The influence of I-131 therapy on FDG uptake in differentiated thyroid cancer

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Abstract

Objective 18F-fluorodeoxyglucose positron emission tomography (FDG-PET) [or PET/computed tomography (CT)] is more likely to show false-negative results when it is performed shortly after chemotherapy and/or radiotherapy because of “metabolic stunning”. The present study aimed to evaluate the influence of I-131 therapy on FDG uptake and the detection of recurrence or metastasis of differentiated thyroid cancer (DTC).

Methods We retrospectively enrolled 16 consecutive FDG-PET/CT studies which had been performed in patients with DTC with elevated thyroglobulin (TG) but negative I-131 whole-body scan. All studies were performed under l-thyroxine suppression. The patients were divided into groups A and B for PET/CT performed within 4 months of I-131 therapy or no such therapy, respectively. Each lesion identified on PET/CT was characterized using a 5-point scale by visual analysis: 0 = definitely benign, 1 = probably benign, 2 = equivocal, 3 = probably malignant, and 4 = definitely malignant. The maximum standardized uptake value (SUVmax) in each lesion was also measured for semi-quantitative analysis. We compared the visual grading and SUVmax of the lesion of highest FDG uptake between groups A and B.

Results For visual analysis, group B had significantly more patients with an uptake score of 3 or 4 than group A (80% vs. 17%, \( P = 0.01 \)). In addition, there were significantly more equivocal results from group A than from group B (67% vs. 10%, \( P = 0.02 \)). If the patients with the highest uptake scores of 2, 3, and 4 were considered to be positive for local recurrence or metastasis, there would be no significant difference between the positive rates of groups A and B (83% vs. 90%, \( P = 0.7 \)). However, the mean SUVmax of positive results was significantly lower for group A than for group B (3.1 ± 0.9 and 6.6 ± 3.5, respectively, \( P = 0.02 \)).

Conclusions The preliminary results suggested that FDG uptake in DTC may be negatively influenced by I-131 therapy within 4 months, resulting in lower FDG uptake and more equivocal results. Further studies are necessary to determine whether it is secondary to “metabolic stunning” caused by I-131 therapy.

Keywords Stunning · FDG · I-131 therapy · PET/CT · Differentiated thyroid cancer

Introduction

On the basis of increased glucose metabolism in cancer cells, 18F-fluorodeoxyglucose positron emission...
tomography [FDG-PET, or better with PET/computed
tomography (CT)] has been widely used in the diagnosis,
treatment evaluation, and follow-up of various kinds of
malignancies. However, earlier studies have noted that
FDG uptake may be transiently reduced or absent
shortly after chemotherapy and/or radiotherapy, so-
called metabolic stunning, and that FDG-PET is more
likely to show false negatives when performed during
this period [1, 2]. The exact time interval after chemo-
and/or radiotherapy needed to avoid stunning of FDG
uptake is still controversial and has been suggested to
range from 6 weeks to 4 months [3].

FDG-PET has been found to be very useful in the
detection of recurrence or metastasis of differentiated
thyroid cancer (DTC) for patients with elevated thyro-
globulin (TG) but negative I-131 whole-body scan (WBS)
[4]. In this subgroup of patients, I-131 therapy is still
considered to be useful and results in a decrease in TG
levels in more than one half of patients [5]. In addition,
the sensitivity of I-131 WBS was found to be related to
the dose used [6], and thus, some centers, including our
hospital, prefer to directly administer I-131 therapy with
a post-therapeutic scan without a diagnostic scan for
patients with elevated or increasing TG. For those with
negative post-therapeutic I-131 WBS and scheduled for
FDG-PET study, whether “metabolic stunning” exists
shortly after I-131 therapy has still not been studied. We
retrospectively reviewed our data and aimed to evaluate
the influence of I-131 therapy within 4 months on the
FDG uptake and the detection of recurrent or metastatic
DTC.

Materials and methods

FDG-PET/CT scans from 16 consecutive patients with
DTC studied from September 2006 to July 2007 at the
Changhua Christian Hospital were retrospectively
reviewed. All patients received total thyroidectomy and
I-131 ablation therapy. All 16 patients were studied
under l-thyroxine suppression. In addition, all of them
had elevated TG levels in a euthyroid or hypothyroid
state, negative TG-antibody and negative diagnostic,
or post-therapeutic I-131 WBS. The 16 patients were further
divided into groups A and B for PET/CT performed
within 4 months of I-131 therapy or no such therapy.

All studies were performed using an integrated PET/
CT scanner (Gemini GXL; Philips Medical Systems,
Cleveland, OH, USA), which integrates a PET scanner
of GSO crystal and a 16-slice multidetector computed
tomography scanner. Patients were asked to fast for at
least 6 h before an intravenous injection of 370 MBq of
FDG, and imaging was started 60 min after the injec-
tion. Non-contrast enhanced CT scanning was per-
formed first, typically from base of the skull to midthigh,
for attenuation correction and anatomical reference with
the following parameters: 100 mAs, 120 kV, slice thick-
ness 5 mm, pitch 0.938, and collimation 16 × 1.5. Emis-
sion data were then acquired for 8–10 beds with an
acquisition time of 1.5 min/bed position and with the
same range of CT scanning. Four of the 16 patients who
all had negative post-therapeutic I-131 WBS also received
IV contrast administration after acquisition of emission
data with the same position and scanning range for
obtaining CT images of diagnostic quality. A 3D itera-
tive reconstruction algorithm (3D-row action maximum
likelihood algorithm; 3D-RAMLA) was used for recon-
struction of PET images.

The PET and CT portions of the PET/CT images were
jointly interpreted using a dedicated image fusion work-
station. Each lesion identified on PET/CT was character-
ized using a 5-point scale by visual analysis: 0 = definitely
benign, 1 = probably benign, 2 = equivocal, 3 = probably
malignant, and 4 = definitely malignant. The scoring was
done by an experienced nuclear medicine physician and
a radiologist in consensus. Basically, a lesion was scored
as 0 or 1 if it showed only mild-FDG activity (less than
mediastinum) or was considered as non-tumoral uptake,
such as blood vessels, salivary glands, vocal cords,
muscle, fat, and lymphoid tissues (symmetric pattern). A
lesion was scored as 3 or 4 if it showed high FDG activity
(higher than the liver) and was considered as tumoral
uptake, such as local recurrence, regional lymph node
metastasis, or lung and bone metastasis. If a lesion
showed moderate FDG activity (between the mediasti-
num and liver) and was difficult to categorize according
to the above criteria, it was scored as 2.

For semi-quantitative analysis, a region of interest
was contoured around the areas of increased
FDG uptake, and the maximum standardized uptake
value (SUV max) was calculated. In addition, the size of
the positive lesions was also measured on the CT
images.

Continuous variables were expressed as mean ± SD
and tested by Student’s t test. Noncontinuous variables
were tested by a chi-square contingency table. A P value
lower than 0.05 was considered to be a significant
difference.

Results

The detailed demographic data and clinical characteris-
tics were summarized in Table 1. There were 6 and 10
patients in groups A and B, respectively, and there were
no significant differences in age or sex between them.