

## Physiological FDG uptake in the palatine tonsils

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In clinical F-18 fluorodeoxyglucose (FDG) positron emission tomography (PET) studies of the head and neck region, remarkable symmetric tonsillar FDG uptake is sometimes observed. We determined the incidence and degree of tonsillar FDG uptake and investigated the significance of tonsillar FDG uptake. Between June 1998 and August 1998, we obtained informed consent from 17 patients who were scheduled to undergo a FDG-PET study for their own disease (11 men and 6 women; aged 22 to 77 yr) and who did not have head and neck disease to perform FDG-PET scanning of the head and neck region in addition to their target organs. The incidence and degree of tonsillar FDG uptake were determined. Remarkable tonsillar FDG uptake was found in 9 patients. The SUVs of these FDG uptakes ranged from 2.48 to 6.75, with a mean of  $4.29 \pm 1.20$  (SD). Tonsillar FDG uptakes in the remaining 8 patients were not remarkable, and their SUVs ranged from 1.93 to 3.31, with a mean of  $2.46 \pm 0.45$ . Head and neck disease does not appear to have been responsible for the increase in tonsillar FDG uptake. Differences among tonsillar FDG uptake in these 17 patients without head and neck disease appear to reflect differences in activity of "physiological" inflammation of the palatine tonsils.

**Key words:** physiological inflammation, FDG, PET, tonsil

### INTRODUCTION

IN CLINICAL F-18 fluorodeoxyglucose (FDG) positron emission tomography (PET) studies of the head and neck region, remarkable symmetrical tonsillar FDG uptake is sometimes observed.<sup>1–3</sup> The FDG uptake in such cases is too high to be distinguished from that of lymph node metastasis. Jabour et al.<sup>1</sup> found that relatively high tonsillar FDG uptake was observed in all of 10 patients. We previously studied the degree and incidence of tonsillar FDG uptake in 132 patients with head and neck disease.<sup>4</sup> Remarkable tonsillar FDG uptake was observed in 61 cases (46%), and the mean standardized uptake value (SUV) for the 122 corresponding lesions was  $3.84 \pm 1.26$

(mean  $\pm$  SD).

The following two questions were raised by these findings: Were these head and neck diseases related to the increase in tonsillar FDG uptake? And what is the significance of this tonsillar FDG uptake? We found no report in a search of the literature that answered these questions.

In this study, therefore, in 17 patients without head and neck disease, FDG-PET scanning was performed on the head and neck region in addition to target organs in order to exclude the influence of head and neck disease on tonsillar FDG uptake. We determined the incidence and degree of tonsillar FDG uptake and investigated the significance of tonsillar FDG uptake.

### MATERIALS AND METHODS

#### Patients

Between June 1998 and August 1998, we obtained informed consent from 17 patients who were scheduled to undergo FDG-PET study for their own disease (11 men and 6 women; aged 22 to 77 yr) and who did not have head

Received September 14, 2000, revision accepted February 28, 2001.

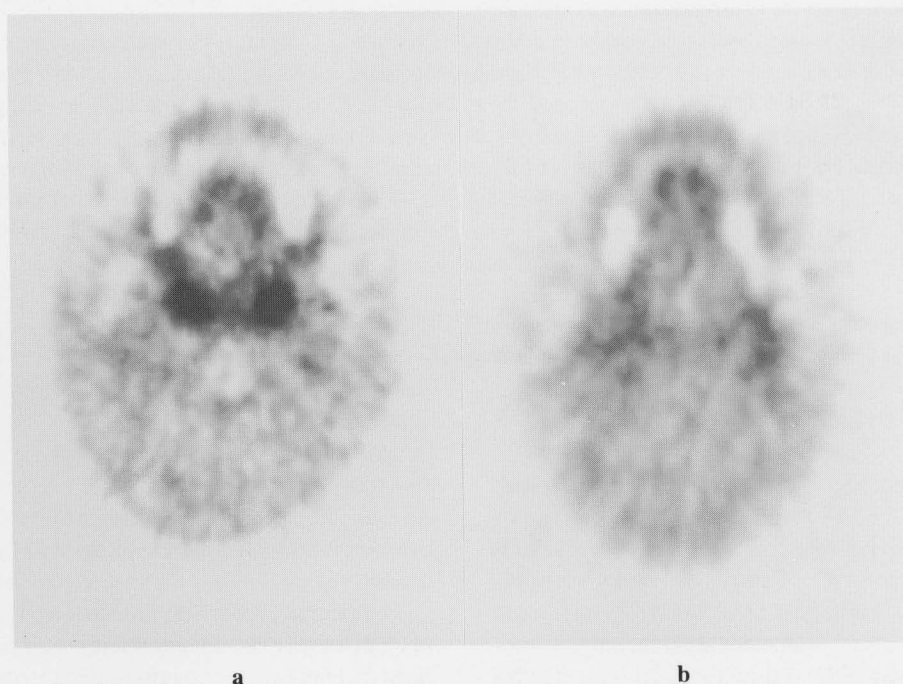
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**Table 1** SUVs of tonsillar FDG uptake

No.	Age/sex	Disease	Status	CRP	BS levels (mg/dl)	SUV		Remarkable FDG uptake
						Right	Left	
1	73/F	HCC	pretreatment	0.1	107	2.78	2.51	
2	51/M	BT	pretreatment	0.1	91	4.27	4.23	+
3	61/F	HCC	pretreatment	0.1	108	3.09	2.49	+
4	61/M	HCC	pretreatment	<0.1	96	5.60	4.97	+
5	77/M	HCC	pretreatment	0.3	103	1.93	2.05	
6	65/M	HCC	pretreatment	0.1	108	4.87	4.38	+
7	72/M	HCC	pretreatment	0.3	115	3.31	2.71	
8	65/F	HCC	pretreatment	0.1	105	3.09	3.02	
9	63/M	HCC	1 month after TAE	0.3	90	4.45	4.15	+
10	36/M	epilepsy	pretreatment	0.1	100	4.80	3.60	+
11	73/M	lung ca.	1 year after operation	0.1	104	2.43	2.60	
12	63/F	cholangio ca.	6 month after operation	0.3	110	2.90	2.97	+
13	61/M	pancreas ca.	pretreatment	0.3	77	2.14	2.69	
14	71/M	HCC	pretreatment	0.3	96	3.65	3.34	+
15	56/F	BT	pretreatment	<0.1	106	1.99	1.96	
16	29/F	BT	pretreatment	<0.1	114	6.71	6.68	+
17	22/M	BT	pretreatment	<0.1	97	2.25	1.95	

F: female, M: male, HCC: hepatocellular carcinoma, BT: brain tumor, ca.: carcinoma, TAE: transarterial embolization



**Fig. 1** FDG-PET images of two types of tonsillar FDG uptake. a: Remarkable tonsillar FDG uptake (right: 5.60, left: 4.97) in a 61-year-old man. b: Unclear tonsillar FDG uptake (right: 2.25, left: 1.95) in a 22-year-old man.

and neck disease to perform FDG-PET scanning of the head and neck region in addition to their target organs (Table 1). No swelling of the palatine tonsils was observed in any patient, and C-reactive protein (CRP) levels were below 0.4 mg/dl (normal range 0–0.4 mg/dl in our hospital). Blood sugar (BS) levels of the 17 patients just before FDG injection ranged from 77 to 115 mg/dl, and

the mean BS level was  $101.59 \pm 9.66$ .

#### FDG and PET images

FDG was produced with the NKK-Oxford superconducting cyclotron and NKK synthesis system. A HEADTOME IV SET-1400W-10 (Shimadzu Corp., Japan), which has 4 detector rings providing 7 contiguous slices at 13 mm

intervals, was employed for the PET studies. The effective spatial resolution was 14 mm in FWHM. Before emission scanning, transmission scans were performed with a  $^{68}\text{Ge}/^{68}\text{Ga}$  ring source for attenuation correction. Images were obtained from 40 to 55 minutes after intravenous injection of 185–370 MBq FDG while fasting.

#### Data analysis

We first analyzed FDG-PET images visually to avoid preconceptions from analysis of the quantitative data. FDG uptake by the palatine tonsils which was much greater than that by the surrounding soft tissues was considered as remarkable tonsillar FDG uptake.

For quantitative analysis, regions of interests (ROIs: circles 6 mm in diameter) were placed on symmetrical tonsillar FDG uptake. FDG uptake was visually judged by 3 radiologists in comparison FDG-PET images with computed tomographic images and/or magnetic resonance images. Standardized uptake values (SUV = tissue concentration/activity injected per body weight) of the ROIs were determined.

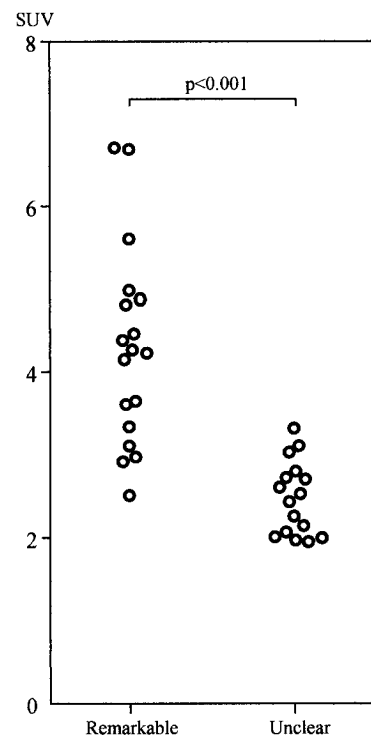
For statistical analysis, the Mann-Whitney U-test was used. P values < 0.05 were considered statistically significant.

## RESULTS

SUVs of FDG uptake of the 17 patients ranged from 1.93 to 6.71, with a mean SUV of  $3.49 \pm 1.30$  (SD). On visual analysis, remarkable tonsillar FDG uptake was found in 9 of these patients (Fig. 1a, b). SUVs of these FDG uptakes ranged from 2.48 to 6.75, with a mean SUV of  $4.29 \pm 1.20$ . The FDG uptakes of the tonsils in the remaining 8 patients were not clearly distinguishable from those of the surrounding normal structures. SUVs for the unclear tonsillar FDG uptake in the 8 patients ranged from 1.93 to 3.31, with a mean SUV of  $2.46 \pm 0.45$ . There was a significant difference between the SUVs of the two groups ( $p < 0.001$ , Mann-Whitney U-test).

## DISCUSSION

Remarkable tonsillar FDG uptake was found in 9 patients (53%). The tonsillar FDG uptake in the remaining 8 patients was not clearly distinguishable from those of the surrounding normal structures. None of the patients studied had head and neck disease. CRP of all patients were within the normal range. BS levels of 17 patients ranged from 77 to 115 mg/dl. No patient had severe hyperglycemia. Effects of hyperglycemia on the decrease in FDG uptake were considered negligible, and these findings indicate that a difference exists between these two groups in the rate of glucose metabolism. The incidence of remarkable tonsillar FDG uptake was 53% in this study. In our previous study,<sup>4</sup> an increase in tonsillar FDG uptake was observed in 61 of 132 cases (46%), and the



**Fig. 2** SUVs of FDG uptakes in 9 patients with remarkable tonsillar FDG uptake ranged from 2.48 to 6.75, with a mean SUV of  $4.29 \pm 1.20$ . SUVs of unclear tonsillar FDG uptake in remaining 8 patients ranged from 1.93 to 3.31, with a mean SUV of  $2.46 \pm 0.45$ . There was a significant difference between the SUVs of the two groups ( $p < 0.001$ , Mann-Whitney U-test).

mean SUV of the 122 corresponding lesions was  $3.84 \pm 1.26$ . The incidence of remarkable tonsillar FDG uptake in the patients with head and neck disease was no higher than that in the patients without head and neck disease. The mean SUV of remarkable tonsillar FDG uptake in patients with head and neck disease was not significantly different from that in the patients without head and neck disease. This suggests that head and neck diseases are not responsible for the increase in tonsillar FDG uptake observed.

The palatine tonsils are located at the gateway to the respiratory and alimentary tracts, and are continually and directly exposed to antigens; a certain amount of inflammation in them is therefore "physiological."<sup>5</sup> Tonsils are lymphoid organs. In tonsillitis, follicular hyperplasia in activated lymphoid tissue<sup>5</sup> and an increased rate of glucose metabolism in lymphocytes<sup>6</sup> are observed. We previously studied two patients with chronic tonsillitis by means of FDG-PET and histopathological examination.<sup>7</sup> Tonsillar FDG uptakes were remarkably increased in both patients. The uptakes in the right and left tonsils were 7.4 and 6.7, respectively in one patient, whereas those in the other patient were 4.4 and 4.3, respectively. Comparison with histopathological findings revealed that the tonsillar FDG uptake reflected tonsillitis. In the present study, none

of the 17 patients had symptomatic complaints, and none had CRP levels beyond the normal range, but remarkable tonsillar FDG uptakes were observed in 9 of the 17 patients, which probably reflected focal "physiological inflammation" in the tonsils. Moreover, the tonsillar FDG uptake reflected the inflammatory activity estimated by histological examination.<sup>7</sup> A similar line of evidence in a comparison of FDG uptake and histological findings has also been confirmed in lung lesions by Ichiya et al.<sup>8</sup> Differences in tonsillar FDG uptake among our 17 patients without head and neck disease should therefore reflect the differences in activity of "physiological" inflammation.

Remarkable FDG uptake due to physiological inflammation of the tonsils should be taken into consideration during the interpretation of FDG-PET images of the head and neck region.

Inspection is the gold standard in the evaluation of tonsillar diseases. The degree of tonsillitis is generally judged by the complaints of the patients and the findings of inspection, but the degree of actual tonsillitis *in vivo* cannot be measured quantitatively. FDG-PET is the first avenue for assessing the degree of activity of tonsillitis *in vivo*.

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