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A N I N T E R N A T I O N A L J O U R N A L

Importance of the Nutritional Status for the Interpretation of Nuclear Medicine Examinations

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ABSTRACT

Malnutrition is very prevalent in the Third World, but still in developing Countries and is found in certain communities in developed Countries. Several laboratories examinations are affected by malnutrition. Recently, gestational or neonatal malnutrition were considered to contribute to the development of chronic diseases in adulthood, this phenomena was named programming or metabolic imprinting. Similar consideration were suggested for Nuclear Medicine examinations. Here we review the literature about this aspect and present our own data showing changes in biodistribution of a radiopharmaceutical compound in different animal models of adult malnutrition or caused by maternal malnutrition programming.

Key words: Programming, Nuclear Medicine, malnutrition, biodistribution, radiopharmaceuticals

INTRODUCTION

In Third World and developing countries economic factors, food habits and lack of nutritional guidance, lead to a high prevalence of malnutrition. Protein is the most expensive nutrient and its lack is more common than the deprivation of other nutrients (Teodósio et al., 1990). In developed countries, other factors contributes to the increase in malnutrition statistics, such as anorexia nervosa, vegetarians and vegans diets, severe "fad" diets, specially in busy, very well-paid professionals (Maire et al., 2002; Schneider, 2000).

Is very well documented that malnutrition affects thyroid function. One of the most common Nuclear Medicine examination is thyroid iodine or technetium uptake and scintigraphy. These examinations are affected by malnutrition, as we showed in fasted rats or protein malnutrition (Moura et al., 1987; Ramos et al., 1997). Recently, we showed (Passos et al., 2002a) that maternal protein malnutrition during lactation programs thyroid function of the adult offsprings. They showed higher thyroid hormones serum concentrations and thyroid radioiodine uptake, when they were 6 months-old. So, not only malnutrition has an effect during the period in which it occurred, as well as it has long acting effects that could appears a very long time after malnutrition has happened. This phenomenon was observed in other situations and it was associated with the appearance of chronic diseases in adulthood, such as diabetes mellitus, hypertension, coronary diseases and obesity. It has been termed programming (Lucas, 1994) or metabolic

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imprinting (Waterland and Garza, 1999) and it was defined as any event applied in a critical period that had long term effects in another period of life. Conditions that changes the biodistribution of radiopharmaceuticals may produce misleading interpretations of nuclear medicine examinations, due to poor organ visualization or false positive results. This may lead to repeat examinations, resulting in unnecessary irradiation of the organs (Gomes et al., 1998).

As malnutrition is highly prevalent in the world, it is important to define the biodistribution of radiopharmaceuticlas in different kind or periods of malnutrition, such as protein or energy deficiencies and evaluate if those nutritional disturbances in critical periods of life, could program the organs in changing their uptake rates of the different radiocompounds.

We studied adults rats submitted to a low-protein (LP - 8% protein) or low-energy (LE - approximately 60% energy-restriction, 23% protein) diet, during 21 days (Passos et al., 2000). After this period we evaluated the biodistribution of ^{99m}Tc-O_4Na in several tissues. In LP rats, there was an increase in stomach (66%), brain (138%) and heart (71%) uptake and decrease (83%) in thyroid uptake (Table 1). In LE group, the uptake was decreased only in the bone (52%). The higher availability of ^{99m}Tc-O_4Na, since it was less uptaked by the thyroid could explain the increase in uptake by other organs. However, this explanation is unlikely since the thyroid mass is too small compared to the other organs.

Table 1 - Biodistribution of ^{99m}Tc-O_4Na (%ID.g$^{-1)}$ of control and low-protein (LP) or low-energy (LE) young adult rats

	Groups		
Organ	Control	LP	LE
Thyroid	505±152	87±24*	471±55
Stomach	50±6	84±9*	38±4
Heart	4.3±0.5	7.4±1.3*	3.1±0.4
Brain	0.4±0.07	0.9±0.2*	0.4±0.01
Bone	6.2±0.7	4.6±0.7	3.0±.4*

(mean±SD of 10 animals in each group)
* p<0.05 or less against control

It is possible that tissue or organ specific changes in ^{99m}Tc-O_4Na uptake mechanisms could play an important role in those changes. Also, changes in the permeability of the blood-brain barrier could explain the increase in brain uptake in LP group. As this radiopharmaceutical is used mainly to study the thyroid and choroid plexus of the brain, we must be cautious on the interpretation of the results in malnourished patients.

We also showed, recently (Passos et al., 2002b), that the biodistribution of ^{99m}Tc-O_4Na was programmed by maternal protein or energy malnutrition during lactation. So, adult rats whose mother were submitted to a low protein diet showed the similar increase in stomach uptake (65%) and decrease in thyroid uptake (67%), but no changes in brain or heart uptake, as observed in adult rats submitted to LP diet (Table 2). By the contrary, the further consequences of maternal energy-restriction on the offspring´s ^{99m}Tc-O_4Na biodistribution were even more marked than in LE treatment in adult rats. We observed increase in stomach (65%), liver (53%) and testes (52%) uptake in this group, while only bone had changes in the uptake when energy-restriction was applied in the adulthood.

Table 2 - Biodistribution of ^{99m}Tc-O_4Na (%ID.g$^{-1)}$ of adult rats whose mother received during lactation the following diets: control, low-protein (LP) or low-energy (LE)

	Groups		
Organ	Control	LP	LE
Thyroid	500±140	336±58	725±174
Stomach	51±5	94±7*	94±4*
Liver	8.3±1.1	7.8±1.0	12.7±0.9*
Testes	2.5±0.2	2.6±0.4	3.8±0.3*

-(mean±SD of 10 animals in each group)
*p<0.05 or less against control

The thyroid uptake differ in LP group if the radiotracer was iodine or technetium. The difference could be due to the fact that only iodine is organified. So, those animals could have a decrease in the transport of iodine, that is the same for technetium, but have an increase in the thyroid hormone biosynthesis.

Thus, lactation could be a critical period that determines future changes in the biodistribution of radiopharmaceutical compounds in the adult offspring. Therefore, the nutritional status of mothers during lactation must be considered when

nuclear medicine examinations are indicated because this condition may produce false results. There is scanty data on this subject, thus it is necessary further studies in animals and malnourished humans to test the bioavailability of other radiopharmaceuticals and functional studies to establish the molecular basis of these changes.

RESUMO

A desnutrição é muito prevalente em países do Terceiro Mundo, mas ainda o é em países em desenvolvimento e em certas comunidades de países desenvolvidos. Diversos exames laboratoriais são afetados pela desnutrição. Recentemente, demonstrou-se que a desnutrição no período gestacional ou neonatal contribui para o surgimento de doenças crônicas na idade adulta. Este fenômeno foi denominado de programação ou impressão metabólica. Considera-se, de forma similar, que os exames de Medicina Nuclear poderiam ser afetados pela desnutrição ou programação. Neste artigo revisamos a literatura a este respeito, incluindo nossos próprios dados que mostram modificações na biodistribuição de um radiofarmaco em diferentes modelos animais de desnutrição em adultos ou causada por programação.

REFERENCES

Gomes, M. L.; Souza Braga, A. C.; Mattos, D. M. M.; Souza Freitas, R.; Boasquevisque, E. and Bernardo-Filho, M. (1998), The effect of mitomysin-C on the biodistribution of $^{99}Tc^{m}$-MDP in Balb/c mice. *Nucl. Med. Commun.,* **19,** 1177-1179.

Lucas, A. (1994), Role of nutritional programming in determining adult morbitidity. *Arch. Dis. Child.,* **71,** 288-290.

Maire, B.; Lioret, S.; Gartner, A. and Delpeuch, F. (2002), Nutritional transition and non-communicable diet-related chronic diseases in developing countries *Sante*, **12,** 45-55.

Moura, E. G.; Ramos, C. F.; Nascimento, C. C. A.; Rosenthal, D. and Breittenbach, M. M. D. (1987), Thyroid function in fasting rats: variations in ^{131}I uptake and transient decrease in peroxidase activity. *Braz. J. Med. Biol. Res.*, **20,** 407-410.

Passos, M. C. F.; Ramos, C. F.; Bernardo-Filho, M.; Mattos, D. M. M. and Moura, E. G. (2000), The effect of protein or energy restriction on the biodistribution of $Na^{99}Tc^{m}O_4$ in Wistar rats. *Nucl. Med. Commun.*, **21,** 1059-1062.

Passos, M. C. F.; Fonte Ramos, C.; Dutra, S. C. P.; Mouço, T. and Moura, E. G. (2002a), Long term effects of malnutrition during lactation on the thyroid function of offspring. *Horm. Metab. Res.*, **34,** 40-43.

Passos, M. C. F.; Ramos, C. F.; Dutra, S. C. P.; Bernardo-Filho, M. and Moura, E. G. (2002b), Biodistribution of ^{99m}Tc-O_4Na changes in adult rats whose mothers were malnourished during lactation. *J. Nucl. Med.*, **43,** 89-91.

Ramos, C. F.; Lima, A. P. S.; Teixeira, C. V.; Britto, P. D. and Moura, E. G. (1997), Thyroid function in post-weaning rats whose dams were fed a low-protein diet during suckling. *Braz. J. Med. Biol. Res.*, **30,** 133-137.

Schneider, D. (2000), International trends in adolescent nutrition. *Soc. Sci. Med*., **51**, 955-967.

Teodósio, N. R.; Lago, E. S.; Romani, S. A. M. and Guedes, R. C. A. (1990), A regional basic diet from norhteast Brazil as a dietary model of experimental malnutrition. *Arch. Latinoamer. Nutr.*, **40**, 533-547.

Waterland, R. A. and Garza, C. (1999), Potential mechanisms of metabolic imprinting that lead to chronic disease. *Am. J. Clin. Nutr.*, **69,** 179-197.

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