SYNERGISTIC EFFECT OF RADIATION AND CADMIUM CHLORIDE ON MOUSE TESTIS

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Summary

Human beings are constantly exposed to low level of radiation from different sources and it is simultaneous exposure of organism to heavy metals is unavoidable, due to their ever-increasing utilization in modern technology. Among heavy metals, cadmium is known to be the most toxic. Cadmium is virtually ubiquitous, not only being deposited and accumulated in various body tissues, but also found in varying concentration throughout all environmental components (air, soil, food and water) in which man must live. Therefore, in today's world a combined exposure to physical, chemical and biological agent is unavoidable. Such situation can occur in the environment as well as in the work place.

In the light of above, the present study was aimed to evaluate the combined effect of radiation and cadmium on the histoarchitecture of testis of Swiss albino mice. The animals from all the experimental groups were sacrificed by cervical dislocation at pos-treatment intervals of 1, 2, 4, 7, 10, 14 and 28 days, after sacrificing the animals, pieces of testis were taken out and fixed in Bouin's fluid for histological observations by routine procedure.

The changes observed in the testis were Pycnosis, Karyolysis, Karyorrhexis, intertubular oedema, hyperaemia, cytoplasmic degranulation, vacuolation, loosening of germinal epithelium and shrinkage of tubules. But these changes become more severe in the testis of combined treatment animals as compared to individual one. The damage and recovery pattern showed a dose-dependent and synergistic action.

Key words: Radiation, Cadmium chloride and Testis

Introduction

A very little information is available on the combined effect of heavy metal (cadmium) and radiation and the mechanism by which they exert their own toxicity. However, a common opinion appears that enhancement of risk increases due to the combined exposure to heavy metal and radiation [1, 2].

The combined effects of chemical and radiation have mostly been studied in unborn babies because of their high sensitivity to these toxicants. The general aspect of the interaction between radiation and chemicals during prenatal development were summarized [1] and later reviewed by Streffer and Muller [2] on the interaction between ionizing radiation and lead. Teratogenic interactions also studied between radiation and cadmium in mice [3]. Combined effect of radiation and cadmium on mouse kidney was studied and found synergistic effect [4]. There are indications that additive or synergistic relationships exist between *in vivo* application of cadmium and radiation [5].

Cadmium is quite enough for interaction with ionizing radiation, because it has high affinity for –SH and disulphide groups of proteins [6]. Besides this, cadmium binds with thiol groups of the cellular components, which are mainly responsible for protecting repair system against damage caused by radiation induced free radicals [7]. Due to the indirect effect of radiation, free radicals are formed which are scavenged by –SH groups, an inherent protective mechanism present in the cells. When cadmium is simultaneously added to radiation, these –SH groups are not available for protection because cadmium binds with them. Due to this, DNA is exposed to these free radicals and the risk increases during the combined exposure. Therefore, in the present study an attempt has been made to investigate the synergistic effect of radiation and cadmium on histopathology of the testis of Swiss albino mice.

Material and Methods

Six to seven week old male Swiss albino mice were procured from C.C.S University, Hissar and maintained at 20-25^{O}C. They were housed in polypropylene cages and maintained on balance mice feed and tap water *ad libitum*. In order to investigate the effect of radiation & cadmium on mice testis all the animals were divided into four different groups. The animals of group-I were sham-irradiated to serve as control. The II group of animals was orally fed with cadmium chloride at the dose rate of 20 ppm. Animals of group III were exposed to sub-lethal dose of gamma radiation from CO^{60} source (Theratron) of AECL make, at P.B.M. Hospital, Bikaner (Rajasthan). Dose was calculated at mid point by multiplying dose rate and tissue air ratio. This group was further divided into three sub-groups on the basis of radiation does received i.e. sub-group IIIa (1.25Gy), IIIb (2.50Gy) and IIIc (5.00Gy). Animals of group IV were orally fed with cadmium chloride solution (20ppm) and also expose to different doses of gamma radiations. This group was also further subdivided into three sub-groups on the basis of radiation dose received i.e. sub-group IVa (1.25Gy + $Cdcl_2$), IVb (2.50Gy + $Cdcl_2$) and IVc (5.00Gy + $Cdcl_2$). Five animals from each group were sacrificed at 1, 2, 4, 7, 10, 14 and 28 days of post-treatment.

Results and Discussion

The testis of control mice showed normal histological characteristics [fig-1], whereas the testis of treated animals exhibited pronounced disturbances in the seminiferous tubules. In the present study histopathological changes revealed dose dependent alterations. The general histopathological changes in all the experimental groups included changes like Pycnosis, karyolysis, karyorrhexis, necrosis of cells, cytoplasmic vacuolation, loosening of germinal epithelium, intertubular oedema and shrinkage of tubules [8, 9, 10 and 11].

After irradiation cell death of early spermatogonial stages together with exfoliation [fig-2] in some tubules were also observed. Although they varied in the severity according to the size of the dose delivered. At day-1 and 2, more degenerative cells are observed. It may be due to death of cells in their attempt to divide [12]. These are observed in the various parts of the germinal epithelium up to day-14. The natural arrangement of the cellular tiers is also disrupted [fig-3] and the seminiferous tubules appear flaccid. The cytoplasmic vacuolation cause a number of empty spaces in the germinal epithelium (12,13,14,15) which become more pronounced at later intervals in 1.25 Gy and 2.50 Gy dose groups, while they start to appear earlier in the higher doses(5.00Gy).

The degenerative changes are continued upto day-14 in the mouse testis. It may be explained on the basis that the degenerative cells are continued to be observed in the testis until every lethally damaged cells gets degenerated and eliminated from testis [13]. In the IIIa (1.25Gy) and IIIb (2.50Gy) sub-groups, where the cells damage was mild, considerable amount of recovery was noted by day-10, whereas in (5.0Gy) sub group, where the stem cells affected greatly, less recovery was appeared. In comparison to germinal epithelium, sertoli and leydig cells are more radio-resistant. In the present study also sertoli and leydig cells are less affected by radiation.

The general histological changes observed after cadmium chloride treatment are of same type as in irradiation. It has been observed that testicular degenerations after cadmium chloride is followed by recovery, which is probably due to insufficient conc. of cadmium within testis [fig-4]. The observations support the theory implying matellothionein as a factor in the protection of testicles [18, 19]. Pathology observed in the testis of the animals with combined exposure is of same types as observed after radiation and cadmium chloride individually. But these changes become more severe [fig-5, 6] as compared to individual one and show synergistic effect. Therefore, present investigation share the common opinion that risks increases due to combined exposure of heavy metal and radiation [1, 2].

Acknowledgement

Author gratefully acknowledges University Grant Commission for financial assistance and irradiation facility provided by the Department of Radiotherepy, PBM Hospital Bikaner (India). Author also acknowledges Dr. R. K. Purohit Department of Zoology, Goverment College, Bikaner and Dr. M. L. Gupta, Join Director, College education Rajasthan, Jaipur (India) for scientific advice.

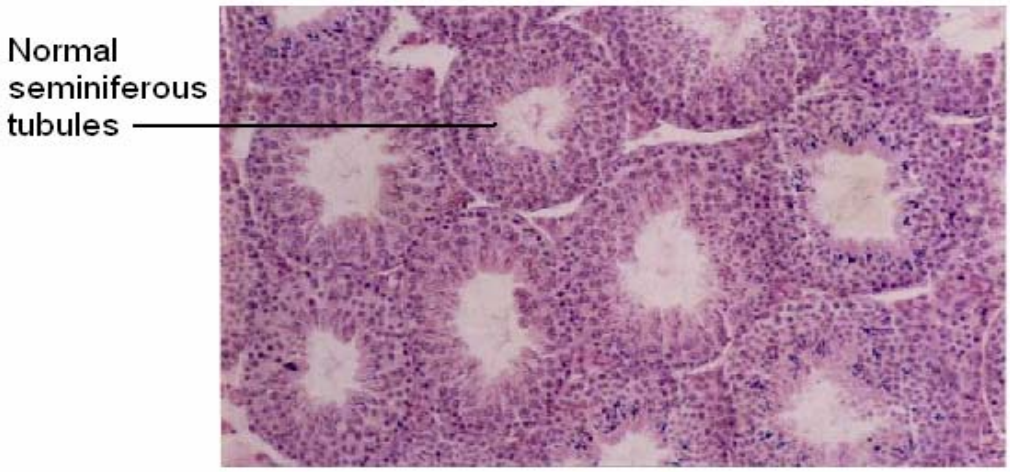

Fig:-1 Showing normal histological structure of testis

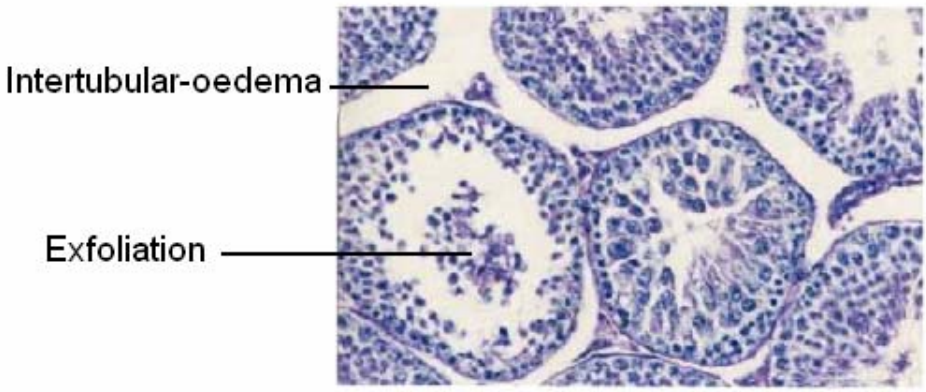

Fig:-2 Showing exfoliation karyolysis and intertubular-oedema and other radiolesions.

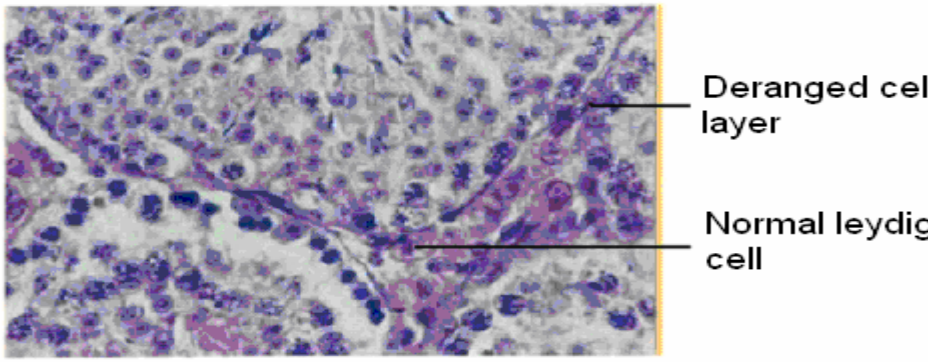

Fig:-3 Showing karyolysis, Karyorrhexis, phcnotic, nuclei, daranged cellular layer normal leydig cell.

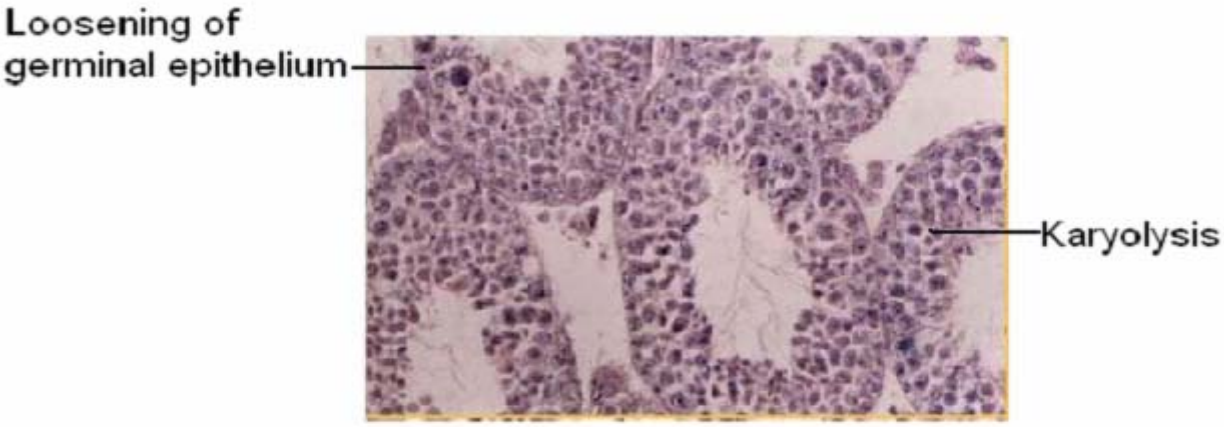

Fig:-4 Showing intertubular-oedema, pycnotic nuclei and dead cells. Karyolysis, karyorrhexis and loosening of germinal epithelium are also seen.

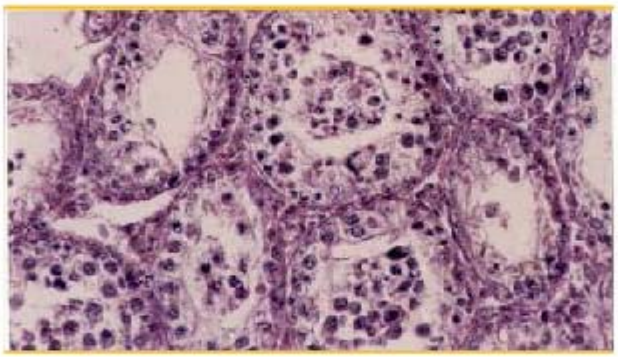

Fig:-5 Showing all types of damage (more severe) after combined treatment (2.50 Gy + Cadmium chloride)

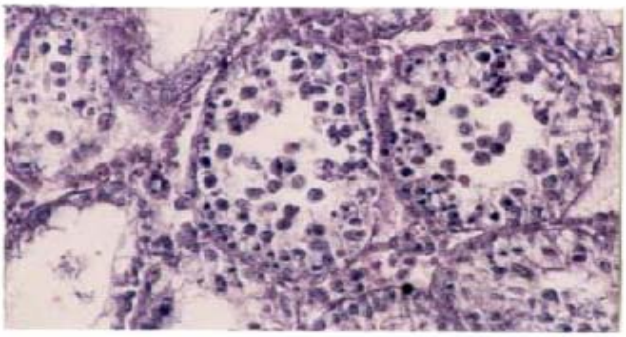

Fig:- 6 Showing all types of damage (more severe) after combined treatment (5.00 Gy + Cadimium chloride).

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