CASE REPORT

Is FCH PET able to identify foci of infection superiorly to FDG PET?

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SUMMARY

We report a case of a brain abscess identified on fluorine-18 choline (FCH) positron emission tomography (PET) scan, which was not identified on fluorodeoxyglucose (FDG) PET scan. To our knowledge, there are no previous case reports of incidental brain abscess identified by FCH PET imaging. A 51-year-old man, with liver cirrhosis complicated by hepatocellular carcinoma (HCC) was enrolled in a research trial comparing HCC detection in FCH PET versus FDG PET. During the course of the trial, he underwent radiofrequency ablation (RFA) for HCC. A repeat FCH PET scan post-RFA incidentally revealed a 2.5â€‰cm lesion with avid uptake in the left occipital area of the brain. The patient was asymptomatic. MRI suggested this was an abscess. A craniotomy and drainage was performed, with culture of *Streptococcus intermedius* (*S. milleri* group) from the thick-walled collection, a causative organism for previous episode of pneumonia. He successfully completed a 6 week course of antibiotics.

BACKGROUND

We report a case of a brain abscess found incidentally on fluorine-18 choline (FCH) positron emission tomography (PET), which was not identified on fluorodeoxyglucose (FDG) PET scan.

Fluorine 18 (¹⁸F) FDG PET imaging has important roles in the diagnosis, staging and response assessment of a wide range of solid tumours. FDG is transported into cells at a rate dependent on both the number of glucose transporters in the cell membrane and the cellular metabolic rate. Malignant cells demonstrate an increase in the number of glucose transporters in their membrane. Similarly, inflammatory cells not only have an increased number of glucose transporters, but appear to be able to increase their affinity for glucose.¹ Thus, FDG PET provides a valuable mode of identifying infection and inflammation, in addition to malignancy. However, FDG PET displays low sensitivity in low glucose metabolising and, thus, in well-differentiated tumours (renal cell carcinoma, prostate cancer, hepatocellular carcinoma (HCC), bronchioalveolar carcinoma).²

FCH is a radiotracer primarily used to detect tumour cells. Tumour cells demonstrate increased choline uptake due to the upregulation of choline kinase. Once the choline is transported into cells, it is phosphorylated by choline kinase and then metabolised to provide the end product phosphatidylcholine, which is incorporated into the cellular

membrane. FCH PET demonstrates good contrast between normal and pathological tissue in prostate cancer, HCC, renal cell carcinoma, thymomas and bronchioalveolar carcinoma.² Preliminary studies suggest that FCH may also accumulate in inflammatory tissue; however, there is limited published literature for this indication.³

The *Streptococcus milleri* group, *Streptococcus intermedius*, *Streptococcus constellatus*, *Streptococcus anginosus*, are known for their tendency to manifest as an abscess. *S. intermedius* is an aerotolerant, anaerobic, commensal organism and has been demonstrated to be the most pathological of the three species. *S. intermedius* often causes abscesses as a solitary isolate, as opposed to the other two species which commonly form polymicrobial abscesses.⁴ The most common cause of a *S. milleri* brain abscess is an otogenic infection; however, lung infections are a risk factor for their development.^{5 6} Brain abscesses occur in 1 per 100 000 persons per year in the USA, with the most common genera being *Streptococcus*.⁶

CASE PRESENTATION

A 52-year-old man with a history of alcohol and hepatitis C-related Child-Pugh B cirrhosis (ongoing alcohol intake of 30 standard drinks per day) is referred for investigation of a 3 cm segment 4 liver lesion and numerous lung lesions. Additionally, he has a history of intravenous drug use, is a current heavy cigarette smoker (30 pack-year history) and occasionally uses methamphetamines and marijuana. A lung biopsy showed that the lung lesions were *S. milleri*-related organising pneumonia and he was treated with antibiotics in February 2016. His liver lesion was biopsied, confirming a well-differentiated hepatocellular carcinoma.

He was enrolled in a PET scan research trial comparing FDG PET and FCH PET in the context of HCC detection. His FDG PET demonstrated no uptake in the confirmed HCC, but revealed mild uptake in his lungs, suggestive of a resolving pneumonia. His FCH PET demonstrated intense avidity in the segment 4 liver lesion, as well as uptake in the right lower lobe of the right lung suggestive of infection (figures 1 and 2). The HCC was subsequently treated with radiofrequency ablation (RFA) (figure 1).

Repeat FDG and FCH PET scans were performed 2 months post-RFA as per trial protocol. The repeat FDG PET scan showed that the activity in the right lower lobe of the lungs had almost completely resolved. The repeat FCH PET suggested a

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Figure 1 Baseline fluorine-18 choline (FCH) positron emission tomography (PET) demonstrating an FCH-avid liver lesion (1). Post-radiofrequency ablation PET demonstrating a photopaenic treated liver lesion (2).

response to RFA, with resolution of previous activity in the liver lesion. The right lung activity had improved (figure 2). However, there was interval development of an FCH-avid lesion in the left occipital lobe of the brain (figure 3). Differentials included a primary brain tumour or metastatic brain lesion (HCC or lung cancer). An urgent MRI brain suggested the mass lesion was consistent with an intracerebral abscess (figure 4). Craniotomy

Figure 2 Baseline fluorine-18 choline (FCH) positron emission tomography (PET) demonstrating likely inflammatory changes in the right lower lobe (1). Post-radiofrequency ablation FCH PET showing improvement in the inflammatory changes in the right lower lobe (2).

Figure 3 Fluorine-18 choline (FCH) positron emission tomography (PET) (1) and fluorodeoxyglucose (FDG) PET (2) images of the brain. The lesion in the left occipital lobe is intense and well defined on the FCH PET scan, but is not clearly associated with increased activity on the FDG PET scan. Minor photopaenia in the left occipital lobe on the FDG PET scan may reflect adjacent oedema. The FCH-avid brain lesion was initially incidentally found on the FCH PET whole body scan performed as part of a trial.

was performed in June 2016. *S. intermedius* (from the *S. milleri* group) was cultured from a thick-walled abscess. A peripherally inserted central catheter line was inserted and long-term intravenous antibiotics were administered. The patient was asymptomatic from the abscess during his involvement in the research trial and subsequent investigations, in particular, no fevers, headaches, neurological symptoms, seizures or nausea and vomiting. Full neurological examination was normal. Biochemical markers also remained within normal limits.

Figure 4 MRI, T1 stealth sequence. There is gadolinium enhancement of the abscess capsule and no other enhancing lesions detected in the brain.

We report a case of an incidental brain abscess identified on FCH PET, which was not seen on FDG PET scan. To our knowledge, there are no prior cases reporting the detection of FCH-avid foci of infection when a FDG PET scan was negative. The reduced sensitivity on FDG PET was likely due to high background glucose transport and metabolism in normal brain, whereas choline has a much lower transfer rate across the blood–brain barrier and, therefore, has low background activity. This case also illustrates that infection should be considered as a potential differential diagnosis for FCH-avid brain lesions.

INVESTIGATIONS

Imaging

1st June 2016 (2 months post-RFA). Fluorocholine PET:

1. The previously documented FCH-avid lesion in segment 4 of the liver is no longer evident.
2. There has been interval development of an FCH-avid lesion in the left occipital region.

3rd June 2016 (2 months post-RFA). FDG PET:

1. There is now reduced FDG activity in the treated segment 4 liver lesion.
2. FCH avid and predominantly non-FDG avid abnormalities in the brain and chest.

14th June 2016. MRI brain:

Appearance in the left lateral occipital lobe likely represents intracerebral abscess.

23rd June 2016. CT head:

Expected postoperative appearances.

6th October 2016. MRI head:

Persisting but improved left occipital peripherally enhancing focus.

Blood tests

As detailed in [table 1](#).

DIFFERENTIAL DIAGNOSIS

Differential diagnosis for brain lesion identified on FCH PET scan:

- Metastatic disease: HCC metastases, lung cancer.
- Primary brain tumour.
- Abscess.

TREATMENT

The patient was commenced on levetiracetam for seizure prophylaxis. Craniotomy and drainage of the left occipital lesion was performed. Intraoperatively, it was noted to be a thick-walled abscess. Surgery was successful without complication. Infectious disease physicians recommended intravenous ceftriaxone and intravenous metronidazole for a period of 2 weeks. The patient was discharged home with a 4-week course of moxifloxacin and metronidazole.

OUTCOME AND FOLLOW-UP

The patient was followed up in the infectious diseases outpatient clinic in August. He continued on a 4-week course of moxifloxacin and metronidazole at discharge. At a neurosurgery outpatient appointment 4 months postoperative, he had recovered well and a repeat MRI showed improvement in the peripherally enhancing lesion. Hepatology follow-up showed no recurrence of HCC. However, a pulmonary nodule was found to be increasing in size. Given an extensive smoking history, the patient has been referred to the respiratory team for further investigation and management. The patient's blood tests remain

Table 1 Patient blood test results at various time points

	1 February 2016— admission for pneumonia	15 June 2016— admission for craniotomy	6 October 2016—4 months postcraniotomy
Hb (g/dL)	129	138	133
WCC ($11 \times 10^9/L$)	23.2	4.0	4.86
Platelets ($\times 10^9/L$)	202	158	145
Neutrophils ($11 \times 10^9/L$)	20.18	2.21	4.77
CRP	140	3	<1
Sodium (mmol/L)	131	135	129
Urea (mmol/L)	3.1	2.8	2.6
Creatinine ($\mu\text{mol/L}$)	52	61	60
Bilirubin ($\mu\text{mol/L}$)	41	12	15
ALT (IU/L)	60	26	43
ALP (IU/L)	265	140	192
GGT (IU/L)	198	211	123
INR (IU)	1.5	1.3	—
Albumin (g/L)	25	33	38

ALP, alkaline phosphatase; ALT, alanine aminotransferase; CRP, C-reactive protein; GGT, gamma glutamyl transferase; Hb, haemoglobin; INR, international normalised ratio; WCC, white cell count.

Learning points

- Infection cannot be excluded as a differential based on fluorodeoxyglucose (FDG) positron emission tomography (PET) scanning alone, particularly in areas with high background glucose metabolism.
- In our case, a fluorine-18 choline (FCH) PET scan was better able to detect a brain abscess than an FDG PET scan.
- Brain abscess can be asymptomatic.
- Brain abscess should be considered in the differential diagnosis of FCH-avid brain lesion.

stable with mild liver function test abnormalities and no signs of decompensation.

DISCUSSION

To our knowledge, there are no prior cases reporting FCH PET identifying foci of infection superiorly to FDG PET. Additionally, this case study demonstrates that cerebral abscess should be considered in the differential diagnosis of FCH-avid intracerebral lesion.

Contributors LEH collected the results and drafted the report. She is the guarantor. HH drafted and revised the report. MW revised the report. RF analysed and prepared the images and revised the report.

Competing interests None declared.

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