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**Self Assessment Module on Nuclear Medicine
And PET/CT Case Review**

Interpretation of FDG-PET/CT in the Brain and the Head and Neck

Submitted by:

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Case 1: 65 year old man with progressive memory loss. The pattern of FDG uptake in the brain in this patient is most likely due to:

- a) Alzheimer dementia
- b) Frontotemporal dementia (Pick disease)
- c) Normal aging
- d) Vascular dementia

Answer: A

Rationale: In the images shown, there is hypometabolism of the parietal cortices, with relative preservation of uptake in the motor cortices and frontal lobes. This pattern is characteristic of Alzheimer dementia.

References:

Hoffman JM, Welsh-Bohmer KA, Hanson MW, Crain BJ, Hulette C, Earl N, Coleman RE. FDG-PET Imaging in Pathologically Verified Dementia. *J. Nucl. Med.* 41(11):1920-1928, 2000.

Eric M. Reiman, Kewei Chen, Gene E. Alexander, Richard J. Caselli, Daniel Bandy, David Osborne, Ann M. Saunders, and John Hardy Functional brain abnormalities in young adults at genetic risk for late-onset Alzheimer's dementia *PNAS* 101:284-289, 2004

Silverman, D.H.S., Small, Chang, C.Y. et. al. Positron Emission Tomography in Evaluation of Dementia: Regional Brain Metabolism and Long-term Outcome *JAMA* 286:2120-2127, 2001

Small, G.W., Maxxiotta, J.C., Collins, M.T. et. al. Apolipoprotein E Type 4 Allele and Cerebral Glucose Metabolism in Relatives at Risk for Familial Alzheimer Disease. *JAMA* 273(12):942-947 1995

Case 2: 70 year old man with progressive memory loss. The pattern of FDG uptake in the brain in this patient is most likely due to:

- a) Alzheimer dementia
- b) Frontotemporal dementia (Pick disease)
- c) Normal aging
- d) Vascular dementia

Answer: B

Rationale: In the images shown, there is hypometabolism of the frontal cortices, with relative preservation of parietal uptake. This pattern is characteristic of frontotemporal dementia.

References:

Vitali P, Migliaccio R, Agosta F, et al. Neuroimaging in dementia. Semin Neurol Sep; 28(4):467-83.2008

Case 3: 55 year old man with Cushing syndrome and prior transphenoidal resection of the pituitary. What is the name of the little thing that hangs down in the back of the throat?

- a) Cupola
- b) Dracula
- c) Uvula
- d) Vallecula

Answer: C

Rationale: This protuberance from the soft palate is termed the uvula.

Case 4: 68 year old woman with a clinical history of nasal congestion and epistaxis and maxillary sinus mass. Regarding FDG-PET/CT evaluation of head and neck tumors, which of the following is true?

- a) PET has a lower sensitivity for detection of head and neck cancers than CT.
- b) Most squamous cell cancers of the head and neck are hypermetabolic
- c) Apparent lesion size on PET is a poor indicator of true lesion size.
- d) Tumor measurements on PET can be obtained without regard to windowing.

Answer: A

Rationale: In a study by Schwartz, et al (see reference below), most oral and oropharyngeal squamous cell cancers were hypermetabolic, with an average SUV of 8.3. PET has been shown to be more sensitive than CT for lesion detection in the head and

neck. FDG-PET can be used to measure lesion size for radiotherapy planning, but care must be taken with regard to windowing.

References:

Gambhir, S.S., Czernin, J., Schwimmer, J., Silverman, D.H.S., Coleman, R.E., and Phelps, M.E. A Tabulated Summary of the FDG PET Literature J Nucl Med 42: 1S-93S. 2001

Schwartz, D.L., Ford, E., Rajendran, J., et. al. FDG-PET/CT imaging for preradiotherapy staging of head-and-neck squamous cell carcinoma Int J Radiation Oncol Biol Phys 61(1) 129-136 2005

Daisne, J.F., Duprez, T., Weynand, B., Lonneux, M., Hamoir, M., Reychler, H. and Gregoire, V. Tumor Volume in Pharyngolaryngeal Squamous Cell Carcinoma: Comparison at CT, MR Imaging, and FDG PET and Validation with Surgical Specimen Radiology October 233:93-100 2004

Case 5: 68 year old man with newly diagnosed esophageal cancer and pretreatment evaluation. Which of the following patterns is most suspicious for primary malignancy in the head and neck.

- a) Diffuse, modest uptake
- b) Nodular, low-grade uptake without CT correlate
- c) Nodular, intense uptake with a mass on CT
- d) Intense, diffuse uptake.

Answer: C.

Rationale: Of the patterns above, nodular intense uptake with associated CT mass is the most worrisome for pathology. The other patterns are often seen with inflammation and lymphoid hyperplasia.

Case 6: Demographics: 64 year old man with large right facial mass. Biopsy shows squamous cell carcinoma, suspected primary parotid carcinoma. Which of the following statements is true regarding the detection of occult primary head and neck tumors:

- a) PET can detect sites of primary tumor not visualized with CT or MRI.
- b) Nodal metastases with occult primary accounts for approximately half of head and neck cancers
- c) PET is used to exclude primary tumor sites in patients with metastatic disease to the neck.
- d) In patients with suspected occult primary tumor, PET is only useful for identification of the primary

Answer: A.

Rationale: In patients with unknown primary of head and neck origin, FDG-PET is able to identify a primary site of tumor in between 11-25% of patients with previous negative studies.

References:

Rusthoven, K.E., Koshy, M. Paulino, A.C. The role of fluorodeoxyglucose positron emission tomography in cervical lymph node metastases from an unknown primary tumor. Cancer 101 (11):2641-2649 2004

Haas, I. , Hoffmann, T.K. Engers, R. And Ganzer, U. Diagnostic strategies in cervical carcinoma of an unknown primary (CUP).. Eur Arch Otorhinolarygol 259(6):325 2002

Case 7: 58 year old man with T2a prostate cancer, Gleason 3 + 3 and left cervical adenopathy, suspected lymphoma. Which of the following is true regarding detection of nodal metastatic disease from head and neck cancers with FDG-PET?

- a) The sensitivity of PET is lower than that of CT
- b) The specificity of PET and CT are similar
- c) Positive nodes on PET should be treated without need for biopsy.
- d) PET frequently fails to demonstrate sites of nodal metastatic disease.

Answer: B.

Rationale: FDG-PET is more sensitive than CT for detection of nodal metastases, but the sensitivity of the two modalities has been found to be similar.

References:

Stoeckli, et. Al. 202, Head and Neck 24:245

Schoder, H., Carlson, D.L., Kraus, D.H. et. al: ¹⁸F-FDG PET/CT for Detecting Nodal Metastases in Patients with Oral Cancer Staged N0 by Clinical Examination and CT/MRI J Nucl Med 47: 755-762 2006

Fleming, A.J. Jr. and Johansen, ME. The clinician's expectations from the use of positron emission tomography/computer tomography scanning in untreated and treated head and neck cancer patients. Curr Opin Otolarygol Head and Neck Surg 16 (2):127-134 2008.

Case 8:

67 year old man with epistaxis and serous otitis media and newly diagnosed nasopharyngeal cancer. Which of the following statements is true regarding radiotherapy planning with FDG-PET and PET/CT?

- a) Using PET rarely results in a change in patient management
- b) Gross tumor volumes are usually higher with PET than with CT
- c) There is a standardized procedure for using PET images for radiation treatment planning

d) Lesion size on PET/CT has been found to approximate the true tumor volume.

Answer: D

Rationale: Tumor volume on FDG-PET has been found to closely approximate the true lesion volume, and for this reason PET can be used to generate GTV with accuracy.

References:

J.F. Daisne, T. Duprez and B. Weynand et al., Tumor Volume in Pharyngolaryngeal Squamous Cell Carcinoma: Comparison at CT, MR Imaging, and FDG PET and Validation with Surgical Specimen Radiology (233)93–100. 2004

Case 9: 53 year old man with right tonsillar carcinoma treated with cisplatin and radiation therapy. What is the stage of this patient by FDG-PET/CT?

- a) Stage III
- b) Stage IVA
- c) Stage IVB
- d) Stage IVC

Answer: D

Rationale: The presence of an osseous metastasis in this patient (M1) signifies stage IVC disease.

References:

Manolidis S., Donald, P.J., Valk, P., Pounds, T.R. The use of positron emission tomography scanning in occult and recurrent head and neck cancer. Acta Otolaryngol Suppl (Stockh) 534:1-11 1998

Chau, J.L. et. Al Head and Neck 2008

Case 10 : 52 year old man with progressive jaw pain, enlarging right neck nodes. Nodal biopsy shows metastatic squamous cell cancer. What is the approximate frequency of incidental second primary malignancy in patients with Head and Neck cancer undergoing FDG-PET/CT?

- a) <0.1%
- b) 1-2%
- c) 5-8%
- d) 15-20%

Answer: C

In a study by Fleming et al, the incidence of second primary tumors in patients with head and neck tumors imaged with FDG-PET was found to be 8.1%

References:

Fleming, A.J., Jr. Smith, S.P. Jr. Paul, C.M. et al. (Ohio State University Columbus)

Impact of [18F]-2-Fluorodeoxyglucose–Positron Emission Tomography/Computed Tomography on Previously Untreated Head and Neck Cancer Patients) Laryngoscope 117:1173-1179, 2007§

Wong, R.J. Current Status of FDG-PET for head and neck cancer. J. Surg Oncol 97:649-652 2008.

Agress H Jr, Cooper BZ. Detection of clinically unexpected malignant and premalignant tumors with whole-body FDG PET: histopathologic comparison. *Radiology* 230:417-22. 2004

Ishimori, T., Patel, P.V., and Wahl, R.L. Detection of Unexpected Additional Primary Malignancies with PET/CT J Nucl Med 46: 752-757 2005

Beatty, J.S., Williams, Hadyn, Aldridge, B.A. et. al. Incidental PET/CT findings in the cancer patient: How should they be managed? Surgery 146:274-281 2009

Case 11: 79 year old man with squamous cell cancer of the oral cavity with wide local excision. Recurrence followed by surgery and neck dissection. What is the next best step in the management of this patient?

- a) No further workup
- b) Repeat biopsy
- c) Follow up imaging in 6 months
- d) Surgical excision

Answer: B

Rationale: The intensity of uptake in this patient is concerning for recurrence, and is higher than expected for typical inflammatory change. A repeat biopsy is the best choice. As an alternative, a short interval follow up scan is reasonable (2-3 months); a 6 month delay is too long.

References

Gambhir, S.S., Czernin, J., Schwimmer, J., Silverman, D.H.S., Coleman, R.E., and Phelps, M.E. A Tabulated Summary of the FDG PET Literature J Nucl Med 42: 1S-93S. 2001

Nam, S.Y. Lee SW, IM KC, et al. Early evaluation of the response to radiotherapy of patients with squamous cell carcinoma of the head and neck using 18FDG-PET. Oral Oncol 41:390-395, 2005.

Yao M, Smith RB, Graham MM, *et al.* The role of FDG PET in management of neck metastasis from ... Int J Radiat Oncol Biol Phys. 60:1410-1418. 2004

Case 12: 57 year old man with left sided throat pain and newly diagnosed SCC left tonsil. What is the etiology of the nasopharyngeal uptake?

- a) Lymphoid hyperplasia
- b) Metastatic disease
- c) Nasopharyngeal carcinoma
- d) Nasopharyngeal lymphoma

Answer: A

Rationale: Since the uptake in this case is focal, intense, and nodular, with an associated mass on CT, further workup is necessary to exclude the malignancies outlined above. In this case, biopsy was performed and the lesion was shown to represent lymphoid hyperplasia.

References :

Nakagawa, t., Yamada, M. and Suzuki, Y. ¹⁸F-FDG Uptake in Reactive Neck Lymph Nodes of Oral Cancer: Relationship to Lymphoid Follicles. J Nucl Med 49: 1053-1059. 2008

Case 13: 52 year old man with history of melanoma removed from the left foot 4 years previously, positive sentinel node, received interferon therapy for 1 year and recurrence on dorsum of left foot, excised. Now, NED. What is the most likely etiology of the sellar uptake in this patient?

- a) Low-grade hypothalamic glioma
- b) Metastatic disease
- c) Pituitary adenoma
- d) Primary CNS lymphoma

Answer: C

Rationale: Focal hypermetabolism in the sella is a common incidental finding on FDG-PET, and is most often seen in the setting of a pituitary macroadenoma.

References:

De Souza, B., Brunetti, A. and Fulham, M.J. et. al. Pituitary microadenomas : A PET study. Radiology 177:39-44. 1990

Francavilla, T.L., Miletich, R.S. and DeMichele, D. Et. Al. Positron Emission Tomography of Pituitary Macroadenomas: Hormone production and effects of Therapies. Neurosurgery. 28(6) 826. 1991