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CALCIUM (Ca^{2+}) CONTENT IN THE LOWER JAWS OF RATS IRRADIATED IN THE HEAD REGION WITH X-RAYS

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Abstract

Irradiating the head region of 8-day-old rats with a dose of 8.64Gy of X-rays, at the age of 42 days, results in stunting of lower jaw growth as illustrated by measuring the length and height of the jaws. This irradiation dose also has as a consequence an increased content of Ca^{2+} in the bone tissue of the lower jaw (270.36±27.97 mmol/kg bone tissue) when compared to the corresponding non-irradiated controls (188.58±19.26 mmol/kg bone tissue, $p<0.05$) and rats irradiated with a dose of 3.84Gy of X-rays (143.99±15.29 mmol/kg bone tissue, $p<0.01$).

Introduction

It has been shown that in clinical radiotherapy, when the head region is in the field of radiation exposure, unwanted side effects may occur including adverse effects on the developing dentition [1]. Studies on rats serving as mammalian model systems, have also demonstrated that ionizing radiation affects the development of dentition in these animals by breaking the continuity of the incisor and stunting the full development of the third molar [2]. Changes in the content of magnesium [3] and selenium [4] was observed in the lower jaws of adult rats when their head region was irradiated with X-rays at the age of 8 days. Since calcium, together with magnesium and phosphorus is the main macro element constituting the skeletal tissue in the mammalian body, the object of this study was to measure the content of Ca^{2+} in the bone tissue of lower rat jaws after irradiating the head region of these animals with X-rays at the age of 8 days.

Materials and Methods

In the experiments, female rats of the Wistar strain were used. The heads of 8-day-old rats were exposed to a single dose of 3.84 Gy or 8.64 Gy of X-rays from a Siemens instrument (dose rate: 0.71355 Gy/min), details of the irradiation procedure and post-irradiation care of the animals is described elsewhere [3]. Non-irradiated animals of the same age served as controls. At the age of 42 days, all animals were sacrificed, the lower jaws removed and cleaned of surrounding tissue. Morphometric measurements were performed with a caliper. The jaw length (sagittal dimension) was defined as the distance between the incisival edge and *angulus-mandibulae*. The height was defined as the vertical distance between the position of the third molar and lower mandibular edge. Calcium in the previously mechanically ground jaws and ashed was measured by atomic absorption spectrometry (AAS). The Ca^{2+} content was

expressed as mmol/kg of rat jaw bone tissue. The results are expressed as the Mean ± S.E.M. ANOVA was used followed by the Scheffe test to determine the statistical differences between the groups. The level of significance was set at $p<0.05$.

Results and Discussion

As demonstrated in Table 1., the values for the length and height of jaws from rats irradiated with 8.64Gy of X-rays are significantly lower when comparing these morphometric parameters with those of non-irradiated controls and rats irradiated with 3.84Gy of X -rays.

Table 1. Morphometric measurements of the length and height of lower jaws in non-irradiated control and X-irradiated rats

Animals	length of jaw in mm.	height of jaw in mm.	statistical difference between the groups
1.Controls non-irradiated	23.60±0.15 (16)	4.44±0.11 (17)	1-2. $p>0.1$ not significant
2.Irradiated-3.84Gy	23.63±0.32 (11)	4.52±0.10 (11)	2-3. $p<0.001$ significant
3.Irradiated-8.64Gy	18.47±1.73 (8)	3.75±0.08 (8)	1-3. $p<0.001$ significant

Mean±S.E.M.; ( )-number of animals; p-statistical significance.

As illustrated in Fig. 1, the content of Ca^{2+} in the bone tissue of the lower jaw of non-irradiated control rats is 188.58±19.26 mmol/kg bone tissue. In rats irradiated with a dose of 3.84Gy, Ca^{2+} content is 143.99±15.29 mmol/kg bone tissue. The bone tissue of rats irradiated with a dose of 8.64Gy of X-rays, shows a significant increase of Ca^{2+} content (270.36±27.97 mmol/kg bone tissue) as compared to the intact controls ($p<0.05$) and rats irradiated with a dose of 3.84Gy ($p<0.01$). This accumulation of Ca^{2+} in the lower jaw of rats irradiated with 8.64Gy is similar to the accumulation shown previously in the case of magnesium [3] and may be also explained by the stunted jaw growth and lowered activity of the pituitary gland [5].

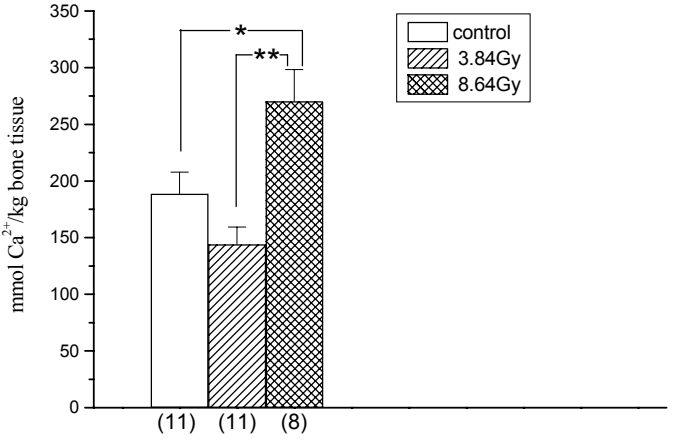

Figure 1. Ca $^{2+}$ content in the bone tissue of rat lower jaws.
( )-No of animals; *p<0.05, **p<0.01

Conclusion

Irradiating the head region of 8 day-old-rats with 8.64Gy of X-rays, at the age of 42 days, results in the stunting of jaw growth and a significant increase of Ca^{2+} content in the lower jaw bone tissue. This effect of the high irradiation dose applied may result not only from the direct action of X-rays on the bone tissue itself, but also as a result of damage to the pituitary gland which was in the field of irradiation.

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