

Estimation of Patient's Effective Dose From 18F-FDG Whole-Body PET/CT Procedures

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Abstract

Original Research Article

The aim of this study to Estimate the patient's dose from 18F-FDG (18F-fluorodeoxyglucose positron emission tomography/computed tomography) whole body investigations. The dose calculated using RADAR Medical Procedure Radiation Dose Calculator to estimate the effective dose, for 156 patients (110 males and 40 female) were examined by Discovery PET/CT 710, GE Medical Systems in Kuwait Cancer Control Center. The results showed that variation in effective dose, were the effective dose ranged from 156 to 9.94 mSv. And found that the effective dose for female 3.88 mSv was higher than the dose for male 3.71 mSv, this variation come from the higher value of BMI between the females 28.49 kg/m² than the BMI of males 26.50 kg/m², also there was lightly variation of effective dose between the right and left lung, were the effective dose for right lung 3.86 mSv was higher as same as the BMI 27.19 kg/m² was higher than the dose 3.59 mSv and BMI 26.82 kg/m² of left lung. The results provide that there is no difference demonstrates in the effective dose from 18F-FDG in male and female patients. And recommended that all the clinical practice should be justify and be careful about the concept risk-benefit ratio to any and efforts 18FDG whole-body PET/CT scan.

Keywords: effective dose, 18F-FDG, PET/CT, lung Scan.

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INTRODUCTION

The combined Computed Tomographic (CT) and Positron Emission Tomographic (PET) PET/CT scanner consider an important role in diagnosing and grading human disease. It allows for the simultaneous acquisition of anatomical information (CT) and functional information (PET) of the patient within a single examination, and thus provides recorded images and inform about the functional and anatomical of the imaged organ [1].

The technology of CT depends on attenuation correction for the PET acquisition data is preferred as conventional gamma ray source (such as germanium-68) is preferred, and the scanning time has been significantly reduced in the PET /CT study [2] and improve the quality of corrected PET scans [3-5]. This integrated method has become an important tool recently for clinical investigation with increased clinical use, and the expansion of oncology diagnostics to other clinical indications, including infection, cardiac study, neurology and inflammation. PET/CT plays an important role in clinical applications and leads to greater imaging information possible to derive accurate diagnosis and indicate the most appropriate treatment

for the received patient's. However, the concern about the total radiation dose of patients in the study of PET/CT is a major concern among doctors. PET has seen rapid progress in recent years, from a research tool to routine clinical use. Much of the increase in PET use can be lead to applications in oncology imaging and increased availability of the F-FDG radiopharmaceutical, which is the most widely, used PET radiopharmaceutical [6].

Integrated the ¹⁸F-fluoro-2-deoxyglucose with PET/CT becomes largely using in oncology, especially to follow up the patient's treatments. Imaging changes in glucose metabolism, as reflected in cell uptake and the retention of 18 F-FDG, can lead to a more timely and accurate assessment of response than those provided by standard morphological imaging [7].

The PET scan informs about the physiological function and with using a set of detectors that are independent of detection from CT transmission, and although two independent PET and CT images may be co-registered to form a single image, the two scans are most accurately coupled when both are acquired during the same exam using a combined PET and CT scanner,

which lead to built-in CT provides other conveniences such as attenuation correction, most modern PET scanners are dual PET/CT units. Regardless the acquisition conditions, the patient's dose of a PET and the patient's dose of CT in the PET / CT exams are first evaluated separately in different ways after that they combined to give a full dose of the whole-body radiation. Referral to PET/CT studies should be monitoring to justified in each case [8]. Optimization the diagnostic information to achieve a high reasonably while maintaining radiation doses as low as reasonably achievable, according to ICRP recommendations [9]. In addition, increased awareness of the risk of exposure to ionizing radiation has led to efforts to reduce the radiation dose incurred during X-ray and nuclear medical imaging tests. [10]. The implementation of any dose-saving strategies is strictly dependent on accurate dose measurement/dosimetry to maximize the benefit/risk ratio from imaging tests [11].

The effective dose used to approximate of patient's relevant dose of internal and external sources, and estimate of population characteristics to evaluating optimization efforts. Evaluation of organ doses from PET based on the injected activity, while the CT organ doses evaluated based on exams parameters dose or a specific Monte Carlo simulation scanner. And they help us with more accurately to calculate the actual patient dose with patient-specific and scanner factors. Without specific information, risk assessments may be based on

reference or literature values that should be carefully selected if used to assess risks [12].

MATERIAL AND METHODS

The study performed by Discovery PET/CT 710, GE Medical Systems (3000 N. Grandview Blvd. Waukesha, WI 53188, USA). PET/CT study performed to 156 patients (110 male and 40 female) were examined in Kuwait Cancer Control Center by 18F-FDG Whole-Body PET/CT. the patients and dose parameters were recorded, the patient's demographic data (age, gender, weight and high) and the dose parameters was the administrated activity for both left and right lung. The dose calculations using RADAR Medical Procedure Radiation Dose Calculator to estimate the effective dose.

Procedure

The patient received an intravenous injection of 4.4 mCi of 18F-FDG. After an initial uptake phase of an approximately 65 minutes, a CT-Scan without oral contrast without IV contrast, without breath holding at low mA level was acquired for attenuation correction and localization purposes only. Arms were held up. Subsequently PET images from the vertex to mid-thigh were obtained. CT, PET and fused images were reconstructed in trans-axial, coronal and sagittal projections and interpreted from a workstation. Patient's plasma glucose is 5.2 mmol/l.

RESULTS

Table-4.1: Show patients and dose parameters for all patients

	Mean	Median	STD	Min	Max	3d Quartile
Age (years)	60.19	61	11.44	31	85	69
BMI kg/m²	27.05	26.9	5.50	16.1	54.7	30.5
Activity mCi	5.35	4.69	2.48	2.22	14.14	5.41
ED mSv	3.76	3.30	1.74	1.56	9.94	3.80

Table-4.2: Show patients and dose parameters for male patients

	Mean	Median	STD	Min	Max	3d Quartile
Age (years)	61.29	62	10.40	31	83	69
BMI kg/m²	26.50	26	4.79	16.1	47.9	30.05
Activity mCi	5.28	4.82	2.28	2.41	14.14	5.41
ED mSv	3.71	3.39	1.59	1.69	9.94	3.81

Table-4.3: Show patients and dose parameters for female patients

	Mean	Median	STD	Min	Max	3d Quartile
Age (years)	57.28	59	13.52	31	85	68
BMI kg/m²	28.49	27.8	6.90	16.4	54.7	31.2
Activity mCi	5.53	4.43	2.98	2.22	12.67	5.41
ED mSv	3.88	3.11	20.09	1.56	8.90	3.80

Table-4.4: Show patients and dose parameters for all patients according to lung side:

	RT				LT			
	Mean	STD	Min	Max	Mean	STD	Min	Max
Age (years)	60	11.49	31	85	62	11.42	31	82
BMI kg/m ²	27.19	5.84	16.1	54.7	26.82	27	16.4	40
Activity mCi	5.49	2.62	2.22	14.14	5.11	4.68	2.28	11.98
ED mSv	3.86	3.31	1.56	9.94	3.59	3.29	1.60	8.42

DISCUSSION

This study done to evaluate the patient's dose from PET/CT procedure using 18F-FDG during whole-body procedures. And the 18F-FDG had high ability to detect early lung metastatic cancer. Patient's parameters represent as age and Body Mass Index (BMI), and dose information as administrated activity and effective dose. The statistical work represents as mean, median, standard deviation, minimum, maximum and third quartile (75th percentile).

Table 4.1 shows the data for all patients for age the mean $\pm$ STD was 61 ± 11.44 years, the BMI was 27.05 ± 5.50 kg/m², the activity 5.35 ± 2.48 mCi and the effective dose 3.76 ± 1.74 mSv.

The activity in this study 5.28 ± 2.48 mCi was lower than the activity in the previous study Marti-Clement *et al.* 2017 [13], Quinn *et al.* 2016 [16], Kaushik *et al.* 2015 [15] and Khamwan *et al.* 2010 [16] with 8.86 ± 1.92 mCi, 12.30 ± 0.81 , 9.24 ± 1.89 mCi and 8.43 ± 1.89 mCi respectively.

And the results of effective dose according to gender. For male the age was 62 ± 10.40 years, the BMI 26.50 ± 4.79 , the activity 5.28 ± 2.28 mCi and the effective dose 3.71 ± 1.59 mSv.

The female the age was 59 ± 13.52 years, the BMI 28.49 ± 6.90 kg/m², the activity 5.53 ± 2.98 mCi and the effective dose 3.88 ± 20.09 mSv. Comparing with Kaushik *et al.* 2015 [15] the effective dose for male and female ranged from 10.1-14.5 mSv and 10.7-14.5 mSv respectively, and Quinn *et al.* 2016 [14] showed as mean $\pm$ standard deviation and minimum and maximum, for male the effective dose 9.0 ± 1.6 (5.4-12.8) mSv, and for female 10.0 ± 1.5 (3.4-13.6) mSv.

Finally, the effective dose for all patients's according to both lung side (left and right), found that the patients that examined for right lung was 94 patients and 56 patients for left lung. The age was 60 ± 11.49 years, the BMI 27.19 ± 5.84 kg/m², activity 5.49 ± 2.62 mCi and the effective dose 3.86 ± 3.31 mSv.

CONCLUSION

Estimate of patient's dose from 18F-FDG Whole-Body, the dose calculations using RADAR Medical Procedure Radiation Dose Calculator to estimate the effective dose, for 156 patients (110 male and 40 female) were examined by Discovery PET/CT

710, GE Medical Systems in Kuwait Cancer Control Center using 18F-FDG Whole-Body PET/CT.

The results provide that there is no difference demonstrates in the effective dose from 18F-FDG in male and female patients. And recommended that all the clinical practice should be justify and be careful about the concept risk-benefit ratio to any and efforts 18FDG whole-body PET/CT scan.

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