

## CASE REPORT

## 2-<sup>18</sup>F]fluoro-2-deoxy-D-glucose ([<sup>18</sup>F]FDG) positron emission tomography for the diagnosis and treatment of Burkitt lymphoma

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### Abstract

**Background/Objective:** Burkitt lymphoma, a form of non Hodgkin lymphoma, is a rare aggressive mature B-cell neoplasm with a favorable prognosis. The objective of this article is to demonstrate that the prompt diagnosis and the application of effective treatments of Burkitt lymphoma is facilitated by the efficacious use of 2-<sup>18</sup>F]fluoro-2-deoxy-D-glucose positron emission tomography.

**Case Report:** A 45-year-old man presented with pain in and around his joints and his bones. After multiple inconclusive diagnostic procedures, a 2-<sup>18</sup>F]fluoro-2-deoxy-D-glucose positron emission tomography scan was obtained revealing diffuse intense radiotracer activity throughout the skeletal system with multiple areas of photopenia in multiple vertebral spine levels and the posterior iliac crest. Subsequent bone marrow biopsy showed a high Ki-67 proliferative index consistent with Burkitt lymphoma.

**Conclusions:** This case report is of interest to all clinicians who may evaluate adults with pain in and around joints and bones. Burkitt lymphoma merits inclusion in the differential diagnosis of pain in and around joints and bones in adults. Utilization of 2-<sup>18</sup>F]fluoro-2-deoxy-D-glucose positron emission tomography will facilitate the prompt diagnosis of Burkitt lymphoma and the application of effective interventions.

### Key words

Atypical malignancies, B-cell neoplasms, Metastases, Photopenia, Radiotracers

## 1 Introduction

Lymphoid neoplasms can be categorized <sup>[1]</sup> in three broad classes as follows: Hodgkin disease, B-cell neoplasms, and T-cell neoplasms <sup>[2]</sup>. Burkitt lymphoma, a non Hodgkin lymphoma, is a rare aggressive neoplasm of mature B-cells <sup>[3]</sup> characterized by a monoclonal proliferation of B lymphocytes. Under the microscope there are small noncleaved cells with a “starry sky” appearance <sup>[2]</sup>. The three distinct clinical variants of Burkitt lymphoma affect (1) adults with immune deficiencies and (2) children with (a) endemic and (b) sporadic types <sup>[2, 4]</sup>. Burkitt lymphoma occurs in adults who have already experienced immune deficiencies <sup>[2]</sup>. The endemic form of Burkitt lymphoma in Africa produces tumors of the jaw

and facial bones in children<sup>[2]</sup>. Burkitt lymphoma was the most common cancer of children in Uganda and related regions of Africa in the middle of the past century<sup>[2, 5]</sup>. The sporadic form of Burkitt lymphoma outside Africa produces tumors of the abdomen, particularly the distal ileum, cecum, and mesentery of children<sup>[2]</sup>. Burkitt lymphoma carries a translocation of the c-myc oncogen from chromosome 8 to either the immunoglobulin (Ig) heavy chain region on chromosome 14 or one of the light chain loci on chromosome 2<sup>[6]</sup>. In a German cohort of children and adolescents with Burkitt lymphoma/leukemia, the median age at diagnosis of malignancy was 8.4 years, the male to female ratio was 4.5:1, and more than four fifths had event-free survival at five years<sup>[7]</sup>. Cure is typically achieved in children, adolescents, and adults with Burkitt lymphoma today<sup>[3]</sup> by means of contemporary treatments<sup>[8]</sup>.

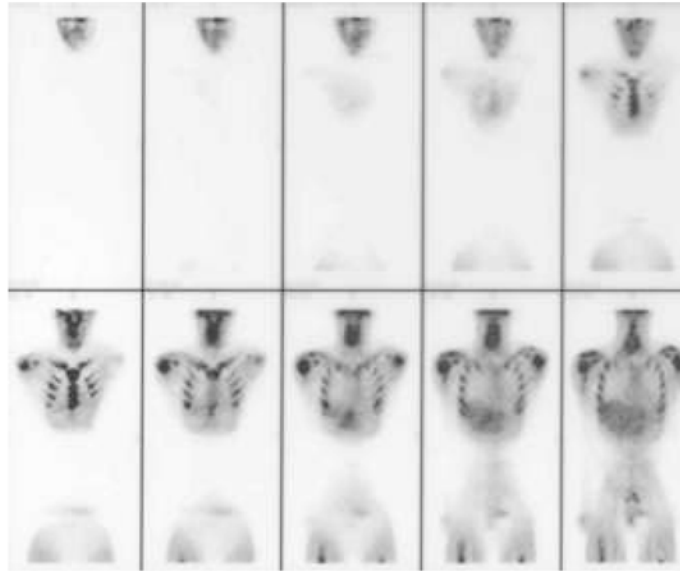
Although whole-body computed tomography (CT) may detect no abnormalities in people with Burkitt lymphoma<sup>[9]</sup>, CT may possibly demonstrate diffuse tumor infiltration of abdominal organs by lymphomatous tissue<sup>[10-12]</sup>. Several advantages over CT are offered by the administration of 2-[<sup>18</sup>F]fluoro-2-deoxy-D-glucose ([<sup>18</sup>F]FDG) positron emission tomography (PET) – computed tomography (CT) and [<sup>18</sup>F]FDG PET. A retrospective review of the utilization of [<sup>18</sup>F]FDG PET – CT and [<sup>18</sup>F]FDG PET in 15 cases of Burkitt lymphoma demonstrated 100% sensitivity and 94-96% specificity indicating that [<sup>18</sup>F]FDG PET – CT and [<sup>18</sup>F]FDG PET represent promising tools for Burkitt lymphoma including staging, treatment monitoring, and predicting disease aggressiveness<sup>[4]</sup>. Since CT alone may demonstrate no evidence of a lymphomatous infiltrate, including the absence of a mass effect, [<sup>18</sup>F]FDG PET – CT is sensitive powerful tool for the localization and the staging of extranodal involvement in patients with Burkitt lymphoma without clinical suspicion of extranodal lesions<sup>[4]</sup>.

We shall present a case to confirm that [<sup>18</sup>F]FDG PET is a valuable tool for the clinical management of people with Burkitt lymphoma. Indeed, the prompt diagnosis and treatment of Burkitt lymphoma is facilitated by [<sup>18</sup>F] FDG PET<sup>[4, 6, 13-15]</sup>. We present a case to illustrate the value of [<sup>18</sup>F]FDG PET to diagnose and stage Burkitt lymphoma.

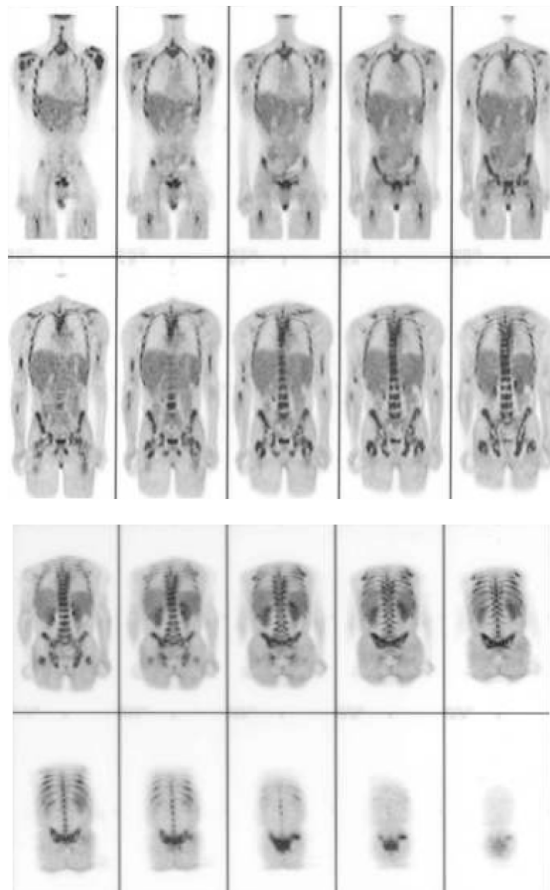
## 2 Case report

A 45-year-old man presented with pain in and around all joints and bones. To evaluate the pain in his shoulders and neck, magnetic resonance imaging (MRI) was performed revealing a herniated C3-4 disk. Then the acute onset of severe pain radiating down his arms led to an emergent anterior C3-4 discectomy and fusion with allograph. Laboratory evaluation for surgery revealed pancytopenia. Several bone marrow aspirates, all dry, were performed. Bone marrow biopsies showed fatty necrosis of the marrow. To evaluate a suspected malignancy, computed tomography (CT) was performed revealing moderate splenomegaly and retroperitoneal lymphadenopathy. On CT the liver was normal. CT revealed no axillary, mediastinal, or pelvic lymphadenopathy. Bone windows showed no focal abnormalities except for focal punctate lucencies in both iliac crests, consistent with prior bone marrow aspirations and biopsies. Monoclonal gammopathy suggested the diagnosis of multiple myeloma. [<sup>99m</sup>Tc]methylene diphosphonate (MDP) bone scan showed increased inhomogeneous activity uptake in the appendicular skeleton and multiple patterns of activity throughout the skeletal system. To evaluate likely metastatic disease, we performed [<sup>18</sup>F]FDG PET. Please refer to Figures 1 and 2.

[<sup>18</sup>F]FDG PET revealed diffuse intense radiotracer activity throughout the skeletal system with multiple areas of photopenia in the vertebral spine at the levels of T9, L2, and L5, and the posterior iliac crest consistent with marrow necrosis suggesting leukemia or possibly lymphoma. [<sup>18</sup>F]FDG PET revealed no soft tissue masses. Flow cytometry revealed abnormal B cells with positive markers of CD19, CD20, CD10, and lambda immunoglobulin light chain restriction consistent with aggressive lymphoma. Further bone marrow biopsy showed a high Ki-67 proliferative index consistent with Burkitt lymphoma. The results of [<sup>18</sup>F]FDG PET were valuable for staging the lymphoma and developing an effective treatment plan.



**Figure 1.** 2- $^{18}\text{F}$ fluoro-2-deoxy-D-glucose positron emission tomography of a 45-year-old man. The images demonstrate diffuse intense radiotracer activity throughout the skeletal system.



**Figure 2.** 2- $^{18}\text{F}$ fluoro-2-deoxy-D-glucose positron emission tomography of a 45-year-old man. The skeletal system demonstrates diffuse intense radiotracer activity with multiple areas of photopenia in the vertebral spine at the levels of T9, L2, and L5, and the posterior iliac crest.

### 3 Discussion

Burkitt lymphoma is a rare atypical malignancy affecting children, adolescents, and adults. When Burkitt lymphoma is promptly diagnosed and effectively treated, most patients have a favorable prognosis. Among imaging techniques [ $^{18}\text{F}$ ]FDG PET is a noninvasive method for evaluating and staging atypical malignancies including Burkitt and other non-Hodgkin lymphomas [6, 13, 14, 16, 17]. [ $^{18}\text{F}$ ]FDG PET frequently detects lesions of Burkitt lymphoma undetected by other procedures [14]. Additionally greater [ $^{18}\text{F}$ ]FDG uptake on PET can be helpful to distinguish Burkitt lymphomas and other aggressive non-Hodgkin lymphomas from indolent non-Hodgkin lymphomas and non-malignant conditions [18]. Lymphomas typically exhibit patchy, not diffuse, uptakes on [ $^{18}\text{F}$ ]FDG PET. A bone marrow biopsy is the standard of care required in the evaluation of a person with a suspected lymphoma. [ $^{18}\text{F}$ ]FDG PET provides a powerful tool to identify the bones with infiltrations of lymphomatous cells to prepare for diagnostic bone marrow biopsies. Although [ $^{99\text{m}}\text{Tc}$ ] methylene diphosphonate (MDP) scans can localize lymphomatous infiltrates in bones, [ $^{18}\text{F}$ ]FDG PET provides greater resolution to identify by visual assessment the regions of bone with the greatest infiltrates.

Granulocyte colony stimulation factor (GCSF), a treatment for patients with lymphomas and other malignancies, can also produce diffuse uptakes on [ $^{18}\text{F}$ ]FDG PET. However, the current patient had received neither GCSF nor any other treatment. Additionally, several benign conditions, including acute inflammation, pancreatitis, retroperitoneal fibrosis, and growths of the salivary glands, may present uptakes on [ $^{18}\text{F}$ ]FDG PET suggesting malignancies [19].

Further research is needed to compare and contrast the sensitivity, specificity, positive predictive value, and negative predictive value of the current imaging modalities including [ $^{18}\text{F}$ ]FDG PET, MRI, and CT for patients with Burkitt lymphoma, other non-Hodgkins lymphomas, and other atypical malignancies.

The identification of metastases is a crucial step to develop an appropriate treatment plan for Burkitt lymphoma. Utilization of [ $^{18}\text{F}$ ]FDG PET scans facilitates the identification of metastases and accurate staging of the disease [6, 13-17, 20, 21]. Additionally PET scans with [ $^{18}\text{F}$ ]FDG and possibly 3-deoxy-3-[ $^{18}\text{F}$ ]fluorothymidine ([ $^{18}\text{F}$ ]FLT) provide tools to monitor the efficacy of interventions for lymphomas and other malignancies [13, 21, 22]. To a much greater degree than other imaging techniques, [ $^{18}\text{F}$ ]FDG PET scan is valuable for evaluating the extent of atypical malignancies such as Burkitt lymphoma [8]. [ $^{18}\text{F}$ ]FDG PET – CT represents an optimal tool to combine both [ $^{18}\text{F}$ ]FDG PET and CT in a single study to identify the locations of lymphomatous infiltrates throughout the body of people with Burkitt lymphoma and other lymphoid neoplasms. Furthermore [ $^{18}\text{F}$ ]FLT PET – CT represents a promising tool to evaluate the amount of viable bone marrow reserve in patients with Burkitt lymphoma and to monitor the proliferation of lymphomas during treatment [23].

A 45-year-old man with Burkitt lymphoma underwent many inconclusive tests. [ $^{18}\text{F}$ ]FDG PET determined the extent of his lymphomatous lesions to facilitate the prompt appreciation of his involvement with Burkitt lymphoma. This resulted in the development of an appropriate treatment plan. To facilitate the prompt diagnosis and treatment of patients with Burkitt lymphoma, clinicians will benefit from the utilization of [ $^{18}\text{F}$ ]FDG PET scans for adults who present with pain in and around joints and bones [24].

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