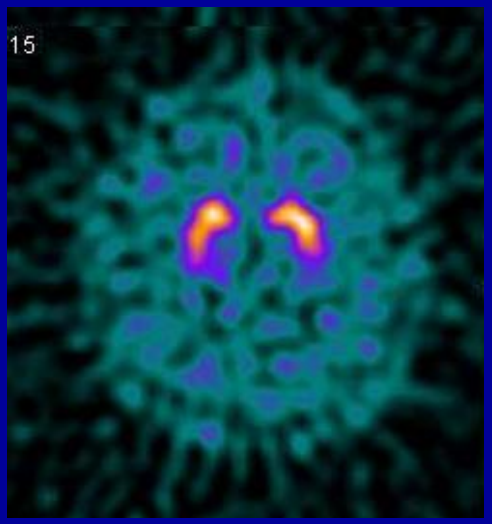
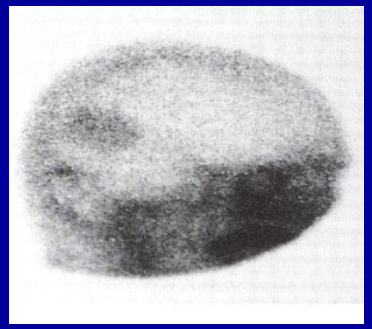
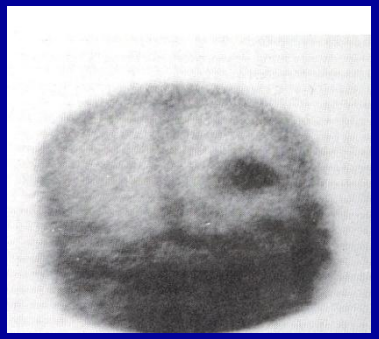
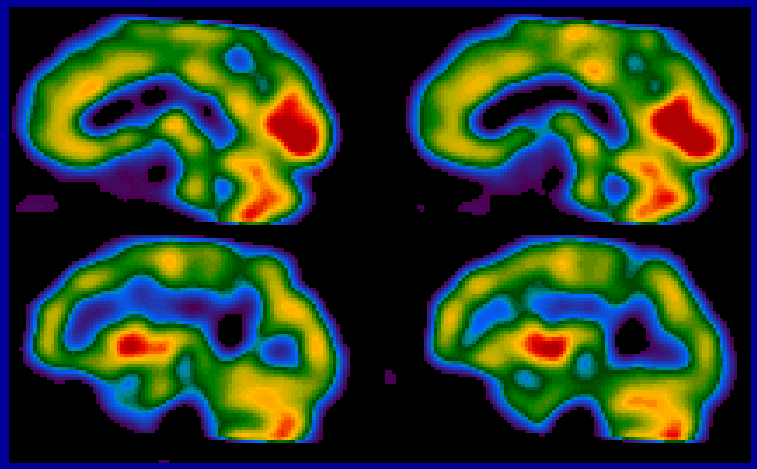
Examinations in neurology









Assoc. prof. V. Marković, MD., PhD.

Assoc. prof. A. Punda, MD., PhD.

I. Zebić, MD., nucl. med. spec.

Radiopharmaceuticals

1. Radiopharmaceuticals which do not cross the blood-brain barrier:
    - Tc-99m-pertechnetate
    - Tc-99m-DTPA

2. Radiopharmaceuticals that cross the blood-brain barrier:
    - Tc99m-HMPAO (hexametil-propylene-amine-oxime, Ceretec)
    - Tc99m-ECD (ethylene di-cysteine ethyl ester, bicisat)

3. Radiopharmaceuticals for the visualization of brain receptors:
    a) dopamine receptors
        - presynaptic - J-123 -IOFLUPAN (DaTSCAN)
        - postsynaptic - J-123-IBZM (iodobenzamide, D2 receptor agonist
    b) serotonin receptors
        - IMP (jodamphetamin)

4. Monoclonal specific antibodies labeled with I-131, which is generally applicable for detection of neuroblastoma.

Brain scintigraphy - cerebral angioscintigraphy and gammaencephalography

Brain scintigraphy is diagnostic imaging method that used iv. inj. Tc-99m-pertechnetate and dynamic recording on gamma-camera, to provide data on **vascular, focal and diffuse brain diseases.**

Tc-99m-pertechnetate, normally, does not cross the blood-brain barrier

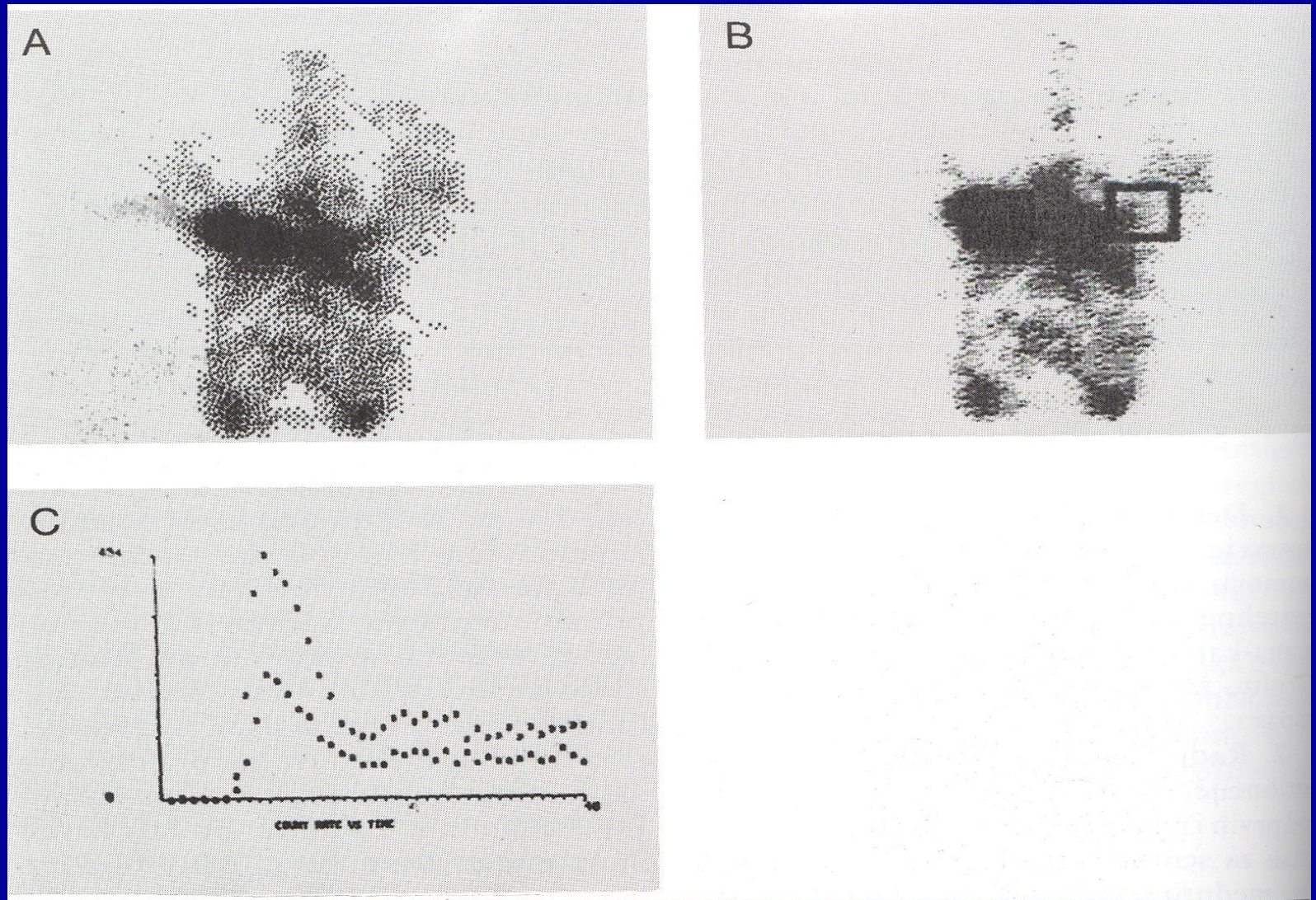
- Factors affecting the accumulation of Tc-99m pertechnetate to the brain
  - Local damage of the blood-brain barrier
  - Noncerebral tissue within the brain
  - Local increased volume of circulating blood
- Imaging protocol
  - I.v. 550 MBq (15mCi) Tc-99m pertechnetate
  - Angioscintigraphy (dinamic perfusion sci for 40 sec.)
  - The early (5-10 min.) and delayed planar scintigraphy (2-3 h)

Types of lesions

- **Type 1.**

  The lesion is visible in the arterial phase, remains hyperactive in the capillary phase, and during the venous phase activity significantly fall / disappears. The lesion is again clearly visible after recirculation:

  Aneurysma and arteriovenous malformations.

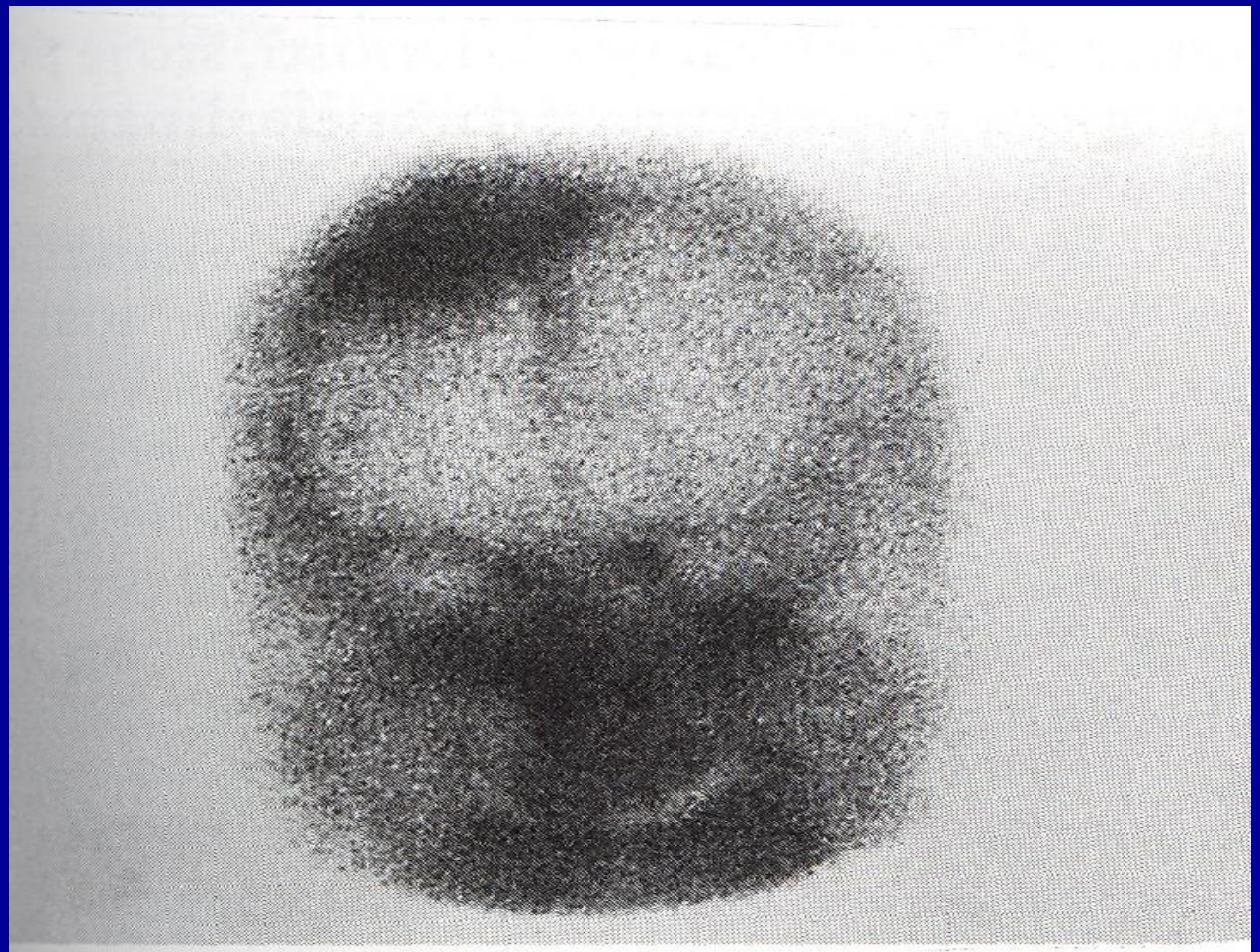


Slika 6-1. Arterijsko-venska malformacija desno bazalno: A = rani dinamički scintigram, B = isti scintigram s regijama interesa, C = dinamičke krivulje, desna je viša.

- **Type 2.**

  The lesion is well visible in the arterial phase, during the venous phase activity slightly decreases (in contrast to the type 1), then gradually increases and reaches a maximum after 5 minutes. At a later stage time activity gradually fall:

  Meningioma, metastatic cancer of the rectum



Slika 6-2. Meningeom parijetalno desno.

- **Type 3.**

The lesions are poorly visible on angioscintigraphy and sci. of vascular space. Activity gradually increases and the lesion is clearly visible two hours after injection:

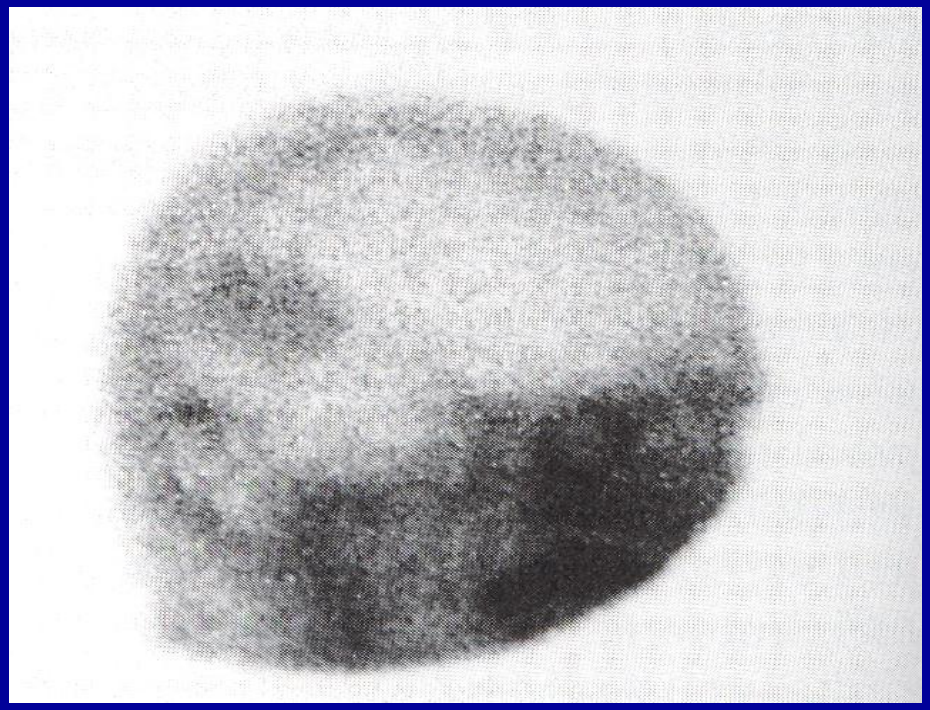
Glioblastoma, lung cancer and metastatic breast cancer.

- **Type 4.**

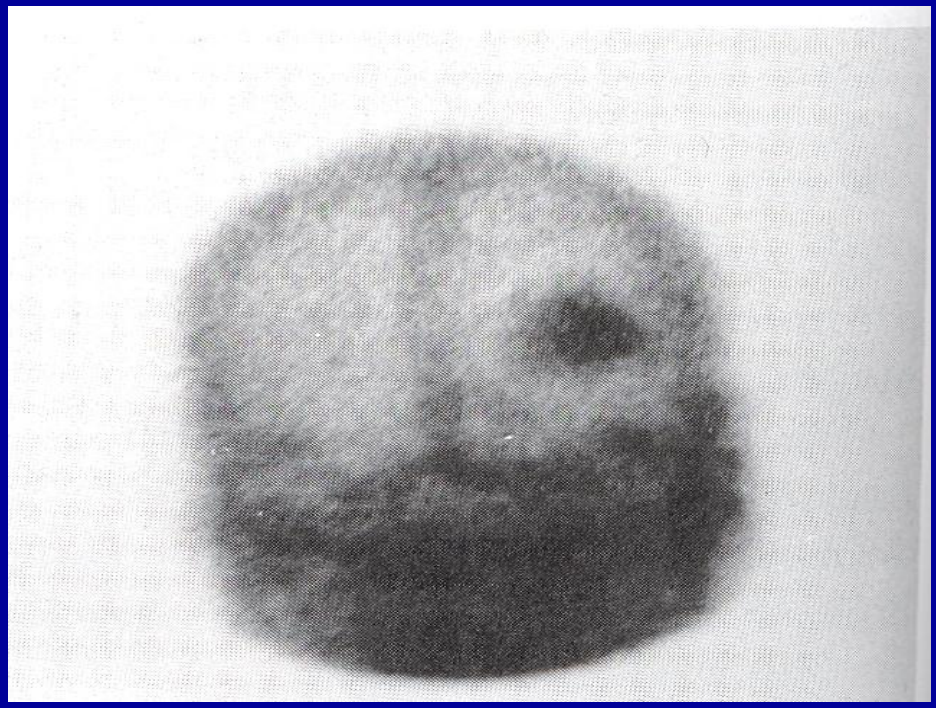
  The lesion is visible only after a few hours, i.e. in the late static scans were negative. Sometimes there is perfusion defect on angioscintigraphy:

  Astrocytoma, intracerebral hematoma, cerebral infarction, cerebral abscess, acoustic neurinoma, some metastases.

Right lateral projection



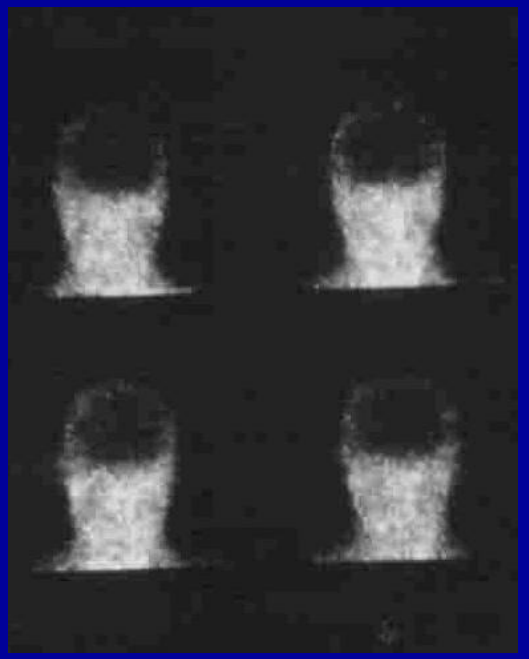
Posterior projection



In the right parieto-occipital region is cerebral infarction, in the irrigation area of right posterior cerebral artery

Brain death

- Irreversible loss of all brain function, as well as the function of the brainstem
- The main signs of brain death:
  - coma
  - absence of brainstem reflexes
  - apnea



Causes of brain death

- Traumatic brain injury
- Spontaneous intracerebral hemorrhage
- Ischemic brain lesion
- Decompensated primary brain tumors
- Ischemic - anoxic brain damage
- Inflammation of the central nervous system

Reversible conditions that may mimic brain death

- Hypothermia <35 ° C
- Hypotension (systolic blood pressure <80 mmHg)
- Metabolic and endocrine disorders (hepatic encephalopathy, hyperosmolar coma, preterminal uremia)
- Drug intoxication (neurodepressors, antiepileptics, anticholinergics, muscle relaxants)
- Alcohol intoxication

The importance of determining brain death

- A person is legally dead
- organ transplantation

- Diagnosis is made by clinical examination and confirmed by one of paraclinical tests

Clinical examination

- The absence of reaction to light
  - Unresponsive to light
  - Moderate extended (4 mm) to the extended (9mm) pupils
- Absence of corneal reflexes
- The absence of reaction to pain stimulus in the area of n. trigeminus innervation
- The absence of oculocephalic reflexes
  - It can not be tested in the case of fractures of the head and cervical spine
- The absence of oculovestibular reflexes
  - It can not be tested in the case of injury of the eardrum

Clinical examination

- The absence of pharyngeal reflex
- The absence of tracheal reflexes
- Muscles atony
- The absence of spontaneous breathing during apnea test

Diagnosis

- Brain death is determined by two consecutive clinical examination

- The distance between the two views:
  a) for adults and children over 12 years is a minimum of **3 hours**
  b) for children between 2 and 12 years minimum of **12 hours**
  c) for children from 2 months to 2 years at least **24 hours**

- Carried out by a commission composed of:
  - The anesthesiologist and neurologist / neurosurgeon /
  - The anesthesiologist and pediatrician who works in the field of intensive care medicine for children up to 12 years.

Confirmatory tests

- Selective brain angiography
- Transcranial Doppler sonography
- Perfusion scintigraphy
- Evoked brain potentials
- Electroencephalography
- Multislice CT contrast angiography
- MR angiography

Brain perfusion scintigraphy

- It does not require special preparation of patients
- It only takes a stable blood pressure
- Normal ventilation
- Take into account whether barbiturate therapy administered because of the potential reduction in brain blood flow
- The main disadvantage is difficult view of the posterior cranial fossa

RADIOPHARMACEUTICAL	APPLIED ACTIVITY
^{99m}Tc-pertechnetat	555-740 MBq / 15-20 m Ci i.v.
^{99m}Tc-DTPA	555-740 MBq / 15-20 m Ci i.v.
^{99m}Tc-HMPAO	370-1110 MBq / 10-30 mCi i.v.
^{99m}Tc-ECD	370-1110 MBq / 10-30 mCi i.v.

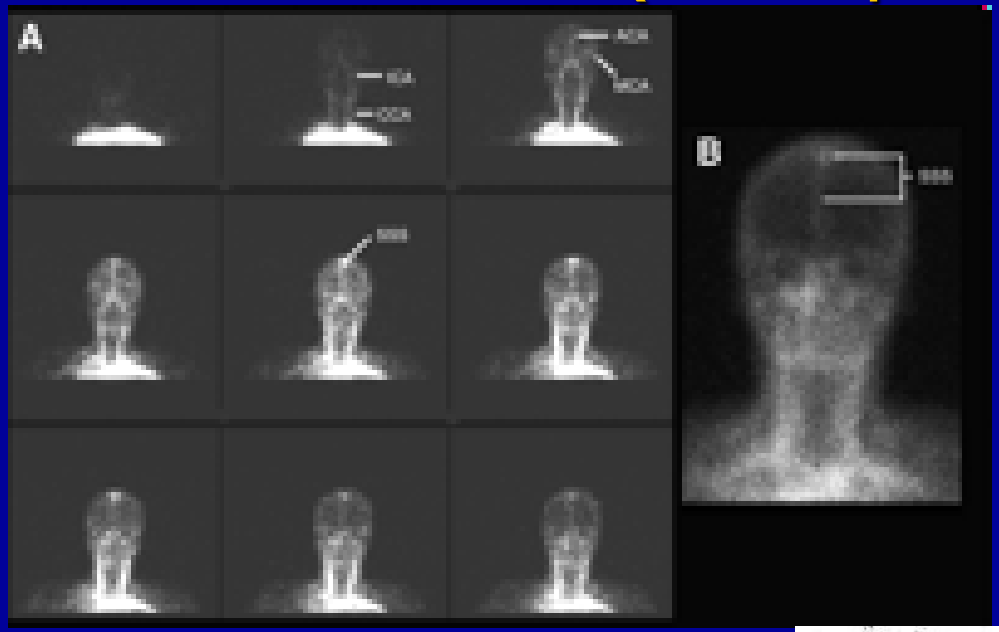
Cerebral (brain) death

- **Angioscintigaphy:** there is no brain perfusion i.e. arrival of radiopharmaceuticals in the brain blood vessels

- **Early and late static scintigraphy:**

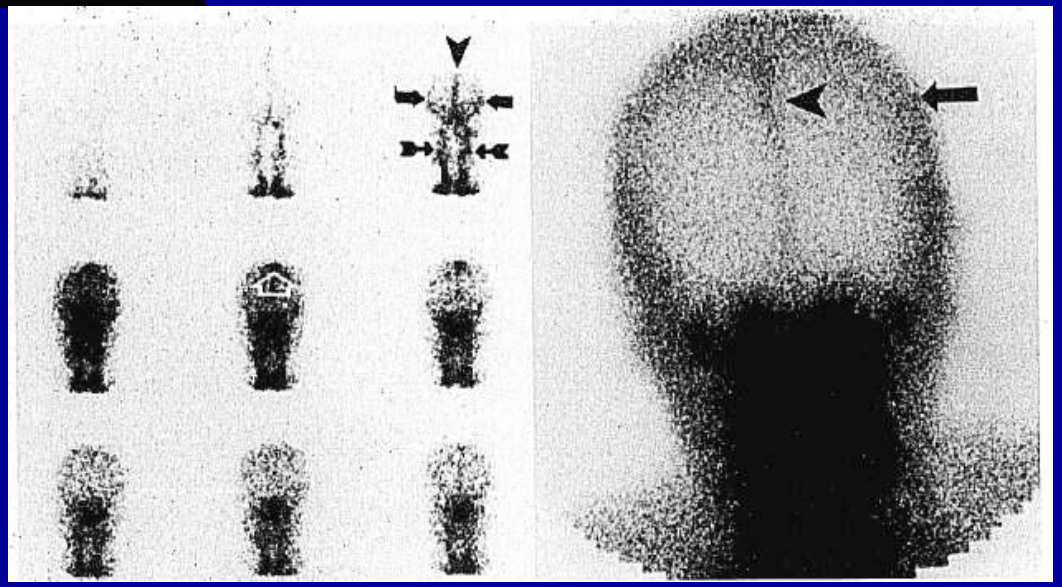
  there is no activity in the venous system, i.e. in sagittal and other venous sinuses of the brain.

Angioscinitgraphy - normal findings (^{99m}Tc-pertechnetate)



Normal perfusion (A) and blood pool phase (B). There is a flow in the common carotid artery (CCA) and internal carotid artery (ICA), the anterior cerebral arteries(ACAS) and middle cerebral artetries(MCAs), and at the end of the upper sagittal sinus (SSS).

Normal perfusion and early static sci. (anterior projection)



Late static images, 99mTc-DTPA - normal findings (there is activity in the venous sinuses)

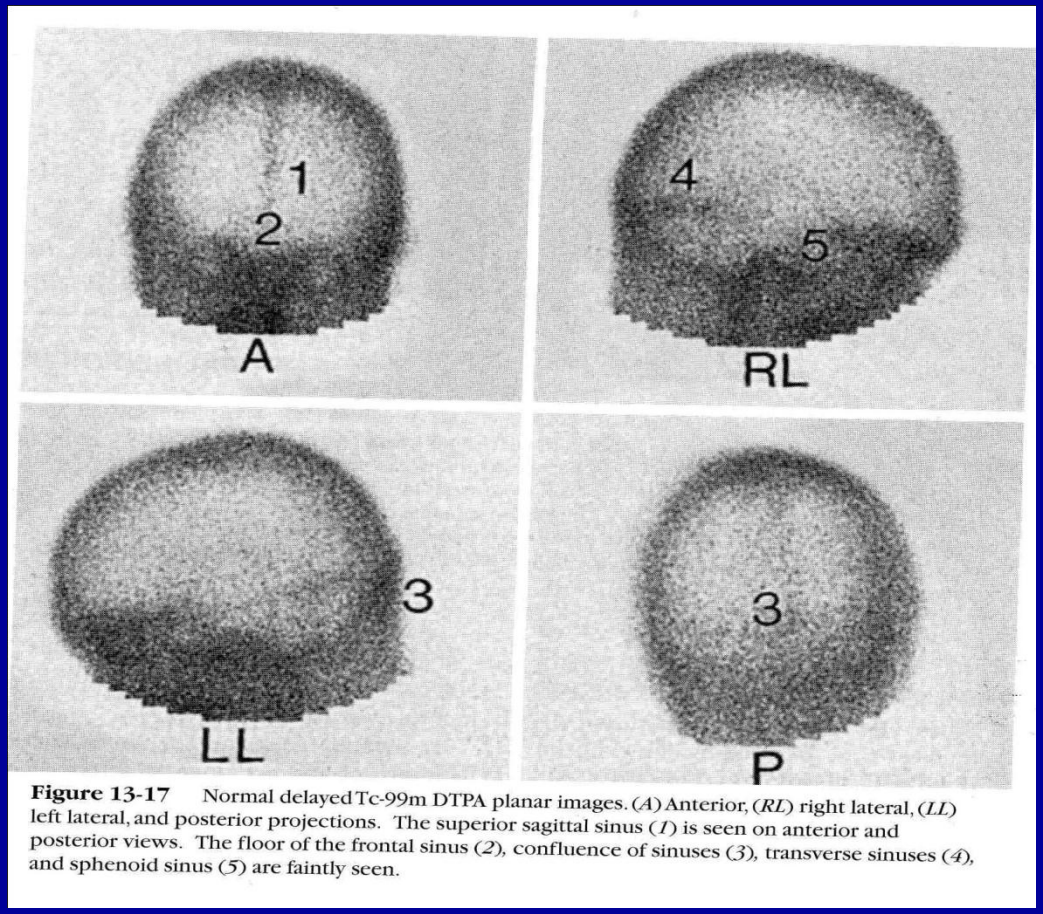
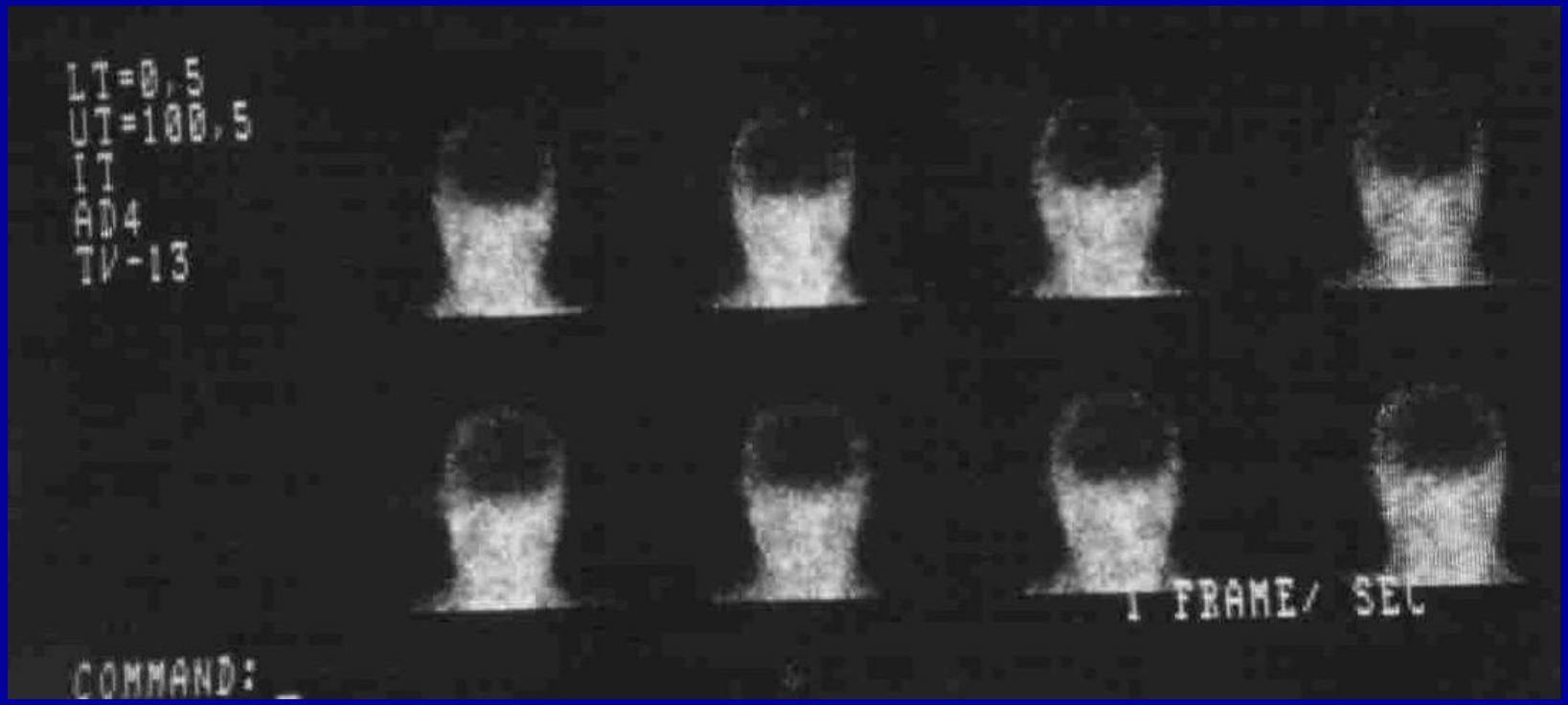
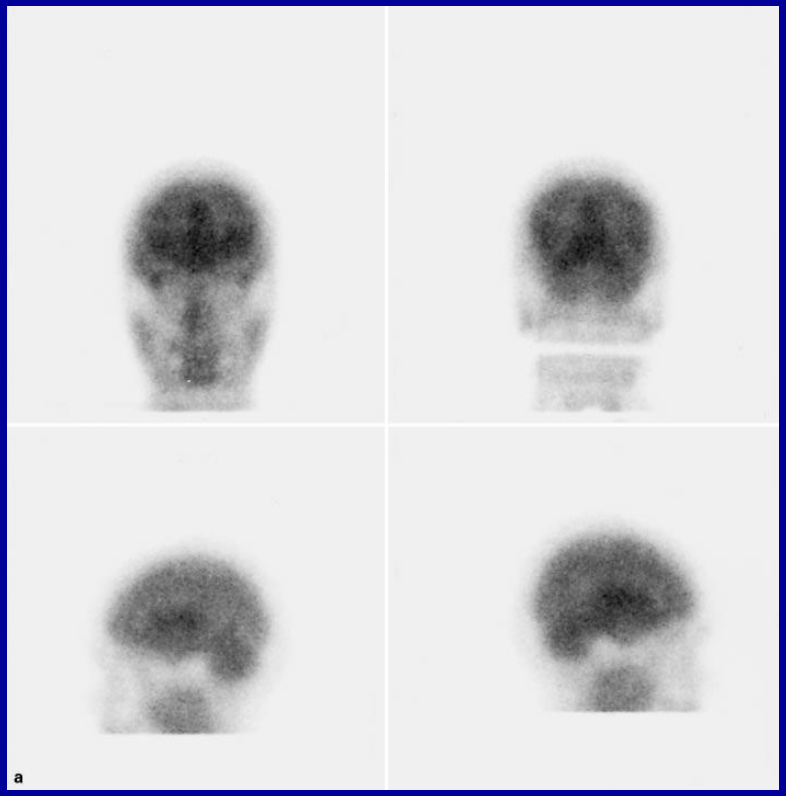


Figure 13-17 Normal delayed Tc-99m DTPA planar images. (*A*) Anterior, (*RL*) right lateral, (*LL*) left lateral, and posterior projections. The superior sagittal sinus (*1*) is seen on anterior and posterior views. The floor of the frontal sinus (*2*), confluence of sinuses (*3*), transverse sinuses (*4*), and sphenoid sinus (*5*) are faintly seen.



A positive finding of brain death (angioscintigraphy and late static); Department of Nuclear Medicine, University Hospital Centre Split; 1990.

Tc-99m-HMPAO



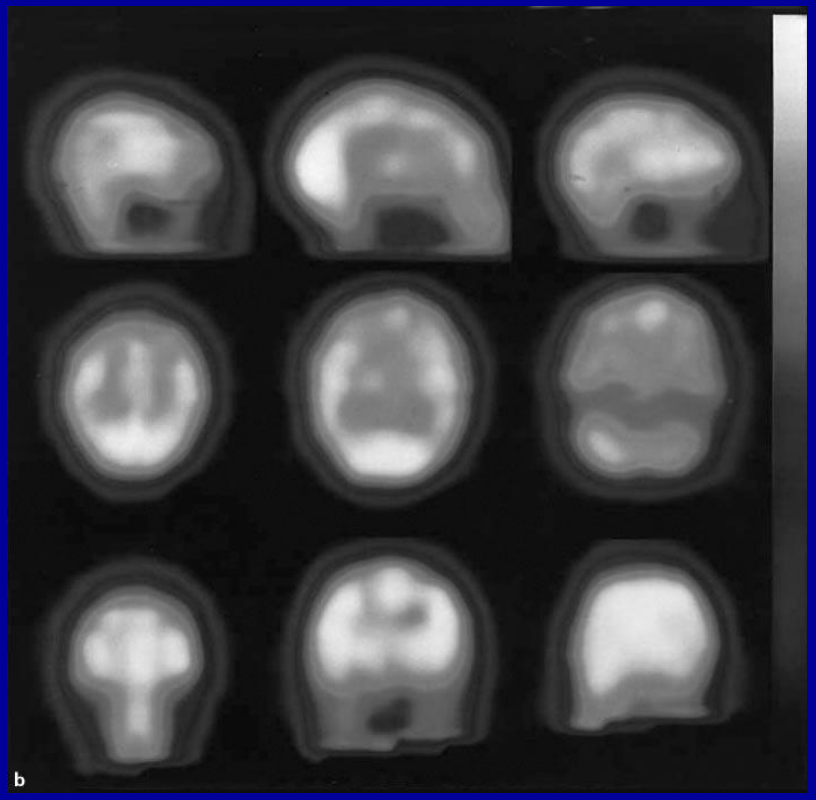
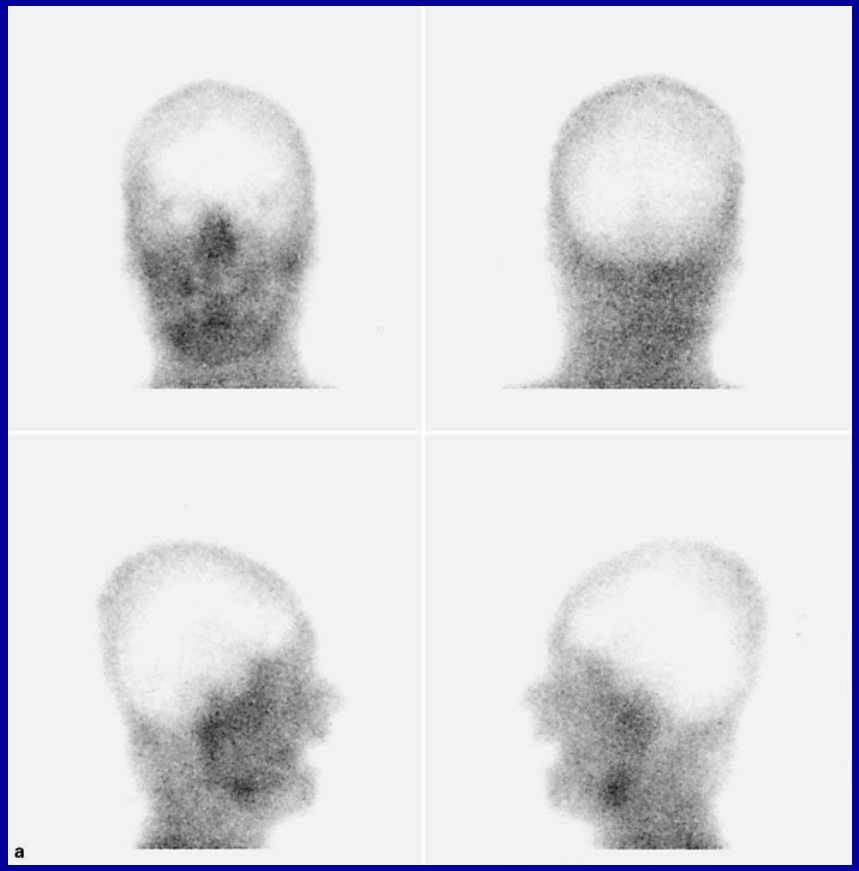


Fig. 1. Planar (a) and SPECT (b) images showing normal cerebral perfusion in supratentorial and infratentorial cerebral compartments.

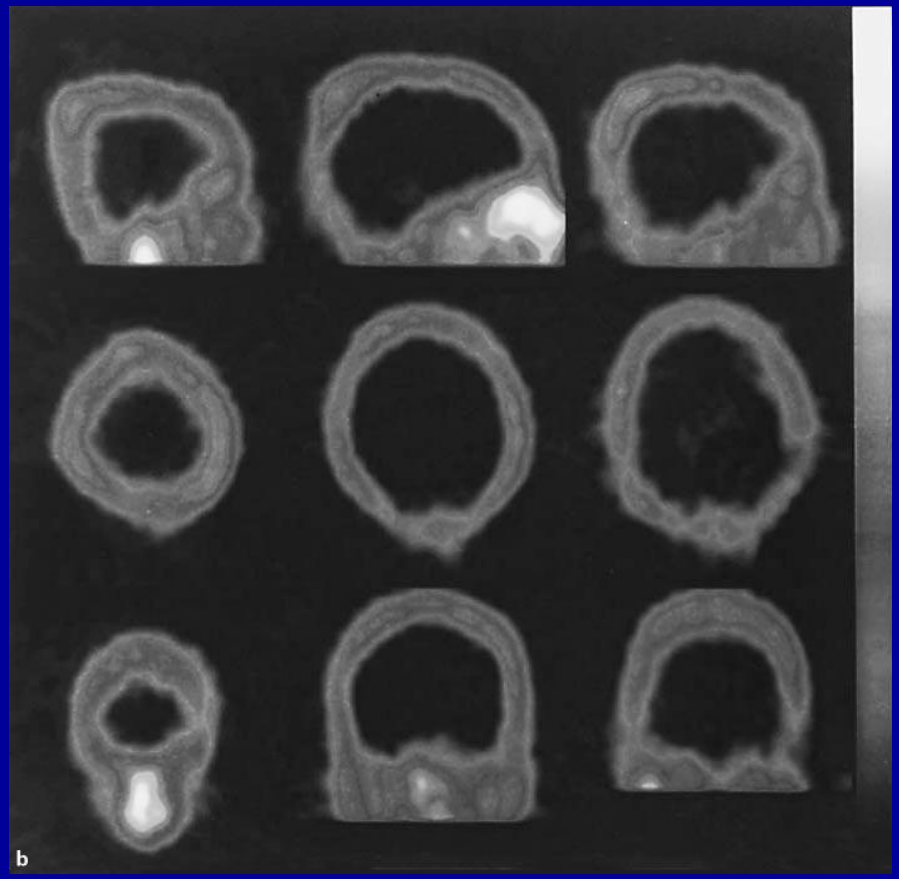


Static scintigraphy finding in brain death:

- The lack of activity in the brain
- It is required an assessment of both hemispheres and if possible posterior cranial fossa (cerebellum)

SPECT finding in brain death:

No uptake of radiopharmac. in the brain



Radionuclide cisternography

- Intrathecally application of radioactive indicators and monitoring the distribution and flow of cerebrospinal fluid (CSF) through the subarachnoid spaces

- Indications:
  1. Hydrocephalus
  2. Shunt patency in patients with hydrocephalus
  3. CSF leak: rhinorrhea, otorrhea

Radiopharmaceuticals

- **In-111 – DTPA**

  Dose (activity): 18.5 MBq (0.5 mCi)

  Injection site: intrathecal (subarachnoid space)

  L4-L5

  - Tc-99m-DTPA rarely

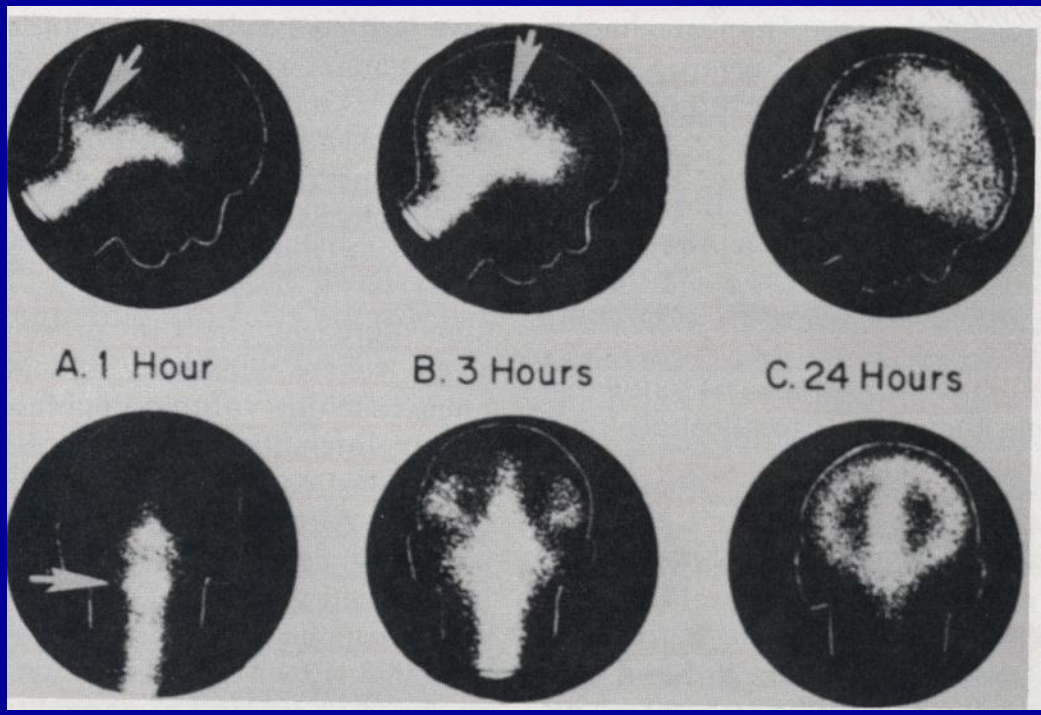
The normal flow of CSF

- CSF is secreted by ventricular choroid plexus of the brain - flows out of the fourth ventricle in the subarachnoid space. A part of CSF descends in the spinal cord and the rest of it moves over the cerebral hemispheres and finally reabsorbed through the pacchionian granulations of the pia arachnoid villi into the upper sagittal sinus.

1 h: Cerebellomedulariy cistern (cisterna magna) and bazal cisterns

3 h: Quadrigeminal cistern, (superior cistern) activity in the cerbral fissures - between the hemispheres and certain brain lobes

24 h: activity is over the convexities of the brain



1. Hydrocephalus

- Hydrocephalus is a pathological increase in the volume of cerebrospinal fluid and is associated with an increase of the brain ventricles

The pathogenesis of hydrocephalus

- The course of CSF was blocked by some processhemorrhage, tumors, infections- production of CSF continues, leading to an increase in CSF pressure- ventricules are spreading, pressure rises above the venous pressure - resulting changes in ventricular ependymoma and fluid begins reabsorbed through the capillaries in the periventricular white matter.

- If there is equilibrium established before a damage to the brain occurs, then "compensated" hydrocephalus is formed, often without specific symptoms. Compensation is possible in infants with an open fontanel, thereby increasing the head and thus reduce the pressure
- If the ventricles continues to increase, that is resulting with progressive loss of brain substance and develops classic hydrocephalus

1. Hydrocephalus

- Classification:
  1. Obstructive
  2. Nonobstructive

1. Obstructive hydrocephalus

a) Obstructive **noncommunicating**: barriers to flow of cerebrospinal fluid is formed inside the ventricules (tumor, cyst, aqueduct stenosis) - cisternography shows **normal flow of cerebrospinal fluid**

b) Obstructive **communicating**: obstruction occurs outside the ventricles, in the basal cisterns, convexity of the brain or in the arachnoid willi (subarachnoid hemorrhage, subdural hematoma, meningitis, meningeal carcinomatosis). It includes **hydrocephalus with normal pressure**. On cisternography there is **reflux of radiopharmaceuticals in the ventricules** and the absence or very delayed dynamics of the flow of activities across the cerebral hemispheres

Hydrocephalus with normal pressure

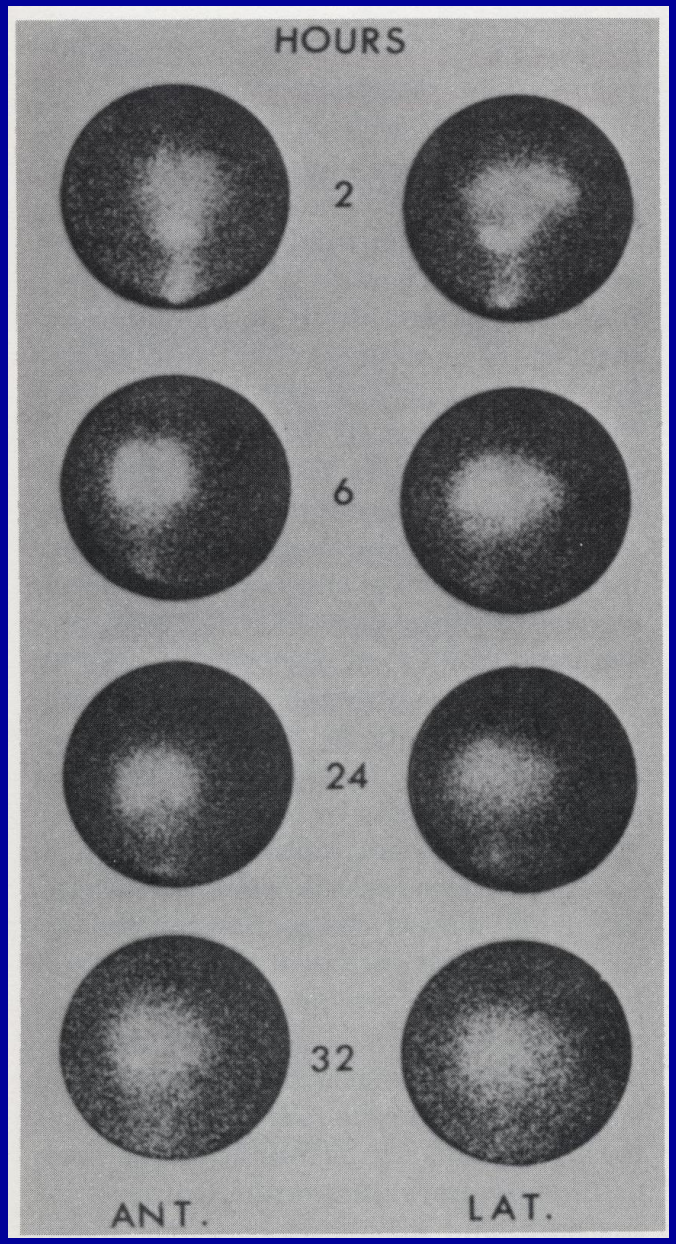
- The cause of the premature dementia, spastic walk, urinary incontinence
- Causes and cisternography findings are as in obstructive communicating hydrocephalus with increased pressure
- It is not entirely clear why the pressure of CSL is normal (or slightly increased)
- TH.: removal (shunting) CSF

2. Nonobstructive hydrocephalus

- Refers to the state of brain atrophy, either

  generalized (hydrocephalus ex vacuo), occurs due to loss of brain substance because of the degenerative processes. Symptoms are similar to those in patients with "normal pressure hydrocephalus "

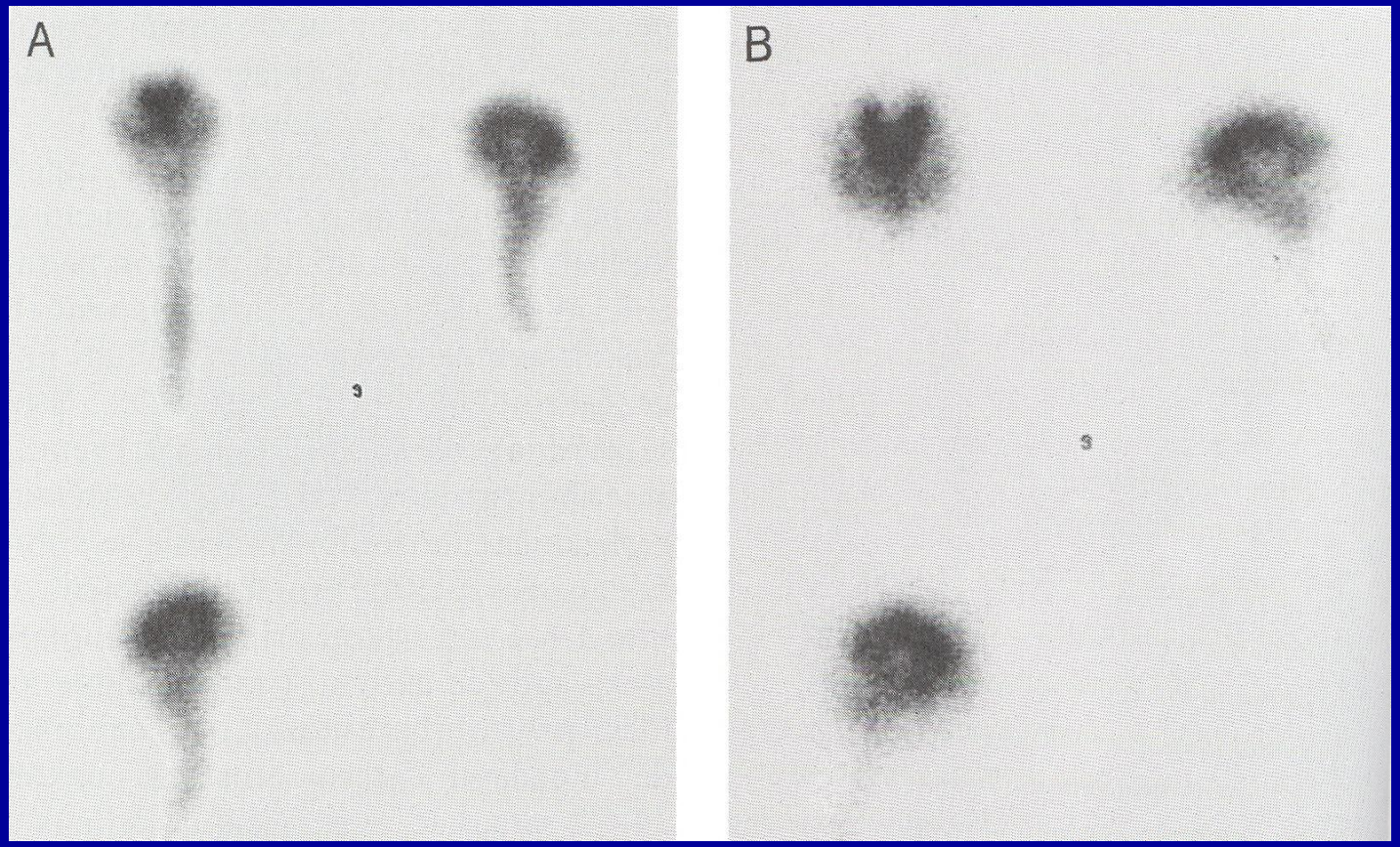
  or **localized** like in porencephaly



Obstructive communicating hydrocephalus

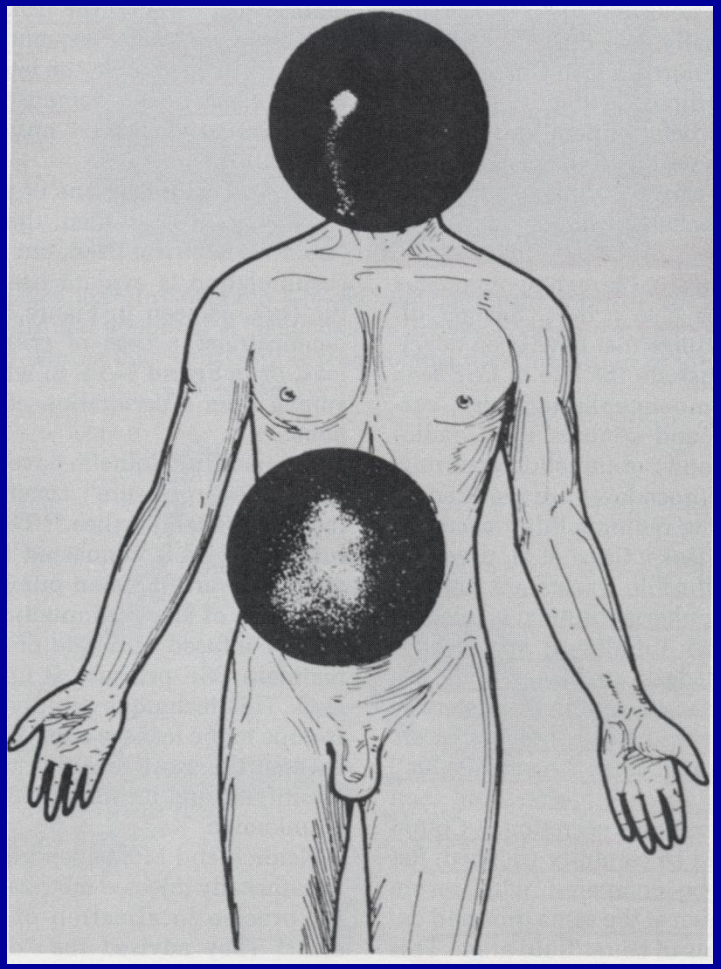
Ventricular reflux is present and increased ventricles.
No activities over the brain covexities

Hydrocephalus with normal pressure



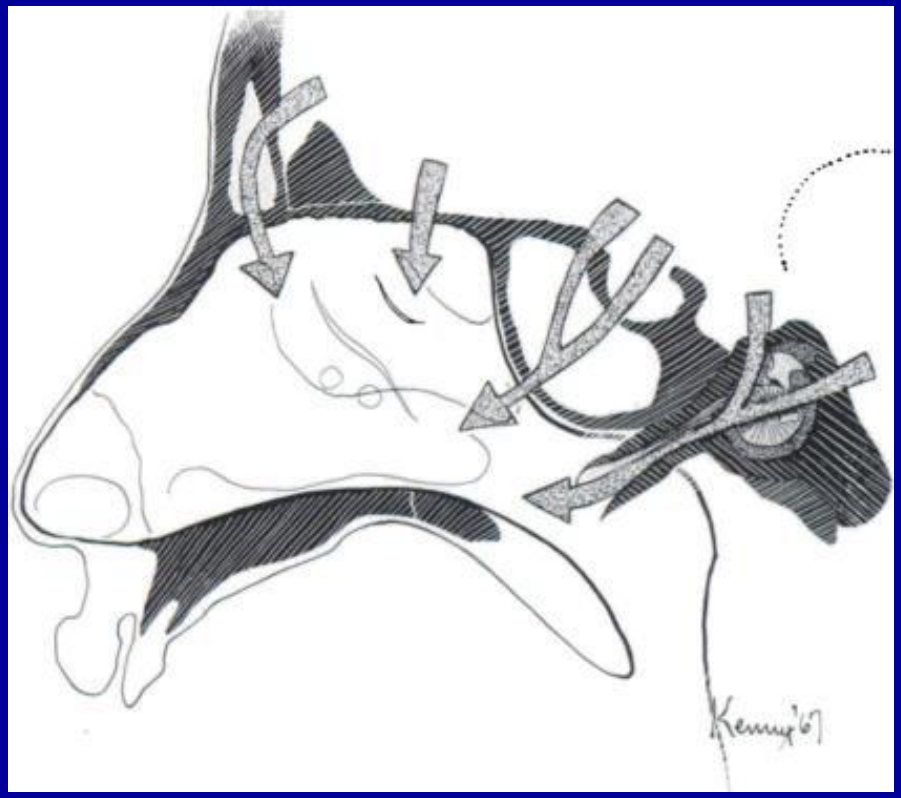
6 i 24 hours after injection: Ventricular reflux is present.
No activities over the hemispheres.

2. Shunt patency in patients with hydrocephalus



Accumulation of activity within abdominal cavity – normal shunt patency

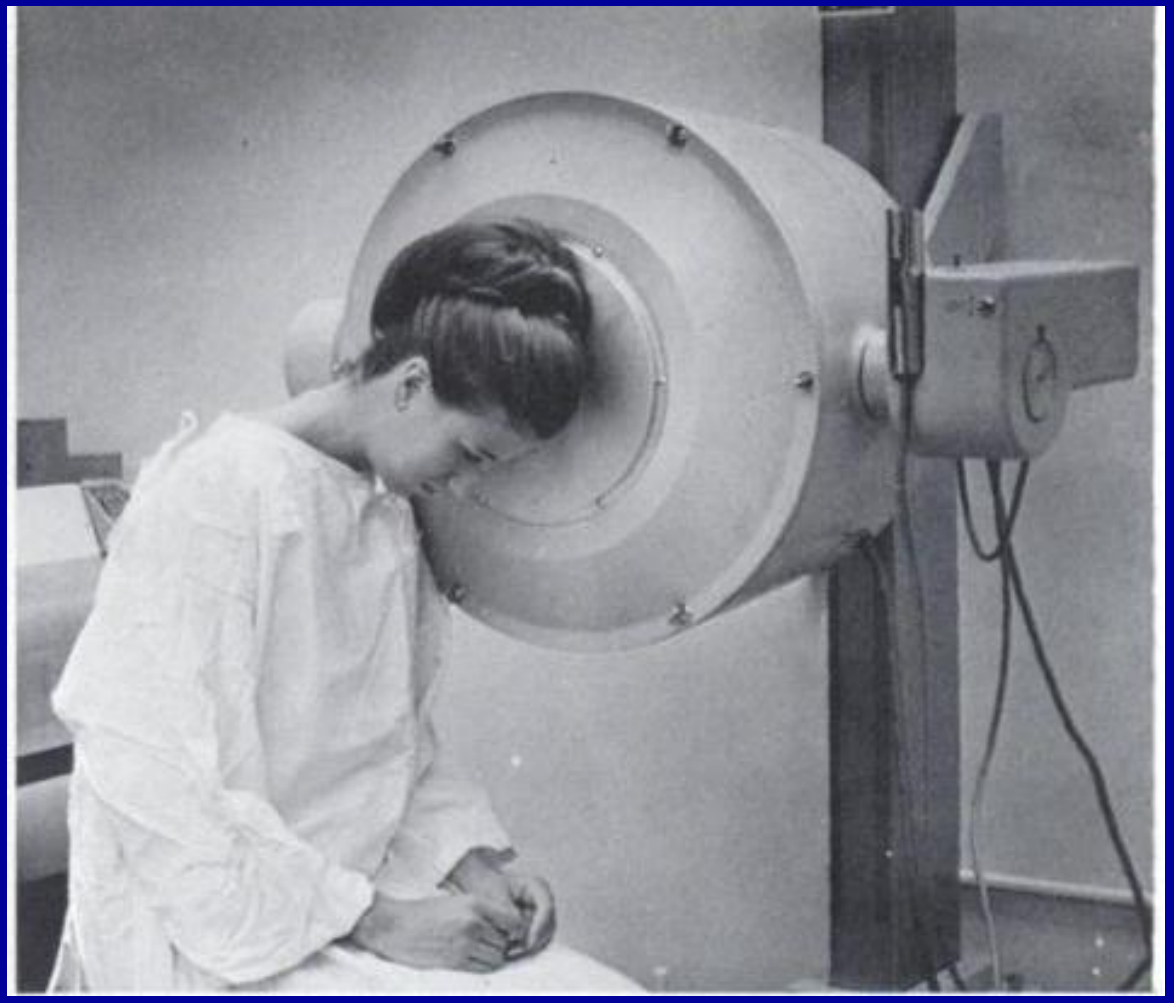
3. CSF leak: rhinorrhea, otorrhea



Head injury, meningitis

The most common sites of CSF leakage: the frontal sinus, cribriform plate, roof of the sphenoid bone to the nasopharynx, and through the petrous part of the temporal bone via the ear and Eustachian tube to the nasopharynx

Imaging of the lateral, front and posterior projection while the patient is bent head to increase intracranial pressure and provoke leakage of cerebrospinal fluid



CSF leakage after a head injury and meningitis

Right lateral projection 4 h after the injection of radiopharmaceutical: The leakage of CSF through the cribriform plate into the maxillary sinus

Leakage of CSF after craniotomy for resection of frontal bone with filler insertion because of posttraumatic infection after trauma.

Accumulation of activity in frontal sinus as well as a large area of accumulation of activity in the subarachnoid space behind the inserted filler of frontal bone

A patient with chronic mastoiditis, meningitis and recurrent leakage of CSF on the left side

Posterior planar image shows accumulation of radiopharmaceuticals in the petrosal part of the left temporal bone. Surgical exploration of the middle ear on the left, revealed leakage of CSF, that through the Eustachian tube drains into the nasopharynx

Single photon emission tomography of the brain - Brain perfusion scintigraphy

- Three-dimensional image display of distribution of cerebral perfusion
- The most commonly used radiopharmaceuticals for cerebral perfusion:
  - Tc-99m- HMPAO (hexamethyl propylene amine oxime)
  - Tc-99m- ECD (ethylene-di-cysteine ethyl ester)
- Liposoluble, distributed according to the cerebral perfusion, exceed blood-brain barrier, in the brain cells are changed into a hydrophilic forms which prevents the return diffusion in circulation.

- Indications: testing changes-abnormalities of cerebral flow that occur after a stroke, epilepsy, Alzheimer's disease and other forms of dementia, transient ischemic attacks, migraine and brain tumors.

Single photon emission tomography of brain - Brain perfusion scintigraphy

Imaging protocol with **Tc-99m- HMPAO:**

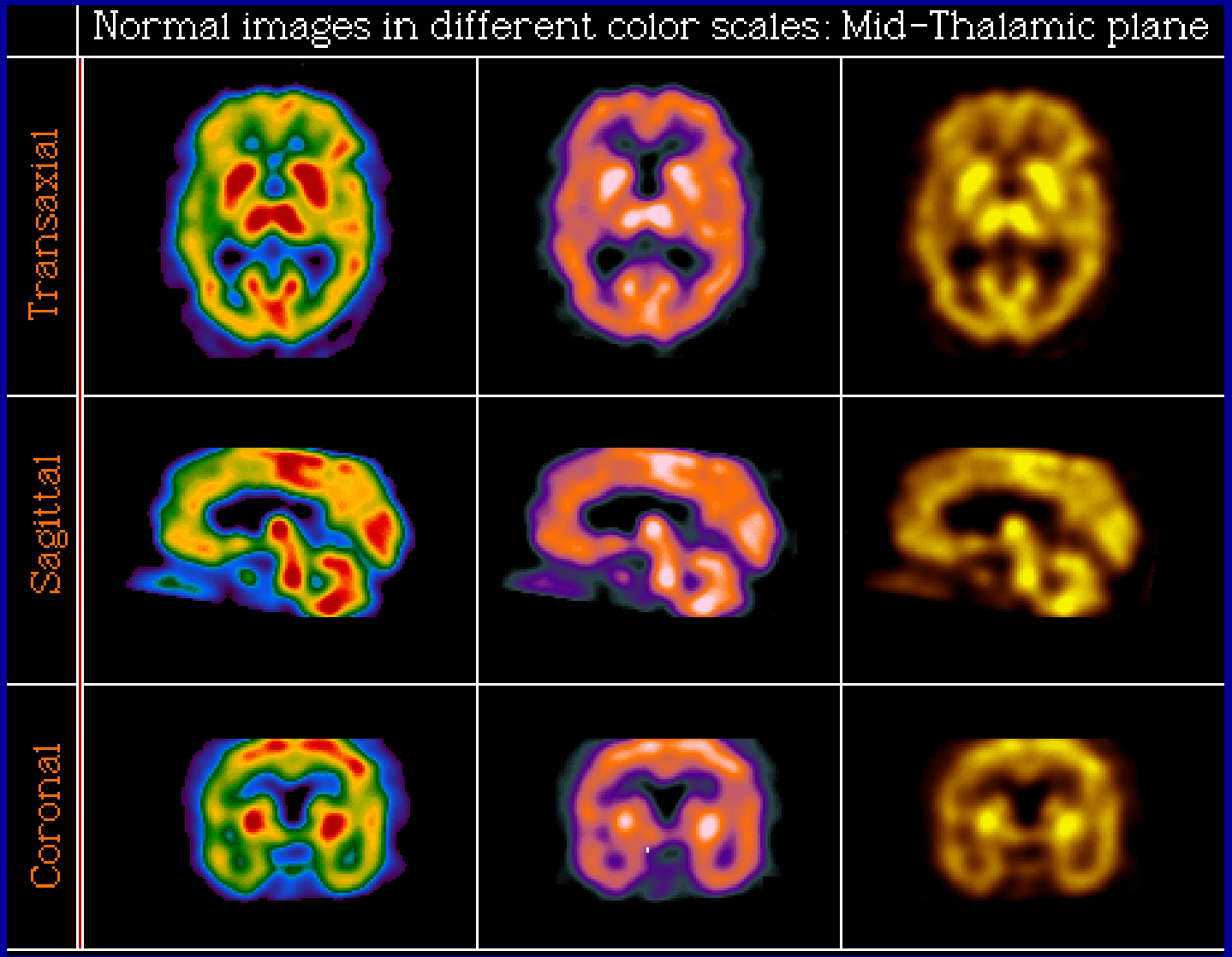
- i.v. 740-1110 MBq (20-30 mCi) Tc-99m - HMPAO

- SPECT after 10 min.; duration of imaging is 20 min., 64 projections

- Clinical application

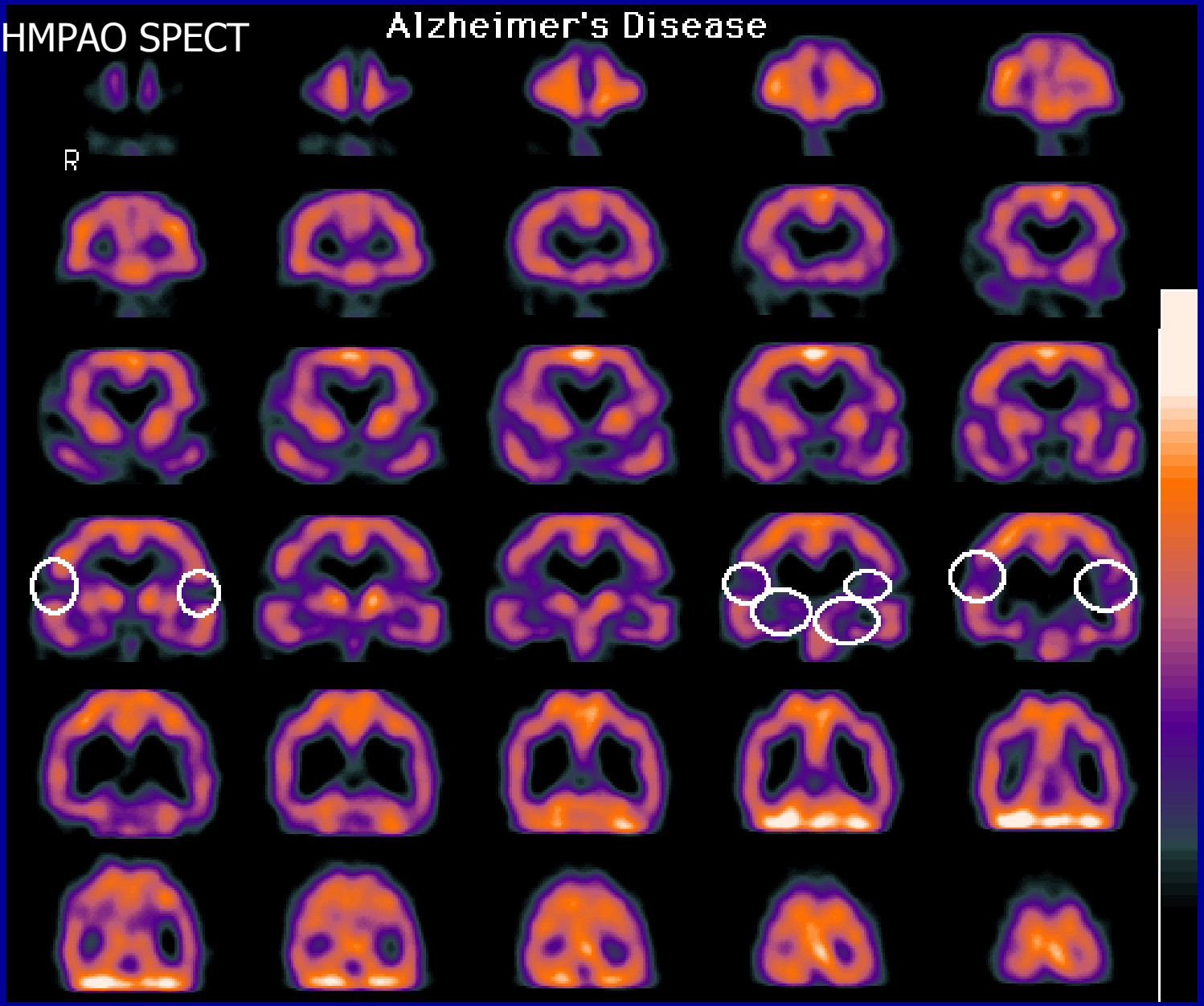
  - Detection of dementia
  - Assessment of brain damage after vascular stroke
  - Epilepsy

Tc-99m-HMPAO SPECT

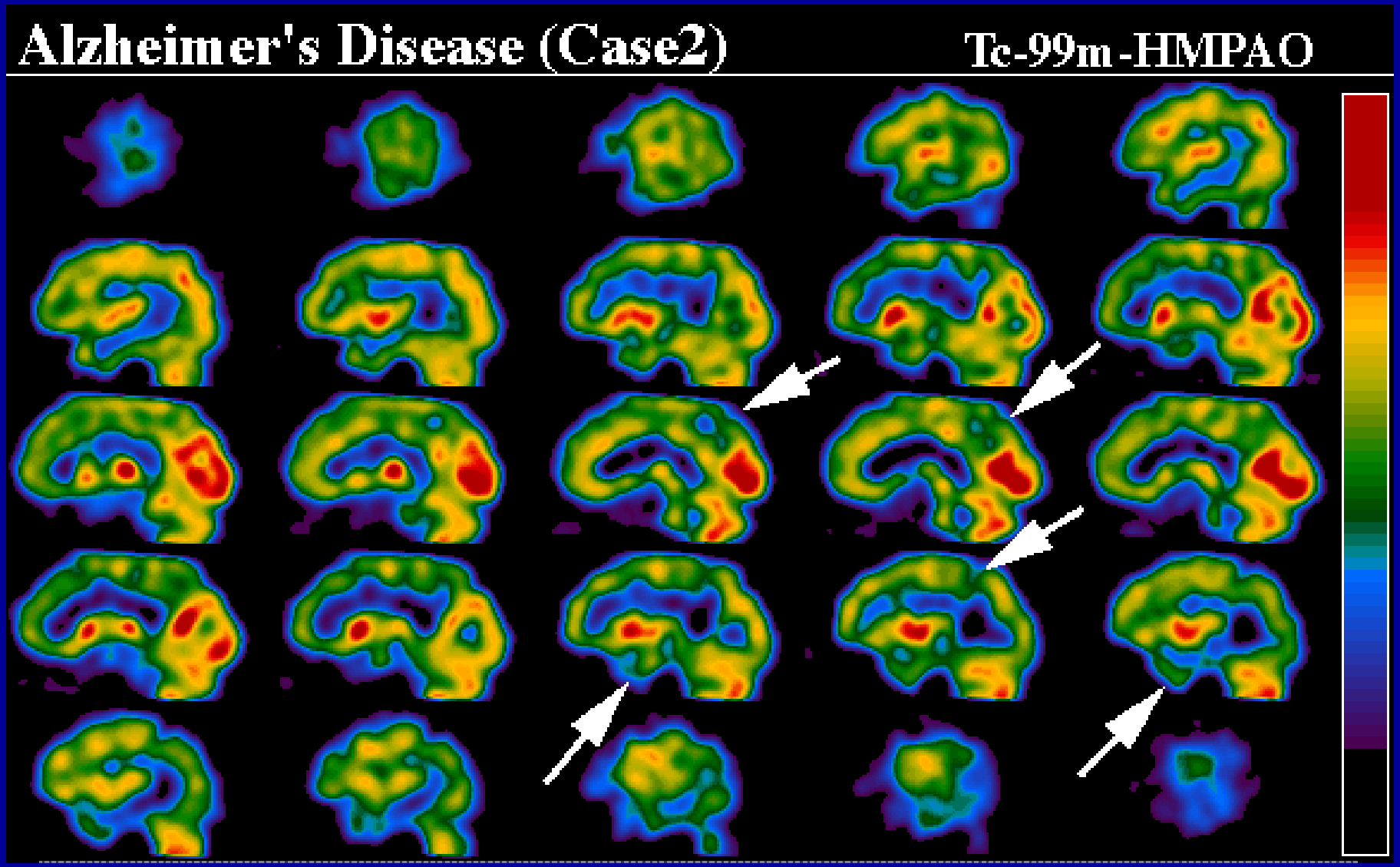


Normal findings

Tc-99m HMPAO SPECT

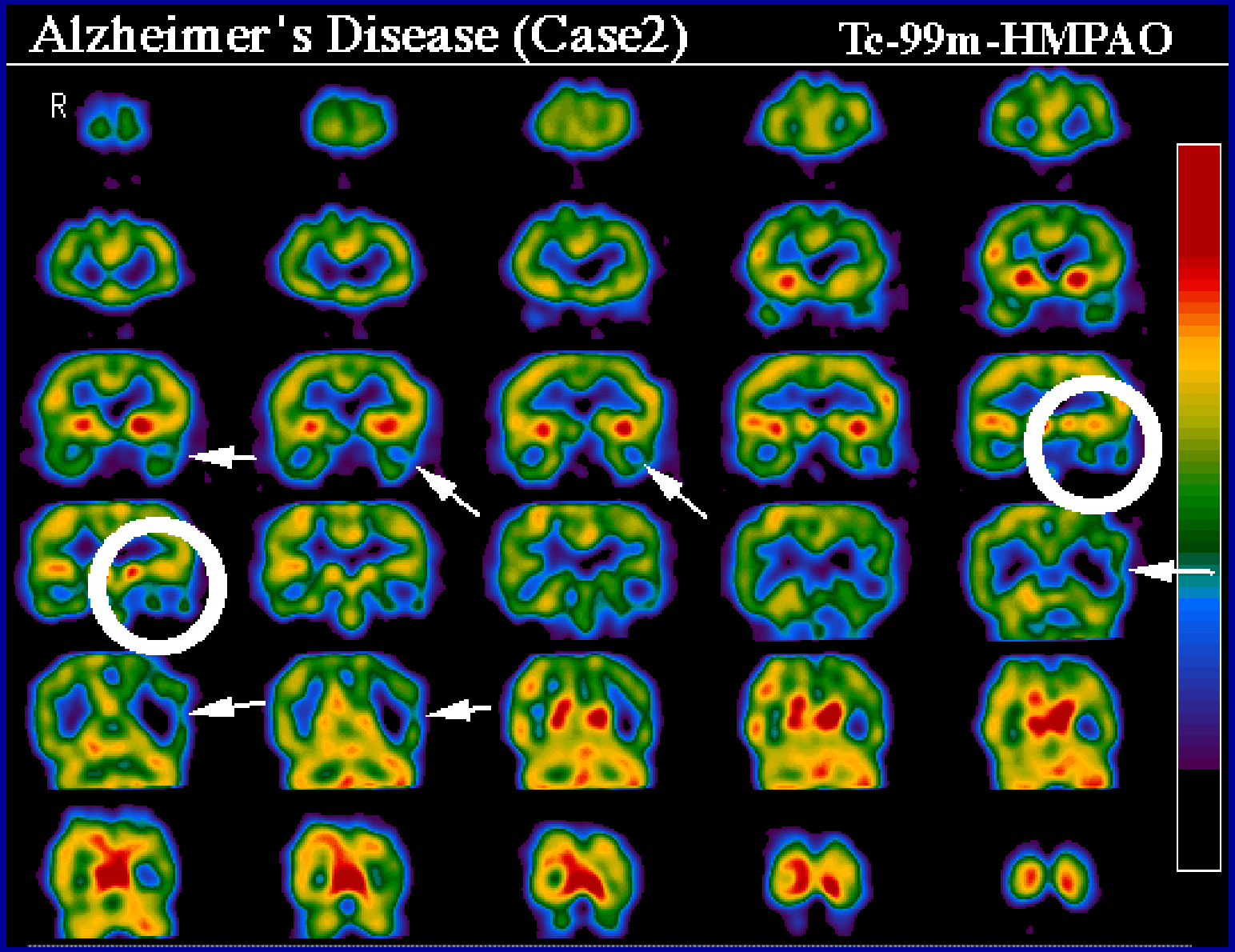


Male, 64 g .; progressive loss of memory. Alzheimer's disease: decreased perfusion in the lower parts of the temporal and parietal lobes bilaterally



Male, 72 g., The progressive loss of memory.

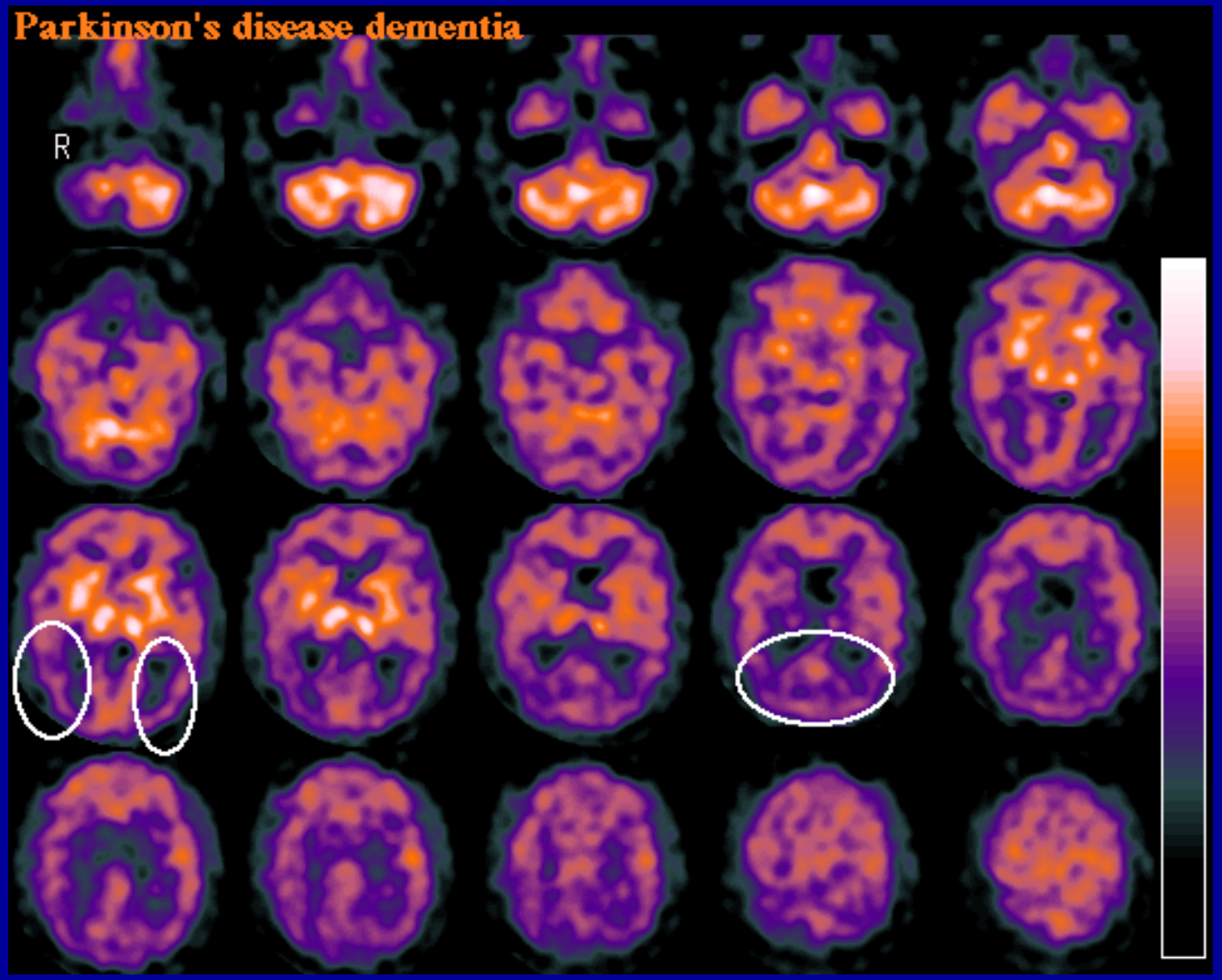
Perfusion defects that affect the parietal and temporal lobe bilaterally.



Male, 72 g., The progressive loss of memory.

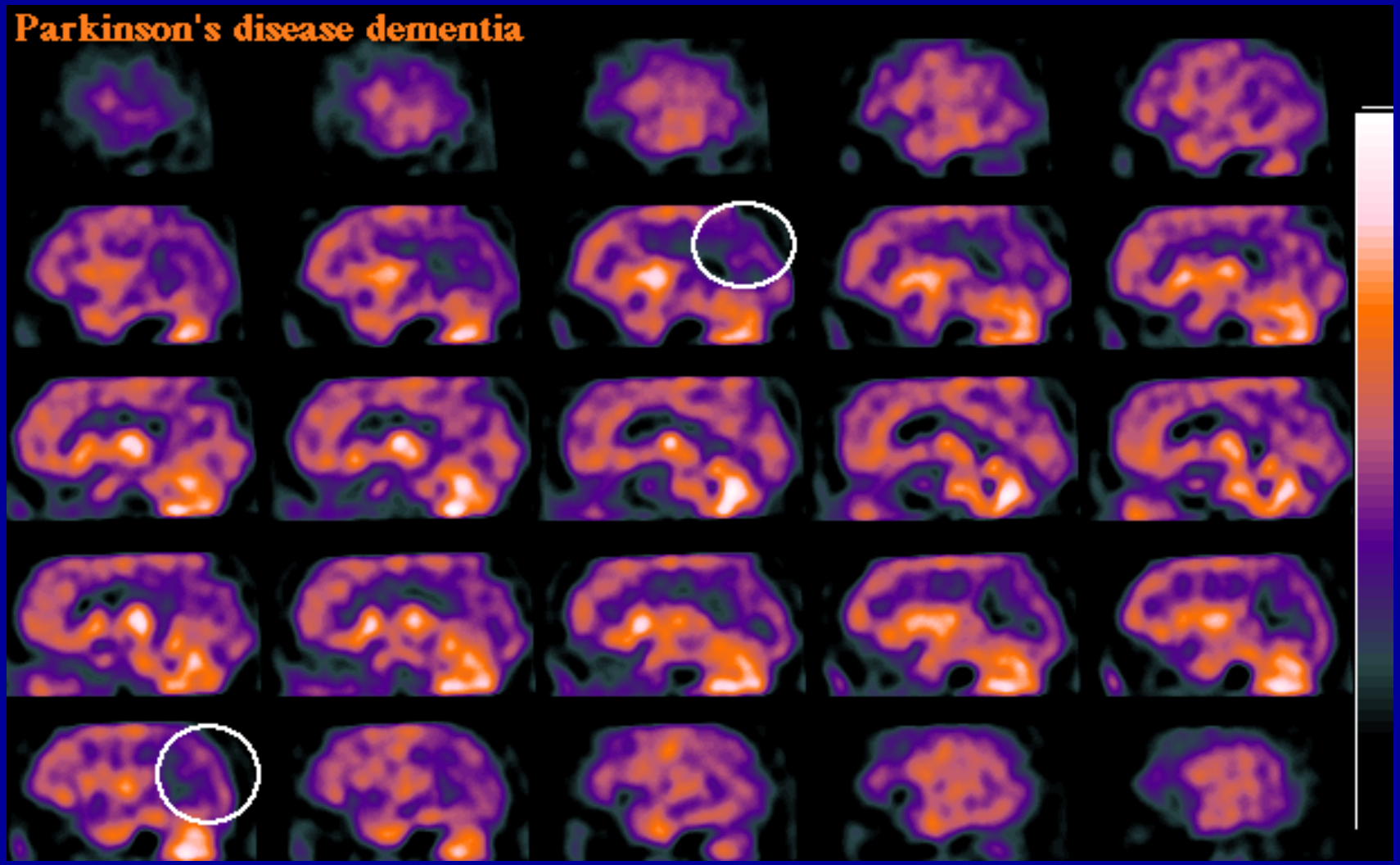
Perfusion defects that affect the parietal and temporal lobe bilaterally.

Dementia of Parkinson's disease



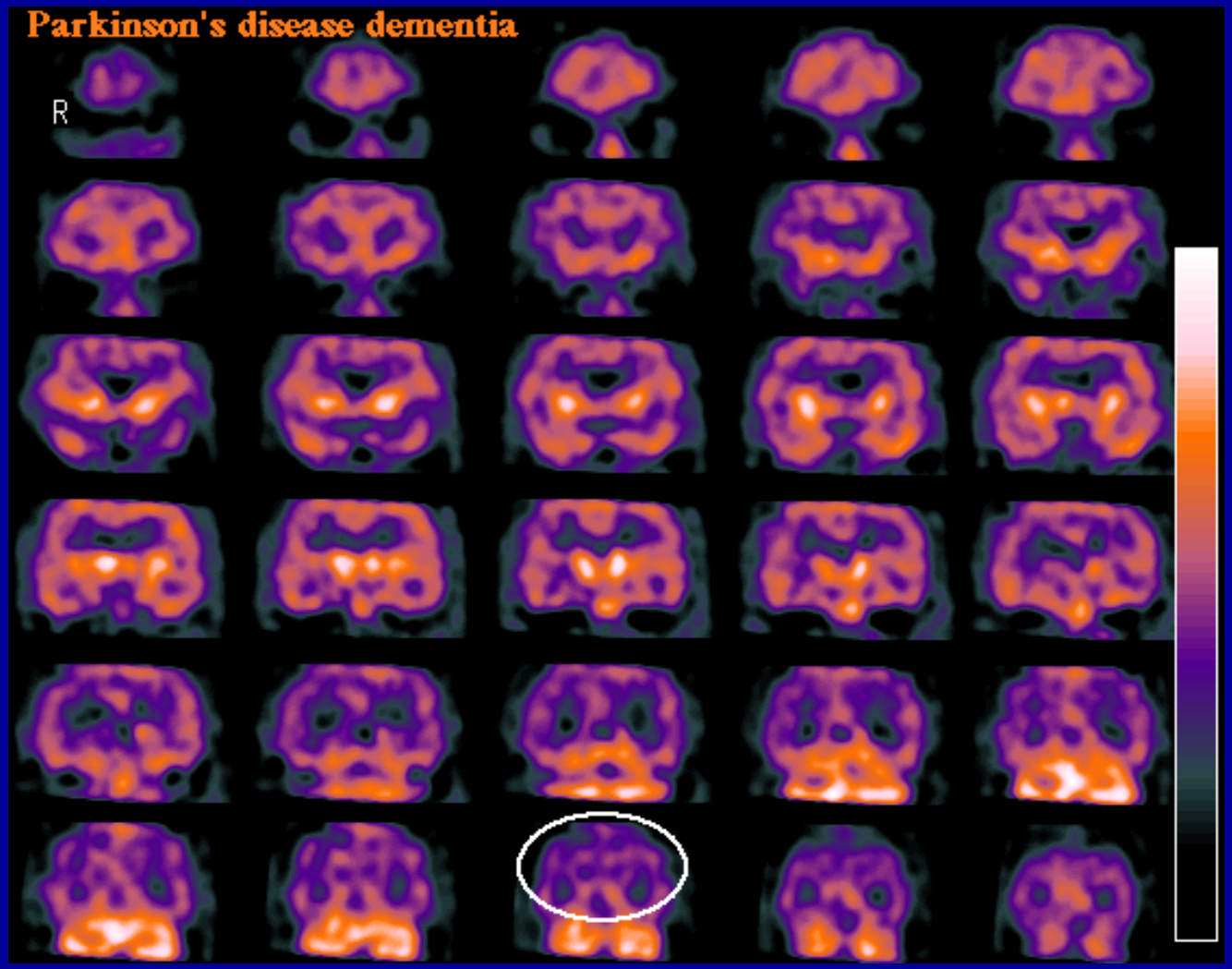
Male 88 g., Parkinson's disease, progressive loss of memory. Decreased perfusion in the back of the temporal and parietal lobes, bilaterally, and increased background activity.

Dementia of Parkinson's disease



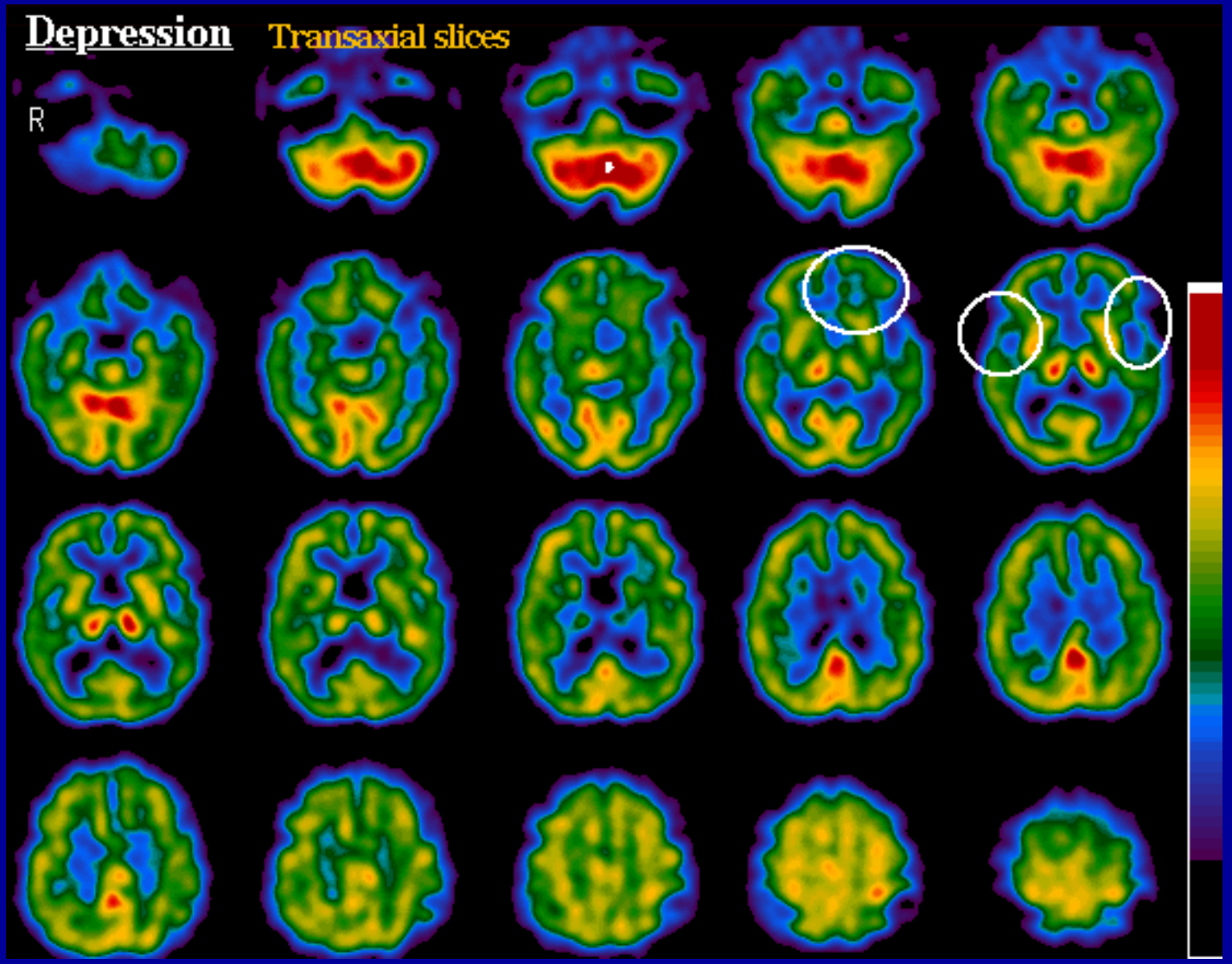
Male 88 g., Parkinson's disease, progressive loss of memory. Decreased perfusion in the back of the temporal and parietal lobes, bilaterally, and increased background activity.

Dementia of Parkinson's disease



Male 88 g., Parkinson's disease, progressive loss of memory. Decreased perfusion in the back of the temporal and parietal lobes, bilaterally, and increased background activity

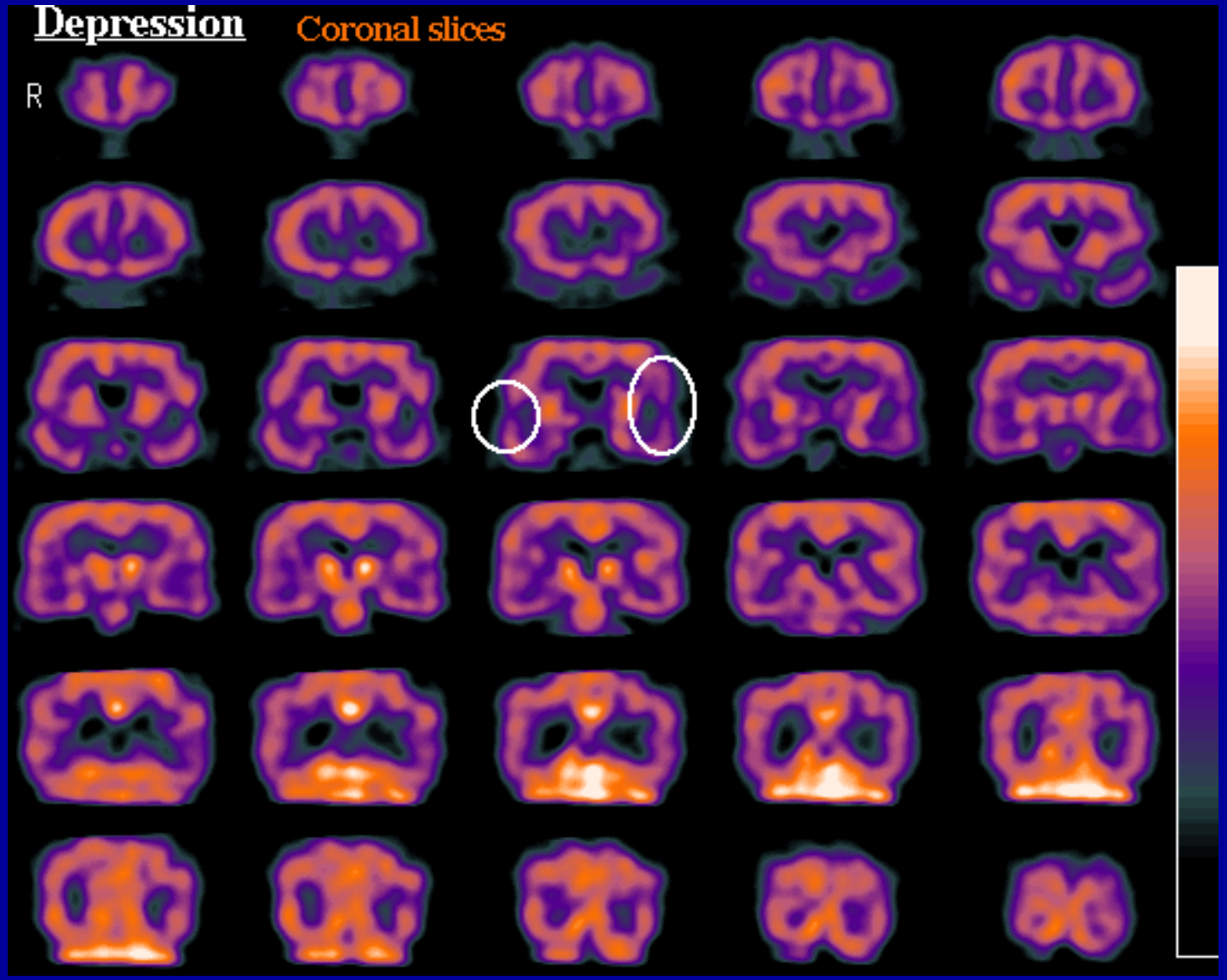
Depression



Male 86 g., Depression.

Decreased perfusion in the frontal temporal lobes bilaterally.

Depression

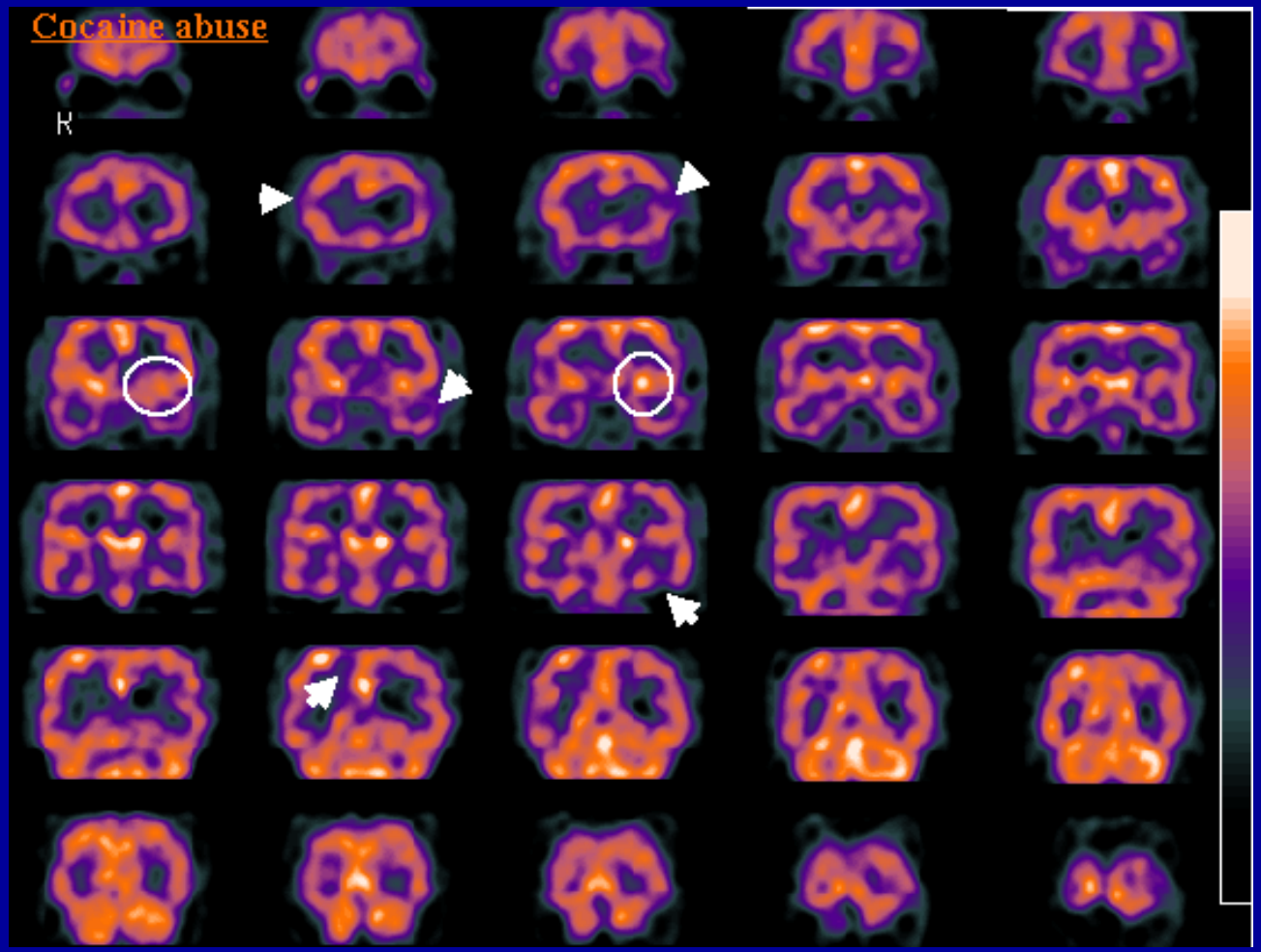


Male 86 g., Depression.

Decreased perfusion in the frontal temporal lobes bilaterally.

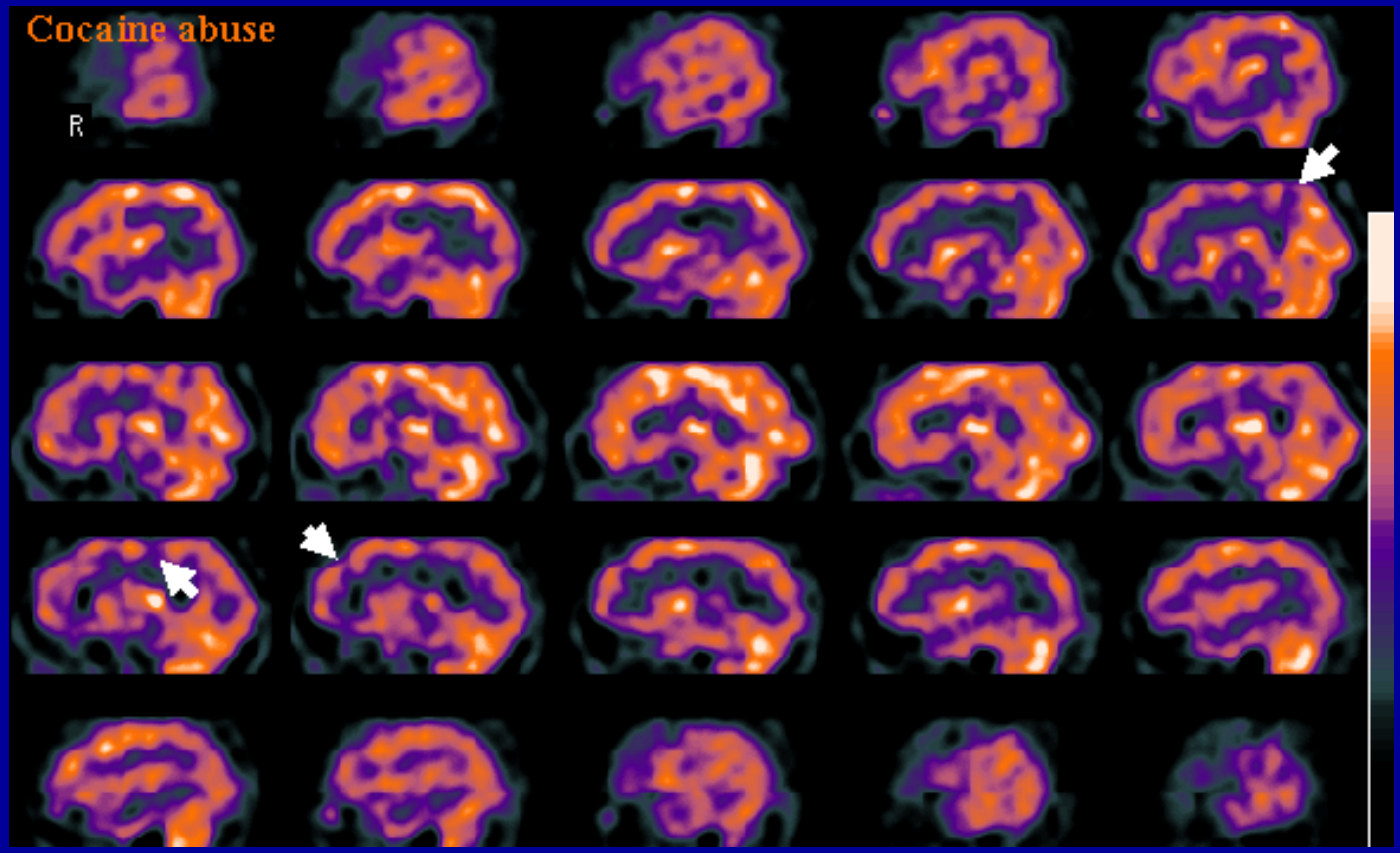
29 years old, 5 years cocaine addict

1. Globally decreased perfusion of the brain
2. Multiple defects of perfusion in the temporal cortex on both sides and in the lower parietal cortex to the left
3. The high background activity



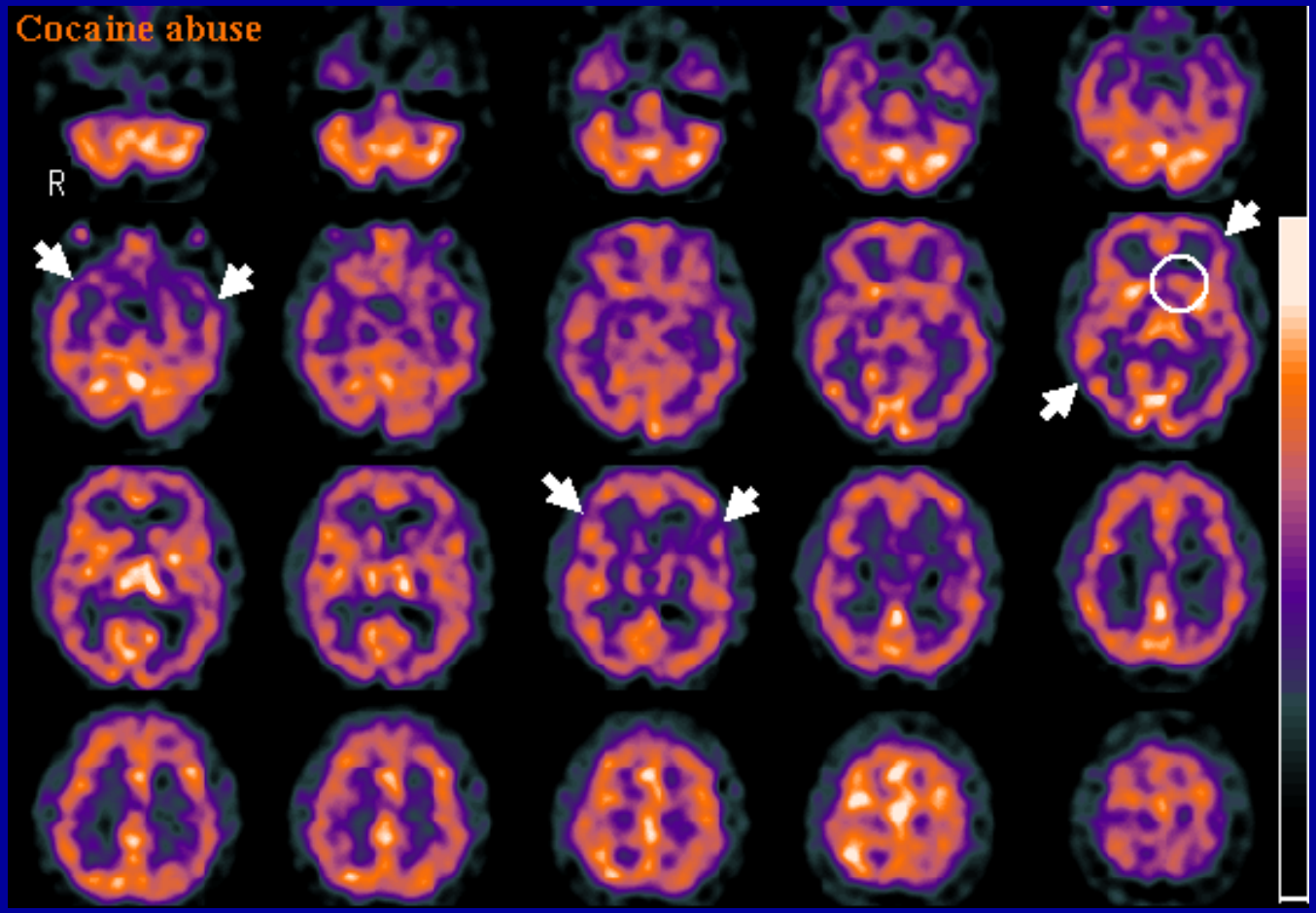
29 years old, 5 years cocaine addict

1. Globally decreased perfusion of the brain
2. Multiple defects of the perfusion in parietal cortex to the left
3. The high background activity



29 years old, 5 years cocaine addict

1. Globally decreased perfusion of the brain
2. Multiple defects in of the perfusion in the temporal cortex on both sides and in the lower and upper parietal cortex to the left
3. The high background activity



Receptor scintigraphy
Receptor scintigraphy in the diagnosis of Parkinson's disease

They are grouped based on location of dopamine metabolism they imaged:

1. Those who bind to the PRESYNAPTIC MEMBRANE - they are used for testing nigrostriatal presynaptic dopamine system:

   a) I-123 ioflupan (DaTSCAN; I-123] N-x-**F**luoro**P**ropyl- 2b-**C**arbomethoxy 3b-(4- **I**odophenyl) **T**ropane (**FP-CIT**)) : target dopamine transporter

   b) F-18-DOPA, precursor of dopamine. It serves to show regional distribution of the neurotransmitter dopamine, that is, the estimate presynaptic dopamine integrity

2. Bind to the POSTSYNAPTIC MEMBRANE (postsynaptic D2 receptor): I-123-IBZM (iodobenzamid), D2 receptor antagonist

Parkinson's disease

- Tremor (shaking)
- Rigor (arms, legs and neck muscle stiffness)
- Bradykinesia (slowing of movement)

Substantia nigra – the center of events

- Parkinson's disease is the result of a **progressive degeneration and death of brain cell**s in a pars compacta of the substantia nigra and **loss of black pigment neuromelanine.**

Substantia nigra – the center of events

- Parkinson's disease is the result of a **progressive degeneration and death of brain cells in a pars compacta of the substantia nigra and loss of black pigment neuromelanine.**

- Result of damage to brain cells that produce dopamine is **deficiency of dopamine in the nigrostriatal pathway** in the brain (almost 80 percent of overall dopamine).

- Another characteristic of pathological process is presence of Lewy bodies in areas of degeneration, but also in the whole brain mass.

- Because this part of the brain is responsible for controlling voluntary coordinated movements and for starting motor actions, involuntary movements are begining.

- The cause of cell death is unknown (free radicals, oxidative stress).

- Disturbed the balance between the dopaminergic and cholinergic mechanisms

- CORPUS STRIATUM :
  - NUCLEUS LENTIFORMIS (PUTAMEN AND GLOBUS PALLIDUS)
  - NUCLEUS CAUDATUS.

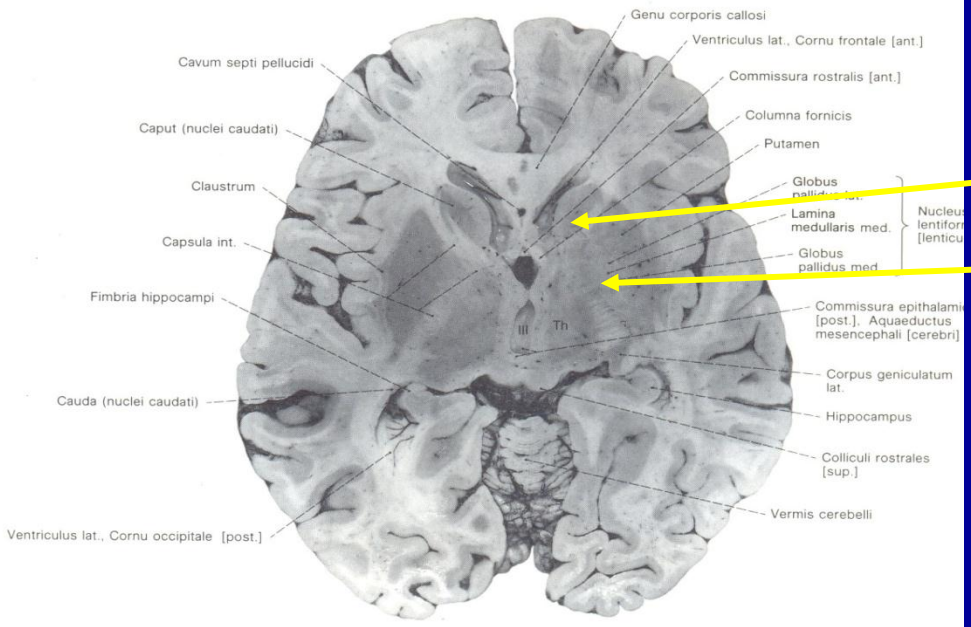


Fig. 517a. Horizontal section through the prosencephalon at the level of the capsula interna and the colliculi rostrales [superiores]. Arrow = fissura hippocampi, III = ventriculus tertius, Th = thalamus

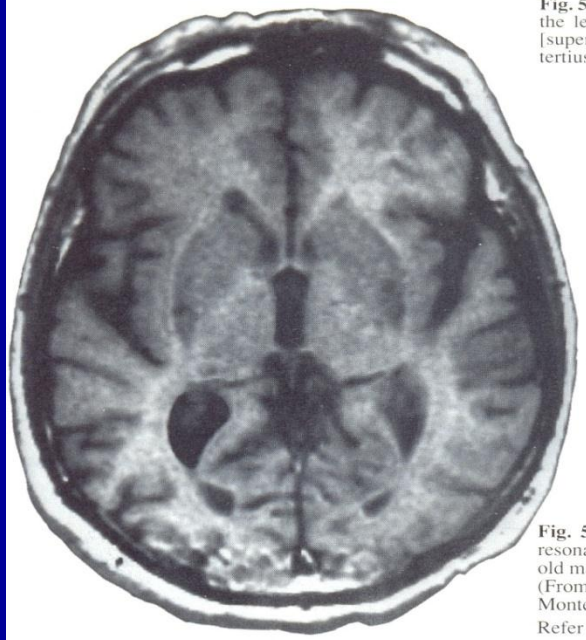


Fig. 517b. Magnetic resonance image (MRI) (Magnetic resonance system, General Electric). Brain image (19-year-old male) corresponding to the plane of section in Fig. 517a. (From: Dr. M. T. McNamara, Princess Grace Hospital, Monte Carlo, Monaco).

Refer to explanatory text in Vol. II, page 146.

CORPUS STRIATUM:

a) **Nucleus caudatus**

b) **Nucleus lentiformis: Putamen i Globus pallidus**

Parkinson's disease is not manifested until the level of dopamine in the striatum has fallen by more than 80 percent, corresponding to the loss of brain cells in the substantia nigra of 50-60 percent.

Epidemiology of Parkinson's disease

- PD is the third most common neurological disorder.
- It occurs in 1% of the population older than 60 years.
- Today, about 2 mill. people suffering from PD in the world

Etiology of Parkinson's disease

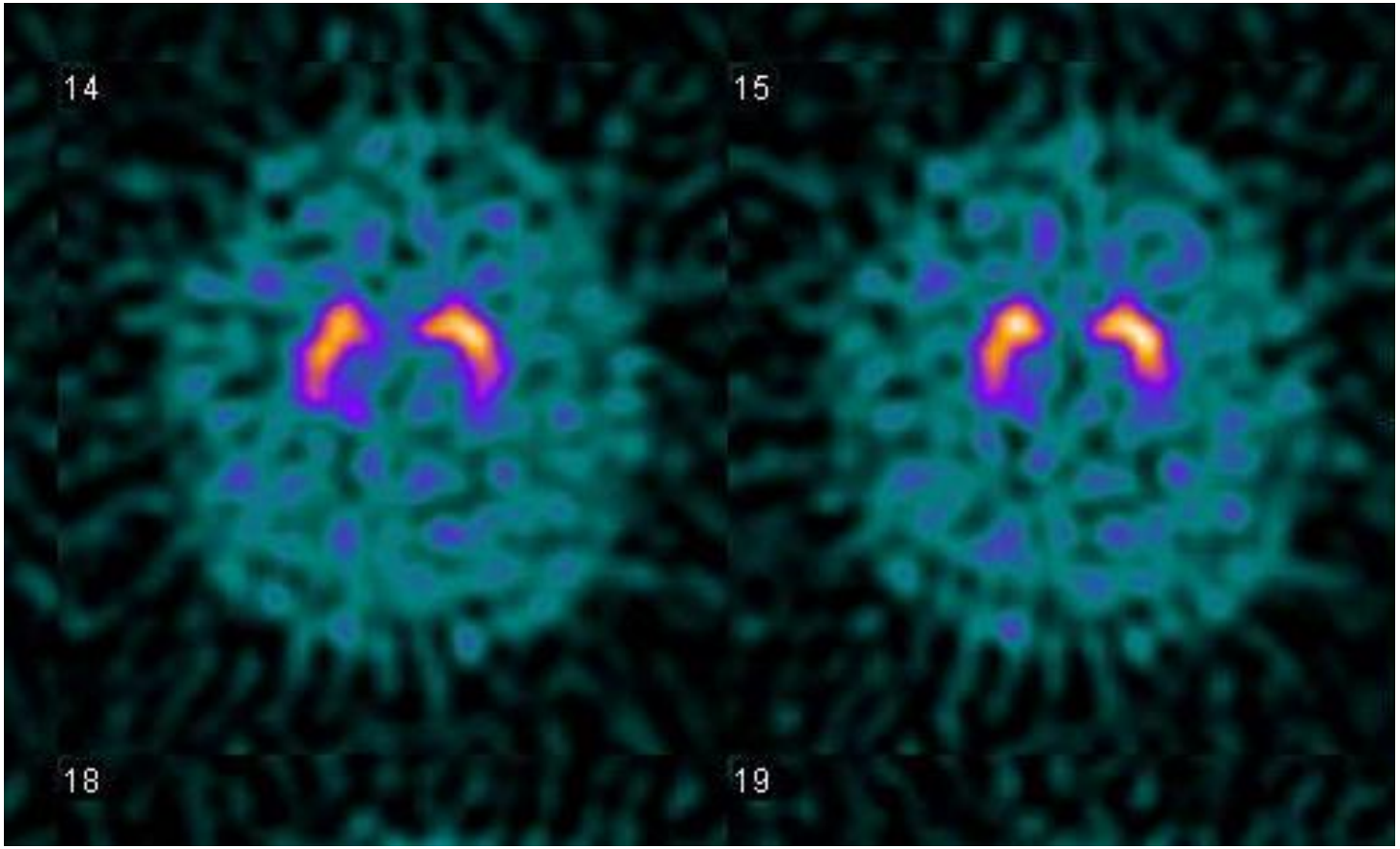
a) genetic factors

b) environmental factors

The integrity of presynaptic receptors - IOFLUPAN I-123 (DaTSCAN)

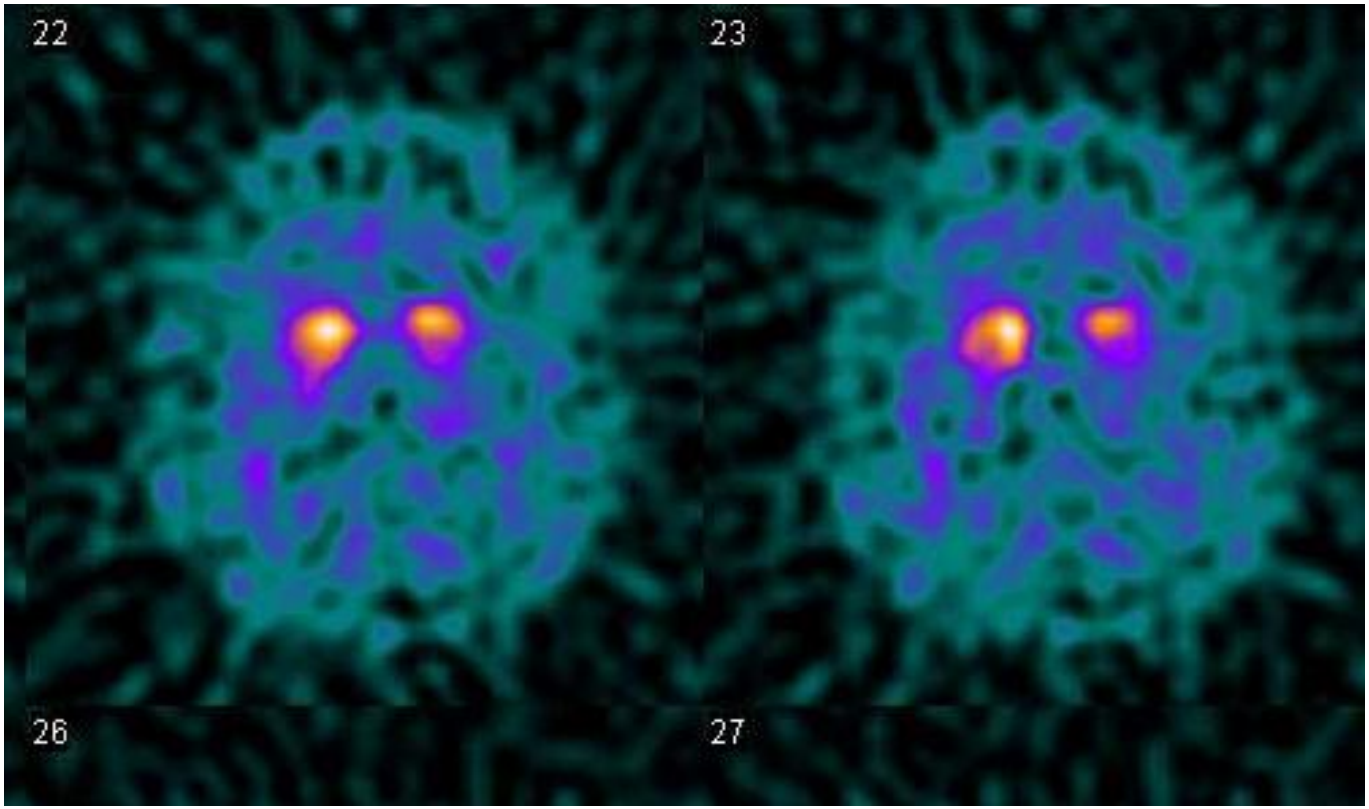
- IOFLUPAN I-123 (DaTSCAN) is given iv., at a dose of 111-185 MBq slowly (15-20 sec.). The bottle contains 185 or 370 MBq of ioflupane.
- Imaging is 3-6 hours after iv. application
- Effective dose for 185 MBq (I-123) is 4.35 mSv.

Normal findings of DaTSCAN



Homogeneous activity in the nucleus caudate and putamen (corpus striatum) which is characteristic for preserved presynaptic dopaminergic system and exclude neurodegenerative disease.
The finding points to the essential tremor or secondary parkinsonism (medications, infections, trauma, vascular, ..).

DaTSCAN: Parkinson’s disease

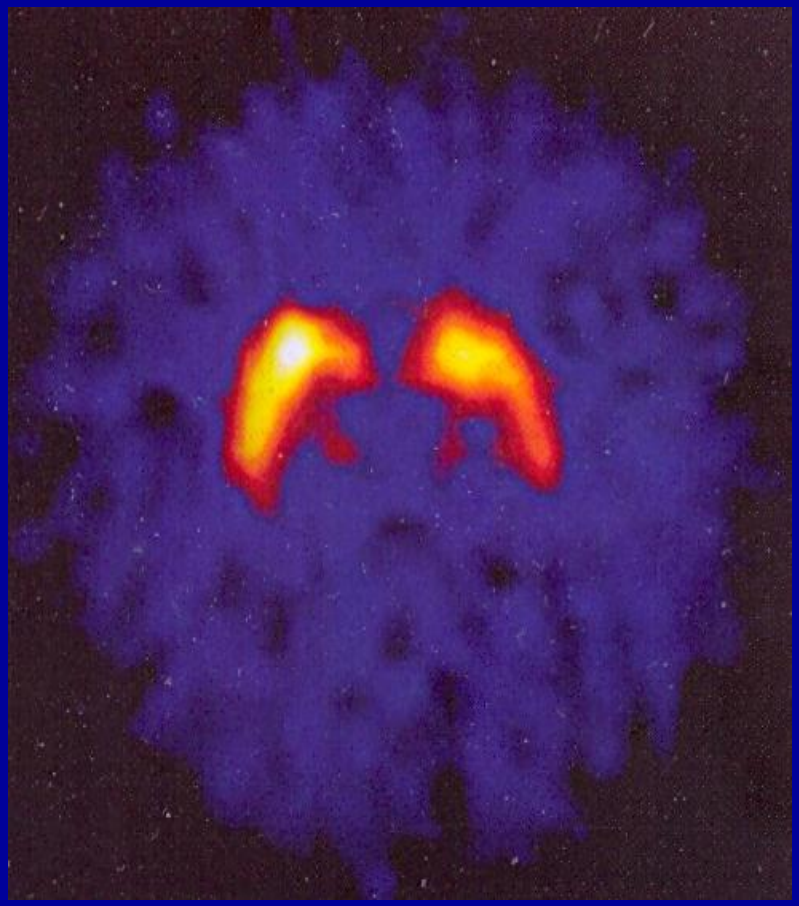


Activity is only in the head of the caudate nucleus indicating a medium heavy damage of the nigrostriatal presynaptic dopamine system - medium severe form of Parkinson's disease (or another neurodegenerative disease accompanied by Parkinson's syndrome: Multisystemic atrophy, progressive supranuclear palsy and corticobasal degeneration).

I-123 ioflupan: 3 stages of PD

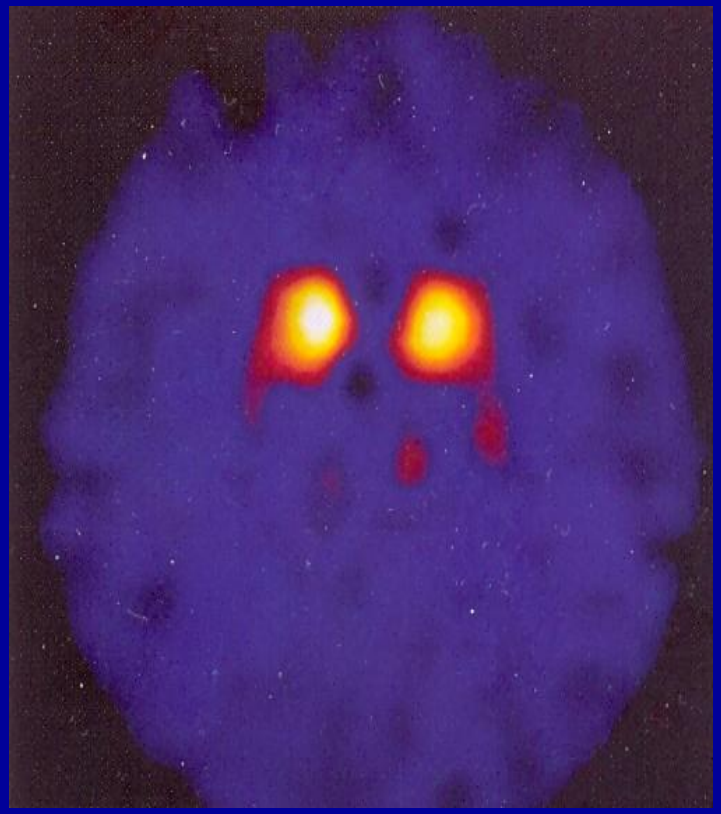
- Grade 1: asymmetric uptake, only in one hemisphere decreased uptake in the putamen, in another hemisphere normal or nearly normal results
- Grade 2: bilateral significantly reduced uptake in the putamen with normal act. in n. caudatus
- Grade 3: reduced uptake bilaterally in the putamen and n. caudatus

I-123 ioflupan- DaTSCAN: 3 stages of PD



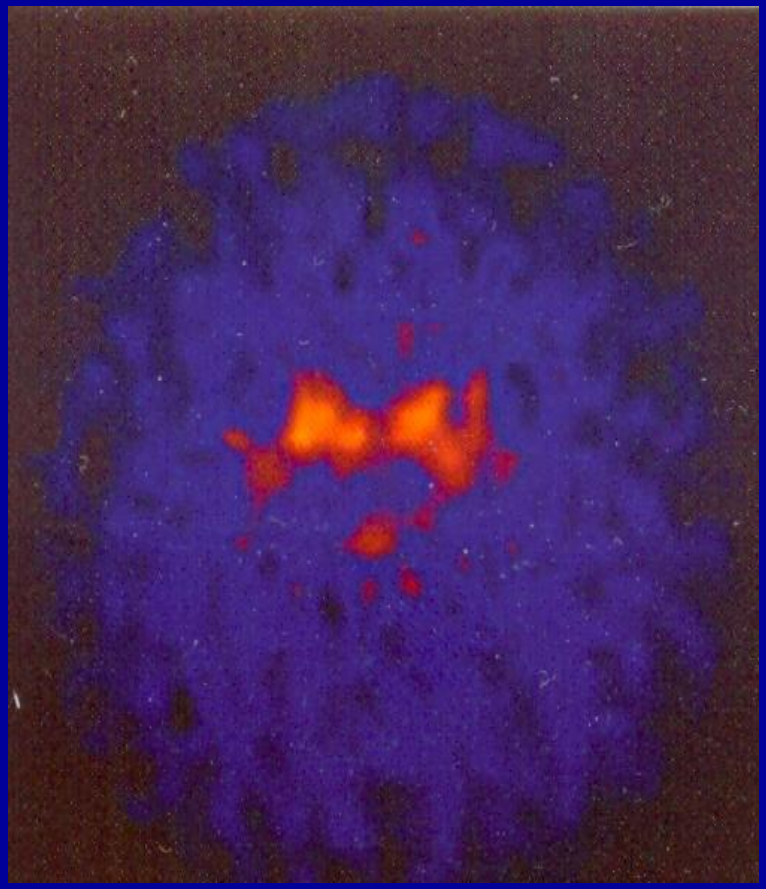
Stage 1: asymmetric uptake, only in one hemisphere decreased uptake in the putamen, in another hemisphere normal or nearly normal results

2. Stage of PB



Stage 2: bilaterally significantly reduced uptake in the putamen with normal act. in n. caudatus

3. Stage of PB



Stage 3: reduced uptake bilaterally in the putamen and n. caudatus

Differential diagnosis

- Parkinsonian syndrome, other neurodegenerative diseases:
  - MSA: multisystemic atrophy
  - PSP: progressive supranuclear palsy
  - CBD: corticobasal degeneration

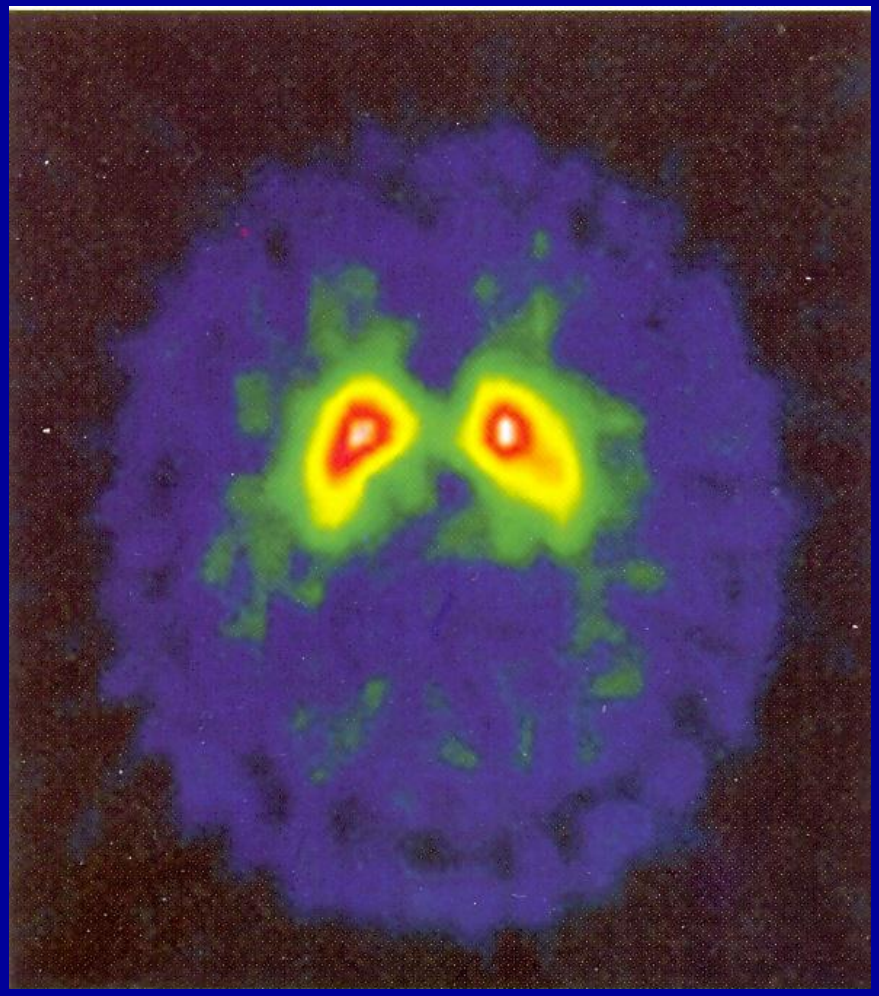
DaTSCAN positive

- Other etiology tremor:
  - drug induced
  - psychogenic
  - essential
  - vascular
  - dystonia
  - orthostatic

DaTSCAN negative

Other etiology tremor

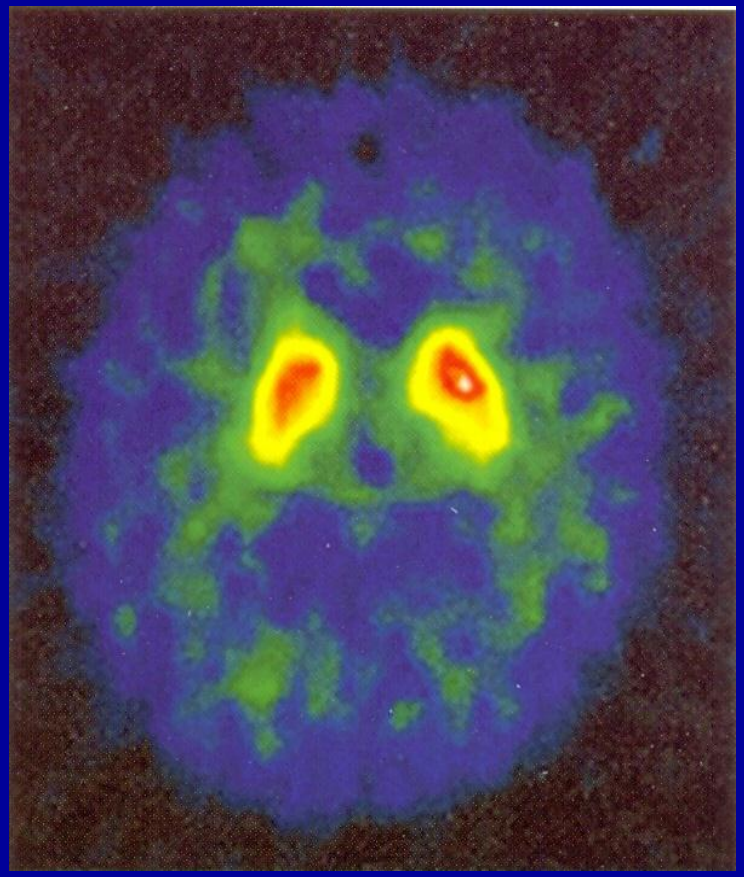
- I-123 ioflupan DaTSCAN
  - essential
  - psychogenic
  - Drug induced
  - vascular
  - dystonia
  - orthostatic



Normal findings

Integrity of postsynaptic receptors
I-123-benzamid

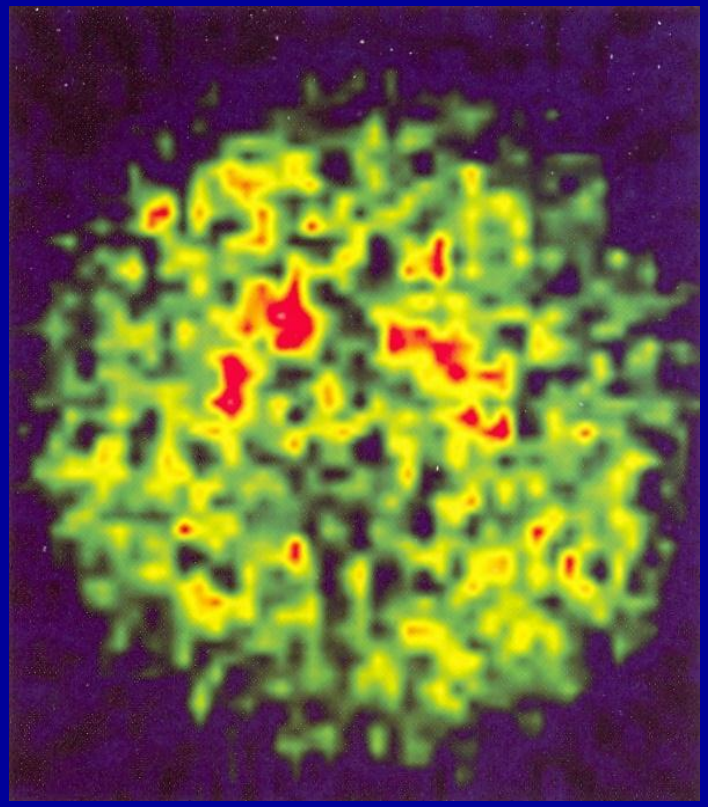
- I-123-IBZM



Parkinson's disease: normal findings

Integrity of postsynaptic receptors I-123-benzamid

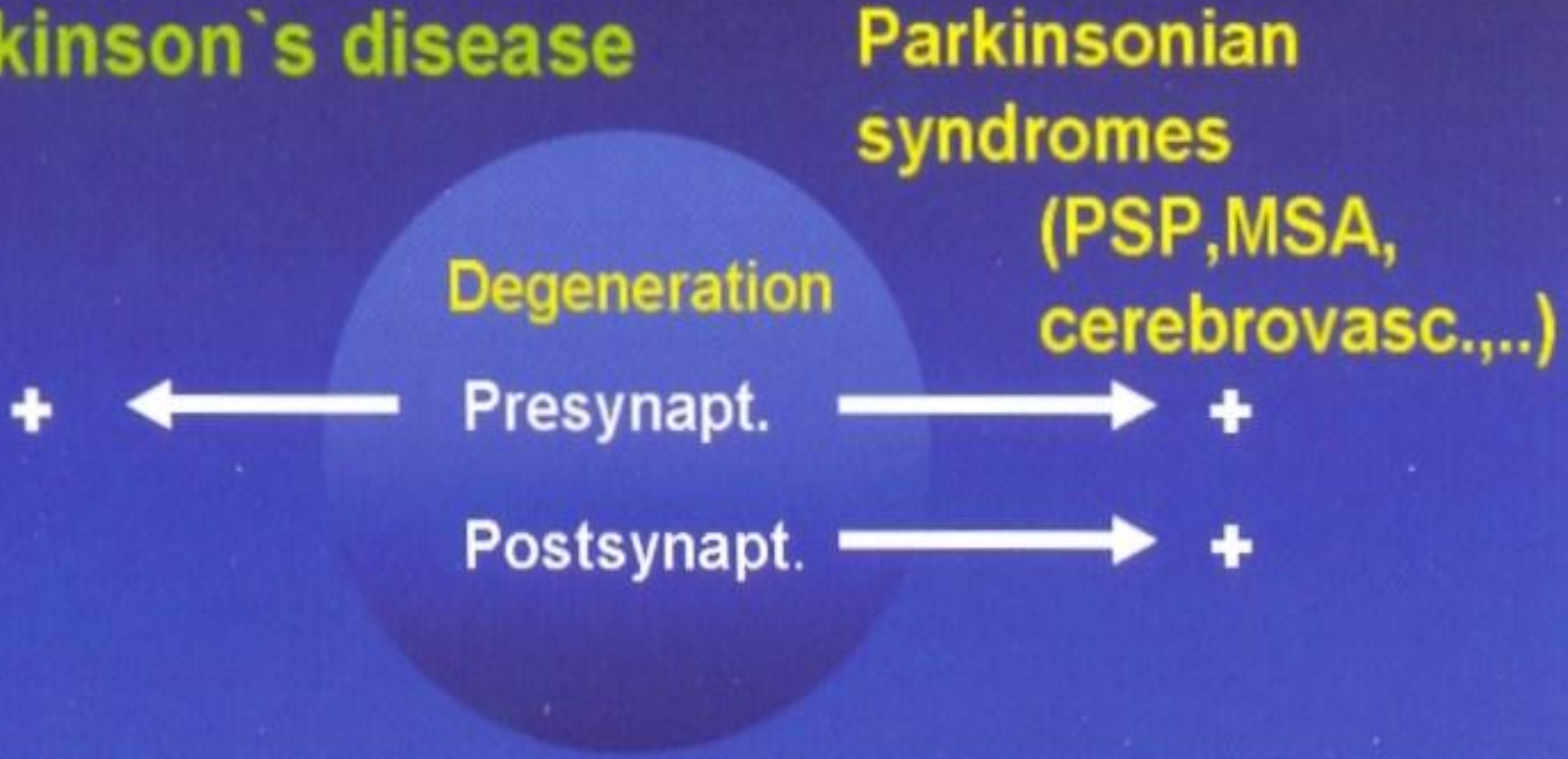
- I-123 IBZM



Decreased accumulation:

a) atrophy,
b) progressive supranuclear palsy
c) corticobasal degeneration

Differential diagnostics of Parkinsonism



Differential diagnostics

Parkinson`s disease

Essential Tremor,
Drug induced PS

Degeneration

Presynapt.

Postsynapt.

DaTSCAN pathol.

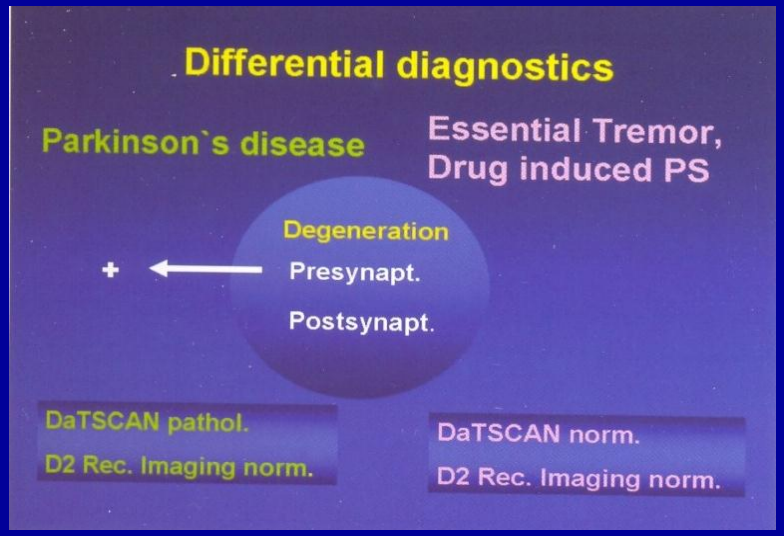
D2 Rec. Imaging norm.

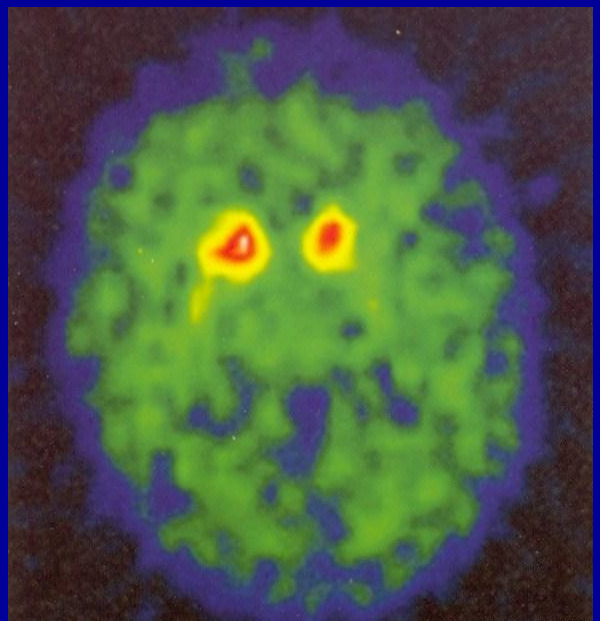
DaTSCAN norm.

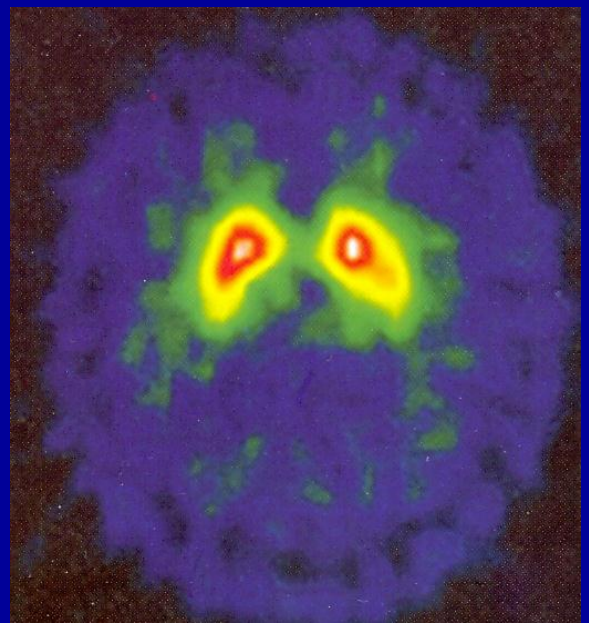
D2 Rec. Imaging norm.

I-123 ioflupan (DaTSCAN)

Oher etiology tremor:
- Drug induced
- psychogenic
- essential
- vascular
- dystonia
- orthostatic

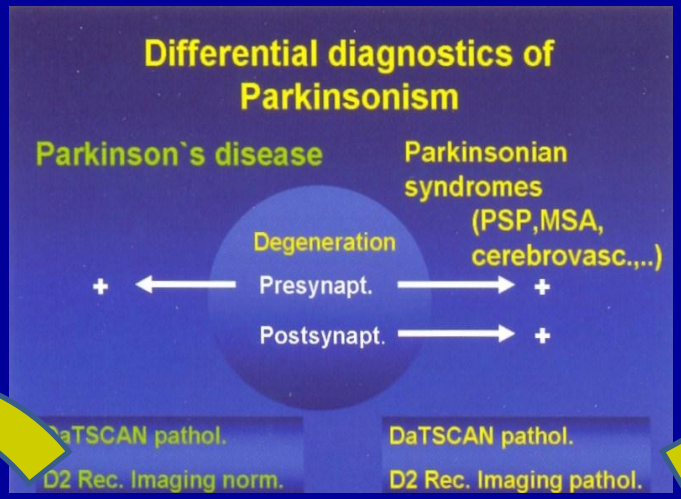


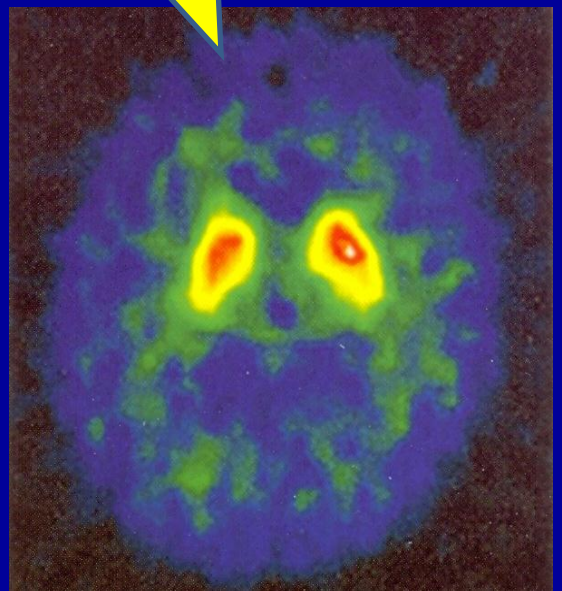


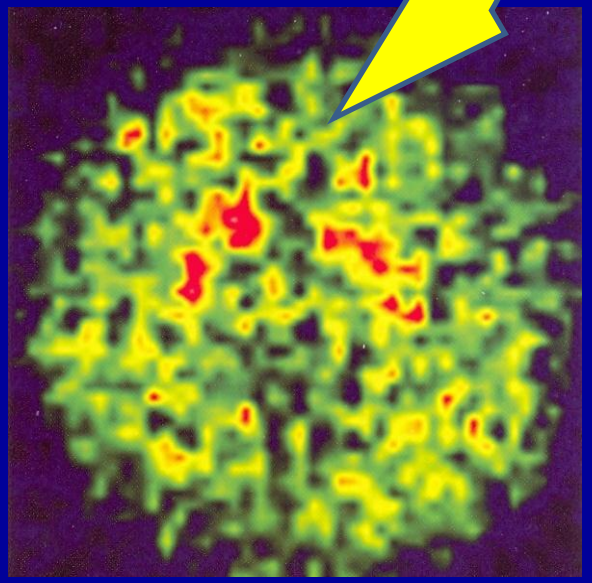


I-123-IBZM (iodobenzamid)

MSA: multisystemic atrophy
PSP: progressive supranuclear palsy
CBD: corticobasal degeneration







DaTSCAN

- HIGH SENSITIVITY: 97% of Parkinson's syndrome was identified with DaTSCAN .
- HIGH SPECIFICITY: no case of essential tremor was misdiagnosed as Parkinson's syndrome.
- Simple, fast, serious side effects have not been reported, there is no need for the reduction of anti-Parkinsonian drugs.
- Expensive !!!!!!!!

OTHER DIAGNOSTIC POSSIBILITIES
Dementia with Lewy bodies (DLB)

Dementia with Lewy bodies (DLB) is a form of dementia that has some of the characteristics of Alzheimer's and Parkinson's disease. Includes 10% of elderly dementia.

DaTSCAN will in patients with dementia with Lewy bodies resulting from nigrostriatal degeneration, be positive while in patients with Alzheimer's dementia is going to be negative.

Sensitivity 78% and specificity of 94% in differentiating between DLB and AD.

Positron Emission Tomography of the brain

- Examination of regional cerebral blood flow and volume
- The metabolism of oxygen and glucose
- Protein synthesis
- Neurotransmitter systems and neuroreceptors system

Radionuclides-pharmaceuticals

Positron emitters, cyclotron production

- C-11 (20,4 min)
- N-13 (9,96 min)
- O-15 (122 sec)
- F-18 (110 min)

Four groups of radiopharmaceuticals

1. Those who exceeding blood-brain barrier:
   - Ga-68
   - N-13 – glutamat
   - Rb-82

2. For cerebral perfusion:

- O-15 – water
- N-13
- O-15 – Carbon monoxide (marking the erythrocytes)

3. For measurement of glucose metabolism:

- 18 - fluorodeoxyglucose (enters in the first part of glucose metabolism pathway)
- C-11 - glucose

4. For examination of neurotransmitters

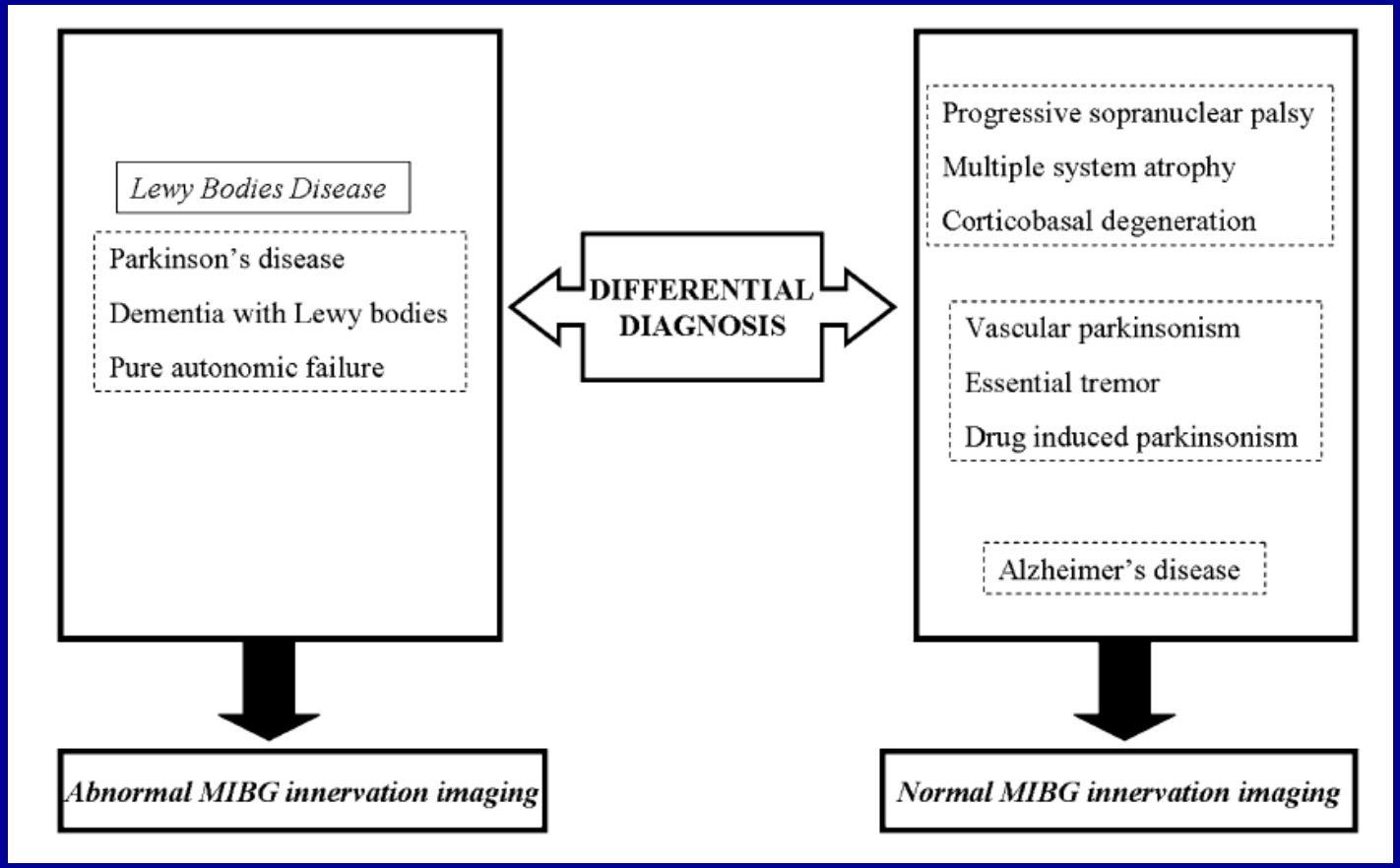
Clinical application

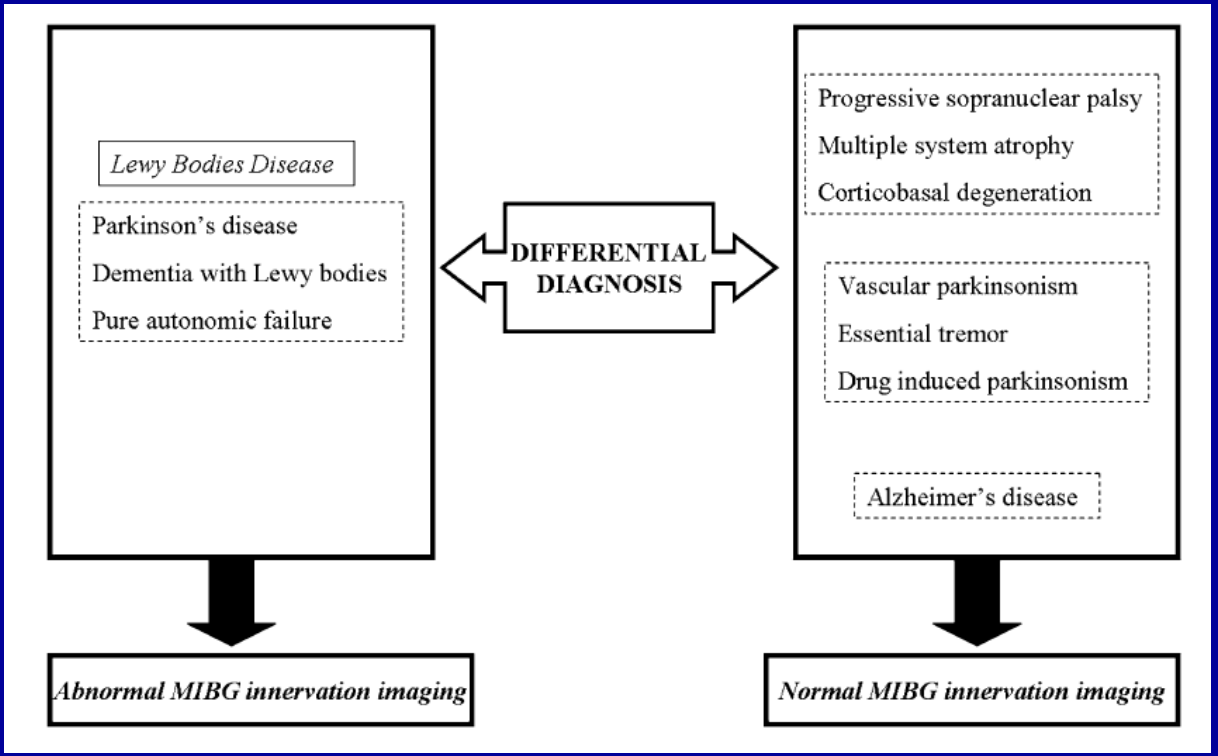
- Epilepsy
- Parkinson's disease
- Brain stroke
- Dementia
- Schizophrenia
- Tumors
- Testing of normal physiology

Testing myocardial innervation

- MIBG is a structural analogue of norepinephrine by which is enabled non-invasive assessment of adrenergic innervation of the heart
  - MIBG (metajodobenzilgvanidin) – marked by a J-131 or J-123
  - Dose **I-131** MIBG =18,50 MBq (0,5 mCi) i.v.
  - Dose **I-123** MIBG 185 MBq (5mCi) J-123 i.v.
  - Imaging after 15 min. and after 3-4 hours (static scintigraphy or SPECT).

Sympathetic myocardial innervation





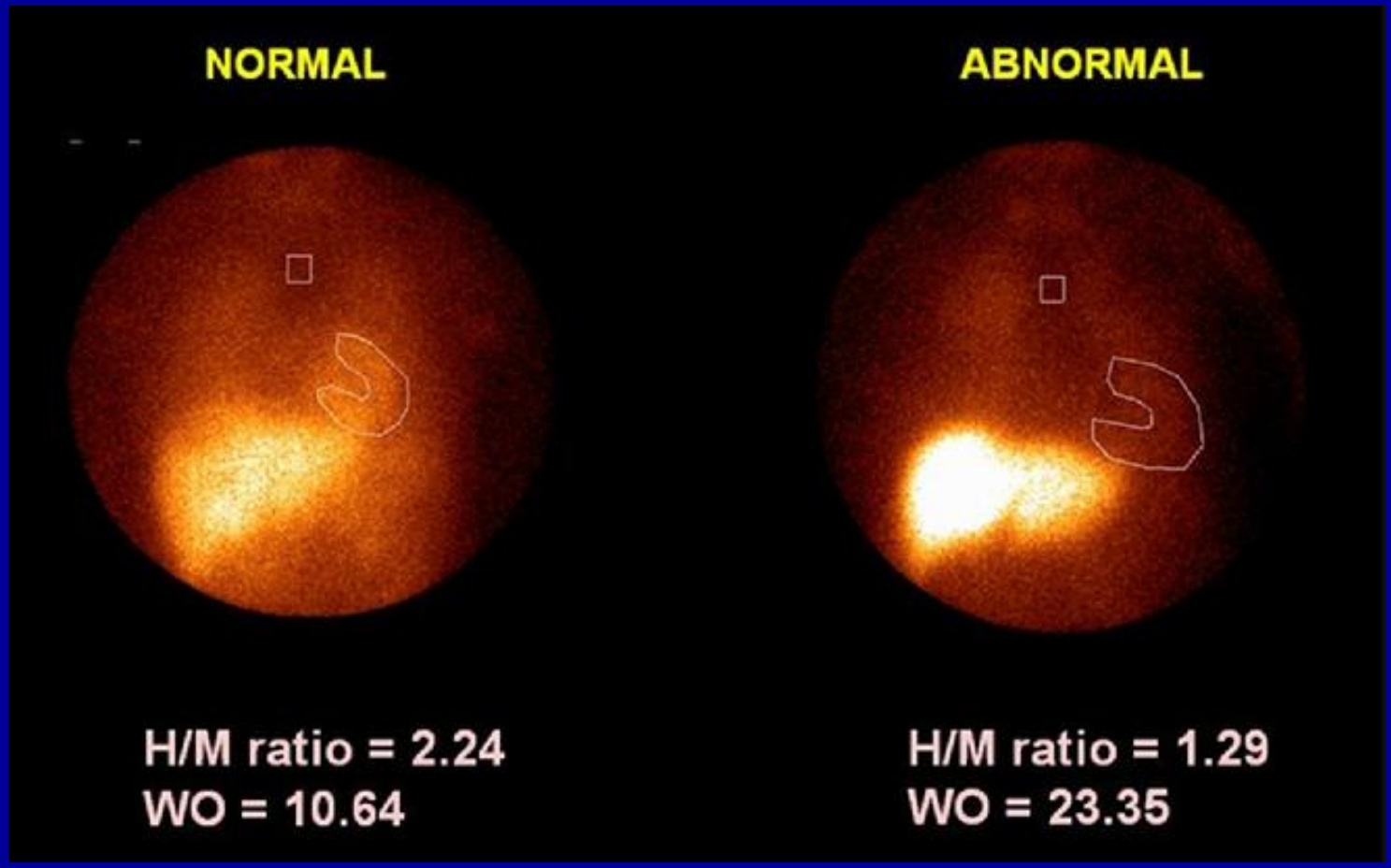
Indications:

1. Differential diagnosis between Parkinson's disease (PD) and Parkinson's syndrome (other neurodegenerative diseases witch are presenting with extrapyramidal syndrome: multiple system atrophy (MSA), corticobasal degeneration (CBD) and progressive supranuclear palsy (PSP)

2. Diff. dg. between PD and other forms of parkinsonism (vascular parkinsonism, essential tremor, drug induced tremor

3. Diff. dg. of Lewy bodies dementia and Alzheimer's dementia

4. Diff. dg. Of Lewy bodies dementia and PD: a MIBG uptake was more decreased in DLB than in PD



Examples of planar cardiac 123I-*MIBG images. The example* on the left shows normal cardiac 123I-*MIBG uptake with a H/M ratio* of 2.24 and a normal tracer washout (WO) from initial to delayed images of 10.64%. The example on the right shows an abnormal H/M ratio of 1.29 with an abnormal tracer washout of 23.35%.

THE END!