

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

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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.

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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. Diethylentriaminepentacetic 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.

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