Chapter 18

THE ROLE OF 18F-FDG PET/CT DETECTING BONE MARROW INVOLVEMENT IN NEWLY DIAGNOSED LYMPHOMA PATIENTS

Sibel GÖKSEL[1]

INTRODUCTION

Lymphoma is the most common hematologic malignancy in the world. Bone marrow (BM) involvement is one of the most important prognostic factor, increases disease to stage 4 according to the Ann-Arbor staging system and affects both treatment and prognosis in hodgkin's disease (HD) or non hodgkin lymphoma (NHL) (1). BM involvement is associated with poor prognosis in patients with lymphoma (2). Therefore, the presence of BM involvement is important in patient management at the time of diagnosis. BM infiltration by malignant cells detected by bone marrow biopsy (BMB) occurs in up to 6.5% in HD. Malignant BM infiltration occurs in 30% to 50% of all patients with NHL diagnosis, 4% to 90% of patients with indolent NHL and 18% to 36% of patients with aggressive NHL (2-5). The European Society for Medical Oncology (ESMO) recommend a BMB in all patients for diagnosis, treatment and follow-up of HD and NHL (6, 7). Nowadays, BMB is considered as part of initial staging in lymphoma patients.

18F- fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) is non-invasive and semi-quantitative imaging modality. It is the most sensitive and specific molecular imaging technique for staging and response evaluation of many cancers (8). It is a whole body scan that gives functional information about the cells using the glucose metabolism. Metabolically active malignant cell take radio-labeled glucose more than normally cell and becomes visible. FDG PET/CT can be used for initial staging and assessing treatment response evaluation for various malignant tumors including aggressive NHL and Hodgkin lymphoma (HL), and is being used increasingly in lymphoma patients (9-11). It is used successfully for staging and post-treatment follow-up examinations in aggressive lymphoma patients (12-14). Several lymphomas are

[1] Uzm. Dr., Recep Tayyip Erdoğan Üniversitesi Eğitim Araştırma Hastanesi, sibelkandemirgoksel@gmail.com

REFERENCES

1. Rosenberg SA (1977). Validity of the Ann Arbor staging classification for the non-Hodgkin's lymphomas. Cancer Treat Rep, 61, 1023-7.
2. Conlan MG, Bast M, Armitage JO, et al (1990). Bone marrow involvement by non-Hodgkin's lymphoma: the clinical significance of morphologic discordance between the lymph node and bone marrow. Nebraska Lymphoma Study Group. J Clin Oncol, 8 (7), 1163-72. Doi: 10.1200/JCO.1990.8.7.1163
3. Macintyre EA, Vaughan Hudson B, Linch DC, et al (1987). The value of staging bone marrow trephine biopsy in Hodgkin's disease. Eur J Haematol, 39 (1), 66-70. Doi: 10.1111/j.1600-0609.1987.tb00166.x.
4. Foucar K, McKenna RW, Frizzera G, et al (1982). Bone marrow and blood involvement by lymphoma in relationship to the Lukes-Collins classification. Cancer, 49 (5), 888-897.
5. Bennett JM, Cain KC, Glick JH, et al (1986). The significance of bone marrow involvement in non-Hodgkin's lymphoma: the Eastern Cooperative Oncology Group experience. J Clin Oncol, 4(10), 1462-9. Doi: 10.1200/JCO.1986.4.10.1462.
6. Jost LM, Kloke O, Stahel RA (2005). ESMO minimum clinical recommendations for diagnosis, treatment and follow-up of newly diagnosed large cell non-Hodgkin's lymphoma. Ann Oncol, 1, i58–9. Doi: 10.1093/annonc/mdi820.
7. Jost LM, Stahel RA (2005). ESMO minimum clinical recommendations for diagnosis, treatment and follow-up of Hodgkin's disease. Ann Oncol, 1, i54–5. Doi: 10.1093/annonc/mdi814.
8. Muslimani AA, Farag HL, Francis S, et al (2008). The utility of 18-F-fluorodeoxyglucose positron emission tomography in evaluation of bone marrow involvement by non-Hodgkin lymphoma. Am J Clin Oncol, 31(5), 409-12. Doi: 10.1097/COC.0b013e318168d90b.
9. Wirth A, Seymour JF, Hicks RJ, et al (2002). Fluorine-18 fluorodeoxyglucose positron emission tomography, gallium-67 scintigraphy, and conventional staging for Hodgkin's disease and non-Hodgkin's lymphoma. Am J Med, 112 (4), 262-8.
10. Hernandez-Maraver D, Hernandez-Navarro F, GomezLeon N, et al (2006). Positron emission tomography/computed tomography: diagnostic accuracy in lymphoma. Br J Haematol, 135(3), 293-302. Doi: 10.1111/j.1365-2141.2006.06284.x.
11. Freudenberg LS, Antoch G, Schütt P, et al (2004). FDG-PET/CT in re-staging of patients with lymphoma. Eur J Nucl Med Mol Imaging, 31(3), 325-9. Doi: 10.1007/s00259-003-1375-y.
12. Stumpe KD, Urbinelli M, Steinert HC, et al (1998). Whole-body positron emission tomography using fluorodeoxyglucose for staging of lymphoma: effectiveness and comparison with computed Tomography. Eur J Nucl Med, 25(7), 721–8.
13. Buchmann I., Moog F., Schirrmeister H., Reske S.N. (2000). Positron Emission Tomography for Detection and Staging of Malignant Lymphoma. Fischbach W. (eds), In: Gastrointestinal Lymphoma. Recent Results in Cancer Research, vol 156 (pp 78-89). Berlin, Heidelberg: Springer. Doi: 10.1007/978-3-642-57054-4_10.
14. Kostakoglu L, Coleman M, Leonard JP, et al (2002). PET predicts prognosis after 1 cycle of chemotherapy in aggressive lymphoma and Hodgkin's disease. J Nucl Med, 43(8), 1018–27.
15. Cheson BD, Pfistner B, Juweid ME, et al (2007). Revised response criteria for malignant lymphoma. J Clin Oncol, 25(5), 579–586. Doi: 10.1200/JCO.2006.09.2403.

16. Elstrom R, Guan L, Baker G, et al (2003). Utility of FDG-PET scanning in lymphoma by WHO classification. Blood, 101(10), 3875-6. Doi: 10.1182/blood-2002-09-2778.
17. Tsukamoto N, Kojima M, Hasegawa M, et al (2007). The usefulness of (18)F-fluorodeoxyglucose positron emission tomography ((18)F-FDG-PET) and a comparison of (18)F-FDG-pet with (67) gallium scintigraphy in the evaluation of lymphoma: relation to histologic subtypes based on the World Health Organization classification. Cancer, 110(3), 652-9. Doi: 10.1002/cncr.22807.
18. Goldberg MA, Lee MJ, Fischman AJ, et al (1993). Fluorodeoxyglucose PET of abdominal and pelvic neoplasms: potential role in oncologic imaging. Radiographics, 13(5), 1047-62. Doi: 10.1148/radiographics.13.5.8210589.
19. Okada J, Yoshikawa K, Itami M, et al (1992). Positron emission tomography using fluorine-18-fluorodeoxyglucose in malignant lymphoma: a comparison with proliferative activity. J Nucl Med, 33(3), 325-9.
20. Bain BJ (2006). Morbidity associated with bone marrow aspiration and trephine biopsy - a review of UK data for 2004. Haematologica, 91(9), 1293-4.
21. Wang J, Weiss LM, Chang KL, et al (2002). Diagnostic utility of bilateral bone marrow examination: significance of morphologic and ancillary technique study in malignancy. Cancer, 94(5), 1522–1531.
22. Pelosi E, Penna D, Deandreis D, et al (2008). FDG-PET in the detection of bone marrow disease in Hodgkin's disease and aggressive non-Hodgkin's lymphoma and its impact on clinical management. Q J Nucl Med Mol Imaging, 52(1), 9-16.
23. Chen YK, Yeh CL, Tsui CC, et al (2011). F-18 FDG PET for evaluation of bone marrow involvement in non-Hodgkin lymphoma: a meta-analysis. Clin Nucl Med, 36(7), 553-9. Doi: 10.1097/RLU.0b013e318217aeff.
24. Pakos EE, Fotopoulos AD, Ioannidis JP (2005). 18F-FDG PET for evaluation of bone marrow infiltration in staging of lymphoma: a meta-analysis. J Nucl Med, 46(6), 958–63.
25. Adams HJ, Kwee TC, de Keizer B, et al (2014). FDG PET/CT for the detection of bone marrow involvement in diffuse large B-cell lymphoma: systematic review and meta-analysis. Eur J Nucl Med Mol Imaging, 41, 565–574. Doi: 10.1007/s00259-013-2623-4.
26. Chen Y, Zhou M, Liu J, et al (2018). Prognostic Value of Bone Marrow FDG Uptake Pattern of PET/CT in Newly Diagnosed Diffuse Large B-cell Lymphoma. Journal of Cancer, 9(7), 1231-1238. doi: 10.7150/jca.23714.
27. Salaun PY, Gastinne T, Bodet-Milin C, et al (2009). Analysis of 18F-FDG PET diffuse bone marrow uptake and splenic uptake in staging of Hodgkin's lymphoma: a reflection of disease infiltration or just inflammation? Eur J Nucl Med Mol Imaging, 36, 1813–21. Doi:10.1007/s00259-0091183-0.
28. Elstrom RL, Tsai DE, Vergilio JA, et al (2004). Enhanced marrow [18F] fluorodeoxyglucose uptake related to myeloid hyperplasia in Hodgkin's lymphoma can simulate lymphoma involvement in marrow. Clin Lymphoma, 5(1), 62–4.
29. Flowers CR, Sinha R, Vose JM (2010). Improving outcomes for patients with diffuse large B-cell lymphoma. CA Cancer J Clin, 60, 393– 408. Doi: 10.3322/caac.20087.
30. Khan AB, Barrington SF, Mikhaeel NG, et al (2013). PET-CT staging of DLBCL accurately identifies and provides new insight into the clinical significance of bone marrow involvement. Blood, 122, 61-7. Doi: 10.1182/blood-201212-473389.
31. Cortes-Romera M, Sabate-Llobera A, Vilchez SM, et al (2013). Bone marrow evaluation in initial staging of lymphoma: 18F-FDG PET/CT versus bone marrow biopsy.

Clin Nucl Med, 39(1), e46-52. Doi: 10.1097/RLU.0b013e31828e9504.
32. Berthet L, Cochet A, Kanoun S, et al (2013). In newly diagnosed diffuse large B-cell lymphoma, determination of bone marrow involvement with 18F-FDG PET/CT provides better diagnostic performance and prognostic stratification than does biopsy. J Nucl Med, 54, 1244–50. Doi: 10.2967/ jnumed.112.114710.
33. Paone G, Itti E, Haioun C, et al (2009). Bone marrow involvement in diffuse large B-cell lymphoma: correlation between FDG-PET uptake and type of cellular infiltrate. Eur J Nucl Med Mol Imaging, 36, 745–50. Doi: 10.1007/s00259-008-1021-9.
34. Kim HY, Kim J-S, Choi DR, et al (2015). The Clinical Utility of FDG PET-CT in Evaluation of Bone Marrow Involvement by Lymphoma. Cancer Res Treat, 47(3), 458-464. Doi: 10.4143/crt.2014.091.
35. Yılmaz F, Soyder N, Kiper D, et al (2017). The role of PET/CT in the evaluation of bone marrow involvement in lymphoma patients at the initial staging. Marmara Medical Journal, 30, 1-7. Doi: 10.5472/marumj.299374.