The role of ^{18}F-FDG PET/CT in Neurolymphomatosis: A Comprehensive Imaging Approach

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Abstract

Neurolymphomatosis (NL) is an uncommon and rare neurologic disorder characterised by extranodal lymphoma, where the tumour cells invade the cranial nerves, nerve plexus, nerve root, spinal nerve roots, trunk nerves or peripheral nerves. MRI is the modality of choice, but is often challenging in detection of early recurrence, assessing residual disease and response evaluation. 18F-FDG PET/CT has superior diagnostic performance compared with body CT in the evaluation of NL. 18F-FDG PET-CT is helpful in evaluation of disease extent and potential to guide biopsy. 18F-FDG PETCT is a highly sensitive technique for early localisation of NL than MRI or CT alone. Besides diagnostic and prognostic value in NL, it might be very helpful in response assessment.

Keywords: ^{18}F-FDG PET/CT; Neurolymphomatosis; peripheral nervous system.

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Literature survey

Neurolymphomatosis (NL) is an uncommon disease and rare neurologic disorder characterised by extranodal lymphoma, where the lymphoma cells invade the peripheral nervous system (cranial nerves, nerve plexus, nerve root, spinal nerve roots, trunk nerves or peripheral nerves).[1] Generally, it is a manifestation of disseminating or relapsing disease, but it may occur as a primary presentation of lymphoma.[2] Mostly NL occurs in aggressive subtype of leukaemia or non-Hodgkin's diffuse large B-cell lymphoma (NHL).[3] NL predominantly arises from diffuse large B-cells lymphoma, although rare cases of follicular lymphoma, mantle cell lymphoma and peripheral T-cell lymphomas have been reported.[4,5] The diagnosis of NL is made by clinical methods followed by imaging with MRI or PET/CT of the suspected region. The imaging findings usually overlaps, and differential diagnosis includes nerve damage from radiation neuritis, leptomeningeal lymphomatosis, nerve root compression, herpes zoster, paraneoplastic syndromes and lymphoma-associated vasculitis.[6,7] Biopsy is the gold standard for the diagnosis of NL, although it has numerous technical difficulties including locating and accessing the involved nerves, prone to permanent nerve damage and high false negative rates.[8] In this review, we have compiled recent updates in the radiological diagnosis of NL.

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Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is the modality of choice for initial assessment and management of NL as it helps in localizing, characterisation and evaluating the extent of nerve involvement by neurolymphomatosis.[9] It has the ability to identify abnormalities such as nerve enlargement, thickening, or infiltration by lymphoma cells by providing detailed images of the nerves, nerve roots, plexuses, and cranial nerves. NL generally exhibits diffuse enlargement of the peripheral nerves or plexus, frequently with multifocal nodularity and T2-weighted hyperintensity and contrast enhancement on MRI.[10] It also helps to differentiate lymphomatous infiltration from other conditions that may present with similar neurological symptoms, such as inflammatory or infectious processes. Diffusion weighted imaging on MRI might be helpful to extract the functional information needed to make the correct diagnosis and avoid false negative results.[11] MRI is also useful for guiding biopsy and monitoring the response to treatment. However, MRI is often challenging in detection of early recurrence, assessing residual disease, lack of whole-body assessment and response evaluation. Additionally, there may be contraindications to undergo an MRI. There is currently no consensus on specific MRI criteria or diagnostic thresholds for neurolymphomatosis and interpretation/diagnosis solely relies on the expertise and experience of radiologists.

^{18}F-FDG PET/CT

^{18}F-FDG PET is frequently used in diagnostic staging, restaging, and response evaluation in various cancer patients due to increased tumour glucose metabolism.[12] ^{18}F-FDG PET is also the most widely used radiotracer in lymphoma because of its high uptake by lymphoid cells.

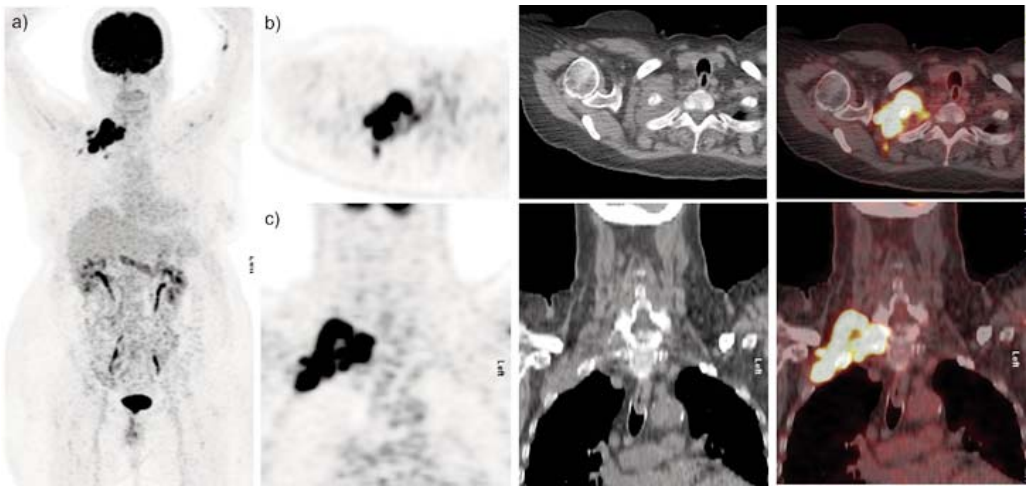

Figure-1: A 54-year-old female, a known case of chronic lymphocytic leukaemia in remission, presented with pain in her right arm and neck with progressive numbness in the right hand. The patient underwent 18F-FDG PET/CT scan, which showed increased tracer accumulation in the right neck and right supraclavicular region in the distribution of C5 to T1 nerve roots of the brachial plexus which was proven to be neurolymphomatosis on nerve biopsy.

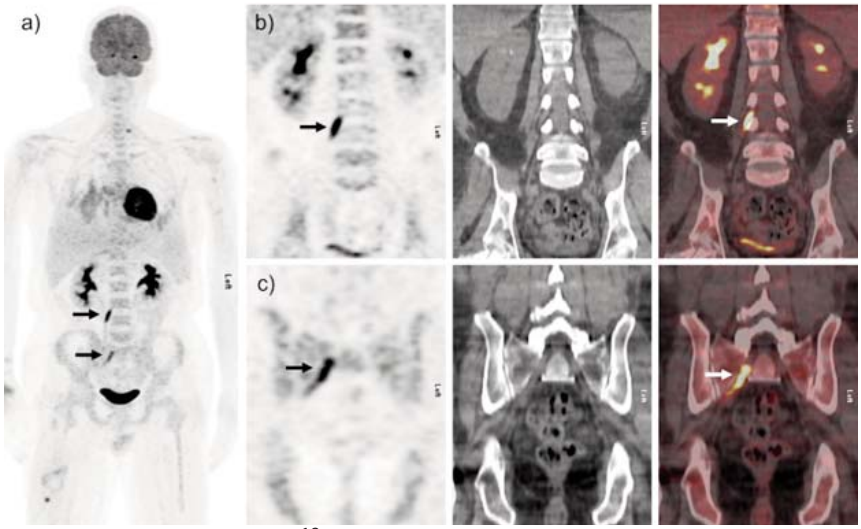

Figure-2: a) ^{18}F-FDG PET maximum intensity projection (MIP) image. (b,c) ^{18}F-FDG PET showed increased FDG uptake in the right L3 and S1 nerve roots (black arrow). Corresponding CT showed varying degrees soft-tissue-thickening with increase tracer uptake on fused PET/CT images (white arrow). Findings are consistent with multifocal neurolymphomatosis.

The clinical utility of ^{18}F-FDG PET/CT in lymphoma is well known due to high metabolic activity in active lymph nodes and other lesions. NL has a characteristic appearance on ^{18}F-FDG PET/CT. It generally presents as linear or fusiform ^{18}F-FDG uptake along anatomic nerve sites with or without thickened nerve (Figure 2). A linear or fusiform uptake pattern simulating a nerve pathway should raise concern of NL in lymphoma patients even with no clear morphological abnormality on CT. Literature shows that ^{18}F-FDG PET-CT has a sensitivity 87.5-100% for identifying malignant peripheral nerve lesions.[13] Davidson T et al.[14] found variable FDG avidity in the lesion with an average SUV max 7.1 and range, SUV max 2.3-10.8.

^{18}F-FDG PET-CT has high diagnostic accuracy compared to conventional imaging modalities in evaluating disease extent, monitoring treatment response and disease prognostication of lymphoma.[15] ^{18}F-FDG PET-CT is a more effective technique than CE-CT for the evaluation of extranodal involvement in Hodgkin and non-Hodgkin lymphoma patients.[16] ^{18}F-FDG PET complements MRI and provides additional information in diagnosis, staging, treatment planning, and monitoring of the NL. The International Primary CNS Lymphoma Collaborative Group retrospectively analysed and showed that PET and PET/CT may be more sensitive than MRI in diagnosis of neurolymphomatosis. PET and PET/CT presented abnormal findings of neurolymphomatosis in 16/19 patients (84%), compared with 36/47 patients (77%) in MRI.[17]

^{18}F-FDG PET is valuable in determining the extent of the disease and staging neurolymphomatosis (Figure 1). It helps to identify additional sites of lymphoma involvement, such as lymph nodes, other organs, or bone marrow, leading to a more comprehensive staging in a single sitting that can expedite definitive treatment. ^{18}F-FDG PET/CT also assists in planning targeted treatments, such as radiation therapy fields or biopsy site selection. In addition, ^{18}F-FDG uptake may have a prognostic value in NL. Higher metabolic activity or more widespread disease burden detected on ^{18}F-FDG PET/CT may indicate a poorer prognosis. However, the activation of brown fat in ^{18}F-FDG PET-CT scans can pose challenges in accurately assessing areas of neurolymphomatosis involvement. In such cases, the increased metabolic activity in brown fat can potentially hinder the detection and interpretation of pathological changes. Proper patient preparation becomes crucial in overcoming these challenges.

Response evaluation

^{18}F-FDG PET/CT is very useful for monitoring treatment response and for assessing disease progression. It helps evaluate the metabolic activity of lymphoma lesions, including nerve involvement, and can detect residual or recurrent disease earlier than anatomical imaging modalities alone.[18] Several studies demonstrate the usefulness of ^{18}F-FDG PET in response assessment of NL after chemotherapy.[19, 20]

Conclusions

^{18}F-FDG PET-CT is a sensitive imaging modality for the detection of neurolymphomatosis lesions. It helps in the initial diagnosis, staging, guiding biopsy, treatment planning, response assessment, and prognostication of the disease. Combining the information from ^{18}F-FDG with MRI and other diagnostic tests provides a comprehensive evaluation and aids in making informed clinical decisions.

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