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POSTER PRESENTATIONS

P01 — Sunday, October 16, 2011, 16:00 — 16:30, NIA Exhibition Area

Physics & Instrumentation & Data Analysis: Instrumentation

P001

Comparison of three techniques for calculating the 20% count rate loss in a gamma probe for sentinel node biopsy surgery

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AimTo compare two standard methods (“decaying source” and “two-source” methods) for measuring count rate performance in gamma probes with a new method (“distance method”), and to evaluate the tests for their suitability as part of routine QA procedures.IntroductionCharacterisation of the count rate capability due to dead time is a component of gamma probe QA. Dead time reduces the recorded counts and QA measurements must be taken on the linear response range. NEMA recommends the decay method for gamma probes (1), whilst the two source method is a standard technique for nuclear instrumentation (2). No method is ideal. The decaying source method requires measurements over a long time interval, whilst the two-source method requires the count rate loss value to be roughly known, and it is an indirect measurement. The proposed distance method has the potential to be rapid and to be workable direct measurement with little a priori knowledge required.MethodThe 20% count rate loss count rate (R_{20}) of a Europrobe gamma probe was estimated using the standard decaying source and two-source methods. The new distance method was applied using a “hot” source and a “cool” source and changing the count rate by varying the source-probe distance. The two responses were compared using the cold source count rate as a reference to obtain the R_{20} value.ResultsThe 20% count rate drop R_{20} was calculated to be at 3,937 cps (decay method), 3,500 cps (two-source method), 3,991 (distance method). The decay method duration was about 12 hours, whilst the two-source and distance methods took about an hour to prepare sources and record measurements, and both need a jig and/or water bath.ConclusionsGood agreement was observed between the decay method and the proposed distance method. This may be a practical, shorter-time alternative to the established decay method and further comparisons are being undertaken into reproducibility between probes and operator variability.References1. NEMA standards publication NU3-2004 “Performance measurements and quality control guidelines for non-imaging intraoperative gamma probes,” 20042. Adams et al., “Deadtime measurements in scintillation cameras under scatter conditions simulating quantitative nuclear cardiography,” J Nucl Med 19: 538-544, 1978

P002

Design and Construction of Shielding Sleeves to Test Radionuclide Calibrator Linearity for Clinical Use

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AimTo investigate and design multi-element shielding sleeves to use as an alternative to the decaying source method of performing linearity measurements for radionuclide calibrators. This will allow linearity QC to be performed in a matter of minutes by replicating the natural decay of the source over a few days.Materials and MethodsA design was created by using a line source model to calculate the range of multi-element thicknesses needed to shield a Tc-99m source to produce a range of measurements across the entire range of clinically assayed activities. The sleeve design was chosen to ensure consistent geometry between measurements and various designs of sleeves were analysed to assess the range of measurements that could be performed and the practicality (weight, cost, etc) in performing the measurements. We investigated the attenuation properties of various materials when considering the final design.As part of the initial analysis, existing lead pots were used to determine the constancy in assays of a Tc-99m source through lead.ResultsThe range of Tc-99m activities used in the design of the sleeves was 10 - 6000 MBq to match the clinical range assayed. A sleeve set was designed such that combinations of sleeves could be placed within each other to produce 12 measurements with 4 sleeves, minimising the overall time of measurements and the manufacturing costs. The initial measurements through existing lead pots showed that there was consistency in the method of measurement with a standard deviation of 2.6% in the calculated equivalent decay time.ConclusionUsing the initial findings, a final design using alternative materials and manufacturing methods will be considered. A test design will be produced to measure the difference between expected and measured attenuation, considering scatter contribution, to produce a more accurate model with which to finalise the design of the sleeves.

P02 — Sunday, October 16, 2011, 16:00 — 16:30, , NIA Exhibition Area

Physics & Instrumentation & Data Analysis: Image Reconstruction

P003

Improvement of image quality using cross projection angle data in emission computed tomography

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Aim: General data acquisition for single photon emission computed tomography (SPECT) is performed in 90 or 60 direction using a gamma camera. On the other hand, positron emission tomography (PET) is measured from 128 to 256 directions, but cannot be changed as one chooses. The purpose of this study was to investigate a cross projection angle (CPA) method of emission computed tomography (ECT) by applying the cross plane in PET.Method: The CPA method was evaluated to a digital phantom (Shepp-Logan phantom) with attenuation and statistical noise and a Hoffman 3-D brain phantom. A PET scanner and a gamma camera, CTISiemens ECAT EXACT HR+ and GE Healthcare Millennium MG, were used to scan images of a Hoffman 3-D brain phantom. The projection data of CPA method was corrected for normalization. Attenuation and scatter corrections of SPECT image were performed using Chang's method and a modified triple energy window, respectively. Each correction (i.e. attenuation, scatter, deadtime, etc.) of PET image were used recommended for the scanner model. All ECT images were reconstructed by the filtered back-projection method with a ramp filter cut off at the Nyquist frequency. Quality of the reconstructed images was evaluated in terms of Normalized Mean Square Error (NMSE) values and a two dimensional power spectrum analysis.Results: NMSE values of PET and SPECT images using CPA method were very nearly zero. As for a two dimensional power spectrum analysis, PET and SPECT images quality using CPA method were approximately 1.8 times better than conventional method. Also, the spatial resolution of CPA method was not change compared with the conventional method.Conclusion: Our preliminary data suggest that effective improvement of image quality can be expected with cross projection angle. Also, the CPA method was considered clinical useful and a widely available simple method.

P004

The role of reconstruction algorithm and SPECT acquisition orbits in somatostatin receptors' detectability

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AimThe aim of this work was to evaluate the effects on the performance in somatostatin receptors' detectability due to both reconstruction algorithms and different acquisition orbits.Material and MethodsThe study was performed by the γ-camera SYMBIA-S(Siemens), simulating SPECT patients examinations using an anthropomorphic Alderson phantom with seven inserts of different volumes(0.4÷4 ml), to reproduce tumoral foci in thorax, liver, abdomen. Mediastinum, liver, abdomen and lesions were filled with ^{111}In water solution with different concentrations to simulate lesion-to-background ratios found in clinical SPECT studies. Acquisitions were performed by body-contour(BC) and circular(CO) orbits. Data were reconstructed by FBP and iterative algorithms implemented on e.soft-workstation:Osem-2D and Flash-3D^{TM}. Flash-3D^{TM} includes 3D-beam-collimation model. Iterative reconstructions were performed by 20 sub-sets and 5,10,15,20,30 iterations;the choice of sub-sets was previously optimized. Eleven sets of images were reconstructed for both OC and BC studies.Lesion detectability was assessed by contrast(C%) and signal-to-noise-ratio(SNR) therefore all the sets of images were analyzed: 1) to calculate C% and SNR for each lesion in the phantom acquired with circular orbit ($C\%L_{CO}$; SNR-L_{CO}) and body-contour($C\%L_{BC}$;SNR-L_{BC}); 2) to evaluate the paired t-test between correspondent values of $C\%L_{CO}$,$C\%L_{BC}$ and SNR-L_{BC} , SNR-L_{CO}.Results$C\%L_{CO}$($C\%L_{BC}$) evaluated on the images reconstructed with Flash-3D^{TM}, were significantly higher ($p<0.05$) than correspondent values $C\%L_{CO}$($C\%L_{BC}$) calculated with OSEM-2D and FBP, similarly for the $C\%L_{CO}$($C\%L_{BC}$) of OSEM-2D compared to correspondent values of FBP. For each reconstruction algorithm differences between $C\%L_{CO}$ and $C\%L_{BC}$ were not significant.The mean values of $C\%L_{CO}$ were for Flash-3D^{TM}, OSEM-2D and FBP respectively: 76,72,57 while for $C\%L_{BC}$ were respectively: 75,73,59.SNR-L_{BC}(SNR-L_{CO}) values for Flash-3D^{TM}were, both OC and BC, significantly lower ($p<0.05$) than correspondent values SNR-L_{BC}(SNR-L_{CO}) for OSEM-2D and FBP. The differences between SNR-L_{BC} and SNR-L_{CO} values were significant only for OSEM-2D.ConclusionsPerformance in lesion detectability are influenced mainly by the choice of reconstruction algorithm rather than by the kind of orbits used for SPECT. When assessed for Flash-3D^{TM} contrast was significantly higher, for both OC and BC, than OSEM-2D and FBP while the

disability scale score (EDSS) less than 6.5 (41 females and 27 males) and 114 control individuals (72 females and 42 males).Results: The amount of F%, L%, M% and BMD in the whole body, arms and trunk was not statistically different between MS patients (males and females) and controls, except in the lower extremities of female patients where there was increased F% and reduced L% compared to controls. There were no correlations between F%, L%, M%, or BMD at any anatomic region with EDSS or the cumulative corticosteroid dose.Conclusions: The reduced L% in the lower extremities of female patients may represent a risk for local osteoporosis and suggests that regular physical therapy may prevent this complication. In addition, brief steroid courses in ambulatory MS patients can be safely given during disease exacerbations.

P262

Regional brain metabolic glucose changes to diazepam and Progressive muscle relaxation according to Jacobson: a FDG-PET study

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Introduction: Orally administered Diazepam is commonly prescribed in standard PET-CT oncological studies to control patient anxiety. However, its usefulness and discretionary prescription is controversial. At present and according to Jacobson, drug-free methods have shown efficacy to induce relaxation and reduce anxiety in these patients, like progressive muscle relaxation (PR).The aim of our study was to evaluate the changes in cerebral metabolic glucose rate induced after the administration of an anxiolytic medication and after PR as compared to a control group.**Material and methods:** Seventy-seven oncological patients without neurodegenerative clinical disorders or metastatic brain lesions were included in this study; 30 patients were studied after sedative medication (Diazepam); 17 subjects were studied after PR. Another 30 patients scanned in resting conditions were also included as control group. All groups were age and gender matched.Brain PET scans were acquired in a Siemens tomograph (Biograph) in 3D mode, 30 minutes after 18F-FDG administration. Regional cerebral glucose metabolism was compared among groups with SPM8, after intensity normalizing the global 18F-FDG PET uptake to that of white matter (WM). A WM mask was created by thresholding the a-priori WM image provided with SPM8. Voxels having a WM probability over 95% were selected and images were multiplicatively scaled to render identical WM uptake values. Two Student's two-sample t-tests were conducted comparing the Diazepam and PR groups with respect the Control group. Statistical significance threshold was set to $p < 0.001$ uncorrected for multiple comparisons and no extent threshold was applied.**Results:**Compared to the control group, both Diazepam and PR induced similar, although not identical, significant decreases in cortical metabolic activity. Statistical significance of these hypometabolisms is shown in tables (1, 2). No statistically significant increases in 18F-FDG uptake were observed in either of the two groups.**Conclusion:**The pattern of changes in cerebral glucose metabolic rate induced after diazepam administration was very similar than that observed after PR. In conclusion, the relaxation states achieved after PR and the pharmacological intervention were very similar, thus pointing at PR as an effective, drug-free and non-invasive alternative for the control of anxiety in patients undergoing oncological PET-CT scanning.

P263

Interobserver Variability of FDG Brain PET in Clinical Routine: More Than You Think

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Introduction:More than 26 million people worldwide suffer from dementia. Early diagnosis is essential for adequate management, remains difficult and is based on a combination of clinical, biological and imaging tests. FDG PET has shown to improve diagnostic accuracy, in particular for the differential diagnosis between Alzheimer's disease (AD) and frontotemporal dementia (FTD), and is increasingly used for diagnosis and follow-up. Reproducibility when interpreting brain scans is very important. This study aims to evaluate the interobserver variability in clinical routine.Patients and Methods:We conducted a prospective monocentric study in 30 consecutive patients undergoing FDG brain PET. Patient files were reconstructed in a standardised manner: re-sliced along the bicommissural axis; the color scale was normalised with a maximum on the thalami and striata. Three independent observers interpreted the scans, first by looking at the same 24 slices (standardised technique), then by reconstructing the scan themselves with no constraint on re-slicing and color scale normalisation (individualised technique). Eleven cerebral areas were rated from 4 to 0 (4 normal FDG uptake, 0 no uptake). The observers also rated the scans normal or pathological. Kappa statistics were used to determine the degree of intra- and interobserver agreement. Weighted kappa is an index of agreement over and above that expected by chance. All statistical analysis was performed using Stata 11.0 software.Results:For the rating of cerebral areas there was fair agreement between observers with the individualised technique (Kappa=0.308) and moderate agreement with the standardised technique (Kappa=0.346). The areas with the least concordance were mesial frontal, anterior temporal and mesial temporal (Kappa=0.266, 0.280 and -0.163 respectively) with the individualised technique. For the classification in normal and pathological there was fair interobserver agreement with the standardised technique (Kappa=0.289) and moderate agreement with the individualised technique (0.550).Discussion:This study shows significant interobserver variability when reporting on FDG brain PET in a routine clinical setting. The least reproducible areas: mesial frontal, anterior temporal and mesial temporal are involved in neurodegenerative disorders such as AD and FTD. This finding is of critical importance and raises issues regarding the ability of FDG brain PET to be used as a diagnostic and follow-up tool, in particular in multicenter clinical trials. Centers performing FDG brain PET should be aware of this finding and pay particular attention to its consequences in patient management. Prospective trials should investigate whether diagnostic accuracy and interobserver concordance are improved with software-assisted interpretation.

P264

Voxel-Based Brain SPECT Control Data Base from Clinical Patient Data using Generalized Extreme Studentized Deviate Many-Outlier Procedure: Comparison with Subject-Based Normal Data Base from Normal Volunteers

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Objective: Generalized extreme studentized deviate many-outlier (ESD) procedure (Rosner B, Technometrics 25, 165, 1983), which is a noble method to detect potential outliers, could be used to generate voxel-based control database from clinical patient data for statistical brain SPECT analysis. The objective of this study was to demonstrate its validity in comparison with the multicenter normal database generated from normal volunteers. Method: The multicenter subject-based normal database (NDB) for I-123 IMP brain perfusion SPECT, which was generated from normal healthy volunteers (n=34, 61±8 y old , M/F=17/17) using the same gamma camera system and 3D-SSP co-registration software, was used for comparison. A voxel-based control data base (CDB) was generated from randomly selected age-matched patients (n=47, 63±7 y old, M/F=20/27) from one institution using the same data acquisition method as used for NDB and ESD procedure to eliminate outliers on a voxel-by-voxel basis. Between NDB and CBD, voxel mean and SD were compared, and number of voxels that had statistically different voxel mean and SD was counted and expressed as fraction (%) of the total voxel numbers (n=15964) in the standardized brain surface image. Results: Voxel mean and SD were close to each other between NDB (1.00±0.11 and 0.06±0.001) and CDB (1.00±0.12 and 0.08 ±0.021) . The fractions of the voxels that had statistically different ($P<0.05$ with BonFerroni multiple comparison correction) voxel mean and SD between NDB and CDB were3.1% and 1.2%. Mean differences between NDB and CDB were small enough in both voxel mean (0.026 ±0.024) and SD (0.022 ±0.013). There were significant correlations in voxel mean ($R=0.959$, $P<0.00001$) and SD ($R=0.248$, $P<0.0001$) between NDB and CDB, indicating similar spatial distributions of these values. Conclusion: Although voxel-based CDB was not completely the same as subject-based NDB, the difference between them was small enough. Generation of voxel-based control database with ESD procedure could be clinically feasible as a practical approach in statistical brain SPECT analysis.

P265

Comparison of FDG-PET, MRI and EEG findings and surgical outcome in operated lesional and non-lesional temporal lobe epilepsy

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Aim:To evaluate the diagnostic value of PET, EEG and MRI in patients with lesional and non lesional temporal lobe epilepsy(TLE) by comparing the findings with the operated side and surgical otcome.Materials&Methods:494 patients with intractable epilepsy were studied with PET between 2004-2010. Patients were evaluated retrospectively. 114 of these patients diagnosed with TLE underwent surgery. Sixteen of these had normal findings on MRI(non-lesional) and the rest had lesional TLE. All patients had video-EEG monitoring(ictal-interictal), MRI, PET and some of the patients had invasive EEG monitoring as part of a presurgical evaluation. The dominant hypometabolic area on PET and the side with the dominant discharges on EEG's were considered as the epileptogenic lobe. The

findings of PET and other modalities were compared to the operated temporal lobe for lobar concordance. Operated temporal lobe side was excepted as the gold standard for epileptogenic zone(EZ). Operated 82 patients out of 114 were followed up for 25.8±10.2months(5-47months) after surgery according to seizure outcome.Results:In the non-lesional TLE group, PET was able to correctly lateralize the EZ in all of 16 patients showing %100 concordance with the resection side. At follow-up after surgery (22.9±12.1months), seizure control was achieved in 13 patients (%81)(Engel I) and 3 patients has rare seizures(almost seizure free)(Engel II). There were no patients without improvement in seizure control (Engel III and IV). Ictal EEG also showed a %100 concordance, while interictal EEG was concordant with the EZ in %75 of the patients. In the lesional TLE group of 98 patients, PET showed %100 concordance with the operation side, while ictal EEG, interictal EEG and MRI showed %98, %89 and %97 concordance, respectively. Ictal EEG had bilateral temporal discharges on 2 patients, whose EEG findings could correctly lateralize the EZ only after invasive EEG monitoring. At follow-up(26.5±9.6 months), %89(59/66) of the patients were classified as Engel I. There were no patients in Engel III and IV class. Between two groups (lesional and nonlesional) there were no significant difference in the follow-up duration after surgery and the surgical outcome.Conclusion:It was found that lobar concordance of PET for both lesional and non-lesional TLE was %100. In the non-lesional TLE group %81 and in the lesional TLE group %89 of the patients were seizure free after surgery. There were no patients in both groups with poor outcome, which may show that PET may be a predictor of good surgical outcome.

P266

Superiority of Tc-99m ECD brain SPECT to Tc-99m HMPAO brain SPECT in localizing the infarction zone in the same brains with subacute stroke

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Background: We investigated diagnostic performance of Tc-99m ECD brain single-photon emission computed tomography (SPECT) and Tc-99m HMPAO brain SPECT to localizing the infarction zones in the same brains with subacute strokes.*Methods:* We examined 49 patients using brain SPECT with Tc-99m ECD and with Tc-99m HMPAO, and magnetic resonance imaging (MRI) of the brain less than 7 days of their stroke onset. MRI showed cortical infarction in 29 patients. Split dose and sequential SPECT techniques were used for Tc-99m ECD SPECT and Tc-99m HMPAO SPECT, without repositioning of patients. Asymmetric index (AI) of infarction zones was calculated. The subtraction images of Tc-99m ECD SPECT and Tc-99m HMPAO SPECT were coregistered to MRI template.*Results:* Among 29 patients with cortical infarction on MRI, visual side-by-side interpretation of Tc-99m HMPAO SPECT showed hypoperfusion in infarct zones in 27 patients except two patients with infarction in occipital lobes. In these two patients, Tc-99m ECD SPECT showed hypoperfusion in the same site with cortical infarctions in one patient. In the other patient, there was no hypoperfusion on both of Tc-99m ECD SPECT, and Tc-99m HMPAO SPECT. The asymmetric index (AI; 35.0 ± 30.0) of Tc-99m ECD SPECT was larger (p = 0.002) than the AI (17.4 ± 20.2) of Tc-99m HMPAO SPECT. Visual side-by-side interpretation showed larger extent of hypoperfusion in infarct zones on Tc-99m ECD SPECT than Tc-99m HMPAO SPECT in 10 (34%) of 29 patients. Among these 10 patients, the subtraction images of Tc-99m ECD and Tc-99m HMPAO SPECT coregistered to MRI sowed significant lower Tc-99m ECD uptake than Tc-99m HMPAO uptake in 4 (40%) patients. *Conclusions:* Compared with Tc-99m HMPAO SPECT, the degrees of hypoperfusion in infarct zones was significantly larger with Tc-99m ECD SPECT in a head-to-head comparison of the same patient during subacute stroke. The subtraction images coregistered to MRI supported the visual assessment. Therefore, we suggest that Tc-99m ECD SPECT was superior to Tc-99m HMPAO SPECT for enabling the mapping of full extent of the infarct and also the degree of tissue destruction

P267

The role of tecnetium-99m ECD SPECT in the evaluation of long-term outcome after mild traumatic brain injury

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Introduction: We prospectively evaluated the role of ^{99m} Tc-ECD SPECT in acute phase of mild traumatic brain injury (MTBI) for predicting the delayed and sustained neuropsychological complications after a typical recovery period. **Methods**: Forty five cases with MTBI were participated in this study. They underwent computed tomography (CT) and ^{99m} Tc-ECD SPECT imaging within a week of their closed head trauma. After mean interval of 9 months from the time of accident, all patients were re-evaluated by clinical and neuropsychological tests (Milon and Wechsler) for the assessment of imbalance, personality changes and memory deficits. **Results:** Twenty five patients showed abnormal and 20 revealed normal brain perfusion on early SPECT images. In 19 cases of total 20 normal SPECTs, we didn't see any sign of delayed or sustained memory deficit and imbalance (negative predictive value=95%). However, the predictive value of positive initial SPECT for the detection of delayed memory deficit and imbalance were 40% and 20%, respectively. An early abnormality on SPECT, but not on CT, was the significant predictor of long-standing memory deficits (odds ratio=13.49, p=0.020). **Conclusion:** Negative SPECT study is a more reliable predictor of good outcome than CT in terms of absent memory deficit and imbalance beyond a 6-month follow-up period in patients with MTBI. In addition, SPECT abnormality was confirmed to reliably predict more chance of persistent memory deficit. However, abnormal SPECT does not necessarily predict unfavorable outcome.

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Evaluation of perfusion differences in Semantic Dementia and Alzheimer's disease using ^{99m}Tc-HMPAO SPECT with automated Brodmann areas mapping

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AIM: Semantic dementia (SD) and Alzheimer's disease (AD) are both associated with neurodegenerative changes in temporal lobes which lead to impairment of semantic and episodic memory, respectively. Clinical assessment may not easily detect the differing cognitive profiles, resulting in under-diagnosis of SD, presumably mislabelled as AD.The aim of our study was the evaluation of perfusion in specific Brodmann areas (BA) in AD and SD patients, using an automated 3D-voxel-based processing software, in order to reveal more localised perfusion differences between these disorders and improve the differential diagnosis of SD from AD patients.**MATERIALS-METHODS:** Sixty consecutive patients from an outpatient Memory Clinic were participated in the study. We used the established DSM-IV criteria for the diagnosis of dementia and the specific established criteria for the diagnosis of AD and SD. All the patients had a neuropsychological evaluation with a battery of tests including the mini-mental state examination (MMSE). We studied 39 patients with AD (10 men and 29 women, age±SD 71±8 years, MMSE±SD 19±5, education±SD 9.3±4.7 years, duration of disease±SD 4±2 years) and 21 patients with SD (5 men, 16 women, age±SD 69±8 years, MMSE±SD 13±8, education±SD 9.5±5 years, duration of disease±SD 4.1±3.2 years). All patients were right-handed, except 2 patients who were left-handed. All the patients underwent a brain SPECT scan 20 min after the intravenous administration of 740MBq of ^{99m}Tc-HMPAO. We applied the NeuroGam^{TM} software on the reconstructed data, for the semi-quantitative evaluation of brain perfusion in BA in the right (R) and left (L) hemispheres. Perfusion values in BA were expressed as mean±SD percentage of mean perfusion of the cerebellum.**RESULTS:** SD patients had lower perfusion values in BA 20L and 21L (inferior and middle left temporal lobe) compared to AD patients. Multiple logistic regression analysis showed that 21L could independently differentiate SD from AD (p=0.046). The AUCs for 21L was 0.68. The optimal cut-off of 21L for the discrimination of SD from AD was 61.2 with sensitivity 82.1, specificity 52.4, positive predictive value 76.2 and negative predictive value 61.1.**CONCLUSION**: Hypoperfusion in inferior and middle temporal lobe of the left (dominant) hemisphere in SD patients is associated with the different cognitive profile to that seen in AD patients. Brain perfusion SPECT imaging with automated BA mapping could improve the definition of brain areas that are specifically implicated in these disorders resulting in a more accurate differential diagnosis.

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Scintigraphic Methods in the Evaluation of Brain Death and Their Correlation with Clinical Examination and Apnea Test

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Aim: Although brain death is a clinical diagnosis, confirmation of the diagnosis with a diagnostic test is mandatory in several countries including ours. Since patients with brain death diagnosis are potentially organ donors, test selection is important in terms of sensitivity, timing and also organ preservation. Scintigraphic methods are known to be sensitive, non-invasive and safer than contrast angiography which is accepted as gold standard. In this retrospective study we evaluated the concordance of scintigraphic methods including radionuclide angiography and brain perfusion SPECT with clinical diagnosis and apnea test.**Material and Method:** Between July 2008 and September 2009, 24 patients including 2 pediatric and 22 adult cases (age range: 7-57) were referred to nuclear medicine department for the