Review Article

Nuclear detonation, thyroid cancer and potassium iodide prophylaxis

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ABSTRACT

The recent nuclear disaster at Japan has raised global concerns about effects of radioactive leakage in the environment, associated hazards, and how they can be prevented. In this article, we have tried to explain about the guidelines laid down by World Health Organization for a potassium iodide prophylaxis following a nuclear disaster, and its mechanism of action in preventing thyroid cancer. Data was collected mainly from the studies carried out during the Chernobyl disaster of Russia in 1986 and the hazardous effects especially on the thyroid gland were studied. It was seen that radioactive iodine leakage from the nuclear plants mainly affected the thyroid gland, and especially children were at a higher risk at developing the cancers. Potassium Iodide prophylaxis can be administered in order to prevent an increase in the incidence of thyroid cancers in the population of an area affected by a nuclear disaster. However, one has to be cautious while giving it, as using it without indication has its own risks.

Key words: Chernobyl disaster, potassium iodide prophylaxis, nuclear detonation and crisis, thyroid cancer, radioactive iodine, world health organization guidelines

Introduction

In the second week of March 2011, a massive earthquake of magnitude 9.0 on the Richter scale struck Japan causing a tsunami,[1] which mainly affected the areas of Fukushima, Miyagi and Iwate. Similar to another recent tragic tsunami of Southeast Asia, the tsunami in Japan is also expected to cause several thousands of deaths.[1] It not only disrupted the infrastructure in the affected areas, but also caused the total destruction of the atomic nuclear electricity plants in the disaster area of Fukushima.[1] Such a crisis of nuclear detonation due to a tsunami has never been witnessed before in history.

A number of reports about the ill-effects on the health of the population residing in these affected areas have come forward, changes in normal contents at the cellular level, being their main consideration.[2] The increased incidence of cancer, especially of the thyroid, post the radioactive leakage from the nuclear plant, is of concern, with respect to public health and endocrinology.[3-5] Such a situation is new, and requires global attention. Hence, in this article, the author has attempted to summarize about the occurrence of thyroid cancer following a nuclear leakage crisis, and has discussed the possibility of adopting prophylactic measures by making use of potassium iodide in such situations.

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Effect of Radioactive Substance Leakage from the Nuclear Plant on Thyroid Gland

The effect of exposure to leaked radioactive substances from a nuclear plant on the thyroid gland was first observed in 1986 in Russia, after the Chernobyl disaster.[6,7] Kriukov first noted the abnormalities introduced in the thyroid gland structure after the incident in the ultrasonic scanning of the individuals staying in the affected areas.[4] Also, the incidence of thyroid cancer was found to be increased.[5]

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Baverstock and Williams reported that, "radiation to the thyroid from radioisotopes of iodine has caused several thousand cases of thyroid cancer, but very few deaths; exposed children being most susceptible".[8] Finally, it should be noted that only the incidence of thyroid cancer, and not others, was found to be significantly increased in the populations affected by the Chernobyl disaster,[9] and the risk was most significant in children.[8]

Many hypothesis have been put forth to explain this increase in the incidence of thyroid cancers. According to the first theory, the leaked radioactive iodine from the nuclear reactors can find an easy way into the thyroid gland, and thus cause the mutagenic changes.[5] According to another theory, the population also showed many genetic abnormalities of the thyroid cells, and molecular biology studies revealed translocation of the Rearranged During Transfection (RET) gene, in carcinoma type Rearranged during Transfection/Papillary Thyroid Carcinoma Type 1 (RET/PTC1) in elderly and Rearranged during Transfection/Papillary Thyroid Carcinoma Type 3 (RET/PTC3) in children, and expression of Tyrosine-protein kinase receptor UFO/ AXL receptor tyrosine kinase (Axl) and growth arrest-specific 6 (Gas6) in children, predisposing such individuals to the development of cancer.[9] The impairment of T cell activity and senility of the immune system, which slows down the killing of the cancerous cells, is also proposed.[10]

Potassium Iodide Prophylaxis in the Crisis

The recent Japanese nuclear detonation crisis has raised global public health concerns and several measures are being taken to prevent the radioactive contamination. Entering into the affected areas has been prohibited by the government, and consumption of edible products and water from these areas is banned. Also, the proposition of giving a potassium iodide prophylaxis to the masses is being discussed.[11-13] The concept behind giving the iodide prophylaxis is the observation that stable iodine supplementation in an iodine deficient population can modify the risk of development of thyroid cancer.[14]

However, the use of iodide prophylaxis has to follow the recommended guidelines,[15] as the use without indication can have its own risks.[16] Crocker noted that "It is recommended that all appropriate counter-radiation measures be considered in the case of a reactor accident; however, the harmful side effects of the various actions be weighed carefully."[17] According to guidelines laid down by World Health Organization (WHO), pregnant and breast-feeding women, infants and children under 18 years of age should be given the iodide prophylaxis first, and the potassium iodide should be used immediately where inhalation of radioactive iodine occurs.[18] More information for potassium iodide prophylaxis in cases of nuclear leakage is presented in Table 1. Following the guidelines given in Table 1 has shown to reduce the cancer risk by a factor of three.[18] Also, Figure 1 presents the mechanism due to which this practice has been shown to be effective in preventing thyroid cancer. However, it is important to note that the prophylaxis should not be delayed, and be started as soon as possible, as the efficacy of the prophylaxis will be significantly decreased if it is started late (the golden period is within the first 3 hours of exposure).[18]

Table 1: Guidelines by World Health Organization for potassium iodide prophylaxis following a nuclear disaster

Issues	Details
Recommended strength	130 mg/day per oral for 1–2 weeks (might continue if the high contamination of radiation is still existed)
Preparation form	The available forms include a) potassium iodide table (130 mg) and b) Lugol solution (1 cc has potassium iodide equal to 130 mg).
Who should receive?	According to WHO guidelines,[18] the first group to get prophylaxis includes, a) pregnant women, b) breast-feeding women, c) infants and d) children under 18 years. On the other hand, the last group to get the prophylaxis includes subjects more than 40 years old (because risk of induction of hyperthyroidism or thyroiditis is more than the possible benefit of prevention of thyroid cancer).
When?	Detectable level of radiation equal to or more than mGyv

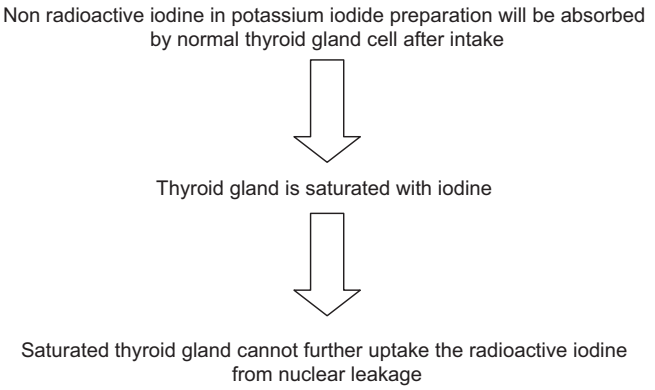

Figure 1: Diagrammatic representation of the mechanism of potassium iodide prophylaxis in preventing thyroid cancer

Conclusion

Thus, it can be concluded that though potassium iodide prophylaxis may prove useful in preventing an increase in the incidence of thyroid cancer post a nuclear disaster, it has to given following the recommended WHO guidelines, and only when indicated.

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