Purpose  This study aimed to evaluate the value of the standardized uptake value (SUV) ratio between lymph nodes and bone marrow (BM) measured by Fluorine-18-fluorodeoxyglucose PET and computed tomography (18F-FDG PET/CT) for predicting pelvic lymph node (PLN) metastasis in patients with locally advanced cervical cancer (LACC).

Materials and methods  A total of 62 patients with pathological stage Ib-Iva cervical cancer who underwent 18F-FDG PET/CT before treatment were reviewed retrospectively. We measured the metabolic and morphological parameters of lymph nodes and primary tumors, bone marrow SUV (SUVBM) and calculated the ratio of lymph nodes maximum SUV (SUVmax) to bone marrow SUV (SUVLN/BM) and the ratio of short-axis diameter to long-axis diameter (Ds/l) of lymph nodes. A receiver operating characteristic (ROC) curve was performed to evaluate the diagnostic efficacy of each parameter.

Results  There were 180 lymph nodes with pathological evidence included in the study. Our results indicated that Ds/l, SUVmax of lymph nodes (SUVLN) and SUVLN/BM were independent risk factors for PLN metastasis in LACC (P<0.05), and SUVLN/BM showed the best diagnostic performance by ROC curve analysis. The SUVBM in the anemia group was significantly higher than that in the nonanemia group (3.05 vs. 2.40, P<0.05); furthermore, false-positive cases decreased when the SUVLN/BM was used as the diagnostic criterion instead of SUVLN, especially in the anemia group. ROC curve analysis showed that the area under the curve value of the combination of SUVLN/BM and Ds/l was 0.884 (P<0.05), which was higher than Ds/l or SUVLN/BM alone.

Conclusions  SUVLN/BM could improve the ability to predicting PLN metastasis in patients with LACC, and the diagnostic efficacy of the combination of SUVLN/BM and Ds/l might be better than that of a single parameter.

Keywords: 18F-FDG PET/CT, locally advanced cervical cancer, metastasis, pelvic lymph node

Introduction  Cervical cancer is the fourth most common malignant tumor in women worldwide [1], and more than 60% of the newly diagnosed patients were diagnosed with locally advanced cervical cancer (LACC) [2]. Extra-cervical invasion of cervical cancer is mainly through the lymph node pathway, and the pelvic lymph node (PLN) is the most common metastatic site. The assessment of lymph node by imaging or pathological examination is integrated into the latest International Federation of Gynecology and Obstetrics (FIGO) staging system [3]. Therefore, it is extremely important to predict PLN metastasis accurately for the treatment strategy and prognosis in patients with LACC.

Preoperative evaluation of PLN of cervical cancer mainly depends on imaging examination. Traditional imaging examinations, such as computed tomography (CT) and MRI, usually base the identification of metastatic nodes on node size measurements, a short-axis diameter greater than 10 mm is the most accepted criterion [4]. However, the size of lymph node does not always correlate with their tumor involvement [5,6]. Fluorine-18-fluorodeoxyglucose PET and computed tomography (18F-FDG PET/CT), with the dual advantages of anatomical positioning and functional imaging, has been widely used in the diagnosis, staging and prognosis evaluation of various tumors; recently, it tends to be the best imaging method to detect lymph node metastasis [7]. Some semiquantitative metabolic parameters of 18F-FDG PET/CT, especially the maximum standard uptake value (SUVmax), have proved to be valuable in the diagnosis of lymph node metastasis [8,9]. However, high uptake...
of 18F-FDG can be also seen in benign or inflammatory lymph node, which has resulted in false-positive results [10–14]. Thus, many researchers turned their attention to other metabolic parameters. For example, some investigators used the SUV ratio of lymph node to the primary tumor, mediastinum or liver to predict mediastinal lymph node metastasis to eliminate the influence of blood glucose, weight, reconstruction technology, noise, as also as background hypermetabolism caused by systemic inflammation or other [15–17]. Similar methods have been used in cervical cancer. For example, a study had shown that the SUV ratio of lymph node to the primary tumor is an independent predictor of cervical cancer recurrence [18]. Another study showed that the SUV ratio of the lymph node to pelvic blood pool was related to extractive recurrence free-survival [19]. There were some studies indicated that increased bone marrow 18F-FDG uptake was caused by systemic inflammation [20,21] and anemia [22,23]. To our knowledge, vaginal bleeding is the most common symptom in patients with cervical cancer that could result in anemia. But so far, there have been no studies showing that anemia leads to the high uptake of FDG in the lymph node. If we assume that anemia will lead to high FDG uptake in the lymph node, will the SUV LN/bone marrow (BM) have better diagnostic efficacy than the SUV lymph node (SUV LN)?

In addition, some researchers have proposed a ‘combined diagnosis’ method based on 18F-FDG PET/CT to improve the diagnostic efficiency of lymph node metastasis, and these results proved that the combination of metabolic parameters and morphological parameters can better predict lymph node metastasis for patients with lung cancer [24,25] and cervical cancer [26].

The purpose of this study was to assess the predictive ability of the SUV LN/BM for PLN metastasis in patients with locally advanced cervical cancer, and to explore whether it can reduce false-positive cases; and further evaluate the diagnostic value of the combination of morphological parameters (lymph node diameter based on CT) and metabolic parameters (SUV LN/BM-derived from SUV based on PET); moreover, this study is the first time to apply the ratio of the lymph node SUVmax to bone marrow SUV to predict PLN metastasis of cervical cancer.

Materials and methods

Patients

This retrospective analysis included 62 patients diagnosed with LACC between July 2017 and June 2021, who underwent 18F-FDG PET/CT examination before receiving any therapy. The inclusion criteria were as follows: (1) LACC confirmed in all patients by cytology or histopathology; (2) radical resection of cervical cancer and pelvic lymph node dissection were performed within 1 month after PET/CT examination; (3) staged IB-IVA according to FIGO stage system (2018) [3] and (4) no systemic inflammation and other tumors. Patients who conducted blood routine examination within 1 week before PET/CT examination were divided into the anemia group and the nonanemia group. Anemia is defined as hemoglobin level <120 g/L in females according to the WHO criteria [27].

18 F-FDG PET imaging protocol

All patients underwent PET/CT scan (Discovery PET-CT 710, GE Healthcare, USA); 18F-FDG is produced by our medical cyclotron, radiochemical purity >95%. The patients fasted for at least 6 h, and the glucose levels in the peripheral blood were <120 mg/dl before 18F-FDG injections. The CT and PET data were acquired for the proximal thigh towards the base of the skull, 60 min after the injection of a weight-adjusted dose of 3.70–5.55 MBq/kg. After the initial low-dose CT (120kV, 100 mA, noise index 18, thickness 3.75 mm), conventional PET imaging with an acquisition time of 2.5 min/bed position in a 3-dimensional (3D) mode was conducted. The images were reconstructed using iterative methods.

18 F-FDG PET image analysis

All PET and CT images were analyzed by volume viewer 4.6 in an AW workstation (GE Healthcare). The morphological and metabolic parameters of the primary lesion and lymph node were measured by two experienced nuclear medicine physicians, such as primary tumor maximum SUV (SUVT), primary tumor metabolic volume (MTVT), primary tumor total glycolysis (TLGT), SUVBM, SUV LN, the maximum diameter of the primary tumor (DT), short-axis diameter of lymph node (Ds) and long-axis diameter of lymph node (Dll). To measure FDG uptake of the BM, a volume of interest (VOI) was drawn over the vertebral body of each of five vertebrae (L3-5 and S1-2 spines, unless a pathologic condition such as compression fracture or severe osteoarthritic changes was present). The mean SUV of each VOI was measured using an automatic contour set at 75% of the maximum SUV because the 75% cutoff value of the maximum SUV showed good reproducibility between subjects for measuring the most representative of the lesions. The mean SUV of the four selected vertebrae was calculated and defined as SUVBM [28–30]. SUV LN/T and SUV LN/BM are the SUVmax ratios of lymph node to primary lesion and the ratio of lymph node SUVmax to SUV BM; Ds/l is the ratio of short-axis diameter to long-axis diameter of lymph node.

Statistical analysis

The semiquantitative parameters of primary tumor and lymph node were quantitative data; the data of normal distribution were expressed as mean ± SD (x ± s), and the data of abnormal distribution is expressed as the medians (P25, p75). To compare the statistical difference of
quantitative parameters between the group with lymphonodus metastasis and without lymphonodus metastasis, the t-test was used for normal distribution data, while the Mann-Whitney U test was used for abnormal distribution data. Binary logistic regression analysis was applied to select predictive factors of lymph node metastasis. The receiver operating characteristic (ROC) curve was used to analyze the diagnostic efficacy of PET/CT parameters in lymph node metastasis. All statistical tests were performed using IBM SPSS software, version 22.0, and differences were presumed to be significant when the P value was <0.05.

Results

General characteristics of patients
Among the 62 patients with LACC, the median age was 51.0 (range, 23–68) years. There were 59 cases of squamous cell carcinoma (95.2%) and three adenocarcinomas (4.8%). According to the FIGO stage system, 13 (21.0%) were reported as stage I, 14 (22.6%) stage II, 30 (48.4%) stage III and 5 (8.0%) stage IV. In total 28 patients (45.2%) were confirmed to have metastasis in lymph node. According to the FIGO stage system, 13 (21.0%) were stage I, 14 (22.6%) stage II, 30 (48.4%) stage III and 5 (8.0%) stage IV. In total 28 patients (45.2%) were reported as stage I, 14 (22.6%) stage II, 30 (48.4%) stage III and 5 (8.0%) stage IV. In total 28 patients

Lymphatic metastasis

IV 5 (8.0)
III 30 (48.4)
II 14 (22.6)
I 13 (21.0)

Adenocarcinoma 3 (4.8)
Squamous carcinoma 59 (95.2)

Pathological type

Age (range) (years) 23–68

BM were 1.80 and 0.90, respectively (Table 2).

0.80 and 0.70, SUVLN were 3.90 and 2.40 and SUVLN/BM were 1.80 and 0.90, respectively (Table 2).

The ROC curves analysis (Table 3) revealed that the area under the curve (AUC) value of Ds, Ds/l, SUVLN, SUVLN/T and SUVLN/BM were 0.685 (95% CI, 0.602–0.767), 0.725 (95% CI, 0.646–0.805), 0.787 (95% CI, 0.714–0.853), 0.784 (95% CI, 0.718–0.857) and 0.852 (95% CI, 0.793–0.910), respectively, all P < 0.05, and the cutoff values were 1.05, 0.75, 3.35, 0.25 and 1.45, respectively. The AUC value of Ds/l was greater than Ds, and SUVLN/BM was greater than SUVLN and SUVLN/T, which showed that the diagnostic efficiency of Ds/l for PLN metastasis was better than Ds in morphological parameters, and SUVLN/BM was better than SUVLN and SUVLN/T among metabolic parameters. The diagnostic sensitivity, specificity, accuracy, positive predictive value and negative predictive value of the combination of SUVLN/BM and Ds/l was 68.8, 87.5, 78.1, 84.6 and 73.7%, respectively. The AUC value of the combination of SUVLN/BM and Ds/l was 0.884 (95% CI, 0.832–0.935; P < 0.05), which was higher than Ds/l or SUVLN/BM alone (Fig. 1). The diagnostic sensitivity, specificity, accuracy, positive predictive value and negative predictive value of the combination of SUVLN/BM and Ds/l were 75.0, 87.5, 81.3, 85.7 and 77.8%, respectively.

Univariate and multivariate logistic regression model for predicting pelvic lymph node metastasis

The results of the logistic regression model for predicting PLN metastasis are shown in Table 4. Univariate analysis revealed that Ds, Ds/l, SUVLN, SUVLN/T and SUVLN/BM were significantly associated with PLN metastasis, whereas in multivariate analysis, only Ds/l ( odds ratio [OR] = 2.302; 95% CI, 1.205–5.697; P = 0.001), SUVLN/BM (OR = 2.974; 95% CI, 1.386–4.933; P = 0.026), SUVLN/BM (OR = 3.280; 95% CI, 1.696–5.280; P = 0.001) were statistically significant predictors for PLN metastasis.

Patient-based comparison of SUVBM in anemia group and nonanemia group
The average value of SUVBM in the anemia group (n = 38) and nonanemia group (n = 20) were 3.05 and 2.40 (P = 0.01), respectively. When SUVLN/BM and SUVLN were used as diagnostic criteria for PLN metastasis, the number of false-positive diseases was 10 and 22, respectively, of which the number of false-positive diseases in the anemia group was 4 and 13, respectively, and the number of false-positive diseases in the nonanemia group was 6 and 9 respectively (P = 0.26).

Discussion

This study showed that the SUVLN/BM, derived from SUV on PET, is a useful predictor for PLN metastasis in patients with LACC, and may result in the reduction of false-positive cases; the combination of SUVLN/BM and Ds/l derived from lymph node size on CT could improve the diagnostic efficiency of PLN metastasis in patients with LACC.

In our study, SUVLN/BM, the SUV ratio of the lymph node to bone marrow, showed the best diagnostic performance

Table 1 Patient characteristics

| Characteristic              | n (% ) | P value |
|----------------------------|--------|---------|
| Age (median) (years)       | 51     | 0.856   |
| Age (range) (years)        | 23–68  |         |
| Pathological type          |        | 0.863   |
| Squamous carcinoma         | 59 (95.2) |       |
| Adenocarcinoma             | 3 (4.8) |         |
| FIGO stage                 |        | <0.001  |
| I                          | 13 (21.0) |       |
| II                         | 14 (22.6) |       |
| III                        | 30 (48.4) |       |
| IV                         | 5 (8.0) |         |
| Lymphatic metastasis       |        |         |
| Yes                        | 28 (45.2) |       |
| No                         | 34 (54.8) |       |

FIGO, International Federation of Gynecology and Obstetrics.
Table 2 Comparison of parameters on 18F-FDG PET/CT between metastatic and nonmetastatic lymph nodes

| Variables | LNM (−) | LNM (+) | P value |
|-----------|---------|---------|---------|
| (n=100) | (n=80) |         | P value |
| Primary tumor |         |         |         |
| DT(cm) | 4.26 ± 1.39 | 4.30 ± 1.65 | 0.915 |
| SUV | 15.25 (11.28, 20.31) | 14.70 (9.83, 18.71) | 0.692 |
| MTVT(cm³) | 11.60 (5.91, 18.56) | 17.00 (9.14, 31.91) | 0.052 |
| TLGT | 89.70 (43.36, 231.28) | 131.20 (86.11, 376.14) | 0.121 |
| SUVT | 2.75 (2.29, 3.10) | 2.45 (2.20, 2.91) | 0.232 |
| SUVBM | 2.75 (2.29, 3.10) | 2.45 (2.20, 2.91) | 0.232 |
| SUVLN | 2.40 (1.90, 3.40) | 3.90 (2.90, 6.00) | <0.001 |
| SUVLN/T | 0.20 (0.10, 0.20) | 0.30 (0.20, 0.50) | <0.001 |
| SUVLN/BM | 0.80 (0.70, 1.20) | 1.80 (1.20, 2.30) | <0.001 |

BM, bone marrow; DT, the maximum diameter of the primary tumor; Ds, short-axis diameter of LN; D1, long-axis diameter of LN; LN, lymph node; LNM, lymph node metastasis; MTVT, primary tumor metabolic volume; SUV, standardized uptake value; SUVT, primary tumor maximum SUV; TLGT, primary tumor total glycolysis.

Table 3 Diagnostic performance of 18F-PET/CT quantitative parameters and combined parameters

| Variables | AUC | 95% CI | P value | Sensitivity % | Specificity % | Accuracy% | NPV% | PPV% |
|-----------|-----|--------|---------|--------------|---------------|-----------|------|------|
| Ds | 0.685 | 0.602–0.767 | <0.001 | 30.00 | 97.50 | 63.75 | 92.31 | 58.21 |
| Dl | 0.529 | 0.437–0.620 | 0.053 | 1.05 | 2.20 | 58.75 | 76.92 | 55.22 |
| Ds/l | 0.725 | 0.646–0.805 | <0.001 | 0.75 | 68.75 | 68.75 | 68.75 | 68.75 |
| SUVLN | 0.787 | 0.714–0.853 | 0.001 | 3.35 | 70.00 | 72.50 | 71.25 | 71.79 |
| SUVLN/T | 0.784 | 0.718–0.857 | <0.001 | 0.25 | 63.75 | 78.75 | 71.25 | 75.00 |
| SUVLN/BM | 0.852 | 0.793–0.910 | <0.001 | 1.45 | 68.75 | 87.50 | 71.13 | 84.62 |
| Combination | 0.884 | 0.832–0.935 | <0.001 | 1.45 | 75.00 | 87.50 | 81.25 | 85.71 |

AUC, area under the curve; BM, bone marrow; CI, confidence interval; Ds, short-axis diameter of LN; D1, long-axis diameter of LN; LN, lymph node; NPV, negative predictive value; PPV, positive predictive value; SUV, standardized uptake value.

among all parameters. In previous studies, the SUV ratio of lymph node to primary tumors, mediastinum or liver was considered to be more valuable in predicting lymph node metastasis of lung cancer and breast cancer [16,17,31]. For example, in a study involving 136 breast cancer patients, Park et al. [31] found that the SUVmax ratio of lymph node to primary tumor could predict axillary lymph node metastasis better than the SUVmax of lymph node. In another study, Kuo et al. [16] found that lymph node/mediastinal blood pool and lymph node/liver SUV ratios improved the detection of N2 metastases in patients with nonsmall cell lung cancer compared with SUVLN. There are a few similar studies on patients with cervical cancer. Brunette et al. [19] used the normalization of lymph node SUVmax (SUV of lymph node to pelvic blood pool) to predict lymph node metastasis of cervical cancer, and the results showed that the standardized SUV did not increase the diagnostic accuracy, but was related to extractive recurrence free-survival. In addition, a study has shown that SUVLN/T is an independent predictor of cervical cancer recurrence [18]; however, our study showed that SUVLN/T is not an independent predictor of PLN metastasis of cervical cancer. SUVLN (the SUVmax of lymph node) was commonly used to distinguish between benign and malignant lymph node [9]. Our study showed higher SUVLN and SUVLN/BM both increased the risk of metastasis (HR = 2.974, 3.280; P 0.05), and the diagnostic efficiency of SUVLN/BM was to be better than SUVLN in this study, which may be related to a large proportion of anemia patients in this study. The SUVLN/BM, as a diagnostic index was applied to predict PLN metastasis of cervical cancer for the first time in our study, and more research are needed to confirm the role of SUVLN/BM.

Previous studies have suggested that anemia could cause the FDG uptake of BM [22,23], and this study also confirmed that SUVBM in the anemia group was significantly higher than that in the nonanemia group (P 0.05). Moreover, false-positive cases decreased when the SUVLN/BM was used as the diagnostic criterion instead of SUVLN for PLN metastasis, and the decreasing degree of false-negative cases in the anemia group was higher than that in the nonanemia group. Unfortunately, there is no statistical difference in the false-positive rate between the anemia group and the nonanemia group with different diagnostic criteria (SUVLN and SUVLN/BM) (P 0.267)(P 0.267), whose reason may be attributed to the small sample size of the anemia subgroup. Therefore, more data are needed to affirm this in the future.

Ds/l as a morphological parameter on CT is also a potential parameter to predict lymph node metastasis in this study. Short-axis diameter greater than 10 mm is the most accepted criterion in traditional imaging examination [32,33]. Li et al. [26] hold that although the overall diagnostic efficacy of Ds/l alone is limited it provides a certain contribution to reduce false-negative cases. Ds/l is better
The value of the SUVLN/BM in predicting pelvic lymphatic metastasis
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than DS and becomes the best morphological parameter to predict PLN metastasis of cervical cancer in our study.

In our study, the diagnostic efficacy of the combination of SUVLN/BM and DS/l was better than that of any single parameter. Li et al. [26] revealed the combination diagnosis method that can better predict PLN metastasis for patients with early-stage cervical cancer, and the results coincide with our research. However, their study showed that the combination of primary tumor metabolic parameter and the morphological parameter is helpful to evaluate lymph node metastasis, whereas our study showed the combination of lymph node metabolic parameters and morphological parameters is helpful to evaluate lymph node metastasis. Our study showed that the metabolic parameters of the primary tumor are not related to lymph node metastasis, these differences may be related to different constituent samples, such as tumor stage, pathological type, and so on.

However, this study had several limitations. First, this study is a retrospective study, and it was conducted at a single institution with a limited number of cases and a small proportion of anemia, therefore, prospective, multicenter and large sample studies are essential to further confirm these results. Second, the measurements of metabolic parameters and nodal size were made in every case also including traditional normal-sized nodes, implying a large workload requires a large amount of time.

**Conclusion**
This study suggested SUVLN/BM, a metabolic parameter derived from SUV on ¹⁸F-FDG PET, could improve the ability to predict PLN metastasis in patients with LACC and might reduce the false-positive cases; the diagnostic efficacy of the combination of the metabolic parameter derived from SUV based on ¹⁸F-FDG PET and the morphological parameter based on CT could better than that of a single parameter.

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Conflicts of interest
There are no conflicts of interest.
References

1 Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018; 68:394–424.

2 Cibula D, Pötter R, Planchamp F, Aival-Lundqvist E, Fischerova D, Hae-Meder C, et al. The European Society of Gynaecological Oncology/ European Society for Radiotherapy and Oncology/European Society of Pathology guidelines for the management of patients with cervical cancer. Virchows Arch 2018; 472:919–936.

3 Bhagia N, Berek JS, Cuello Freudes M, Denny LA, Gremen S, Karunaratne K, et al. Revised FIGO staging for carcinoma of the cervix uteri. Int J Gynaecol Obstet 2019; 145:129–135.

4 Eisenhauer EA, Therasse P, Bogaerts J, Schwartz LH, Sargent D, Ford R, et al. New response evaluation criteria in solid tumours: revised RECIST guideline (version 1.1). Eur J Cancer 2009; 45:228–247.

5 Pieterman RM, van Putten JW, Meuzelaar JJ, Mooyaart EL, Vaalburg W, Koëter GH, et al. Preoperative staging of non-small-cell lung cancer with positron-emission tomography. N Engl J Med 2000; 343:254–261.

6 De Leyn P, Vansteenkiste J, Cuypers P, Deneffe G, Van Raemdonck D, Moirand R, et al. Multimodal PET/CT: a useful tool in the evaluation of mediastinal lymph nodes in patients with normal-size mediastinal lymph nodes on CT. Eur J Cardiothorac Surg 1997; 12:706–712.

7 Choi HJ, Ju W, Myung SK, Kim Y. Diagnostic performance of computer tomography, magnetic resonance imaging, and positron emission tomography or positron emission tomography/computer tomography for detection of metastatic lymph nodes in patients with cervical cancer: a meta-analysis. Cancer Sci 2010; 101:1471–1479.

8 Xu G, Du S, Zhang S, et al. Value of integrated PET/IVM MR in assessing metastases in hypermetabolic pelvic lymph nodes in cervical cancer: a multi-parameter study. Eur Radiol 2020; 30:2483–2492.

9 Payavash S, Meric K, Cayci Z. Differentiation of benign from malignant cervical lymph nodes in patients with head and neck cancer using PET/CT imaging. Clin Imaging 2016; 40:101–105.

10 Mabuchi S, Komura N, Sasano T, Shimura K, Yokoi E, Kozasa K, et al. Revised FIGO staging for carcinoma of the cervix uteri. Int J Gynaecol Obstet 2019; 145:129–135.

11 Nakagawa T, Yamada M, Suzuki Y. 18F-FDG uptake in reactive neck lymph nodes of oral cancer: relationship to lymphoid follicles. J Nucl Med 2008; 49:1053–1059.

12 Yamada S, Kubota K, Kubota R, Ido T, Tamashashi N. High accumulation of fluorine-18-fluorodeoxyglucose in turpentine-induced inflammatory tissue. J Nucl Med 1995; 36:1301–1306.

13 Ruddy JH, Warburton EA, Fryer TD, Jones HA, Clark JC, Antoun N, et al. Imaging atherosclerotic plaque inflammation with [18F]-fluorodeoxyglucose positron emission tomography. Circulation 2002; 105:2708–2711.

14 Ishimoto T, Saga T, Mamede M, et al. Increased [18F]FDG uptake in a model of inflammation: concanavalin A-mediated lymphocyte activation. J Nucl Med 2002; 43:659–663.

15 Goo JM, Im JG, Do KH, Yeo JS, Seo JB, Kim HY, Chung JK. Pulmonary tuberculosis evaluated by means of FDG PET: findings in 10 cases. Radiology 2000; 216:117–121.

16 Kuo WH, Wu YC, Wu CY, Ho KC, Chiu PH, Wang CW, et al. Nodal aorta and node/liver SUV ratios from (18)F-FDG PET/CT may improve the detection of occult mediastinal lymph node metastases in patients with non-small cell lung carcinoma. Acad Radiol 2012; 19:685–692.

17 Mabuchi S, Komura N, Sasano T, Shimura K, Yokoi E, Kozasa K, et al. Revised FIGO staging for carcinoma of the cervix uteri. Int J Gynaecol Obstet 2019; 145:129–135.

18 Chung HH, Cheon GJ, Kim JW, Park NH, Song YS. Prognostic importance of lymph node-to-primary tumor standardized uptake value ratio in invasive squamous cell carcinoma of the uterine cervix. Eur J Nucl Med Mol Imaging 2017; 44:1862–1869.