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Full length research paper

Dosimetric evaluation due to radiation in thyroid issued by Tc^{99m} and I^{131}

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Abtract

The absorbed dose in the thyroid uptake studies is estimated, by analysis of the biokinetics of radiopharmaceuticals containing the I-131 (iodide) or Tc- 99m (pertechnetate) Using the MIRD formalism and Cristy-Eckerman representation for adult thyroid patients, demonstrated that the dose absorbed by the gland due to emissions of I-131(iodide) is self - dose and is given by 340.9 mGy / MBq ; dosimetric contribution of organs that are part of its bio kinetics (excluding thyroid) is not significant in the estimated dose.The absorbed dose to the gland due to emissions of Tc-99mTc (pertechnetate) is 0.0234 mGy / MBq; 7.6% are organ dosimetry contributions that are part of its biokinetics (excluding thyroid), and is very significant in the estimated doses to be ignored

Keywords: MIRD dosimetry, Cristy-Eckerman phantom, thyroid uptake, iodide and pertechnetate.

INTRODUCTION

The dose absorbed by the thyroid gland of an adult, for uptake studies, can be estimated by analyzing the biokinetics of radiopharmaceuticals used, containing I-131(iodide) orTc- 99m pertechnetate

MATERIAL AND METHODS

To estimate the absorbed dose to the thyroid of adult patients, due to the dosimetric contributions biokinetics bodies, were used MIRD formalism and representation of Cristy-Eckerman to these organs. **M**edical **I**nternal **R**adiation **D**osimetry considered equations (Radiation doses received by patients following administration of radiopharmaceutical, 2013)

$$\frac{D_{fotones}(tiroides)}{A_0} = \sum_{i=1}\left[\sum_k \Delta_k \Phi_k (tiroides \leftarrow i)\right]\tau_i \quad rad/\mu Ci$$

$$\frac{D_{particle}(tiroide \leftarrow tiroide)}{A_0} = [\bar{E}_{particle}\frac{\tau_{tiroide}}{m_{tiroide}} + \bar{E}_{particle}\frac{\tau_{TB}}{m_{TB}}]x2{,}13 \quad rad/\mu Ci$$

τ_{TB} = Total residence time of the body

m_{TB} = Total body mass

The absorbed fractions, Φk (thyroid ← i) g^{-1}, of "i" analyzed organs (organs biokinetics), for photon energies "k" of I-131 and Tc-99m were obtained from ORNL / TM-8381 / V7 (Cristy MYK and Eckerman, 1987). Residence times of radiopharmaceuticals mentioned in each organ biokinetics given in Tables 1 and 2, were obtained from the website (Kinetic Models Used as the Basic for the Dose Estimates, 2013)

$\Delta_k = 2{,}13\ n_k\ E_k\ (\frac{rad - gm}{\mu Ci - hr})$, represents the average energy of the "k" photons emitted in the decay of I^{131} and Tc^{99m}, given in Table 3, were obtained from web page (Radionuclide Decay Data 2013)

$\bar{E}_{particle}$ (MeV/des.), Represents the average energy of particles emitted by the I-131 and Tc-99m, ie represents the electrons appearing in the decay processes for capturing and Auger electrons are given in Table 4 and

Table 1: Residence times (hours) and bio kinetics of I-131 (iodide) (Kinetic Models Used as the Basic for the Dose Estimates, (2013)

0rgans of bio kinetics iodide	Thyroid	Stomach	Small intestine	Kidneys	Bladder	Rest of body
τ_i (hours)	60,72	1,66	1,66	0,095	1,32	7,76

Table 2: Residence times (hours) and biokinetics of 99mTc (pertechnetate) (Kinetic Models Used as the Basic for the Dose Estimates,2013)

Organs of bio kinetic. Iodide	Thyroid	Stomach	ULI Content	Kidney	Bladder	Rest of body	ULI wall	LLI content
τ_i (horas)	0,037	0,154	0,743	0,033	0,345	4,32	0,54	0,363

Table 3: Data for nuclear emitted photons (MeV) of I-131 and Tc-99m most significant (Radionuclide Decay Data 2013)

RFM	Photons	E_k (Me V)	n_k /des	$\Delta_k = 2{,}13\ n_k E_k$ $(\frac{rad - gm}{\mu Ci - hr})$
I^{131}	Gamma	0,080	0,026	0,0044
		0,284	0,06	0,0363
		0,364	0,817	0,6334
		0,637	0,0717	0,097
		0,723	0,0177	0,027
	Radiation Característic	0,0295	0,0138	0,00088
		0,0298	0,0256	0,0016
		0,0336	0,009	0,0006
Tc^{99m}	Gamma	0,14053	0,8906	0,2665
		0,1426	0,0002	0,0001
	Radiation Característic	0,0183	0,021	0,0008
		0,0184	0,040	0,0016
		0,0206	0,012	0,0005

were obtained from web page (Radionuclide Decay Data 2013).

Mass values thyroid and organ biokinetics were obtained from 0RNL / TM-8381 / V1 (Cristy MYK and Eckerman, 1987) and are given in Table 5 Using the MIRD methodology and Cristy-Eckerman representation thyroid of adult patients, the study is to demonstrate whether the dosimetric contributions organs that are part of the biokinetics of I-131 (iodide) and Tc-99m (pertechnetate), is significant in the estimated absorbed dose to the gland

RESULTS

The results are shown in Table 6 and show that:

(1) The absorbed dose to the gland due to emissions from I-131 (iodide) is 340.9 mGy / MBq; 99.98% is self - dose (90.06% to beta emissions, 3.76 %, conversion electrons, Auger electrons 0.15%, and the remaining 6.01%, due to the gamma / photon radiation characteristic). The dosimetric contribution of organs that are part of its biokinetics (excluding thyroid) is negligible

(2) The absorbed dose to the gland due to emissions of Tc-99m (pertechnetate) is 0.0234 mGy / MBq, the 92.77% is self - dose (70.51% conversion electrons, 4.27% to Auger electrons, the remaining 17.99% of gamma / photon radiation characteristics). The dosimetric contribution of organs that are part of its biokinetics (excluding thyroid), is 7.26%, significant value to be ignore

The results reported doses are consistent with results published in" Radiation Dose Estimates for Radiopharmaeuticals "(Radiation dose estimates for radiopharmaceuticals 2014)

Depending on the type of radiopharmaceutical used and biokinetics, shall the significance of their contributions in

Table 4: Data for nuclear emitted particles (MeV) of I-131 and Tc-99m most significante (Radionuclide Decay Data 2013)

RFM	Partícles	E_k (MeV)	n_k/des	$n_k E_k$ (MeV/des)	$\bar{E}_{particle} = \sum n_k E_k$ (MeV/des)
I^{131}	Beta	0,0694	0,021	0,00145	0,182
		0,0966	0,073	0,007	
		0,1916	0,899	0,1722	
		0,283	0,0048	0,00135	
	Electron Conversion	0,0456	0,0354	0,0016	0,0076
		0,359	0,0025	0,00089	
		0,3299	0,0155	0,0051	
		0,2497	0,003	0,00075	
	Electrons Auger	0,0034	0,051	0,00017	0,000317
		0,0246	0,006	0,000147	
Tc^{99m}	Electron Conversion	0,1195	0,088	0,01052	0,01439
		0,1216	0,0055	0,00067	
		0,1375	0,0107	0,0015	
		0,1396	0,0017	0,00024	
		0,140	0.0019	0,00026	
		0,0016	0,746	0,0012	
	Electrons Auger	0,0022	0,102	0,00022	0,00054
		0,0155	0,0207	0,00032	

Table 5: Mass values (g) for thyroid and whole body of an adult Cristy -Eckerman representation (Cristy and Eckerman, 1987)

Masa (gramos)	Adulto
Tiroides	20,7
Cuerpo total (TB)	73700

Table 6: Absorbed dose to the thyroid of adult, due to I-131 and Tc-99m in the representation Cristy - Eckerman and MIRD formalism (mGy / MBq)

RFM	emissiones	D(thy ← thy)/Ao	D(thy←i)/Ao*	Sub-total	TOTAL
I^{131} (iodide)	Photons: γ X	19,84 0,69	0,05 0,006	20,53	340,9
	Emission Beta e^- conversión e^- Auger	307,03 12,82 0,52	-	320,37	
Tc^{99m} (pertecnetate)	Photons: γ X	0,0037 0.00051	0,00167 0.000043	0.0059	0,0234
	e^- conversión e^- Auger	0,0165 0,001	-	0,0175	

(*) i = all source organs except the thyroid

the estimated absorbed dose to the thyroid gland (Quimby and Feitelberg, 1970)

CONCLUSIONS

Using the formalism MIRD and Cristy - Eckerman representation thyroid of adult patients, it is shown that for studies of thyroid uptake, the dosimetric contribution of organs that are part of the biokinetics of I-131 (iodide), excluding the thyroid is not significant in the estimated dose; while the dosimetric contribution of organs that are part of the biokinetics of Tc-99m (pertechnetate),

excluding the thyroid, is very significant in the estimated absorbed dose to the patient to be ignored.

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