Imaging Tumoral Proliferation with Positron Emission Tomography (P.E.T)

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Abstract: Positron Emission Tomography (P.E.T.) scan, permits to follow the diffusion of the radiopharmaceutical throughout all the body, after its injection; it is rapidly becoming a major diagnostic imaging modality used predominantly in determining the presence and severity of cancers, neurological conditions, and cardiovascular disease. It is currently the most effective way to check for cancer recurrences. 14 cases were studied showing computerized tomography Emission Tomography (PET) with the hybrid image of (C.T.) and (P.E.T.) to localize the center of the tumorous tissue also the impact of the radiopharmaceutical on the level of some hormones is mentioned.

Key words: FDG/PET, malignant brain lesions, exploration of the whole body.

INTRODUCTION

P.E.T scan is constituted of three machines: a) The cyclotron which generates the radio elements, b) The camera which detects the emitted rays from the radio elements, c) scanner which permits the fusion of all the gathered informations on the same image[1].

Until recently a PET center required a cyclotron and a radiochemistry laboratory on site to produce the $^{18}$F Fluorinated Dextro Glucose FDG. As a result there was a scarcity of centers. However, there are now multiple sites that make FDG and distribute it to the centers that only need to have a PET scanner to perform the imaging study[2].

The radiopharmaceutical $^{18}$F-FDG is currently the only fluorinated tracer used in routine clinical positron emission tomography (PET) Fluorine 18 is considered as the ideal radioisotop for PET, due to a low positron energy (0.64 MeV), which not only limits the dose rate to the patients but also results in a relatively short range of emission in tissue, therefore providing high-resolution images. Further, the 110 min, physical half-life allows for high-yield radiosynthesis, transport from the production site to the imaging site, and imaging protocols that could span hours, which permits dynamic studies and assessing metabolic processes that may be fairly slow.

(FDG-PET) has been used for detection staging, and response monitoring in breast cancer patients. Although studies have proven its accuracy in detection of the primary tumor and auxiliary staging, its most important current clinical application is in detection and defining the extent of recurrent or metastatic breast cancer and for monitoring response to therapy[3].

Another Radiopharmaceutical: O- (2-$^{18}$F) Fluorethyl) -L- tyrosine (FET), has been introduced in medicine as an amino acid derivative and more safer than the deoxyglucose derivative (F.D.G) specially for diabetic patients.

These results indicate that FET PET is a useful method to identify malignant brain lesions. It appears that high- and low-grade brain tumours exhibit a different uptake kinetics of EET. A kinetic analysis of FET PET may provide additional information in the differentiation of suspected brain lesions[4].

The degree of uptake of FDG is sometimes influenced by diabetes mellitus D.M. a study (5) was conducted to compare the diagnostic ability of FDG-PET in patients with cervical cancer complicated by DM and those without DM no significant results were observed, while Bingham et al[6] has declared that: "Hypoglycemia is associated with reduced brain glucose content in aware and unaware subjects, with a relative preservation of metabolism in areas associated with sympathetic activation.

Mechanism and Interpretation of the Action of Radiopharmaceutical: The radioactive substance is linked to glucose which is taken by the cancer cells as they proliferate very quickly. One hour after injection, they capted the glucose 50 times more than the normal cells resulting different colors which attach doctor's attention and permit detection of very small tumors which are invisible by other methods of investigations. Cancer cells have higher metabolic rates than normal cells, and show up as denser areas on a PET scan. PET is useful in diagnosing certain cardiovascular and neurological diseases because it highlights areas with increased, diminished or no metabolic activity.

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This new tool of diagnosis offers significant advantages over imaging forms of imaging as CT. or M.R.I. scans.

This technique has an important advantage of exploration of the whole body in one time only. Before the PET scan, when we suspect any abnormal function in the patient we prescribe a scanner to the whole body segment by segment which requires many hours for interpretation.

PET is considered particularly effective in identifying whether cancer is present or not, if it has spread, if it is responding to treatment, and if a person is cancer free after treatment. Cancers for which PET is considered particularly effective include lung, head and neck, colorectal, osophageal, lymphoma, melanoma, breast, thyroid, cervical, pancreatic, and brain as well as other less-frequently-occurring cancers.

As a matter of fact the technique is interesting in certain types of cancers in particular pulmonary cancer for evaluation of its extent (the most frequent use) also in lymphoma. The PET scan helps to detect recurrence of colon cancer or melanoma, especially when blood investigations for follow up indicate recurrence of cancer and morphological investigation show nothing abnormal.

Application of P.E.T. Scan in Diagnosis:

- Identification of tumors from benign lesions especially in cancer of head and week[7].
- Early detection of tumors, as PET images biochemical activity, it can characterize a tumor as benign or malignant, hence avoiding surgical biopsy when PET scan is negative[8].
- Staging of Cancer: PET is extremely sensitive in determining the full extent of disease, especially in lymphome, malignant melanomas, breast[9], lung, colon and cervical cancers and bone metastases[10].
- Assessing the effectiveness of chemotherapy: the level of tumor metabolism is compared on PET scans before and after treatment[11].
- PET also is useful in differentiating Alzheimer's disease from other forms of dementia disorders, such as vascular dementia, Parkinson's disease, Huntington's disease, etc[12,13].
- Epilepsy: PET is one of the most accurate methods available to localize areas of the brain causing epileptic seizures and to determine if surgery is a treatment option.
- Cardiovascular Disease: By measuring both blood flow (perfusion) and metabolic rate within the heart, physicians using PET scans can pinpoint areas of decreased blood flow such as that caused by blockages, and differentiate muscle damage from living muscle, which has inadequate blood flow (myocardial viability). This information is particularly important in patients who have had previous myocardial infarction and who are being considered for a revascularization procedure.
- Imaging metastasis deposit in vertebral paget's disease (M)[14].
- prognostic value of interim FDG-PET after two a three cycles of chemotherapy in Hodgkin lymphoma[15] and malignant lymphoma[16].
- Treatment follow up of brain Tumors[17] and prostate cancer[18].

Cases and Comments:

Fig. 1: shows cancer at the base of tongue and osopharynx

Comment: (the patient :big smoker) tumers are localized in aropharynx and base of tongue; as shown in CT coronals, PET coronals and the fused coronals. The right picture (MIP Navigate) shown cervical adenopathy with peritonal carcinoma.

FDG-PET has a useful and important role in the diagnosis of head and neck cancers and in the demonstration of occult or hidden tumers, distant and metastatic disease.

Comment: PET allows quantitative assessment of brain[17] tumor's pathophysiology and biochemistry hence it provides different biochemical and molecular information about primary brain tumors when compared to histological methods or neurobiological studies. PET reveals prognostic value with respect to survival and identifies early disease and differentiates benign from malignant lesions.
Case (2)

Fig. 2: Female patient with Glioblastoma of the left hemisphere of brain arrows and the red point refer to the tumorous part in the brain

Case (3)

Fig. 3: Cancer in uterus cervix, no metastasis.

Comment: The fused coronals indicate clearly the diseased part of the uterus cervix; as the patient was young no metastases were observed.

Case (4)

Fig. 4: Colorectal cancer with metastasis in liver and right femur

Comment: The fused coronals and MIP navigate indicate metastases in the liver and right femur due to the radiated colorectal

Case (5)

Fig. 5: Tumor in left kidney, paravertebral ganglia (MIP)

Comment: the fused transsexual (C.T. and P.E.T.) indicate exactly the tumor place in the kidney in addition to the MIP navigate shown paravertebral ganglia and mediastinal ganglia.
Comment: This investigation assessed the value of (FDG-PET) after two cycles of chemotherapy for prediction of progression free survival and overall survival as shown before and after treatment.

Comment: (FDG-PET) in this case provide new information and complement structural imaging techniques in the evaluation of such disorders enabling the differentiation of benign and malignant pulmonary nodules, as shown in the fused transsexuals, MIP navigate reaches all body involvements in order to obtain the clearest picture and all cancerous tissues.

Comment: fused transaxial PET shown cancer in lung and liver, while MIP navigation position shows global body with all the cancerous tissues.

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Comment: The new radiopharmaceutical 0-(2-[18F]fluorethyl)-l-tyrosine i.e. FE T-PET, proves its efficacy as in clinical evaluation of brain tumours specially with patients suffering from diabetes mellitus. Fused coronals (CT and PET) show the tumorous focals (indicated in red colour and arrows).

**Fig. 10:** Colorectal cancer (aperted increase in C.E.A) cancer in sternum, vertebrate and supra –renal gland also liver metastasis.

Comment: all cancerous place in the body are coloured in red, after operation there was increase in Carcino Embrionic Antigain (C.E.A.).

**Fig. 11:** Cancer of colon with metastasis in right lung and left lung also liver

**Case (11)**

**Fig. 12:** Multiple localizations all over the body and invading the sacrum (after breastectomy still lone pair).

Comment: as it is clear (FDG- PET) explores all the cancerous tissue in the body, which is not in accordance with Uematsu et al(9) who declared that Bone SPECT & superior to (FDG-PET) in detecting bone metastases in breast cancer.

Our findings are against their opinion : “: the sensitivity of ectoblastic lesions is limited with (FDG PET )”.

**Case (12)**

**Fig. 13:** Cancer of esophagus and brain.

**Case (13)**
Comment: Fused sagittals (CT and PET) indicate clearly cancerous places in the body (red colour centered in brain and aesophagus while MIP navigate shows the global body (white and black).

Fig. 14: (R) Localization in liver and (L) suprarenal gland

Comment: (FDG-PET) explained the reason for unstably case of the planet regarding his activity by exploring cancer in supra-renal gland where secretion of cortical is minimal in the morning not following the known control cycle in healthy people, also ALAT and ASAT enzymes show higher estimations than in healthy people.

Conclusion: PET probes and drugs are being developed tougher as molecular probes to image the function of targets without disturbing them and in mass amounts to modify the target's function as a drug. Molecular imaging by helps to close the gap between in vitro to in vivo integrative biology of disease.

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