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From Diagnosis to Therapy: A Comprehensive Review on the Role of Radioactive Isotopes in Thyroid Cancer Management

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ABSTRACT

The use of radioactive isotopes in the diagnosis and treatment of thyroid cancer is now an integral part of modern nuclear medicine. Gamma-emitting isotopes such as technetium-99m and iodine-123 serve as the main diagnostic imaging weapon enabling great sensitivity and specificity, non-invasive functional visualization of thyroid physiology and disease. Iodine-131 is the dominant therapeutic isotope, emitting cytotoxic beta radiation for the treatment of metastatic differentiated thyroid cancer and thyroid remnant ablation. The effectiveness of radioactive iodine treatment is dependent on various factors including sodium-iodide symporter expression as well as dosimetry methods seeking to maximize absorbed dosages whilst simultaneously achieving successful treatment alongside minimizing non-target organ toxicity. Molecular radiotheragnostics and personalized dosimetry methods are slowly entering the clinical routine and will ensure higher diagnostic power and treatment efficacy in the future. Radioiodine-refractory thyroid cancers have long been challenging to manage, warranting novel approaches to integrate molecular biology, targeted therapies and immunotherapy. The changing context of radionuclide use in thyroid care highlights the necessity of multidisciplinary approaches, which promise to increase patient outcomes and the management of thyroid cancer.

Keywords: Radioactive isotopes, Radioiodine, Thyroid cancer, sodium-iodide symporter

INTRODUCTION

The application of radioisotopes in medicine is a significant milestone for imaging and therapeutic purposes. The field has progressed a lot given that natural radioactivity was uncovered by Henri Becquerel in 1896, then radioactive components similar to radium and polonium had been set aside by Marie Curie. In the 1930s, the synthesis of artificial radioisotopes yielded a means of controlled medical use of radiation. Post World War-II era, the field of radioisotopes burgeoned in the diagnosis and treatment of diseases from iodine-131 for the treatment of thyroid disease to what has become the mainstay of contemporary nuclear medicine [1, 2].

Historical Development

The heart of nuclear medicine is fundamentally the dual role of radioisotopes for diagnosis and therapy. Gamma-emitting isotopes like technetium-99m (99mTc), iodine-123 (123I), and fluorine-18 (18F) are predominantly used for diagnostic applications of radiotracers. They are then integrated into radiopharmaceuticals with the capability of noninvasively visualizing biological functions with high sensitivity and specificity. One of the most common and well-known use of ^99mTc is its application in single-photon emission computed tomography (SPECT) imaging of cardiac perfusion, bone pathology, and tumor localization. Stable Longer Delivery of 18F-FIB-V Which is Crucial for PET(positron emission tomography) Based on 18F-Labeled Compound Such as fluorodeoxyglucose(FDG): standard oncological, neurological and cardiological evaluating PET imaging agent [2, 3].

Radioisotopes

Radioisotopes are unstable isotopes of elements that emit radiation as they decay to stable forms. Their unique radioactive properties allow them to be used as tracers, therapeutic agents, and sources of radiation across a variety of fields, most notably in medicine, as shown in Figure (1), industry, agriculture, and scientific research.

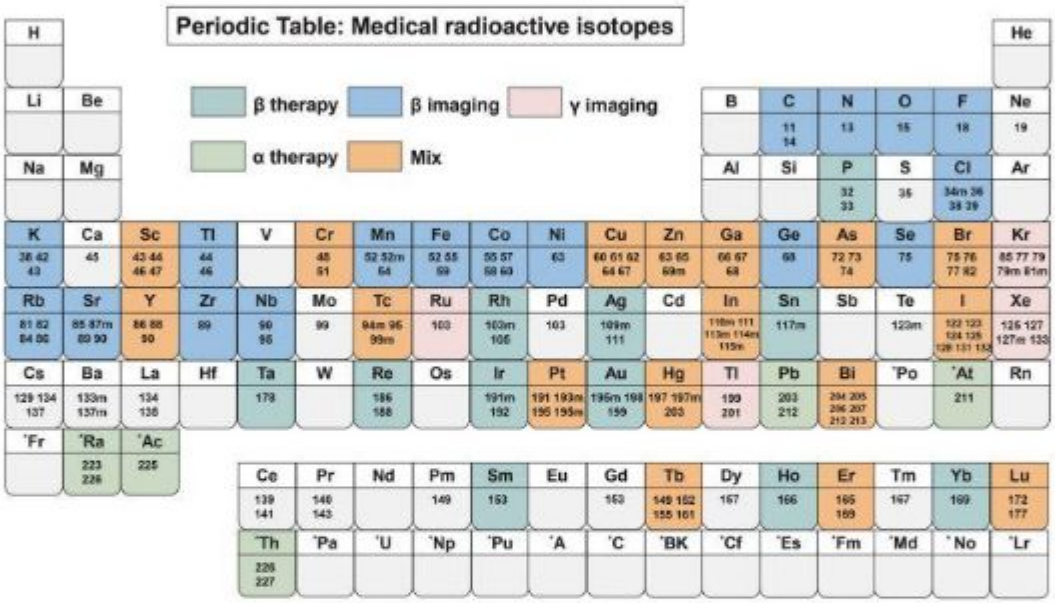

Figure 1: List of the medical radioactive elements in the periodic table. Elements that emit radiation are called radionuclides[2].

Radioisotope Tracers

A radioactive tracer, or radiotracer, radioactive label [1] or radioisotope label, is a substance (specifically a compound) that can be tracked through chemical and physical processes by its radioactivity. Such a radiolabeled compound emanates radiation out of the body, which is usually in the form of gamma rays, and can be picked up with an imaging equipment. This emission facilitates quantitative evaluation and non-invasive visualization of physiological, biochemical, or molecular life processes in vivo via the tracer [4].

Radioisotope tracers are a fundamental game changer in nuclear medicine, since they enable highly functional imaging; more detail than that available from classical anatomical imaging. As an example, a large volume of single-photon emission computed tomography (SPECT) uses technetium-99m (^99mTc) labeled compounds for the assessment of primary tumor localization, bone metabolism, and coronary perfusion [1]. Positron Emission Tomography-Computed Tomography (PET/CT): A tracer tagged with positron emitting isotopes (fluorine-18,) In oncology, ^18F-fluorodeoxyglucose (FDG) is a widely-used tracer to detect cancer metabolism and monitor treatment response. [2, 4].

Depending on the target organ and physiological process being studied, tracers are given orally, by injection, or by inhalation in clinical diagnostics. The radiotracer provides accurate functional information on blood flow, receptor binding, metabolism, or cellular activity by selectively distributing inside the body based on the biological characteristics of the labeled molecule. Many radioisotopes have short physical half-lives, which reduce radiation exposure to patients and enable quick imaging procedures [3, 4].

In addition to medical imaging, tracers are used in therapy, where radioactive isotopes provide diseased tissues with cytotoxic radiation. One example of this is the treatment of thyroid disorders using iodine-131. Their versatility across scientific disciplines is demonstrated by their use in studies ranging from environmental tracing and industrial process monitoring to biochemical pathway elucidation [3].

The radioactive isotope is bound to physiologically active molecules that preferentially aggregate in particular organs or tissues in order to create radiotracers. This targeting power allows for early illness diagnosis before anatomical alterations become noticeable and improves diagnostic specificity. Analogs of glucose labeled with ^18F, for example, enable the monitoring of metabolic rates in malignant tissues, whereas molecules labeled with ^99mTc track bone metabolism and cardiac perfusion [5].

When employing tracers, safety and effectiveness are crucial factors. Most radiotracers have short physical half-lives to minimize radiation exposure while providing sufficient time for diagnostic imaging. Doses are carefully controlled to balance image quality and patient safety. It is necessary to choose a tracer based on the following selection criteria:

- Type of radiation emitted: alpha particle, beta particle, or gamma ray.
- Half-life of the radionuclide.
- Energy of the emitted radiation.
- Optimization of the activity injected [6, 7].

Anatomy of the Thyroid Gland

The name Thyroid Gland dates back to 1543, when Vesalius first introduced the term. Out of ignorance he called it Glandulare laryngis, because he believed this gland lubricated the larynx. The term thyroid originates from the Greek word "Thyreos" which means shield. This term was first coined by Thomas Wharton in 1656 [8].

The thyroid gland is a highly vascularized endocrine gland located in the neck, stretching from C5 to T1, brownish-red in color and pseudo-lobulated at autopsy. Its structure shaped like a butterfly or an "H" [9]. Each left and right lateral lobe of the thyroid gland exhibit an inferior and superior pole. In adults, each thyroid lob is about 4 cm long and the mean weight of the thyroid gland is 15–25 grams (somewhat higher in females) [8]. This is accompanied by a midline isthmus, a narrow connection of thyroid tissue generally traveling over the 2nd, 3rd and 4th tracheal rings. The isthmus is typically 2 cm wide and high and 2–6 mm thick [8, 10]. It is surrounded by a fibrous capsule, which extends inwards into the gland as septae, dividing it into lobules. This capsule also makes ligaments that bind the gland to adjacent structures as shown in Figure (2).

On the microscopic level the thyroid is made up of thyroid follicles, which are globular structures consisting of colloid, filled predominantly by thyroglobulin, the thyroid hormones (TH) precursor in the T3 (triiodothyronine) and T4 (thyroxine) biosynthetic pathway. These follicles are lined with follicular cells (thyrocytes) which synthesize and secrete them in response to thyroid-stimulating hormone (TSH) stimulation. C-cells, more appropriately referred to as parafollicular cells, are responsible for the production of calcitonin, a hormone that is involved in calcium homeostasis [11, 12]. Thyroid is highly vascularized structure; blood supply originates mainly from superior thyroid artery. The branches of arteriovenous fistula shunt are branches from external carotid artery, and inferior thyroid artery arises from thyrocervical trunk of subclavian artery. These arteries supply enough perfusion to keep metabolic activities running [9, 13].

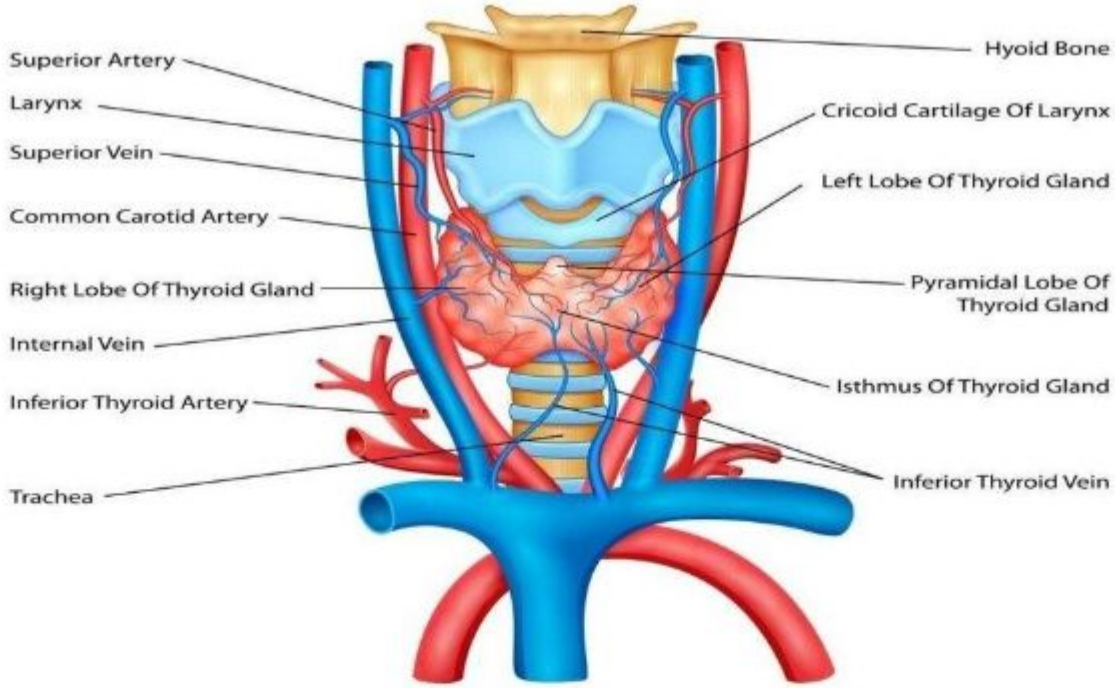

Figure 2: Anatomy of thyroid gland [8]

Regulatory Mechanisms

The secretion of T3 and T4 is regulated by a feedback loop involving:

- **Hypothalamus**: Releases thyrotropin-releasing hormone (TRH).
- **Anterior Pituitary Gland**: Releases TSH in response to TRH.
- **Thyroid Gland**: Secretes T3 and T4; elevated levels inhibit TRH and TSH secretion to maintain homeostasis [14].

Functions of Thyroid Hormones

Thyroid hormones play a vital role in various physiological functions:

- **Metabolism**: They regulate basal metabolic rate (BMR), influencing carbohydrate, fat, and protein metabolism [15].
- **Growth and Development**: Crucial for healthy growth, especially in youngsters, impacting organ maturation and skeletal development [14].
- **Thermoregulation**: Use thermogenesis processes to help maintain body temperature [9].
- **Cardiovascular Function**: By improving the sensitivity of β-adrenergic receptors in cardiac tissues, one can raise heart rate and cardiac output [9].

Pathophysiology

Numerous disorders can result from thyroid gland dysfunction, including:

1- Hypothyroidism: The symptoms of hypothyroidism include bradycardia, weight gain, weariness, and cold sensitivity. It is characterized by insufficient hormone production. It frequently arises from autoimmune conditions such as iodine insufficiency or Hashimoto's thyroiditis [15].

2- Hyperthyroidism: Overproduction of hormones can result in palpitations, anxiety, heat sensitivity, and weight loss. Common causes include illnesses like Graves' disease [15].

Roles of Iodine in Thyroid Gland

The most important contribution of iodine to human physiology is its participation in the synthesis by the thyroid gland of the thyroid hormones. Biological significance of iodine is due to its incorporation into the hormone thyroxin (T4) and triiodothyronine (T3) which regulate growth, development and the basal metabolism rate. Iodine is absorbed into the thyroid follicular cells by active transport via the sodium/iodine symporter (NIS). Iodine is

then oxidized and organified within thyrocytes by the action of thyroid peroxidase (TPO), allowing its incorporation into the tyrosine residues of the thyroglobulin molecule. Iodinated tyrosines are coupled to make T4 and T3, which are stored in the colloid and released into circulation to mediate systemic metabolic effects [16, 17]. Apart from its classical role in thyroid hormone synthesis, iodine exhibits strong antioxidant properties, acting as a reactive oxygen species (ROS) scavenger and thereby providing cellular protection. Moreover, apart from its role in thyroid hormone biosynthesis iodine has broader physiological relevance due to its bactericidal, antiviral and antifungal properties. It is also the case that various other human cancer cell lines suggest these extrathyroidal roles pertain to anti-cancer effects as well. Although thyroid gland uniquely accumulates iodine and uses it to synthesize thyroid hormones, iodine is also found in a large number of other tissues including breast, placenta, and the gastrointestinal tract [16, 18], suggesting that there could be multiple physiological roles of iodine.

Thyroid hormones that are synthesized from iodine are essential, especially during fetal life, infancy, and childhood, and they regulate important processes such as neural differentiation, myelination, gene expression, and growth. Iodine deficiency impacts normal thyroid hormone biosynthesis, which contributes to a wide spectrum of disorders like goiter, hypothyroidism, impaired neurocognitive development, and greater risk for adverse pregnancy outcomes. On the other hand, an excess of iodine can trigger thyroid dysfunction, such as autoimmune thyroiditis and hyperthyroidism, which underscores the narrow physiological range for an optimal iodine intake [17, 19-21].

Radionuclides for Thyroid Gland

By taking advantage of the thyroid's only physiologic property of collecting iodine and other elements, radionuclides make it a central component of the diagnosis and treatment of thyroid disorders. Table (1) shows the main radionuclides used in nuclear medicine for thyroid imaging and therapy, which include technetium-99m (^99mTc) pertechnetate and radioisotopes of iodine, such as Iodine-123 (^123I) and Iodine-131 (^131I) [22-25]. As a result of its excellent imaging characteristics and gamma emission, ^99mTc pertechnetate is a preferred radiopharmaceutical in thyroid scintigraphy, allowing thyroid function, nodularity, and differentiation of lesions to be obtained with a minimum radiation dose [26]. ^123I is a short-lived gamma emitter; creating a clear thyroid visualization with a dose of radiation significantly lower than that of ^131I, and is therefore implemented in diagnostics [27]. ^131I is the beta and gamma emitter workhorse for ablation of remnant thyroid tissue and differentiated thyroid cancer metastases (diagnostic and therapeutic at the same time) [25]. Over the years, radioiodine therapy for differentiated thyroid cancer has seen its application modified these last years, with relevant modifications in guidelines and clinical trials to assure its optimal use with the minimal side effect [25]. In particular, the ongoing advancements in radiopharmaceuticals as well as imaging modalities promote timely management of thyroid disease in a patient-centered way, ultimately increasing diagnostic and therapeutic precision in modern nuclear medicine.

Table 1: Main radioactive isotopes used in diagnosis and treatment thyroid gland [22-25]

Isotope	Application	Half-life	Main Radiation Emitted	Academic Source
^{123}I	Imaging	≈ 13 hours	Gamma (159 keV)	[22].
^{131}I	Therapy, Imaging	≈ 8 days	Beta (606 keV), Gamma (364 keV)	[23]. [24].
^{99m}Tc	Imaging	≈ 6 hours	Gamma (140 keV)	[25]

Protocols of Radiation Dose for Thyroid Treatment

RAI therapy dosing protocols depend on risk of disease, goals of treatment, and some patient-specific characteristics. These treatment doses are often expressed in GBq or millicuries of radioiodine (I^{131}).

Recent meta-analyses have documented a solid dose-response relationship between the effective radiation absorbed dose to the thyroid gland and the result of therapy for both Graves' disease and functional thyroid nodules. The quotiant of reaching euthyroidism potentiates with increased radiation absorbed dose reaching a plateau between 120–180 Gy (equivalent to 12–18 Gy fractions) whereas 128 Gy appears to be optimal for achieving the euthyroid dosage exerting a high hypo-secretory efficacy with minimal risk for hypothyroidism.

While the standard dosing aims between 370 and 555 MBq, personal dosimetry to personalize absorbed doses to improve the treatment by avoiding under- or over-treatment has been shown to be beneficial [22].

For example, risk stratification by clinical guidelines such as the ATA defines risk categories for differentiated thyroid cancer, which guide RAI dosing. Remnant ablation is applied with doses usually between 1.1 to 3.7 GBq (30–100 mCi) in low-risk patients, whilst for intermediate or high-risk patients the doses range from 1.1 to 5.5 GBq (30–150 mCi) for adjuvant therapy. In this setting, high-risk patients with active disease might need 3.7 to 7.4 GBq (100-200 mCi) or dosimetry-based doses. In comparison, low doses and high doses differ in terms of clinical predicate; low doses [21, 22] are selected on the basis of age, tumor characteristics, and postoperative thyroglobulin levels [23].

Approaches to dosimetry in RAI therapy fulfil two roles: an "as high as safely administrable" (AHASA) method, which restricts organ radiation doses, and an "as low as reasonably achievable" (ALARA) method, which focuses on giving the therapeutic dose to thyroid tissue or metastases whilst sparing the rest of the body from unnecessary exposure. While personalized dosimetry is of particular importance in patients who are pediatrics, elderly, or metastasizing, many centers still opt for simpler fix-dose regimens due to ease of use [23]. Research efforts are ongoing to develop the best personalized treatments for TH before end-organ damage occurs by incorporating disease-specific factors such as thyroid volume and half-life of radiation absorbed dose rate into patient-tailored treatment planning, minimizing adverse effects of therapy such as lifelong hypothyroidism or secondary malignancies [22, 23].

Radionuclides Uptake in the Thyroid: Mechanisms and Clinical Applications

Mechanism of Radionuclide Uptake in Thyroid Gland

This uptake mechanism is mainly provided by the NIS, an integral membrane glycoprotein located at the basolateral membrane of the thyroid follicular cell. NIS facilitates the active transport of iodide ions against the concentration gradient from the bloodstream to the thyroid cells, in which two sodium ions are transported together with 1 iodide ion using the sodium gradient that is maintained by Na-K-ATPase. It selectively concentrates iodine up to 30 folds compared to plasma levels allowing for the efficient biosynthesis of thyroid hormone [28].

The NIS is expressed and translocated to the membrane under the regulation of the thyroid-stimulating hormone (TSH), which controls iodide uptake. In pathological states, NIS functions and expression are modified affecting the uptake of radionuclides. In differentiated thyroid cancer refractory to radioiodine (RAI) treatment, increased endocytosis and decreased membrane targeting of NIS are some of the mechanisms for reduced uptake of radionuclides. Chloroquine, a pharmacological agent that inhibits endocytosis, has been demonstrated to promote NIS retention at the membrane and increase RAI uptake in preclinical models of radioiodine-refractory thyroid cancer [25, 29].

Clinical Uses of Radionuclide Uptake in Thyroid Disease

Thyroid radionuclide uptake is a test using isotopes like radioactive iodine-131 (I-131), iodine-123 (I-123), or technetium-99m pertechnetate to assess the function of the thyroid gland. The radioactive iodine uptake (RAIU) test simply describes the amount of vocation of radionuclide up to thyroid gland within certain period (usually 4-6 and 24 hours after vocation) [30, 31].

RAIU is employed primarily for:

-Differentiation of causes of hyperthyroidism include Graves' disease, toxic nodular goiter, and thyroiditis.

18F-FDG-PET/CT: optimizing I-131 dosing for hyperthyroidism treatment.

–Evaluation of thyroid nodules to distinguish 'hot' (functioning) from 'cold' (nonfunctioning) nodules (with a higher risk of being malignant if cold) [31,32].

Radionuclide capture also has a significant role in the management of thyroid cancer, be it in detecting residual or metastatic disease or assessing therapeutic response following a thyroidectomy. RTDCs continue as a major area of research, with new agents and approach involving either restoring or increasing radionuclide retention into the tumors [31, 33].

Factors Influencing Radionuclide Uptake

Radionuclide uptake in the thyroid gland is determined by a series of physiological and pathological factors:

- TSH levels are major determinants of NIS expression & iodide uptake.
- Iodine intake and body iodine stores can modulate uptake capacity.
- Some medications and radiological contrast agents can affect the uptake.

- Disorders of thyroid function (such as hypothyroidism, thyroiditis, or thyroidectomy) alter radionuclide kinetics [31].

Thyroid Imaging Modalities

Ultrasonography (US) Most common imaging method and the most sensitive technique for the study of thyroid nodules and other intrathyroid lesions. It uses high-frequency sound waves (7–13 MHz transducers) to generate real-time images and high-resolution morphological characterization without radiation exposure. To assess cervical lymph nodes and to help differentiate benign from malignant nodules, Doppler ultrasound provides additional pattern evaluation of the vascularity [34].

Radionuclide Imaging:

Evaluation of the functional state of the thyroid gland in thyroid scintigraphy by using isotopes Tc-99m pertechnetate, I-131 iodine, F-18 FDG, and gallium-67. Hot/warm/cold nodules are detected and play a vital role in the assessment of thyroid cancer, such as in the monitoring of residual disease and metastases. More recent methods including SPECT and PET provide 3-dimensional functional imaging and the ability to fuse anatomical and functional data, increasing sensitivity for visceral metastasis and recurrent cancer [34].

Computed Tomography (CT) and Magnetic Resonance Imaging (MRI):

Its adjunctive role in evaluation of tumor extension, large goiter, thyroid cancer staging, and for detection of metastases. CT is more sensitive for the detection of intrathyroidal calcifications than MRI, and malignant nodules can be distinguished from benign nodules by diffusion-weighted imaging (DWI) of MRI. PET-CT and PET-MRI are two cutting-edge assessment methods for cancer integrated into one [34, 35].

Functional and Molecular Imaging

1- Thyroid Uptake and Scintigraphy
2- Determines radioactive iodine uptake, indicating thyroid functional capacity, and directing towards a diagnosis of hyperthyroidism, thyroiditis or cancer [36].
3- Ultrasound-Guided Fine Needle Aspiration (FNA): Biopsy of thyroid nodules with imaging to ensure malignancy [37, 38].

Current and Future Aspects of Radionuclide Therapy for Thyroid Gland

Current radionuclide therapy (RNT) for thyroid gland cancer, mainly radioactive iodine (I-131) therapy, remains a cornerstone of treatment for differentiated thyroid cancer (DTC) following thyroidectomy. Its current clinical use has evolved from routine application to a more selective, risk-adapted, personalized approach based on tumor biology and patient risk stratification.

The therapy's current aspects include radioiodine ablation to destroy normal thyroid remnants in low-risk patients to aid follow-up. Adjuvant therapy to eliminate suspected microscopic tumor tissues in low- and intermediate-risk patients to reduce recurrence risk. Treatment of persistent or metastatic disease to improve survival and quality of life [39, 40].

Future directions in radionuclide therapy for thyroid cancer emphasize molecular theranostics—integrating molecular imaging and targeted radionuclide treatments tailored to individual tumor profiles. Advances in molecular profiling, imaging technologies, and radioiodine refractory cancer management are enabling more precise treatment. Novel targeted therapies, including kinase inhibitors (e.g., sorafenib, sunitinib) and agents sensitizing tumors to radioactive iodine, are used for resistant cases. Research is also exploring the use of beta-catenin modulation to enhance sodium iodide symporter function, improving radioiodine uptake [42, 43].

Clinical trials with new drugs like larotrectinib for specific genetic alterations (NTRK fusion) are showing promising outcomes, minimizing side effects compared to chemotherapy. Efforts continue to optimize dosing and imaging protocols with software tools to simplify dosimetry and treatment planning for broader clinical adoption. Overall, the future lies in personalized, molecularly guided radionuclide therapies integrated with systemic targeted treatments for complex thyroid cancer cases [45].

Clinical Limitations and Challenges of Current Radionuclide Therapy for Thyroid Gland

Current radionuclide therapy for thyroid gland cancer faces several clinical limitations and challenges. A major issue is radioiodine-refractory differentiated thyroid cancer, where tumor cells lose the sodium iodide symporter (NIS) function, which reduces their ability to uptake radioactive iodine, leading to poor response to standard radionuclide therapy and necessitating alternative treatments. The molecular heterogeneity and more aggressive

thyroid cancer variants require personalized dosimetry and combination therapies to improve efficacy while minimizing toxicity [41].

In clinical practice, internal dosimetry adds complexity and time, requiring sequential imaging for dose quantification, which can be challenging for patients with advanced disease or limited mobility. The lengthy imaging protocols, coordination for delayed scans, and data processing may delay treatment start, which is problematic for fast-growing tumors. Moreover, the benefits of individualized dosimetry have not been conclusively proven to outweigh these logistical and cost challenges in routine clinical use.

Radioactive iodine therapy, while effective for many thyroid cancer patients, can cause adverse effects such as salivary gland damage, dry mouth, transient bone marrow suppression, and has associated long-term risks including secondary malignancies. Its efficacy is sometimes hindered in high-risk or refractory cases, where multiple treatment modalities including surgery, chemotherapy, targeted therapies, or external beam radiation may be needed. There is ongoing research and software development to simplify dosimetry procedures and improve treatment personalization [40,42].

CONCLUSION

Radionuclide therapy remains a vital and effective treatment modality for thyroid cancer, particularly differentiated thyroid cancer, relying primarily on radioactive iodine (I-131) for therapeutic use, and gamma-emitting isotopes such as technetium-99m and iodine-123 for precise diagnostic imaging. The review highlights that treatment efficacy is strongly dependent on biological factors like sodium-iodide symporter expression and advances in personalized dosimetry aimed at maximizing therapeutic doses while minimizing toxicity to non-target organs. Challenges persist, especially in managing radioiodine-refractory thyroid cancers, which require innovative approaches integrating molecular biology, targeted therapies, and immunotherapy. The review underscores the promising role of molecular radiotheranostics, which combines diagnostic imaging and therapy tailored to individual tumor profiles, enhancing precision medicine in thyroid cancer management. A multidisciplinary approach encompassing nuclear medicine, endocrinology, molecular biology, oncology, and radiology is essential to improve patient outcomes by optimizing diagnosis, treatment planning, and follow-up. Future directions emphasize the development of novel radiopharmaceuticals, personalized dosimetry software, and combination modalities to address refractory disease and reduce side effects.

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ETHICS STATEMENTS

This research was conducted in accordance with established ethical standards and in compliance with the research policies and academic ethics of the research institution.

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من التشخيص إلى العلاج: مراجعة شاملة لدور النظائر المشعة في علاج سرطان الغدة الدرقية

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الخلاصة

يُعتبر استخدام النظائر المشعة في تشخيص وعلاج سرطان الغدة الدرقية جزءًا أساسيًا من الطب النووي الحديث. تلعب النظائر المشعة التي تُصدر أشعة جاما مثل technetium-99m و iodine-123 الدور الرئيسي في التصوير التشخيصي، مما يتيح حساسية ونوعية عالية، وتصوير وظيفي غير جراحي لفسيولوجيا الغدة الدرقية وأمراضها. أما iodine-131 فهو النظير العلاجي الأساسي، حيث يصدر إشعاع بيتا السام للخلايا، ويُستخدم لعلاج سرطان الغدة الدرقية المتمايز المنتشر وإزالة بقايا الغدة الدرقية. تتوقف فعالية علاج اليود المشع على عوامل عدة منها التعبير عن ناقل الصوديوم-اليود و بالإضافة إلى طرق قياس الجرعات التي تسعى إلى زيادة الجرعات المُمتصة لتحقيق علاج ناجح في الوقت نفسه مع الحد الأدنى من الآثار الجانبية مثل قصور الغدة الدرقية. بدأت طرق العلاج التشخيصي الإشعاعي الجزيئي ومعايرة الجرعات الشخصية تدخل تدريجيًا في الروتين السريري، مما يعطي قدرة تشخيصية عالية وكفاءة علاجية عالية في المستقبل.

لطالما شكّلت سرطانات الغدة الدرقية المقاومة لليود المشع تحديًا في التعامل معها، مما استدعى اتباع مناهج جديدة لدمج البيولوجيا الجزيئية والعلاجات الموجهة والعلاج المناعي. يُبرز السياق المتغير لاستخدام النويدات المشعة في رعاية الغدة الدرقية ضرورة اتباع مناهج متعددة التخصصات، والتي تُبشر بتحسن نتائج المرضى وإدارة سرطان الغدة الدرقية.

الكلمات المفتاحية: النظائر المشعة، اليود المشع، سرطان الغدة الدرقية، ناقل الصوديوم-اليود