# EFFECT OF ATTENUATION CORRECTION ON REGIONAL CEREBRAL BLOOD FLOW DISTRIBUTION IN NORMAL SUBJECTS AT REST.

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VII. Asia and oceania congress of Nuclear Medicine and Biology
&
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# INTRODUCTION

Brain volume standardisation techniques are nowadays often implemented to improve the diagnostic accuracy.

They require a data base of control cases to be matched to pathological studies.

Hence the assessment of the rCBF distribution in control subjects is of utmost importance.

Evaluation was made with (A) as well as without (NA) uniform Chang attenuation correction.

This was made in order to explore the impact of attenuation correction on rCBF distribution.

Principal component analysis (PCA) was used in order to reduce the number of analysed variables.

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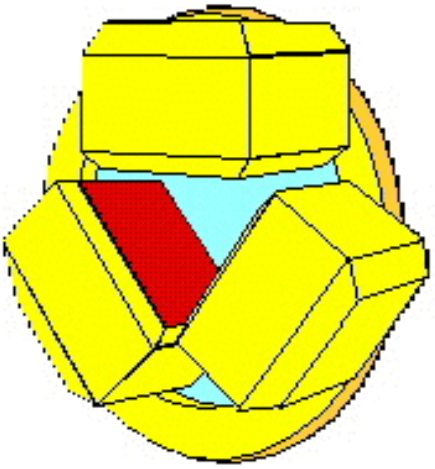
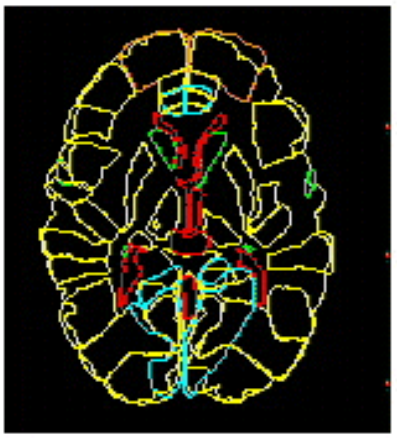


# 3D STANDARDISATION SOFTWARE

# CBA



# SUBJECTS

50 healthy subjects (31 to 78 yrs).

Recruited among spouses and friends to stroke patients.

Examinations performed:

- Medical interview
- **Neurological rating scales**
  - NIH Scale
  - Scandinavian Stroke Scale
- Routine Blood Samples
- Psychiatric evaluation

Exclusion criteria:

- Previous brain trauma
- Cerebro-vascular disorder
- **Hypertension**
- Diabetes
- Epilepsy
- Alcohol/drug abuse
- Psychiatric disorders

## FACTORIAL GROUPING WITHOUT ATTENUATION CORRECTION

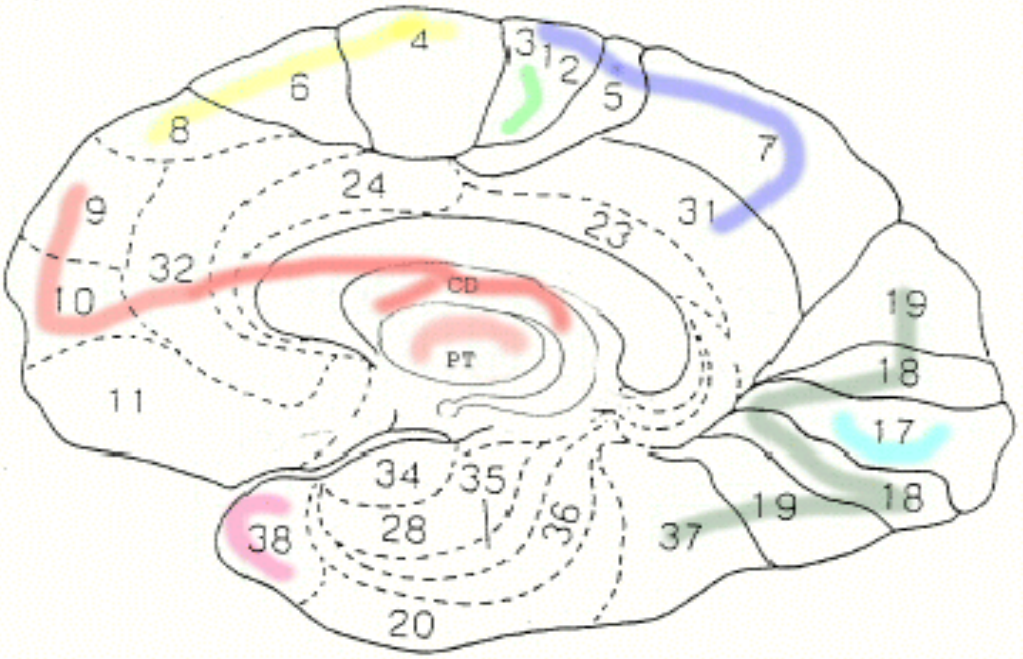
| Factor (FNA) | Neuro-functional description (cortex) | VOIs (Brodmann) | mean | sd | Regression: Factor * Age (p=) |
|---|---|---|---|---|---|
| 1 | ASSOCIATIVE PARIETAL | 39R 39L 40R 40L | 43.1 | 1.6 | 0.020 |
| 2 | FRONTAL & CAUDATUS | 09R 09L 10R 10L 32R 46R CDR CDL | 43.8 | 1.2 | |
| 3 | PARIETAL | 05R 05L 07R 07L 31R 31L SER | 46.8 | 1.5 | |
| 4 | CENTRAL STRUCTURES | PTR PTL THR THL | 44.7 | 1.5 | 0.021 |
| 5 | TEMPORAL | 21L 38R 38L | 37.1 | 1.9 | |
| 6 | RIGHT OCCIPITAL | 18R 19R 46L HPR | 41.4 | 1.5 | |
| 7 | PRIMARY VISUAL | 17R 17L | 49.7 | 2.0 | |
| 8 | TEMPORAL | AUDR AUDL 21R | 45.1 | 1.5 | |
| 9 | MEDIAL FRONTAL | 44R 44L 45L SEL | 44.0 | 1.5 | 0.000 |
| 10 | LEFT OCCIPITAL | 18L 19L 37L | 42.7 | 1.4 | |
| 11 | POSTERIOR FRONTAL | 04R 04L 06R 06L 08R 08L | 43.7 | 1.2 | |

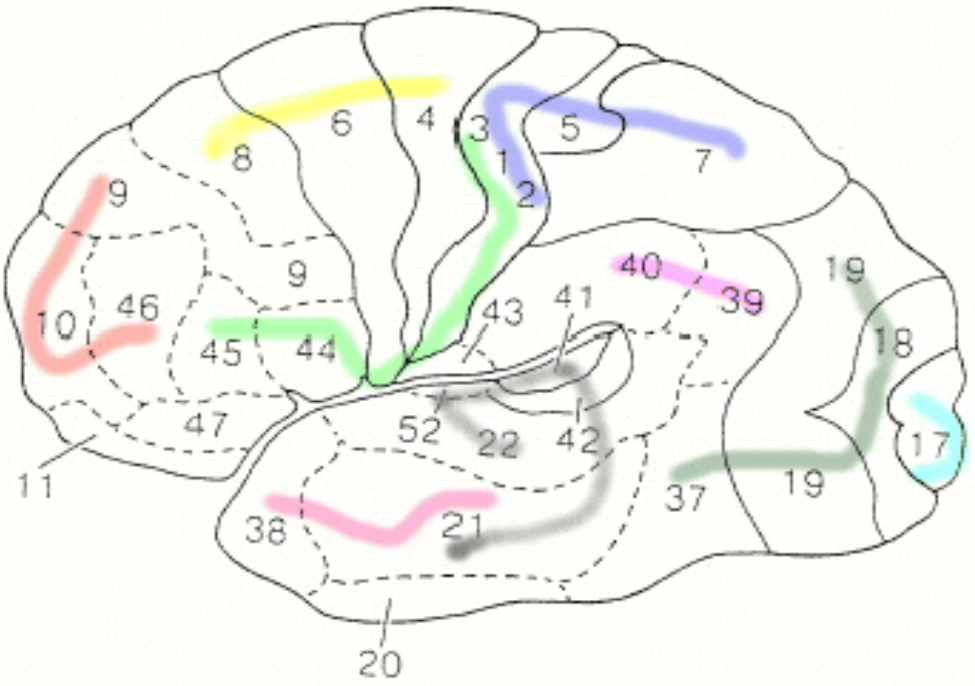
**R=right, L=left**

## VOIs IN WHICH LEFT AND RIGHT SIDE ARE GROUPED IN THE SAME FACTOR (WITHOUT ATTENUATION)

| VOIs (Brodmann) | HEMISPHERE & FNA | |
|---|---|---|
| | R | L |
| AUD | 8 | 8 |
| 04 | 11 | 11 |
| 05 | 3 | 3 |
| 06 | 11 | 11 |
| 07 | 3 | 3 |
| 08 | 11 | 11 |
| 09 | 2 | 2 |
| 10 | 2 | 2 |
| 17 | 7 | 7 |
| 31 | 3 | 3 |
| 38 | 5 | 5 |
| 39 | 1 | 1 |
| 40 | 1 | 1 |
| 44 | 9 | 9 |
| CD | 2 | 2 |
| PT | 4 | 4 |
| TH | 4 | 4 |

# FACTORIAL GROUPING IN NON-ATTENUATED CORRECTED DATA



## FACTORIAL GROUPING WITH ATTENUATION CORRECTION

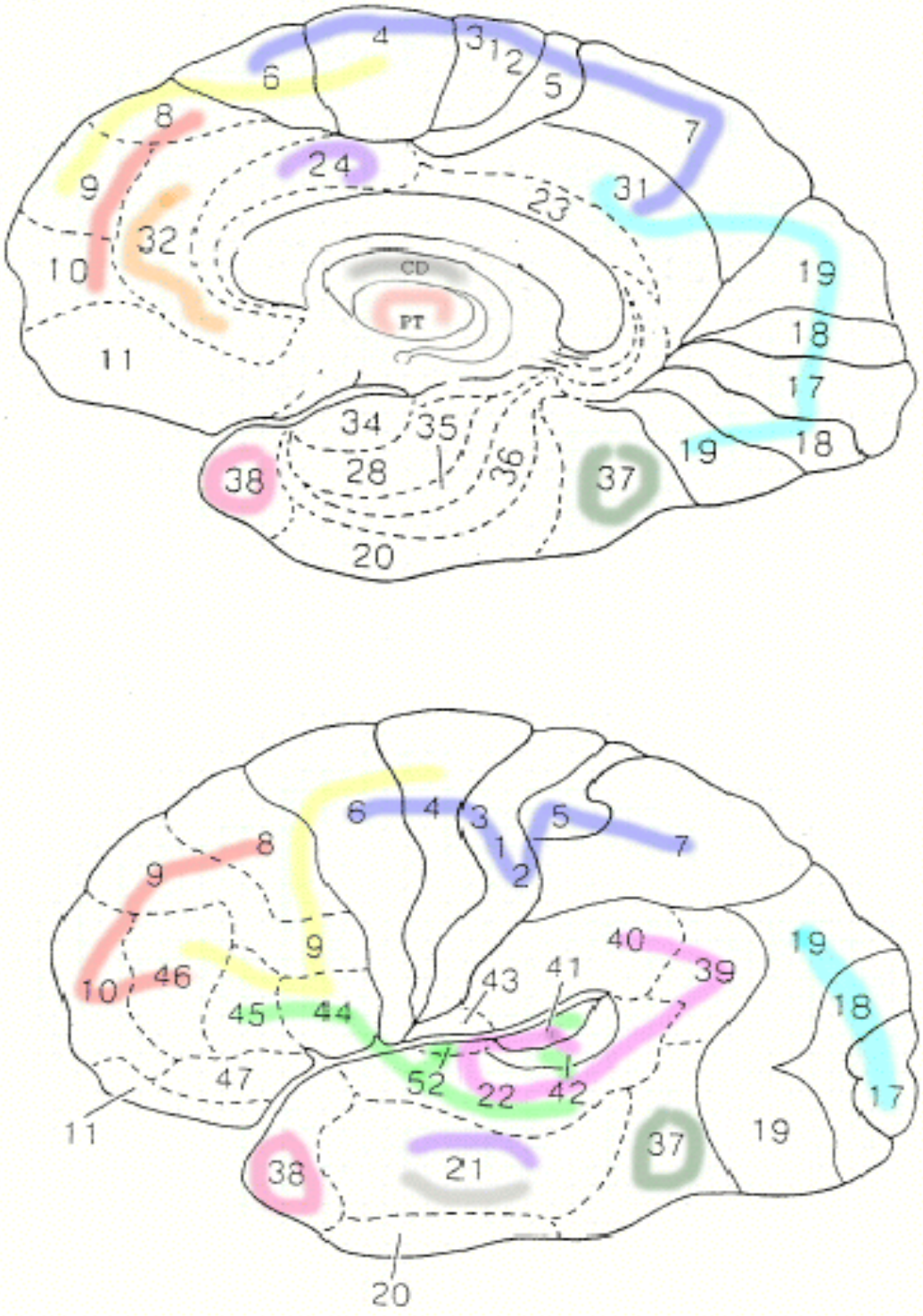
| Factor (FA) | Neuro-functional description (cortex) | VOIs (Brodmann) | mean | sd | Regression: Factor * Age (p=) |
|---|---|---|---|---|---|
| 1 | BRAIN VERTEX | 04L 05R 05L 06L 07R 07L 31L SER SEL | 46.0 | 1.3 | 0.048 |
| 2 | LEFT FRONTAL | 08L 09L 10L 46L | 44.3 | 1.2 | |
| 3 | RIGHT ASSOCIATIVE PARIETAL | AUDR 39R 40R | 42.7 | 1.1 | |
| 4 | LEFT FRONTO-TEMPORAL | AUDL 44L 45L HPL | 43.5 | 1.4 | 0.012 |
| 5 | OCCIPITAL | 17R 17L 18R 18L 19L 31R | 44.7 | 1.5 | |
| 6 | RIGHT FRONTAL | 04R 06R 08R 09R 44R 45R 46R | 45.3 | 1.1 | |
| 7 | CENTRAL STRUCTURES | PTR PTL THR THL | 49.7 | 1.5 | 0.001 |
| 8 | TEMPORO-CINGULATE | 21R 24R 24L | 41.7 | 1.5 | 0.003 |
| 9 | ANTERIOR TEMPORAL | 38R 38L | 37.5 | 1.7 | |
| 10 | CAUDATUS | 21L CDR CDL | 41.3 | 1.4 | |
| 11 | POSTERIOR TEMPORAL | 37R 37L | 42.5 | 1.7 | |
| 12 | ANTERIOR CINGULATE | 32R 32L | 48.8 | 1.3 | |

R=right, L=left

## VOIs IN WHICH LEFT AND RIGHT SIDE ARE GROUPED IN THE SAME FACTOR (WITH ATTENUATION)

| VOIs | HEMISPHERE & FA() | |
|---|---|---|
| | R | L |
| 05 | 1 | 1 |
| 7 | 1 | 1 |
| 17 | 5 | 5 |
| 18 | 5 | 5 |
| 24 | 8 | 8 |
| 32 | 12 | 12 |
| 37 | 11 | 11 |
| 38 | 9 | 9 |
| SE | 1 | 1 |
| CD | 10 | 10 |
| PT | 7 | 7 |
| TH | 7 | 7 |

# FACTORIAL GROUPING IN ATTENUATED CORRECTED DATA



**SIGNIFICANT CORRELATIONS BETWEEN FACTORS OBTAINED WITH ATTENUATED AND NOT-ATTENUATED rCBF DATA (p<.01)**

| Factor | FNA 1 | FNA 2 | FNA 3 | FNA 4 | FNA 5 | FNA 6 | FNA 7 | FNA 8 | FNA 9 | FNA 10 | FNA 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FA1 | | | 0.50 | | | | | | | | |
| FA2 | | 0.47 | | | | | | | | | |
| FA3 | 0.58 | | | | | | | | | | |
| FA4 | | | | | | | | | 0.45 | | |
| FA5 | | | | | | | 0.75 | | | | |
| FA6 | | | | | | | | | | | 0.56 |
| FA7 | | | | 0.61 | | | | | | | |
| FA8 | | | | | | | | | | | |
| FA9 | | | | | 0.65 | | | | | | |
| FA10 | | | | | | | | | | | |
| FA11 | | | | | | | | | | 0.55 | |
| FA12 | | | | | | | | | | | |

**rCBF DIFFERENCES BETWEEN AD PATIENTS AND CONTROLS USING THE FACTORIAL GROUPING OBTAINED WITH ATTENUATED DATA**

| FACTORS | AD n=17 | | CONTROL n=19 | | F(1,34)= | p= |
|---|---|---|---|---|---|---|
| | Mean | sd | Mean | sd | | |
| FA1 | 44.2 | 1.6 | 45.9 | 1.6 | 9.13 | 0.005 |
| FA2 | 43.9 | 2.1 | 44.5 | 1.6 | | |
| FA3 | 38.9 | 2.9 | 43.9 | 1.1 | 48.96 | 0.000 |
| FA4 | 39.5 | 2.6 | 43.1 | 1.1 | 28.99 | 0.000 |
| FA5 | 43.6 | 2.2 | 44.4 | 1.4 | | |
| FA6 | 45.0 | 1.6 | 45.4 | 1.1 | | |
| FA7 | 49.7 | 2.5 | 50.1 | 1.4 | | |
| FA8 | 36.3 | 2.9 | 40.8 | 1.5 | 35.48 | 0.000 |
| FA9 | 32.9 | 2.4 | 37.3 | 2.0 | 34.94 | 0.000 |
| FA10 | 36.1 | 3.5 | 40.5 | 1.7 | 24.07 | 0.000 |
| FA11 | 40.3 | 2.2 | 42.7 | 1.6 | 14.53 | 0.001 |
| FA12 | 48.5 | 2.3 | 48.9 | 1.5 | | |
| ALL | | | | | 50.94 | 0.000 |

## CONCLUSIONS

Brodmann areas and central structures were grouped by PCA in functionally correlated clusters in both A and NA.

A good correlation was found between factorial groups sharing similar neuro-functional paths in A and NA.

Chang uniform attenuation correction modified the factorial grouping between A and NA.
One factor that might account for this discrepancy is the manual positioning of the body outline markers.

The implementation of such factorial grouping in a control group/Alzheimer Disease patients comparison confirmed rCBF alterations in temporo-parietal cortex and validated the study.

**ABSTRACT FORM**

# VII. ASIA AND OCEANIA CONGRESS OF NUCLEAR MEDICINE AND BIOLOGY

&

# IV. INTERNATIONAL CONGRESS OF NUCLEAR ONCOLOGY

01 - 05 October 2000
Istanbul / TURKEY

**Please return your abstract to:**

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**ABSTRACT FORM**
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AUTHORS: M. PAGANI, D. SALMASO, C. JONSSON, R. HATHERLEY, H. JACOBSSON, S.A. LARSSON AND A. WAGNER.

HOSPITAL/ INSTITUTION: Section for Nuclear Medicine, Dept. of Hospital Physics, Dept. of Diagnostic Radiology, Dept. of Neurology, Karolinska Hospital, Stockholm, Sweden; Inst. of Experimental Medicine, Inst. of Psychology, CNR, Rome, Italy.

TITLE:

EFFECT OF ATTENUATION CORRECTION ON REGIONAL CEREBRAL BLOOD FLOW DISTRIBUTION IN NORMAL SUBJECTS AT REST.

Purpose. A database of control cases is nowadays often implemented in the analysis of brain pathologies. Hence, the assessment of regional cerebral blood flow (rCBF) distribution in control subjects at rest is of utmost importance.

Subjects and methods. We have investigated rCBF in 50 normal subject with ages ranging from 31 to 78 years. 1000 MBq of 99m-Tc-HMPAO was administered to each subject and SPECT was performed by a three-headed gamma camera. Data were analysed by a Computerised Brain Atlas able to standardise brain anatomy in the 3D space. The uptake in 23 cortical volumes of interest (VOIs) as well as in central structures and hippocampus on both sides, was analysed before (NA) and after (A) applying Chang attenuation correction. Principal component analysis (PCA) was used in order to reduce the number of analysed variables. This will help in clarifying rCBF changes in both pathology and normal physiology.

Results. In the NA analysis, VOIs with high anatomo-functional correlation were grouped by PCA in 11 not-correlated factors. This explained the 80% of the general variance of the data. In the NA analysis, the left and right sides were grouped in the same factor in 17/27 VOIs. In the A analysis this was true for 12/27 VOIs and PCA grouped the VOIs in 12 factors explaining the 81% of the variance. Nine NA and A factors grouping VOIs with similar anatomo-functional characteristics were significantly correlated. Factors including VOIs from parietal association cortex, central structures and Broca areas in NA and brain vertex, fronto-temporal cortex, central structures and anterior cingulate cortex in A showed significant age correlated changes.

Conclusions. A good rCBF correlation was found between cortical and central VOIs sharing similar anatomo-functional trait. Chang attenuation correction slightly modified the factorial grouping between NA and A. One factor that might account for this discrepancy is the manual positioning of the body outline markers. The implementation of such factorial grouping in neurodegenerative disorders evaluation is analysed.

# NÜKLEER TIP

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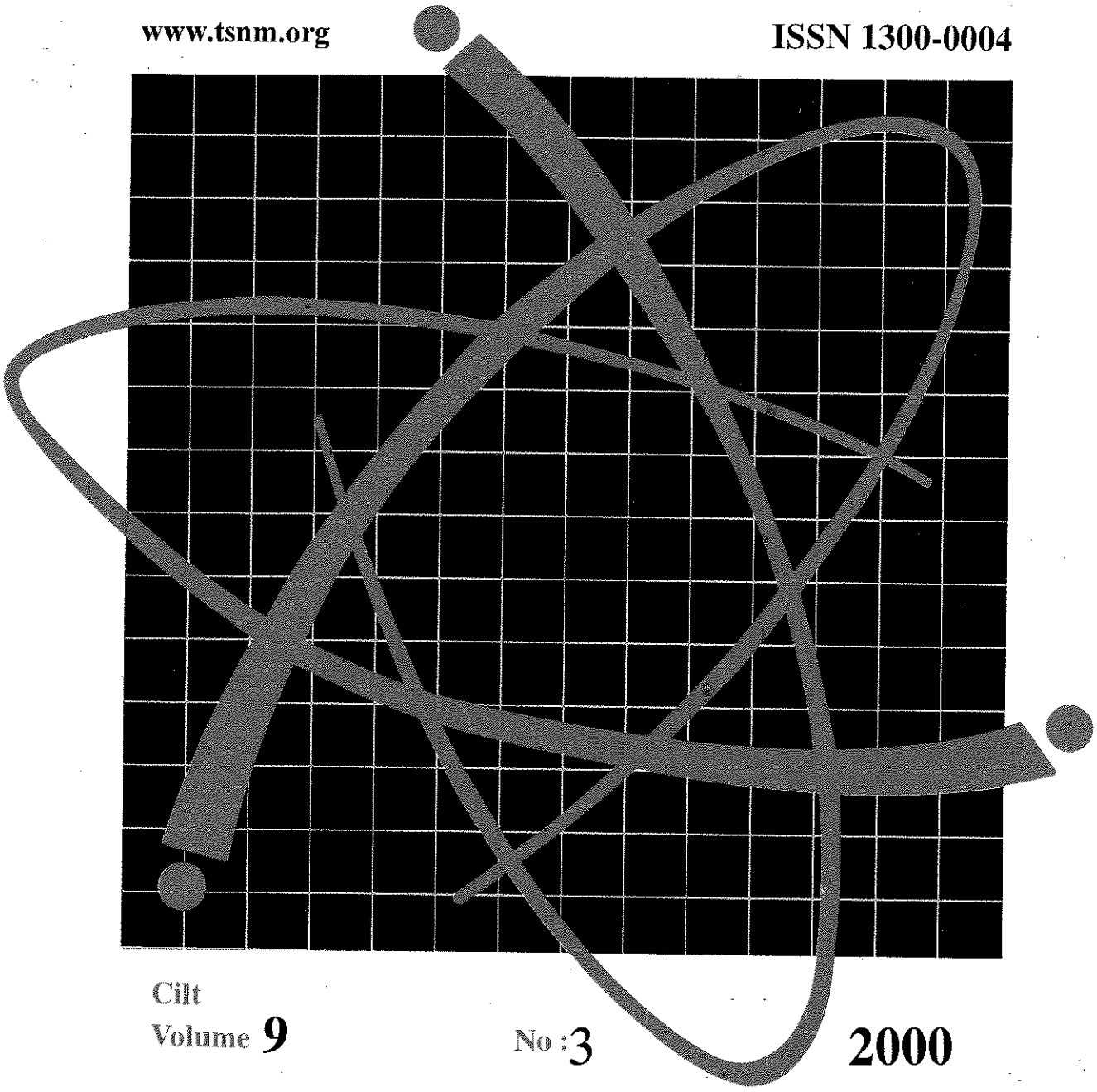

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POSTER-223

## EFFECT OF ATTENUATION CORRECTION ON REGIONAL CEREBRAL BLOOD FLOW DISTRIBUTION IN NORMAL SUBJECTS AT REST.

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Section for Nuclear Medicine, Dept. of Hospital Physics, Dept. of Diagnostic Radiology, Dept. of Neurology, Karolinska Hospital, Stockholm, Sweden; Inst. of Experimental Medicine, Inst. of Psychology, CNR, Rome, Italy.

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POSTER-225

## TC-99 HMPAO SPECT STUDY OF REGIONAL CEREBRAL BLOOD FLOW IN RISPERIDONE-TREATED SCHIZOPHRENIC PATIENTS

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It has been known that reduced regional cerebral blood flow (rCBF) observed in schizophrenic patients is not changed by conventional antipsyhotics. There has been no definite data of risperidone, a novel antipsychotic, and effects on brain perfusion patterns in schizophrenic patients. The objective of this study was to evaluate rCBF by risperidone treatment in relation to CBF and clinical correlates of schizophrenia, particularly positive and negative components of the symptoms.

Eleven patients (24.77±7.65 years) who fully met DSM-IV criteria for schizophrenia were included in the study. Control group consisted of 14 age (25.56±8.76 years) and sex matched healthy volunteers. The drug-washout period was 2 week prior to the risperidone treatment in a dose of 6 mg/day. Patients' symptoms were assessed by BPRS (Brief Psychiatric Rating Scale) on the day of the first SPECT examination while they were drug-free, and this protocol repeated after 6-week risperidone treatment. The SPECT imaging was performed after 20 minutes following the injection of 550 MBq Tc-99m HMPAO. For the semiquantative analysis of the data, rectangular region of interest (ROI) drawn over upper and lower frontal, temporal, parietal and occipital regions were used to obtain activity ratios, taking cerebellum as reference. Mean cortical/ cerebellar ratios (C/c) calculated for each ROI in patient and control groups. The SPECT imaging data were evaluated by semiquantitative analysis.

We found bilateral frontal, parietal and temporal hypoperfusion in drug-free schizophrenic patients compared to the controls. After 6-weeks of risperidone treatment, the perfusion values were significantly increased compared to the drug-free values and normalised in left low frontal, parietal, temporal cortical regions ($F=3.82$, $F=1.23$, $F=1.45$, $p<0.05$ respectively).

Our results support that frontal and temporal cortical perfusion patterns of schizophrenic patients change with 6 week risperidone treatment, and this change associated with clinical improvement including both positive and negative symptoms, may represent a different brain activity pattern to be a response to risperidone.

POSTER-224

## COMPARISON OF CEREBRAL DISTRIBUTION BETWEEN Tc-99m HMPAO AND Tc-99m ECD IN NORMAL VOLUNTEERS: ANALYSIS OF SPECT IMAGES BY STATISTICAL PARAMETRIC MAPPING

H. Seto*, N. Watanabe*, K. Noguchi*, M. Kageyama*, M. Shimizu*, H.Kawabe*, S. Tonami**, S. Inagaki**
Department of Radiology and **Division of Central Radiological Services, Toyama Medical and Pharmaceutical University, Toyama, Japan

**Purpose:** Differences in cerebral distribution among neuroradiotracers have been observed in brain SPECT iamges. Development of Statistical Parametirical Mapping (SPM) will facilitate spatial normalization of PET or SPECT images to a standerdized stereotactic space for objective comparison. The aim of our study to examine the apparent differences in regional cerebral flow (rCBF) assessed by SPECT images using Statistical Parametric Mapping in normal volunteers who received the two radiotracers, Tc-99m D, L-hexamethylpropyene amine oxide (Tc-99m HMPAO) and Tc-99m ethylene-dicysteine diethylester (Tc-99m ECD).

**Materials and methods:** Eleven healthy volunteers aged 23-46yr (26.4±6.8yr) were enrolled in our study. Brain SPECT was performed using a three-head rotating gamma camera system (FWHM; 9mm). The subjects received the two radiotracers, Tc-99m HMPAO (740MBq) and Tc-99m ECD (740MBq) at a one-week interval. Subsequent analysis of these SPECT images were done using Statistical Parametric Mapping. Images were intensity-thresholded and spatially normalized to a standardized stereotactic space. This allowed for the objective analysis of these data, demonstrating the extent and magnitude of rCBF changes.

**Result:** Our results revealed significant changes of cerebral distribution between Tc-99m HMPAO and Tc-99m ECD in normal volunteers, probably due to the differences in pharmacokinetics between the two radiotracers. The large areas of the parietal, occital and superior temporal cortices were significantly higher in the Tc-99m ECD SPECT than in the Tc-99m HMPAO SPECT ($p<0.001$ ), and the small area of the brain stem were significantly higher in the Tc-99m HMPAO SPECT than in the Tc-99m ECD SPECT ($p<0.001$).

**Conclusion:** Our study present a method of image analysis to assess rCBF and the apparent differences between Tc-99m HMPAO and Tc-99m ECD in brain SPECT images using Statistical Parametric Mapping, that will helps us to evaluate brain SPECT images with Tc-99m HMPAO and Tc-99m ECD.

POSTER-226

## A NEW METHOD OF PARTIAL VOLUME EFFECT CORRECTION ON RATE CONSTANT ESTIMATION IN COMPARTMENT MODEL ANALYSIS OF DYNAMIC PET STUDY

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**Purpose:** Rate constants in a ROI estimated by a compartment model analysis for dynamic PET study are affected by the fractional tissue component (FTC), which depends on both the spatial resolution and the size of the ROI. We have studied the relationship among the estimates of rate constants, spatial resolution and ROI size in order to develop a partial volume effect (PVE) correction method on rate constant estimation.

**Materials and Method:** A brain phantom and 3 segmented tissue phantoms (STPs) (gray matter, white matter and striatum) with various spatial resolution were made. The activity in each tissue was generated with a 3-parameter model for $^{18}$F-FDG kinetics. At first, The relationship between the Recovery Coefficient (RC) and estimates of rate constants in the ROI without tissue mixture were evaluated by using a STP with various resolution. Next, the FTCs were calculated for all ROIs by using STPs with various resolution. The rate constants (K1, k2, k3, CMRGlc) were estimated by Modified Marquardt method. The values of estimates vs. FTC were plotted and the regression line was drawn. The values at 100% of FTC were estimated by extrapolation of the regression line. We have applied this method to 3 normal subjects and FTC in the ROI was calculated from the segmented MR images with same resolution as PET.

**Results:** In a STP, the estimates of K1 and CMRGlc decreased according to the RC, but k2 and k3 kept to be constant value without spillover the surrounding tissues. In the noise free simulation data, the all estimates correlated with FTC ($r>0.99$) and became close to true value as FTC became 100%. In the noise added data, the true values for K1 and CMRGlc were estimated by extrapolation of the regression line determined from the estimates for large ROIs with less noise. In the clinical data, the estimates of K1 and CMRGlc correlated with the FTC ($r>0.90$) and the values at 100% of FTC could be estimated.

**Conclusion:** The values of estimates without tissue mixture due to PVE could be predicted from the regression line. This study suggests that the effect of tissue mixture due to PVE on the rate constant estimation may be corrected for by using various sizes of ROIs and their FTC obtained from MRI.