

# Subclinical Impairment of Renal Function Following Abdominal Radiotherapy: An Analysis Using Specific Scintigraphic and Biochemical Endpoints



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## PURPOSE:

Specific aims were to evaluate pre- and post-radiotherapy (RT) relative renal function changes in patients based on renal scintigraphy (RS), hemoglobin and creatinine. Our hypothesis was that renal function is altered from abdominal radiation and can be quantified.

## PATIENTS AND METHODS:

Between 2004 and 2006, RS was performed before and at regular intervals after RT in 17 patients. The RS was evaluated in the posterior projection following the intravenous administration of 6 mCi of 99mTc MAG-3. Sequential renal images were examined out to 30 minutes enabling quantitative analysis of the RS.

The kidney with greater volume receiving more than 20 Gy was defined as the primary radiated kidney. RS of the primary radiated kidney was used as an index of the relative kidney function. The relationship between renal function and kidney dose-volume parameters was established. Area under curve (AUC) with reduced activity in RS of primary radiated kidney with time after the onset of RT was also analyzed.

## RESULTS:

Median age was 59 years (range 39-78) and 12 patients (12/17, 70.6%) were female. Primary sites were: pancreas 11 (65%), stomach 3, duodenum 2, and ampulla 1. Mean radiation dose was 48.5 Gy (range 41.4-50.4) given in daily 1.8 Gy fractions using a 3D conformal technique. Median follow up was 23 months. Mean RS in the primary radiated kidney was reduced from 48.7% (range 39–55, SD 5.3) pre-RT to 46.6% (range 36-55, SD 6.4) 6-12 months after RT (p = 0.07), table 1. Mean creatinine was reduced from 0.92 mg/dl (range 0.6-1.3) pre-RT to 1.02 mg/dl (range 0.6-1.5) after RT (p = 0.18). Mean hemoglobin was reduced from 12.1 g/dl pre-RT to 11.4 g/dl after RT (p = 0.16).

Mean V10 (percentage of the volume of the primary radiated kidney that received more than 10 Gy), V15, V20, V25, V30, V35, and V40 were 63.2%, 59.6%, 55.3%, 50.2%, 30%, 24.8%, and 22.3% respectively, table 2. Mean AUC was 992.4. V25, V30, V35, V40 and AUC were associated with ≥ 5% decrease of RS in the primary radiated kidney (p < 0.04, Wilcoxon rank-sum test). On multivariate analysis, decrease in primary radiated kidney function did not correlate significantly with time, gender, hypertension, AUC or age, however smoking status (p = 0.01) was a significant predictor of decreased renal function.

**Table 1.** Renal Scan Following Abdominal Radiotherapy

	0-6 months (n=107)	6-12 months (n=17)	12-18 months (n=7)	Univariate P-value
Primary Kidney** (PK)	49.57(5.44)	46.59(6.36)	44.03(6.28)	0.0866
Secondary Kidney (SK)	50.43(5.43)	53.41(6.36)	55.97(6.28)	0.0866
Ratio (PK/SK)	1.00(0.21)	0.90(0.22)	0.81(0.20)	0.0654

\* Values are given as: mean (sd)

\*\*The kidney with greater volume receiving more than 20 Gy was defined as the primary radiated kidney.

**Table 2.** Renal Scan Changes vs Dose-Volume-Histogram and Area under curve

PreRT vs PostRT 6-12mo	Primary V10	Primary V15	Primary V20	Primary V25	Primary V30	Primary V35	Primary V40	AUC
RS ≥ 5% (n= 5)	63.32 (15.25)	59.60 (13.39)	55.28 (13.15)	50.18 (10.44)	30.14 (12.35)	24.80 (13.42)	22.34 (13.97)	992.40 (216.03)
RS < 5% (n= 12)	64.16 (20.20)	58.57 (22.14)	52.78 (21.18)	29.57 (16.84)	14.31 (13.89)	10.51 (11.62)	10.51 (11.62)	649.38 (209.64)
P-Value	0.7802	0.8187	0.5583	0.0128	0.0255	0.0173	0.0255	0.0347

RS: Renal Scan

## CONCLUSION:

We confirmed our hypothesis, since renal scintigraphy allows for the identification of radiation effects in partial kidney volumes. The extent of scintigraphic change correlates with dose-volume parameters for the primary radiated kidney. Our observations may suggest that renal dose from image guidance warrant further scrutiny.