

Fluorodeoxyglucose positron emission tomography-computed tomography in a pregnant woman with carcinoma breast

ABSTRACT

A 35-year-old female with a 15-week period of gestation was detected with locally advanced cancer of the left breast. She was suggested to undergo a medical termination of pregnancy (MTP) followed by invasive Oncological imaging - Contrast enhanced computed tomography (CECT) chest–abdomen–pelvis/fluorodeoxyglucose positron emission tomography-CT (FDG PET-CT) for staging the disease. However, to avoid the risk of iatrogenic novel coronavirus 2019 infection to the patient, on her request, the hospital admission was carried out after the oncological workup and thus PET-CT was conducted before the MTP. FDG PET-CT revealed FDG avid primary in the left breast along with extensive metastases to liver and skeletal lesions. The developing fetus also showed physiological FDG uptake. The patient has undergone an MTP and is presently under treatment for metastatic breast cancer. The case report illustrates the radiation safety guidelines on fetal radiation exposure, steps to decrease fetal radiation exposure, and illustration of fetal FDG uptake.

Keywords: Breast cancer, fetal fluorodeoxyglucose, pregnancy

INTRODUCTION

PET-CT is a novel imaging for detecting the tumour burden of a cancer patient. It involves the use of radiopharmaceuticals for staging, assessing the response to therapy, and evaluation of a suspected recurrence of tumour. This use of ionizing radiation for imaging is regulated by ICRP regulations - Justification of the practice, optimization of the practice, and dose limitation – the minimum possible dose that serves the purpose of the intervention. These regulations attempt to prevent the deterministic effects and minimize the stochastic risk caused by ionizing radiation.

PET-CT is hybrid imaging that uses X-rays of CT Tube and Gamma photons from the radiopharmaceuticals to provide vital information for treatment. PET-CT is contraindicated in a pregnant patient because of the concern of an increase in the stochastic risk in the developing foetus. A typical whole-body radiation dose in a single PET-CT scan is of the order of 15-20mSv, this is lower than the 100mSv dose which is considered the dose limit for therapeutic abortion by many experts.

However, over the years several articles have shown that if the benefit outweighs the risk, and no other better imaging is available PET-CT can be performed in a pregnant patient.

This case report describes one such scenario where the benefit outweighed the risk and a scan was performed. The case report lucidly described the FDG biodistribution in the

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foetus, the intervention that can be made to decrease the foetal radiation exposure, and a brief overview of the ICRP regulations on aspects of radiation safety in the pregnant patient.

CASE REPORT

A 35-year-old primigravida in her 15-week period of gestation was being evaluated for a tender lump in her left breast. She revealed to be under regular follow-up for the abovementioned breast lesion which was detected 6 months back in December 2020. The lesion was labeled as benign Breast Imaging Reporting and Database System 2 (BIRADS-2) on a mammogram study for which the documents were not available. She was unable to have a regular follow-up after her conception due to the pandemic and fear of contracting infection. However, her worsening condition made her seek medical help.

Her clinical examination revealed a hard lobulated breast mass measuring 9 cm in maximum dimension involving the entire left breast. The mass was fixed to the underlying chest wall with skin edema and hard nontender but mobile ipsilateral axillary lymph nodes. Clinical suspicion raised the alarm for breast cancer TNM cT4cN2Mx.

Ultrasound mammography upstaged the lesion as BIRADS intravenous (IV) C/V. Trucut biopsy characterized the lesion as a triple-negative invasive mammary carcinoma. Being clinically an advanced breast cancer, the patient along with her husband was counseled, informed, and offered available treatment choices which included consent for medical termination of pregnancy (MTP) followed by positron emission tomography-computed tomography (PET-CT) for staging of disease. Because of the peak of coronavirus disease (COVID) pandemic, the clinicians and the patient agreed to opt for minimum inpatient hospital stay to avoid the risk of contracting COVID-19 infection. Hence, with the patient consent, her admission and MTP were planned after her oncological workup.

The patient along with her husband was counseled a day before and again on the day of the scheduled PET-CT scan about the potential radiation-induced risk to the fetus should they have a change of heart. Detailed written informed consent was taken from the patient and her husband for the same.

Fluorodeoxyglucose (FDG) PET-CT was conducted 45 min after IV injection of 283 MBq (megabecquerel) of ^{18}F -FDG using whole-body full-ring LYSO PET-CT scanner (GE Discovery). CT images were obtained using 140 kV and 155

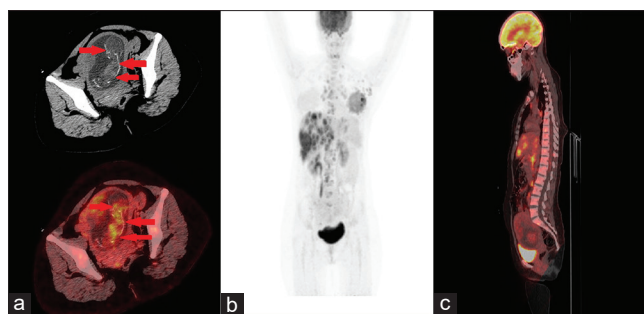


Figure 1: (a): Axial section images (CT and fused PET-CT) at the level of the mid pelvis showing fetal FDG uptake pattern (red arrows) in the region of brain, myocardium, and kidneys, (b) MIP image depicting left breast primary along with extensive metastases to liver and bones, (c) Sagittal fused PET-CT images depicting comparative intense FDG uptake in the bladder as compared to fetal FDG uptake. CT: Computed tomography, PET-CT: Positron emission tomography-CT, FDG: Fluorodeoxyglucose, MIP: Maximum intensity projection

mAs (mean) without the administration of IV/oral contrast. The patient was advised to maintain adequate hydration by regular consumption of water and frequent urination during the postinjection period before and after the scan to decrease the fetal radiation exposure.

Relatively minimal FDG uptake was noted in the region of the fetal brain, heart, and kidneys [Figure 1a]. FDG PET-CT revealed metabolically active left breast primary with hepatic, skeletal, and nodal metastases in the patient [Figure 1b and c]. The patient was labeled as a case of metastatic breast cancer (MBC). She was later admitted and she underwent an MTP. She is presently undergoing chemotherapy for MBC.

DISCUSSION

PET-CT is an uncommon modality for tumor evaluation in pregnant patients for the risk of radiation both during CT and due to the radioactive tracer. The risk of ionizing radiation from PET as well as from CT and the potential toxicity of radiopharmaceuticals limits its use.^[1] The threshold radiation dose to mitigate risk to fetus ranges from 50 to 100 mGy (milligray) as per the international commission on radiological protection (ICRP) guidelines.^[2-4] Although deterministic effects of ionizing radiation are not seen below this threshold, these are also not the primary concern of the clinician. The risk and fear are of cancer induction, a stochastic effect whose probability increases with increasing lifetime exposure to ionizing radiation.

The stochastic effects are the primary cause of concern of clinicians conducting an invasive imaging due to medicolegal issues. In our case, although the couple had consented for an MTP, had PET-CT showed a limited disease amenable to surgical intervention the couple may have decided to

continue with the pregnancy. This change of plan would have raised concern for us.

Hence, counseling about the risk of radiation hazards to the developing fetus with detailed written consent and sessions of counseling of the couple at every stage before PET-CT was mandatorily performed to avoid medicolegal hassles.

Initially, all noninvasive modalities were explored to stage the disease of the patient as our center did not have experience of PET-CT in pregnancy. However, a multispecialty approach and mandatory informed consent clearly outlining the risk of the procedure made it possible. The patient was adequately hydrated and was administered the lowest permissible dosage of radioactivity to further decrease the radiation dosage to the fetus. No adverse effects were noted during and after the scan.

Literature search shows ample instances of the use of FDG PET-CT in pregnancies from as early as 5 weeks to as late as 7th month of pregnancy for oncological applications.^[5] A study published by Stabin has been used in most of these studies for fetal dose estimates.^[6] The average fetal dose as calculated by several of these articles is 4.06 ± 3.22 mGy (milligray) much below the threshold radiation dose for deterministic risk as promulgated by international guidelines.^[1-4] Further steps to decrease the radiation dose have been achieved by administering lower dose of radiotracer, hydration (oral or IV saline infusion) prior to ¹⁸F-FDG, IV frusemide administration to promote rapid excretion of ¹⁸F-FDG, and bladder catheterization.^[1,5]

These articles lucidly describe the FDG uptake in various fetal organs. A study by Zanotti-Fregonara *et al.* and Gill *et al.* describes FDG uptake in the fetal myocardium and in fetal kidneys and bladder.^[1,5] Similar findings have also been reported by Hsieh *et al.* and Calais *et al.* who describe FDG uptake in the fetal myocardium and kidneys.^[7,8] In our case, FDG accumulation was noted in the fetal brain, myocardium, and probably kidneys and bladder. These findings suggest that FDG does accumulate in the fetus and patients should be informed about the same. Although fetal exposure to radiation and FDG accumulation cannot be completely eliminated, steps such as adequate hydration, frequent voiding of the bladder, usage of low-dose CT, and lowest possible FDG dose can help decrease the exposure further.

CONCLUSION

Several articles have been published indicating the role of FDG PET-CT in evaluation of pregnant patients. All of them acknowledge the fact that the use of FDG PET-CT should not be limited with pregnancy status of the patient and can

be performed, provided there is no better imaging modality available and information gained outweighs the risk. These articles show that FDG does accumulate in fetal tissues, but the major radiation exposure is due to FDG accumulating in the bladder of the patient. Despite this, the average fetal dose is far below the permissible threshold radiation dose prescribed by ICRP. Still, steps such as patient hydration, lower dose of radiotracer, use of diuretics, and bladder catheterization can further limit the fetal radiation dosage, thus minimizing the stochastic risk of radiation. Thus, we would like to conclude that FDG PET-CT which is an essential modality for tumor staging should not be limited for fear of radiation risk to the developing fetus, as in majority of the cases, the benefits outweigh the risk.

Informed consent

Written informed consent was obtained from the patient for publication.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her consent for her images and other clinical information to be reported in the journal. The patient understands that name and initials will not be published and due efforts will be made to conceal her identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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