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Gamma radiation induced atrophic gastritis in mice

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Abstract

Radiation biology has acquired greater relevance and significance in addressing the health issues. Gastric diseases has become one of the common gastrointestinal disorders that involves the entire mucosal thickness and can penetrate the muscular mucosa. Gastric disorders occurs as a result of imbalance between aggressive factors of acid and pepsin and maintenance of gastric integrity through endogenous factors. The objective of the present study was to evaluate radiation induced changes in the stomach of Swiss Albino male mice. Animals were divided into two groups: Group I containing normal mice served as control for each experimental stage, mice of Group II were irradiated with 5Gy γ – rays. 24 hours after irradiation mice were sacrificed by cervical dislocation on days 10, 20 and 30. Stomach was cut into thin section and subjected to hematoxylin eosin staining. Stomach of normal mice was healthy. Gastric mucosa of normal mice was thick, the epithelium was complete and there was no sign of damage. The irradiated group mice mucosa showed decrease in thickness with damaged areas. Loss of glandular regions were also seen. The irradiated group mice mucosa showed decrease in thickness with damaged areas while the parietal cell having lesser volume, polygonal form, wrinkled arrangement with large intracellular spaces were observed. Thus, our finding suggested that radiation induced stress causes imbalance in defence mechanisms and lead to the atrophic gastritis with mucosal injury.

Keywords: Gamma radiation; Atrophic gastritis; Wrinkled arrangement; Parietal cells

1. Introduction

In present time, nuclear terrorism and weapons related effects are raising much alarm and concern to public health. Radiation is often used to treat malignant tumors, or in combination with surgery or chemotherapy. Despite the advantage of radiotherapy and the improvements in techniques, many patients experience moderate to severe side effects including xerostomia, diarrhea, mucositis, dermatitis, ulceration and fibrosis [1].

Ionizing radiation transfuses deleterious effects in biological system. Ionizing radiation in interaction with living cells causes a variety of changes depending on absorbed dose, duration of exposure, interval after exposure and susceptibility of tissues. The exposure of mammals to ionizing radiation, such as gamma-radiation, can cause the development of a complex, dose-dependent series of potentially fatal physiological and morphological changes, such as nausea, vomiting, loss of appetite, decreased leucocyte count and weakened immune-function. Oxidative stress contributes to normal tissue damage during tumor therapy with irradiation. [2,3]. Radiation is one of the physical agents that induce oxidative stress which is defined as an increase in reactive oxygen species or a decrease in antioxidant defence mechanisms[4]. Reactive oxygen species are involved in pathogenesis of many diseases[5]. The realization about adverse effects of radiation began immediately after the discovery of X-ray in the form of skin cancer. Parallely, the awareness about existence of radio-nucleides intensified the threat of radiation. Radiations produce a wide variety of biological effects. Warren and Whipple [6] observed that radiation sickness intensity is dose dependent. Massive dose to abdomen or whole body may lead to the early gastrointestinal damage followed by death[7] . Host [8] observed 5 percent loss in rats during first 3 days after whole body exposure. High radiation doses induced severe morphological changes in

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gastrointestinal tract, radiation sickness and mortality[9]. Bond *et al.,*[10] reported a continued body weight loss due to anorexia, reduced food and water intake aided by diarrhoea after irradiation. Endogenous infections might have also contributed to the death of irradiated mice. A dose dependent sickness, anorexia and mortality in Swiss albino mice after exposure to different doses of gamma radiation have been reported by some researchers [11,12,13,14,15,16,17,18].

The stomach is the primary organ of digestion system. Through receptive relaxation, it stores food bolus from the esophagus. Digestion of food occurs initially by secretion of pepsin and gastric acid and also facilitates the peristalsis until the stomach is empty.

Radiation induced gastric injury can be direct or indirect. Direct injury causes the breakage of chemical bonds thus releasing electrons that damage the DNA and causes cell death[19]. The indirect injury involves the ionization of water thus releasing free radicals and reactive oxygen species. These reactive molecules are highly unstable and attack multi-macromolecular substances like nucleic acids, lipids and proteins. A variety of enzymes and antioxidant metabolises the normal level of (ROS) Reactive oxygen species[20].

Stomach is a muscular, hollow, dilated part of the gastrointestinal tract that functions as an important organ in digestive system. Stomach walls are made of three layers: mucosa, submucosa muscularis externa and serosa. The cellular component of stomach consists of a mixed population of cells of three main types. These cells are acid secreting cells (parietal cells), mucus secreting cells and pepsin secreting cells (zymogenic cells) [21].

Gastric ulceration is one of the common diseases affecting millions of people and now is considered to be the modern age epidemic affecting about 10% of world population. Ionizing radiations are widely used these a days for therapeutic purposes. But these produce deleterious effect on body by damaging the tissues. Gastric disorders occurs as a result of imbalance between aggressive factors of acid and pepsin and maintenance of gastric integrity through endogenous factors.

2. Materials and methods

The present study was carried out on stomach of adult sexually mature swiss albino mice weighing 20-30 gms. All experimental procedures were conducted after approval of institutional animal ethics committee (IAEC/Bio/9-2010) of H.P University Shimla.

Mice were divided into 2 groups: Group I served as control and Group II were irradiated with 5gy gamma rays only. Mice were sacrificed by cervical dislocation and stomach was excised on 10,20 and 30 days. Stomach was opened along the greater curvature. It was rinsed with water to remove gastric contents and blood clots. Tissue was fixed in aqueous bouin's fixative for 24 hours and then subjected to hematoxylin eosin staining and observed.

3. Results and discussion

Gastric mucosa of normal mice was thick, the epithelium was complete. There was no sign of damage. Cells have large volume and pyramidal form. Cell edges were tactful and these were neatly arranged. The irradiated group mice mucosa showed decrease in thickness with damaged areas. while the parietal cell having lesser volume, polygonal form, wrinkled arrangement with large intracellular spaces were observed fibrosis dividing muscularis fibers was induced also. Loss of glandular areas were also observed. This loss of glandular region lead to increase in intra cellular spaces. There is a progressive degeneration leading to wrinkled cell arrangement. Such gastric atrophy leads to atrophic gastritis. Lesions and erosions were also noticed in the mucosa. Present results are in agreement with Goldgraber*et al.,* [22] who found that irradiation causes patchy loss of glandular architecture, marked architectural disorganization and loss of mucosal thickness. Degenerative changes in gastric cells (Chief, mucus and parietal cells of gastric mucosa) after irradiation were also explained by Michael and Alberts [23].

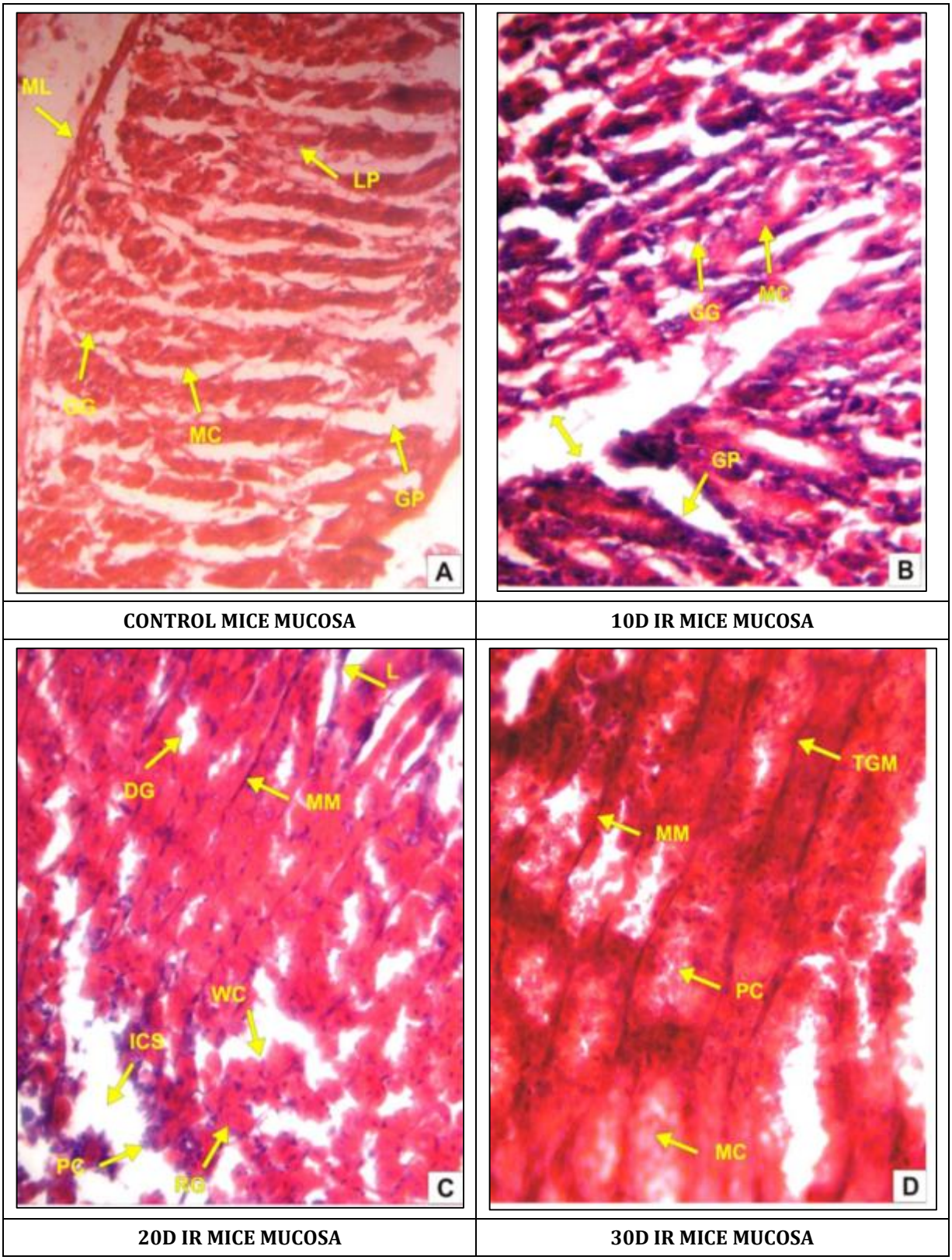

Figure 1 [A]The image shows the normal stomach architecture of stomach. [B]. The 10 day irradiated (IR) mice stomach section showing normal mucosa. [C]. The 20day (IR) mice stomach revealing intercellular spaces (ICS), wrinkled cell arrangement and distortion of parietal cells (PC) and parietal glands (PG). [D].The 30day mice irradiated (IR) stomach revealing more distortion from normal structure with muscularis mucosa (MM)and parietal cells arrangement is disturbed.

Oxidative stress-induced tissue damage with reactive oxygen species (ROS) is implicated as a cause and consequence of a variety of disorders including coronary heart disease, neurodegenerative disorders, autoimmune pathologies, cancer, apoptosis etc [24]. Exposure of gastric mucosa to damaging factors such as ethanol, thermal stress or various irritants that are commonly named 'breakers' of gastric mucosal barrier produces pathological changes [25]. Radiation is the most deliberated environmental hazard in the world, which exerts its deleterious effects through the generation of chemically active free radicals that in turn can damage the molecular structure resulting in cellular dysfunctions or mutations[26].Short-term and long-term oxidative stress reactions after ionizing radiation generate large amounts of ROS, which disturb the balance of oxidative and antioxidant systems in cells, especially in the gastrointestinal tract. Since ROS are highly reactive with intracellular proteins, lipids, carbohydrates and nucleic acids, excessive ROS production can not only lead to apoptosis and necrosis caused by DNA damage[27], but can also cause mitochondrial membrane damage and increased permeability, prompting the release of cytochrome C (a mitochondria-dependent pro-apoptotic molecule) into the cytoplasm, activating the Caspase-9-dependent apoptosis pathway and causing apoptosis (programmed cell death) in affected cells, resulting in increased apoptosis of gastric mucosal epithelial cells and vascular endothelial cells, and a decreased cell division rate. Furthermore pathologies such as gastric mucosal erosion, ulceration and eventually gastric mucosal atrophy and intestinal epithelial metaplasia are induced. Irradiated cells secrete a large number of bystander signaling mediators which not only effect the target organs but they spread to the other cells also. These signaling mediators stimulate the production of ROS/RNS, cytokines and chemokines, oxidases and other inflammatory factors [28].

4. Conclusion

The present study convincingly demonstrated that ionizing radiation induces stress in the body. This oxidative stress causes imbalalance in defence mechanisms of mucosal architecture leading to the atrophic gastritis.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The present study involved animals. The ethical approval was given by Institutional Animal ethics committee.Approval no. was IAEC/Bio-9/2010.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Dormand EL, Banwell PE and Goodcare TE. Radiotherapy and would healing . *Int.* Wound J.2005.2: 112-127.

[2] Sankaranarayanan K. Estimation of the genetic risks of exposure to ionizing radiation in humans: Current status and emerging perspectives. J. Radiat. Res.2006. 47: B57-66.

[3] Song LH, Yan HL and Cai DL. Protective effects of soybean isoflavone against gamma-irradiation induced damages in mice. J. Radiat. Res.2006. 47:157-65.

[4] Hazra B, Santana B, Nripendranath M. Antioxidant and free radicals scavenging activity of *Spondias Pinnata*. Complementary Alternative Medicine 2008,8:63.

[5] Wilcox CS and Gutterman D. Focus on oxidative stress in cardiovascular and renal systems. Am. J. Physiol. Heart Circ Physiol.,2005. 288: 3-6.

[6] Warren SL, Whipple GH. Roentgen ray intoxication. I. Unit dose over thorax negative over abdomen lethal. Epithelium of small intestine sensitive to X-rays. J Exp Med.1922a.35:187-202.

[7] Baker DG and Mitchell RI. Studies of intestine during acute radiation syndrome. Gastrol.1963. 44: 291.

[8] Host H. Comparative effect of cyclophosamide nitrogen mustard and total body irradiation on survival and on white blood cells in rats. Radiat. Res.1966, 27: 638.

[9] Casarette AP. Differential cell sensitivity in Radiation Biology Prentice Hall Inc., Eugle Wood Cliffs, New jersy: 1968.159-189.

[10] Bond VP, Fliender TM and Archambean JO. Mammalian Radiation lethality, Academic Press, New York.1986.

[11] Saini MR, Kumar S, Jagetia GC and Saini N. Effect of Liv-52 against radiation sickness and mortality. Ind. Pract. 1984.137: 1133-1138.

[12] Kumar A and Uma Devi P.Chemical protection of mice against radiation induced sickness and mortality by 2-MPG. Radiobiol. Radiother.1983.24: 231.

[13] Jain MP, Sharma VK. Phytochemical investigation of roots of *Adhatoda vasica*. Planta Medica.*1982*.46:250. 9.

[14] Purohit RK. Modification of radiation induced changes in mammalian skin and liver by liv.52 , A Ph.D thesis, University of Rajasthan , Jaipur .1996.

[15] Saxena, A. 1997. Enterohepatic response against the combined effect of mercury and radiation in mice and its modification by Liv-52. A Ph.D thesis, University of Rajasthan, Jaipur.

[16] Samarth RM, Goyal PK, Kumar A. Radioprotective effects of *Mentha piperita.* Journal of Medicinal and Aromatic Plant Science.2001. (22/23): 91–97.

[17] Singh N. Prophylactic use of vitamins against cytogenetic damage in mouse bone marrow. Proc. J. Med. Phy.2001. 49:192-194.

[18] Srivastava AS, Saxena HP, Singh DR. Adhatoda vasica, a promising insecticide against pests of storage. Lab Dev.1965. 3(2):138.

[19] Huang RX, Zhou PK. DNA damage response signaling pathways and targets for radiotherapy sensitization in cancer. Signal Transduct. Target Ther.2020;5:60.

[20] Dröge W. Free radicals in the physiological control of cell function. Physiol Rev. 2002:82:47-95.

[21] Naik SR, Bajaj SC, Goyal RK, Gupta DN and Chuttani HK. Parietal cell mass in healthy human stomach. Gasteroenterology,1971. 61,682-685.

[22] Goldgraber MD and Moshe B. The response of esophageal cancer to irradiation. A serial cytological study of two cases. University of Chicago Clinics, Department of Medicine, Chicago 37.1954.

[23] Michael CM and Albert KS. Studies on the histopathological effects of ionizing radiation on the oyster: The degenerative phase involving digestive diverticulae stomach and gut. J. Invert. Pathol.1970.1: 14-37.

[24] Kayode AAA, Kayode OT. and Odetola. Anti-Ulcerogenic activity of two extracts of Parquetin anigrescens and their effects on mucousal antioxidants defence system on ethanol-induced ulcer in rats. Res. J. Medicine. Plant.2009.3(3): 102-108

[25] Brzozowski T, Konturek PCH, Sliwowski Z, Drozdowicz D, Hahn EG. and Konturek S J. Importance of nitric oxide and capsaicin-sentitive afferent nerves in healing of stress lesions induced by epidermal growth factor. J. Clin. Gastroenterol. 1997.25 (1): 28-38.

[26] Masumura K, Kuniya K, Kurobe T, Fukuoka M, Yatagai F, Nohmi T. Ion induced mutations in the gpt delta transgenic mouse: comparison of mutation spectra induced by heavy-ion, X-ray, and gamma-ray radiation. Environ Mol Mutagen.2002

[27] Yahyapour R, Motevaseli E, Rezaeyan A et al. Reduction-oxidation (redox) system in radiation-induced normal tissue injury: molecular mechanisms and implications in radiation therapeutics. Clin Transl. Oncol2018.20:975–88.

[28] Havaki S, Kotsinas A, Chronopoulos et al. The role of oxidative DNA damage in radiation induced bystander effect. Cancer Lett.2015;356:43–51.