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DosimetricContributionof the Organs ofthe BiokineticsofI-123 and Tc-99m in ThyroidDose ofChildren 1 to5 years

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ABSTRACT:*Using the MIRD formalism and representation Cristy-Eckerman in the thyroid of children aged 1 to 5 years, it is shown that the dose absorbed by the gland, due to I-123 (iodide) are given by 28.901 mGy / MBq and 15,475 mGy / MBq respectively; the dosimetric contribution of bodies that are part of its biokinetics (excluding the thyroid) is not significant in the estimated dose. The absorbed dose to the gland in children 1 to 5 years, due to Tc-99m (pertechnetate) is 0.211 mGy / MBq and 0.112 mGy / MBq respectively . Corresponding to 4.27% and 4.46% of those doses, (in children 1 and 5 years respectively), to diametric contributions of organs that are part of its biokinetics (excluding the thyroid), and are significant in the estimated dose to be ignored.*

Keywords:*Cristy-Eckerman phantom, iodid,MIRD dosimetry,pertechnetate, thyroid uptake*

I. INTRODUCTION

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

II. MATERIAL AND METHODS

To estimate the absorbed dose to the thyroid of children patients, due to the dosimetric contributions biokinetics bodies, were used MIRD formalism and representation of Cristy-Eckerman to these organs. Medical Internal Radiation Dosimetry considered equations[1]:

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

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

τ_{TB}=Total residence time of the body
$m_{TB=}$ Total body mass

The absorbed fractions, Φ_k (thyroid ← i) g^{-1}, of "i" analyzed organs (organs biokinetics), for photon energies "k" of I-131 and Tc-99m were obtained from Cristy M. and K.Eckerman[2,3]. Residence times of radiopharmaceuticals mentioned in each organ biokinetics given in Tables 1 and 2, were obtained from the website [4]

Table 1: Residence times (hours) and biokinetics of Tc-99m (pertechnetate) [4]

Órgansbiokinetic	Thyroid	Stomachcontent	ULI Content	Kidney	Bladdercontent	LLI content	Rest of body
τ_i (hours)	0.037	0.154	0.743	0.033	0.345	0.363	4.32

Table 2: Residence times (hours) and bio kinetics of I-123 (iodide) [4]

Órgansbiokinetic	Age (years)	Thyroid	Stómachcontent	Small intestine	Kidneys	Bladder	Rest of body
τ_i(hours)	1	2.910	1.08	1.08	0.062	0.833	5.03
	5	2.920	1.08	1.08	0.062	0.833	5.03

$\Delta_k = 2{,}13\ n_k\ E_k \quad (\frac{rad-gm}{\mu Ci-hr})$, represents 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 [5]

Table 3: Data for nuclear emitted photons (MeV) of I-123 and Tc-99m most significant[5]

RFM	**Photons**	E_k (Me V)	n_k/des	$\Delta_k = 2{,}13\ n_k\ E_k\ (\frac{rad-gm}{\mu Ci-hr})$
I^{123}	Gamma	0,159	0,833	0,2821
		0,529	0,0139	0,0157
	RadiationCaracteristic	0,0272	0,246	0,0143
		0,0275	0,460	0,0269
		0,0310	0,160	0,0106
Tc^{99m}	Gamma	0,1405	0,8906	0,2665
		0,1426	0,0002	0,0001
	RadiationCaracterístic	0,01832	0,021	0,0008
		0,0184	0,0402	0,0016
		0,0206	0,012	0,0005

$E_{particle}$(MeV/des.), Represents the average energy ofparticles emitted by the I-131 and Tc-99m, ie representsthe electrons appearing in the decay processes forcapturing and Auger electrons are given in Table 4 andwere obtained from web page [5]

Table 4: Data for nuclear emitted particles (MeV) of I-123 and Tc-99m most significante(Radionuclide **[5]**

RFM	Partículas	E_k(MeV)	n_k/des	$n_k\ E_k\ (MeV/des)$	$\bar{E}_{particle} = \sum n_k E_k\ (MeV/des)$
I^{123}	ElectronConversion	0,1272	0,136	0,0173	0,0206
		0,1540	0,0177	0,0027	
		0,1580	0,0035	0,0006	
	ElectronAuger	0,0032	0,94	0,0030	0,0058
		0,0227	0,1235	0,0028	
Tc^{99m}	Electron Conversión	0,1195	0,088	0,0105	0,0437
		0,1216	0,0055	0,0007	
		0,137	0,0107	0,0015	
		0,1396	0,0048	0,0007	
		0,140	0,019	0,0027	
		0.0016	0,746	0,0012	
	ElectronAuger	0,0022	0,102	0,0002	0,0005
		0,0155	0,0207	0,0003	

The values mass thyroid and organ biokinetics for children, are given in Table 5, and were obtained from Cristy M and K Eckerman [6].

Table 5: Mass values (g) for thyroid and whole bodyof an childrenCristy -Eckerman representation [6]

Age (years)	Massthyroid (m_f) (grams)	Mass of body (m_{TB}) (grams)
1	1.78	9720
5	3.45	19800

Using the methodology MIRD and representation of Cristy-Eckerman in thyroid of children, 1 and 5 years, the study is to demonstrate whether the dosimetric contributions of the organs that are part of the biokinetics of I-123 (iodide) and Tc99m (pertechnetate) are significant in the estimated absorbed dose for thyroid uptake studies.

III. RESULTS AND DISCUSSIONS

Table 6: Absorbed dose to the thyroid of children, one years, due to I-123(Iodide) and Tc-99m(Pertechnetate) in the representation Cristy – Eckerman and MIRD formalism (mGy / MBq)

Radiopharmac	Emissions	$\frac{D(T \leftarrow T)}{A_0}$	$\frac{D(T \leftarrow i)^*}{Ao}$	Sub- total	Total (mGy/MB)
Tc^{99m}	γ photons	0,020 (9.48%)	0,009 (4.27%)	0.0321 (5.17%)	0.211
	X radiation	0.003 (1.42%)			
	Internalconvertion	0,173 (81.99%)		0.179 (84.8%)	
	Augerelectron	0.006 (2.84%)			
I^{123}	γ photons	1,706 (5.90%)	0.017 (0.06%)	4,196 (14.5%)	28,901
	X radiation	2,473 (8.56%)			
	Electronic capture	19,251 (66.61%)		24,705 (85.4%)	
	Augerelectron	5,454 (18.87%)			

Table 7: Absorbed dose to the thyroid of children, five years, due to I-123(Iodide) and Tc-99m(Pertechnetate) in the representation Cristy – Eckerman and MIRD formalism (mGy / MBq)

Radiopharmac	Emissions	$\frac{D(T \leftarrow T)}{A_0}$	$\frac{D(T \leftarrow i)^*}{Ao}$	Sub- total	TOTAL (mGy/MBq)
Tc^{99m}	γphotons	0.013 (11.61%)	0,005 (4, 46%)	0.020 (17.86%)	0.112
	Xradiation	0.002 (1.79%)			
	Electroniccon vertion	0.089 (79.46%)		0.092 (82.14%)	
	Augerelectron	0,003 (2,68%)			
I^{123}	γradiation	1,169 (7,56%)	0,008 (0.05%)	2,683 (17,34%)	15,475
	Xradiation	1,506 (9,73%)			
	Electronic capture	9,968 (64,41%)		12,792 (82.66%)	
	e^-Auger	2,824 (18.25%)			

(*) i = all source organs except the thyroid

The results ofthyroidabsorbed dosein childrenone to five years, they are given inTables 6and 7 andshow that:

(i) The absorbed dose of I-123 in thyroid of children 1 year is 28.901 mGy / MBq; 99.94% of the dose corresponds to its self - doses (to 66.61% due to electron capture; 18.87% to Auger electrons; 5.90% due to gamma photons and 8.56% to the characteristic radiation). The remaining 0.06% corresponds to the dosimetric contribution due to biokinetics organs. The absorbed dose of I-123 in thyroid of children 5 years is 15,475 mGy / MBq; 99.95% of the dose corresponds to its self - doses (64.41% to electron capture; 18.25% of Auger electrons, 7.56% due to gamma photons and 9.73% to the characteristic radiation). The remaining 0.05% corresponds to the dosimetric contribution due to organs biokinetics.

The absorbed dose to the organs of the biokinetics due to I-123 is less than 1% and largely corresponds to local deposit of energy of its particles in such organs.

(ii) The absorbed dose of Tc-99m in thyroid of children 1 year is 0,211 mGy / MBq; 95,73 % of the dose corresponds to its self - doses (to 81,99 % due to conversion electron ; 2,84% to Auger electrons; 9,48 % due to gamma photons and 1,42% to the characteristic radiation). The remaining 4,27% corresponds to the dosimetric contribution due to biokinetics organs. The absorbed dose of Tc-99m in thyroid of children 5 years is 0,112 mGy / MBq; 95,54% of the dose corresponds to its self - doses (79,46% to conversion electron ; 2,68 % of Auger electrons, 11,61% due to gamma photons and 1,79 % to the characteristic radiation). The remaining 4,46% corresponds to the dosimetric contribution due to organs biokinetics,

Dosimetric contributions of the organs, which are part of the biokinetics of Tc-99m (except the thyroid) are very significant to be ignored and are due to its photons.

Depending on the type of radiopharmaceutical used and biokinetics, shall the significance of their contributions in the estimated absorbed dose to the thyroid gland [7,8]

IV. CONCLUSIONS

Using the MIRD formalism and representation Cristy-Eckerman in the thyroid of children aged 1 to 5 years, it is shown that dosimetric contribution of bodies that are part of its biokinetics due to I-123 (excluding the thyroid) is not significant in the estimated dose. The dosimetric contributions of organs that are part of its biokinetics due to Tc - 99m (excluding the thyroid), are significant in the estimated dose to be ignored.

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