BÖLÜM

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BEYİN CERRAHİSİNE YARDIMCI NÜKLEER TIP YÖNTEMLERİ

Ebru TATCI[1]

GİRİŞ

Medikal tedaviye dirençli parsiyel epilepsilerin tedavisinde nöbetleri ortadan kaldırmak veya sayısını azaltmak için epileptojenik odağın rezeksiyonu önerilmektedir. İktal odağın preoperatif dönemde doğru olarak lokalize edilmesi tedavi başarısını artırır. Ayrıca beyin tümörlerinin tam olarak rezeke edilmesi için tümörün lokal yayılım alanının belirlenmesi gerekmektedir. Bu bölümde iktal odağın ve tümör dokusunun preoperatif dönemde lokalize edilmesine ve cerrahi sınırın belirlenmesine yardımcı nükleer tıp yöntemlerinin rolünden bahsedilmiştir.

EPİLEPSİ CERRAHİSİNE YARDIMCI NÜKLEER TIP YÖNTEMLERİ

Epilepsiler parsiyel (fokal) veya jeneralize nöbetler olarak iki ana gruba ayrılırlar. Fokal epilepsiler beynin belli bir bölgesinde başlayan nöbetlerdir. Jeneralize epilepsi ise aynı anda her iki serebral hemisferde oluşan anormal aktiviteye bağlı olan nöbetlerdir. Fokal olarak başlayan bir epilepsi jeneralize olabilir (1). Parsiyel epilepsiler en sık görülen epilepsi tipleridir. Temporal, oksipital, parietal ve frontal loblarda izlenebilir. Temporal lob epilepsisi (TLE) parsiyel epilepsinin en sık olan görülen tipidir. TLE ikiye ayrılır: a) Mesial temporal lob epi-

[1] Uzm. Dr., Nukleer Tıp Uzmanı. SBU Ataturk Goğus Hastalıkları ve Goğus Cerrahisi Eğitim ve Araştırma Hastanesi Nukleer tıp bolumu, Ankara. ebrualkandr@yahoo.com

Beyinde yer kaplayan lezyonların ayırıcı tanısında, tümörün evrelendirilmesinde, canlı tümör dokusunun saptanmasında, tümör derecesinin ve prognozun belirlenmesinde beyin PET etkin bir görüntüleme yöntemidir. Bunların ötesinde beyin tümörlerinde biyopsi alınacak en uygun alanı belirlemede ve rezeksiyon yapılacak hastalarda tümör yayılımını göstermede PET güvenilir bir yöntemdir. Normal beyin dokusunda düşük yoğunlukta tutulan ve düşük dereceli gliomayı da gösterebilen aminoasid PET, beyin tümörlerinin görüntülenmesinde FDG ile yapılan PET' den üstündür.

Malign lezyonlarda tutulum gösteren Tl-201 ve Tc-99m MIBI gibi radyoaktif ajanların preoperatif dönemde intravenöz enjeksiyonu sonrasında intraoperatif dönemde gama prob ile radyoaktivite dedeksiyonu yapılabilir. Böylece malignite ile normal beyin dokusu arasındaki sınırlar tam olarak belirlenebilir ve lezyon rezidü doku bırakmadan çıkarılabilir.

KAYNAKLAR

1. Stafstrom CE, Carmant L. Seizures and Epilepsy: An Overview for Neuroscientists. Cold Spring Harb Perspect Med. 2015; 5(6): a022426. doi: 10.1101/cshperspect.a022426
2. Sarikaya I. PET studies in epilepsy. Am J Nucl Med Mol Imaging 2015;5(5):416-430.
3. Blair RDG. Temporal Lobe Epilepsy Semiology. Hindawi Publishing Corporation Epilepsy Research and Treatment. 2012, 751510. doi:10.1155/2012/751510
4. Englot DJ, Birk H, Chang EF. Seizure outcomes in non-resective epilepsy surgery: An update. Neurosurg Rev. 2017; 40 (2): 181-194. DOI: 10.1007/s10143-016-0725-8.
5. Knowlton RC. The role of FDG-PET, ictal SPECT, and MEG in the epilepsy surgery evaluation. Epilepsy Behav 2006; 8:91–101.
6. Cendes F, Theodore WH , Brinkmann B, at al. Neuroimaging of epilepsy. Handb Clin Neurol. 2016 ; 136: 985–1014. doi:10.1016/B978-0-444-53486-6.00051-X.
7. Parvizi J, Kastner S. Human Intracranial EEG: Promises and Limitations. Nat Neurosci. 2018 ; 21(4): 474–483. doi: 10.1038/s41593-018-0108-2
8. Chandra SP, Bal CS, Jain S, et al. Intraoperative Coregistration of Magnetic Resonance Imaging, Positron Emission Tomography, and Electrocorticographic Data for Neocortical Lesional Epilepsies May Improve the Localization of the Epileptogenic Focus: A Pilot Study. World Neurosurg. 2014 ; 82 (1-2), 110-7. DOI: 10.1016/j.wneu.2013.02.057
9. Goffin K, Dedeurwaerdere S, Laere KV , et al. Neuronuclear Assessment of Patients With Epilepsy. Semin Nucl Med. 2008; 38 (4):227-39. doi.org/10.1053/j.semnuclmed.2008.02.004.
10. Kim S, Mountz JM. SPECT Imaging of Epilepsy: An Overview and Comparison with

F-18FDG PET. Int J Mol Imaging. 2011; 2011: 813028. doi: 10.1155/2011/813028
11. Kottamasu SR. Brain imaging during seizure:Ictal brain SPECT. The Indian Journal of Pediatrics. 1997; 64: 575-580.
12. Newton MR, Berkovic SF, Austin MC, et al. Postictal switch in blood flow distribution and temporal lobe seizures. J Neurol Neurosurg Psychiatry. 1992; 55(10):891–894. doi: 10.1136/jnnp.55.10.891.
13. Devous MD Sr., Thisted RA, Morgan GF, et al: SPECT brain imaging in epilepsy: A meta-analysis. J Nucl Med 39:285-293, 1998
14. Kazemi NJ, Worrell GA, Stead SM, et al. Ictal SPECT statistical parametric mapping in temporal lobe epilepsy surgery. Neurology 2010; 74 (1): 70-6. 2010.
15. Pareto D, Aguiar P, Pavía J, et al. Assessment of SPM in Perfusion Brain SPECT Studies. A Numerical Simulation Study Using Bootstrap Resampling Methods. IEEE Trans Biomed Eng. 2008; 55 (7): 1849-53.
16. Chang DJ, Zubal IG, Gottschalk C, et al. Comparison of statistical parametric mapping and SPECT difference imaging in patients withtemporal lobe epilepsy.Epilepsia2002;43:68–74
17. Sulc V, Stykel S, Hanson DP, el al. Statistical SPECT processing in MRI-negative epilepsy surgery. Neurology , 2014; 82 (11): 932-9
18. Bohnen, NI. (2011). Hareket bozuklukları, inme ve epilepsi. (Biray Caner, Ömer Uğur, M. Fani Bozkurt, Çev. Ed). *PET ve PET/BT prensipler ve uygulamalar* içinde (s. 479-499). Ankara: Rota tıp kitapevi.
19. Kumar A, Juhász C, Asano E, et al. Objective Detection of Epileptic Foci by 18F-FDG PET in Children Undergoing Epilepsy Surgery. J Nucl Med. 2010; 51 (12): 1901-7
20. Willmann O, Wennberg R, May T, et al. The contribution of 18F-FDG PET in preoperative epilepsy surgery evaluation for patients with temporal lobe epilepsy A meta-analysis .Seizure 2007; 16 (6:, 509-20.
21. Vollmar C, Noachtar S. Neuroimaging in Epilepsy. Türk nöroloji dergisi. 2004; 10 (3): 185-200.
22. Rausch R, Henry TR, Ary CM, et al. Asymmetric Interictal Glucose Hypometabolism and Cognitive Performance in Epileptic Patients. Arch Neurol. 1994; 51 (2): 139-44.
23. Kim YK, Lee DS, Lee SK. 18F-FDG PET in Localization of Frontal Lobe Epilepsy: Comparison of Visual and SPM Analysis. J Nucl Med. 2002; 43 (9): 1167-74.
24. Newberg AB, Alavi A. PET in seizure disorders. Radiol Clin N Am. 2005; 43: 79 – 92.
25. Ferrie CD, Maisey M , Cox T, et al. Focal abnormalities detected by 18FDG PET in epileptic encephalopathies. Arch Dis Child. 1996; 75 (2); 102-7.
26. Cross JH , Auvin S, Falip M, et al. Expert Opinion on the Management of Lennox–Gastaut Syndrome: Treatment Algorithms and Practical Considerations. Front Neurol. 2017; 8;505
27. Theodore WH, Brooks R, Margolin R, et al. Positron emission tomography in generalized seizures. Neurology 1985;35 (5), 684-90.
28. Hikima Akio, Mochizuki H, Oriuchi N, et al. Semiquantitative analysis of interictal glucose metabolism between generalized epilepsy and localization related epilepsy. Ann Nucl Med. 2004: 18 (7), 579-84.

29. Sigel E and Steinmann ME..Structure, Function, and Modulation of GABA(A) Receptors. J Biol Chem 2012: 287 (48), 40224-31
30. Haefely W. Benzodiazepine Interactions With GABA Receptors. Neurosci Lett. 21984: 47 (3); 201-6
31. Ryvlin P, Bouvard S, Bars DL, et al. Clinical Utility of flumazenil-PET Versus [18F] fluorodeoxyglucose-PET and MRI in Refractory Partial Epilepsy. A Prospective Study in 100 Patients. Brain. 1998; 121 (11): 2067-81.
32. Bartenstein PA, Prevett MC, Duncan JS, et al. Quantification of opiate receptors in two patients with mesiobasal temporal lobe epilepsy, before and after selective amygdalohippocampectomy, using positron emission tomography. Epilepsy Res. 1994; 18 (2): 119-25.
33. Koepp MJ, Richardson MP, Brooks DJ, et al. Focal cortical release of endogenous opioids during reading-induced seizures. Lancet 1998; 352: 952-5.
34. Galovic M and Koepp M. Curr. Advances of Molecular Imaging in Epilepsy. Curr Neurol Neurosci Rep. 2016; 16 (6): 58.
35. Savic I, Lindström P, Gulyás B,et al. Limbic reductions of 5-HT1A receptor binding in human temporal lobe epilepsy. Neurology 2004; 62 (8): 1343-51.
36. 36. Martinez A, Finegersh A, Cannon DM, et al. The 5-HT1A receptor and 5-HT transporter in temporal lobe epilepsy. Neurology 2013; 80: 1465-71.
37. HT, Luat AF, MD, Kumar A. α-[11C]-Methyl-L-tryptophan–PET in 191 patients with tuberous sclerosis complex. Neurology. 2013; 81(7): 674–680.
38. Viviane E. Bernedo Paredes, Hans-Georg Buchholz, et al. Reduced D2/D3 Receptor Binding of Extrastriatal and Striatal Regions in Temporal Lobe Epilepsy. PLoS One. 2015; 10(11): e0141098. doi: 10.1371/journal.pone.0141098.
39. Tatlidil R, Xiong J, Luther S. Presurgical lateralization of seizure focus and language dominant hemisphere with O-15 water PET imaging. Acta Neurol Scand. 2000;102(2):73-80.
40. Galazzo IB, Mattoli MV, Pizzini FB, et al. Cerebral metabolism and perfusion in MR-negative individuals with refractory focal epilepsy assessed by simultaneous acquisition of 18F-FDG PET and arterial spin labeling. Neuroimage Clin. 2016; 11: 648–657. doi: 10.1016/j.nicl.2016.04.005
41. Chandra PS, Salamon N, Huang J, et al. FDG-PET/MRI Coregistration and Diffusion-Tensor Imaging Distinguish Epileptogenic Tubers and Cortex in Patients with Tuberous Sclerosis Complex: A Preliminary Report. Epilepsia. 2006;47 (9): 1543-9.
42. Filho OC, Filho OV, Ragazzo PC, et al. A new method for intraoperative localization of epilepsy focus by means of a gama probe. Radiologia Brasileira. 2014; 47(1):23-27. DOI: 10.1590/S0100-39842014000100010
43. Chen R, Smith-Cohn M, Cohen AL, et al. Glioma Subclassifications and Their Clinical Significance. Neurotherapeutics. 2017; 14(2): 284–297. doi: 10.1007/s13311-017-0519-x
44. Suchorska B, Tonn JC, Jansen NL. PET Imaging for Brain Tumor Diagnostics. Curr Opin Neurol.2015; 27 (6), 683-8. DOI: 10.1097/WCO.0000000000000143

45. Pirotte B, Levivier M, Goldman S, et al. Positron emission tomography-guided volumetric resection of supratentorial high-grade gliomas: A survival analysis in 66 consecutive patients. Neurosurgery .2009; 64(3):471-81. DOI: 10.1227/01.NEU.0000338949.94496.85.
46. James R. Fink, Mark Muzi, Melinda Peck, et al. Continuing Education: Multi-modality Brain Tumor Imaging – MRI, PET, and PET/MRI. J Nucl Med.. 2015; 56(10): 1554–1561. doi: 10.2967/jnumed.113.131516
47. Zukotynsk Ki, Fahey F, Kocak M, et al. 18F-FDG PET and MR Imaging Associations Across a Spectrum of Pediatric Brain Tumors: A Report from the Pediatric Brain Tumor Consortium. J Nucl Med. 2014 Sep; 55(9): 1473–1480. doi: 10.2967/jnumed.114.139626
48. Langen K, Galldiks N. Update on Amino Acid PET of Brain Tumours. Curr Opin Neurol. 2018; 31 (4), 354-36. DOI: 10.1097/WCO.0000000000000574.
49. Jung JH and Ahn BC. Current Radiopharmaceuticals for Positron Emission Tomography of Brain Tumors. Brain Tumor Res Treat. 2018 ; 6(2): 47–53. 10.14791/btrt.2018.6.e13.
50. Abdelwahab M.A, Omar W.F18 FET PET/CT in Brain Tumors. Egyptian J. Nucl. Med. 2016; 13 (1).
51. Albert NL, Weller M, Suchorska B, et al. Response Assessment in Neuro-Oncology working group and European Association for Neuro-Oncology recommendations for the clinical use of PET imaging in gliomas. Neuro-oncology. 2016; 18 (9), 1199-208. doi.org/10.1093/neuonc/now058
52. Calabria F, Cascini GL. Current status of 18 F-DOPA PET imaging in the detection of brain tumor recurrence. Hell J Nucl Med. 2015; 18 (2), 152-6. 10.1967/s0024499100211.
53. Ito K, Matsuda H, Kubota K. Imaging Spectrum and Pitfalls of 11C-Methionine Positron Emission Tomography in a Series of Patients with Intracranial Lesions. Korean J Radiol. 2016; 17 (3): 424-34. doi: 10.3348/kjr.2016.17.3.424
54. Ulus A, Yakupoğlu H, Batay F, et al. Transsfenoidal Hipofiz Adenomu Cerrahisi ve Nöronavigasyon. Türk Nöroşirürji Dergisi, 2004; 14 (3): 166-171.
55. Slavin KV. Neuronavigation in Neurosurgery: Current State of Affairs. Expert Rev Med Devices.2008; 5 (1): 1-3. DOI: 10.1586/17434440.5.1.1
56. Heper AO, Erden E, Savas Ali , et al. An Analysis of Stereotactic Biopsy of Brain Tumors and Nonneoplastic Lesions: A Prospective Clinicopathologic Study. Surg Neurol. 2005; 64 (2): 82-8. DOI: 10.1016/j.surneu.2005.07.055
57. Pirotte B, Goldman S, Massager M,et al. Comparison of 18F-FDG and 11C-Methionine for PET-Guided Stereotactic Brain Biopsy of Gliomas.J Nucl Med. 2004; 45 (8): 1293-8.
58. Mosskin M, von Holst H, Bergström M, et al. Positron emission tomography with 11C-methionine and computed tomography of intracranial tumours compared with histopathologic examination of multiple biopsies. Acta Radiol. 1987;28:673–681.
59. Goldman S, Levivier M, Pirotte B, et al. Regional glucose metabolism and histopathology of gliomas: a study based on positron emission tomography-guided stereotactic biopsy. Cancer. 1996;78:1098–1106.

60. Misch M, Guggemos A, Driever PH, et al. 8F-FET-PET guided surgical biopsy and resection in children and adolescence with brain tumors. Childs Nerv Syst 2015; 31 (2); 261-7. DOI: 10.1007/s00381-014-2552-y
61. Vilela Filho O, Carneiro Filho O. Gama probe-assisted brain tumor microsurgical resection: a new technique. Arq Neuropsiquiatr. 2002 ;60(4):1042-7. Epub 2003 Jan 15.
62. Filippi L, Santoni R, Manni C, et al. Imaging Primary Brain Tumors by Single-Photon Emission Computerized Tomography (SPECT) with Technetium-99m Sestamibi (MIBI) and Tetrofosmin. Current Medical Imaging Reviews, 2005; 1: 61-66. DOI: 10.2174/1573405052953047
63. Kojima T, Kumita S, Fumio Yamaguchi F, et al. Radio-guided brain tumorectomy using a gama detecting probe and a mobile solid-state gama camera. Surg Neurol 2004;61:229–38. 10.1016/j.surneu.2003.07.015
64. Serrano J, Rayo JI, Infante JR, et al. Radioguided surgery in brain tumors with thallium-201. Clin Nucl Med. 2008 ;33(12):838-40. doi: 10.1097/RLU.0b013e31818bf26a
65. Seddighi A, Akbari ME, Seddighi AS, et al. Radioguided surgery using gama detection probe technology for resection of cerebral glioma. Hell J Nucl Med. 2015 ;18 Suppl 1:68-75.