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Research article

EXPOSURE TO SODIUM FLUORIDE AFFECTS THYROID FOLLICULAR CELLS IN ALBINO RATS

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ABSTRACT: Living organisms are mainly exposed to inorganic fluorides through food, water and air; it exerts toxic effects on many soft tissues and organs. The thyroid gland has a strong capacity for absorbing and accumulating fluoride. To accomplish this, rats were exposed to sodium fluoride in a concentration of (5, 10, 15 and 20 mg/kg bw) daily through drinking water for 15 days of duration. After the treatment period rats were sacrificed and thyroid glands were removed, weight and processed for light microscopy. The results showed that the body weight of treated rats decreases while the weight of thyroid gland increases significantly. Light microscopic examination of thyroid gland shows thyroid follicles increases and colloid volume were decreases as the dose increases. In the higher dose thyroid gland showed increasing interfollicular spaces and fusion of the follicles. These results indicate that sodium fluoride exposure exerted harmful effects on rats and the thyroid gland cells.

Key words - Sodium fluoride, Thyroid follicles, Thyroid weight, Albino rat

INTRODUCTION

Fluoride (F) is abundant in the environment and exists only in combination with other elements as fluoride compounds, which are constituents of minerals in rocks and soil [11]. Sources of fluoride include natural fluoride in food stuffs and water (fluoridated water usually at 5.5 mg/L) in fluoridated areas of Maharashtra [9].The main source of fluoride for humans is the intake of ground water contaminated by geological sources (maximum concentration reaching 30-50mg/L) [11]. The exposures with the sodium fluoride (NaF) in relation to the epidemiological study of skeletal and prevalence severity of dental fluorosis of Chandrapur district, Maharashtra [8, 10].

The Food and Nutritional Board recommended that public water supplies be fluoridated when natural fluoride levels are significantly below 0.7 mg/L. Besides skeletal and dental tissues, high F permeability is known to allow F ion penetrate cell membranes and accumulate in diverse soft tissues such as stomach, small intestine, liver, kidney and brain pyruvic transaminase, threatening the health of human and animal [16]. Numerous disorders have been connected to the systemic fluoride consumption [13, 4].

Although fluorosis has been investigated for many years, there are relatively few studied of its effect on the endocrine glands such as the thyroid glands. Liu *et al.,* (2002) found that thyroid gland has a strong capacity for absorbing and accumulating fluoride. The thyroid gland is one of the most sensitive organs in its histopathological and functional responses to excessive amounts of fluoride [21]. 1ppm fluoride in drinking water does not affect either thyroid function or its structure [6], on the other hand increased dietary fluoride has resulted in thyroid enlargement and caused structural and functional changes [18].

To enrich our knowledge regarding exposure to sodium fluoride affects reproductive organs in the female albino rats. Extensive study were undertaken, to elucidate especially, the histological changes of the uterus with different doses of NaF [22] were reported earlier, while the sodium fluoride thyrotoxicity is well proven clinically but the detailed histological changes have not been fully studied. So, the present work aimed to study the structural changes which might result from sodium fluoride on the thyroid gland of albino rats.

MATERIALS AND METHODS

Sodium fluoride

Sodium fluoride was purchased from the Sigma chemical company, ST Lous, MO, and USA. The Sodium fluoride is very difficult to anneal and cleaves readily limiting the useful size of pieces to about 80mm, was administered orally to animals.

Animals and Treatment

The study was performed on adult female Albino rats (*Rattus norvegicus*) with body weights 150-180 gm. Each rats were caged separately they were raised in ventilated animal house unit at research laboratory of Zoology Department of RTM Nagpur University, under the controlled temperature 25± 2 ^{0}C on a 12 hrs light /dark cycle. The animals were acclimatized for 7 days prior to beginning the study.

The rats were randomly divided into 5 groups each consisting of 6 animals. The first group served as a control provided defluoridated water and remaining animals of group II, III, IV and V were treated with the doses of sodium fluoride (Sigma chemical company, USA) at 5mg, 10mg, 15mg and 20mg/kg bw/day, daily orally in drinking water for 15 days. All methods used in this study were approved by the Committee for the purpose of control and supervision of experiments on animals (478/01/a).

Observations

Throughout the test period, clinical observations conducted at once a day. Female rats were weighted on the first day of dosing, at least weekly thereafter and at termination.

Histopathological observation

After 15 days of treatment the animals were autopsied through cervical dislocation. Thyroid gland were taken, weighed and fixed in 10% formalin, embedded into paraffin sectioned at 5um thickness and mounted on glass microscope slides. The slides were stained with haematoxylene – eosin and examined by microscope.

Statistical analysis

The student t-test (Graph pad Prism version 4.03) for Windows (Graph pad software Inc., San Diego, California, USA). Analysis was used to compare results obtained from the exposed groups from the control group.

RESULTS

The rats orally administrated with different doses of NaF for 15 days of duration showed the body weight of treated rats gain initially for 1 or 2 days and after that decreases significantly as compared with control rats. Similarly the weight of the thyroid gland increased significantly as the doses increases (Figs. 1 & 2). In the control group light microscopic examination revealed the well known histological structure of thyroid gland. The gland was formed of follicles that selectively absorb iodine from the blood for production of thyroid hormone and also for storage of iodine in thyroglobulin. The follicles are surrounded by a single layer of thyroid cuboidal epithelial cells with rounded nuclei which secretes T3 and T4 hormones. Inside the follicles a region called the follicular lumen filled with acidophilic colloid which serves as a reservoir of materials for thyroid hormone production. The epithelial cell height was normal and no interfollicular spaces were apparent. Numerous blood vessels course throughout the connective tissue in between the follicles (Figs. 3 & 4).

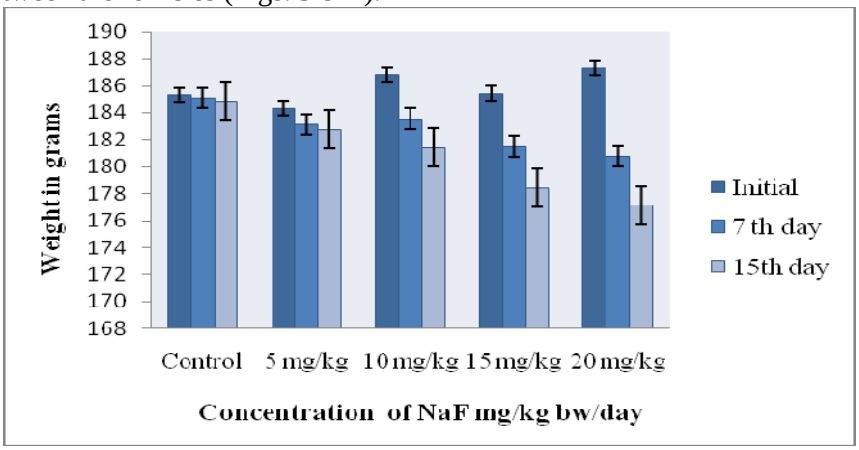

Fig.1: Body weights of control and sodium fluoride treated rats. (n=6 rats/group)
The values are mean ± S.E. p<0.001

The animals treated orally with sodium fluoride, thyroid gland showed variable changes. Group II (5 mg/ kg bw/ day) appeared more or less similar to control ones (Fig. 5). Group III to V thyroid gland appears increased in the number of follicles which were lined by epithelial cells with reduced cell height and had low colloid contents with many peripheral vacuoles. Colloid droplets appeared in the apical and basal parts of the cytoplasm (Fig. 6). Some of these droplets were fused and formed large colloid masses. Some follicles showed signs of degeneration in the forms of a decrease in area percentage of colloid and fusion of the follicles (Figs. 7 & 8).

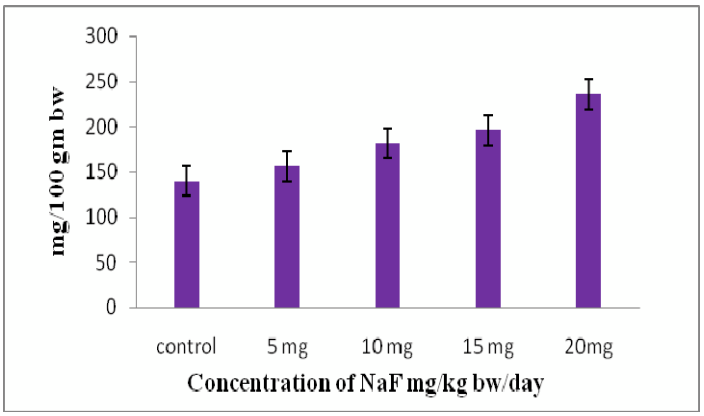

Fig.2: Weight of Thyroid gland of control and sodium fluoride treated groups. The values are mean ± S.E. p<0.001

Fig.3: T.S. of the thyroid gland of a control adult rat showing thyroid follicles lined by follicular epithelial cells (FC) containing colloid (CL). The follicles were variable in size forming the gland lobules separated by thin connective tissue septa (S) with blood vessels (bv). (HE × 100)

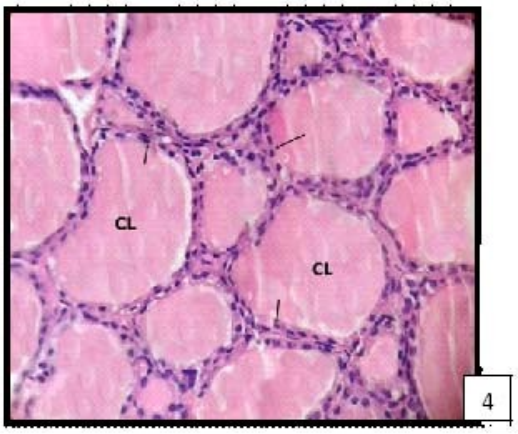

Fig.4: T.S. of the thyroid gland of control rat showing normal thyroid follicles with normal epithelial cell (→) height completely filled colloid and no interfollicular spaces. (HE × 400)

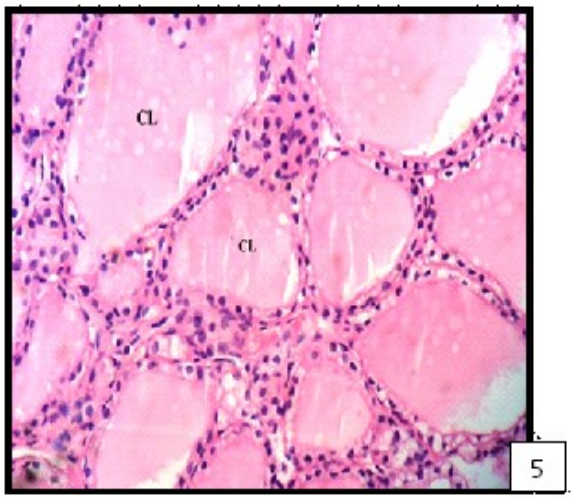

Fig.5: T.S. of the thyroid gland of a treated (5 mg/kg bw/day) rat somewhat similar of control rat. Slight reduction of colloid (HE × 400)

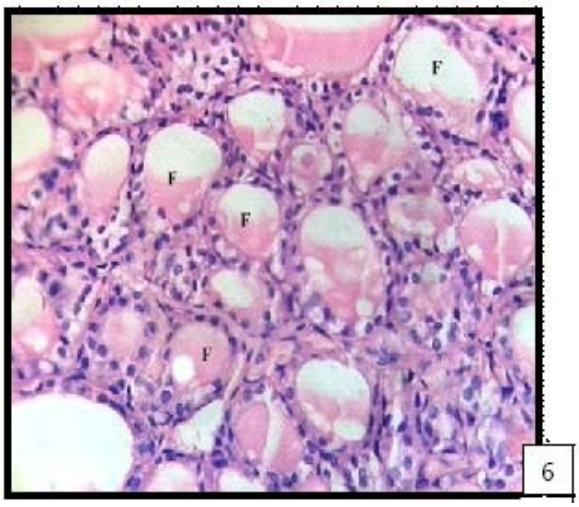

Fig.6: T.S. of the thyroid gland of a treated (10 mg /kg bw/day) rat shows increasing number of follicles (F) and low colloid (HE × 400)

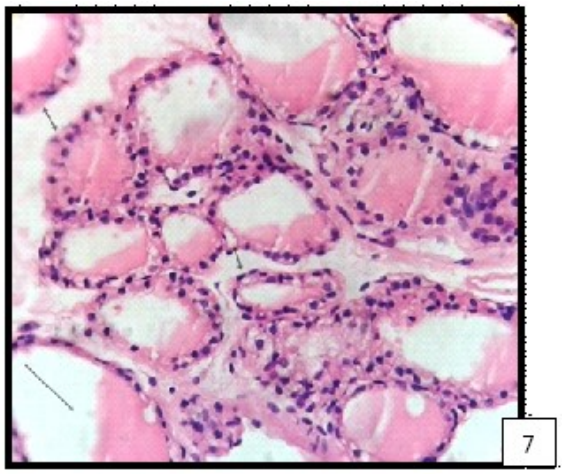

Fig.7: T.S. of the thyroid gland treated (15 mg/kg bw/day) rat shows increasing number of follicles and low Colloid (⟶) and increasing interfollicular spaces (⟷) (HE × 400)

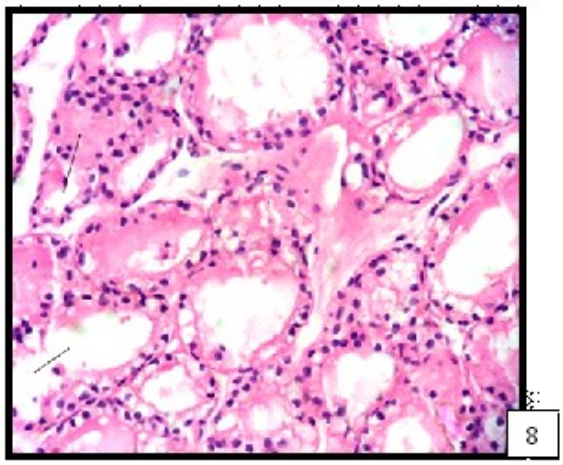

Fig.8: T.S. of the thyroid gland of a treated (20 mg/kg bw/day) rat shows increasing number of follicles and low colloid, increasing interfollicular spaces and fusion of the follicles (→) (HE ×400)

DISCUSSION

Fluorides are organic and inorganic compounds containing the fluorine element, formed by halogen family (Fluorine F). Living organisms are mainly exposed to inorganic fluorides through food and water. Based on quantities released and concentrations present naturally in the environment as well as the effects on living organisms, sodium fluoride the most relevant inorganic fluoride. It is a non toxic compounds for recommended dose but change to toxic if dose increase up to the standard level. The thyroid glands which regulate the body's metabolic rate play an exquisitely important role in human health. Because all metabolically active cells require thyroid hormone for proper functioning, thyroid disruption can have a wide range of effects on virtually every system of the body.

In the present study, a significant reduction in body weight of sodium fluoride treated animals was recorded in comparison to control group. Similar results were reported by other co-workers [23, 7, 2, 3]. The reduction in body weight which could be attributed to low food consumption, altered protein and energy metabolism [14, 7]. The administration of sodium fluoride on experimental rats may cause an enlargement of the thyroid gland [19, 5]. Similar result was observed in present study.

In the Present investigation the rats thyroid gland on exposed to sodium fluoride demonstrated noticeable structural changes most probably seen in thyroid gland caused by fluorine toxicity. It appears that thyroid gland accumulate fluoride rapidly. The results were in agreement with Liu [17] found that fluoride can induced structural changes and dysfunction in the thyroid gland and also the excessive fluorine injured structure of thyroid including mitochondria and endoplasmic reticulum [24].

The study demonstrated that the rats treated with NaF showed that the follicular cells of thyroid gland marked decreased in cell height in addition to reduced colloid content. The decreased height reflects the decreased activity of the follicular cells [15]. In Lead acetate treated group, a significant decrease in follicular epithelium height which suggested unstimulated and resting follicular cells as follicle epithelium height depends on the functional state of the thyroid gland [12]. Decreased colloid content observed in the present work is similar to Bouaziz [5] in addition to increased follicular number and vascularity. The area of the colloid in the lumen of the follicles decrease, this indicate that thyroid gland of the follicular treated rats were in an active state was reported in present study. The other study reported that the degenerative changes of the follicular epithelial cells and the fluoride interacts with a wide range of cellular processes, such as gene expression, cell cycle, proliferation and migration, respiration, metabolism, ion transport, secretion, apoptosis and oxidative stress by [1]. The present findings demonstrated that excessive intake and accumulation of fluoride in the body is a serious risk factor for the development of thyroid dysfunction and histopathological changes in thyroid gland.

CONCLUSION

In this work we focused on showing the effect of sodium fluoride on the cellular function of Thyroid gland. The studies describe above demonstrated that sodium fluoride can interact with the thyroid follicular cells and absorbed in more quantity.

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