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Research article

EFFECT OF ELECTRON BEAM RADIATIONS ON ANXIETY IN EXPERIMENTAL ANIMAL MODELS

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ABSTRACT

Objectives: The aim of the study was to test the effect of whole body electron beam radiation on anxiety statein Swiss albino mice.

Methods: Mice were irradiated with three different doses (2Gy,4Gy,6Gy)of electron beam radiations.After 24hours of radiation exposure animals were taken for testing level of anxiety using elevated plus maze and light dark arena apparatus.

Results: Whole body electron beam irradiation at doses of 2, 4 and 6Gy lead to significant ($p<0.001$) anxiogenic activity in irradiated mice.

Conclusions: Electron beam radiation has the potential to cause anxiety.

Key Words: Electron beam radiation, mice, anxiogenic.

INTRODUCTION

All living beings on earth are exposed to radiations (DRDO).Our mother earth is radioactive ever since its formation into a solid mass over 4½ billion years ago. Yet, we came to know about radiation and radioactivity for just over one hundred years until it was discovered by Wilhelm Conrad Roentgen on November 8, 1895, for which he received the first Nobel Prize for physics in 1901 (EPA,2012;Gazda MJ,2004). Radiation is a form of energy. The atoms of some elements are radioactive and spontaneously release energy (radiation) as they transform from unstable to stable forms. Radiation is part of our environment. It comes from both natural and manmade sources (EPA, 2012; Kithamura,2001). There are actually two kinds of radiation, and one is more energetic than the other. It has so much energy that, it can knock electrons out of atoms, a process known as ionization. These ionizing radiations like X-rays, gamma rays can affect the atoms in living things, thereby posing a health risk by damaging tissue and DNA in genes. There are also other, less energetic types of non-ionizing radiation (including radio waves, microwaves and visible light) (DRDO; EPA, 2012). High energy electron-beam radiation [EBR] is an ionizing radiation that is used in radiotherapy since the early 1950s. Accessibility of high-energy electron has eased the effective management of superficial malignant tumors. The usage of electron-beam radiation is a likely alternative for treating AIDS related skin lesions. Now a days, electron-beam irradiation is used for processing products like syringes, cardiothoracic devices etc. Due to their extensive use in hospitals during the past few years, apprehension concerning the health effects of electron beam radiation has developed (Deepa B, 2012; Deepa B, 2013)

It is not clear what specific changes are produced by electron beam radiation in central nervous system. This research was carried out to study the effect of EBR on anxiety in Swiss albino mice.

MATERIALS AND METHODS

Experimental Animals:

Experiments on animals were conducted after getting prior approval from institutional animal ethics committee (KSHEMA/AEC/01/2010).Animals was taken from central animal house of the institution. Healthy adult Swiss albino mice of both sex, aged 3-6 months of weight 20-25g was used for the study. Animals were housed under standard housing conditions at room temperature 25±1^{0}C, 12:12 hour light/dark cycle. Animals were provided with standard pellet diet and water *ad libitum*.

Radiation Procedure:

The irradiation work was carried out at Microtron centre, Mangalore University, Mangalore, Karnataka. A variable energy accelerator, Microtron was used to deliver radiation. The unanaesthetized animals were restrained in well ventilated Perspex boxes and exposed to whole bode EBR at distance of 30cm from the beam exit point of the Microtron accelerator at a dose rate of 72Gy/min. Three different doses of EBR 2,4 & 6 Gy were given.

Assessment of Anxiety:

For assessing anxiety in animals, they were divided into four groups. Each group consisted of 12 animals (6 males & 6 females). Group I served as normal control. Group II, III & IV received EBR at doses 2Gy, 4Gy & 6Gy respectively. After 24 hours of radiation exposure animals were taken for following tests.

Elevated Plus Maze (EPM) test:

This test has been widely validated to measure anxiety in rodents. The plus mazes combines three potential anxiogenic factors- novelty, height, and open space. Briefly, the cross-shaped maze consists of four arms that are interconnected by a central platform 5cmx5cm. Two opposing arms are surrounded by side and end walls 35cm high (closed arms) whereas the remaining two arms are unprotected 25cm x 5cm (open arms). The maze is suspended 25cm above the room floor. The animal is placed on the central platform, facing one of the enclosed arms and was observed for 5 minutes. During the 5minute test period, time spent in open and enclosed arms was recorded (Manikkoth S, 2013; Rauniar GP, 2007; Verma H, 2008).

b) Light-Dark Arena (LDA) test:

Light – Dark exploration test is one of the few test specifically designed for rodents. The apparatus is divided into two parts; 1/3 with opaque walls and a cover (dark compartment) whereas the remaining 2/3 was open and illuminated (light compartment). The door between the two compartments permits the animal to move from one side to another. The mice is released into the light compartment and observed for 5 minutes. During the test period, the time spent in light and dark compartment was observed (Manikkoth S, 2013; Rauniar GP, 2007; Verma H, 2008).

Statistical Analysis:

All the results were expressed as Mean ± Standard deviation (SD). Data were analysed using One-way ANOVA followed Tukey Kramer Test using Prism software. $P<0.05$ was considered statistically significant.

RESULTS

a) Effect of EBR on the time spent in open and enclosed arms using EPM:

There was a significant decrease in time spent in open arm of EPM ($p<0.001$) and significant increase in time spent in closed arm of EPM ($p<0.001$) for the groups II,III & IV of mice exposed to electron beam radiation , on comparing with normal group I (Table -1)

Table-1: Effect of EBR on the time spent in open and enclosed arm using EPM

Group	Time spent in each arm in seconds	
	Open	Closed
Normal(DW)	48.27 ±1.400	182.66 ± 6.53
2 Gy	20.33 ± 3.367[a]	274.91 ± 4.1[a]
4 Gy	11.25 ± 3.91[a]	284.66 ± 3.7[a]
6 Gy	3.08 ± 1.62[a]	294.08 ± 2.84[a]
One way ANOVA followed by Tukey Kramer test. N=12 [a] : $p<0.001$, considered very highly significant on comparing with normal group.		

b) Effect of EBR on the time spent in Light and Dark compartment using LDA

There was significant decrease in the time spent in the light compartment of LDA ($p<0.001$) and significant increase in the time spent in the dark compartment of LDA ($p<0.001$) for the groups II,III and IV of mice exposed to electron beam radiation, on comparing with normal group I (Table-2).

Table–2: Effect of EBR on the time spent in Light and Dark compartment using LDA

Group	Time spent in each arena in seconds	
	Light	Dark
Normal(DW)	36.35 ± 7.33	152.66 ± 6.053
2 Gy	19.16±5.96[a]	267.25 ± 3.44[a]
4 Gy	13.08±5.01[a]	279.16 ± 5.27[a]
6 Gy	5.58±1.88[a]	293.17± 2.55[a]
One way ANOVA followed by Tukey Kramer test. N=12 [a] : $p<0.001$, considered very highly significant on comparing with normal group		

DISCUSSION

The results exhibited that the mice irradiated with EBR have shown anxiogenic activity in EPM and LDA models of anxiety. Among the two tests used for evaluation of anxiolytic activity, the EPM and LDA tests are the best validated method for assessment of anxiety (Manikkoth S, 2013).

Anxiety disorder is one of the most common mental ailments exhibited by humans. It can cause considerable distress and debility. The neurobiology of anxiety disorders is not fully known (Arya Aswini, 2011).It is a fact that abnormal functioning of the neurotransmitters plays an important role in the pathology of anxiety disorders (André Rex). Low level of GABA in CNS is most commonly linked with anxiety disorders (Griebel G, 1995). Apart from GABA, 5-HT has also an important role in the progress of anxiety disorders (Johannes Tauscher, 2011). Several pre-clinical studies showed that Dopamine and Nor-epinephrine also plays an important role in the pathophysiology of anxiety disorders (Douglas Bremmer, 1996; Hayley M Robinson, 2006). Oxidative stress also plays an important role in the etiology of anxiety disorders (Samina Salim, 2011).

In this study, animals irradiated with electron beam radiations showed significant anxiogenic activity in both the animal models of anxiety as evidenced by decrease in time spent in open arms of EPM and light arena of LDA. The anxiogenic activity can be due to electron beam radiation mediated alterations of the neurotransmitters (André Rex,Abdel-hamid,2004;AboulEzz HS,2012). Recently an animal study has shown that chronic exposure to electromagnetic radiations lead to decrease in GABA levels in the brain (Mona EL-Demerdash,2009). It's a known fact decrease in GABA, the inhibitory neurotransmitter is behind the pathology of anxiety (André Rex). Apart from the effect on neurotransmitters, electron beam radiations mediated release of reactive oxygen species may add upto their anxiogenic potential (Hovatta I, 2010;Yamini K,2010).

CONCLUSION

Electron beam radiation has the potential to induce anxiety. Further studies are on-going to understand the molecular basis of electron beam radiation induced anxiety.

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