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## 3.10. Image Analysis

This activity describes criteria and procedures related to producing quantitative measurements from the images that are necessary to reliably meet the Profile Claim.

### 3.10.1 Discussion

The Image Analyst using computer workstation analysis tools shall perform the specified measurements. The main quantitative data analysis task is to determine the Specific Binding Ratios (SBR) of Ioflupane DaTscan for the right and left caudate and putamen. The derived results are then compared to an age normalized database to provide a reference for the SBR versus age matched normals. The profile describes the data analysis methodology.

Quantitative Specific Binding Ratio (SBR) of Ioflupane DaTscan will be based upon patient SBR and compared to an age normalized database (or striatal phantom or digital reference object as the case may be). Qualified systems will be able to achieve a SBR within a certain range (i.e., ±5% of reference value) for quantitative imaging of I-123 Ioflupane for the DaTscan phantom (described in this profile). The profile does not seek to make disease determination but to provide the methodology for data analysis and also for qualification of systems and processing for I-123 Ioflupane DaTscan data analysis.

Input Data:

The output images from Image Reconstruction are considered the input for Image Analysis. Once stored on the analysis workstation the image data will be processed for region of interest image analysis as described below. The original input data will be maintained as a separate file and will be stored along with the processed data for image analysis.

Methods to be Used:

Uptake in the striatum (i.e., caudate and putamen) and background region (e.g., cerebellum or occipital region) is characterized by defining a region-of-interest (ROI). The measurand is the specific binding ratio and is determined from the following equation:

 (eq 1)

where the *backgrndROI* counts are normalized to the same ROI volume as the striatal ROI (i.e., caudate or putamen). This is equivalent to the concentration of counts associated with specific binding to the domain transporter in the target area divided by background. This binding ratio is an approximation for the binding potential (BPnd) when determined during the secular equilibrium phase of radiotracer washout which occurs 3 to 4 hours post injection with 123I Ioflupane.

Regions of interests will be drawn on preprocessed images as described below.

On spatial normalized SPECT image volumes the transaxial slice with the highest striatal uptake is identified and the 8 hottest striatal slices around it are averaged to generate a single slice image, which represents about 75-80% of the axial extent of visualized striata, dependent upon the reconstruction parameters.

Regions of interest (ROI) are then placed on the left and right caudate, the left and right putamen, and the occipital cortex (reference tissue). The caudate regions should sampled be from the caudate head which is readily identified on the pathologic Parkinson’s disease image. The putamen regions are usually sampled in the mid-putamenal area determined by the template. This is a compromise between being too far posteriorly where the putamen becomes very thin and irregular and sampling too anteriorly where counts from the adjacent caudate may contaminate the putamenal SBR. It should be clear which values belong to which striatal structures. This can be done by capturing DICOM coordinates along with ROI values or secondary screen capture of the ROI for identification.

Count densities for each region are extracted and used to calculate specific binding ratios (SBRs) for each of the striatal regions. SBR is calculated as (target region/reference region)-1, as described above in eq 1.Alternative ROI sampling strategies have been successfully employed in the determination of SBR. Specifically, larger regions encompassing the full anatomical extent of left and right caudate and putamen are placed on the ioflupane SPECT image spatially normalized to a common SPECT template. This has the advantage of greater count statistics based on the larger number of voxels sampled. The disadvantage lies in the lower degree of spatial information regarding DAT signal loss within the striatal substructures, esp the putamen, where the extent of DAT reduction follows a topographic pattern of change. By averaging all putamenal regions in the context of a large single ROI sample, both more and less affected voxels are counted, resulting in less overall reduction relative to the smaller ROI approach outlined above.

Specific binding ratios are usually described as ipsilateral and contralateral caudate and putamen with reference to the side of the patient’s predominant symptoms. In addition, SBRs need to be age adjusted for proper assessment of cut-off values for abnormal DAT signal reduction.

Required characteristics of resulting data:

The specific trial protocol shall prospectively define the SBR parameter that is required for the striatum and the caudate and putamen, specifically. Some studies may also compare different metrics (e.g., right to left asymmetry indices or caudate to putamen ratio) and will require recording multiple parameters. SBR measures (and the analysis tools used to obtain them, including software version) shall be used consistently across all subjects and across all sequential SBR measurements.

SBR’s are intended as a measure of relative uptake and in that sense, can be regarded as dimensionless (unitless).

It should be clear which values belong to which structures (e.g., the whole striatum, left – right caudate, left – right putamen). This can be done by capturing DICOM coordinates along with the SBR or secondary screen captures of the ROI for identification. It should be reported what background region was used for normalization (e.g., occipital cortex or cerebellum).

The analysis software should generate a report which indicates regional striatal SBR values corrected for age. This may be achieved by applying a correction based on a linear regression line determined from my cross-sectional study of healthy controls over an appropriate age span. Some programs report out an age expected percent uptake for different regions. Normative DAT databases are you available via the European Association of nuclear medicine (EANM) or the Parkinson’s progression marker initiative (PPMI) hello different acquisition parameters and region of interest sampling strategy influence SBR.

### 3.10.2 Specification

| **Parameter** | **Actor** | **Requirement** |
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| Specific Binding Ratio | Image Analyst | Analysis Workstation  Shall have a suitable monitor of appropriate size and pixel density for diagnostic viewing of medical images. Shall be placed in a room with in room lighting appropriate for image data analysis and interpretation (i.e., a radiology reading room). Shall have appropriate computation power and memory to carryout ROI or VOI data analysis. |
|  | Post processed image for data analysis  Image for data analysis shall be reconstructed in accordance with parameters as described in Section 3.7. If needed image is spatially normalized. The transaxial slice with the highest striatal uptake is identified and the 8 hottest striatal slices around it are averaged to generate a single slice image |
|  |  | ROI software analysis tools  Using analysis workstation tools, regions of interest are placed on the left and right caudate, the left and right putamen, and the occipital cortex (reference tissue). Count densities for each region are extracted to calculate SBRs for each of the striatal regions and for the striatum as a whole. Need to decide if ROIs are drawn by hand or automatically. Also need to decide if image based partial volume correction will be used. Finally, do we make a statement about if MRI is available it can be used for striatum (i.e., caudate and putamen) definition. |
|  |  | Age matched normal database is essential to interpret the quantitative outcome |