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TBI-ADRD Positron Emission Tomography and Computed Tomography with 18F-FDG Standard Operating Procedure

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We use this protocol and it's working

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Disclaimer

The authors have nothing to disclose

Abstract

This standard operating procedure (SOP) document describes the process of data acquisition for Positron Emission Tomography (PET) and Computed Tomography (CT) with the radioactive tracer Fluorodeoxyglucose F18 (^{18}F-FDG) in mice.

Attachments

PDF

appendix 1.pdf
51KB

Guidelines

This protocol requires prior approval by the users' Institutional Animal Care and Use Committee (IACUC) or equivalent ethics committee.

Materials

- **Radiotracer and Radioactive Handling**
  - ^{18}F-Fluorodeoxyglucose (^{18}F-FDG), sterile and pyrogen-free: 20mCi
  - Lead Shield syringe holder
  - Lead Shield
  - Dose Calibrator
  - Geiger Counter
  - HIDEX Gamma Counter
  - Personal Dosimeters
  - Radioactive waste containers
- **Animal Handling and Preparation**
  - Water circulating heating mat or other small animal warming system (HTP-1500 Heat Therapy Pump)
  - Standard Gram balance for weight collection (OHAUS Balance CAT# 30253019)
  - Fasting cages
- **Imaging, Anesthesia, Injection supplies**
  - PET/CT acquisition system
  - Isoflurane anesthesia system with oxygen supply or concentrator
  - Induction chamber
  - 1mL syringe (McKesson CAT# 309659)
  - 18g needle (McKesson CAT# 1031789)
  - 0.9% Bacteriostatic injectable sterile saline (McKesson CAT# 239930)
  - 0.5mL 28g Insulin syringe (McKesson CAT# 329465)
  - Sharps container
  - Disposable under pads (McKesson CAT# 724031)
  - Cloth tape for positioning head (McKesson CAT# 944366)
  - PPE (Gloves, lab coat, protective eyewear, disinfectant)
  - Timer

Before start

- Mice will hide food in bedding, nesting materials, and continue to eat residual food left behind. This can affect data collection; it is imperative that the mice be moved to brand-new cages with hoppers that have not had any food in them. Measures should also be taken to minimize stress and acclimation prior to imaging.
- The morning of imaging, mice are identified and weighed using a standard gram balance.

Scope

1 The scope of this SOP includes:
- List of materials and required equipment
- Description of the material and the setup of the materials
- Walkthrough of the procedures before, during, and after data acquisition

Responsibilities

2
- SOP Author: responsible for production of the SOP and its described procedures
- SOP Owner: responsible for reviewing and approving changes to the SOP
- Staff: responsible for adhering to SOP guidelines
- NO CHANGES to this SOP are authorized without the explicit approval of the SOP Owner

Introduction

3 PET imaging with ^{18}F-FDG is a widely used nuclear medicine technique for assessing glucose metabolism in tissues. It plays a critical role in the diagnosis, staging, and monitoring of various oncologic, neurologic, and inflammatory conditions. Due to the sensitivity of PET imaging, the tools used, as well as the use of radioactive materials, standardized procedures are essential to ensure image quality, subject and staff safety, and regulatory compliance.

This SOP provides a structured framework for the consistent and safe performance of ^{18}F-FDG handling and imaging. Outlined are the general principles governing subject preparation, radiotracer handling, image acquisition, and quality control. The procedures described herein are designed to comply with applicable institutional policies, radiation safety standards, and IACUC standards.

Materials & Methods

4 **Materials**
- Radiotracer and Radioactive Handling
- ^{18}F-Fluorodeoxyglucose (^{18}F-FDG), sterile and pyrogen-free: 20mCi
- Lead Shield syringe holder
- Lead Shield
- Dose Calibrator
- Geiger Counter
- HIDEX Gamma Counter
- Personal Dosimeters

- Radioactive waste containers

Animal Handling and Preparation

- Water circulating heating mat or other small animal warming system (HTP-1500 Heat Therapy Pump)
- Standard Gram balance for weight collection (OHAUS Balance CAT# 30253019)
- Fasting cages

Imaging, Anesthesia, Injection supplies

- PET/CT acquisition system
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- Timer

Methods

Animal Preparation

- Animals must be fasted for at least 10 hours prior to imaging with 18F-FDG. Due to mice's coprophagia and nesting behaviors, the night prior to imaging, mice need to be moved from their home cage into a new clean cage, including a new clean hopper sans food. Water supply should be maintained at all times.
- Note: Mice will hide food in bedding, nesting materials, and continue to eat residual food left behind. This can affect data collection; it is imperative that the mice be moved to brand-new cages with hoppers that have not had any food in them. Measures should also be taken to minimize stress and acclimation prior to imaging.
- The morning of imaging, mice are identified and weighed using a standard gram balance.

Radiotracer Preparation

- Upon arrival, the radiotracer is documented in compliance with institutional radiation safety regulations.
- Note: Radiotracer should remain behind the lead shield when not actively in use.
- The stock dose of radiotracer is diluted with 0.9% bacteriostatic injectable saline to inject mice with 75 uCi of radiotracer.
- Note: When working with radiotracers, it is important to understand that there will be nonspecific binding or residual sticking in the syringe. You must account for this when drawing up your tracer and injecting. We have found that 18-F-FDG has ~10% sticking. If you want to give the mouse 75 uCi you should draw up ~83 uCi of tracer.

- Draw up your diluted tracer using a 0.5 mL insulin syringe
- Record the amount of tracer in uCi and the time the tracer was drawn up in HH:MM:SS

Tracer Administration

- The tracer is administered to the mouse via intraperitoneal injection, with a 45-minute conscious uptake period.
- Restraint: Scruff the mouse securely using the two-handed technique, exposing its ventral side. Tilt the head down and away from you, allowing the organs to move away from the injection site.
- Site Identification: injection should be given in the lower quadrant of the abdomen parallel to the top of the knee, just outside of midline. In female mice, you can use the space between the last two nipples just outside of midline as a landmark. Aspirate your needle to ensure proper placement and inject.
- Note: If you do not have negative pressure or you see blood and/or urine upon aspiration do not give the injection. Gently pull out your needle and try again.
- Once you inject your tracer, you need to document the injection time in HH:MM:SS and start a 45-minute timer for uptake.
- Place your mouse in a cage that is on the heated water circulating mat.
- Place your syringe into the dose calibrator and record the residual tracer as well as the time in HH:MM:SS.
- Attenuation and anatomical reference data is obtained using integrated imaging modalities via CT and PET. Scan time on the CT is ~5 minutes, and scan time on the PET scanner is ~10 minutes. To maximize animal throughput, calculate the combined scan time of 15 minutes and inject a new mouse every 20 minutes. This way, when one mouse is coming off the scanner, you can have another ready to start the scan. Stagger your injections so that you give yourself enough time to induce anesthesia.

Anesthesia and PET Acquisition

- Prior to inducing anesthesia, turn on your anesthetic machine to prime your lines and induction chamber.
- Once your timer has indicated the 45-minute uptake time is complete, you can induce anesthesia by placing your mouse in the anesthetic chamber with 2-5% isoflurane gas with an oxygen flow rate of 2 L/min. Once the proper anesthetic plane has been reached, place the mouse on the CT small-animal bed. The mouse should be positioned in a standardized orientation using the nosecone to ensure reproducibility. You can use a piece of cloth tape across the head to secure the mouse in place. Anesthetic maintenance is dependent on your anesthesia machine model, but a typical maintenance dose is 1-3% iso at 1-2 L/min O2.
- Once the CT is complete, move the bed or animal over to the PET scanner and begin the PET acquisition. Document PET Start time in HH:MM:SS
- Upon completion of the PET scan, mice can be returned to a new home cage with food or euthanized according to institutional procedure approval.

References

5 1. Cherry SR, Gambhir SS. Use of positron emission tomography in animal research. ILAR J. 2001;42(3):219–232. doi: 10.1093/ilar.42.3.219. - DOI - PubMed
2. Wong K-P, Sha W, Zhang X, Huang S-C. Effects of administration route, dietary condition, and blood glucose level on kinetics and uptake of 18F-FDG in mice. J Nucl Med. 2011;52(5):800–807. doi: 10.2967/jnumed.110.085092.EFFECTS. - DOI - PMC - PubMed

Appendices

6 Appendix 1: SOP Record Log

Protocol references

1. Cherry SR, Gambhir SS. Use of positron emission tomography in animal research. ILAR J. 2001;42(3):219–232. doi: 10.1093/ilar.42.3.219.
2. Wong K-P, Sha W, Zhang X, Huang S-C. Effects of administration route, dietary condition, and blood glucose level on kinetics and uptake of 18F-FDG in mice. J Nucl Med. 2011;52(5):800–807. doi: 10.2967/jnumed.110.085092.EFFECTS.