors with samples were putin vacuum-sealed a high-density polyethylene bag(prevent the influx of radon gas and increasing rangealpha particles) and clamped in position, as shown in Fig. 2. However, the most massive and energetic of radioactive emission. The alpha particles are the shortest in range because of its strong interaction with matter. The alpha particles (not penetrating far) deposit their considerable energy in a short distance.



Fig. 2. Samples weighted and placed on the sheets of  $\alpha$ -detector, a: The detectors with samples sealed in bag, b:The detectors with samplesin the freezer at -20 °C

The detectors with samples sealed in a high-density polyethylene bagis placed together inside the freezer at -20 °C for 60days to allowalpha particle tracks from the natural levels of activityin the tissue to accumulate on the TASTRAK detectors. In this technique, the alpha particles are measured without the chemical treatment of the samples using CR-39 detectors. At the end of the exposure period, the CR-39 detectors are etched under controlled conditions in NaOH solution reported elsewhere<sup>6-9</sup>. Then the CR-39 detectors are washing and drying Fig. 3. The number of  $\alpha$ -tracks per unit area for the tissuesamples is counted using an optical microscope (A. Kruss. Optronic, Germany) with the MDCE-5C camera at 10 × magnificationas shown in Fig. 4.



Fig. 3 The process of washing and drying detectors



Fig. 4.An optical microscope connected to the computer software

The CR-39 efficiency in this research was calculated (85%) using the following formula:

$$\varepsilon = 1 - \frac{V_B}{V_T},\tag{1}$$

where  $V_B$  = bulk etch rate ( $\mu$ m h<sup>-1</sup>), and  $V_T$  = track etch rate ( $\mu$ m h<sup>-1</sup>). The alpha emission rate  $E_a$  is calculated using the formula:

$$E_{\alpha}(mBq\ cm^{-2}) = \frac{(\rho_s - \rho_b)}{\varepsilon \% P_{\gamma} \% T}, (2)$$

where, *T*: Exposure time (Seconds),  $P_{\gamma}$ : Probability of Alpha*transition*,  $\rho_s$ : Number of tracks produced by the samples (track cm<sup>-2</sup>),  $\rho_b$ : Number of background tracks in the detector (track cm<sup>-2</sup>). The alpha particles quoted in present study include the removal of mean background track density. For the area of the tissue powder surface in contact with the detector, themean numbers of recorded alpha particle track were565, with 472 as the lowest number and 753 as the highest.

#### **Results and Discussion**

The alpha emission rates in the tissue samples are found. The heights emission rate of alpha particles (0.198 mBq cm<sup>-2</sup>) found in ovarian tissue, whereas the lowest rate (0.122 mBq cm<sup>-2</sup>) found in gluteustissue as shown in Table 2. These rates are normal and alpha particles do not cause of cancer in studying tissues, which are no clear increase in these measurements by comparison conducted by global research, so the cancerous tissue samples are not caused by radioactive contamination.Fig. 5shows the tracks produced by the tissue of typical samples.

Sample Code	Trackscm <sup>-2</sup> d <sup>-1</sup>	$E\alpha$ (mBq cm <sup>-2</sup> )
T262	20.17	0.198
T195	12.63	0.124
T190	15.55	0.153
T182	14.14	0.139
T179	12.44	0.122

Table 2 The rate of emission of alpha particles in the tissues



# Fig. 5 Tracks in the tissue of typical samples, a: Thyroid (female), b: Bone, c: Gluteus, d: Thyroid(male), e: Ovarian

The alpha particle activity was measured in the tooth and bone samples in other countries using a CR-39 detector.Henshaw et al. (1988) measured the average <sup>210</sup>Po and <sup>226</sup>Ra activity values in human bones in the UK (1.46 Bq kg<sup>-1</sup> and 0.003 Bq kg<sup>-1</sup>, respectively)<sup>13</sup>. Henshaw(1989) found that the average <sup>226</sup>Ra activity value in human teeth (UK) was found to be 9 Bq kg<sup>-14</sup>. James et al. (2004) showed that <sup>210</sup>Pb-supported <sup>210</sup>Po accumulates on the outer enamel of teeth. The mean alpha activity measured in human teeth obtained to be 5 Bq kg<sup>-1</sup> in the UK<sup>14</sup>. The concentrations of plutonium and the total alpha emitters in human teeth obtained of 5 mBq kg<sup>-1</sup> and 7 Bq kg<sup>-1</sup>, respectively in the UK (O'Donnell et al. 1997)<sup>15</sup>. Bunzl and Kracke (1983) measured the plutonium concentration in human bone collected (4 mBq kg<sup>-1</sup>) in Germany<sup>16</sup>. Henshaw et al. (1994) studied the uptake and distribution of natural alpha particles and found <sup>226</sup>Ra concentration in fetal teeth (2.05 Bq kg<sup>-1</sup>) in the UK<sup>5</sup>.

#### Conclusions

The variation in alpha emission rates as natural radioactivity in the tissuescollected from Najaf citymay depend on the transfer rate of radionuclides from soil, water, food, and air to human tissues. This study showed the emission of alpha particles is a regular rate of radioactivity naturally present in the human bodies. Overall, the results of alpha activity of tissue samples are low and no cause dangerous effects on all human health. This means that the samples are free of environmental pollution of the alpha particles. These results can be a biomarker for the transfer rate of radionuclides from air, soil, water, and food forhuman and animal tissues. This study is useful in determining the exposure rates of alpha particles of the population within the study area fradiological prevention and protection from extreme dose exposure.

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