PET-CT Evaluation, Scoring and Response Assessment of Hodgkin's and Non-Hodgkin's Lymphoma: Observation of a Single Institute

[1]Md. Rezwan-ul-Haque, [1]Mariom Nusrat, [2]Kazi Reazuddin Ahmed, [2]Sudipto Das, [1]Moontaha Binte Rashid, [1]Jerin Sultana, [3]Jinia Afrin Khan, [1]Ilteza Tabassum, [4]Zeenat Jabin

[1]Medical Officer, [2]Scientific Officer [3]Senior Medical Officer [4]Director & Professor
Institute of Nuclear Medicine & Allied Sciences (INMAS), Suhrawardy, Dhaka

Correspondence Address : Dr. Md. Rezwan-ul-Haque, Medical Officer, INMAS, Suhrawardy, ShSMCH campus, Sher-e-Bangla Nagar, Dhaka-1207. E-mail: hrezwanul2@gmail.com

ABSTRACT

Introduction: ^{18}F-Fluorodeoxyglucose Positron Emission Tomography (^{18}F-FDG PET-CT) is a non-invasive imaging technique that combines PET and CT in a single instrument. It detects and measures metabolic activity in cancer cells, providing both anatomical and metabolic information. Whole body ^{18}F-FDG PET-CT plays a vital role in staging, evaluating therapeutic response, excluding relapse, and various stages of management of lymphoma and constitutes a step towards the pursuit of personalized therapies.

Patients and methods: This observational study was done in the PET-CT division of the Institute of Nuclear Medicine & Allied Sciences (INMAS), Suhrawardy, between May 2024 and December 2024. A total of 42 patients diagnosed with Hodgkin's lymphoma (HL) and non-Hodgkin's lymphoma (NHL) who requested whole-body ^{18}F-FDG PET-CT scans were enrolled in this study. Image findings were analyzed and properly documented in a predesigned format to evaluate the results.

Results: A total of 42 lymphoma patients with an average age of 41.11 ± 17.50 years were studied. Histologically diagnosed NHL was seen in 26 patients, and among them, B-cell lymphoma was the most common (84.6%), diffuse large B-cell lymphoma (DLBCL) (42.3%) was the most aggressive, and follicular lymphoma (15.4%) was the most indolent subtypes. HL was diagnosed in 16 patients. Male predominance (78.6%) was observed in both types with relatively early onset in NHL. Cervical lymph nodes appear to be the most commonly affected (78.5%) lymph nodes. Higher Deauville scores among the 42 study subjects reflected the severity of disease.

Conclusion: PET-CT is most effective when clinicians, reporting nuclear medicine physicians, and radiologists understand the uses and limitations and participate as a multidisciplinary team for accurate interpretation of baseline and post-treatment scans.

Keywords: ^{18}F-FDG PET-CT, Lymphoma, Deauville score, response assessment

Bangladesh J. Nucl. Med. Vol. 28 No. 1 January 2025

DOI: https://doi.org/10.3329/bjnm.v28i1.79478

INTRODUCTION

Malignant diseases known as lymphomas develop from the immune system's component cells or from their progenitors. They can develop from almost any organ or tissue in the body. (1, 2). Lymphoma is representing approximately 5% of all cancers (3). They are regarded as one of the cancer types that are most treatable. Hodgkin's lymphoma (HL) and non-Hodgkin's lymphoma (NHL) are the two primary categories into which lymphomas are generally divided; approximately 85% of lymphomas are non-Hodgkin's lymphoma. (1, 4). These are subdivided into many subtypes. The 5-year relative survival rate is 96% for all people with HL and 85.6% for all people with NHL who were younger than 50 years at diagnosis. The treatment and prognosis of both non-Hodgkin's lymphoma and Hodgkin's lymphoma depend on the grading, staging, and histological subtypes (4). In the past, the imaging evaluation and follow-up of lymphoma patients was based solely on findings at contrast-enhanced CT. However, contrast-enhanced CT has limited sensitivity in detecting lymphomatous involvement of normal-sized lymph nodes, bone marrow, spleen, and extra-nodal tissues. An essential imaging technique for diagnosing lymphoma is ^{18}F-FDG PET-CT, which helps with precise staging and treatment choices and avoids undertreating patients with advanced disease who are mistakenly labelled as having a limited stage. if patients have symptoms that point to a relapse in their illness. In summary, ^{18}FDG PET/CT is a step toward the goal of individualized treatment and plays significant roles in the different stages of lymphoma care. The false positive rate is only 10.3%, with the maximum accuracy rate being about 87.8% in lymphoma patient staging with PET-CT (5).

Because cancer cells absorb a lot of glucose, an FDG scan can identify them. According to the Warburg effect, malignant cells have higher levels of FDG than healthy tissue (6). Under the project of 8 NMC, a PET-CT machine was installed in INMAS, Suhrawardy. The first PET-CT scan was performed in INMAS, Suhrawardy, in May 2024

with the Siemens Biograph-mCT machine. INMAS, Suhrawardy is now contributing to the management and treatment plan of cancer patients, including lymphoma, for the last 8 months.

PATIENTS AND METHODS

Patients

This retrospective observational study comprised 42 lymphoma patients who had whole-body ^{18}F-FDG PET and contrast-enhanced CT to evaluate diagnosed lymphoma cases and find out nodal and extra nodal involvement between May 2024 and December 2024 at INMAS, Suhrawardy. Suspected locations of disease involvement from histologically verified lymphomas were investigated and scored according to the Deauville scoring system.

All patients underwent a comprehensive history and baseline laboratory tests like blood glucose, SGPT, and serum creatinine before the PET-CT scan. Imaging was scheduled at an interval of at least 3 weeks after the last cycle of chemotherapy and 3 months after the last session of radiotherapy.

Early post-operative cases, uncontrolled diabetic patients, and patients with too recent a history of CT or RT were excluded from the study.

Imaging technique:

An ^{18}F-FDG PET-CT scan combined with CE-CT was performed simultaneously for each patient, in which the FDG-PET with low-dose CT was performed first, followed by the CE-CT scans. The PET imaging was conducted from the top of the skull to the mid-thigh approximately 60 min after the intravenous administration of 1 mCi ^{18}F-FDG per 10 kilograms of body weight. For better visualization of the image, some patients were infused with contrast. Routine monitoring of blood sugar levels was performed, and patients fasted for a minimum of four hours before the ^{18}F-FDG injection. All scans were conducted using PET/CT scanners, namely the Biograph™ mCT PET/CT- Siemens.

Interpretation of images:

Different methods were used for assessment of radiotracer uptake by normal and pathologic tissues; analysis of PET images was via visual and semi-quantitative assessment (SUV max measurement). Active lesions were recorded at areas of high FDG uptake. SUV max was measured at each lesion and compared to background activity. The standard background activity was measured at the liver (right lobe). In patients having diseased liver, the background activity was measured at the mediastinal blood pool.

RESULT

A total of 42 patients (M= 33, F= 9) age ranging from 05 to 69 years (mean ± SD = 41.11 ± 17.50) years were studied. Among them 26 (62%) were non-Hodgkin's lymphoma (NHL) and 16 (38 %) is Hodgkin's lymphoma (HL) (Table-1).

Table 1: Category of lymphomas in study patients

Diagnostic status	Frequency	Percentage
Hodgkin's Lymphoma	16	38.09%
Non-hodgkin's Lymphoma	26	61.91%
Grand Total	42	100%

Male predominance was observed among the studies patients of both HL and NHL (78.6%) (Figure 1).

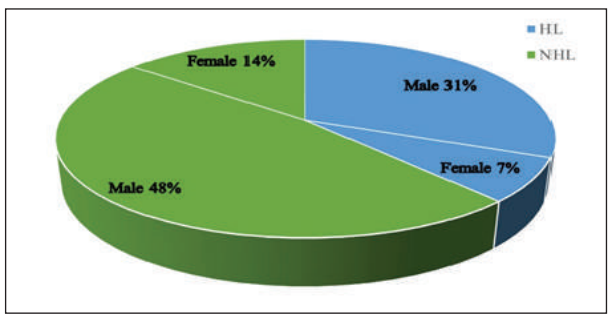

Figure 1: Gender wise lymphoma patients studied in INMAS, Suhrawardy

NHL patients were reported from 5 to 65 years of age (mean ± SD = 45.53 ± 16.16 years). On the other hand, HL patients were reported from 11 to 69 years of age (mean ± SD = 33.94 ± 17.20 years) (Figure-2).

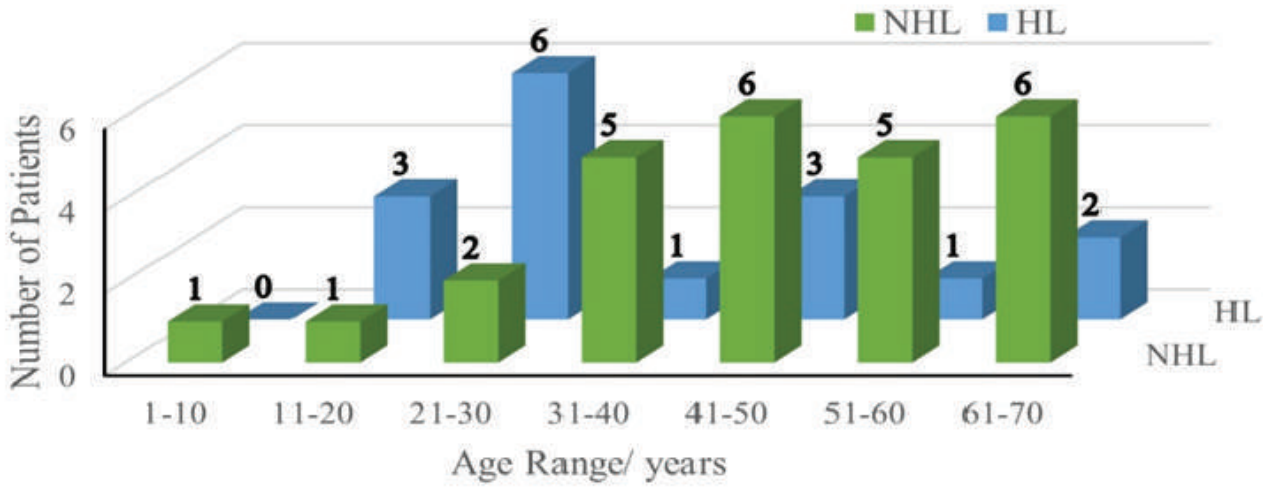

Figure 2: Age distribution of both Hodgkin's and Non-Hodgkin's lymphoma patients

22 of 26 (84.6% of NHL) NHL cases were B-cell lymphoma, and the rest of the 4 of 26 (15.4% of NHL) NHL cases were T-cell lymphoma. In the case of B-cell lymphoma, diffuse large B-cell lymphoma (DLBCL) (42.3% of NHL) is mostly reported. On the basis of prognostic subdivisions, diffuse large B-cell lymphoma (42.3% of NHL) is the most reported case, which is considered an aggressive variant. On the other hand, in the case of the indolent variant, follicular lymphoma (15.4% of NHL) is mostly reported. 13 of 16 (81.2% of HL) HL cases were mixed cellularity types. No nodular sclerosing subtype of lymphoma cases was reported (Figure 3).

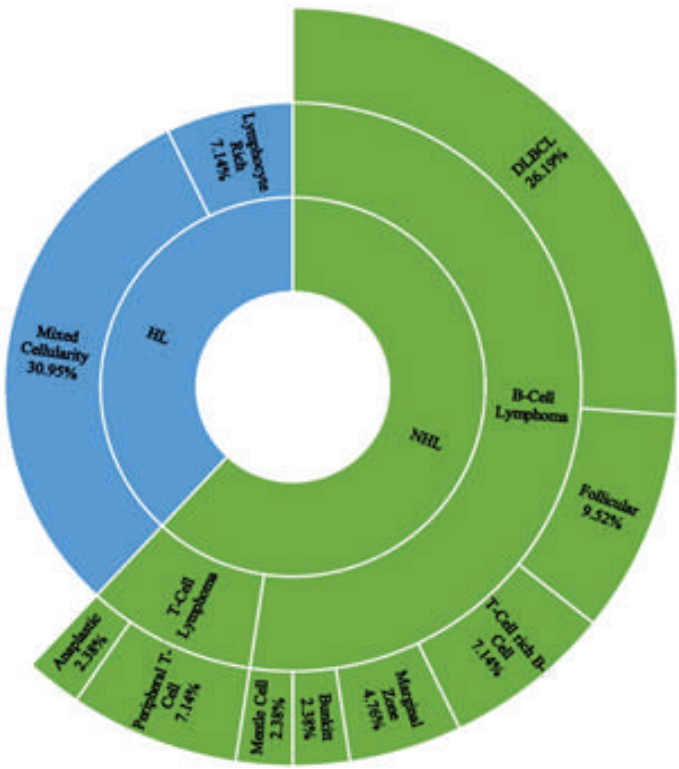

Figure 3: Types and subtypes of lymphoma patients attending INMAS, Suhrawardy for 18F-FDG PET-CT

Cervical and abdomino-pelvic lymph nodes were affected in most of the NHL patients and cervical & inguinal lymph nodes were affected in most of the HL patients. Hepatic, splenic and bone marrow involvement is mostly reported in HLs and intestinal involvement is mostly reported in NHLs (Figure 4).

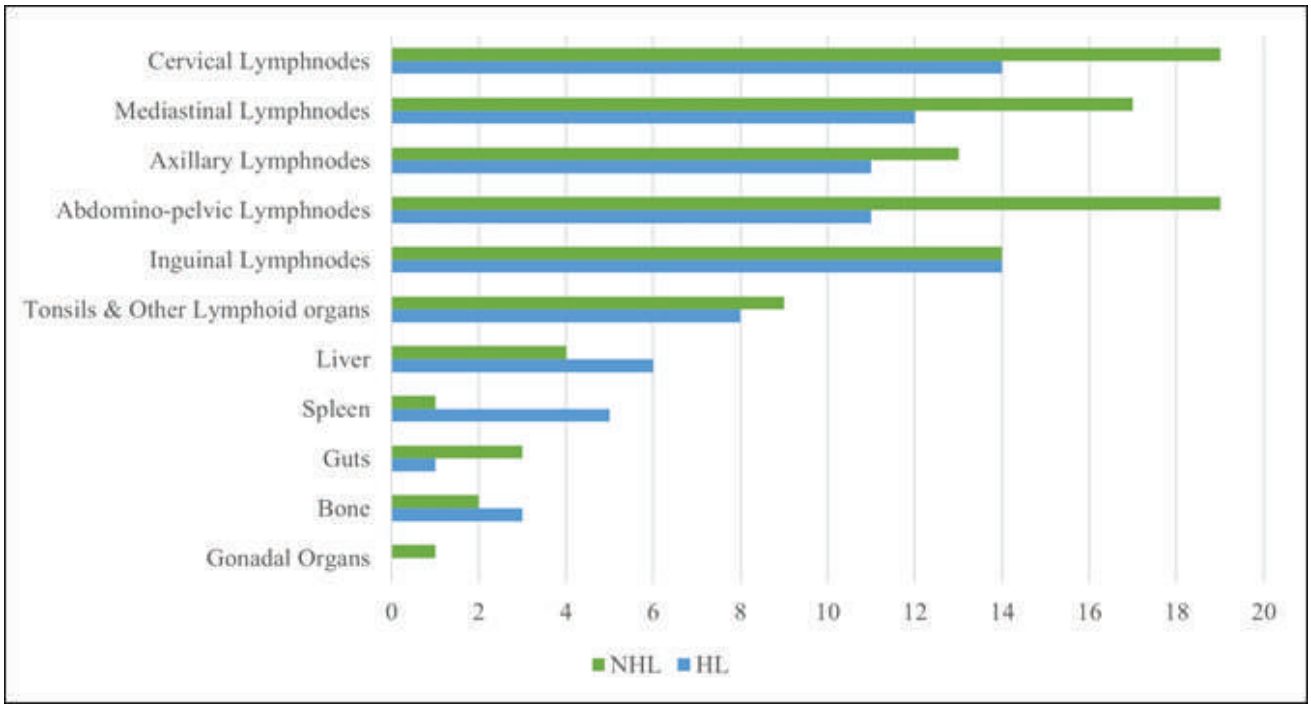

Figure 4: Sites of disease involvement in Hodgkin's and Non-Hodgkin's lymphoma

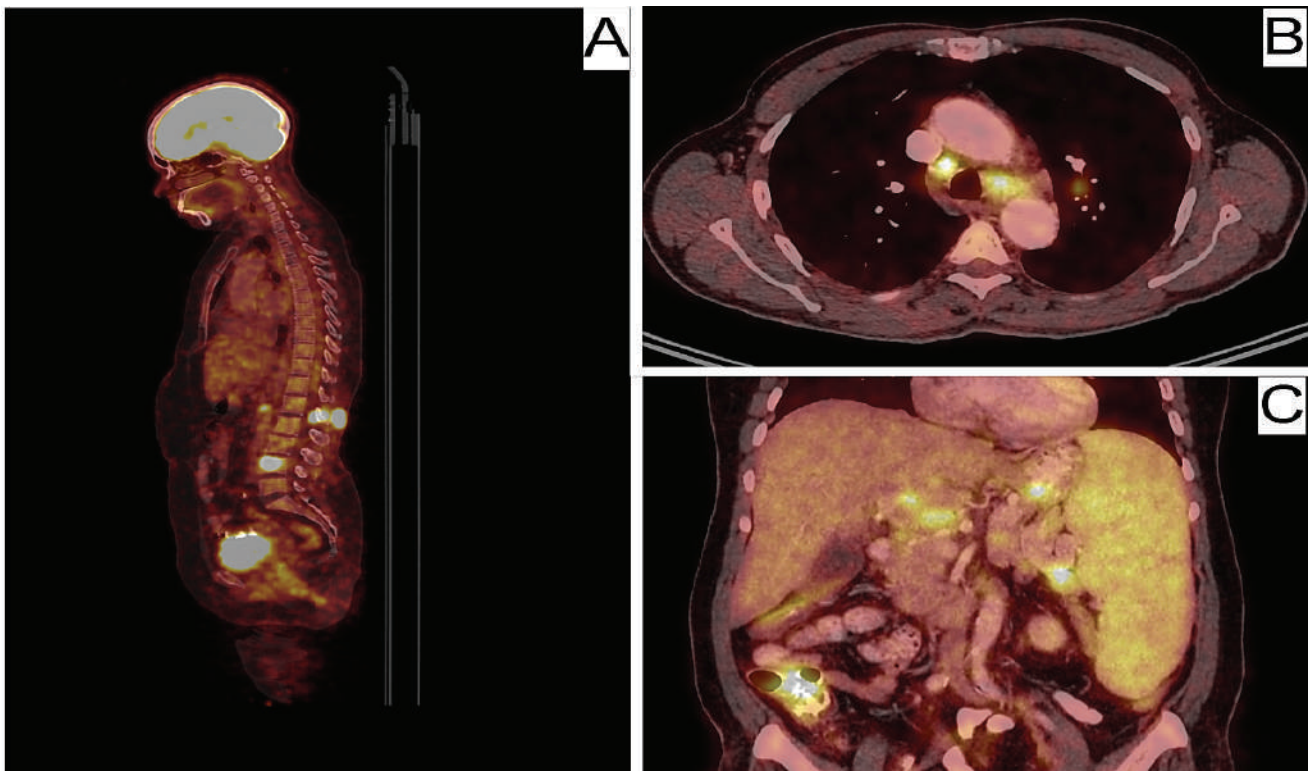

Figure 5: A) Sagittal image of a 71 year old Non-Hodgkin's lymphoma patient, showing multiple vertebral involvements. B) Axial image showing mediastinal lymph nodes in a 56 years old male of Hodgkin's lymphoma. C) Coronal image showing significant enlargement of spleen in a Non-Hodgkin's lymphoma patient.

The majority of lymphoma patients at INMAS, Suhrawardy, achieved a 5-point Deauville score of 5/5 (33.3%) (Figure 6).

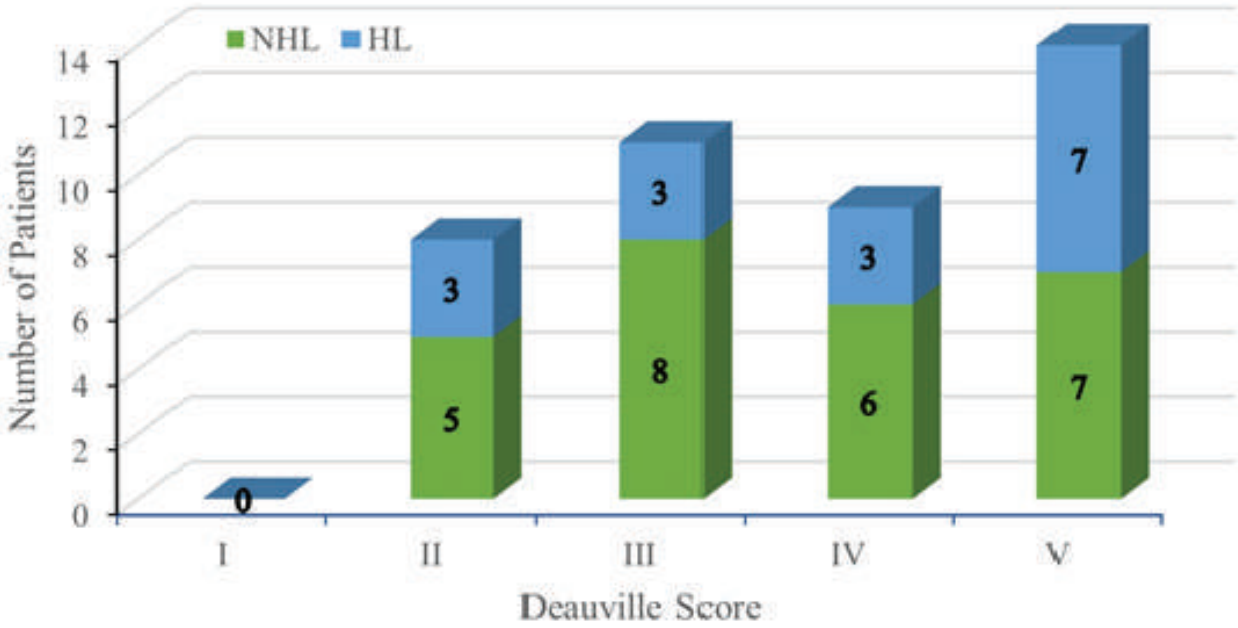

Figure 6: Deauville scores of lymphoma patients

DISCUSSION

The purpose of this study was to assess the demographic distribution and severity assessment of the lymphoma patients and to compare these data with other previous studies. This study included 42 patients who was diagnosed with lymphoma based on immunohistochemistry and histology. The study was conducted from May 2023 to December 2023 at INMAS, Suhrawardy. Patients with tuberculosis, infectious diseases and lactating mothers were excluded.

The study involved patients aged 05-69 years, with a mean age of 41.11 ± 17.50 years. Majority of lymphoma patients were NHL (63%), with male predominance of both NHL and HL (78.6%). Similar findings were noted by D'souza MM et al. (2013) and Radkiewicz C et al (2023), they found that most of the lymphomas are NHL (nearly 85%) and most of them had male predominance (56.4%) (1, 9).

NHL patients were reported from 5 to 65 years of age (mean ± SD = 45.53 ± 16.16 years), with 84.6% being reported after 30 years, suggesting late onset of NHL. On the other hand, HL patients were reported from 11 to 69 years of age (mean ± SD = 33.94 ± 17.20 years), with 56.2% were reported before years, suggesting early onset of HL. Similar findings were noted by Huh J et al. (2012) and Müller AM et al. (2005); they found that there are 2 peaks of HL: one is from 20-35 years and another is from 50-70 years (median age 31 years). Where another study shows that most of the NHL is diagnosed around 75 years of age (10, 11).

About 84.6% of total NHL were B-cell lymphoma, and the rest, about 15.4% of total NHL, were T-cell lymphoma. Among the B-cell lymphomas, diffuse large B-cell lymphoma (about 42.3%) is the most common. Similar findings were noted by Huh J et al. (2012) and Müller AM et al. (2005); they found that B-cell lymphomas formed 79.1% of the NHLs, whereas T-cell lymphomas formed 16.2% of the total, and diffuse large B-cell lymphoma (about 33.8%) of all B-cell lymphomas (10, 11).

There was no nodular sclerosing subtype non-Hodgkin's lymphoma reported in INMAS, Suhrawardy. Although it is the most common subtype. The probability of this result is due to a smaller number of samples.

In the basis of prognostic subdivisions, diffuse large B-cell lymphoma (about 42.3%) was the most reported case as an aggressive variant, and follicular lymphoma (about 15.4%) was the most reported case as an indolent variant. Similar findings were noted by D'souza MM et al. (2013) and Lu P. et al. (2005); they found that DLBCL (about 30%) is the most commonly reported aggressive subtype and follicular

lymphoma (about 22%) is the most commonly reported indolent subtype (1, 4).

Cervical lymph nodes were the most commonly involved site in both HL and NHL (78.5% of all cases) in this study, and in the case of NHL, the 2nd most commonly involved site was the inguinal lymph nodes. Laurent C et al. (2015) also found that the most commonly involved lymphoma sites are cervical lymph nodes (36.8% of all cases) and inguinal lymph nodes (16.4%) (12). Most of the patients in this study had relatively higher Deauville scores, suggesting the severity of diseases.

Study limitations include small number of patients and non-specific FDG uptake as increased FDG absorption in tissues is a symptom of benign disorders with elevated glycolysis, including granulomatous illness, inflammation, and infection. False positive results may occur in certain organs, and marrow infiltration can be challenging due to bone marrow hyperplasia.

CONCLUSION

Despite having a smaller study size, has made a significant contribution to this field because its findings are consistent with broader research trends. This observation highlighted the growing global concern regarding cancer incidence, particularly lymphoma, and emphasizes the crucial role of early diagnosis, staging and assessing therapeutic response with ^{18}F-FDG PET-CT scans in improving survival rates.

REFERENCES

1. D'souza MM, Jaimini A, Bansal A, Tripathi M, Sharma R, Mondal A, Tripathi RP. Fdg-pet/ct in lymphoma. The Indian journal of radiology & imaging. 2013 Oct;23(4):354.
2. Toma P, Granata C, Rossi A, Garaventa A. Multimodality imaging of Hodgkin disease and non-Hodgkin lymphomas in children. Radiographics. 2007 Sep;27(5):1335-54.
3. Paes FM, Kalkanis DG, Sideras PA, Serafini AN. FDG PET/CT of extranodal involvement in non-Hodgkin lymphoma and Hodgkin disease. Radiographics. 2010 Jan;30(1):269-91.
4. Lu P. Staging and classification of lymphoma. InSeminars in nuclear medicine 2005 Jul 1 (Vol. 35, No. 3, pp. 160-164). WB Saunders.
5. Isasi CR, Lu P, Blaufox MD. A metaanalysis of 18F-2-deoxy-2-fluoro-D-glucose positron emission tomography in the staging and restaging of patients with lymphoma. Cancer: Interdisciplinary International Journal of the American Cancer Society. 2005 Sep 1;104(5):1066-74.
6. Gersten O, Wilmoth JR. The cancer transition in Japan since 1951. Demographic Research. 2002 Jul 1;7:271-306.
7. Delbeke D, Coleman RE, Guiberteau MJ, Brown ML, Royal HD, Siegel BA, Townsend DW, Berland LL, Parker JA, Hubner K, Stabin MG. Procedure guideline for tumor imaging with 18F-FDG PET/CT 1.0. Journal of nuclear Medicine. 2006 May 1;47(5):885-95.
8. Castellucci P, Nanni C, Farsad M, Alinari L, Zinzani P, Stefoni V, Battista G, Valentini D, Pettinato C, Marengo M, Boschi S. Potential pitfalls of 18F-FDG PET in a large series of patients treated for malignant lymphoma: prevalence and scan interpretation. Nuclear medicine communications. 2005 Aug 1;26(8):689-94.
9. Radkiewicz C, Bruchfeld JB, Weibull CE, Jeppesen ML, Frederiksen H, Lambe M, Jakobsen L, El-Galaly TC, Smedby KE, Wästerlid T. Sex differences in lymphoma incidence and mortality by subtype: A population-based study. American Journal of Hematology. 2023 Jan;98(1):23-30.
10. Huh J. Epidemiologic overview of malignant lymphoma. The Korean journal of hematology. 2012 Jun;47(2):92.
11. Müller AM, Ihorst G, Mertelsmann R, Engelhardt M. Epidemiology of non-Hodgkin's lymphoma (NHL): trends, geographic distribution, and etiology. Annals of hematology. 2005 Jan;84:1-2.
12. Laurent C, Do C, Gourraud PA, de Paiva GR, Valmary S, Brousset P. Prevalence of Common Non-Hodgkin Lymphomas and Subtypes of Hodgkin Lymphoma by Nodal Site of Involvement: A Systematic Retrospective Review of 938 Cases. Medicine (Baltimore). 2015;94(25):e987.