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# Evaluation Study on the Accuracy of PET-CT in Clinical Staging of Lymphoma

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**Abstract: Objective:** To evaluate the accuracy of PET-CT in the clinical staging of lymphoma and to provide reliable evidence for the formulation of clinical treatment plans and prognosis assessment. **Methods:** The clinical data of 86 patients with pathologically confirmed lymphoma who received diagnosis and treatment in our hospital from March 2022 to March 2024 were retrospectively analyzed. The accuracy, sensitivity, and specificity of PET-CT were compared with those of conventional imaging in lymphoma clinical staging, and the detection of occult lesions by PET-CT was recorded. **Results:** A total of 86 patients were included, including 23 cases of Hodgkin lymphoma and 63 cases of non-Hodgkin lymphoma. Based on the Ann Arbor staging system, 18 cases were stage I, 25 cases stage II, 29 cases stage III, and 14 cases stage IV. The overall staging accuracy of PET-CT was 91.86% (79/86), significantly higher than that of traditional imaging (76.74%, 66/86). The corresponding diagnostic accuracy for each stage was 88.89% in stage I, 92.00% in stage II, 93.10% in stage III, and 89.29% in stage IV. Its sensitivity and specificity both exceeded 85%. In addition, PET-CT successfully identified 12 occult lesions that were not detected by conventional imaging, including 4 cases of bone marrow infiltration, 5 cases of distant lymph node metastasis, and 3 cases of extranodal involvement. **Conclusion:** PET-CT can accurately reflect the metabolic activity and extent of tumor dissemination, and it demonstrates superior performance over traditional imaging techniques in improving the accuracy of lymphoma clinical staging.

**Keywords:** PET-CT; lymphoma; clinical staging; accuracy evaluation

## Introduction

Lymphoma is a type of malignant tumor originating from the lymphohematopoietic system, mainly classified into Hodgkin lymphoma (HL) and non-Hodgkin lymphoma (NHL). With advances in modern medicine, a variety of effective therapeutic approaches have been developed for different lymphoma subtypes, such as chemotherapy, radiotherapy, targeted therapy, and even stem cell transplantation. However, regardless of the therapeutic strategy, accurately determining the clinical stage of the disease remains one of the key steps in selecting treatment pathways and predicting therapeutic outcomes. Traditional clinical staging mainly relies on anatomical imaging techniques such as CT and MRI, as well as bone marrow cytological examination[1]. In recent years, positron emission tomography combined with computed tomography (PET-CT) has gained wide attention due to its ability to simultaneously

obtain functional metabolic information and structural characteristics. Previous studies have shown that this technique not only improves early diagnostic capability but also demonstrates unique advantages in staging management of lymphoma[2]. Therefore, this study conducted a systematic retrospective analysis of a cohort of pathologically confirmed lymphoma cases to objectively assess the actual clinical performance of PET-CT, and to further determine whether it has the potential to replace or surpass traditional imaging methods, thereby promoting its rational application in standardized diagnostic and therapeutic procedures.

## 1 Data and Methods

### 1.1 General Information

This study included all newly diagnosed lymphoma inpatients who were admitted to the Department of Hematology of our hospital and received a confirmed pathological diagnosis between March 2022 and March 2024. A total of 86 eligible cases were finally enrolled. The age range was 18–75 years, with a mean age of 52.3±13.4 years. Males accounted for 54.65% ($n$ = 47) and females for 45.35% ($n$ = 39).

**Inclusion criteria:** lymphoma confirmed by histopathology or flow cytometry; completion of a full PET-CT scan and corresponding comparative imaging examinations before treatment; availability of at least six months of complete follow-up data to verify staging accuracy.

**Exclusion criteria:** history of other malignant tumors; presence of severe cardiopulmonary diseases that could affect imaging quality.

### 1.2 Imaging Examination Procedures

All participants underwent standardized PET-CT examinations before initiating antitumor therapy. The device used was the GE Discovery MIDR PET/CT scanner. The injected dose of fluorodeoxyglucose (FDG) was approximately 3.7 MBq per kilogram of body weight. After injection, patients rested quietly for about 60 minutes to ensure adequate tracer uptake before whole-body scanning. The scanning range extended from the top of the head to the mid-thigh, with a slice thickness of 3 mm, and iterative reconstruction algorithms were applied to enhance the signal-to-noise ratio. Images were independently reviewed by two senior nuclear medicine physicians, and in cases of disagreement, a third expert was consulted to reach consensus. Meanwhile, each subject also completed conventional imaging assessments, including contrast-enhanced chest and abdominal CT or pelvic MRI, along with bone marrow aspiration smears to determine the presence of abnormal lymphoid cell infiltration.

### 1.3 Definition of the Gold Standard

To ensure the authenticity and reliability of subsequent data analysis, a dual-validation mechanism was adopted to determine the final staging of each patient. Initial staging was based on pathological reports and was further verified and refined using more than six months of follow-up data. Repeat biopsy or additional auxiliary tests were referenced if necessary. The Ann Arbor staging system was used as the unified standard, classifying patients into four stages (I–IV), corresponding respectively to localized involvement of a single region, involvement of multiple regions within one organ, extensive involvement on both sides of the diaphragm, and distant dissemination.

### 1.4 Data Processing Methods

All statistical analyses were performed using SPSS Version 26.0. Categorical data were expressed as frequencies and percentages, and intergroup comparisons were conducted using the chi-square test. For measurement data, t-tests were used for normally distributed variables, while rank-sum tests were applied for non-normal distributions. A value of $P < 0.05$ was considered statistically significant.

## 2 Results

### 2.1 Comparison of Overall Staging Consistency

After reassigning staging based on the aforementioned gold standard, the actual distribution of each stage within the cohort is shown in **Table 1**. Notably, the concordance rate between the preliminary PET-CT staging results and the final confirmed staging reached 91.86% (79/86). In contrast, traditional imaging examinations achieved a match rate of only 76.74% (66/86), demonstrating a significant difference between the two methods ($P < 0.01$).

**Table 1** Comparison of Staging Accuracy Between PET-CT and Traditional Imaging

| Stage | Actual Cases | PET-CT Correct | Accuracy (%) | Traditional Imaging Correct | Accuracy (%) |
|---|---|---|---|---|---|
| I | 18 | 16 | 88.89 | 13 | 72.22 |
| II | 25 | 23 | 92.00 | 18 | 72.00 |
| III | 29 | 27 | 93.10 | 22 | 75.86 |
| IV | 14 | 13 | 89.29 | 11 | 78.57 |
| Total | 86 | 79 | 91.86 | 66 | 76.74 |

### 2.2 Sensitivity and Specificity Analysis

Further analysis of performance parameters revealed that PET-CT demonstrated an overall sensitivity of 92.31% and a specificity of 90.48%. In the traditional imaging group, the corresponding values were only 78.85% and 76.19%, respectively, indicating that PET-CT not only detects positive lesions more efficiently but also better differentiates negative regions.

### 2.3 Detection of Occult Lesions

Among the 86 patients included in this study, PET-CT identified 12 previously unrecognized suspicious lesions that were missed by conventional imaging. The detailed findings are as follows:

**Bone marrow infiltration:** 4 cases (all showed negative results in bone marrow biopsy but exhibited hypermetabolic foci on PET images);

**Distant lymph node metastasis:** 5 cases (commonly located in concealed regions such as the paratracheal and supraclavicular areas);

**Extranodal organ involvement:** 3 cases (affecting the liver, spleen, and testes).

These newly detected abnormalities directly resulted in an upward revision of the initial staging in 7 patients, indicating that PET-CT plays an important role in revealing hidden risk factors that may significantly impact clinical decision-making.

## 3 Discussion

As a core component of the body's immune defense network, the lymphatic system plays an essential role in eliminating external pathogens and maintaining internal homeostasis. When this complex regulatory mechanism is disrupted, various lymphoproliferative disorders may arise, among which lymphoma is the most common and poses significant clinical threats. Currently, more than 500,000 new cases are diagnosed worldwide each year, making lymphoma one of the fastest-growing cancers in terms of incidence. According to the WHO classification guidelines[3], lymphoma can be broadly divided into two major categories: HL and NHL. HL accounts for approximately 10% of all cases and commonly affects adolescents, with the presence of Reed–Sternberg cells serving as a typical pathological feature. In contrast, NHL is more diverse and complex, encompassing multiple sublineages such as B-cell and T/NK-cell origins, each exhibiting distinct biological behaviors and clinical outcomes. Due to the high heterogeneity and migratory nature of lymphoma, achieving precise clinical staging is particularly crucial. Since its introduction in the 1970s, the Ann Arbor staging system has remained the standard framework, classifying disease into four stages, each further divided into A/B subcategories to indicate the presence or absence of systemic symptoms (fever, night sweats, weight loss)[4]. Accurate assessment of disease burden not only guides clinicians in formulating appropriate therapeutic strategies but also plays a vital role in treatment monitoring and recurrence surveillance.

In clinical practice, structural imaging tools such as CT and MRI had long been widely used for lymphoma screening and follow-up. Although these techniques are convenient, fast, and relatively low-cost, they often show significant limitations in certain situations. For example, in small lymph nodes that have not yet exhibited obvious enlargement, it is difficult to make an accurate judgment based solely on size changes; likewise, in deep anatomical regions such as the mediastinum or retroperitoneal space, even slight expansion may be difficult to detect due to surrounding fat encapsulation; in addition, some patients have underlying chronic inflammatory conditions, making CT images susceptible to false-positive misleading signals[5]. Bone marrow aspiration, although regarded as the most authoritative invasive diagnostic method, is limited by its fixed sampling sites and therefore cannot comprehensively reflect the distribution pattern of lesions throughout the entire marrow cavity. When malignant components are confined to a specific localized area, the risk of missed diagnosis is particularly high. Moreover, the trauma caused by repeated punctures is also unfavorable for long-term follow-up needs.

Compared with these traditional methods, PET-CT is an advanced imaging platform that integrates anatomical structure with physiological function. Its core lies in using the radioactive tracer FDG to label abnormal cell clusters in a state of high metabolic activity. Under normal conditions, most tissues and organs have relatively low glucose consumption, except for a few areas such as the brain, cardiac muscle, and intestinal mucosa, which show strong uptake; malignant tumor cells, however, behave in the opposite manner—they often exhibit vigorous energy demands, demonstrating strong FDG uptake even when

no significant morphological enlargement is visible. This unique ability to map metabolic activity gives PET-CT exceptionally high sensitivity and resolution, enabling it to detect early changes invisible to the naked eye. More importantly, with the support of three-dimensional reconstruction software, physicians can clearly visualize the internal distribution patterns of each organ, allowing for more refined differentiation between benign and malignant lesions and more accurate estimation of the extent of involvement[6]. The results of this study clearly demonstrate PET-CT's overwhelming superiority across multiple dimensions. First, its overall staging accuracy reached 91.86%, far exceeding the 76.74% achieved by conventional imaging; second, the success rates for distinguishing stages I–IV were all maintained at high levels, with the middle stages approaching perfection; third, its powerful detection capability identified 12 previously overlooked suspicious sites, including 4 cases of bone marrow infiltration, 5 cases of distant lymph node metastasis, and 3 cases of extranodal organ involvement—findings that directly influenced subsequent treatment decisions. Particularly noteworthy is PET-CT's excellent potential in diagnosing bone marrow involvement. In the past, clinicians frequently encountered situations in which hematologic indicators suggested marrow infiltration but bone marrow aspiration failed to provide definitive evidence due to improperly chosen puncture sites or insufficient sampling depth. With PET-CT's whole-body scanning capability, such problems can now be easily avoided; as long as an abnormal focal accumulation signal appears in the corresponding skeletal region, marrow involvement can be strongly suspected, and targeted aspiration performed thereafter significantly increases the likelihood of obtaining a definitive diagnosis.

In summary, PET-CT demonstrates outstanding functional advantages in the clinical staging of lymphoma. It not only clearly reveals the metabolic activity and extent of infiltration of tumor tissues but also successfully identifies occult lesions that are difficult to detect with conventional imaging, thereby greatly improving the overall accuracy of staging assessment. Its superiority is particularly evident in distinguishing early and intermediate stages. It is recommended that, where conditions permit, PET-CT should be prioritized and incorporated into frontline screening procedures to optimize resource allocation efficiency and improve patient survival outcomes. At the same time, attention must be given to controlling the frequency of use and standardizing operating procedures to minimize the likelihood of potential adverse effects.

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