Evaluation of Dual-Timepoint ^{18}F-FDG PET/CT Imaging for Lymph Node Staging in Vulvar Cancer

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This study aimed to assess the value of dual-timepoint ^{18}F-FDG PET/CT in the prediction of lymph node (LN) status in patients with invasive vulvar cancer (VC) scheduled for inguinofemoral LN dissection. **Methods:** From April 2013 to July 2015, all consecutive patients with VC scheduled for inguinofemoral LN dissection were prospectively enrolled. All patients underwent a preoperative whole-body ^{18}F-FDG PET/CT scan at 1 h (standard examination) and an additional scan from T11 to the groins at 3 h (delayed examination) after ^{18}F-FDG injection. On both scans, each groin was visually scored 0 or 1 concerning ^{18}F-FDG LN uptake relative to background. Semiquantitative analysis included SUV_{max} and the corresponding retention index of SUV_{max}, measured on both scans. The optimal cutoff value of these parameters was defined using a receiver-operating-characteristic analysis. Histopathology was the standard of reference. **Results:** Thirty-three patients were included, with a total of 57 groins dissected and histologically evaluated. At histopathology, 21 of 57 (37%) groins contained metastatic LNs. Concerning visual score, sensitivity, specificity, negative predictive value, positive predictive value, and accuracy were 95.2%, 75%, 96.4%, 69%, and 82.5% on standard scanning and 95.2%, 77.8%, 96.6%, 71.4%, and 84.2% on delayed scanning, respectively. At receiver-operating-characteristic analysis, sensitivity and specificity were 95.2% and 77.8% on standard and delayed ^{18}F-FDG PET/CT for an SUV_{max} cutoff of greater than 1.32 and 1.88, respectively, and 95.2% and 80% for a retention index of SUV_{max} cutoff of greater than 0. **Conclusion:** Standard ^{18}F-FDG PET/CT is an effective preoperative imaging method for the prediction of LN status in VC, allowing the prediction of pathologically negative groins and thus the selection of patients suitable for minimally invasive surgery. Delayed ^{18}F-FDG PET/CT did not improve the specificity and the positive predictive value in our series. Larger studies are needed for a further validation.

Key Words: vulvar cancer; ^{18}F-FDG; dual time point PET/CT; groin lymph node metastasis; FDG-retention index

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Invasive vulvar carcinoma (VC) is an uncommon gynecologic tumor, with an incidence of 2.4 new cases/100,000 women per year (*1*). The pattern of dissemination of VC is mainly lymphatic, with prevalent involvement of the groins, whereas hematogenous spread is rare (*2*). Thus, the most important prognostic factor is the presence of metastatic lymph nodes (LNs) in the groins (*3*). In fact, the 5-y survival rate decreases from 94.7% when locoregional LNs are negative to 62% when they contain metastases (*4*). Therefore, accurate preoperative LN staging is critical to customize the extent of groin surgery and to select patients suitable for minimally invasive procedures, thus avoiding unnecessary inguinofemoral lymph node dissection (IFLD), which is associated with a high morbidity and worse quality of life. In recent years, PET/CT using the glucose analog ^{18}F-FDG has been used increasingly for the evaluation of LN status in gynecologic malignancies (*5*), but only recently has it been recommended in VC (*6*). However, because of the low incidence of VC there are few studies in small series on the diagnostic accuracy of ^{18}F-FDG PET/CT in the detection of metastatic LNs in VC; the reported sensitivity ranges from 67% to 92% and the specificity from 91% to 95% per groin (*7,8*). Recently, dual-timepoint (DTP) or dual-phase ^{18}F-FDG PET/CT has been suggested as a means for detecting metastatic LNs in several gynecologic cancers (*9*), but its usefulness in VC has not yet been evaluated. In particular, DTP ^{18}F-FDG PET/CT requires 2 acquisitions after a single injection of the radiotracer, that is, standard images (1 h after injection) followed by delayed images (3 h after injection) of the body region under assessment. The rationale is that malignant cells, compared with benign cells, usually show increased ^{18}F-FDG uptake retention on delayed-timepoint imaging because of the high glycolysis activity (*10*).

The aim of this prospective study was to investigate the value of DTP ^{18}F-FDG PET/CT for the assessment of LN status in patients with VC scheduled for IFLD.

MATERIALS AND METHODS

Patients and Study Design

The Institutional Review Board approved this longitudinal prospective monocenter study, and all patients signed a written informed consent form. Between April 2013 and July 2015, all consecutive patients with primary histologically proven invasive VC (i.e., depth of

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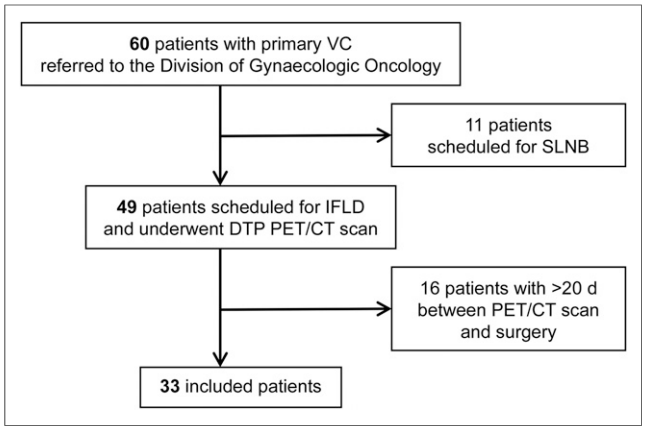

FIGURE 1. Flowchart of patients' selection. SLNB = sentinel lymph node biopsy.

TABLE 1
Patients' Characteristics

Characteristic	Number	Percentage
No. of patients	33	
Mean age ± SD (y)	69 ± 13.4	
Mean body mass index (kg/m^2)	24 (range, 21–42)	
Tumor site		
Central	16	48%
Monolateral	11	34%
Multifocal	6	18%
Vulvar surgical procedure		
Partial vulvectomy	11	33%
Radical vulvectomy	22	67%
IFLD		
Monolateral dissection	9	27%
Bilateral dissection	24	73%
Tumor size		
4 cm	25	76%
≥4 cm	8	24%
Grading		
G1	4	12%
G2	24	73%
G3	5	15%
FIGO stage*		
Ib	15	45.5%
II	3	9%
III	15	45.5%

*2009 revised FIGO staging system.

stromal invasion > 1 mm) referred to the Division of Gynecologic Oncology at A. Gemelli Hospital were evaluated with clinical examination and conventional imaging (*6*). The surgical plan was traced on the base of the disease site and extent, according to international recommendations (*6,11*). All patients scheduled for IFLD were considered eligible for the study and underwent preoperative ^{18}F-FDG PET/CT scanning with DTP acquisition.

Patients with the following characteristics were excluded: prior inguinal surgery dissection; previous chemotherapy or locoregional radiotherapy within the last 5 y; contraindication to the surgery due to age or comorbidities; pregnancy or breast-feeding; blood glucose greater than 200 mg/dL; and surgery performed more than 20 d after ^{18}F-FDG PET/CT. Pathologic results were used as the standard of reference to assess the presence of LN metastases.

^{18}F-FDG PET/CT Acquisition

^{18}F-FDG PET/CT scans were obtained according to the standard procedure of our center (*12*). All patients fasted for at least 6 h, and the glucose blood levels were less than 190 mg/dL before the ^{18}F-FDG injection. According to body weight, 118–303 MBq of ^{18}F-FDG were intravenously administrated. Before ^{18}F-FDG PET/CT acquisition, patients were hydrated with 500 mL of saline solution by intravenous administration. No oral or intravenous contrast agents were used. All ^{18}F-FDG PET/CT scans were acquired using the same PET scanner (Gemini GXL [Philips] or Biograph mCT [Siemens Medical Solutions USA, Inc.]) for each patient at 2 timepoints: 60 ± 10 min (standard ^{18}F-FDG PET/CT scanning) and 180 ± 10 min (delayed ^{18}F-FDG PET/CT scanning) after ^{18}F-FDG injection. Standard ^{18}F-FDG PET/CT scans were acquired from the skull base to mid thigh. Delayed ^{18}F-FDG PET/CT scans were obtained from the 11th vertebra (T11) to the inguinal region. Before the ^{18}F-FDG PET/CT acquisition, low-dose CT images (using a voltage of 110–120 kVp and tube current of 20–40 mAs, with the patient breathing normally) were acquired for anatomic reference and attenuation correction. PET images were then acquired in 3-dimensional mode, with 7–8 acquisition beds (of ~2.5 min each) on standard scans and 1–2 acquisition beds (of ~4 min each) on delayed scans. Matched CT and PET images were reconstructed with a field of view of 50 cm. The line-of-response row-action maximum likelihood algorithm was used for reconstruction with 144 × 144 or 256 × 256 matrix. Attenuation-corrected PET images were reviewed in transverse, sagittal, and coronal planes. PET data were also displayed in a rotating maximum-intensity projection images. To evaluate the images, PET and CT datasets were transferred to an independent computer workstation by DICOM transfer.

^{18}F-FDG PET/CT Image Analysis

All ^{18}F-FDG PET/CT images were interpreted and visually scored by 2 nuclear medicine physicians in consensus.

Qualitative Analysis

Qualitative analysis was performed both on standard and on delayed PET/CT, and the degree of ^{18}F-FDG uptake in the LNs was classified as follows: normal, uptake lower than or equal to background (score 0); and abnormal, uptake higher than background (score 1). The gluteus muscle tissue was used to estimate background activity. The size of the largest LN per groin (short axis) was detected on transaxial CT images of PET/CT.

Semiquantitative Analysis

A spheric volume of interest was placed over the inguinal LN with the highest glucose uptake on the transaxial PET images, for each groin, using an isocontour threshold of 40% method (Syngo.via, MM oncology VA30; Siemens Medical Solutions) based on the SUV (*13,14*). SUV normalization to body weight and to injected dose was automatically assessed using the following equation:

$$\text{SUV} = \frac{\text{Tissue radioactivity concentration (MBq/mL)}}{\text{Injected dose (MBq)/body weight (g)}}.$$

TABLE 2
Qualitative (Visual Score) Results of Standard ^{18}F-FDG PET/CT and Delayed ^{18}F-FDG PET/CT

PET/CT	Visual score	Pathologic evaluation: LN metastasis	Pathologic evaluation: No LN metastasis	Total
Standard	0	1	27	28
	1	20	9	29
	Total	21	36	57
Delayed	0	1	28	29
	1	20	8	28
	Total	21	36	57

Score 0 = uptake ≤ than background; score 1 = uptake > than background.

The SUV_{max} within the volume of interest was measured on standard (SUV_{max} standard) and delayed (SUV_{max} delayed) PET images. Volumes of interest were carefully placed in exactly the same anatomic site, both on standard and on delayed PET/CT scans. When several hypermetabolic LNs per groin were seen on PET/CT images, the highest SUV_{max} was considered the representative value of that groin. When inguinal LNs did not show a significant ^{18}F-FDG uptake, an arbitrary value of 1 for SUV_{max} was adopted.

Furthermore, we calculated the retention index of SUV_{max} (RI_{max}) using the following formula:

$$RI_{max} = (SUV_{max}\ \text{delayed} - SUV_{max}\ \text{standard}) \times 100/SUV_{max}\ \text{standard}.$$

The ^{18}F-FDG PET/CT findings and histopathologic results for the inguinal LNs were compared on a groin-by-groin analysis.

Statistical Analysis

Sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and accuracy of standard and delayed PET/CT were calculated considering qualitative analysis. The receiver-operating-characteristic analysis was used to determine the optimal cutoff values of SUV_{max} standard, SUV_{max} delayed, and RI_{max}, for differentiating benign and malignant inguinal LNs. Differences in sensitivity, specificity, and accuracy between standard and delayed PET/CT were determined using the χ^2 or Fisher test. A P value of less than 0.05 was considered statistically significant. Statistical analysis was performed using MedCalc Statistical Software (version 15.11.4).

RESULTS

A total of 60 patients with primary VC were referred to the Division of Gynaecologic Oncology during the study period. Among these, 33 patients fulfilled the inclusion criteria (Fig. 1). Patients' characteristics are reported in Table 1. All patients had a squamous cell carcinoma of the vulva. The time interval between the ^{18}F-FDG injection and PET/CT acquisition was 60 ± 11 min for standard PET/CT and 162 ± 24 min for delayed PET/CT. Most PET/CT studies (22/33 patients, 67%) were acquired using the GXL scanner. The time interval between ^{18}F-FDG PET/CT study and surgery was 18 ± 1 d. Fifty-seven groins (24 bilateral, 9 unilateral) in 33 patients were dissected. At pathologic examination, 21 groins contained metastatic LNs, and 36 groins were negative for metastases.

The mean size of all measured LNs was 9.4 ± 3.6 mm (median, 8 mm; range, 5–21 mm). The mean size of metastatic LNs was 11.8 ± 4.6 mm (median, 10 mm; range, 6–21 mm), whereas the mean size of nonmetastatic LNs was 8.1 ± 1.7 mm (median, 8 mm; range, 5–12 mm). A significant difference was found between the size of metastatic and nonmetastatic LNs measured on low-dose CT ($P < 0.002$).

Qualitative Analysis

Standard ^{18}F-FDG PET/CT was positive in 29 of 57 groins and negative in 28 of 57 groins. Visual score results are reported in Table 2. Of the 21 groins with metastatic LNs at pathologic examination, standard ^{18}F-FDG PET/CT showed ^{18}F-FDG uptake above the background (score 1) in 20 groins and under background (score 0) in 1 groin. Of the 36 groins with no metastatic LNs at pathologic examination, standard ^{18}F-FDG PET/CT was negative in 27 groins and positive in 9 groins. On a groin-by-groin basis, standard ^{18}F-FDG PET/CT yielded a sensitivity of 95.2% (95% confidence interval [CI], 85.2–99.8), specificity of 75% (95% CI, 61.5–85.1),

TABLE 3
Qualitative Analysis

PET/CT	PET/CT result	Pathologic evaluation: LN metastasis	Pathologic evaluation: No LN metastasis	Total	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
Standard					95.2 (85.2–99.8)	75 (61.5–85.1)	82.5 (72.7–92.3)	69 (55.2–80.2)	96.4 (86.7–99.4)
Per groin	Positive	20	9	29					
	Negative	1	27	28					
	Total	21	36	57					
Delayed					95.2 (85.2–99.8)	77.8 (64.5–87.3)	84.2 (74.8–93.6)	71.4 (57.7–82.2)	96.6 (86.9–99.4)
Per groin	Positive	20	8	28					
	Negative	1	28	29					
	Total	21	36	57					

Data in parentheses are 95% CIs.

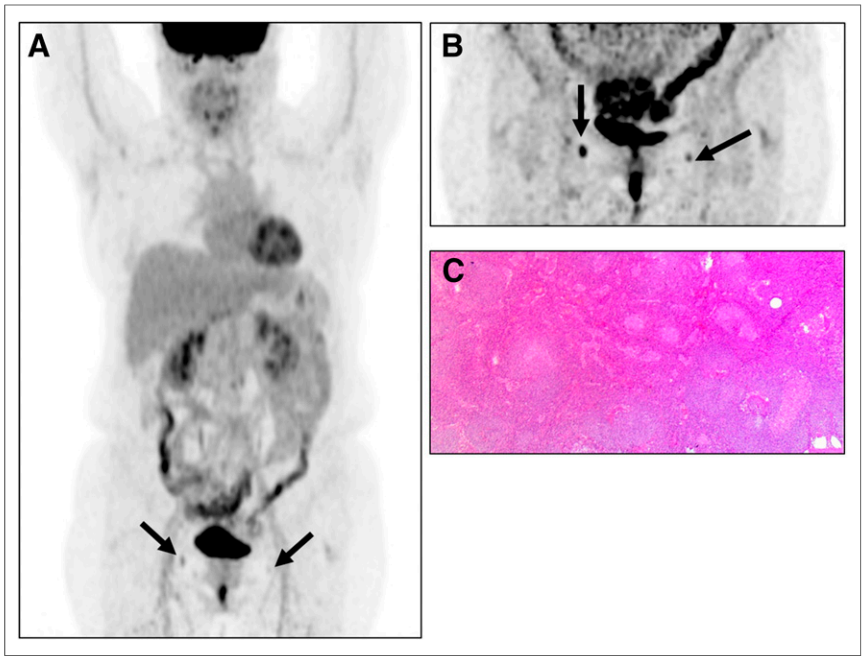

FIGURE 2. A 60-y-old woman with midline tumor. (A) Maximum-intensity projection of standard ^{18}F-FDG PET/CT image showing focal uptake in right groin (SUV_{max}, 3.5) as well as in left groin (SUV_{max}, 2) (arrows). (B) Maximum-intensity projection of delayed scan showing increase of focal uptake in right groin (SUV_{max}, 6.39) and in left groin (SUV_{max}, 3.41) (arrows). (C) Pathologic examination showed no metastatic LNs in either groin.

Semiquantitative Analysis

Mean and median values of SUV_{max} standard, SUV_{max} delayed, and RI_{max} for metastatic groins (group 1) and nonmetastatic groins (group 0) are shown in Table 4. SUV_{max} standard, SUV_{max} delayed, and RI_{max} were significantly higher for group 1 than for group 0 ($P < 0.0001$) (Fig. 3). The area under the curve was larger in SUV_{max} standard, which was 0.919 ($P < 0.0001$; 95% CI, 81.5%–97.5%) compared with 0.899 in SUV_{max} delayed ($P < 0.0001$; 95% CI, 79%–96.3%) and 0.833 in RI_{max} ($P < 0.0001$; 95% CI, 71%–92%). There was no significant difference between the areas under the curve in SUV_{max} standard and SUV_{max} delayed ($P = 0.10$) nor between SUV_{max} delayed and RI_{max} ($P = 0.055$), whereas a significant difference was found between SUV_{max} standard and RI_{max} ($P = 0.04$). At receiver-operating-characteristic analysis, the optimal cutoff values of SUV_{max} standard, SUV_{max} delayed, and RI_{max} were >1.32, >1.88, and >0, respectively. With these cutoff values, the sensitivity and specificity, respectively, were 95.2% and 77.8% for both SUV_{max} standard and SUV_{max} delayed and 95.2% and 80% for RI_{max} (Fig. 4).

NPV of 96.4% (95% CI, 86.7–99.4), PPV of 69% (95% CI, 55.2–80.2), and accuracy of 82.5% (95% CI, 72.7–92.3) (Table 3).

Delayed ^{18}F-FDG PET/CT was positive in 28 of 57 groins and negative in 29 of 57 groins (Table 2). Of the 21 groins with metastatic LNs at pathologic examination, delayed ^{18}F-FDG PET/CT showed abnormal ^{18}F-FDG uptake in 20 groins, with a false-negative (FN) result occurring in 1 groin (same groin that was FN at standard imaging). Of the 36 groins with no metastatic LNs at pathologic examination, delayed ^{18}F-FDG PET/CT was true negative in 28 groins and false-positive (FP) (Fig. 2) in 8 groins. On a groin-by-groin basis, delayed ^{18}F-FDG PET/CT yielded a sensitivity of 95.2% (95% CI, 85.2–98.8), specificity of 77.8% (95% CI, 64.5–87.3), NPV of 96.6%, (95% CI, 86.9–99.4), PPV of 71.4% (95% CI, 57.7–82.2), and accuracy of 84.2% (95% CI, 74.8–93.6) (Table 3). No significant differences in sensitivity, specificity, and accuracy between standard and delayed PET/CT were found.

DISCUSSION

In this prospective study, we evaluated the value of DTP ^{18}F-FDG PET/CT for LN staging. We chose to include only patient candidates for lymphadenectomy, excluding those addressed to the sentinel node biopsy, to ensure that the reference standard (histopathologic results) could include all the inguinal LNs examined preoperatively by ^{18}F-FDG PET/CT. Moreover, given the rapid progression of VC, we decided to include only those patients for whom a maximum 3-wk interval between the preoperative study and surgery was compiled. On the basis of criteria that considered metastatic LNs if they had ^{18}F-FDG uptake higher than background, standard ^{18}F-FDG PET/CT showed high sensitivity (95.2%) and relatively low specificity (75%) in detecting metastatic groins. In particular, we found 9 FP groins and 1 FN groin, the latter due to a metastatic LN of 8 mm in diameter. In 9 FP groins, pathologic examination revealed no LN metastases in

TABLE 4
Mean and Median of SUV_{max} on Standard and Delayed Scans and RI for Metastatic and Nonmetastatic Groups

LN	SUV_{max} standard	*P*	SUV_{max} delayed	RI (%)
Metastatic LNs (group 1)		0.11		
Mean ± SD	5.43 ± 3		7.17 ± 3.9	31.42 ± 15.61
Median	5.51 (range, 1–12.62)		6.88 (range, 1–15.82)	34.39 (range, 0–56.49)
Nonmetastatic LNs (group 0)				
Mean ± SD	1.56 ± 1.2	0.3	1.94 ± 1.9	12.21 ± 25.75
Median	1 (range, 1–5.64)		1 (range, 1–6.98)	0 (range, −1.79–82.57)
P	<0.0001		<0.0001	0.003

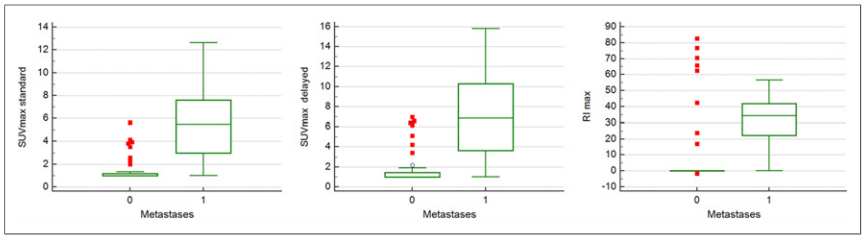

FIGURE 3. Box plots showing distribution of SUV_{max} standard, SUV_{max} delayed, and RI_{max} for metastatic and nonmetastatic groins. 0 = absence of metastases; 1 = presence of metastases.

7 groins and inflammatory LNs in 2 groins. Concerning the FP results, it is widely known in the literature that inflammatory cells and activated macrophages represent a common cause of increased ^{18}F-FDG uptake, as occurring in inguinal reactive LNs after vulvar biopsy or shaving (*15*). Conversely, FN results are most likely associated with PET-undetected micrometastatic foci in not enlarged nodes as well as with extensive necrosis within metastatic LNs with subsequent loss of ^{18}F-FDG uptake (*7*). Previous PET or PET/CT studies in the literature showed a range of sensitivity (from 50% to 100%) and specificity (from 91% to 100%) for detecting metastatic involvement of inguinofemoral LNs in VC patients (*7,8,16,17*). In those studies, no cutoff values of SUV_{max} were determined for metastatic LNs. In our study, an SUV_{max} of greater than 1.32 was found to be the optimal cutoff point on standard PET/CT to provide a sensitivity similar to the one obtained from visual analysis (95.2%) but accompanied by a slightly better (77.8% vs 75%) although not statistically significant ($P = 0.81$) specificity in detecting metastatic groins. As already mentioned, increased ^{18}F-FDG uptake is not specific for neoplastic involvement, because it may also be reactive to inflammation or infection (*18*). On the basis of our data, standard ^{18}F-FDG PET/CT showed a high NPV (96.4%) together with a low PPV (69%) in detecting metastatic groins. Therefore, a negative ^{18}F-FDG PET/CT scan result is highly predictive in excluding groin metastases and could potentially be used to select patient candidates for a minimal groin surgery. In contrast, a positive ^{18}F-FDG PET/CT scan finding is not highly predictive for groin metastases and needs to be interpreted with caution. On the basis of our data, a significant difference was found between the size of metastatic and nonmetastatic LNs measured on low-dose CT. However, further studies are needed to investigate whether the combination of PET and CT criteria can better differentiate between metastatic and nonmetastatic LNs.

The rationale of DTP ^{18}F-FDG PET/CT is that ^{18}F-FDG uptake usually increases in malignant lesions for several hours after intravenous injection, whereas benign lesions and inflammatory cells show stable or decreasing ^{18}F-FDG uptake over time (*19,20*). Such different behavior on delayed PET/CT is believed to be due to increased cell proliferation rate, enhanced expression of hexokinase type-II and glucose transporter-1 in malignant lesions, and continued clearance of background activity, thus resulting in images with improved contrast-to-noise ratio (*10*). Up until now, no studies have yet been performed using qualitative and semiquantitative parameters on both standard and delayed ^{18}F-FDG PET/CT to assess LN status in VC. To our knowledge, only Lin et al. performed delayed PET scanning in VC staging, showing that it did not modify the qualitative analysis of a standard scan. However, they did not apply semiquantitative evaluation and the sample size in their study was limited (11 patients) (*8*). According to our qualitative analysis, delayed ^{18}F-FDG PET/CT showed sensitivity and NPV (95.2% and 96.5%) similar to standard scanning with relatively higher specificity (77.8% vs. 75%) and PPV (71.4% vs. 69%) not reaching statistical significance ($P = 0.9$) in detecting metastatic groins. In particular, in the patient with an FN groin no ^{18}F-FDG uptake, even on the delayed scanning, was seen, most likely due to the limited extent of the metastatic involvement (with micrometastases on histopathology). Moreover, on delayed PET/CT we found 8 FP groins compared with 9 FP groins on standard PET/CT. This finding suggests that the behavior of inflammatory lesions as concerning ^{18}F-FDG uptake is not always predictable, and that delayed PET/CT appears to not reduce the rate of FP results. According to other studies, inflammatory lesions as well as infection may induce higher ^{18}F-FDG uptake on delayed scanning mimicking malignant lesions (*21–24*). In the literature, the use of DTP ^{18}F-FDG PET/CT in gynecologic malignancies is still a subject of discussion, and in our study, the delayed ^{8}F-FDG PET/CT also was not superior to standard images in detecting LN disease. This is in accordance with the results reported in a recent metaanalysis by Shen et al. (*21*), which concluded that DTP ^{8}F-FDG PET/CT had higher sensitivity but lower specificity in detecting LNs metastases on a per-patient analysis, and performed only slightly better than standard PET/CT on a per-lesion basis. On the contrary, in a retrospective study on cervical, endometrial, and ovarian cancer patients, Nogami et al. reported that DTP ^{18}F-FDG PET/CT only significantly improved the specificity for detection of LN metastases, but also concluded that DTP scanning had an unsatisfactory impact on the overall diagnostic efficacy for LN metastasis (*9*). Regarding the semiquantitative analysis, an SUV_{max} greater than 1.88 was considered the optimal cutoff point on delayed PET/CT, providing a same sensitivity and specificity as standard ^{18}F-FDG PET/CT images. Concerning the RI, prior studies reported that the RI might improve the accuracy of DTP ^{18}F-FDG PET/CT in gynecologic cancer for detecting LN metastases (*9,25*). In the present study, we found that an RI of greater than 0% was the optimal cutoff point for nodal evaluation because it improved the specificity (80% for RI on delayed examination

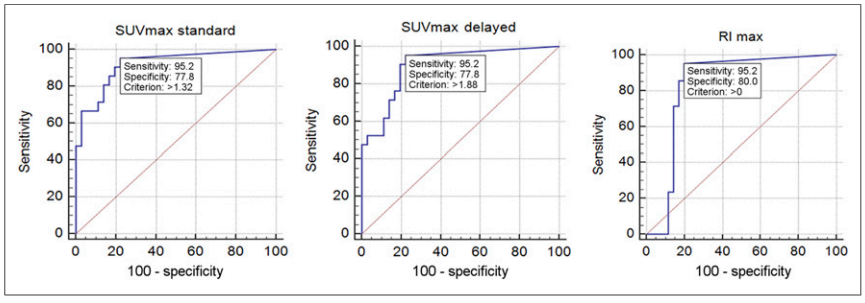

FIGURE 4. The receiver-operating-characteristic curves of SUV_{max} on standard scan and delayed scan and RI.

compared with 77.8% for SUV_{max} on standard PET/CT $P = 0.8$) but did not improve the sensitivity (95.2% in both cases).

Our study suffered some limitations. First, the population was relatively small, but in accordance with the incidence of VC (2.4/100,000 inhabitants per year) (*1*). Second, the patients were scanned on 2 different scanners in our department and this could have minimally affected the SUV homogeneity (*26,27*); however, only 11 patients were scanned on a different scanner. Third, the cutoff value of SUV_{max} and RI in this study was based on the data collected at our institute alone, and the absolute value of SUV_{max} might vary somewhat according to different imaging systems used at other institutions. However, this study has several strengths. First, it is, to our knowledge, the first prospective study to evaluate the comparison between standard and delayed scanning using qualitative and semiquantitative analysis. Second, it evaluates only patients who underwent surgery shortly after PET/CT, to compare PET/CT results with histopathologic findings.

CONCLUSION

In the light of our results, standard ^{18}F-FDG PET/CT has high sensitivity and NPV in detecting groin lymph node metastases in VC patients. This confirms that standard ^{18}F-FDG PET/CT represents an effective preoperative imaging method for LN staging in VC, allowing better planning of groin surgical procedures and selection of patients potentially suitable for minimally invasive surgery. However, delayed PET/CT has not significantly been able to improve the specificity and the PPV in our study. Larger studies are needed to further validate our results.

DISCLOSURE

No potential conflict of interest relevant to this article was reported.

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