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ASSESSMENT OF THE EFFECTS OF LOW DOSE X-RAY RADIATION ON THE LIVER OF WISTAR ALBINO RATS

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ABSTRACT

The aim of this study was to investigate the possible effects of low dose x-ray radiation on the liver in Wistar albino rats. A total of twenty (20) adult male Wistar albino rats, weighing 130-160g were assigned into two groups (groups I and II) of 10 rats each. Group I rats were neither irradiated (control) while group II rats were irradiated. Group II rats were exposed twice at an interval of 60 seconds to x-ray radiation at a source to skin distance (SSD) of 70 cm to deliver a total radiation dose of 18.4mGy at the rate of 9.2mGy/exposure using 100kVp and 30mAs exposure factors and 15 as the quality factor of the X-ray machine (P). Two milliliters (2ml) of blood for serum preparations was aseptically collected from each of the rats in the two groups at post irradiation days 1 and 7. Serum ALT, total protein (TP) and albumin (ALB) were determined using conventional methods. Data obtained were analysed using independent t-Test. The mean value of ALT in group II rats at day 7 post irradiation was slightly higher than the control group. However, the variation was not statistically significant compared to the control. The mean values of serum total protein and albumin in the irradiated and unirradiated control group did not differ significantly at post irradiation days 1 and 7. In conclusion, findings from this study indicated that exposure of rats to acute low dose x-ray radiation did not significantly alter the hepatic function indices. Thus, acute exposure to x-ray radiation may not affect the liver.

Keywords: x-ray, low dose radiation, liver, rats

INTRODUCTION

Reports have shown that exposure to high dose x-ray ionizing radiation (IR) affects the liver enzymes. High dose ionizing radiation (IR) is a cancer-causing agent that can alter several biological effects via oxidative stress (Muirhead et al., 2009; Pernot et al., 2012, Karbownik and Reiter, 2000). Oxidative stress in the body can develop to liver injury due to overwhelmed cellular production of reactive oxygen species (ROS), which can lead to liver diseases (Li et al., 2015). Excessive production of reactive oxygen species (ROS) due to radiation overwhelms cellular antioxidant capacity resulting in a state of oxidative stress leading to serious cellular injuries that contributes to the pathogenesis of several diseases (Gloire et al., 2006). Effects of high dose x-ray radiation as seen in the cases of fluoroscopy and computed tomography (CT) has been reported. However, there is dearth of information on the possible effects of low dose conventional x-ray radiations in the body. Though, liver is not as radiosensitive as other organs, it has however, been reported to be affected by radiation (Kłuciński *et al.,*2005). Monitoring of the hepatic function aid in the assessment of possible radiation-induced damage. To diagnose a potential problem in the liver, the liver function tests are important indices (Chang *et al.,* 2012). The aim of this study was to investigate the possible effects of low dose x-ray radiation-induced liver damage in Wistar albino rats.

MATERIALS AND METHODS

A total of twenty (20) adult male Wister albino rats, weighing 130-160g obtained from the animal house of Department of Veterinary Medicine, University of Nigeria, Nsukka were used for the study. The rats were kept under suitable laboratory conditions throughout the period of investigation. The twenty (20) rats were assigned into two groups (groups I and II) of 10 rats each. Group I rats were neither irradiated (control) while group II rats were irradiated

Irradiation

Group II rats were exposed to acute double exposure to x-rays radiation at a source to skin distance (SSD) of 70 cm to deliver a total radiation dose of 18.4mGy at the rate of 9.2mGy/exposure using 100kVp and 30mAs exposure factors and 15 as the quality factor of the X-ray machine (P).

The radiation dose (mR) was determined using equation (Ayad et al. (1994; Ayad et al. (2001):
Radiation dose (mR) per exposure = $P(kVp)^2 m.A.s / R^2$

Blood/serum collection

Two milliliters (2ml) of blood for serum preparations was aseptically collected from each of the rats in the two groups at post irradiation days 1 and 7.

Parameters assessed

Serum alanine aminotransferase (ALT) was determined by Reitman-Frankel colorimetric method (Thomas, 1998). Serum total protein was determined by Tietz and by photometric test according to the direct biuret method (Thomas,1998) while serum albumin was determined by photometrically based on bromocresol green indicator (Johnson et al.,1999).

Data analysis

Data obtained were analysed using independent t-Test. Data obtained were summarized as mean ± standard error of mean. Probability < 0.05 was considered significant**.**

RESULTS

The mean value of ALT in group II rats at day 7 post irradiation was slightly higher than the control, group I (table 1). However, the variation was not statistically significant compared to the control.

The mean values of serum total protein (table 2) and albumin (table 3) in the irradiated and unirradiated control group did not differ significantly at post irradiation days 1 and 7.

Table 1: The mean ± SEM of ALT (U/L) at post irradiation days 1 and 7

Group	**DAYS POST IRRADIATION**	
	Day 1	Day 7
Group I (unirradiated)	35.21 ± 1.12	34.1 ± 0.5
Group II (irradiated)	38.05 ± 0.1	36. 3 ± 1.0

Table 2: The mean ± SEM of TP (g/dl) at post irradiation days 1 and 7

Group	**DAYS POST IRRADIATION**	
	Day 1	Day 7
Group I (unirradiated)	5.13 ± 0.0	5.01 ± 1.1
Group II (irradiated)	5.60 ± 0.1	5.2 ± 0.00

Table 3: The mean ± SEM of ALB (g/dl) at post irradiation days 1 and 7

Group	**DAYS POST IRRADIATION**	
	Day 1	Day 7
Group I (unirradiated)	4.02 ± 0.0	4.01 ± 0.11
Group II (irradiated)	4.10 ± 0.2	4.11 ± 1.0

DISCUSSION

When cellular production of reactive oxygen species (ROS) overwhelms its antioxidant capacity, a state of oxidative stress is reached leading to serious cellular injuries that contributes to the pathogenesis of several diseases (Gloire et al., 2006). It has been reported that a radiation exposure can induce hepatic toxicity and can increase the risk of hepatic cancers (Ohishi *et al.,* 2011; Barshishat-Kupper *et al.,* 2014). Liver cancer has been reported in medical radiation workers who were exposed from chronic low doses. Elevation of liver function indices are biomarkers of hepatitis, autoimmune diseases, toxicity, and ischemic conditions of the heart. Our findings suggested no significant elevation in any of the liver function indices assessed. This is contrary to the findings of Holten and Christiansen (1998), Moulder et al., (2004) and Wheeler and Bernard (1994) that reported significant decline in serum albumin post irradiation Nwokocha et al. (2012), reported alteration in liver enzymes in rats exposed to total-body high dose irradiation. Nwokocha et al found that the levels of ALT were significantly increased with the increase in the radiation. Leakage from the damaged tissue is a basis of normality in ALT/AST levels (Nwokocha et al). The difference between our current findings and the previous findings may be due to low dose effects associated effects associated with conventional radiographic machine. Nwokocha et al. (2012), suggested that exposure to higher cumulative radiation doses results in a greater increase in ALT, relative risk of liver disease, and the severity of liver disease caused by radiation is related to the absorbed dose.

In conclusion, exposure to low dose x-ray radiation did not significantly alter the hepatic function indices in the study. However, hepatic injury can occur from low doses in patients exposed on a regular basis.

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