

NUCLEAR ONCOLOGY

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Various radionuclides or isotopes are used in the imaging and treatment of cancers in different organs of human body (Table 1).

TABLE 1 Radionuclides used in cancer

Organ	Isotope	Chemical form	Time of scan
Thyroid	I-131	Nal	24-72h after oral dose
Liver	Tc-99m	Colloid	Immediate post-injection (i.v.)
	I-131 /Re- 188	poppyseed oil (Lipiodol)	
Bone	Tc-99m	Methylene Diphosphonate (MDP)	Three phase study: 0-3 h after i.v.inj.
Colon and Rectum	Tc-99m	Antibody	2-5h post-inj i.v.
Kidney	Tc-99m	Diethylene triamine penta acetic acid (DTPA)	0-3h post-inj i.v.
		Dimercapto-Succinic acid (DMSA)	
Lymph-node	Tc-99m	Colloid	0-1h post-inj subcutaneously
Neuro-endocrine tumor	I-131	Meta-iodo-benzyl-guanidine(MIBG)	2-5 days post-inj.
	I-123		
Malignant ascites/pleural effusion	P-123	Colloidal chromic phosphate	

THYROID

The great Arab physician Abul Quasim was the first who used thyroid aspirates to differentiate various types of goitres (1013-1107 A.D.)¹ Since 1938, radioiodine is being used in the diagnosis and treatment of thyroid diseases. It is used for assessing functional status of nodular goitre. In a biopsy-proven papillary/follicular carcinoma of thyroid gland post-thyroidectomy remnant ablation is done by a 29 milli-Curies dose of ¹³¹I and a whole-body gamma-scan is done to detect any occult metastasis. Follow -up

scans are done after 3-6 months intervals with thyrotropin stimulation (avoiding thyroxine for six weeks and tri-iodothyronine for three weeks).¹⁸ ¹⁸F fluorodeoxyglucose (FDG) is used in scanning thyroid metastases in presence of thyroxine feeding. Positron emission tomography (PET) cameras dedicated to oncology, or single photon emission computed tomography (SPECT) cameras with systems of positron coincidence detection are becoming reference techniques.² However, radio-

fluorine is not yet available in Bangladesh. "Hot" nodules that take up radioiodine in excess of the surrounding thyroid have a low probability of malignancy, estimated at 1% to 4%.³ Warm nodules, having uptake about the same as that of the surrounding thyroid, are usually adenomas but have about a 10% chance of being malignant.⁴ Cold nodules have about a 10% to 25% chance of malignancy and require aspiration biopsy; nevertheless, the great majority of cold nodules are benign. Human TSH (thyroid stimulating hormone or thyrotropin), commercially known as thyrogen is being used in some countries to search thyroid metastases quickly, but its clinical utility and cost-effectiveness is not beyond doubt. Whole-body radioiodine scans for detection of residual and metastatic disease before ablation or treatment can be done with a diagnostic 2mCi dose of ¹³¹I, although generally all that is identified is residual thyroid tissue and this low dose of ¹³¹I may reduce uptake of the subsequent ablative therapy dose, in a process known as stunning.⁵ When substantial locoregional disease is detected, or excessive thyroid remnants are identified by scanning (radioiodine uptake >5-10%), additional surgery before radioiodine administration should be strongly considered. A scan is often done several days after administration of the therapeutic radioiodine dose. This post-treatment scan has a greater sensitivity to detect metastatic disease than the pre-ablation diagnostic scan, because sensitivity relates directly to the amount of radioiodine given.^{6,7} By providing evidence of metastatic disease, post-treatment scans can help physicians to decide on the intensity of future diagnostic procedures and treatments.⁷

LYMPH NODE

Lymphoscintigraphy and sentinel lymphnode mapping by surgical gamma probe are very useful procedures in the patients with breast cancer. Sentinel lymph node (SLN) is the first lymph node encountered by lymphatic vessels draining a tumour. The SLN will most likely be the first to be affected by metastasis, and a negative SLN makes it highly

unlikely that other nodes are affected. In breast cancer surgery, axillary node dissection is performed to stage the axilla and does not improve prognosis of the patients. It can also lead to significant morbidity. As 70% of patients are free from metastases, SLN biopsy might replace complete axillary dissection to stage the axilla in clinically no node palpable patients. SLN biopsy can also increase accuracy of histopathologic staging of the axilla by focusing on the SLN. The practice of SLN biopsy requires collaboration among surgical oncologists, nuclear medicine physicians, histopathologists and medical physicists. Nuclear Medicine physicians are responsible for administration of radiopharmaceutical and performing lymphoscintigraphy (SLN imaging). ^{99m}Tc labelled colloids with majority of the particles in the 100-nm to 200-nm size range provide the best results for SLN biopsy in breast cancer. There are four variables in the administration of radiocolloids: site of injection, volume of the injectate, radioactivity injected and the timing of the injection relative to the surgery. 0.5 to 5 ml of radiocolloids with radioactivity varying from 0.5 to 10 mCi have been used. The injection can be made into the tumour, the parenchyma surrounding the tumour, the skin overlying the tumour or the subareolar region of the breast.²⁶⁻²⁸

KIDNEYS

Both Wilms tumor and renal adenocarcinoma may show varying vascular patterns in dynamic renal scan, followed by irregularly spheric voids seen on static scintigrams. An unusually high vascular perfusion pattern suggests arteriovenous malformation (AVM) or the rare angiolipoleiomyoma (ALM) rather than malignant neoplasm.²⁹ Radionuclide renogram provides accurate informations regarding individual kidney functions and may help to monitor therapy of various cancers if needed.

NEURO-ENDOCRINE TUMORS

Adrenal medulla and neuro-endocrine tumors can be imaged by MIBG and also treated by MIBG

labelled by ^{131}I . In 1987, Beierwaltes et al¹⁴ gave C-labelled precursors of epinephrine to dogs and sacrificed the dogs at 6 hr. Then they developed norepinephrine structured analogs.³⁰ MIBG may concentrate diagnostically ^{123}I or ^{131}I and therapeutically ^{131}I in all tumors with neurosecretory granules, e.g. medullary thyroid carcinoma, carcinoid, small cell carcinoma of the lung, Merkel cell carcinoma of the skin, gastrinomas, and insulinomas.¹²⁵ MIBG is being investigated to treat neuroblastomas, the cells of which may be interspersed with normal bone marrow cells.¹²⁵ ^{125}I is an ultra-short-range auger electron emitter, with a range of 10 nm and is localized intracellularly within the nucleus.³¹

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