ACCUMULATION OF I^{131} BY THE SKIN AND HAIR OF ANIMALS AND MAN

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 56, No. 12,
pp. 49-52, December, 1963
Original article submitted January 16, 1963

Most authors [1,5,7,10] and official publications [8] regard the thyroid as the critical organ for I^{131} and the kidneys as responsible for its elimination. Due attention has not been paid to the fact that iodine is distributed among practically every organ and system, including the skin and its derivatives. Some workers [6,9,11,13,16] have reported an increased concentration of stable iodine and I^{131} in the skin of certain animals and man, but have not presented evidence concerning the dynamics of this process or its significance. M. Ya. Gringauz and M. A. Kuntsevich [2] investigated the permeability of the skin to I^{131} in guinea pigs and found a considerable accumulation of iodine in the skin. Nevertheless, these workers did not take into account the iodine content of the skin due to surface sorption of the element when the animals were placed in a radioactive solution. The figures cited by these workers are therefore useless.

Some interesting facts are reported by Brown-Grant [12], who observed a considerable accumulation of I^{131} by the skin in rats, to the extent of 35% of the total amount administered. In this paper, too, however, there is no mention of the dynamics of iodine accumulation.

EXPERIMENTAL METHOD

Experiments were conducted on 50 male albino rats weighing from 102 to 110 g and divided into 6 groups. I^{131}, in the form of NaI^{131}, was injected intraperitoneally in a dose of 5 μCi per rat. The specific activity of the NaI^{131} solution was verified in relation to a standard (Tracer Lab). After receiving the iodine injection, the rats were fixed in metabolism cages so that contamination of their body surface with urine and feces was impossible. The animals were sacrificed by electrocution 15 min, and 2, 4, 6, 24, and 48 h after the injection. Groups 1, 4, 5, and 6 each contained 9 aminals and groups 2 and 3 each contained 7 animals. Radiometric investigations were made of the skin, hair, liver, kidneys, and thyroid (in rats exposed for 6 and 48 h only the activity of the skin and hair was investigated). Hair for investigation was taken from the dorsal and occipital regions, and suspended and dissolved in 3N NaOH. The skin was removed in toto and weighed, after which a weighed sample was freed from hair and also dissolved in 3N alkali, heated on a water bath. The organs were extracted, weighed, and homogenized and 0.4 ml of homogenate was placed on waxed targets to determine their radioactivity. The radioactivity of the dissolved hair and skin was determined in the same way. Measurements were made on apparatuses of types DP-100 and B-2 in lead housings, with MST-17 counters. Each sample was counted on 2 targets and the activity was calculated by a relative method with an accuracy of $\pm$ 10%. The weights of the skin and hair were obtained from the difference between the weights of the pelt before and after depilation.

EXPERIMENTAL RESULTS

Data showing the accumulation of I^{131} by the organs and tissues of the rats are given in Table 1. The figures are mean values obtained from two preparations of each organ obtained from each of the 9 (or 7) animals of the group. The values given are statistically significant.

The investigations showed that I^{131} is accumulated intensively by the skin during the first minutes after injection. The quantity of iodine deposited in the skin rose rapidly, reaching a maximum 2 h after injection. During the next 2 h the iodine content fell sharply, and thereafter fell gradually until the end of the period of observation.

TABLE 1. Accumulation of I^{131} by Organs and Tissues of Rats (% of Dose Administered)

Time after injection of I^{131}	Thyroid	Skin	Hair	Liver	Kidneys	Spleen
15 min	0,01	4,5	0,12	0,13	0,04	0,02
2 h	11,0	33,0	0,12	0,14	0,03	0,02
4 h	15,0	12,0	0,14	0,37	0,04	0,04
6 h	—	7,0	0,18	—	—	—
24 h	22,0	4,6	0,21	0,47	0,10	0,02
48 h	—	3,5	0,24	—	—	—

Iodine accumulated in the hair in a comparatively low concentration, although this showed a tendency to rise with an increase in the time elapsing after injection of iodine. This was presumably explained by penetration of iodine into the hair follicles and by its accumulation in the growing part of the hair. It is interesting to note that a relatively higher activity was found when scrapings were made from the skin; this suggests that accumulation of I^{131} takes place in these tissues (Table 2).

During the first 15 min, when the blood iodine concentration reached a maximum, the specific activity of the skin was 13 times greater than that of the liver, and 2 h after injection it was 160 times greater. This difference in concentration was maintained at the later periods of observation, but at a lower level.

The results of the investigation of the dynamics of I^{131} accumulation by the thyroid obtained in these experiments, which are in agreement with data given in the literature, afford indirect confirmation that our conclusions are correct.

The experimental findings demonstrate that the skin and hair of albino rats are capable of accumulating I^{131} in considerable amounts, exceeding the content of the isotope in the thyroid during the first hours after administration. It is evident that this process takes place not only in albino rats, as Brown-Grant asserts, but also in guinea pigs, rabbits, and calves, as shown by the high concentrations of stable iodine found in the skin of these animals [6,9].

N. V. Zavadovskaya found that up to 7% of administered I^{131} accumulates in the skin of normal rabbits and up to 21% in the skin of rabbits with experimental intestinal obstruction. Admittedly, this author does not state how long after the injection of I^{131} these amounts were found. In the light of our experimental findings it may be postulated that the increased concentration of I^{131} in the skin of the rabbits was attributable not only to the disease, but also to the normal dynamics of its accumulation in the skin in the course of time.

The interesting fact that I^{131} accumulates in the epidermis may evidently be interpreted more widely, for the work of Treherne [15] has shown that the basal layer of the epidermis is a barrier to the free diffusion of nonelectrolytes, and Moral [14] obtained similar results in experiments with solutions of electrolytes (Na).

TABLE 2. Relative Specific Activity of Organs and Tissues of Albino Rats and Specific Activity of Whole Rats (in %)

$$\frac{\text{Content of } I^{131} \text{ (in } \mu\text{Ci) per gram}}{\text{Content of } I^{131} \text{ injected (in } \mu\text{Ci) per body weight}}$$

Time after injection of I^{131}	Skin	Hair	Liver	Kidneys	Spleen
5 min	44	4,4	1,8	3,0	2,2
2 h	320	4,4	1,8	2,2	2,2
4 h	120	5,0	4,4	3,0	4,4
6 h	70	6,5	—	—	—
2 h	44	7,6	6,5	6,7	2,2
48 h	38	8,7	—	—	—

TABLE 3. Accumulation of I^{131} by Hair of Patients and Experimental Animals

Time after injection of I^{131}	Man	Rat
15 min	2.3	4.4
2 h	5.0	4.4
4 h	2.4	5.0
6 h	2.8	6.5
24 h	—	7.6
48 h	—	8.7

If it is assumed that the accumulation of iodine in the skin and hair takes place in man with the same intensity as in rats, than after administration of I^{131} to a patient in a dose of 4 μCi (mean therapeutic dose recommended by the "Instructions for Use of I^{131} for Determination of the Functional State of the Thyroid Gland and for Treatment of Thyrotoxicoses") [4], 280 μCi of I^{131} will have accumulated in his skin 6 h after injection. The content of I^{131} in the hair at this time will have reached 7.2 μCi.

Similar values of iodine accumulation were obtained by Trunnell and Duffy, who studied necropsy material from 9 patients receiving I^{131} for therapeutic purposes. According to these workers, 8 h after injection of iodine its content in the skin was 39.78×10^{-4}% of the administered dose, or if expressed in terms of the weight of the whole skin, 8% of the total injected activity.

In order to discover whether the accumulation of I^{131} by the hair obeys the same general principles in man as in the rat, observations were made on 6 patients receiving therapeutic doses of I^{131} for carcinoma of the thryoid with metastases. The doses of I^{131} which they obtained varied between 0.234 and 0.605 μCi. To decrease the possibility of contamination of the hair by sweat, the region of the occiput and dorsum of the neck was shaved after the patients had taken a bath. The times of collection of the hair and the method of its treatment were described above.

Although the number of patients under observation was too small, the results (Table 3) suggest that human hair also possesses the power of accumulating I^{131}. It is evident that the possibility that I^{131} may accumulate in the skin in other ways, associated with the biochemical changes taking place in the cells during keratinization, has not been ruled out. This factor must also be considered when an explanation is sought for the entry of iodine into the hair, which may be associated with the increased I^{131} concentration in the region of the hair follicles. However, this problem requires further study.

SUMMARY

An intensive accumulation of radioiodine-131 in the skin and hair follows its intraperitoneal injection into rats. The iodine content in the skin reaches a maximum (35% of the dose administered) 2 h after administration. Observations on patients who were given radioiodine-131 in therapeutic doses for cancer of the thyroid demonstrated an evident accumulation of this substance in human hair. Iodine accumulation by the skin and hair is interesting when considering the mechanisms involved in its migration and deposition in the body of animals and man. Further observations on the patients receiving radioiodine for the therapeutic purposes are required to confirm the fact of iodine accumulation by the human skin.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* **A complete list of the cover-to-cover English translations appears at the back of this issue.**
