

Evaluation of ^{99m}Tc -DTPA Renal Scanning for Localization and Shielding of the Kidneys in Patients Candidate for Abdominal Radiotherapy

Mehrossadat Alavi MD¹, Shapour Omidvari MD²

¹Nuclear Medicine and ²Radiotherapy Departments, Namazee Hospital,
Shiraz University of Medical Sciences, Shiraz, Iran.

(Received 12 April 2005, Revised 15 May 2005, Accepted 6 July 2005)

ABSTRACT

Introduction: Clinical radiation nephropathy can result in considerable morbidity and/or mortality. Renal tolerance (TD5/5) has been stated to be 20 Gy when irradiation has been delivered to both kidneys in 3-5 weeks. Therefore to minimize renal toxicity in these patients, localization and shielding of the kidneys are essential. This study was carried out to evaluate the role of ^{99m}Tc -DTPA renal scintigraphy in renal localization for perfect shielding.

Methods: From April 2000 to March 2001, thirteen patients had complete history, physical examination, serum creatinine level, complete blood count, urinalysis and abdominal sonography. Then the patients were referred to nuclear medicine department. After I.V. injection of 10 mCi ^{99m}Tc -DTPA, the kidneys were localized by gamma camera and marked on skin. All patients received abdominal radiation with A-P and P-A fields with cobalt 60 machine up to 3000-5000cGY. Kidneys were shielded posteriorly after 1500cGY with 5 HVL (Half value layer) blocks.

Results: After minimum follow-up of 24 months, no evidence of increasing blood pressure, edema, proteinuria, rising in serum creatinin or changing in kidney size was found.

Conclusion: The results show that localization of kidneys by ^{99m}Tc -DTPA is a useful, easy and safe method to shield kidneys in these patients.

Key words: ^{99m}Tc -DTPA renal scan, Abdominal radiotherapy, kidney shielding.

INTRODUCTION

Clinical radiation nephropathy can result in considerable morbidity and/or mortality (1). Renal function impairment has been reported with unilateral renal dose of 40 Gy or more with 2 Gy fractionation (2). A mean dose of 19.28 Gy delivered to both kidneys with 1.02 to 1.25 Gy per fraction does not change the age related renal function. (3) Renal tolerance (TD5/5) has been stated to be 20 Gy when irradiation is given to both kidneys in 3-5 weeks. Although renal toxicity is avoidable by exclusion of an adequate volume of renal tissue treated more than a modest dose, the kidneys central location frequently makes this difficult when tumors of the abdomen or retro peritoneum are treated (1).

Therefore to minimize renal toxicity in those patients who need abdominal radiotherapy, localization and shielding of the kidney is essentials. We use ^{99m}Tc -DTPA for renal localization. Diethyltriaminepentacetic acid (DTPA) interacts with reduced Tc-99m to form a complex with a net negative charge in natural or weakly acidic solution (4). Biologically, following intravenous injection, ^{99m}Tc -DTPA is rapidly cleared from the blood by glomerular filtration (5-6).

To investigate the role of ^{99m}Tc -DTPA renal scanning this study was carried out to evaluate this method for renal localization.

METHODS

During April 2000 to March 2001 thirteen patients were referred to radiotherapy department of Namazee hospital of Shiraz for abdominal radiation. Seven patients were male and six were female. Before starting radiotherapy all patients had complete history and physical examination, serum creatinin urinalysis, complete blood count and abdominal sonography. The patients were referred to nuclear medicine for renal

localization. We used ^{99m}Tc -DTPA to mark the kidneys on skin. Immediately after intravenous injection of 10 mCi ^{99m}Tc -DTPA imaging was acquired with patient positioned under the gamma camera in prone position. The borders of the localized kidneys were marked on skin by ink.

All patients received abdominal radiation with anteroposterior and posteroanterior fields with cobalt-60 machine. Total dose was 3000 to 5000 CGY in 4 to 6 weeks according to tumor histology. Kidneys were shielded after 1500 CGY posteriorly with 5 HVL blocks. After radiotherapy patients were followed every three months for at least two years. In each visit physical examination was done and U/A, serum creatinine and CBC were checked. Each year afterwards abdominal sonography was repeated.

RESULTS

Among these 13 patients, eight patients were referred with lymphoma, 3 with retroperitoneal liposarcoma and 2 with germ cell tumor. The age range was 12-70 years with a mean age of 46.4(SD=4.8). Three patients had history of hypertension prior to treatment. After finishing treatment one patient missed follow-up and two others succumbed to their disease and were excluded from the study.

In the remaining ten patients and during follow-up period, no evidence of increasing blood pressure, edema, proteinuria or increasing serum creatinine was found.

Abdominal sonography showed no change in kidney size.

DISCUSSION

Although radiation induced renal damage was first described more than 95 years ago, the renal tolerance dose and clinical manifestations of bilateral renal irradiation were first well

categorized by Kunkler, Farr and Luxton. (7-8). They defined four types of clinical syndromes according to the extent of symptoms and the latent period from irradiation to appearance of clinical nephropathy. They stated that acute radiation nephritis appeared 6-12 months after radiotherapy, but hypertension and chronic radiation nephropathy appeared more than 18 months following irradiation.

Although some clinical data suggest that infantile kidneys are more sensitive to ionizing radiation (9), fractionated dose of 14 Gy seems to be safe when given without chemotherapy. (1)

Total body irradiation of 12-14 Gy before bone marrow transplantation has been associated with radiation nephropathy, but intensive chemotherapy in these patients may have contributed to the renal dysfunction.

Regarding the above-mentioned limitations in dose, which can be delivered to renal tissues in abdominal malignancies, a precise way to localize the kidney, is essential.

Kidney localization is performed with the aid

of intravenous pyelogram or CT scan during treatment simulation in many hospitals.

We used ^{99m}Tc -DTPA renal scanning in our center and our patients didn't show any evidence of nephropathy in a period of 24 months after treatment. On the other hand the method was safe. Estimated radiation absorbed dose of ^{99m}Tc -DTPA is low. Target organ is bladder wall with 0.019 mGy/MBq, because 95% of the radiotracer is excreted within 24 hours (10). Also the method was easy and not time consuming.

As a conclusion, in patients who need abdominal radiation, kidney localization and shielding by scanning method is useful, easy and safe.

In this study we had only a single arm and in all patients kidneys were localized with ^{99m}Tc -DTPA, so a comparison with other conventional techniques, like IVP or CT simulator was not possible. Further prospective studies may compare this technique with IVP or CT simulator.

REFERENCES

1. Cassidy JR. Clinical radiation nephropathy. *Int J Radiat Oncol Biol Phys.* 1995; 31:1249-1256.
2. Kim TH, Someville PJ, Freeman CR. Unilateral nephropathy-The long term significance. *Int J Radiat Oncol Biol Phys.* 1994; 10:2053-2059.
3. Flyes I, Wong A, Cheung CS, Zhu Y, Late Y. renal function following whole abdominal irradiation. *Radiotherapy and Oncology.* 1996; 38: 257-261.
4. Russed CD, Crittenden RC. Ionic charge on ^{99m}Tc -DTPA and ^{99m}Tc -EDTA by column ion change. *J Nucl Med.* 1980; 21: 345-360.
5. Kloppen JF. Evaluation of ^{99m}Tc -DTPA for the measurement of glomerular filtration rate. *J Nucl Med.* 1992; 13:107-110.
6. Duffy GJ, Baker FA. Comparison of individual kidney GFR measured by ^{99m}Tc -DTPA gamma camera renography and by direct collection of creatinine from each kidney in radionuclides in nephrology. Academic press, London, 1982; 101.
7. Kunkler PB, Farr RF. The limit of renal tolerance to X-rays. *Br J Radiol.* 1982; 25:190-201.
8. Luxton RW, Kunkler PB. Radiation nephritis. *Acta Radiol.* 1984; 169-178.

Myocardial ^{99m}Tc-MDP Uptake on the Bone Scintigraphy in the Hemodialysis-Associated Amyloidosis: A Case Report

A. Fard-Esfahani MD, M. Assadi MD, M. Saghari MD, M. Eftekhari MD, B. Fallahi Sichani MD, D. Beiki PhD, S. Akbarpour MD and M. Mohammadian MD

Research Institute for Nuclear Medicine, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran

ABSTRACT

Amyloidosis is characterized by an abnormal extracellular deposition of amyloid in different organs, where it usually causes some type of dysfunction. Its cause is unknown. Five different types of amyloidosis have been described according to the underlying disease; immunoglobulin amyloidosis, familial amyloidosis, senile systemic amyloidosis, secondary amyloidosis and hemodialysis-associated amyloidosis. We report a case of hemodialysis-associated amyloidosis in a 56-year-old man that radionuclide imaging demonstrated intense uptake of Tc-99m MDP within the myocardium. The diagnosis of amyloidosis was established by analysis of aspirated abdominal fat, although other non-invasive modalities didn't reveal any positive findings. The first clue to the possible presence of amyloidosis in this case was provided by the radionuclide bone scan performed, which revealed intense tracer uptake in the heart suggesting amyloid deposit. We conclude that in cases of extraosseous accumulation of Tc-99 MDP especially as a diffuse pattern of myocardial uptake, a diagnosis of amyloidosis should be considered, in an appropriate clinical setting.

Key Words : Amyloidosis, Tc-99m MDP, Myocardial uptake

Radioiodine Treatment Effects on Lacrimal Glands Function in Patients with Thyroid Cancer

A. Fard Esfahani MD, F. Akhzari MD, H. Mirshekarpour MD, M. Saghari MD, S. Izadyar MD, J. Esmaili MD, B. Fallahi MD, D. Beiki PhD, A. Takavar PhD

Research Institute for Nuclear Medicine, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran

ABSTRACT

Introduction: There is a limited number of case reports published in the past decade confirming the radio-iodine presence in the tear. These observations as well as reported cases of salivary and lacrimal gland dysfunction after radioiodine therapy stimulated investigators to clarify whether lacrimal gland function can be affected post-radioiodine therapy. Hence we planned a historical cohort study to evaluate this effect.

Methods: We studied 100 eyes of 50 patients who were referred to the nuclear medicine department of Dr. Shariati hospital from 01.1383 to 02.1384 and had received high doses (accumulative dose: 100-450mCi) of I-131 treatment of differentiated thyroid carcinoma with their latest admission at least 3 months previously. Dry eye symptoms (obtained via a standard questionnaire) and Schirmer I test results (mm/5min) of this group were compared with those of an unexposed group (100 eyes of 50 individuals) matched by sex and age. Cases with another known cause(s) of dry eye were not included in either group.

Results: 51% of the exposed eyes and 50% of the unexposed ones revealed at least one of the dry eye symptoms in the questionnaire. Data analysis showed no significant difference between the number of symptoms of two groups, but 2 symptoms (burning, unrelated to light and erythema) were significantly higher in the exposed eyes. From 9 exposed eyes complaining of erythema, Schirmer test result was abnormal only in 2 (one patient). Also among the 10 eyes with burning symptom (unrelated to light) one patient (2 eyes) revealed abnormal Schirmer test result. The study also demonstrated a significantly lower wetting amount of the Schirmer paper in exposed group compared to others. In the patients undergone radio-iodine therapy, results were 0-4 mm in 21%, 5-9 mm in 20% and 10 mm or more in 59%. These results were seen in the unexposed group in 6%, 17% and 77%, respectively. File review of the 21 exposed eyes with 0-4 mm Schirmer test results revealed presence of the migraine history in five (4 woman) surprisingly and ¹³¹I-avid skull metastasis in another patient (2 eyes).

Conclusion: Long-term reduction in the tear secretion from major and/or minor lacrimal glands is seen after high-dose radio-iodine therapy, which seems to be severe in the majority of patients; however these patients complain of dry eye symptoms no more than unexposed population. Conditions such as migraine may be unknown causes of impaired tear secretion and need further investigation.

Key words: Lacrimal glands, Radioactive iodine, Iodine therapy, Long acting effects, Thyroid cancer

Feasibility of Using Statistical Tests in Evaluation of Non-uniformity

S. Rasaneh MSc¹, H. Rajabi PhD¹, F. Rastgo MD², E. Hajizadeh PhD³, A. Bitarafan-Rajabi MSc¹,
N. Yaghoobi MD², H. Firozabadi MD²

¹ Department of Medical Physics, Tarbiat Modares University, ² Department of Nuclear Medicine, Shahid Rajaei Hospital,

³ Department of Medical Statistics, Tarbiat Modares University, Tehran, Iran

ABSTRACT

Introduction: Non-uniformity test is essentially the only required daily QC procedure in nuclear medicine practice. Noise creates statistical variation or random error in a flood image. Non-uniformity on the other hand does not have statistical nature and may be regarded as systemic error. The present methods of non-uniformity calculation do not distinguish between these two types of error. The Jarque-Bera and Kolmogorov-Smirnov tests were examined as alternative methods in calculation of non-uniformity in flood test images.

Methods: Using the Monte carol method, uniform and non-uniform flood images of different matrix sizes and count density were generated. The uniformity of the images was calculated using the present and proposed methods. The results were also tested using 1300 planar images of 128x128 matrix size.

Results: The proposed methods were more accurate and sensitive to non-uniformity at low count density. However, their precisions were less than the conventional methods. There were no significant differences between these procedures at high count density.

Conclusion: The integral and differential uniformity do not distinguish between noise always present in the data or in occasional non-uniformity. In a uniform intact flood image, the difference between maximum and minimum pixel count (the value of integral uniformity) is much more than recommended values for non-uniformity. After filtration of image this difference decreases but still remains high. The proposed methods are more sensitive to non-uniformity at low count density and may be used as alternative methods in daily uniformity test.

Key words: Nuclear medicine, Quality control, Non-uniformity test, Kolmogorov-Smirnov, Jarque-Bera .

Evaluation of Diagnostic Role of ^{99m}Tc -Tetrofosmin Scintigraphy in Cold Thyroid Nodules

M. Eftekhari MD, M. Saghari MD, M. H. Noorani MD, A. Fard-Esfahani MD, D. Beiki PhD, B Fallahi MD

Research Institute for Nuclear Medicine, Tehran University of Medical Sciences, Tehran, Iran

ABSTRACT

Introduction: Various radiopharmaceuticals, including ^{67}Ga , ^{201}Tl , and ^{99m}Tc -sestamibi have been used to differentiate benign from malignant thyroid nodules. ^{99m}Tc -Tetrofosmin, a lipophilic cationic radiotracer, and ^{99m}Tc -sestamibi have also been reported to accumulate in thyroid tumors. In this study, we evaluated the role of ^{99m}Tc -Tetrofosmin in the differentiation of malignant from benign thyroid nodules.

Methods: We prospectively studied 108 patients with solitary cold thyroid nodule on ^{99m}Tc -pertechnetate scintigraphy (33 malignant and 75 benign) to investigate the diagnostic value of ^{99m}Tc -Tetrofosmin scintigraphy. ^{99m}Tc -Tetrofosmin scintigraphy was performed 15, 60, and 120 minutes following IV injection of 20 mCi (740 MBq) of radiotracer in the anterior planar mode with a gamma camera equipped with LEAP collimator. The scans were visually analyzed by two experienced nuclear physician. The nodules with late tracer retention (activity more than adjacent thyroid tissue) were classified as positive and nodules without late retention were interpreted as negative for malignancy. Fine needle aspiration (FNA) was performed in all patients in 3-7 days interval. 52 patients were subsequently operated on while 56 patients refused surgery. These 56 patients, however, had at least two negative FNA results.

Results: 45 out of 108 nodules show high ^{99m}Tc -Tetrofosmin uptake on delayed images; 27 of them were malignant. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated to be 81.8%, 76.0%, 54.0%, and 90.4% respectively. Accuracy of the test was also determined to be 77.7%.

Conclusion: We concluded that ^{99m}Tc -Tetrofosmin scintigraphy is a relatively sensitive, but not enough specific, method in diagnosing malignant thyroid nodules. This agent could be of value in the presence of FNA limitations.

Key words: ^{99m}Tc -Tetrofosmin, Scintigraphy, Malignancy, Cold nodule of thyroid

Comparison of Acceptance Tests for SPECT Systems in Tehran

A. Bitarafan-Rajabi MSc¹, H. Rajabi PhD¹, H. Firouzabadi MD², F. Rastgou MD², N. Yaghoubi MD², M. Amoui MD³, G. Raziee MD⁴

¹Medical Physics Department, Tarbeat Modares University, ²Nuclear Medicine Department, Rajai Heart Center, ³Nuclear Medicine Department, Shohada Tajrish Hospital, ⁴Nuclear Medicine Department, Milad Hospital, Tehran, Iran

ABSTRACT

Introduction: Acceptance test is a necessary procedure after SPECT system installation. The goal of this test is to reveal system's present condition, to compare it with manufacturer's specifications and also as a base for later tests.

Methods: This study investigated four SPECT systems in Tehran. All of the quality control tests are performed on the basis of NEMA and IAEA recommendations and by a same group. These tests include intrinsic spatial resolution, intrinsic energy resolution, temporal resolution, intrinsic linearity, maximum count rate, pixel size, intrinsic and extrinsic uniformity, sensitivity, reconstruction spatial resolution with and without scatter and centre of rotation.

Results: Results of this investigation show that three systems have minimum acceptance conditions, but the fourth one due to its suboptimal energy resolution and spatial resolution lacked the required specifications for acceptance. It was shown during the next six months after installation that this system showed frequent impairments and even had been out of service for a while. However, other systems did not show any considerable problems.

Conclusion: The acceptance test is an essential step after installation of any SPECT system. If there is no considerable deficits at the initial acceptance test of a SPECT system, it won't become troublesome for a long time.

Key words: Acceptance test, Quality control, SPECT

Survey of Radiation Protection Awareness among Radiation Workers in Shiraz Hospitals

F. Amirzadeh, S.H.R. Tabatabaie

School of Health, Shiraz University of Medical Sciences, Shiraz, Iran

ABSTRACT

Introduction: Ionizing radiations are the hazardous agents in the workplace and all forms of ionizing radiation produce some type of injuries. Awareness of application of protection guidelines and knowledge of the principles of radiation protection can play an important role in health of employees. Survey of radiation employee's levels of awareness and practical behavior is essential and should be standardized.

Methods: The hospitals were visited to determine the number of radiation employees and to select the samples. Data was collected by questionnaire and analyses were performed by EPI6 software.

Results: The employee's awareness about protection in the radiation room was 70%, about application of film badge was more than 85%. The employee's awareness of periodic inspection of atomic energy organization expert was 54% and their knowledge of long term and short term radiation effects were 98% and 95%, respectively. There was a meaningful relation concerning the level of education and awareness of the employees about MPD or principles of radiation protection ($P < 0.0007$ and $P < 0.003$ respectively).

Conclusion: Our results reveal that the employees have acceptable knowledge about the use of film badges, however, they lack enough awareness concerning other issues of radiation protection. Proper and periodic educational courses for radiation workers are mandatory.

Key words: Radiation protection, Awareness, Radiation worker, Hospital