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Research Article

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Comparative Evaluation of Diagnostic Performances of Contrast Enhanced CT and 18-F FDG PET/CT in Staging of Lymphoma: Experience from a Tertiary Care Centre in North East India

Dr. Bijit Kumar Duara[1], Dr. Affan Khan[2]*, Dr. Mandakinee Phukan[3], Dr. Sushant Agarwal[4], Dr. Unais Mubarak P.A.[5] and Dr. Abdur Rahman[5]

[1]MD, WHO FELLOW, ACME FELLOW, FICR, Professor and Head of the Department, Department of Radiodiagnosis, Gauhati Medical college and Hospital, Guwahati, Assam, India, 781032

[2]MBBS, Post-Graduate Trainee, Department of Radiodiagnosis, Gauhati Medical college and Hospital, Guwahati, Assam, India, 781032

[3]DRM, DNB, Assistant professor, Department of Nuclear medicine, State Cancer Institute, Gauhati Medical college and Hospital, Guwahati, Assam, India, 781032

[4]MD, DM (AIIMS), Assistant Professor, Interventional Radiology Division, Department of Radiodiagnosis, Gauhati Medical college and Hospital, Guwahati, Assam, India, 781032

[5]MBBS, Post-Graduate Trainee, Department of Radiodiagnosis, Gauhati Medical college and Hospital, Guwahati, Assam, India, 781032

Abstract: Background: Lymphoma is a malignancy arising from lymphocytes or lymphoblasts. Lymphoma can be restricted to the lymphatic system or can arise as extranodal disease. Lymphoma accounts for ~4% of all cancers. Prognosis depends not only on histological subtype and grade but also on stage, hence why imaging plays a pivotal role in treatment. The purpose of this study is to assess the diagnostic performance of contrast-enhanced computed tomography (CECT) and 2-[Fluorine-18] fluoro-2-deoxy-D-glucose positron emission tomography combined to computed tomography (18 F-FDG PET/CT) in the staging of lymphoma. **Methods:** Fifty five patients who were histologically proven as lymphoma, after giving written and informed consent were included in the study following inclusion and exclusion criteria. These patients underwent CECT and 18F-FDG PET/CT examination for staging of the disease. The lesions detected by each modality were categorized into true or false positives using reference standard and staging was done using Lugano criteria for staging of lymphoma. Further diagnostic performances of the two modalities were calculated using statistical analysis and compared. **Results**: Diagnostic performance of 18F-FDG PET/CT; sensitivity of 97.30%, specificity of 99.49%, and accuracy of 99.09% which was higher than diagnostic performance of CECT; sensitivity of 81.27%, specificity of 99.29%, and accuracy of around 96.03%. Staging was discordant in 21.81% of the patients when both the modalities were compared. **Conclusion**: Imaging with 18F-FDG PET/CT scan has a better diagnostic performance, represented by sensitivity and accuracy, than CECT scan in the staging of lymphoma in nodal as well as extra-nodal lesions. This leads to alteration of disease stage which in turn could markedly affect the decision of treatment regimens.

Keywords: CECT: contrast-enhanced computed tomography, 18F-FDG PET/CT: 2-[Fluorine-18] fluoro-2-deoxy-D-glucose positron emission tomography combined to computed tomography, HL: Hodgkin's lymphoma, NHL: Non-Hodgkin's lymphoma.

INTRODUCTION

Lymphoma is a malignancy arising from lymphocytes or lymphoblasts. Lymphoma can be restricted to the lymphatic system or can arise as extranodal disease. Lymphoma accounts for ~4% of all cancers. Based on histopathologic, immunohistochemical, cytogenetic, and molecular investigations, the WHO's ICD (2008) has recognized more than 50 different kinds of lymphoma subtypes (Campo, E. *et al*., 2011). Lymphomas are curable if they are treated with chemotherapy itself or alongside radiation therapy. Sometimes they are treated with stem cell transplantation.

Extra-nodal lymphoma is a name for a rare kind of lymphoid malignancy in which the neoplastic tumor extends beyond the expected regional lymph nodes or lymphoid tissues. Non-lymphoid organs include the gastrointestinal tract, head and neck (Waldeyer's ring), orbit, central nervous system (CNS), lung, bone, and skin, with some organs having a higher tendency than others. Extra-nodal disease can potentially have an impact on prognosis. When extra-nodal areas (excluding the spleen) that are remote from the original nodal illness are involved, the disease is classed as stage III or IV. Primary extranodal disease patients, on the other hand, can still be classed as stage I or stage II. The acquired immunodeficiency syndrome epidemic, indolent viral infections (e.g., Epstein-Barr virus), altered environmental exposures, and increased use of immunosuppressive drugs in transplant recipients and patients with collagen vascular disease may partially explain the changes in the pathophysiologic features and spread of lymphoma that have led to more extensive extra-nodal involvement (Zucca, E. *et al*., 2002).

***Corresponding Author:** Dr. Affan Khan

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The CT scan is the most extensively used imaging modality for staging. Its drawback is that it only detects lymph nodes depending on their size. PET is a novel type of functional imaging modality that uses a glucose analogue (2-fluoro-2-deoxy-D-glucuse [FDG]) radiolabeled with the positron emitter fluorine-18 to detect glycolytic activity, which is elevated in cancers like lymphoma. The short half-life of FDG makes it easier for patients to use and enhances imaging qualities. Modern PET scanners have a resolution of roughly 5 mm, and ability to coregister PET with CT imaging simplifies interpretation by accurate anatomic localization. The SUVmax value is used in analysis of results. SUVmax is a semi-quantitative measure of glucose metabolism (calculated as ratio of activity per volume unit over injected activity per body mass). The LDH level is also a prognostic indicator. Low-grade FDG uptake and low LDH levels are seen in indolent Follicular Lymphoma, whereas greater FDG uptake and LDH levels are seen in aggressive lymphoma (Freudenberg, L.S. *et al.*, 2004). Due to technological improvements such as whole-body imaging, iterative reconstruction approaches, 3-D acquisition, and PET-CT fusion, PET fidelity has increased significantly in the previous ten years. False positives, limited availability, high cost and patient worry are some drawbacks of PET/CT, still it is considered as imaging modality of choice for imaging of lymphoma.

MATERIALS AND METHODS

The study was approved by the Institute Ethics Committee.

We studied 60 lymphoma patients who attended the department of Nuclear Medicine from December 2019 to July 2021 for initial staging of the disease by CECT and 18F-FDG PET/CT scans. 5 patients were excluded as their investigations were not available making the effective sample size to be of 55 patients. The study included patients from 3 years to 74 years of age distributed as 42 males and 13 females; with initial presentation of histologically proven untreated lymphoma. Patients with other malignancies, renal failure, uncontrolled diabetes mellitus, pregnancy, those who did not give written and informed consent and hypersensitivity to iodinated contrast agents were excluded.

Protocol

All 55 patients in the study were subjected to full medical and surgical history and complete clinical examination. The procedure of 18-F FDG PET/CT was explained to the patient and due consent was taken. The patients were advised to stay nil per orally for 6 hours prior to the scan. Creatinine level was checked to be less than 1.5mg/dl and blood glucose level was confirmed to be below 200 mg/dl. Participants avoided strenuous exercise for 24 hours to avoid uptake of the tracer in muscles. Patients were advised not to talk following FDG administration.

Scanning Technique and Imaging Parameters

Intravenous (IV) injection of 18 F-FDG (2-[fluorine-18] fluoro-2-deoxy-D-glucose) through IV line with a dose of 0.1 mCi/kg was done. After 45-60 minutes in a quiet room covered by warm blankets, patient was shifted to the scan room with Siemens Biograph TruePoint 64 PET/CT. First, a low-dose CT scan at 120 kV, 100 mAs, 0.9 pitch, 5 mm slice thickness, for attenuation correction, was obtained in supine position with arms raised and scans performed during quiet respiration in caudal-to-cranial direction covering head to mid-thigh level including images of extremities in relevant cases. This is followed by contrast-enhanced CT at 120 kV, 300 mAs, 0.9 pitch, 5 mm slice thickness, and 2.5 mm reconstruction thickness was done at the same scan range after IV injection of 1 ml/kg of an non-ionic iodinated contrast material (Omnipaque 350mg/ml) using automated injector with flow rate of 2 ml/s. A limited breath-hold technique was used to avoid motion induced artifacts. After completion of the CECT scan a three-dimensional PET acquisition at 1 min/bed position, 8–9 beds/patient average was obtained in the same scan range. PET images were then reconstructed with ordered subset expectation maximum iterative reconstruction algorithm. Bone algorithm was set at window level of 600-700 HU and width of 2000 HU. Soft tissue, algorithm was set at level of 40 HU and width 360 HU. Additional maximum inspiration CT scan for detection of lung lesion was performed (if necessary). This was carried out in helical CT with slice thickness of 0.625 to 1 millimeter, pitch of 1, 80-120 kV and 200 400 mA. Data was reconstructed in lung window with 5 mm slice thickness, window width of 1600 HU and window level (- 500 HU). Delayed images of brain were taken to detect central nervous system involvement to avoid false negative or false positive results due to physiological uptake in the brain parenchyma. Peglec enema was given in cases of suspected gastrointestinal involvement.

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Image Analysis and Data Interpretation

The attenuation-corrected FDG-PET images, CT low dose images, as well as contrast-enhanced CT images were automatically fused on True D Siemens software and CECT images were transferred to Philips Intellispace Portal workstation. The relevant images were interpreted by radiologists and nuclear medicine specialists blinding of the imaging reports and the other reviewers' interpretations. Contrast-enhanced CT (CECT) images are evaluated at axial, coronal, and sagittal reconstructed planes. For each patient, 5 lymph node groups including cervical & supraclavicular, axillary, mediastinal & hilar, abdominopelvic and inguinal groups and extranodal sites including spleen, hepatic, bone marrow, Gastrointestinal system, central nervous system, lungs and pleura, renal, adrenal, muscles, head and neck (including tonsils, nasopharynx, oropharynx and thyroid), breast, pancreas, muscles and skin with subcutaneous tissues were evaluated for lesions at CECT and PET/CT images. So, the total number of examined LN groups was 275 groups/55 patients as the group is considered involved even if a single LN of the group is affected. The bone marrow, spleen, liver, GIT, CNS or lungs & pleura and renal, adrenal, muscles, head and neck (including tonsils, nasopharynx, oropharynx and thyroid), breast, pancreas, muscles and skin with subcutaneous tissues is considered involved whatever the number of its lesions, so the total number was 935 extranodal sites/55 patients. Then staging (according Lugano classification) of lymphoma is done.

Diagnostic Criteria of Lymphoma by CECT

General criteria for lymph nodal involvement: if the short-axis diameter is more than 10 mm and/or the long-axis diameter of 15 mm are exceeded. General criteria for extra-nodal involvement are any focal density alterations, abnormal contrast enhancement, or mass lesions involving soft tissues, bones, parenchymal organs, or serosal cavities (Connors, J. M, 2015).

Diagnostic Criteria of Lymphoma by 18F-FDG PET/CT

Any focus of elevated FDG uptake above mediastinal reference background irrespective of the lesion being seen on CT or not (Kostakoglu, L. *et al*., 2014).

Reference Standard or Criteria Standard

In order to calculate the diagnostic precision of a new method, the results of the method must be compared to those of a gold standard method. The optimal gold standard in case of lymphoma would require sampling of biopsies from all the involved nodal regions and all the involved extranodal organs. For obvious practical and ethical reasons, this is not feasible. Instead, a reference standard for each region or organ was established. A region or organ with involvement seen on both PET and CT was regarded as a true positive focus and a site with no suspicious feature on PET and CT was regarded as a true negative. Discrepant findings were assessed. All the available clinical information was taken into consideration for assessment of discrepant findings. In four cases, there was histological evidence to prove or disprove the presence of disease (one lymph node region, one lung, one bowel involvement and one submandibular gland biopsies). For all other discrepant findings the status of the region or organ was determined using information from clinical data / laboratory investigations / follow-up examinations (USG, CT and PET or PET/CT or MRI).

DATA ANALYSIS

Data were statistically described in terms of number of lesions, percentages, mean ±standard deviation (± SD); sensitivity, specificity, and accuracy of each modality were calculated and compared. Agreement between the 2 modalities was calculated using Cohen's Kappa for interobserver agreement.

RESULTS

Demographic Data

55 lymphoma patients were included in our study, with 37(67.3%) of the patients having NHL and 18(32.7%) of patients having HL, *(Graph 1)*. The age group of patients in our study ranged from a minimum age of 3 years to a maximum age of 74 years with a mean age of 39.7 years, *(Table 1)*. The age group of 41 to 50 years included maximum number of patients 10(18.17%) distributed as 10.90% having NHL and 7.27% having HL. 42(76.4%) patients were males and 13(23.6%) were females in the study group. *(Graph 2)*.

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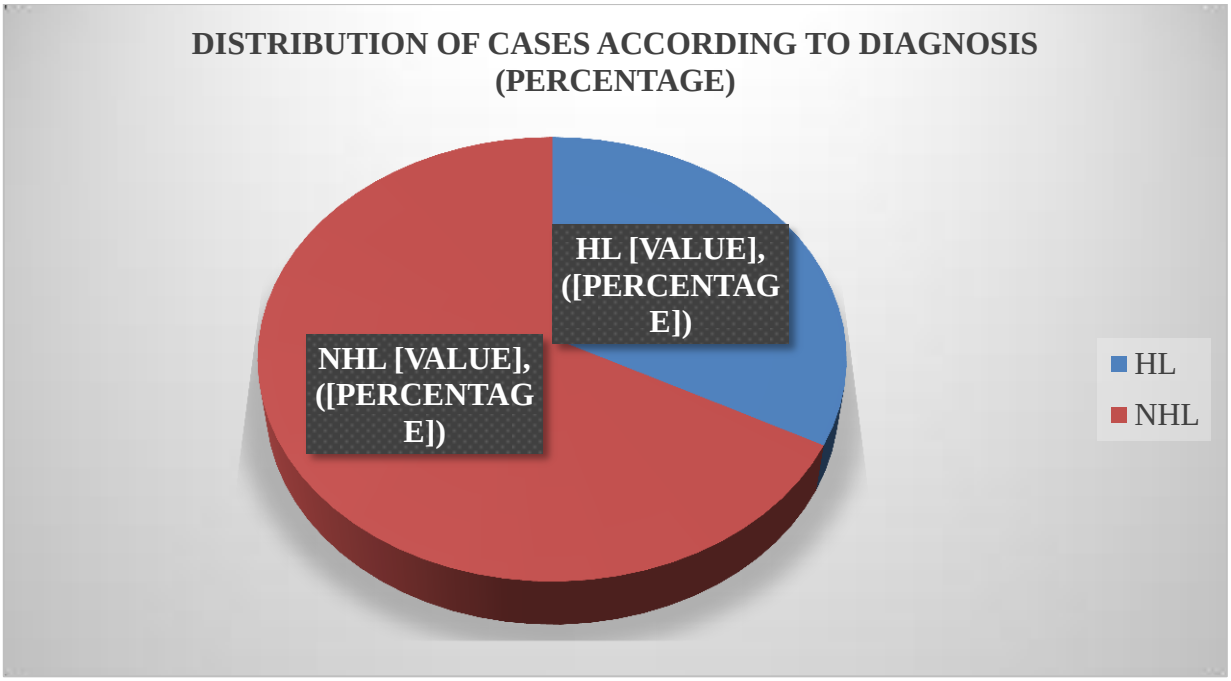
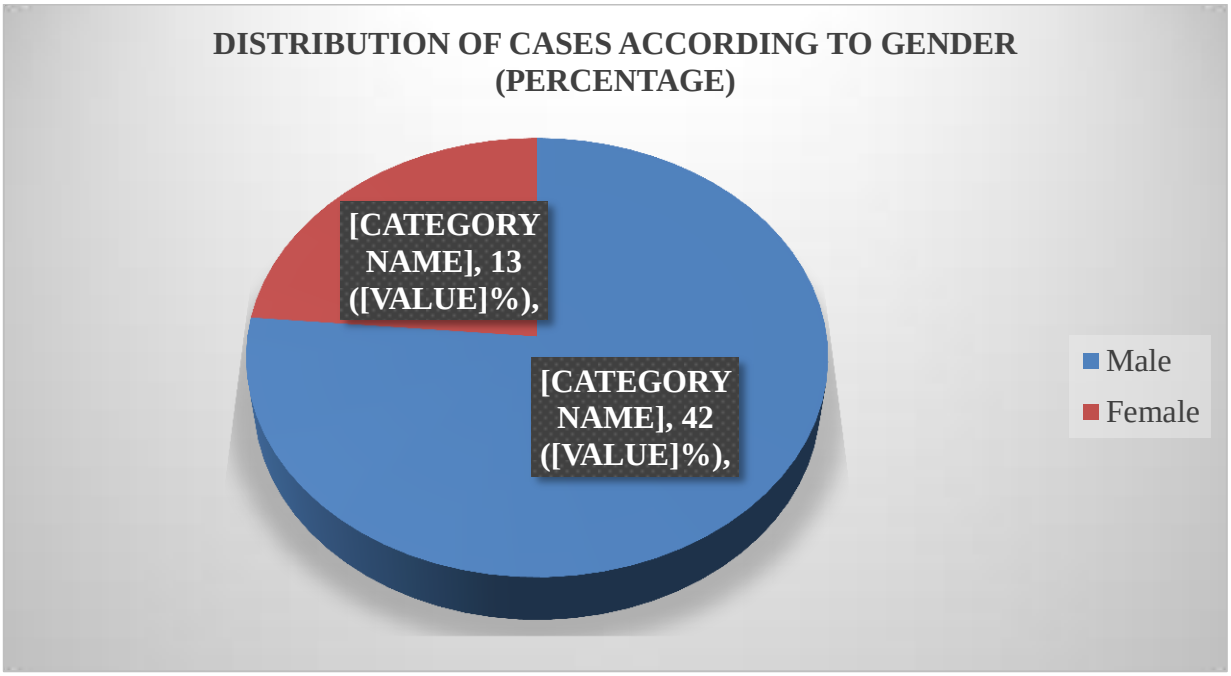


Graph 1: Pie Diagram Showing Distribution of Cases According To Diagnosis



Graph 2: Pie Diagram Showing Distribution of Cases According To Gender

Table 1: Showing Distribution of Cases According To Age Group

Age	Frequency	Percentage (%)
<=10	7	12.7
11-20	3	5.5
21-30	8	14.5
31-40	9	16.4
41-50	10	18.2
51-60	7	12.7
61-70	9	16.4
>70	2	3.6
Total	55	100

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Mean (± S.D.)	39.7 years (± 20)

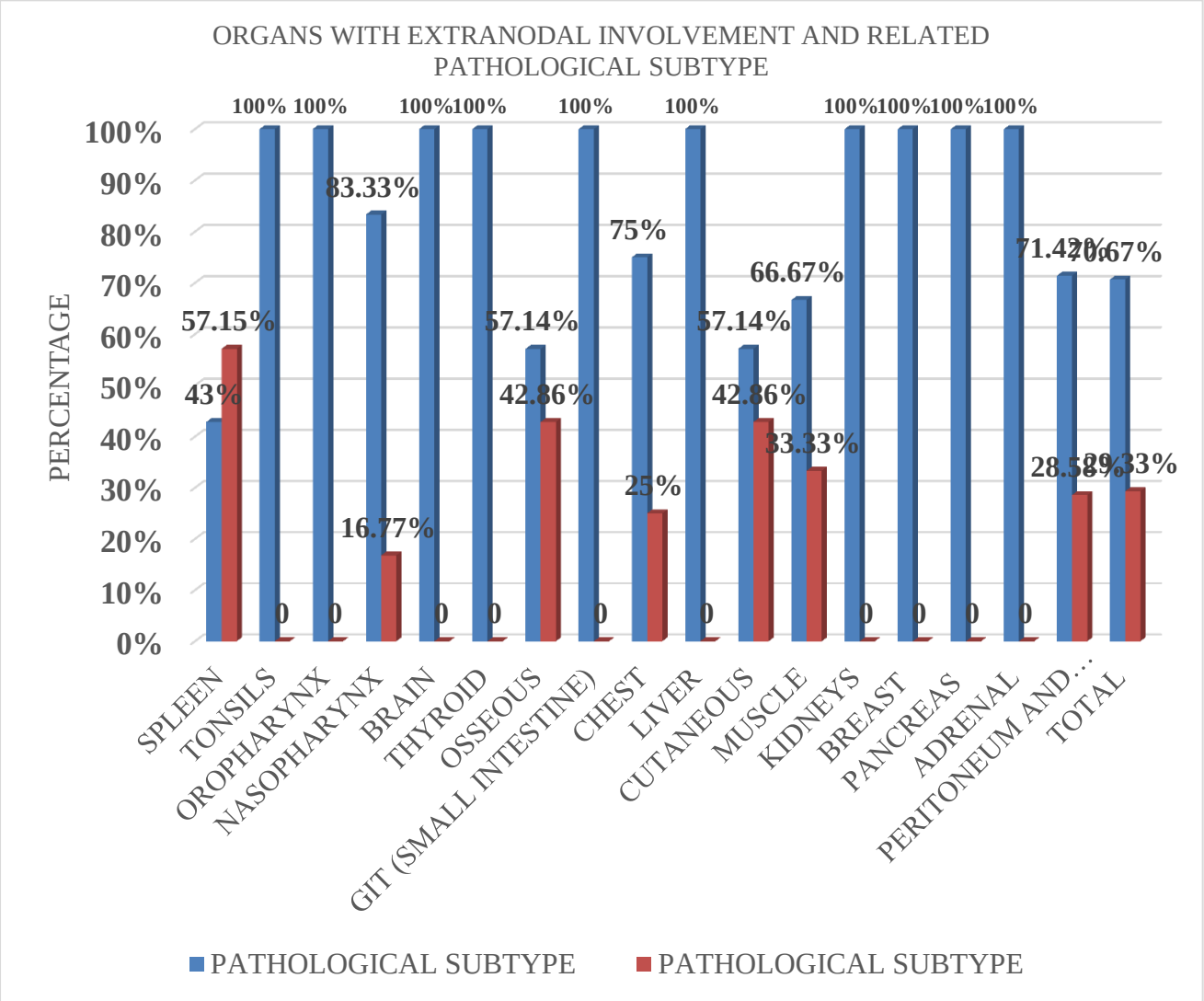
Contrast-Enhanced CT

178 true positive affected sites were detected by CECT and 41/1210 false negative sites were detected representing a percentage of 3.38%. Truly positive nodal involvement was detected in 119(43.27 %) lymph nodal groups with 3(1.09 %) false positive lymph nodal groups representing reactive (inflammatory) lymph nodal enlargement and 28(10.18%) false negative lymph nodal groups were detected. Truly positive extranodal involvement was seen in 59/935 extranodal organs with 4(0.42%) false positive results, representing meningioma, lung consolidation, degenerative changes of bone and benign lung nodules with 13(1.39%) false negative results.

The false negative results in 11 out of 13 examined sites were proved to be positive lesions by their increased FDG uptake on PET/CT except for 2 lesions where PET/CT was also falsely negative.

18 F-FDG PET/CT

F-FDG PET/CT detected 217/1210(17.93%) truly positive involved sites and 5/1210(0.41%) false positive sites. Nodal involvement was truly positive in 144(52.36%) lymph nodal groups with 3(1.09%) false positive results due to inflammatory process correlated with clinical data and 4(0.33%) false negative nodal results. Extra nodal involvement was truly positive in 73(7.80%) extranodal organs with 2(0.21%) false positive results representing meningioma and lung consolidation with 2(0.21%) false negative results representing bone marrow infiltration by tumor cells and submandibular gland involvement(biopsy proven). ***(****GRAPH 3)*



Graph 3: Column Diagram Showing the Organs with Extranodal Lymphomatous Involvement and Related Pathological Subtype

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Our study also assessed the agreement between the two methods using the Cohen's kappa coefficient. Agreement of the PET/CT with the reference standard is almost perfect, presented as κ = 0.83 (95% CI, 0.71 to 0.95). Agreement of the CECT with the reference standard is substantial, presented as κ = 0.67 (95% CI, 0.51 to 0.83). There was difference in the κ index between tests, CECT64 and FDG PET/CT, in the initial staging. The strength of agreement between FDG PET/CT and CECT is substantial for nodal involvement (Kappa value: 0.75) and for extranodal involvement (Kappa value: 0.78) as well as for staging (Kappa value: 0.67).

DISCUSSION

Most of the lymphomas are potentially curable with their prognosis depending on the stage at which the diagnosis is made and histological type of the disease itself (Connors, J. M, 2015). In olden days CT scan used to be the cornerstone of imaging in lymphoma and was playing a crucial role in staging which determined the treatment protocol. At present, the recent advances made in molecular imaging with 18-Fluoro-deoxyglucose PET/CT scanners have enabled the diagnosis, staging, and response assessment in lymphoma patients (Johnson, S.A. *et al*., 2015). Combined functional and anatomical information, as well as superior attenuation correction, are advantages of integrated PET/CT (Buchmann, I. *et al*., 2001). (*Figure 1, 2, 3, 4, 5 & 6)*

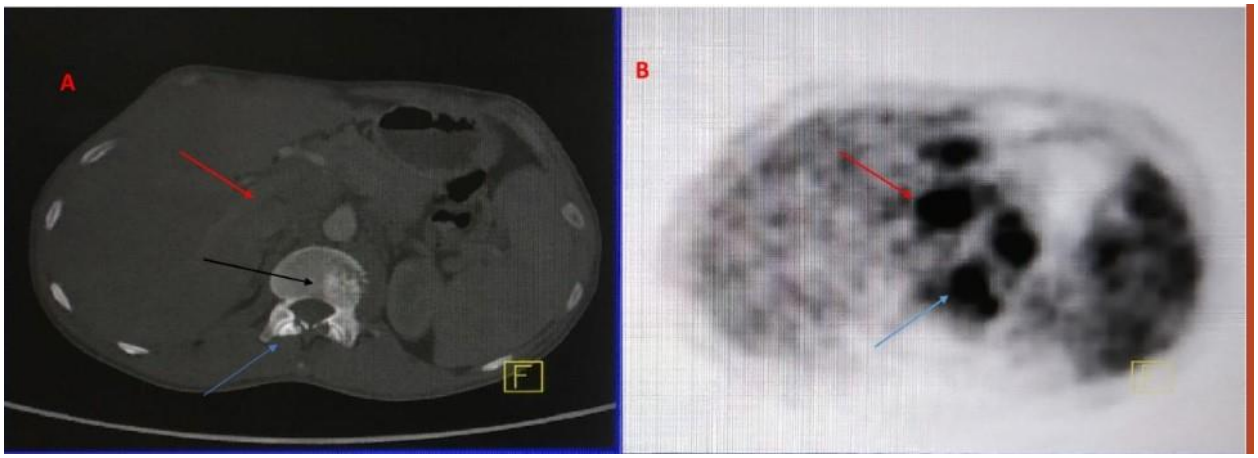

Figure 1: A) Axial CECT image in bone window shows lytic-sclerotic lesion in body and posterior element of L1 vertebra (black & blue arrows) and enlarged aortocaval lymph nodes (red arrow), considered to be lymphomatous involvement; B) Axial PET image shows increased FDG uptake in the L1 vertebra (blue arrow) and aortocaval region (red arrow) considered to be lymphomatous involvement.

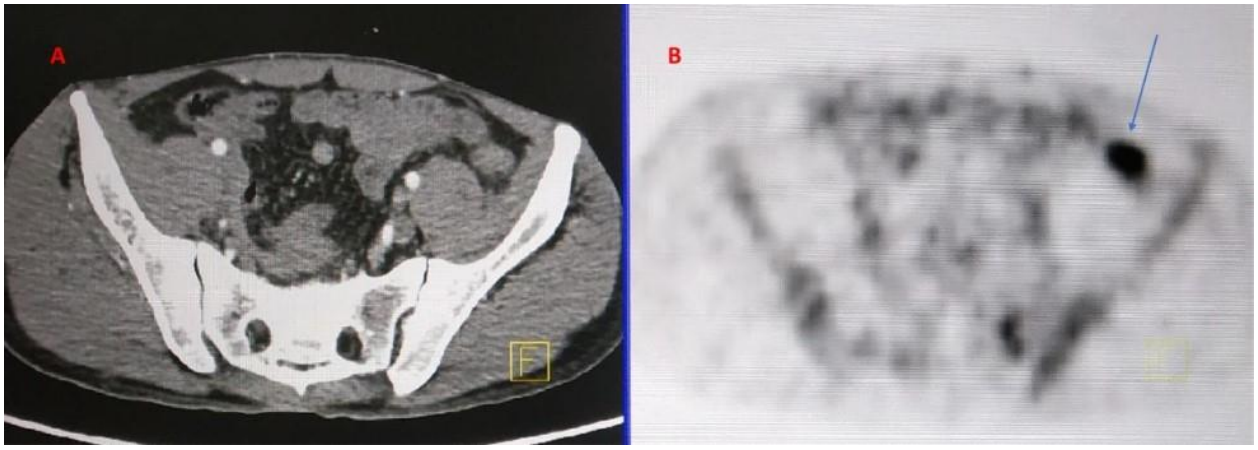

Figure 2: A) Axial CECT image does not show any enlarged lymph node or abnormal enhancing lesion in the region; B) Axial PET image shows increased FDG uptake corresponding to bowel loop in the CECT image which is showing false positive uptake (blue arrow) without any pathological involvement.

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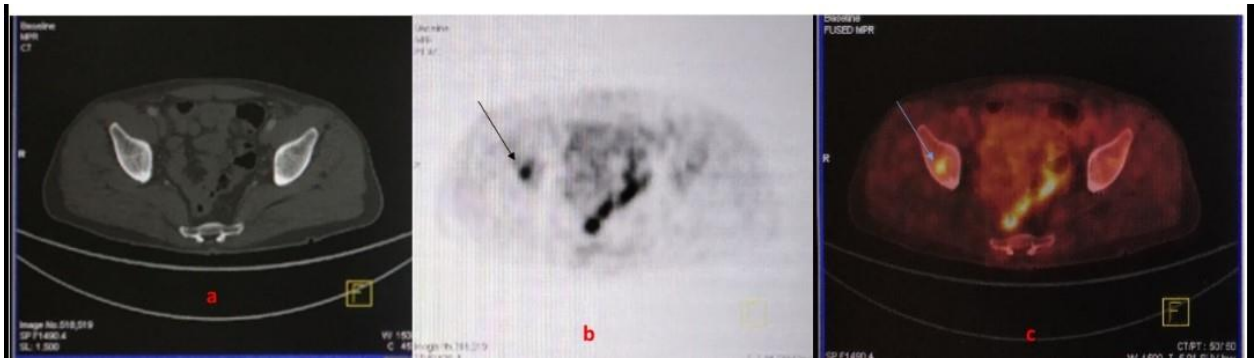

Figure 3: Unremarkable CT scan of lower abdomen and pelvis(a); Bone marrow involvement was considered negative in CT Compared to intense uptake in the pelvic bone on right side on PET and fused PET/CT (black arrow in b & blue arrow in c); Bone marrow involvement was considered positive in PET/CT.

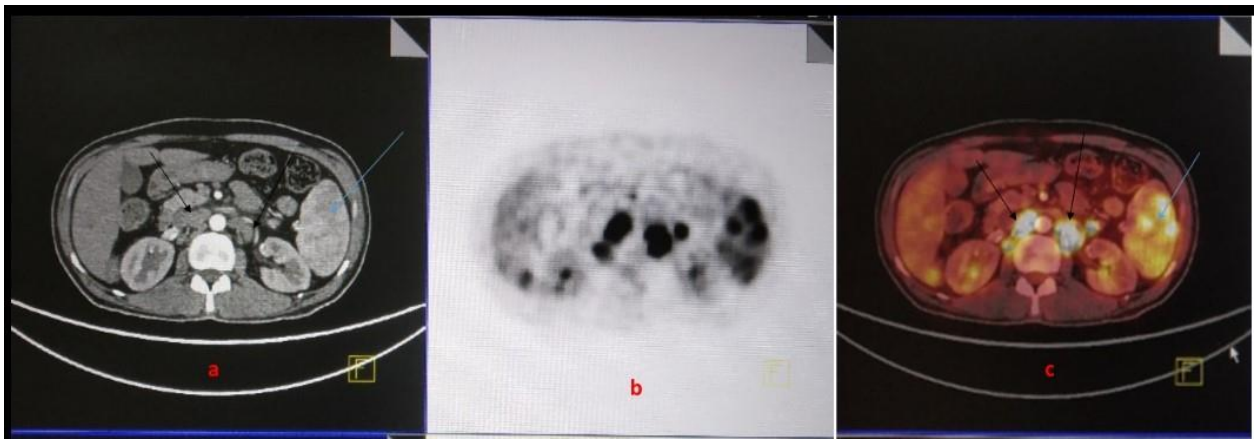

Figure 4: (a) Axial CT scan shows enlarged aortocaval and paraaortic nodes (black arrows) and a normal-sized spleen (blue arrow); nodal involvement was positive and splenic involvement was negative by CT criteria. (b & c) Axial fused PET/CT image shows increased FDG activity in the spleen (blue arrows) and nodes (black arrows); nodal as well as spleen was considered involved by PET/CT criteria.

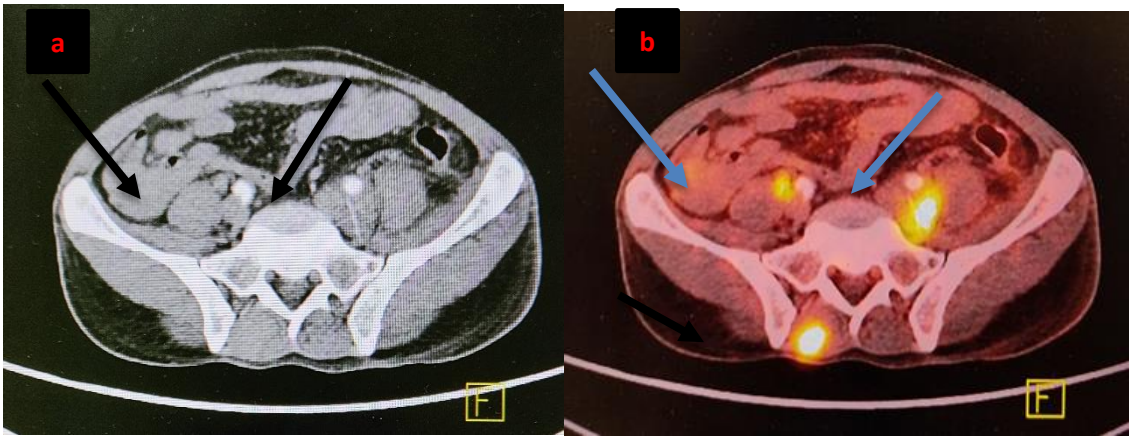

Figure 5: (a) Axial CT scan shows bilateral enlarged common iliac nodes (black arrows); nodal involvement was positive by CT criteria, however paraspinal muscle involvement was not detected; (b) Axial fused PET/CT image shows increased FDG activity in the right paraspinal muscles in the lumbosacral region (black arrows) and common iliac nodes (blue arrows); nodal as well as muscle was considered involved by PET/CT criteria.

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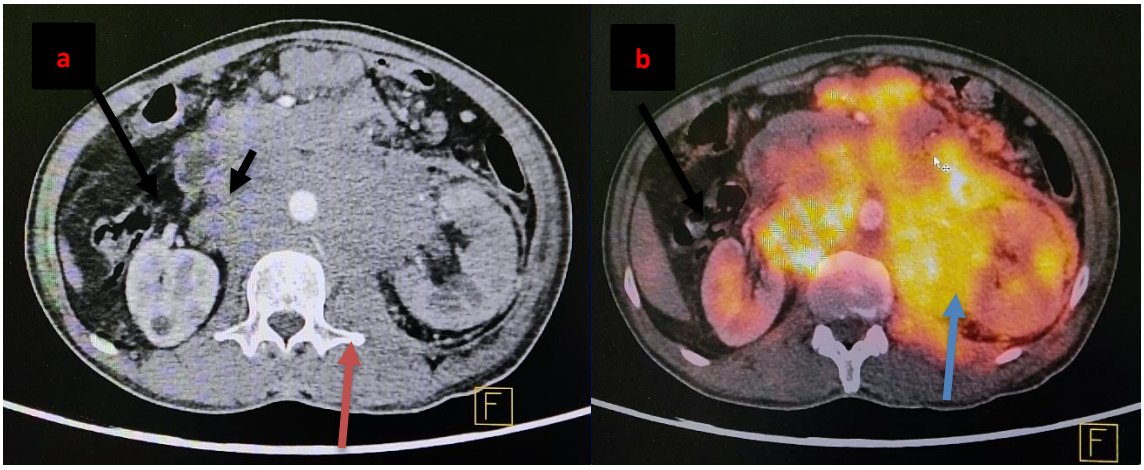

Figure 6: (a) Axial CT scan shows large conglomerated nodal mass in retroperitoneal and para-aortic region (black arrows) encasing the aorta (short black arrow), its branches and IVC; left kidney appeared bulky compared to right kidney (orange arrow) with multiple wedge shaped hypodense areas in the renal parenchyma however there was no definite infiltration by the nodal mass; nodal and renal involvement was positive considered positive by CT criteria; (b) Axial fused PET/CT image shows increased FDG activity in the nodal mass (black arrow) and in interpolar region of left kidney (blue arrow); nodal and renal involvement was considered positive by PET/CT criteria.

Patient Demographics

Age Group

The age group of patients in our study ranged from a minimum age of 3 years to a maximum age of 74 years with a mean age of 39.7 years. This was in agreement with study conducted by (Hutchings, M. *et al*., 2006) and (Schaefer, N.G. *et al*., 2004) where mean age of 41.4 years and 39.6 years was found respectively.

Gender

In our study there were 42(76.4%) males and 13(23.6%) females were present. Both NHL and HL patients showed higher percentage of males (47.27% & 29.09%) than females (20% & 3.63%) respectively, which emphasizes that male affection by both types of lymphoma is higher than female affection. The same sex predilection was resulted by (Roman, E. and Smith, A. 2011) and study conducted by Alnouby, A. *et al*., (2018), which had 63.9% males and 36.1% females.

Diagnosis

In our study, the percent of patients having NHL 67.3% was higher than those having HL 32.7%. This was in agreement with study of (Raanani, P. *et al*., 2006), whose study stated that the incidence of NHL 68% was higher than that of HL 35%. Hernandez-Maraver, D. *et al*., (2006), in their study also found 65.95% to be of NHL and 34.05% patients to be of HL.

Regarding Total Lesions

In our study, PET/CT diagnosed a total number of 220(18.18%) involved regions with diagnostic sensitivity of 97.30%, specificity of 99.49%, and accuracy of 99.09% which was greater than 186(15.37%) involved regions diagnosed by CECT, with diagnostic sensitivity of 81.27%, specificity of 99.29%, and accuracy of around 96.03%.

This was in agreement with study conducted by Zytoon, A.A. *et al*., (2020), where sensitivity 96.6%, specificity 98.8%, and accuracy 99% of PET/CT was higher than CECT with sensitivity 87.5%, specificity 85.7%, and accuracy 88%. Similarly la Fougere, C. *et al*., (2006) study showed that PET/CT sensitivity 97% was higher than that of CECT 87.5%. Hutchings, M. *et al*., (2006), in their study found out the diagnostic performance of PET/CT to be more than CT for nodal staging as well as organ staging; with sensitivity of 92.2% and 72.7%, specificity of 99.3% and 97.2% for nodal staging and organ staging respectively; when compared with sensitivity of 82.6% and 37%, specificity of 98.9% and 99.7% for nodal and organ staging respectively.

Regarding Lymph Nodal Involvement

Our study found out that PET/CT detected 144 true positive involvement of nodal groups with sensitivity 97.30%, specificity 97.64%, and accuracy 97.45% which was higher than CECT that detected 119 true positive nodal group involvement with sensitivity 80.95%, specificity 97.66%, and accuracy 88.73%, denoting substantial agreement between the two modalities

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(kappa value = 0.75). Also, there were 28 false negative lymph nodal group involvement on CECT that decreased to only 4 number of involved groups by PET/CT. In our study the most commonly involved lymph node group was cervical and supraclavicular group (76.36%) in both PET/CT and CECT followed by abdominopelvic group (60%). Inguinal (30.90%) and axillary (25.5%) lymph nodes were least involved by PET/CT and CECT respectively.

Our study was in concordance with study conducted by Zytoon, A.A. *et al*., (2020), which stated that PET/CT detected 312 true positive nodal group involvement with sensitivity 97.5%, specificity 94%, and accuracy 98% which was higher than CECT that detected 266 true positive nodal group involvement with sensitivity 83.1%, specificity 94%, and accuracy 89.6%, denoting significant difference ($P > 0.005$). Also, there were 46 false negative lymph node groups on CECT that decreased to only 3 groups by PET/CT. This was also in agreement with Ricard, F. *et al*., (2014), who stated that the sensitivity of PET/CT 99% was higher than the sensitivity of CECT 85% and also detected in their study 32 false negative lymph node groups by CECT that was corrected to 3 groups by PET/CT. Panebianco, M. *et al*., (2019), showed that among a total number of 1448 nodal sites examined, CECT and PET-CT detected disease involvement in 232 (16%) and 280 (19.3%) nodal areas, respectively ($P < 0.01$). Bednaruk-Młyński,, E. *et al*., (2015), in their study found that CT detected 807 involved nodal areas, whereas PET/CT detected 907 involved areas.

Regarding Extranodal Organ Involvement

In our study, PET/CT detected 73(7.8%) true positive extranodal organ involvements with sensitivity 97.33%, specificity 99.77%, and accuracy 99.57% which was higher than CECT that detected 59(6.31%) true positive extranodal organ involvements with sensitivity 81.94%, specificity 99.54%, and accuracy 98.18% *(Graph 4)*. There were 13(1.39%) false negative extranodal organ involvements when assessed by CECT alone that was corrected to 2(0.21%) by PET/CT. The most common involved extranodal organs in our study were bone marrow (27.27%), followed by spleen (25.45%). The least commonly involved organs were breast, kidney, thyroid, liver and pancreas (1.82%) each. In agreement with our results, in study of Zytoon, A.A. *et al*., (2020), PET/CT detected 100 true positive extranodal organ involvements with sensitivity 94%, specificity 96.2%, and accuracy 99.5% which was higher than CECT that detected 85 true positive extranodal organ involvements with sensitivity 80%, specificity 88.6%, and accuracy 95.9%. There were 25 false negative extranodal organ involvements when assessed by CECT alone that was corrected to zero% by PET/CT. The most common involved extranodal organs in their study were lung 19%, GIT (mainly the stomach) 16%, liver 14% and renoadrenal 12%. Ricard, F. *et al*., (2014), stated that sensitivity of PET/CT in detection of extranodal lymphomatous involvement 88% was higher than that of CECT alone 78% and that 9 false negative extranodal results by CECT were corrected to 5 by PET/CT.

Panebianco, M. *et al*., (2019) in their study found that, with regard to extranodal sites, a total number of 248 areas were examined, CECT and PET-CT identified a disease involvement in 19 (7.7%) and 25 (10.1%) extranodal areas respectively.

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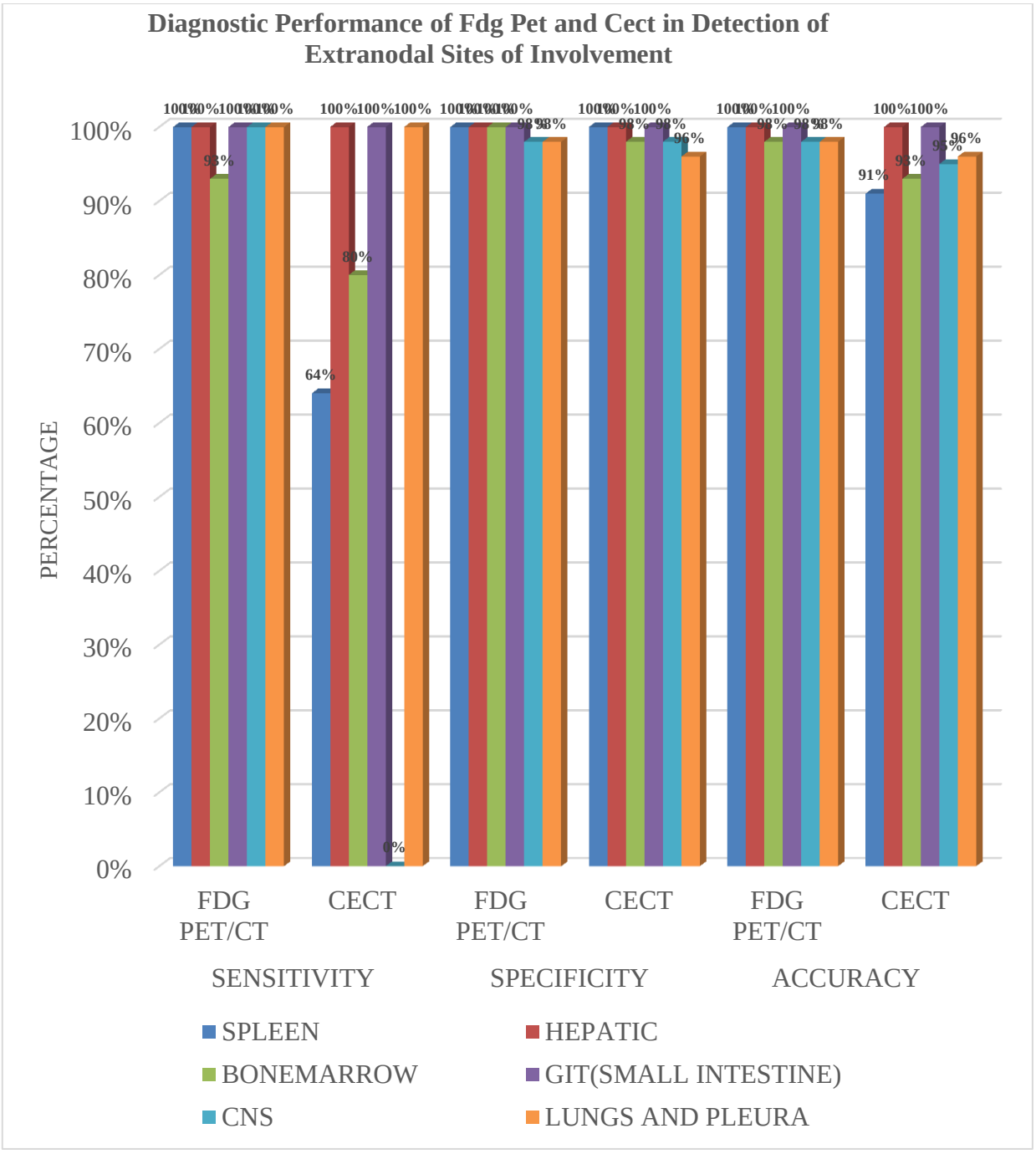

Graph 4: Column Diagram Showing Diagnostic Performance of FDG PET/CT and CECT in Detection of Extranodal Sites of Involvement

Lymphoma Staging According to Lugano Classification

Differences in staging by PET/CT and CECT were found in our study. Discordant staging by both modalities was found in 14.54% of the patients. Lymphoma was upstaged by PET/CT in 7.27% of patients; with major changes in 3.63% (in 2 cases) (i.e., upstaging from stages I or II to stages III or IV) and downstaged in 3.63% (2 out of 55) of cases. CECT upstaged disease in 7.27% of patients; with major changes in 3.63% (in 2 cases) (i.e., upstaging from stages I or II to stages III or IV) and downstaged in 7.27% (4 out of 55) of cases. CECT diagnosed 14.5% (8) of the patients as stage I; 2 of them were diagnosed by PET/CT as stage IV which means upstaging with major changes of 3.63% patients by PET/CT; other 2 were diagnosed as stage II. CECT diagnosed 5.5% of the patients as stage IE. CECT diagnosed 7.3% (4) of the patients as stage II; which means downstaging in 3.6% (2) of patients without significant changes in treatment. CECT diagnosed

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25.5% (14) of the patients as stage III; similar number of patients were diagnosed by PET/CT as stage III. CECT diagnosed 47.3% (26) of the patients as stage IV; However, PET/CT staged 50.9% (28) as stage IV which means downstaging of 3.63% (2) patients by CECT with major changes stage IV-stage I leading to significant changes in treatment protocol. In agreement with our study, Hutchings, M. *et al*., (2006), said that among the patients in whom FDG-PET/CT, was performed, this method would have upstaged ten patients (16%) and downstaged three patients (5%) compared with CT, leading to a change of therapy in four patients (7%). Schaefer, N.G. *et al*., (2004), said that on the basis of findings at PET/CT for staging, treatment was changed in three (16%) patients, and on the basis of contrast-enhanced CT findings, it was changed in one (5.2%) patient. Also, Othman, A. *et al*., (2019), study stated that there was upstaging of 10% of patients and downstaging of 5% of patients after PET/CT. Luminari, S. *et al*., (2013), found that PET/CT upstaged 11% and downstaged 1% of patients.

LIMITATIONS OF THIS STUDY

Smaller sample size of our study (COVID-19 Pandemic resulting in nationwide lockdown followed by statewide lockdown, restrictions in inter-district movement led to lesser number of patients visiting the Tertiary Health Centers),

Lack of histological gold standard [This limitation is also inherent in other previously published studies such as Zytoon, A.A. *et al*., (2020); Hanneke. *et al*., (2014); Hutchings, M. *et al*., (2006) and Raanani, P. *et al*., (2006)].

Incidental Findings

Right internal jugular vein thrombosis was found in one case in CECT, Inflammatory wall thickening of vagina was found in one case, deep venous thrombosis of iliac vessels in one case was found as incidental findings.

CONCLUSION

PET can be misleading when there is an uptake of radioisotope within muscles of the neck, which can be unilateral and focal (for example, at the head of the sternocleidomastoid muscle), and may be mistaken for lymphomatous involvement in supraclavicular and pectoral lymph nodes. Moreover, physiologic FDG uptake in the brain, myocardium, and renal collecting system can obscure lymphoma evaluation in those sites. However PET performed in combination with anatomic imaging (CT scans) allows correlation and these limitations can be overcome. FDG-PET/CT scan should replace CECT in the initial staging of lymphoma, as FDGPET/CT scan showed higher sensitivity and accuracy which led to alteration of disease staging with marked effects on the decision of treatment regimens. Similarly in younger patients in whom diagnostic radiation needs to be kept to minimum and in those patients who are at an increased risk of CT contrast induced allergic reactions or nephropathy unenhanced FDG PET/CT alone would suffice for initial staging of the disease.

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