

# **RADIATION DAMAGE TO THE THYROID AND METABOLIC CHANGES IN CATTLE IN THE INITIAL AND REMOTE PERIOD AFTER THE CHERNOBYL ACCIDENT**

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## **INTRODUCTION**

The initial period after the Chernobyl accident was the most dangerous for animals kept in the zone of radioactive contamination. Dose burdens from I-isotopes on the thyroid gland of cattle in the initial period after the accident contributed significantly into the alteration of the hormonal status, physiological state and productive qualities of cattle on farms of the Gomel area of Belarus.

## **MATERIALS AND METHODS**

To study the remote consequences of the radiation exposure of the thyroid in the initial period after the accident in the 30 km zone at 9-12 km distance from the destroyed atomic reactor 397 heads of cattle of black-motley race aged 1.5-2 y were kept for 2.5 months. According to the tentative estimation the dose absorbed by the thyroid amounted to 270-280 Gy (the 1st group).

The second group of animals (cows) aged 5-8 y grazed on the pasture for 2 months at 15-20 km distance from the Chernobyl NPP. The tentative dose absorbed by the thyroid amounted to 180-190Gy.

For the comparative estimation of physiological parameters and productive indices the animals-analogues from the state farm "Oktyabrskiy" in the "clean" zone of the Gomel area were used (3d group).

## **RESULTS OF INVESTIGATIONS AND THEIR DISCUSSION**

5 months after the accident the animals relocated from the 30 km zone showed the signs of general oppression, reduced response to external irritants, curly, messy and ruffled hair, laboured breathing, disorders of coordination of movements, fibrillary contractions of muscles, body temperature reduction to 34,0-35,0 C. The majority of animals demonstrated the symptoms of exophthalmus, thickening of skin fold near the head, neck and lateral body surfaces from 12 to 17 mm, crooked posture, sternocostal, cranial and submaxillary oedemas, poor appetite, exhaustion, absence of the cud and weakened rumination. 40% of animals demonstrated disturbances of the frequency and rythm of heart contractions and deviations between values of systolic and diasystolic heart tones. The changes of clinical symptoms listed above aggravated when the ambient temperature dropped. In the first year after the accident in animals relocated from the 30 km zone there were observed leucopenia, erythropenia, noticeable eosinophilia and sugar concentration in blood serum 2-3 times higher than normal.

The blood leucogram of animals showed the reduction of per cent concentration of the neutrophilic group and monocytes during the entire period of observation.

While the analysis of degenerative-destructive changes of cells in peripheral blood the qualitative changes of cells were observed (Table I)

**Table I. Degenerative-destructive changes of cells in peripheral blood of cattle having the signs of radiation damage to the thyroid**

Kind of pathology	Cells of blood, %		
	Lymphocytes	Neutrophiles	Monocytes
cytolysis	10.0	0.9	1.0
pycnosis	5.0	1.0	-
vacuolation	7.5	-	50.0
fragmentation	-	12.0	-
chromatinolysis	4.4	2.7	-
double-nuclei lymphocytes	2.0	-	-
cariocraix	1.0	-	-
hypersegmentation	-	50.0	-
atypical lymphocytes	8.0	-	-
Per cents	37.9	66.6	51.0

Thus, among the lymphoid cells in 10% of cases cytolysis was determined, and pycnosis and vacuolation in 5,0 and 7,0%, respectively. Atypical lymphocytes forms were registered in 8% of cases. Among the granulocytic series of form elements of blood, i.e. neutrophiles the changes had the character of hypersegmentation and fragmentation in 50 and 12 % of cases, respectively. Histiocyte range was characterized by increased vacuolation (50%).

Studies of natural resistance indicators of organism have shown that in 85% of relocated animals the lysozymic activity of blood serum reduced. While radioimmune investigations of blood serum the pronounced hypofunction of the thyroid that was characterized by the thyroid hormones (thyroxin, triiodthyronin) reduction by 3 and more times as compared with the norm became apparent. Besides, these hormones were not determined in serum of 55-60% of animals in the first year after the accident. During the first three years in animals with the lethal outcome the thyroxin concentration in blood serum did not exceed 30,0 nmol/l that was 50% less as compared with the control ( $p < 0.01$ ) (Fig. 1). The triiodthyronin concentration in blood serum of animals with the lethal outcome had 2-3 fold reduction as compared with healthy animals (Fig. 2).

The reproductive functions of animals relocated from the 30 km zone in the first year after the accident were characterized by the disturbances of sex cycles, deliveries of still-born calves and calves with various anomalies. Thus, in the 1st group 6 calves were delivered by 30 heifers, 4 heads (66.6%) were lost, in the 2nd group 18 calves were delivered by 26 heifers, 7 heads (38.8%) out of them were lost. In the second year after the accident in the 1st group 26 heifers delivered 9 calves, 6 out of them were lost. In the 2nd group 26 heifers delivered 18 calves. In 1989 during 7 months 36 healthy calves with the average weight of 30-35 kg were delivered by 46 animals. In the third year after the accident in the 1st and 2nd group there were delivered 12 calves from 27 heifers and 20 calves from 27 heifers, respectively.

During the first two years after the accident calving of all the animals in the 1st and 2nd group proceeded with various pathological phenomena. The post-delivery period was characterized by grave endometritits, uterine hemorrhages and inflammatory processes. 2-3 weeks after calving in the majority of animals the lactation period finished and the hypotrophy of the mammary gland parenchyma developed. The average live weight of calves delivered in 1986-1987 was 12-17 kg. They exhibited weak development when compared with normal animals. Thus, calves (bull-calves born in 1986) exhibited the delayed growth, dwarfishness, non-proportional body development and thick and long hair integument. The live weight of them at the age of 2.5 y was only 140-150 kg.

The productive indices of animals were characterized by low values.

Thus, average daily weight gain of young animals in the 1st group was 180, 320 and 356 g in 1986, 1987 and 1988, respectively. and in the 2nd group the corresponding values were 240, 380 and

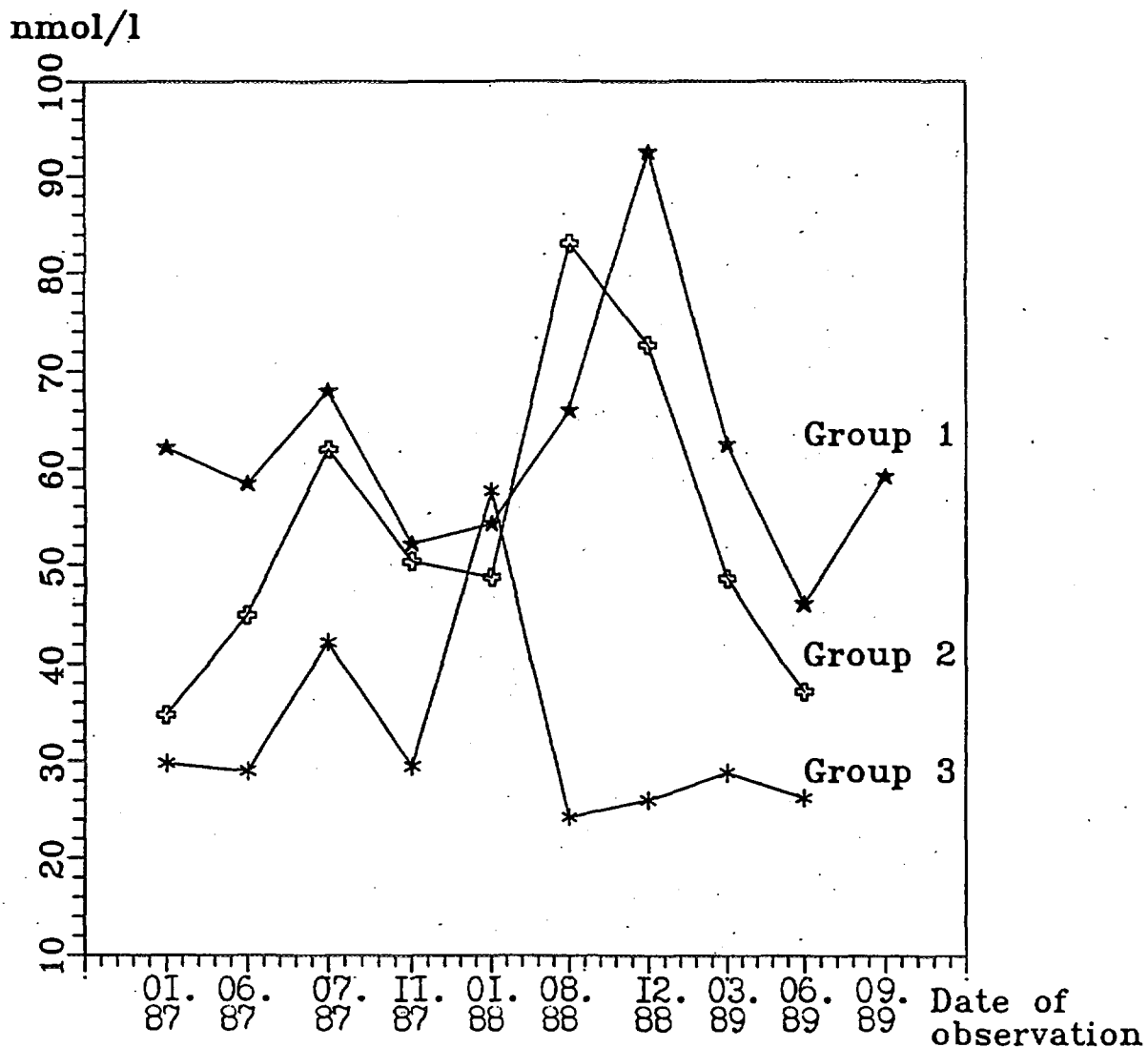


Fig 1. Dynamics of thiroxin concentration in blood serum of cows with symptoms of radiation affection of the thyroid

Note:

- 1 - control group of animals
- 2 - survived
- 3 - with lethal outcome

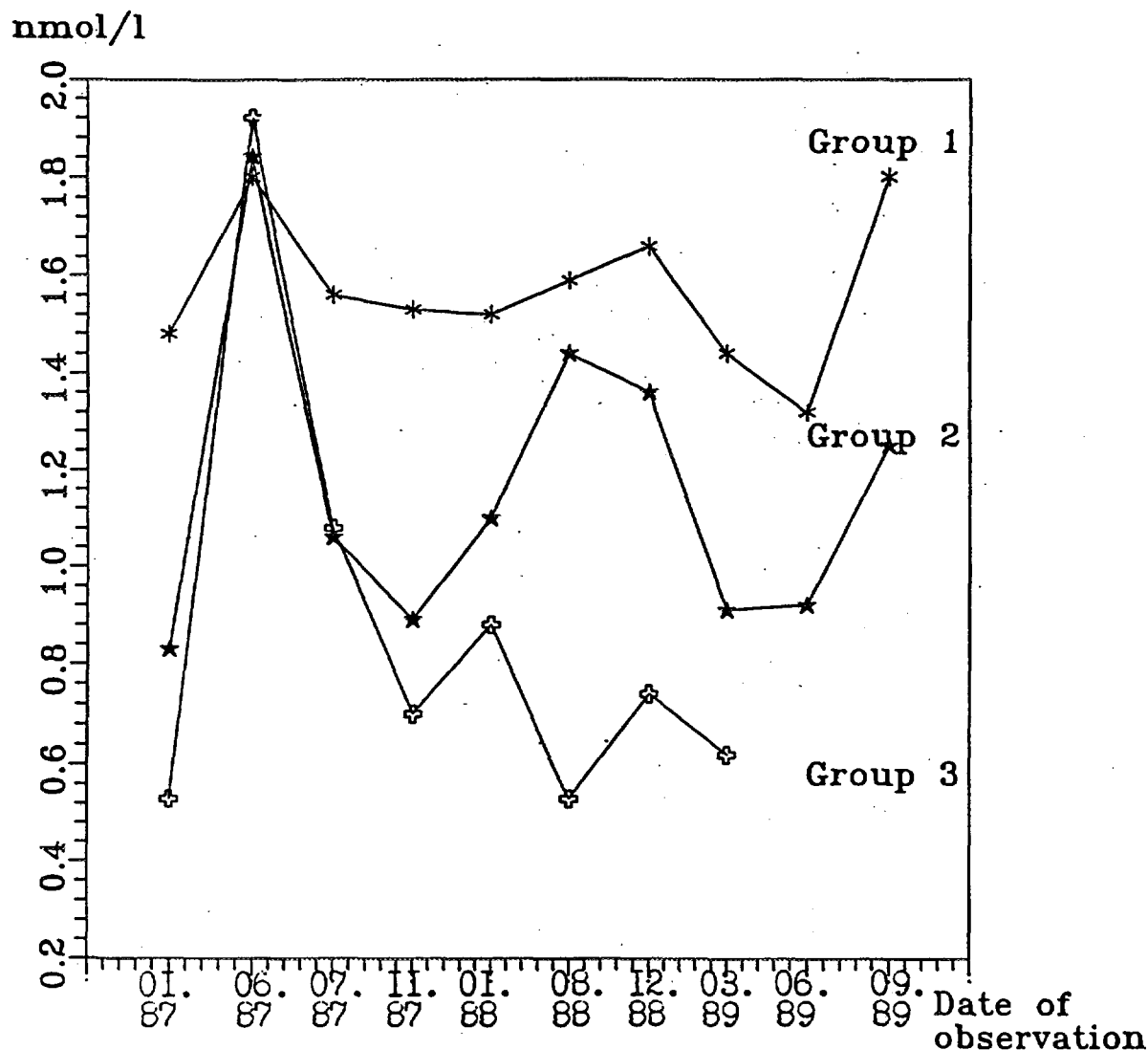


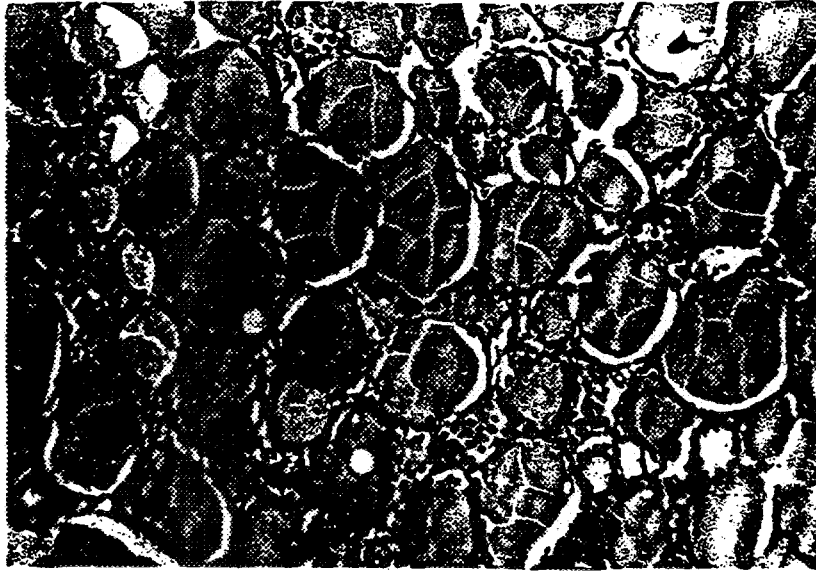
Fig 2. Dynamics of triiodothyronin concentration in blood serum of cows with symptoms of radiation affection of the thyroid.

Note:

- 1 - control group of animals
- 2 - survived
- 3 - with lethal outcome

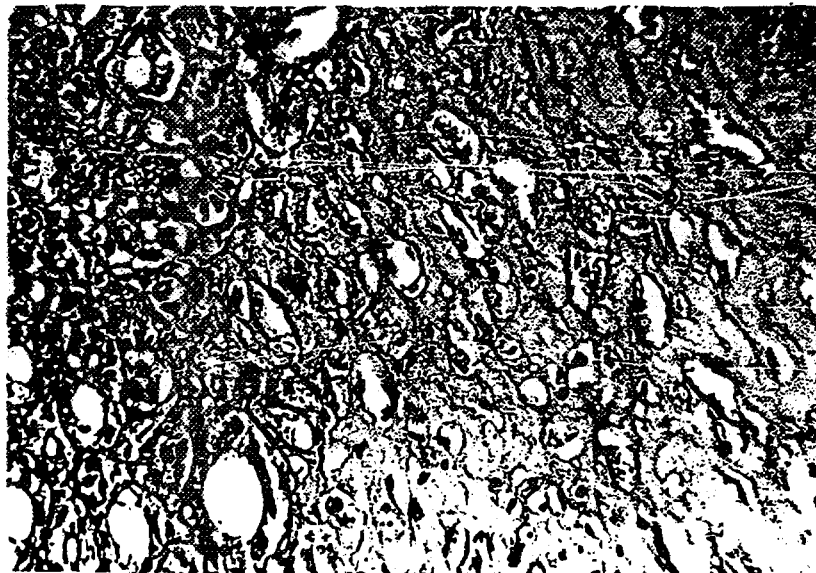
450. Whilst healthy young animals had average daily weight gain of 490, 470, 540 and 560 g in 1986, 1987, 1988 and 1989, respectively. The average daily yield of milk in the 1st group was 2, 2.7 and 3.5 kg in 1986, 1987 and 1988, respectively. And in the 2nd group the corresponding values were 3.5, 4.0 and 6.0. Control animals had the average daily milk yield of 4-5 kg more as compared with animals having the symptoms of radiation damage to the thyroid.

Since October 1986 till March 1987 97 heads (22.6%) out of 397 heads in the 1st group were lost, 271 heads had to be slaughtered and 68 carcasses (25%) out of these were utilized. During the post slaughter examination of carcasses and pathologicanatomic autopsy the multiple gelatinous oedemas of subcutaneous cellular muscular tissue were discovered and mostly in the spots of deposition of fatty tissues were. For the comparative estimation of morphological changes in the parenchyma of the thyroid the figure of the texture of this organ in a healthy animal is presented (Fig.3)



**Fig. 3. The thyroid of a cow. Normal texture of parenchyma.  
Colouring: hematoxylin-eosin. x70**

In animals lost the thyroid gland was absent in 80% of cases, in the others it was shrunk in size and had a dense consistency and a whitish-grey colour. The tissue section did not exhibit lobes. The total necrose of specific glandular tissue and and the replacement of it by the cell-free connective tissue in the parenchyma of the gland (Fig. 4).



**Fig. 4. The thyroid gland. Total necrose of the glandular tissue  
of the thyroid gland of a cow. Colouring: hematoxylin-eosin. x70.**

Beside the vascular reaction the necro-dystrophic changes of follicles epithelium in the form of vacuolation of cytoplasm and picnosis of nuclei, and also partial destruction of follicles and proliferation of glandular epithelium were observed. The increased concentration of interfollicular cellular tissue was registrated in some animals. Interfollicular cells surrounded follicles and partially replaced them. In the places of their accumulation appeared connective-woven fibres (Fig 5).

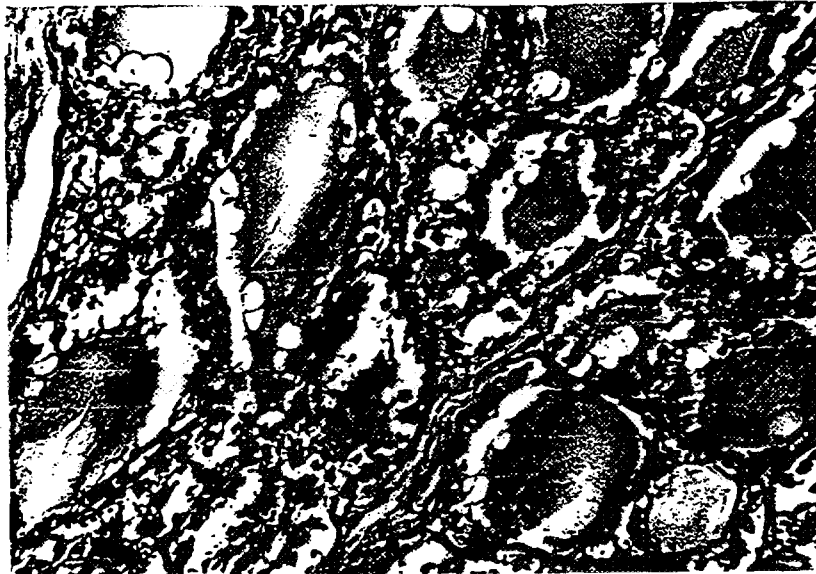


Fig. 5. The thyroid gland. Necrodistrophic changes in the gland parenchyma. Colouring:hematoxylin-eosin. x70

So, in the thyroid gland of animals the atrophic, hypo- and hyperplastic processes were observed causing not only hyperthyroiditis but also the gland function drop (hypothyroiditis) and even its total absence of it (athyroiditis).

## CONCLUSION

In cattle kept at 9-12 km distance (1st group) and 15-20 km (2nd group) from the destroyed atomic reactor for 2.5 months after the accidental release the radiation damage to the thyroid caused by the impact of radioactive I-isotopes were observed. According to the tentative estimations the doses absorbed by the thyroid of animals made 270,0-280,0 and 180-190 Gy. The degree of radiation pathology depended upon the dose of I-131 absorbed by animals and had the signs of myxedema, general oppression, exophthalmus, body temperature reduction for 1-2 C, disorders of coordination of movements, disturbances of heart activity and digestive functions. Leucopenia, eosinophilia, degenerative-destructive changes of cells were not observed in the peripheral blood. The disfunction of the thyroid characterized by the sharp reduction of thyroid hormones concentration by 3 and more times as compared with the norm and also by necrodistrophic changes in the parenchyma of the organ was the most typical of the given animals.

In animals with the heavy degree of the radiation damage to the thyroid with lethal outcome (22.5%) the thyroid was absent (athyroiditis). The disturbances of reproductive functions, growth and development of young animals, productive indices were observed in sick animals. In 1990 young animals of the second generation were delivered by the survived animals and their physiological parameters met the normal values for the given kind of animals.