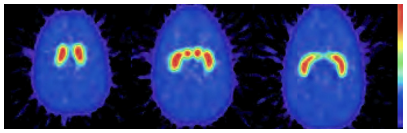
RSD
Radiology Support Devices, Inc.

# Striatal Phantom

## IMAGE QUALITY EVALUATION & ASSURANCE WITH QUANTIFICATION OF STRIATAL UPTAKE

The Striatal Phantom optimizes quantitative imaging in patients, using PET or SPECT. This phantom is based upon a standard RSD head with a calvarial cut to insert or remove the brain shell easily. The nasal cavity and maxillary sinuses are filled with foam with a mass density of 0.23 g/cc.

The brain shell has five compartments which can be filled separately: left and right nucleus caudate, left and right putamen, and the remainder of the brain. This allows different nucleus caudate to putamen ratios as well as different striatal to background ratios to be obtained; this also permits differences between left and right striatal activity to be examined. The volume of the brain shell is about 1,260 ml. The volumes of the nucleus caudate and putamen are 5.4 ml and 6.0 ml respectively.



Fillable External Markers: A set of fillable capsules is provided to serve as external markers. Capsules can be filled with a radioactive solution and attached to the external surface of the phantom. The phantom can then be imaged, using SPECT or PET modalities to compare image-registration techniques.

Quantification of striatal uptake is not straightforward because it depends on a number of factors including type of radionuclide used (Tc-99m, I-123 or F-18), imaging factors (such as collimator type, amount of scatter and attenuation), and image processing parameters (such as scatter and attenuation-correction techniques, type of reconstruction filter, slice thickness, region-of-interest size and its location).

In normal subjects, the putamen and head of the nucleus caudate are small structures with typical dimensions of 7-15 mm in the axial plane (that is comparable to the system resolution). Since partial volume effects are more important for objects with dimensions less than twice the system resolution, the selection of imaging and reconstruction parameters is critically important in calculating the striatal-to-occipital ratio used to measure the relative striatal uptake in the brain.

### Applications

Image quality evaluation

Image registration quality assurance

Quantification of striatal uptake

SUV calculation and validation

### Modalities

SPECT/PET

### Specifications

| Packing Size | Packing Weight |
|---|---|
| 36W x 36D x 36H cm | 5 kg |
| 14W x 14D x 14H in | 12 lb. |

### Model Numbers

| Model No. | Product Description |
|---|---|
| RS-900 | Head without Brain Shell |
| RS-900T | Head with Transparent Brain Shell containing Striatum |
| RS-901T | Transparent Brain Shell with Striatum |

**Publication References:** 1) Willowson K, Bailey D, Schembri G, Baldock C. CT-based quantitative SPECT for the radionuclide $^{201}$Tl: experimental validation and a standardized uptake value for brain tumour patients. Cancer Imaging. 2012;12(1):31-40. DOI: https://doi.org/10.1102/1470-7330.2012.0005. 2) Koch W, Radau PE, Münzing W, Tatsch K. Cross-camera comparison of SPECT measurements of a 3-D anthropomorphic basal ganglia phantom. Eur J Nucl Med Mol Imaging. 2006 Apr;33(4):495-502. DOI: https://doi.org/10.1007/s00259-005-0036-8. Epub 2006 Jan 25. PMID: 16435116.

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# RSD Materials

Soft Tissues: There are unlimited, small variations in density and absorption throughout the human body. Phantom soft tissue is closely controlled to have the average density of these tissues.

Skeletons: RSD skeletons are highly detailed polymer moldings which reproduce the shape, mass density and attenuation coefficients of cortical bone and spongiosa. RSD's proprietary moldings allow for continuous production, eliminate the restrictions of human skeleton bones (including limited availability, unethical collection of human bone specimen, variable size, and uncertain chemical composition), and avoid the loss of marrows in dried natural skeletons thereby making RSD skeletons superior to "real bone."

Molds: Molds for the RSD cortical bone and spongiosa were made from human skeletons consistent with the sizes of the soft tissue molds.

ICRU 44: RSD skeletons conform closely to the standards established by the International Commission on Radiation Units and Measurements (ICRU Report No. 44); mass density is reduced slightly to take into account a small decrease in calcium content for older patients.

## LINEAR ATTENUATION DATA

1. Monte Carlo simulation was used to calculate linear attenuation coefficients as a function of beam.
2. Monte Carlo results were validated with linear attenuation coefficients derived from Hounsfield Unit measurements at discreet energy levels.
3. RSD Phantom material linear attenuation data was compared to NIST data using ICRU Report 44 compositions of human tissues.
4. NIST data was interpolated when necessary.

| MATERIALS | DENSITY (g/cc) |
|---|---|
| RSD Soft Tissue (Opaque) | 1.08 |
| RSD Soft Tissue (Transparent) | 1.10 |
| RSD Cortical Bone | **1.83** |
| RSD Trabecular Bone | **1.17** |

| RSD SOFT TISSUE | | | | | |
|---|---|---|---|---|---|
| Energy (MeV) | Mean (HU) | Calculated (M) | μ (ICRU 44) | % Difference | Ratio |
| 00.08 | 60.30 | 0.1948 | 0.1932 | 0.0080 | 0.9921 |
| 00.10 | 52.88 | 0.1797 | 0.1795 | 0.0015 | 0.9985 |
| 00.12 | 57.10 | 0.1717 | 0.1709 | 0.0044 | 0.9956 |
| 00.14 | 52.95 | 0.1623 | 0.1624 | 0.0007 | 1.0007 |
| 00.20 | -- | 0.1477 | 0.1439 | 0.0261 | 0.9746 |
| 00.30 | -- | 0.1245 | 0.1246 | 0.0004 | 1.0004 |
| 00.60 | -- | 0.0950 | 0.0941 | 0.0101 | 0.9900 |
| 00.80 | -- | 0.0825 | 0.0826 | 0.0013 | 1.0013 |
| 01.00 | -- | 0.0744 | 0.0743 | 0.0018 | 0.9982 |
| 02.00 | -- | 0.0520 | 0.0519 | 0.0018 | 0.9982 |
| 03.00 | -- | 0.0351 | 0.0357 | 0.0171 | 1.0174 |
| 06.00 | -- | 0.0288 | 0.0291 | 0.0088 | 1.0088 |
| 08.00 | -- | 0.0252 | 0.0255 | 0.0098 | 1.0099 |
| 10.00 | -- | 0.0229 | 0.0232 | 0.0149 | 1.0151 |
| 15.00 | -- | 0.0203 | 0.0203 | 0.0015 | 0.9985 |
| 20.00 | -- | 0.0189 | 0.0189 | 0.0017 | 1.0017 |

| RSD CORTICAL BONE | | | | | |
|---|---|---|---|---|---|
| Energy (MeV) | Mean (HU) | Calculated (M) | μ (ICRU 44) | % Difference | Ratio |
| 00.08 | 1365 | 0.4345 | 0.4280 | 0.0151 | 0.9851 |
| 00.10 | 1048 | 0.3496 | 0.3562 | 0.0184 | 1.0188 |
| 00.12 | 0977 | 0.3211 | 0.3274 | 0.0191 | 1.0195 |
| 00.14 | 0902 | 0.2932 | 0.2986 | 0.0180 | 1.0184 |
| 00.20 | -- | 0.2511 | 0.2513 | 0.0009 | 1.0009 |
| 00.30 | -- | 0.2155 | 0.2137 | 0.0084 | 0.9916 |
| 00.60 | -- | 0.1596 | 0.1598 | 0.0011 | 1.0011 |
| 00.80 | -- | 0.1403 | 0.1402 | 0.0010 | 0.9990 |
| 01.00 | -- | 0.1274 | 0.1261 | 0.0106 | 0.9895 |
| 02.00 | -- | 0.0883 | 0.0885 | 0.0017 | 1.0017 |
| 03.00 | -- | 0.0611 | 0.0625 | 0.0229 | 1.0235 |
| 06.00 | -- | 0.0512 | 0.0525 | 0.0246 | 1.0253 |
| 08.00 | -- | 0.0468 | 0.0474 | 0.0120 | 1.0121 |
| 10.00 | -- | 0.0446 | 0.0444 | 0.0039 | 0.9962 |
| 15.00 | -- | 0.0410 | 0.0409 | 0.0016 | 0.9984 |
| 20.00 | -- | 0.0393 | 0.0397 | 0.0102 | 1.0103 |

| RSD TRABECULAR BONE (SPONGIOSA) | | | | | |
|---|---|---|---|---|---|
| Energy (MeV) | Mean (HU) | Calculated (M) | μ (ICRU 44) | % Difference | Ratio |
| 00.08 | 551 | 0.2849 | -- | -- | -- |
| 00.10 | 515 | 0.2586 | -- | -- | -- |
| 00.12 | 439 | 0.2337 | -- | -- | -- |
| 00.14 | 318 | 0.1541 | -- | -- | -- |