EURASIAN JOURNAL OF TECHNOLOGY AND INNOVATION
Innovative Academy Research Support Center
Open access journal www.in-academy.uz

RADIOIODOTHERAPY FOR THYROID CANCER

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ARTICLE INFO

Received: 06th Oktober 2023
Accepted: 10th Oktober 2023
Online: 11th Oktober 2023

KEY WORDS

Thyroid gland, treatment, opinion, Decision.

ABSTRACT

Currently, a number of iodine isotopes with mass numbers from 120 to 139 and half-lives from 2.7 s (I139) to 60 days (I125) are known. In fact, three radioisotopes of iodine are currently most in demand and are used in medicine: I123 for in vivo and I125 for in vitro diagnostic procedures and I131 for therapeutic purposes.

In terms of physical properties, I131 proved to be the most convenient both for theoretical research and for diagnosis and therapy and has become widely used in medicine. The use of radioactive isotopes of iodine in the quality of labeled atoms is based on the fact that, differing in physical properties from a natural element, they fully correspond to it in chemical properties and participate in metabolic processes in the same way as stable iodine. The gamma quanta and beta particles emitted by I131 allow using radio metric devices to accurately trace the path of radioactive iodine in the body and determine its content in various organs and systems, as well as urine, saliva and other secretions. Since 1946, I131 has been used in the treatment of thyroid carcinomas.

For diagnostic purposes, radioactive iodine is injected into the human body in small quantities, called indicator doses (usually 0.55.0 MCI). By weight, I131 is introduced in such a small amount that it does not affect the metabolic processes of stable iodine. Thus, 1 MCI I131 contains 8.1 * 109 mg of iodine. It is obvious that the total content of this element in the body after the introduction of radioactive iodine will practically not change.

Radioiodotherapy of thyroid diseases is based on the mechanism of active transport of I131 from the blood by means of NAIIMPORTER into the follicular epithelium of the thyroid gland, its accumulation in the follicles in a thyroglobulin-related form and secretion with an effective half-life of several days. Due to the ability of thyroid cells and highly differentiated tumors and their metastases to selectively absorb iodine, the concentration of I131 in these tissues is many times greater than the concentration in the blood. The destructive effect of I131 is caused by beta particles that have a short run length in tissues. 90 % of the decay

energy of concrete particles in the tissue is absorbed within 12 mm. Thus, the destructive effect of radioactive iodine is limited to the tissue that actively accumulates it. Nearby tissues remain virtually intact. The gamma quanta emitted by I131 do not have a noticeable biological effect (due to its high penetrating power), but they allow monitoring the location and amount of radioiode in the body. Accumulated I131 in tissues causes ionization of cell molecules, the production of large amounts of free radicals or short-lived toxic poisons that can damage vital biological structures such as DNA and enzymes. All these These events lead to delayed division or death of thyroid cells and/or tumors. Radiation risks and safety of radioiodotherapy

Compared with external irradiation, internal irradiation of radionuclides is less radiotoxic per gray (rad), because their radiation occurs slowly over a certain time. When I131 is used, the radiation dose to the whole body consists of gamma radiation emitted from accumulated radionuclide in the thyroid gland, blood and urine in the bladder. Exceptional cases of leukemia are observed in patients who have repeatedly received high doses of I131 for the treatment of thyroid cancer, especially in childhood. There is no evidence of genetic defects associated with radioiodotherapy in offspring. However, over the past decade, the dangers associated with environmental pollution have become a major concern. Radiation risks directly related to the treatment of I131 patients are included in the potential risks of radiation loads for the population. Opinions on radiation risks and radiation safety standards differ on both sides of the Atlantic and even within the European Union. However, reasonable compromises have been found and expressed in norms that allow regulating radiation loads on the population and personnel during radiotherapy to patients, which pose a relatively limited risk compared to the general problem of environmental pollution.

Radioiodotherapy for thyroid cancer

Over the past two decades, there has been an increase in the incidence of thyroid cancer by almost 28%, while reducing mortality by more than 23%. This is due to the recognition of the disease at early stages, in which the most favorable prognosis is realized after surgical treatment in combination with radioactive iodine therapy. Thorough total or near–total surgical removal of the thyroid gland performed by a qualified surgeon is a necessary first step in the treatment of thyroid cancer. The use of ra dioyod is indicated both for ablation of thyroid tissue residues after subtotal or circumtotal removal of an organ for multifocal, invasive cancer, and for the treatment of regional and distant metastases of differentiated thyroid cancer.

Retrospective studies have shown that after surgical ablation of thyroid remnants in patients with differentiated thyroid carcinoma larger than 11.5 cm with or without metastases to the cervical lymph nodes significantly reduces mortality, as well as significantly reduces the frequency of recurrence or development of distant metastases of thyroid cancer compared with patients receiving only thyroid treatment hormones.

The use of radioactive iodine is justified:

- selective accumulation of iodine by thyroid cells and highly differentiated tumors; · the possibility of achieving a high absorbed dose in the accumulation site with minimal damaging effect on surrounding tissues;

- absence of complications, reversibility of adverse reactions during the introduction of therapeutic activities.

The main goals of radioiodotherapy are:

1. Destruction of residual thyroid tissue and tumors, if it is impossible to remove them surgically.

2. Removal of the substrate synthesizing thyroglobulin, the determination of which in further observation allows the correct use of its content in the blood serum as a tumor marker.

3. Detection and subsequent therapy of metastases of differentiated thyroid cancer, including those not detected by radiography.

Radiotherapy is the method of choice for the treatment of distant metastases of differentiated thyroid cancer. The success of this treatment depends on the accumulation of radioiode in metastases. To do this, after thyroidectomy, it is necessary to create conditions for iodine deficiency in the body, excluding products and medicines containing iodine, bromine, as well as conditions for endogenous stimulation of thyroid-stimulating hormone (serum concentration > 30nE / ml), canceling thyroid hormones in 3 weeks when taking thyroxine, or in 2 weeks – triiodothyronine.

Before treatment with radioactive iodine, an examination is carried out, including:

diagnostic scanning with 131I to determine the location, volume and functional activity of the remaining thyroid tissue (if more than 20% of the injected diagnostic activity accumulates in the remnants of thyroid tissue, the issue of repeated surgery must be resolved after 24 hours);

ultrasound examination of the neck area (abdominal cavity and other organs according to indications);

general and biochemical blood analysis, determination of TSH, free T4, thyroglobulin (TG), antibodies to TG;

radiography or computed tomography of the lungs (skeletal bones according to indications).

In recent years, recombinant TSH (RTG) has been widely used for diagnostic studies with iodo131. It allows you to conduct this study without stopping taking thyroxine, without prolonged preparation and staying in a state of hypothyroidism. The use of RTG can also be useful in cancer therapy in individual patients.

Radioiodine in the form of an aqueous solution of sodium iodide (Na131I) or in a capsule is taken orally, after which the patient is placed on a "closed mode" in a specialized ward, from which air and sewage are decontaminated. Body radiometry is performed daily. When the dose rate is reduced to the level established by radiation safety standards, the patient takes a shower and changes into clean clothes, after which a computer scintigraphy of the whole body is performed, which allows to determine the distribution and identify the foci of pathological accumulation. The effectiveness of radioiodotherapy depends on the amount of absorbed dose in the accumulation foci. Ablation of residual thyroid tissue is achieved with an absorbed dose of about 300 Gy. Successful destruction of metastases of differentiated thyroid cancer is noted at doses of 80140 Gy. There is no effect when the absorbed dose is less

than 35 Gy. Repeated administration of Na131I with an interval of 36 months is carried out when foci of radioiode hyperfixation appear before their complete disappearance.

A complete cure is assessed according to the following criteria:

- absence of focal accumulation of radioiode during whole-body scintigraphy;· serum TG level with an interval of 36 months <2 ng/ml;
- absence of ultrasound and/or radiological signs of tumor recurrence and prostate cancer metastases.

Distant metastases are the main cause of death in differentiated forms of thyroid cancer. Almost 10% of patients with papillary cancer and up to 25% with follicular cancer have distant metastases. Approximately half of distant metastases are diagnosed at the initial treatment. Distant metastases are more common in patients after 40 years. the 5–year survival rate of patients in whom metastases are capable of accumulating iod131 and a complete recovery has been achieved is 96%, the 10-year survival rate is 93%. While in the absence of remission, the 5-year survival rate does not exceed 37%, the 10–year survival rate is 14%.

When studying the nature of distant metastasis of 914 patients observed in the clinic of the MRSC RAMS, aged from 4 to 73 years, 331 (27%) patients had distant thyroid cancer metastases to the lungs. Thyroid cancer metastases to the lungs most often – 179 (55%) cases – were combined with metastases to regional lymph nodes. Only 40 (12%) patients had metastatic lung cancer without regional and distant metastases of other localizations. A combination of metastatic lung and skeletal bone lesions was observed in 18 (5%) patients. Various combinations of thyroid cancer metastases to the lungs with metastases of other localizations were found in 94 (28%) patients. Of the rare localizations of meta-stasis, metastases to the liver, kidneys, spinal cord, subcutaneous adipose tissue, parapharyngeal, axillary, retroperitoneal lymph nodes were noted. In the group of patients with metastases to the lungs and the environment, the full effect of treatment was achieved in 54.7% of patients, stabilization was noted in 15.9%

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mental analysis is in the process of treatment. The total activity during the treatment period ranged from 140 to 2390 mCi 131I. The indicators of 5 and 10–year survival of patients are 97.6 and 88.8%, respectively.

Bone metastases of thyroid cancer present a difficult problem for a complete cure. The results of treatment of 103 patients aged 20 to 73 years with bone metastases of thyroid cancer with histological confirmation of a highly differentiated variant of the primary tumor were analyzed. Folicular cancer was detected in 70 (69%) patients with metastatic lesions of the skeleton alone and in 57 (55%) patients with a combination of bone metastases with metastases to the lymph nodes of the neck, mediastinum, lungs, liver and other organs. The follow-up period ranged from 1 year to 12 years. The average life expectancy of patients with thyroid cancer with isolated skeletal damage was 7.9 years, patients with a combination of metastatic process in bones and other organs – 9.4 years. The use of radionuclide therapy in the complex treatment of this heavy contingent of patients improves the indicators of 5 and 10-year survival to 59.6 and 44.8%, respectively.

The effectiveness of combined treatment of thyroid cancer during radioiodotherapy in the early stages after the surgical stage is significantly higher. As a result, the likelihood of developing a relapse of the disease, repeated surgical interventions, accompanied by an increased risk of complications in the form of traumatization of recurrent nerves and parathyroid glands, decreases. In addition, radioiodablation makes it possible to detect and successfully treat isolated metastases at an early stage even before their X-ray detection. The most effective treatment of patients with pulmonary metastases and single bone metastases that are not detected by radiography. Radiotherapy in patients with large nodular lung metastases or multiple bone metastases is less effective.

Thus, radioiodine therapy plays a key role in the combined treatment of differentiated thyroid cancer, it is indicated for patients with distant metastases and a potentially high risk of tumor recurrence. The use of radiotherapy is possible only after total or near–total removal of the thyroid gland, regional metastases of differentiated thyroid cancer after 34 weeks, and / or after the withdrawal of thyroxine for 3 weeks or triiodothyronine - 2 weeks before treatment. Active accumulation of radioiode is provided by proper preparation and allows the destruction of residual thyroid tissue, tumor foci and metastases that have not been surgically removed.

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