Brain Imaging SPECT & PET: Technical Factors

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Objective

To review the basic technical factors involved with SPECT and PET brain imaging.
What year was it?

Super Bowl - Dallas Cowboys

World Series - Toronto Blue Jays

Stanley Cup - Montreal Canadiens

1993

Nobel Peace Prize - Nelson Mandela

Oscar Best Movie - Unforgiven (Clint Eastwood)
SPECT & PET
Technical Factors

- Patient
- radioPharmaceutical
- Protocol
- Processing
Technical Factors

- Patient
- symptoms determine which
- radioPharmaceutical
- Protocol
- Processing
Technical Factors

Patient

radioPharmaceutical

Protocol

Processing
Patient

Preparation:
- PET - fasting 4hr & blood glucose
- history questionnaire for both SPECT & PET

Injection:
- eyes open, quiet room
- 3-way stopcock for saline rinse

Uptake time:
- both SPECT & PET minimum 30 min
Patient

Positioning:

- single scan or multi-scan study
- head holder, SPECT - shoulders slouched
- head straightening, tilt, & lasers
Patient

Positioning:

- gantry tilt (PET)
- Immobilization
Patient

Positioning:

- SPECT radius of rotation
  - closer better
  - fixed intervals with fan-beam collimators
Technical Factors

- Patient
- radioPharmaceutical
- Protocol
- Processing
radioPharmaceuticals

SPECT: rCBF

(ECD)

(HMPAO)
radioPharmaceuticals

PET: rCMRG
- FDG (2- $^{18}$F Fluoro-2-Deoxy-D-glucose)

Both SPECT & PET:
- preparation
- quality control
- doses
Technical Factors

- Patient
- radioPharmaceutical
- Protocol
- Processing
Protocols

radioPharmaceutical dependant:
  • static or dynamic

Hardware dependant:
  • SPECT
    • single or multi-head, type of collimators (fan-beam)
    • transmission scans
    • SPECT-CT
  • PET
    • dedicated (transmission)
    • PET-CT
Protocols

Acquisition parameters:

• **SPECT**
  • matrix (128), zoom, degrees (3)
  • time (15 min) single or multi-acquisition
  • motion (continuous)
  • transmission scan, or CT

• **PET**
  • transmission scan
  • emission scan (3D mode), time (15 min)
  • list mode?
Technical Factors

- Patient
- radioPharmaceutical
- Protocol
- Processing
Processing

Reconstruction SPECT & PET:
  - FBP or Iterative (OSEM)

Filter selection SPECT & PET:
  - 3-Dimensional post-filter
    - SPECT - optimize to each patient
      - Butterworth (low pass), order fixed (5), vary cutoff frequency to total counts in cerebrum
Filter Optimization

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<td>2900-3200</td>
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SPECT

Butterworth (order 5) cutoff frequency:

0.23  0.3  0.4
Processing

Attenuation correction SPECT & PET:

- manual (Chang method), measured by transmission scan, or CT

PET

no AC  CTAC
Processing

Scatter correction:

• PET - required for 3D mode
  • various methods, vendor specific

• SPECT - optional
  • various methods, vendor specific
Processing

Reorientation & reformatting:

rotation

transaxial

trans obliq
Processing

Reorientation & reformatting:

- software to automatically reorient slices
  - standardized (Talairach stereotactic atlas)
  - uses ACPC (ant commissure post commissure) line, anatomy is in proportion to this

- or visually, using internal anatomical landmarks
  - cantho-meatal (CM) line parallel to ACPC line, 3 landmarks: frontal pole, sub-thalamic, occipital pole
  - determine angle of CM line, reorient transaxial slices to angle
Processing

Reorientation & reformatting:

MRI

ECD
Processing

Reorientation & reformatting:
Processing

Reorientation & reformatting:

$^{123}$I - CIT

$^{123}$I - IBF
Processing

Reorientation & reformatting:
Radioactive surface markers

Whatman no.1 filter paper, 1 - 2 mm square

- 1 - 2.5 µCi (37 - 92.5 KBq) $^{99mTc}$
Radioactive markers

- Outer canthus of eye
- External auditory meatus
Processing

Reorientation & reformatting:

$^{123}$I - CIT
Summary

High quality brain imaging using SPECT & PET are dependant on many technical factors.

Selection of the proper and optimized technical factors helps ensure high quality brain images.
References

SNM Procedure Guidelines: Brain Perfusion Single Photon Emission Computed Tomography (SPECT) Using Tc-99m Radiopharmaceuticals 2.0


Thank-you!

Questions?