# The role of $^{18}$F-FDG PET in the assessment of a benign hematological disorder: polycythemia

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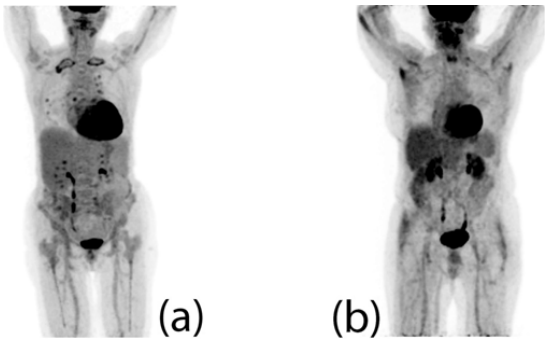
Fluorine-18 fluorodeoxyglucose positron emission tomography ($^{18}$F-FDG PET) imaging was conceived in the early 1970 by investigators at the University of Pennsylvania as a research technique to measure brain metabolism and function by employing a non-invasive imaging approach [1]. Soon after the introduction of whole-body PET instruments, $^{18}$F-FDG was utilized in the assessment of a variety of solid tumors and certain hematological malignancies [2-3]. Yet, the role of $^{18}$F-FDG in assessing benign and uncommon malignant disorders of the bone marrow has not been investigated to a great extent. Fluorine-18-FDG as a molecular probe has the proven capacity to reflect the abnormal glycolytic activities inherent to a variety of disorders, where such information may serve as a guide to the clinical course of the respective disease. Recent efforts have studied bone marrow and extra-medullary disease activity in certain malignancies like chronic lymphocytic leukemia [4, 5]. Nonetheless, few studies have explored the role of $^{18}$F-FDG in assessing the metabolic basis of benign disorders of red marrow. Moreover, the introduction of novel imaging analysis schemes in recent years has allowed for the global assessment of red marrow disease, which can provide a superior means for characterizing the systemic nature and burden of these disorders [6]. Accordingly, semi-quantitative global analysis techniques as applied to the skeletal structures [7-8] in $^{18}$F-FDG PET may provide a tool to better understand these complex marrow abnormalities. Functional imaging of red bone marrow may also reveal critical information specifically regarding the extra-medullary extension of such hematological disorders that cannot be assessed by other diagnostic or imaging techniques.

Myeloproliferative neoplasms (MPN) are an apt category of hematological disease that confer significantly altered systemic metabolic rates of hematopoietic stem cells (HSC) [9] in the marrow, as such they are primed for exploration with $^{18}$F-FDG PET. The hallmark of such disorders involves the excess production of particular cellular components in blood. After a period of excess production, scar tissue may develop in place of the HSC leading to myleofibrosis and decreased hematopoietic activity. One of the least studied disorders within the larger category of MPN with respect to nuclear medicine is polycythemia. Polycythemia may be either primary, polycythemia vera (PV), or secondary. PV involves a JAK2+ in HSC which allows for the excessive proliferation of immature erythrocytes and depressed erythropoietin levels [9]. Secondary polycythemia occurs in response to decreased oxygen intake, often as a result of smoking, which results in increased erythropoietin and hematocrit levels [9]. Primary and secondary polycythemia lead to an increase in overall red marrow activity and a diffusion of active red marrow into the appendicular skeleton. Clinical presentation often includes redness or irritation of the skin along with headache, fatigue and excessive bleeding.

Given the nature of the disease and the enumerated capabilities of $^{18}$F-FDG PET it is expected that one would be able to capture the systematic abnormalities inherent to the disease. Moreover, the handful of case studies supports this possibility. Three case studies have all illustrated diffuse elevated $^{18}$F-FDG uptake throughout the axial and appendicular skeleton that reflects the hyper-metabolic red bone marrow as related to polycythemia [10-12]. Moreover, the use of various functional imaging tracers, in addition to $^{18}$F-FDG, may indirectly reflect hypermetabolism in red bone marrow through abnormal tracer accumulation in the skeletons of patients [13] . The whole body $^{18}$F-FDG scan of a JAK2+ PV patient before treatment (a) as compared to a matched subject (b) is found below; of note is the PV patient's elevated uptake in the pelvis, femur and spine.

Based upon the mentioned precedent, it is evident that PET imaging with $^{18}$F-FDG and other tracers will play a meaningful role in assessing diffuse bone marrow disorders such as hematological malignancies and myeloproliferative abnormalities. Semi-quantification [7] studies of global [5] bone marrow activity in such an application will be a vital means in accurately assessing the systematic nature and global burden of such benign hematological disorders such a polycythemia. Accordingly, the derived metabolic data projects to be a useful tool in the prospective clinical and scientific aspects of the diagnosis of these benign hematological disorders and the assessment of disease progression in light of relevant biological treatments [14].

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