

Ajutüve tuumad

Uku-Laur Tali
Rad. res. II

Juttu tuleb

Tuumad, mis on tänapäevasel piltdiagnostikal eristatavad

Norm - hallaine signaal, erisused eraldi välja toodud

Patoloogia - suurem rõhk signaalimuutustele, väiksem rõhk üksik-koldelistele muutustele (infarkt, tu jm).

Pigem keskendub tuumaspetsiifilistele muutustele, vähem globaalsetele

Corpus striatum (juttkeha)

Nucl. caudatus, putamen, (globus pallidus)

Ekstrapüramidaalsüsteemi motoorne tuum

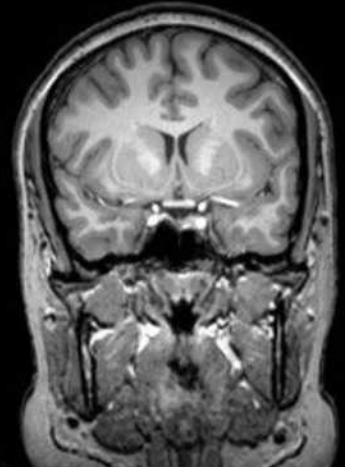
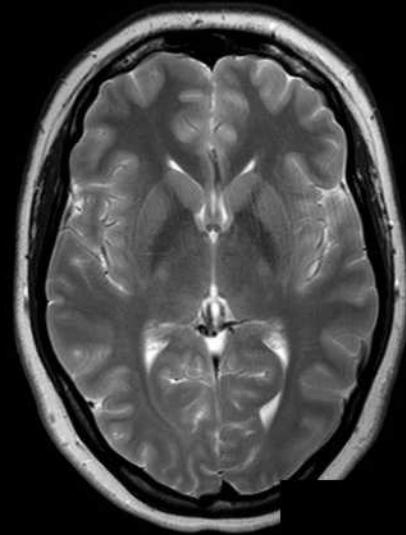
Tasusüsteemid

Atroofia - MSA-P

(parkinsoni tüüpi multisüsteemne atroofia),

Huntington

Putameni nekroos - metanooli mürgistus



Parkinsonismi atroofia

Motoorsete sümptomite puhul

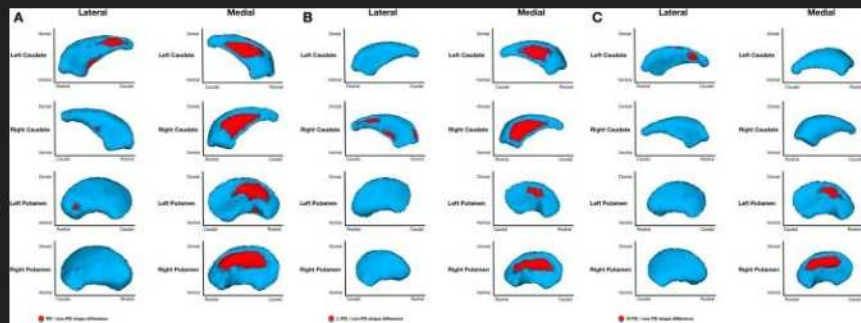
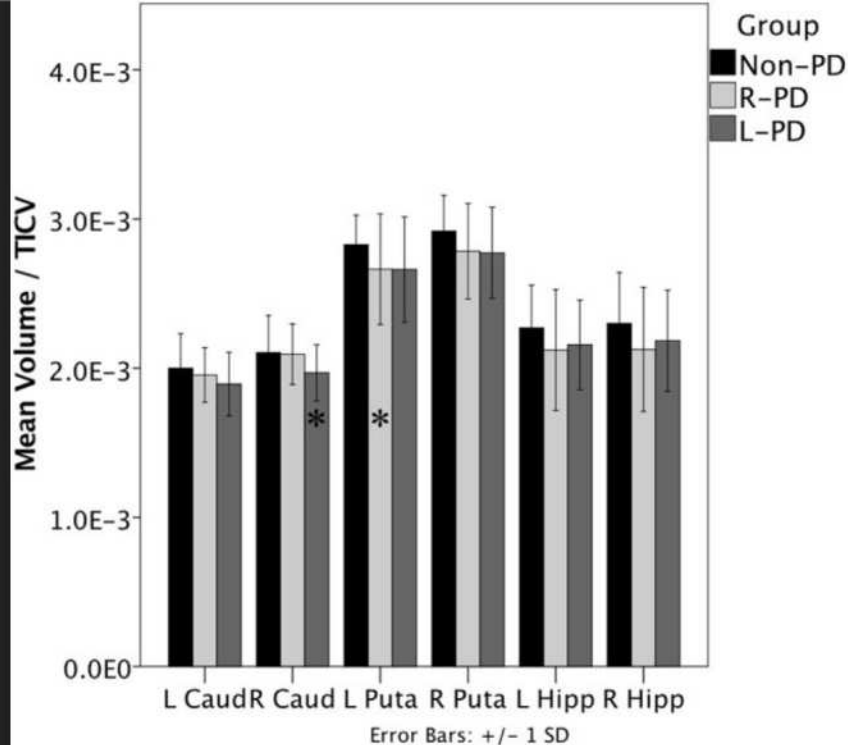
MSA-P

Ruumala / intrakraniaalse ruumalaga

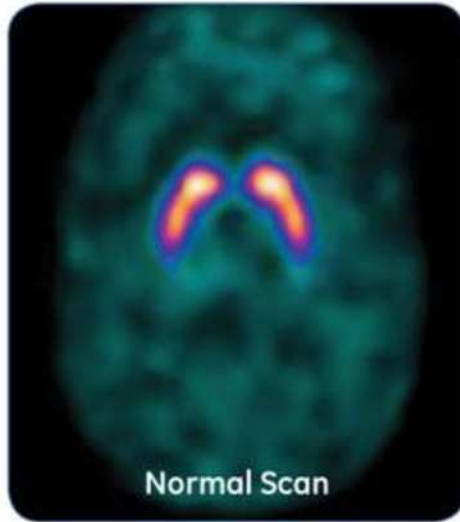
Põhirõhk keskaju ekstrapür. tuumadele,
millest allpool.

Jood-123 ioflupane (DaTSCAN)

Tanner, Jared J et al. "Striatal and Hippocampal Atrophy in Idiopathic Parkinson's Disease Patients without Dementia: A Morphometric Analysis." *Frontiers in neurology* vol. 8 139. 13 Apr. 2017



DaTSCAN



Normal Scan
"Comma"-shaped
Possible essential tremor



Abnormal Scan
"Period"-shaped
Possible parkinsonian syndrome

MSA-P vs muud parkinsonismi tüübid

T2* + keskmine difusioon - 96% täpsusega MSA-P ja muude alatüüpide eristamiseks.

	Volume	R2* (s-1)	MD (× 10-3 mm2/s)
Putamen			
PD	4.24 ± 0.30	29.81 ± 4.60	0.75 ± 0.08
MSA-tot	3.81 ± 0.56	33.86 ± 4.60	0.82 ± 0.10
MSA-P	3,68 ± 0.58	34.37 ± 4.04	0.88 ± 0.08
MSA-C	3.98 ± 0.51	33.24 ± 5.30	0.75 ± 0.07
PD vs MSA-tota	P < 0.002	P < 0.002	P < 0.003
PD vs MSA-P vs MSA-Cb	P < 0.004c	P < 0.006d	P < 0.001e

Barbagallo, G. , Sierra-Peña, M. , Nemmi, F. , Traon, A. P., Meissner, W. G., Rascol, O. and Péran, P. (2016), Multimodal MRI assessment of nigro-striatal pathway in multiple system atrophy and Parkinson disease. *Mov Disord.*, 31: 325-334.

Huntington

Autosoomne dominantne haigus, CAG kordused

Striatumi ruumala vähenemine ja ADC signaali tõus korreleerub haiguse raskusega

Tüüpiline sabatuumaa atroofia ja sellest tingitud ajuvatsakeste eessarvede laienemine; Juveniilse vormi korral peale sabatuumaa ka putamen.

MR spektroskoopiaal laktaadi tõus ja NAA/ kreatiniini suhte langus.

FDG-PET uuringul aktiivsuse langus enne atroofiat

Telford R, Vattoth S. MR anatomy of deep brain nuclei with special reference to specific diseases and deep brain stimulation localization. *Neuroradiol J.* 2014;27(1):29–43. doi:10.15274/NRJ-2014-10004

Huntington

FH/CC normi üleminek: 2,2 - 2,6

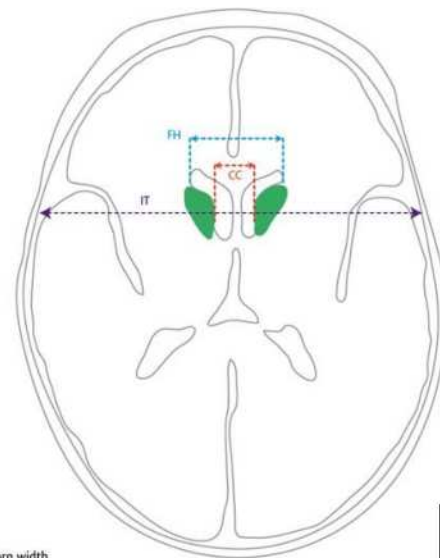
CC/IT normi üleminek: 0,09 - 0,12

(CC vahemiku vähim kaugus)

Ei ole täiesti spetsiifiline - k.a.
muud atroofiad

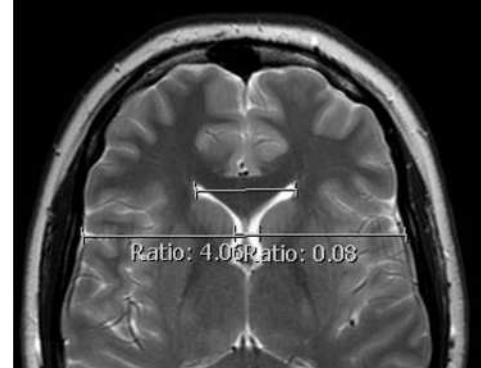
(Nt. Nasu Hakola haigus)

Berti, Valentina et al. "PET/CT in diagnosis of movement disorders." *Annals of the New York Academy of Sciences* 1228 (2011): 93-108 .

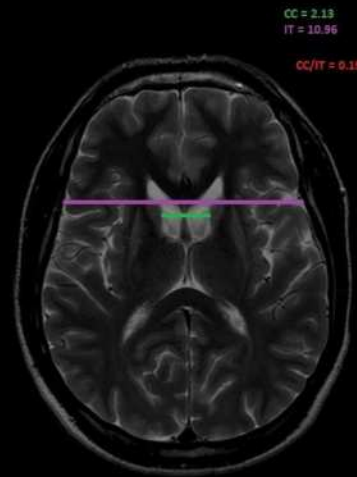
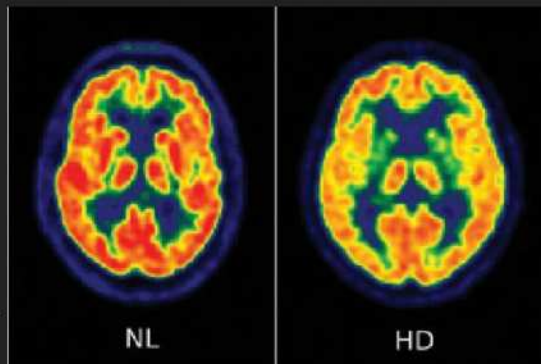


FH = frontal horn width
CC = intercaudate distance
IT = inner table width

Radiopaedia.org



TÜK



Globus pallidus

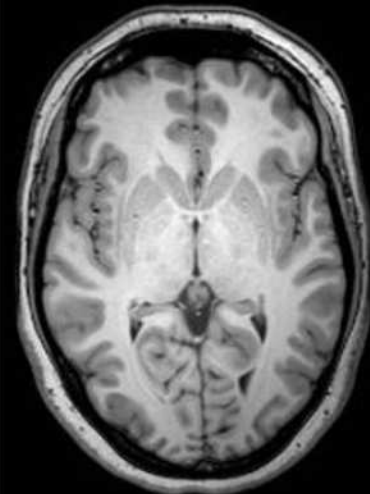
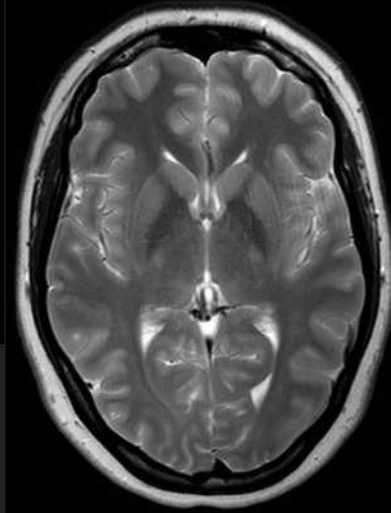
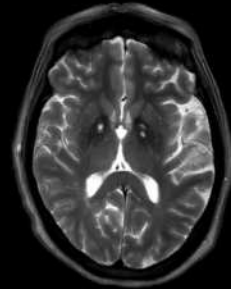
Pars externa, pars interna

T2 signaal võrreldes putameniga madalam - rauasisalduse tõttu

Mangaani ladestus - krooniline hepaatiline entsefalopaatia

T2 hüperintensiivsus - isheemiline kahjustus - vingugaasi mürgistus

Tiigrisilma tunnus - raua kogunemine + keskosa gliosis (pigem mittespetsiifiline, ebakindel tunnus) - seostatakse pantotenaat-kinaas tüüpi neurodegeneratsiooniga



Telford R, Vattoth S. MR anatomy of deep brain nuclei with special reference to specific diseases and deep brain stimulation localization. *Neuroradiol J.* 2014;27(1):29–43. doi:10.15274/NRJ-2014-10004

Hepaatile entsefalopaatia

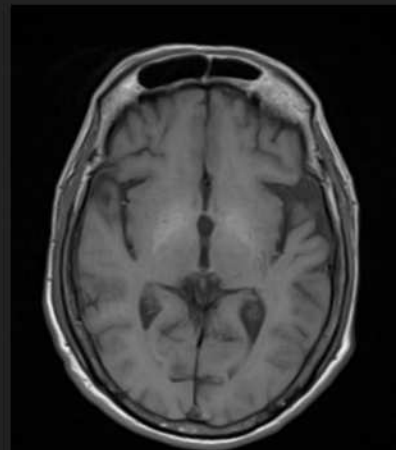
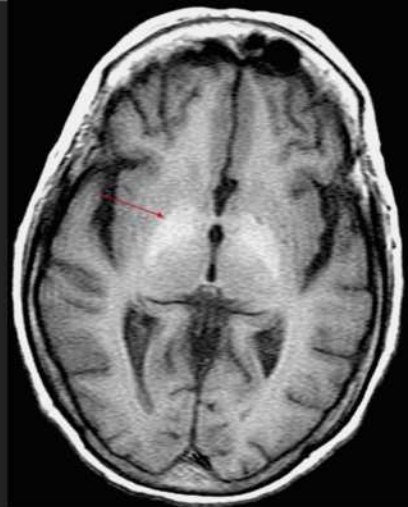
Äge maksapuudulikkus -> astrotsüütide suurenenud ammooniumi sissevõtt -> glutamiiniks -> osmootse rõhu tõus -> turse

Kortikaalsete struktuuride T2 intensiivsuse tõus
(v.a. perirolandiline ja oksipitaalne piirkond)

Krooniline HE - tsirroos või pikaajaline täielik parenteraalne toitmine

GB T1 hüperintensiivsus mangaani ladestumise tõttu

Tagasipööratav protsess (nt. maksasiirdamisega)



BG T1 hüperintensiivsus

- Kaltsium
 - Idiopaatiline
 - Ainevahetushäired
- Maksapuudulikkus
 - Hepatotserebraalne
 - Wilsoni tõbi (vask)
- Toksiinid / isheemia
 - CO
- Hüperglükeemiaga seotud kooreaballism 2 - pigem neostriatumis
- Gadoliinium
- Globaalne hüpoksia
- Veri
 - ICH
 - Hemorraagiline transformatsioon (infarkt)
- Jaapani entsefaliit
- Hamartoom (neurofibromatoos 1)

Vingugaasi mürgistus

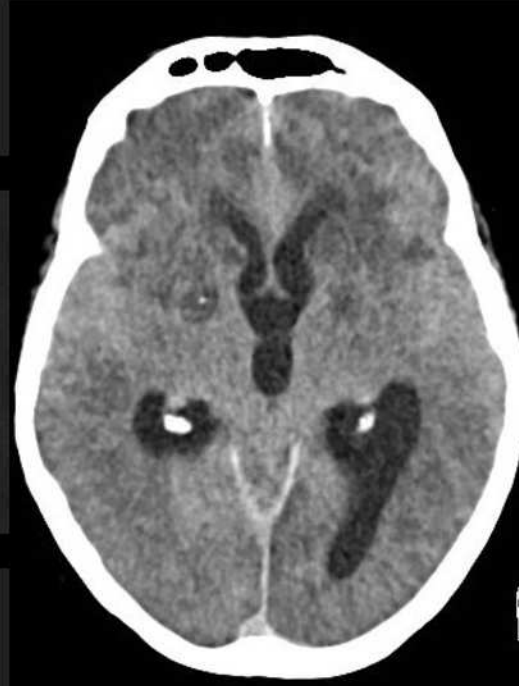
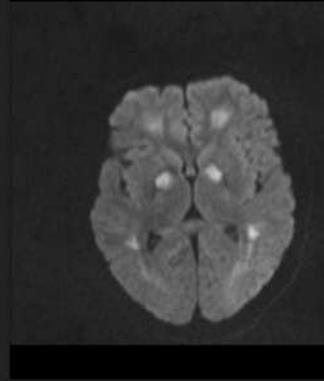
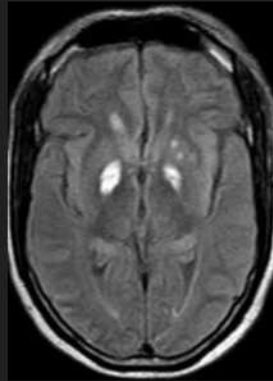
Väljendunud isheemia korral - globaalne hüpoksilis-isheemiline kahjustus

TÜK

Enimlevinud on globus palliduse kahjustus, lisaks valgeaine.

T2 hüperintensiivne, diffusiooni restriksioon

DDx rõhk muudel tuumadel



Telford R, Vattoth S. MR anatomy of deep brain nuclei with special reference to specific diseases and deep brain stimulation localization. *Neuroradiol J.* 2014;27(1):29–43. doi:10.15274/NRJ-2014-10004

BG T2 hüperintensiivsus

LINT mnemoonik

Lümfoom

Isheemia

Neurodegeneratiivne / metaboolne

Toksiline

BG T2 hüpointensiivsus

ChOMP mnemoonik

Põhiliselt raua ladestumine

- Childhood hypoxia
- Old age
- Multiple sclerosis
- Parkinson disease: enam globus pallidus
- Parkinson-plus syndrome: more in putamen
- Verdumised, hemosideriin
- Kaltsium

BG kaltsifitseerumine

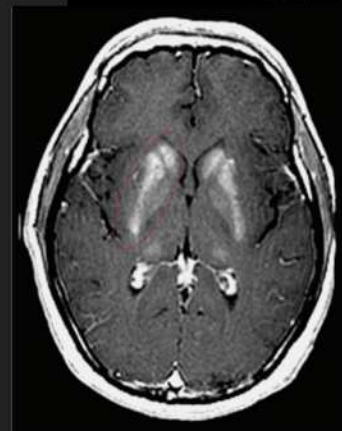
Väga palju erinevaid põhjuseid (idiopaatilised, toksilised, infektsioossed, metaboolsed, päritavad, vaskulaarsed)

Patoloogiliseks saab lugeda alla 40 aastastel patsientidel

Nucl caudatus, putamen, nucl dentatus, pulvinari
lubistused - mõelda nt. pseudohüpoparatiireoidism, Fahr
sündroom, Fabry tõbi, kaltsiumi ainevahetushäired



TÜK



Telford R, Vattoth S. MR anatomy of deep brain nuclei with special reference to specific diseases and deep brain stimulation localization. *Neuroradiol J.* 2014;27(1):29–43. doi:10.15274/NRJ-2014-10004

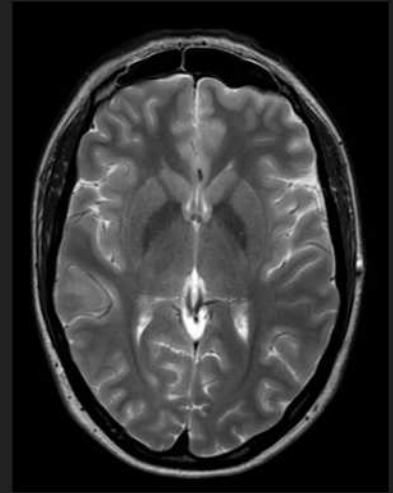
Talamus

Koorealune tunde- ja integratsioonikeskus, üle 100 tuuma (A. Lepp)

Peamine jaotus: nucl anteriores, mediales, ventrolaterales, reticulares, posteriores

Bilateraalsete T2 hüperint. kollete puhul ddx eelkõige -
tuumor, isheemia, veenitromboos

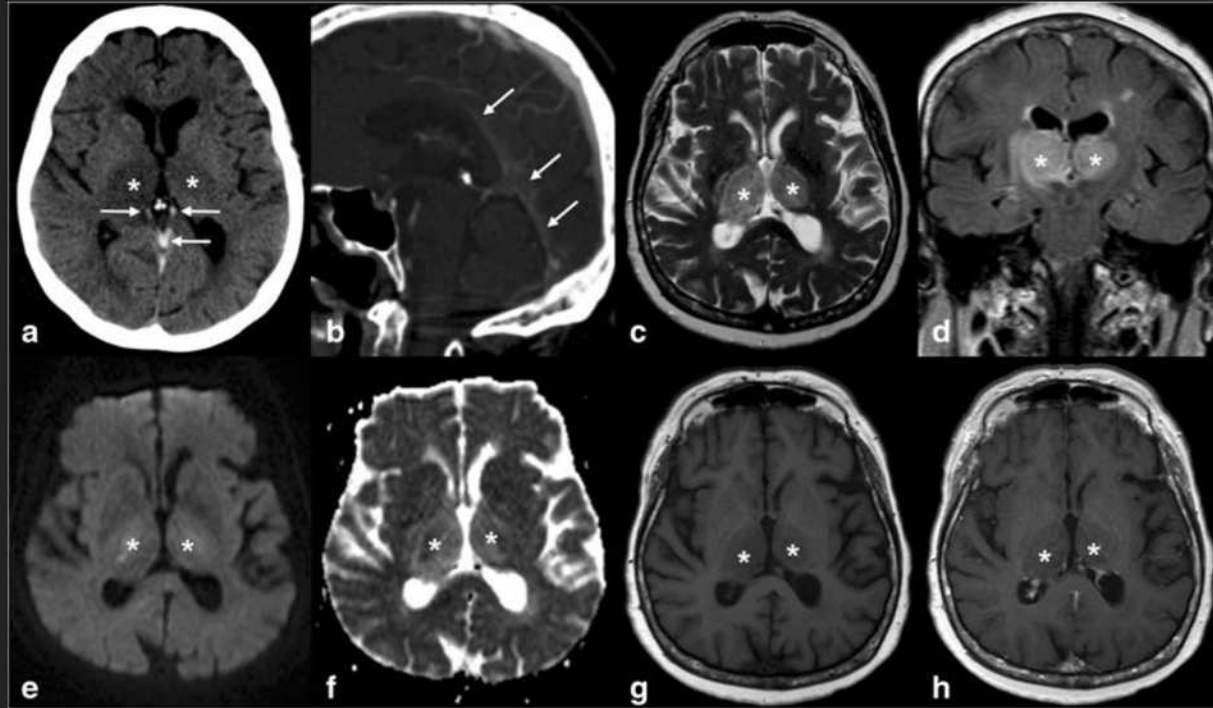
Pulvinari ja dorsomediaalsete tuumade T2 hüperintensiivsus
- Creutzfeld-Jakobi tõi (hokikepi tunnus)



Telford R, Vattoth S. MR anatomy of deep brain nuclei with special reference to specific diseases and deep brain stimulation localization. *Neuroradiol J.* 2014;27(1):29–43. doi:10.15274/NRJ-2014-10004

C. Tuttle, J. Boto; Neuroimaging of acute and chronic unilateral and bilateral thalamic lesions; *Insights into Imaging* 2019; <https://doi.org/10.1186/s13244-019-0700-3>

Siinustromboos



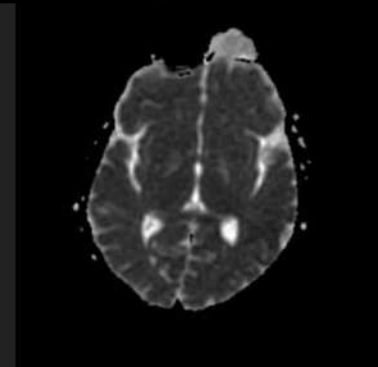
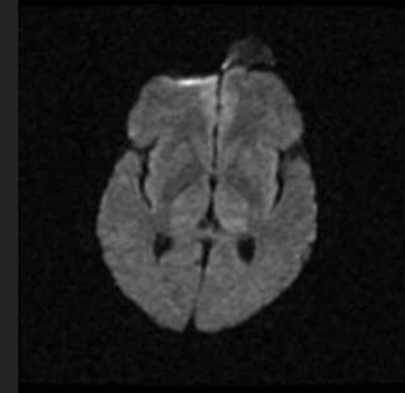
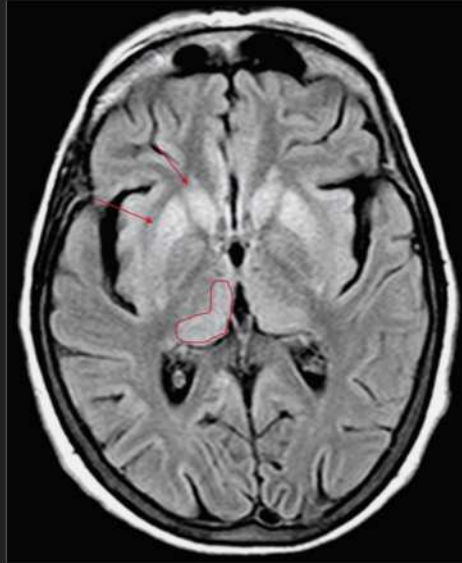
Creutzfeld-Jakob tõi

T2 hüperintensiivsed kolded korteksis, basaalganglionides, valgeaines

Talamuses - hokikepi tunnus

Püsiv diffusiooni restriksioon

FDG-PET hüpometabolism



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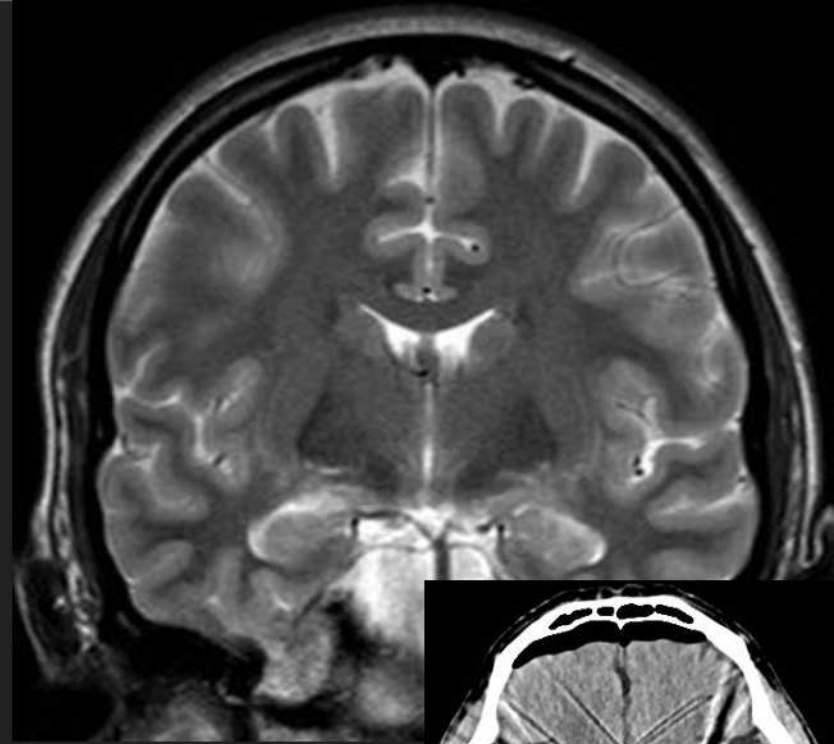
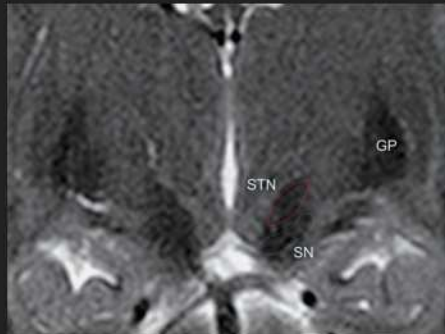
Subtalaamiline tuum

Ekstrapüramidaalne tuum

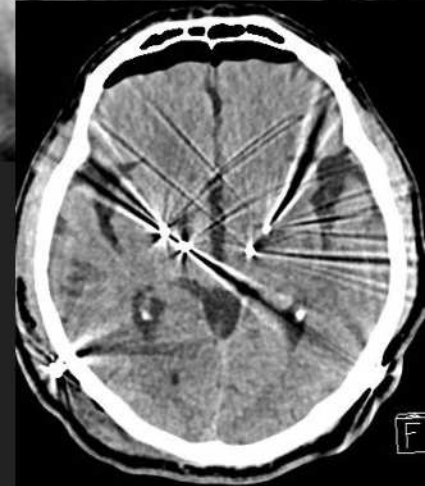
Raua tõttu T2 hüpointensiivne

Koronaarne tasapind mammillaarkehade joonel

Parkinsonismitüüpide süvastimulatsioonravi



TÜK



Mammillaarkehad

Limbiline süsteem

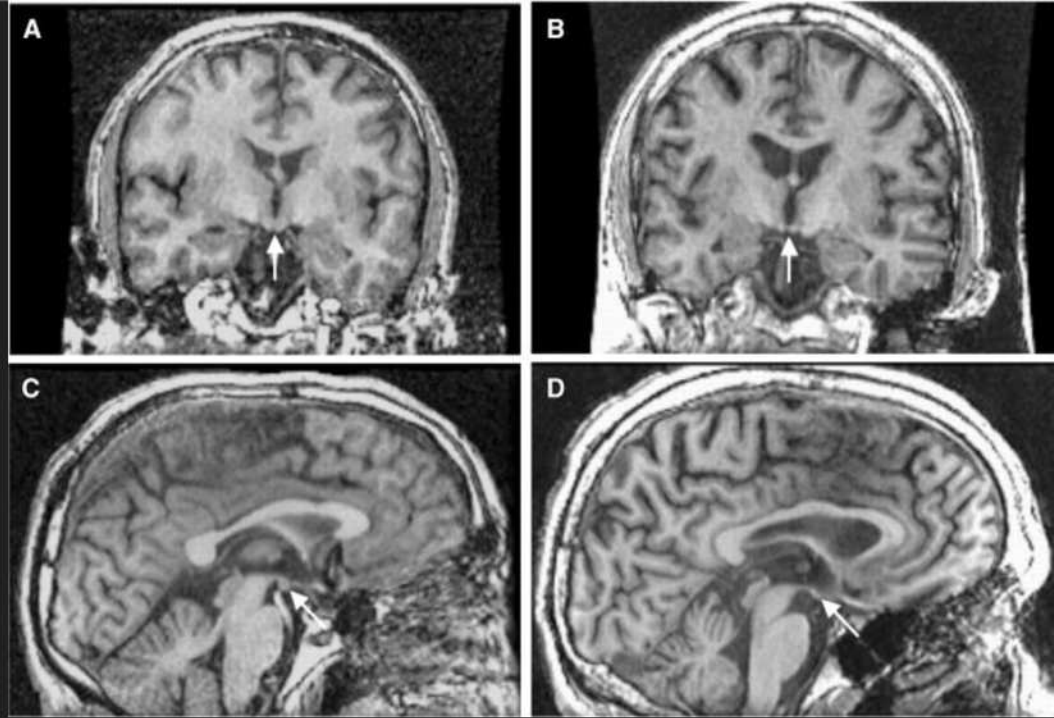
Anatoomiline pidepunkt nt
hippokampuse atroofia vaatamisel

Atroofia - mesiaalse temporaalse
skleroosi sekundaarne tunnus

Wernicke-Korsakoffi sündroom

Lesioonid - amneesia (nt.

Wernicke-Korsakoff sündroom)



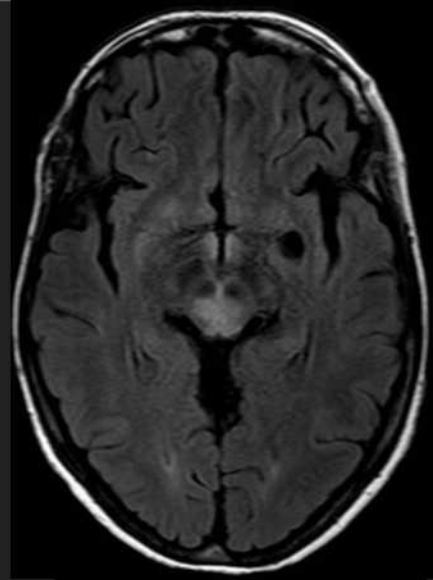
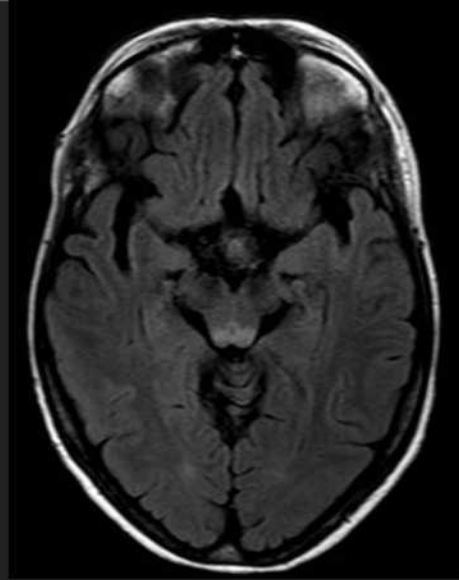
Sullivan EV, Pfefferbaum A. Neuroimaging of the Wernicke-Korsakoff syndrome. *Alcohol Alcohol.* 2008;44(2):155–165. doi:10.1093/alcalc/agn103

Wernicke-Korsakoff

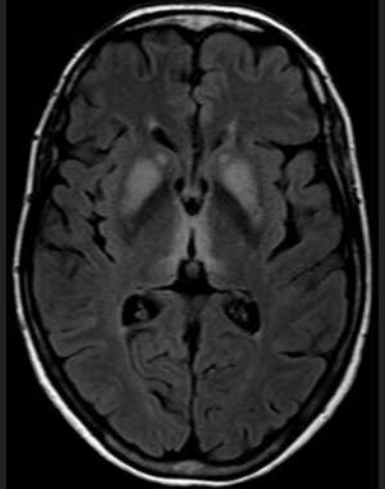
B1 vitamiini puudus

T2 hüperintensiivsus tüüpiliselt
mammillaarkehades, periakvedukti
hallaine, talamus (III vatsakese ümbrus),
tectum, colliculi

Ebatüüpiliselt võib olla haaratud ka pons,
väikeaju ja hippokampus



TÜK



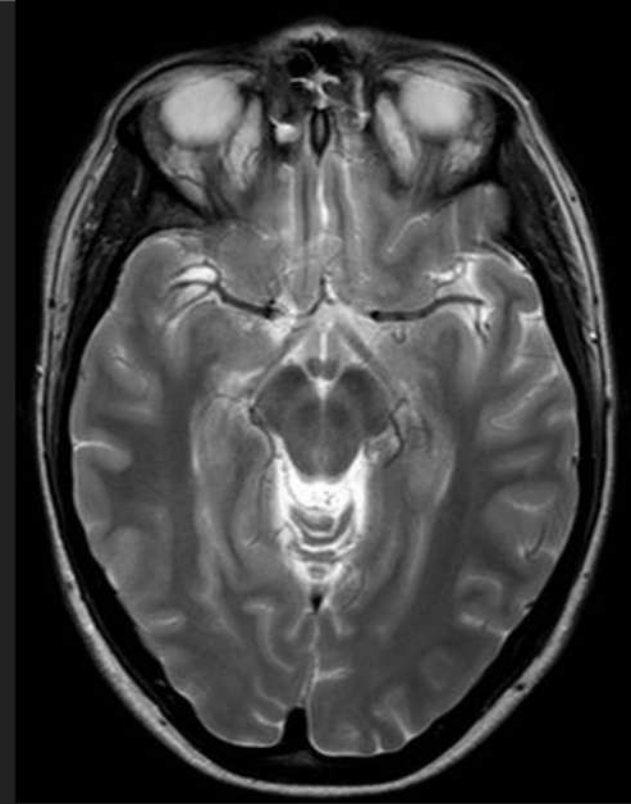
Nucleus ruber - punatuum

Ekstrapüramidaalne motoorne tuum

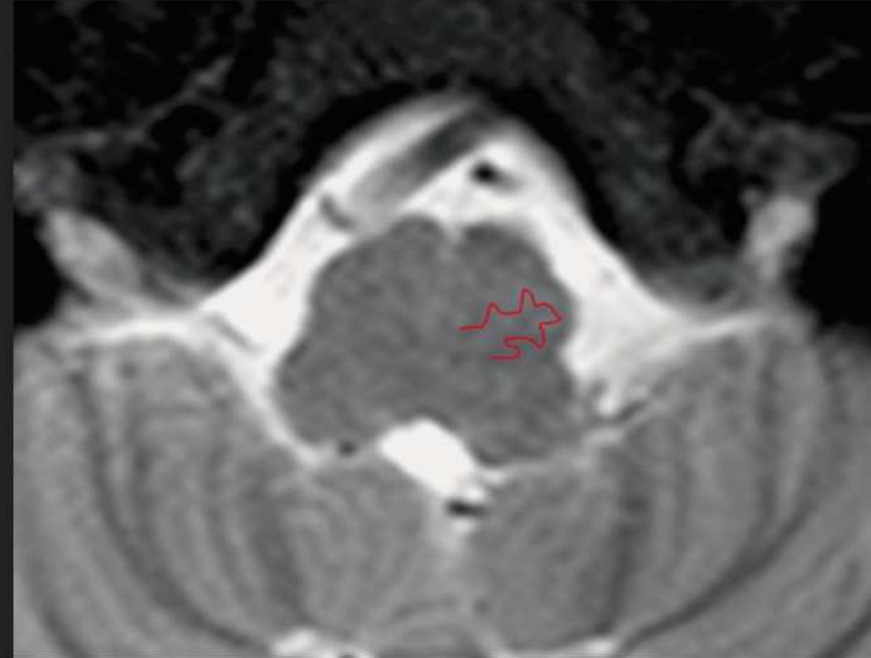
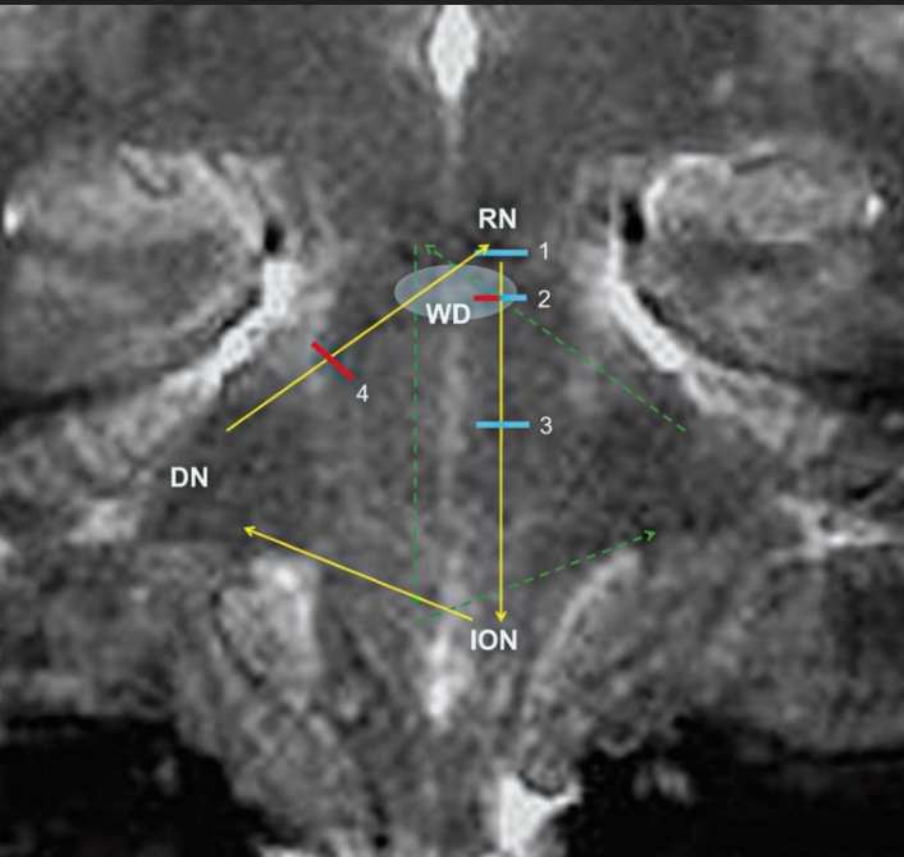
T2 hüpointensiivne (raud)

Lesioonid: oliivi hüpertroofne degeneratsioon -
palatal müokloonus

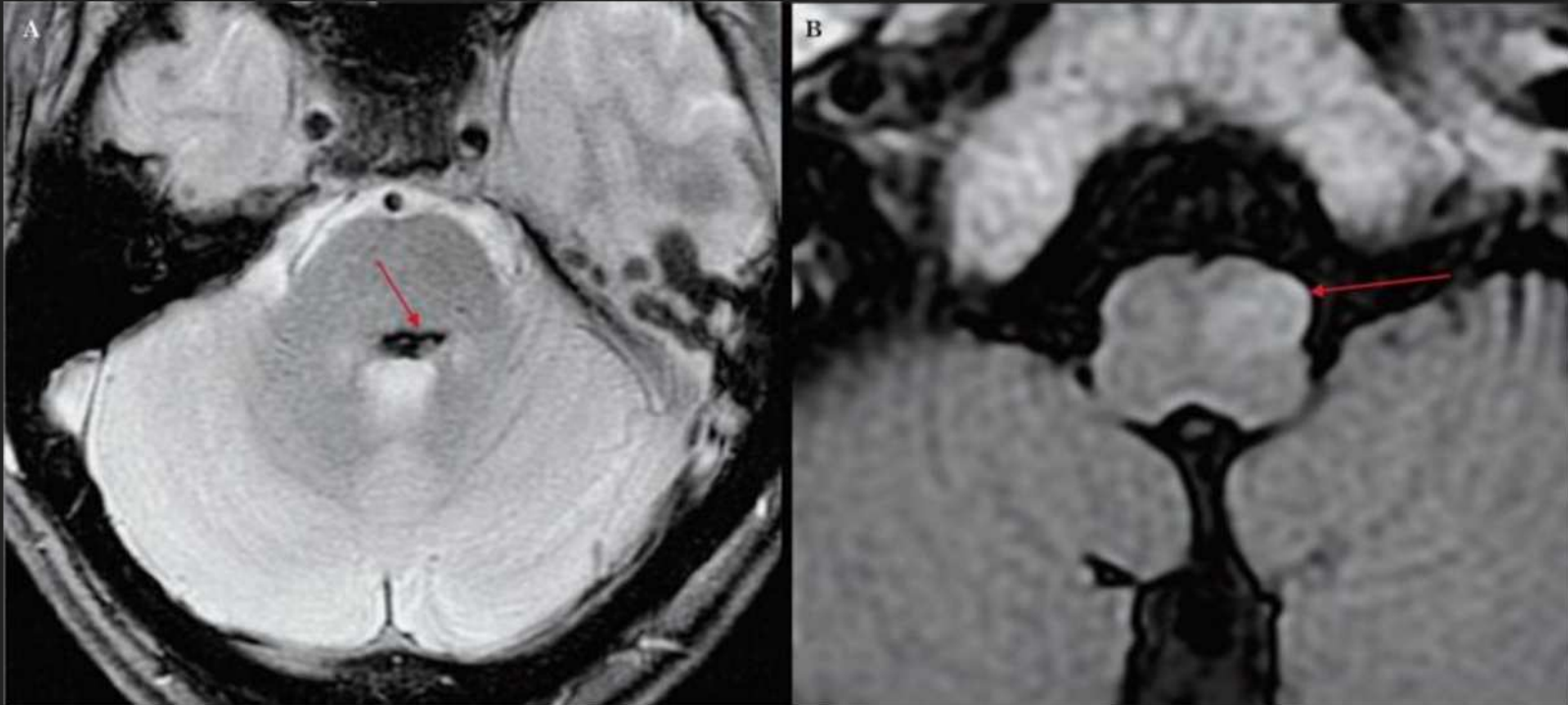
Guillain ja Mollaret kolmnurga lesioonid
(dentato-rubro-olivary pathway)



Oliivi hüpertroofne degeneratsioon



Oliivi hüpertroofne degeneratsioon



Substantia nigra

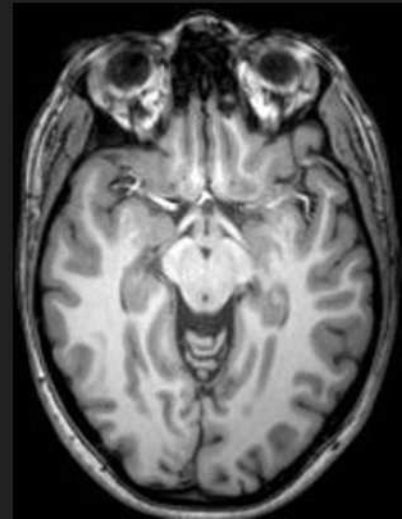
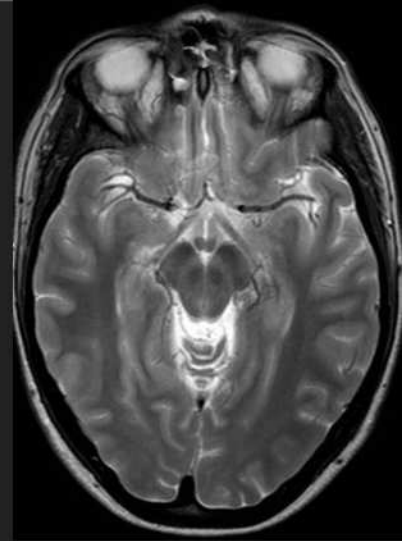
Ekstrapüramidaalne motoorne tuum

Pars compacta - melaniin + vähem rauda - hallainega isointensiivne

Pars reticularis - palju rauda - T2 hüpointensiivne

P. compacta on tsentraalne Parkinsonismi patofüsioloogias

Pars compacta atroofia, enam väljendunud sekundaarse PD puhul ($< 2,4$ mm)



Parkinsonism jm

Koeline maht (atroofia)

Raua kuhjumine

Dorsolateraalse nigra hüperintensiivsuse puudumine - nigrosoom-1

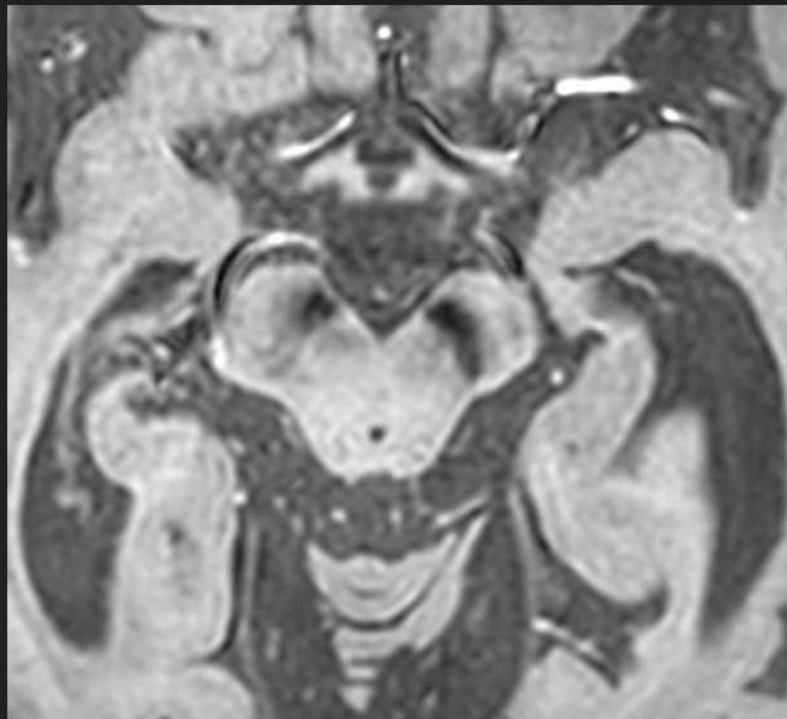
Puuduva pääsukesesaba tunnus (SWI sekventsisis)

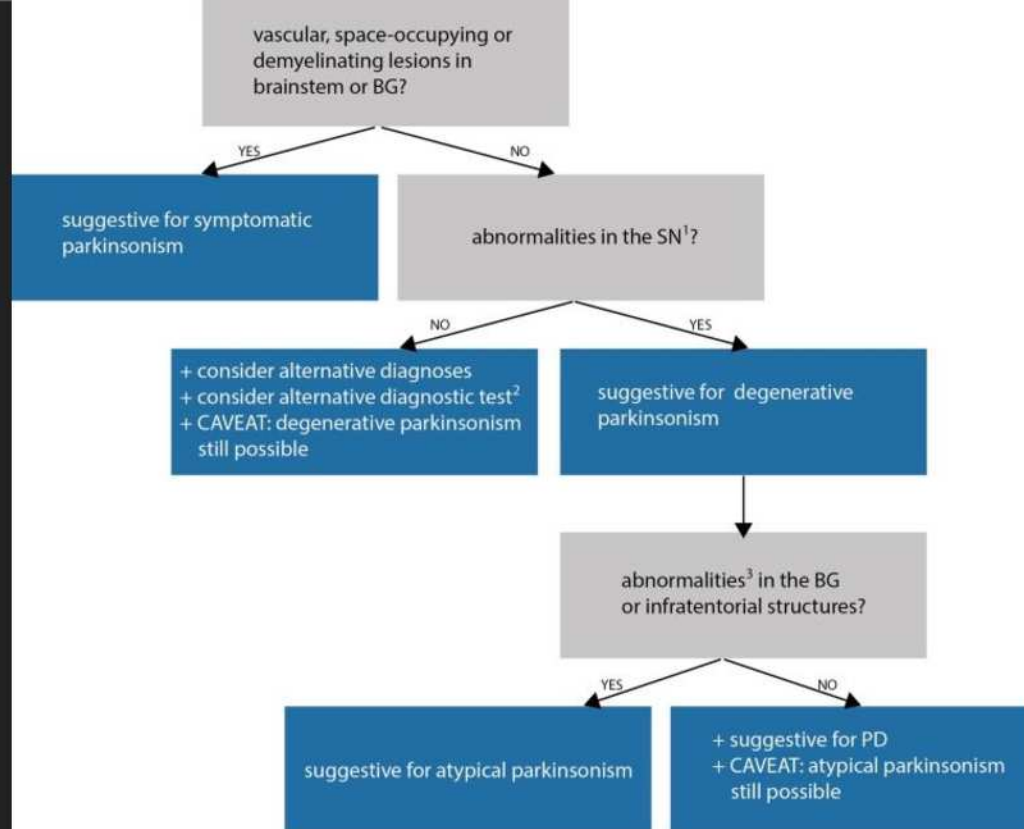
Uued neuromelaniin-tundlikud T1 sekventsidsid

Putameni diffusion

MRT üks eesmärk eristada MSA-d ja PSP-d

Nigrooom-1



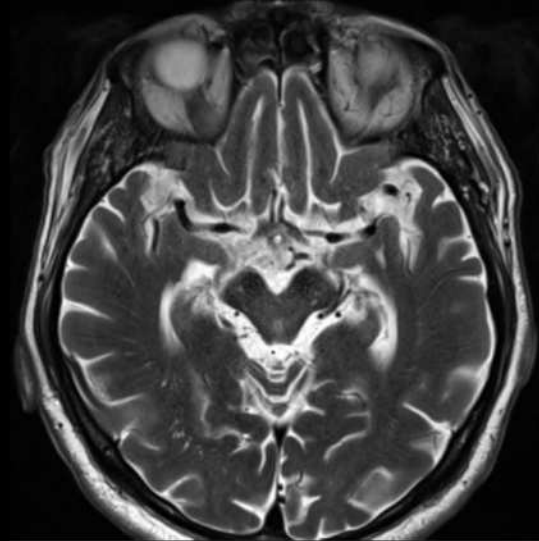
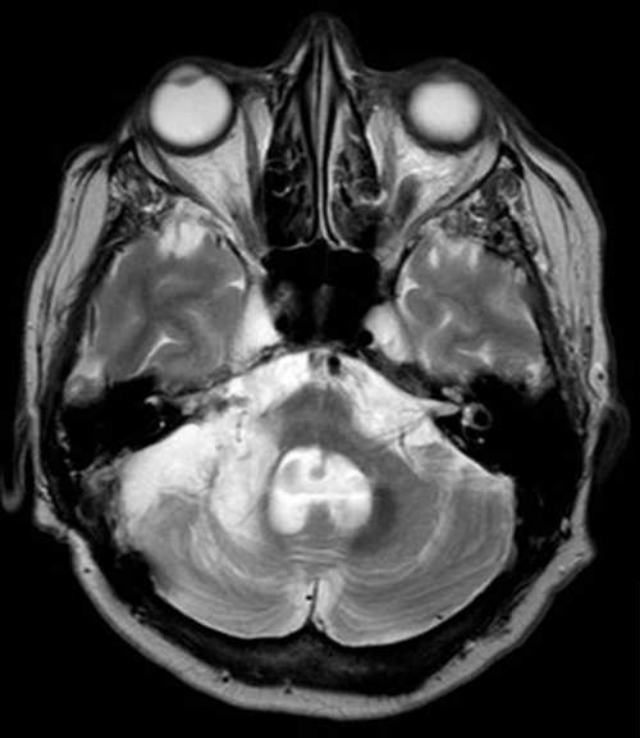


abnormalities ³ in	suggestive for
putamen	MSA > PSP
thalamus	PSP
midbrain	PSP
pons	MSA
cerebellum	MSA
SCP	PSP
MCP	MSA

Heim B, Krismer F, De Marzi R, Seppi K. Magnetic resonance imaging for the diagnosis of Parkinson's disease. *J Neural Transm (Vienna)*. 2017;124(8):915–964. doi:10.1007/s00702-017-1717-8

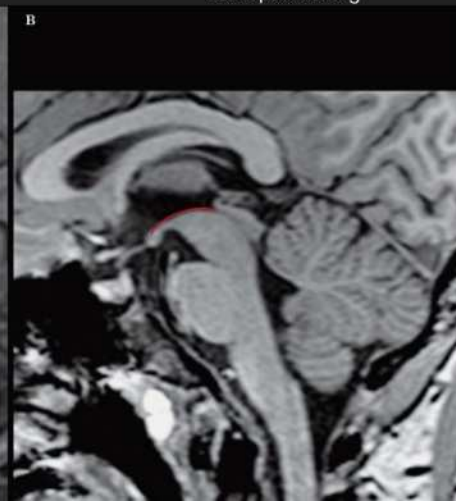
	PD	MSA(-P)	PSP
cMRI			
Normal	++	-/+	-/+
Putaminal atrophy	-	++/++++	++
Putaminal hyperintense rim ^a	+	++	+
Putaminal hypointensity on T2 ^a	-	++	-
Atrophy of pons and vermis cerebellaris	-	++	+
Signal changes in the pons (hot cross bun sign) or MCPs ^a	-	++	-
Midbrain atrophy	-	-	++
Mickey mouse sign and king-penguin silhouette			
MRI planimetry			
Midbrain diameter	-	+	++/++++ ^b
Decreased m _d /p _d ratio	-	+	+++
Decreased m _a /p _a ratio	-	+	+++
Increased MRPI	+	-	+++
Diffusion imaging			
Increased putaminal diffusivity	-	+++	++
Increased diffusivity of MCP	+	+++	+
Increased diffusivity of SCP	-	-	+++
Iron-sensitive sequences			
Increased putaminal iron load (e.g. putaminal hypointensity on T2* and SWI) ^c	+	+++ ^d	++

Heim B, Krismer F, De Marzi R, Seppi K. Magnetic resonance imaging for the diagnosis of Parkinson's disease. *J Neural Transm (Vienna)*. 2017;124(8):915-964. doi:10.1007/s00702-017-1717-8



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TÜK



Väljanopped

Putameni nekroos - metanooli mürgistus

Sabatuuma atroofia - Huntingtoni tõbi

Mangaani ladestus GB-s - krooniline hepaatiline entsefalopaatia

GB isheemiline kahjustus - vingugaas

BG-de kaltsifitseerumine - metaboolsed haigused

Talamuse hokikepi tunnus - Creutzfeld-Jakob

Mõlemapoolne talamuse T2 signaalitõus - siinustromboos

Väljanopped

III vatsakese ümbruse signaalitõus - Wernicke

Guillain ja Mollaret kolmnurga lesioonid - kolle aferentsemal

Degeneratiivsetel haigustel tuleb kogu ajutüvi nagunii üle vaadata

Nigrosoom-1 ja pääsukesesaba tunnus - Parkinsonism

Tänu kuulamast!