Original Article

A Biochemical Study of the Effect of Nuclear Radiation on Radiology Technicians in the CT and X-ray Departments at Al-Imam Al-Kazemin City Hospital

Asmaa A. Jawad[1]*, Dheaa S. Zageer[2]

[1]Department of Chemistry, College of Science, Al-Nahrain University, Jadriya, Baghdad, Iraq.
Email: asmaa85ali@gmail.com
[2]Department of Chemistry, College of Science, Al-Nahrain University, Jadriya, Baghdad, Iraq.
Email: dheaa.zageer@nahrainuniv.edu.iq

Abstract

Aim/Background: The radiology staff is one of the most important groups of hospital workers who must highlight the necessity of maintaining and constantly monitoring their health due to the nature of their work, which exposes them to great danger. Long working hours in a place surrounded by danger, such as ionizing radiation, even if it is very noticeable when examining patients, puts hospital workers at constant risk of contracting many diseases., such as cancer, DNA damage, genetic mutations, or damage to some body organs, such as the liver. Aim of this research is to investigate some parameters in order to diagnose the extent of the radiation's effect on workers. **Methodology:** 30 samples were taken from the radiology department of west radiographers, and 10 control models from the laboratory department in the same hospital for comparison. The most important parameter that was studied includes liver enzyme tests, such as Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT). **Results:** P-value of vitamin D3 and urea are significantly under < 0.05, whereas alkaline phosphatase (ALP), showed the results, which are non-significant and p-value > 0.05. The last parameter is S-ferritin, which shows non-significant under the value p-value < 0.05. **Conclusion:** Monitoring the health status and ensuring the occupational safety of workers in the radiology department, and the requirements for measuring radiation levels in these departments and following them up is necessary for workers to ensure their safety. It is strongly recommended to use safety equipment during all these activities.

Keywords: Ionization Radiation, Liver Enzymes, Aspartate Amino Transferase, S- ferritin, Vitamin D3, Safety Equipment.

Introduction

High-energy radiation with the capacity to disrupt chemical bonds and remove electrons from atoms is known as ionizing radiation (IR). The effects of radiation can lead to cell death, damage to DNA fragments and mutations. A radioactive organ's sensitivity[1] Ionizing radiation is used in two very important aspects in medicine: as a diagnostic tool for some diseases, as well as a tool used in therapeutic.[2]

One of the most important departments that work on ionizing radiation (X-ray), which serves as a diagnostic tool, is the radiology department, and its employees are the radiology staff who work on radiography and computed tomography machines and provide complementary services to the doctor's work in diagnosing some diseases and those who are exposed to the risk of the random effects of ionizing radiation and non-random effects.[3,4] The danger of ionizing radiation lies in the presence of two mechanisms for affecting the body: direct and indirect, as in Figure 1. The direct mechanism works on the target atom or molecule, such as protein, DNA, or RNA, leading to a change in the function or shape of the atom or molecule, or the secret rate of the single strand or double strand of DNA, while the indirect mechanism It directly affects radioactive decomposition, forming radicals that, in the presence of an excess of cell water, form peroxide, which is unstable and leads to serious damage to the body.

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Address for Correspondence: Department of Chemistry, College of Science, Al-Nahrain University, Jadriya, Baghdad, Iraq
Email: asmaa85ali@gmail.com

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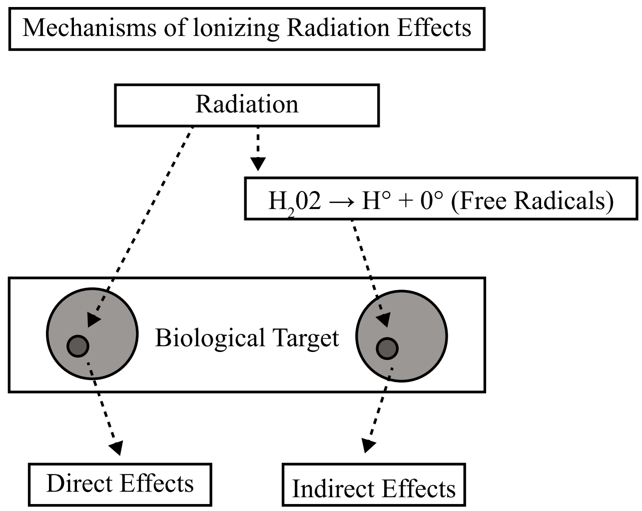

Figure 1: Mechanisms of Ionizing Radiation[5].

The biological effect is divided according to the timing of the effect, and it is of two types: early (Early (Deterministic) or delayed (Stochastic) (random) Or according to the nature of the effect, whether Hereditary or somatic (non- random). As in Figure 2:

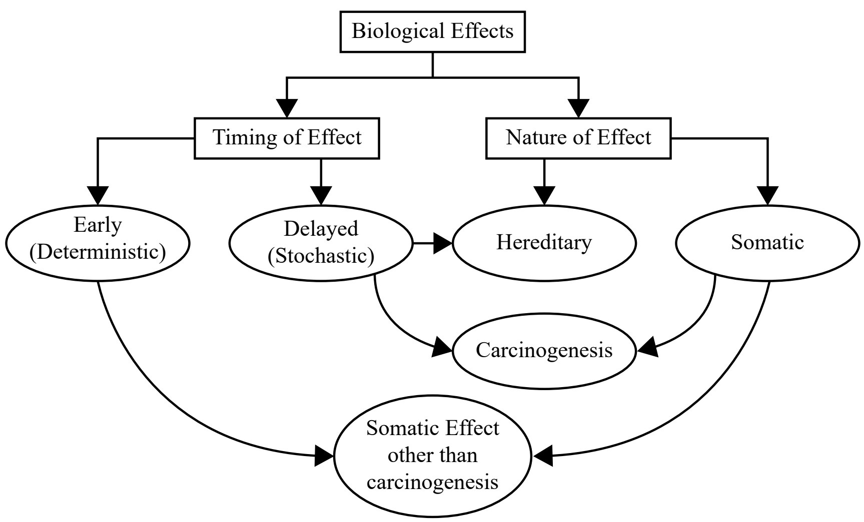

Figure 2: The Various Biological Effects of Ionizin Radiation[5].

Random and unpredictable effects are known as stochastic effects, and they typically occur after long-term, low-dose exposure radiation. The occurrence of carcinogenesis and hereditary consequences after diagnostic imaging is random. The effects of deterministic (non-stochastic) radiation are nonrandom and have a very predictable reaction. There is a radiation exposure threshold beyond which the response is dose-dependent. The deterministic effects of radiation include lung fracture and lung fibrosis[6] and DNA repair.[7-17]

Long working hours, in addition to long years of service, expose workers in hospitals to a constant risk of exposure to ionizing radiation, affecting many markers in the human body. One of the most important aspect being taken during this study is vitamin D3, one of its distinctive properties is its solubility in fats, the deficiency of which is considered a vital indicator for many diseases. It was discovered that it has effects in many body activities, such as its work as an antioxidant and its effect on balance, in addition to its effects on processes. Otherwise, it was studied for people who are exposed to continuous amounts of radiation while working.[18] The second marker is liver enzymes, which give an indication of any harm occurring in the human body when a noticeable change occurs in them. They are alanine aminotransferase (ALT), aspartate aminotransferase The efficiency of liver function can be determined by measuring some enzymes that are encountered in it or possible in other places, such as AST or ALT enzymes. If a change occurs in the values of these enzymes from the known values, it gives an indication that there is damage to the body in general and to the liver in general. Especially as for the ALP enzyme, this enzyme is related to the functioning of the kidneys in addition to the liver, and its increase could be an indicator of damage to the gallbladder in humans or the presence of bone diseases as well This enzyme is not stable in the body, so its increase and decrease in the body gives an indication of the presence of a danger that must be treated.[19-22]

Many diseases are associated with iron accumulation or deficiency. Ferritin in the blood (s.ferritin) is considered a vital marker used to store iron in the liver, spleen, and bone marrow, and any change in it is considered an important indicator, so it is one of the important markers that was measured in this study.[23,24]

This current study aimed at the importance of monitoring the health status and ensuring the occupational safety of radiology department workers, and the requirements for measuring radiation levels in these departments and following them up is essential for workers in this field to ensure their occupational safety.[25]

Protective tools in all radiology departments and the necessity of monitoring, including blood measurements.[26]

Material and Methods

This research was conducted on workers at Al-Imamin City Hospital in Baghdad who operate machines with ionizing radiation radiology staff for X-rays and CT scans with different device energies ranging between (100 - 150) ke and varying working hours (6±1).

The number of samples was 30, including 8 males and the rest females. They were divided into categories: those who work directly on the machine (radiographer, n = 24), 3 nurses, and 3 who work as administrators. The ages of everyone ranged between (24-60), as shown in the first table. As for control samples, they were taken from workers in the laboratory department of the same hospital, and their number was 10 females, aged between 24 and 50 years. The necessary tests were performed by taking 5 ml of blood for each sample into a gelatinous tube, running the centrifuge at several cycles (3000 rpm for 3 minutes), and freezing the serum for testing. Later the tests included three enzymes: ALT and AST were measured by the IFCC method without (P-5"-P). Kinetics. Ultraviolet and ALP AST were measured by enzymatic colorimetry. Kinetic group and UREA enzymatic group-UV. These were All four parameters were measured using ELITech Clinical Systems Selectra Pro Series Analyzers, while Vitamin D3 was measured using ELFA (Enzyme Linked Fluorescent Assay) and finally, S-FERRITIN was measured by.

(An immunoassay device enhanced with a set of latex beads. Samples were selected from people who do not suffer from any hereditary or chronic diseases, do not drink alcohol, and are non-smokers, with the exception of two samples, to avoid the influence of these diseases as factors affecting the parameters for which the data were collected.

Table 1: Technical Information.

Numbering of Samples	Gender	AGE	Servicing Years	The Work on the Device	Smoking	Presences of other Diseases
1.	F	36	7	Radiographer	no	-
2.	F	49	15	Radiographer	NO	-
3.	F	49	8	Radiographer	NO	Hyper tension
4.	F	32	7	Radiographer	NO	-
5.	M	57	27	Administrative	NO	-
6.	F	30	3	Administrative	NO	-
7.	M	26	2	Radiographer	no	-
8.	F	27	4	Radiographer	no	-
9.	F	49	14	Radiographer	NO	-
10.	M	26	1	Radiographer	NO	-
11.	M	57	33	Radiographer	NO	-
12.	F	33	5	nurse	NO	Hyper tension
13.	M	37	18	Administrative	NO	-
14.	F	58	28	nurse	NO	-
15.	F	50	16	nurse	N0	-
16.	F	53	14	Radiographer	NO	-
17.	F	53	30	Radiographer	NO	-
18.	F	41	17	Radiographer	NO	-
19.	F	52	17	Radiographer	NO	-
20.	F	25	1	Radiographer	NO	-
21.	F	42	15	Radiographer	NO	-
22.	F	50	21	Radiographer	no	-
23.	M	40	26	Radiographer	N0	-
24.	M	34	3	Radiographer	yes	-
25.	M	26	1	Radiographer	yes	-
26.	F	25	1	Radiographer	no	-
27.	F	27	5	Radiographer	no	-
28.	F	26	1	Radiographer	no	-
29.	F	26	1	Radiographer	no	-
30.	F	24	1	Radiographer	no	-

Statistics Evaluation

Evaluating statistics by using the Excel program to calculate the mean, standard deviation, and P-Value For this study, $p < 0.05$ was set as statistically significant

Result

Results of a Study of Ionizing Radiation Workers (ALT, AST ALP) and Vitamin D3 and S-FERRTIN

Data obtained comparing people who do not use ionizing radiation and people who use it showed a very noticeable change in the parameters of liver enzymes. It was shown from Table 2 and Figure 1 that liver enzyme indicators (AST and ALT) showed a clear increase in their value when compared to control samples, as the study was conducted by setting the p value < 0.005. The P-Value difference was significant for both enzymes above and also for the Alkaline Phosphate significant enzyme, under study p-value <0.05 and the readings were as follows 12.97± 2.86, 24.76±6.83, 61.55±11.99 The parameters of the control samples are the mean and standard deviation of (ALT, AST and ALP) and the parameters of the samples exposed to radiation were as follows25.25±18.34, 31.15±10.83 and 88.89±20.31 also study parameter was urea, which showed an increase in its value between control samples and samples of people exposed to ionizing radiation, as follows:24.18±5.62 and 29.20±7.59 For the value of the mean and the standard deviation, this study was subject to the value of p-Value<0.05(25±18.34, 31.15±10.83, 88.89±20.31) to mean and SD as appear in Table 2 and Figure 3

Table 2: Data Alanine Aminotransferase, Aspartate Aminotransferase, Alkaline Phosphate, and UREA.

Parameter	Control Group Mean±SD	Ionizing Radiation Workers Mean ± SD	P-Value
ALT* (U/L)	12.97± 2.86	25.25±18.34	P<0.05
AST* (U/L)	24.76±6.83	31.15±10.83	P<0.05
ALP* (U/L)	61.55±11.99	88.89±20.31	P<0.05
UREA *	24.18±5.62	29.20±7.59	P<0.05

Significant difference is * p<0.05

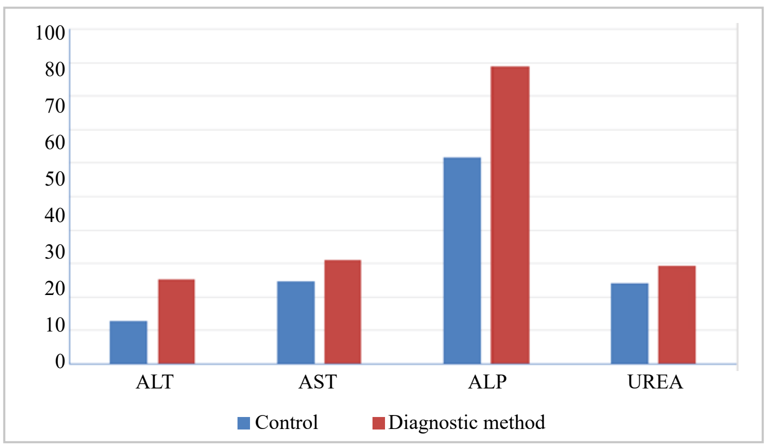

Figure 3: Alanine Aminotransferase, Aspartate Aminotransferase, Alkaline Phosphate, and UREA each Two Groups.

While Practical results exposure to Ionizing radiation on Vitamin D3 & S-FERRTIN from the data obtained, it was also noted that there is difference between samples of those working on ionizing radiation devices and the control samples, as there was a significant decrease in the D3 parameters. These results were very satisfactory under the study of P-Value<0.05 and the readings were as follows46.1±26.28 and15.20±5.78 for control samples and those working with ionizing radiation, the value of the mean and the standard deviation.

also, the results of S-Fertin decreased very slightly, so it is non-significant as a parameter for the samples collected under a study by P-Value >0.05 for control samples and radiation workers for the mean value and the standard deviation, which were as follows: 67.24±30.58 and 60.10±57.97 For control samples and workers exposed to radiation as shown in Table (3) and Figure 4.

Table 3: Vitamin D3 & S-FERRTIN each Two Groups.

Parameter	Control groupMean±SD	Ionizing radiation workers Mean ± SD	P-Value
Vitamin D3 *	46.1±26.28	15.20±5.78	P<0.05
S.ferritin (ng/L)	67.24±30.58	60.10±57.97	P>0.05

Significant difference is * p<0.05

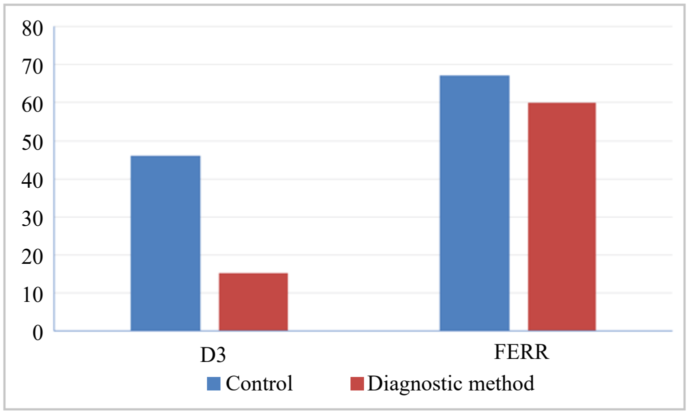

Figure 4: Vitamin D3 and S-FERRTIN in each Two Groups.

Discussion

Living organisms are exposed to the danger of ionizing radiation because of the properties of these rays that enable them to pass through the material, remove the electron and form charged ions, As a result of this effect, the shape and functions of the matter that is exposed to this type of radiation change. Radiation exposure has different effects on organs, tissues, or cells depending on the type and quantity of the dose absorbed and the type of tissue absorbed.[27] The presence of low levels of ionizing radiation will cause many parameters to deviate from normal in the body The radiology staff. It may give an indication of the incidence of many diseases through comparison between samples exposed to radiation and samples not exposed to the control.[28] Ionizing radiation exposure at low doses has a deleterious effect on liver function, increasing the risk of cancer and liver disease. It is uncertain, therefore, what biological processes underlie these negative impacts. To gauge liver damage caused by radiation after minimal radiation exposure. A set of mice was captured and exposed to Acute dosages in one go might vary from 0.02 to 1.0 Gy. Liver protein B alterations were monitored. He makes the point that instant effects result from low and medium radiation exposures. inhibition of the glycolysis pathway and the enzyme pyruvate dehydrogenase's presence therein Liver. Additionally, they cause notable long-term alterations in lipids. Inactivation-related metabolism and elevated hepatic inflammation Receptor alpha-activated peroxisome proliferator is the transcription factor. The knowledge of the possible risk of liver injury in populations exposed to environmental exposure is enhanced by this investigation.[29] Ionizing radiation produces its harmful effects through radiolysis, which leads to the release of reactive oxygen species into cells. Depletion of cellular antioxidants. Ionizing irradiation of mice led to increased activities of serum ALT, AST, and ALP elevated serum transaminases indicate injury to liver cells, which leads to increased cell membrane permeability, which facilitates This is the passage of cytoplasmic enzymes into the blood. Hepatic ALP is found in the ductal and luminal domains of the bile duct epithelium and its levels are elevated due to increased synthesis and consequent release into the circulation. Due to obstruction of the bile ducts.[30] It has been observed that liver damage occurs at high radiation doses, while at low radiation levels injury occurs. The amount of liver injury was monitored through transport enzymes (ALT and AST) of industrial radiographers in China, and studies showed that liver injury occurred with continuous exposure to low levels of radiation.[31] Therefore, a study was conducted on diagnostic technicians working in hospitals. They are among the groups most exposed to ionizing radiation (X-ray) during their work. Therefore, this occupational exposure can cause cancer to be stimulated when continuous exposure to radiation continues. Therefore, a study was conducted in Iraq and measuring some parameters in the liver (ALT and AST) was also found. A significant difference in liver enzymes between the control groups and those working on diagnostic devices.[24] During predetermined durations, cumulative radiation of 1.27 Gy/min is applied to the body as a whole. As radiation exposure increased, levels of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) increased dramatically. Variations may result from acute stress, inflammation, or an unspecific response to stress; however, tolerance and liver repair may cause swings. To accurately identify radiation-related injuries, determine their severity, and ensure appropriate treatment, these examinations are essential.[32]

Oxidative stress consists of free radicals resulting from the indirect effect of ionizing radiation inside the cell. These radicals cause various damages such as oxidation of DNA fragments, oxidation of proteins or fats, in addition to damage to the liver and kidneys. Minor damage may expose it in the future to greater damage to certain organs, such as the liver and kidneys, such as measuring urea for some. The slight change in the urea range between samples exposed to radiation and samples not exposed to radiation, and failure to control it, may lead to kidney damage in the future.[33]

Ionizing radiation (IR) has widespread application in modern medicine, including medical imaging. As a result, healthcare providers are exposed to varying doses of infrared radiation. From the effects of ionizing radiation on cell water and the formation of active oxygen fragments that form reactive oxygen species (ROS), which have various effects on the body. To reduce the negative side effects of radiation associated with oxidative imbalance, radiation-induced oxidative stress has been studied D. According to the study data, it was found that vitamin D3 is one of the factors that protects humans from tissue damage resulting from infrared radiation. Little is known about the effects of vitamin D in radiation protection, but results so far have been promising. Vitamin D deficiency is common in modern societies and may contribute to the severity of harmful side effects of medical exposure to infrared radiation.[34,35] Therefore, those working as radiographers will suffer from a severe deficiency in vitamin D3.[36] The indirect effect of ionizing radiation produces peroxide, which can cause cellular oxidative stress such as vasculopathies, atherosclerosis, and pulmonary leak syndromes. It has been observed when combined Heme, along with endothelial cells, becomes highly resistant to oxidant-mediated injury and to the accumulation of endothelial lipid peroxidation products. Ferritin prevents oxidation-mediated cytolysis in direct relation to its intracellular concentration. We conclude that the endothelium and perhaps other cell types may be protected from oxidative stress through iron-ferritin sequestration.[37] Even though each organism has a different role in the control of iron trafficking. Some of the key elements in the reaction between iron and ferritin, which produces the iron core and the development of hydrogen peroxide. The catalytic location of ferroxidase on the H-chain is crucial in controlling iron availability, as demonstrated by the characterisation of cellular models in which ferritin expression is manipulated. This in turn affects several cellular functions, including as proliferation and resistance to oxidative damage, in a secondary manner.[38] Some changes in iron levels were observed in irradiated lungs compared to non-irradiated lungs. It is possible that these differences in [Fe] are not statistically significant between samples in the lungs exposed to radiation and those not exposed to radiation.[39]

Conclusion

In this study, a group of workers working on ionizing radiation in the hospital in the radiology department (radiographers and CT scans) was taken, and it showed that Many changes and differences were found between the parameters of control samples and samples working with ionizing radiation, which could be like a marker showing the effect of radiation on some organs of the body. Among these parameters are Liver enzymes Alanine aminotransferase, Aspartate aminotransferase , as well as an enzyme alkaline phosphatase, in addition to urea and e D3 marker, showed increased the highest difference between the control samples and samples exposed to ionizing radiation, and these markers were very a significant under the study of p-Value<0.05, on the other hand D3 significant decreed to the control samples under the study of p-Value <0.05while parameter the s-ferritin parameter showed a small significant decreed difference in the study by p-Value>0.05. At the conclusion of this study, we come up with an important conclusion of recommendations for categories of hospital workers regarding ionizing radiation by conducting periodic examinations and wearing full means of protection from ionizing radiation, in addition to attending some courses that give full awareness of the danger of their work and eating healthy food as well.

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