Quantitative PET-CT in Evaluating Response after Radiotherapy

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It is evident in the literature that F-18 fluorodeoxyglucose positron emission tomography enables us to evaluate tumor response to chemo-, radiotherapy or combined. Cellularity, proliferate rate and tumor size play essential roles in FDG uptake. Both pre- and post-treatment FDG PET-CT are useful in predicting response of treatment and status of residual tumor. Such an assessment is frequently achievable by the visual inspection. However, quantitative analysis of tumor FDG uptake is generally needed to precisely compare and predict tumor response in the earlier time. The commonly quantitative measurement used by PET is the standard uptake value (SUV) that reflects relative changes of tumor glucose use during treatment. Besides SUV, incorporation of glucose sensitivity into consideration may be potentially useful as a supplementary global index to reflect the true treatment response especially if patients are scanned with different serum glucose levels.

Key Words: F-18 FDG PET-CT, Glucose sensitivity, Therapeutic response.

INTRODUCTION

Integrated anatomic and functional assessment of the target region in cancerous patients provides complementary data to overcome inherent limitations of one another, and to achieve more meaningful information for better patient management and care¹. A combined positron emission tomography and computerized tomography (PET-CT) not only offers a promising tool diagnosis, staging and radiation treatment planning but also in chemo-sensitivity and response evaluation of radiotherapy by (a) quantifying the high metabolic rate among various cancer types in metabolizing serum glucose using F-18 fluorodeoxyglucose (FDG) as its analog tracer in PET scanning²,³ and (b) the potential ability of the concomitant mapping CT to measure the changes in tumor size⁴,⁵. Many radiopharmaceuticals have been applied in oncology⁶. In this review, it will be focused on F-18 FDG because it (a) can image cellular glycolysis that is one of the most distinctive biochemical features of malignant cells, (b) can be automatically and efficiently radiolabeled and (c) has a relatively longer half-life (110 minutes) not requiring for an on-site cyclotron⁷. Mathematically, the glucose metabolic rate is calculated using the three-compartment model of F-18 FDG tracer kinetics⁸,⁹. The common measurement used by PET is the standard uptake value (SUV). This is defined by tumor activity per dose injected per body mass, which is proportional to the glucose metabolic rate within the normal range of serum glucose concentration. For FDG imaging, the serum glucose is usually restricted to be less than 150 mg/dL for cancer detection. The metabolic response is defined by the percentage change of post-radiotherapy SUV from the pre-radiotherapy (RT) SUV¹⁰ as: ΔM = (SUVpost-RT/SUVpre-RT - 1) × 100%. Based on comments from the European Organization for Research and Treatment of Cancer (EORTC)¹¹, metabolic response is characterized as a SUV reduction by at least 25% or ΔM < -25%. Non-responders are classified as ΔM ≥ -25%. Similar criteria for size changes seen on anatomic imaging modalities have been proposed by the RECIST¹². Both metabolic and size changes may have a continual spectrum. There is high correlation between changes of SUV of primary lung tumors following radiotherapy using F-18 FDG PET-CT imaging with changes in tumor size measured on the concomitant CT as demonstrated by our institution led by Wong et al in 2007¹⁰. After the demonstration of FDG PET in planning and treatment response of the radiotherapy, it appeared that it is time to move the metabolic concept onto a new more hypofractionated