Midbrain lesions

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Midbrain is

- Key structure in the control of vertical eye movements, especially saccades and gaze holding
- Three structures : Key roles in the control of vertical gaze
  - riMLF (rostral interstitial nucleus of the medial longitudinal fasciculus)
  - INC (Interstital nucleus of Cajal)
  - PC (posterior commissure)

Physicians should test

- Head tilt
- Ocular alignment
- Control of vertical eye movements
  - range of eye movements
  - Saccades
  - Smooth pursuits
  - Convergence

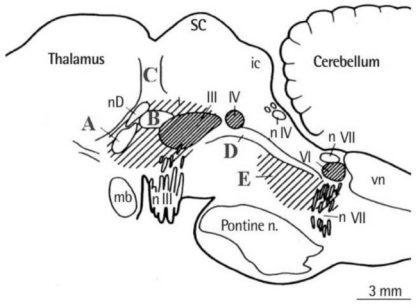
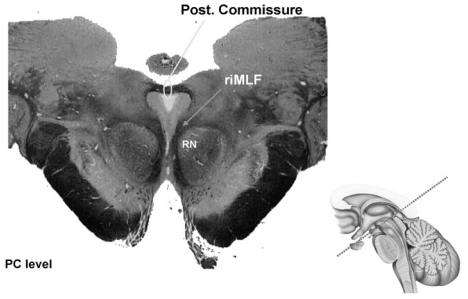
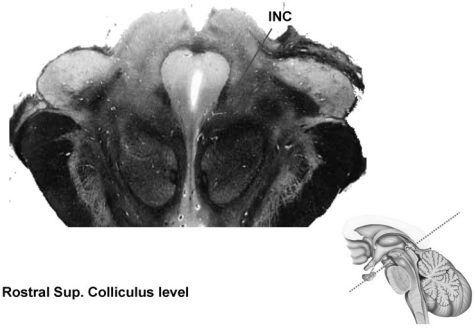


Fig. 6. Schematic drawing of the ocular motor structures involved in the control of vertical and horizontal gaze. A, riMLF; B, interstitial nucleus of Cajal; C, posterior commissure; D, MLF; E, PPRF.

Midbrain

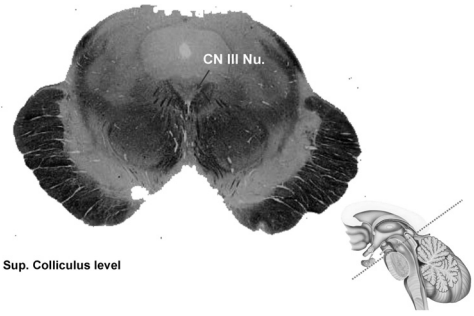


Midbrain

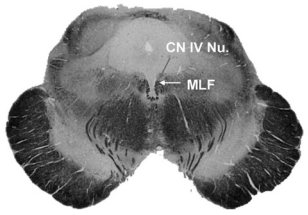


Rostral Sup. Colliculus level

Midbrain



Sup. Colliculus level



Inf. Colliculus level

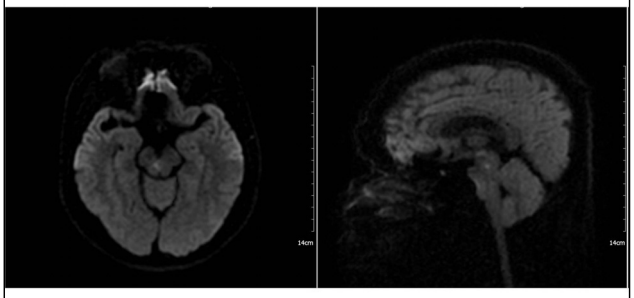
Vertical diplopia

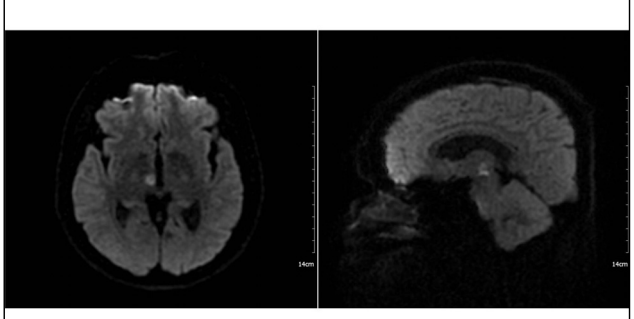
55/M
C.C. vertical diplopia (diagonal), binocular, acute onset

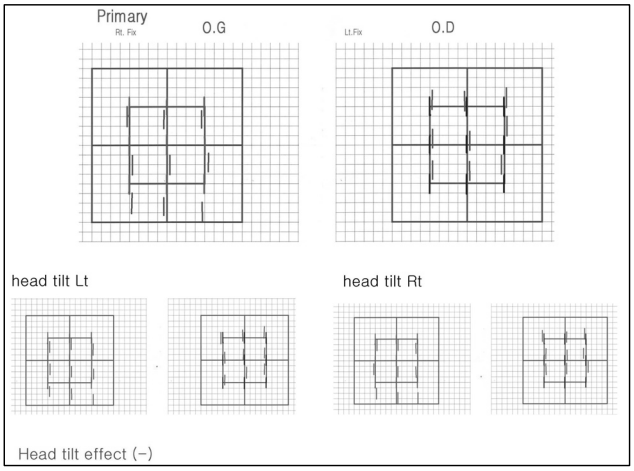
S>
1월 5일 갑자기 머리가 띵한 느낌이 있으면서 두개로 보인다.
대각선으로 벌어져 보인다.
오른쪽으로 보면 더 벌어져 보인다.
O>
Head posture Rt tilt?
Ocular alignment : Rt hyper (9), exo(2.5) in sitting position
Rt hyper (8) in supine position
Eyelid : ok

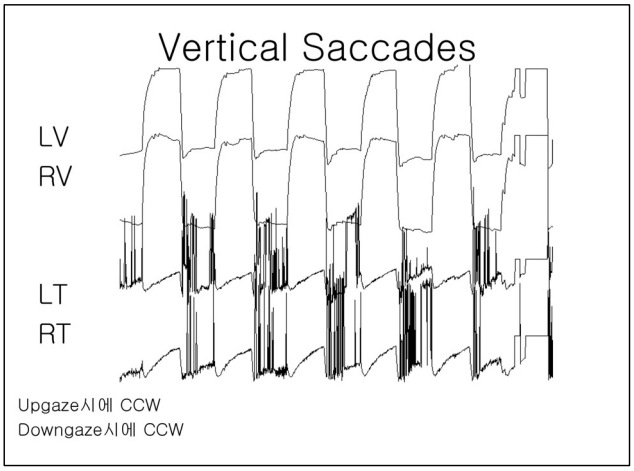
LPR reactive, isocoric, 2mm/2mm
EOM full with convergence
diplopia : head tilt effect (−), supine시에 벌어진게 좁아진다...
SN c.s fix −
GEN −
Saccades: vertical slowing (up > down)
torsibleb on vertical gaze (up > down), ipsilesional on upward, contra on downward
SP ok
no facial palsy
facial sensory ok

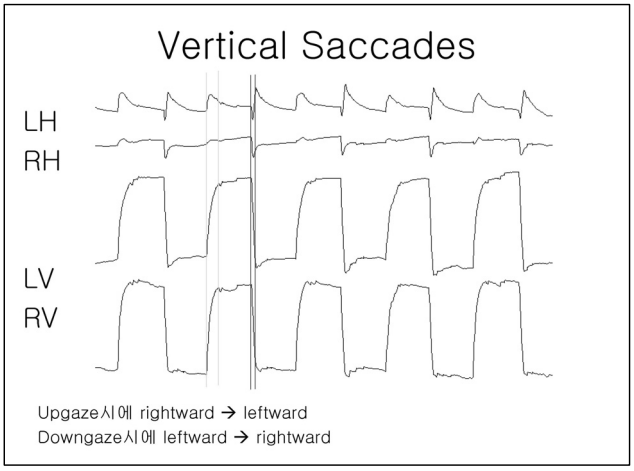
others ok

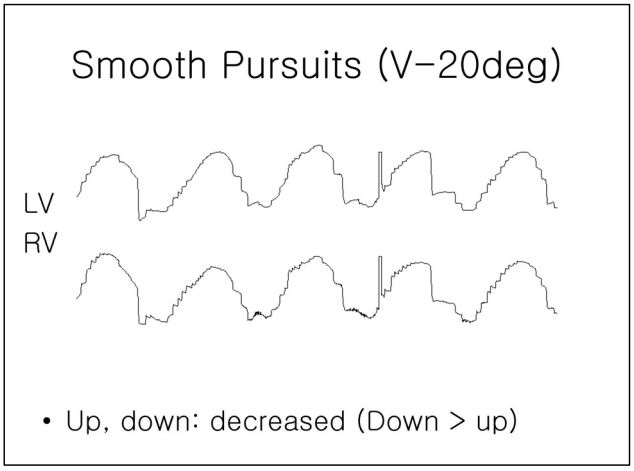


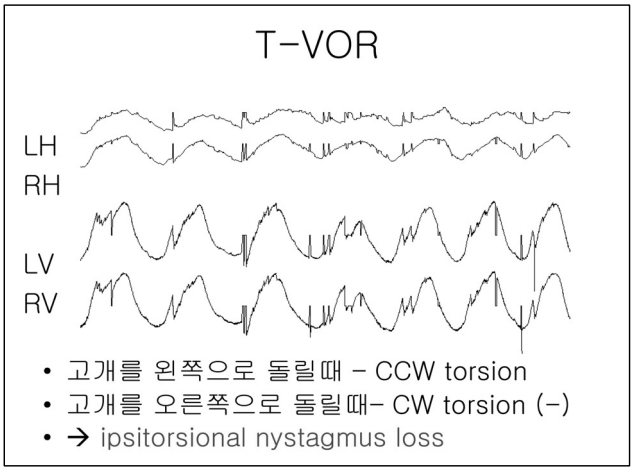


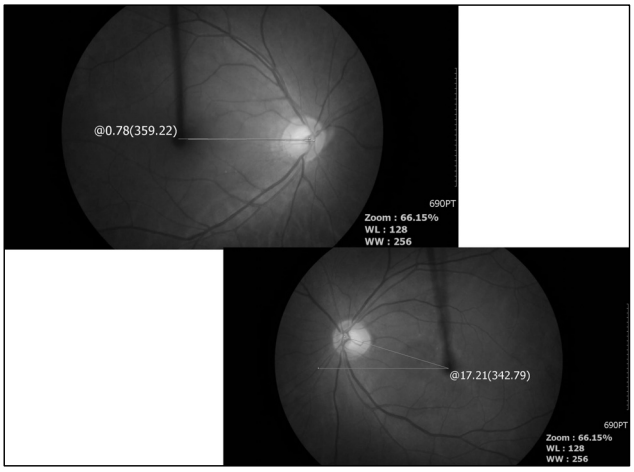

Primary
Rt. Fix
O.G
Lt.Fix
O.D
head tilt Lt
head tilt Rt
Head tilt effect (-)


Vertical Saccades
LV
RV
LT
RT
Upgaze시에 CCW
Downgaze시에 CCW


Vertical Saccades
LH
RH
LV
RV
Upgaze시에 rightward → leftward
Downgaze시에 leftward → rightward


Smooth Pursuits (V-20deg)
LV
RV
• Up, down: decreased (Down > up)


T-VOR
LH
RH
LV
RV
• 고개를 왼쪽으로 돌릴때 – CCW torsion
• 고개를 오른쪽으로 돌릴때– CW torsion (–)
• → ipsitorsional nystagmus loss


@0.78(359.22)
690PT
Zoom : 66.15%
WL : 128
WW : 256
@17.21(342.79)
690PT
Zoom : 66.15%
WL : 128
WW : 256

Final diagnosis

Lesions of riMLF

Box 13–10 Clinical Findings with Lesions of the Rostral Interstitial Nucleus of the MLF (RIMLF)

Unilateral Lesion:

- A mild and variable defect of downward saccades
- Loss of ipsitorsional quick phases (e.g., with a right RIMLF lesion, quick phases that are clockwise from the patient's viewpoint (top pole beating toward the right ear) are lost
- Static, contralesional torsional deviation (top pole) with torsional nystagmus (top pole) beating contralesionally

Bilateral lesion:

- More profound defect of vertical saccades that may be more pronounced for downward than upward eye movements
- Vertical gaze holding, VOR, and pursuit, and horizontal saccades are preserved

Lesions of INC

Box 13–11 Clinical Findings with Lesions of the Interstitial Nucleus of Cajal (INC)

Unilateral lesions or inactivation:

- Impaired gaze-holding function in the vertical and torsional planes following saccades to tertiary positions
- Ocular tilt reaction: skew deviation (ipsilateral hypertropia), extorsion of the contralateral eye and intorsion of the ipsilateral eye, and contralateral head tilt
- Torsional nystagmus that has ipsilesional quick phases—top pole beats to the side of the lesion; downbeat nystagmus may also be present

Bilateral lesions or inactivation:

- Reduced range of all vertical eye movements but saccades not slowed
- Impaired gaze holding after all vertical and torsional movements
- Upbeat nystagmus
- Neck retroflexion

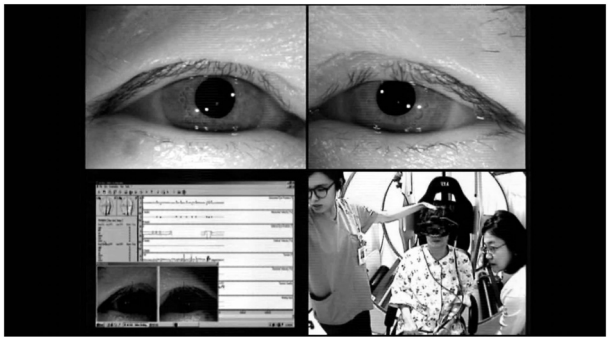
Unilateral lesions or inactivation caudal to INC:

- Hemi-seesaw jerk nystagmus

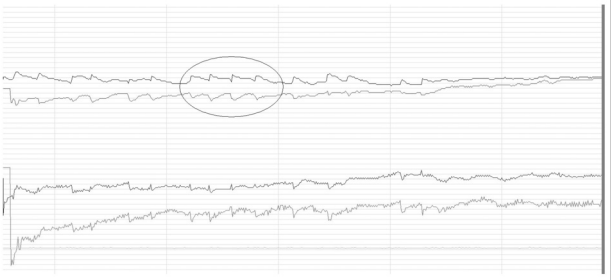
Topodiagnosis of lesions involving INC and riMLF

	INC	riMLF
Unilateral inactivation		
OTR	Contraversive [2,4,16]	Contraversive [3,6]
Torsional nystagmus	Ipsiversive [4,5,17]	Contraversive [5,6,17]
GEN	Vertical and torsional GEN [4,5]	No
VOR		
Torsional	Little effect on VOR gain and phase [5]	Loss of ipsitorsional nystagmus [3,6,18]
Vertical	Little effect on VOR gain and phase [5]	
Saccades		
Torsional	Reduced or abolished contralesional fast phases [5]	All ipsitorsional components were lost [3,6]
Vertical	Reduced amplitudes and normal velocity [5]	Slowed [3]
Bilateral inactivation		
GEN	Vertical and torsional GEN [1,4,5]	No
VOR		
Torsional and vertical	Severely reduced gain and phase lead [5]	Preserved [3]
Saccades		
Torsional		Loss of all vertical and torsional saccades [3]
Vertical	Reduced amplitudes and normal velocity [1,5]	
Unilateral stimulation		
OTR	Ipsiversive [9,14]	
Torsional nystagmus	Contraversive [9,14]	

Convergence nystagmus

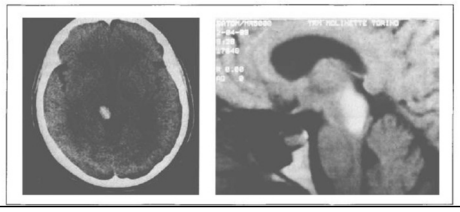


Convergence nystagmus



Convergence nystagmus

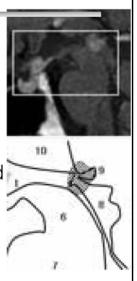
- 양안의 내전(adduction) 과 외전(abdcution)으로 구성되는 수평 방향의 이향성(disjunctive) 안진
- 흔히 양안의 후퇴(retraction)와 동반



Pseudoabducens palsy

- Increased or sustained convergence
- Perhaps d/t an excess of convergence tone
- Midbrain-diencephalic junction lesion

Dorsal midbrain syndrome (Pretectal syndrome)



- Upgazing palsy
- Down gazing defect
  - Saccades and pursuit may be impaired
  - VOR intact
- Convergence-retraction nystagmus

- Skew deviation (MLF, INC)
- Light near dissociation

Features of dorsal midbrain syndrome

Limitation of upward eye movements:
- Saccades
- Smooth pursuit
- Vestibulo-ocular reflex
- Bell's phenomenon

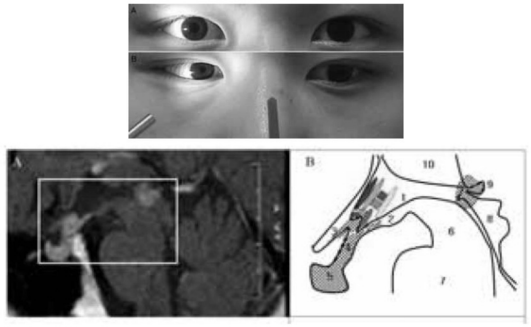
Dissociation of lid and eye movements: Lid retraction (Collier's sign), occasionally ptosis

Disturbances of downward eye movements:
- Downward gaze preference ("setting sun" sign)
- Downbeating nystagmus
- Downward saccades and smooth pursuit may be impaired, whereas vestibular movements are relatively preserved

Disturbances of vergence eye movements:
- Convergence-retraction nystagmus
- Paralysis of convergence
- Spasm of convergence
- Paralysis of divergence
- "A" or "V"-pattern exotropia
- Pseudo-abducens palsy

Fixation instability (square-wave jerks)
See-saw nystagmus
Skew deviation, ocular tilt reaction
Pupillary abnormalities (light-near dissociation)

Light-near dissociation



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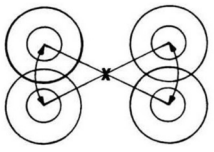
Seesaw nystagmus

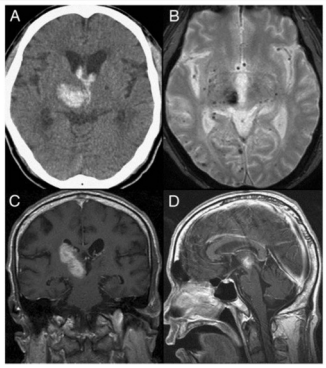
- Compressing or invading the brainstem bilaterally at the mesodiencephalic junction



Paroxysmal OTR

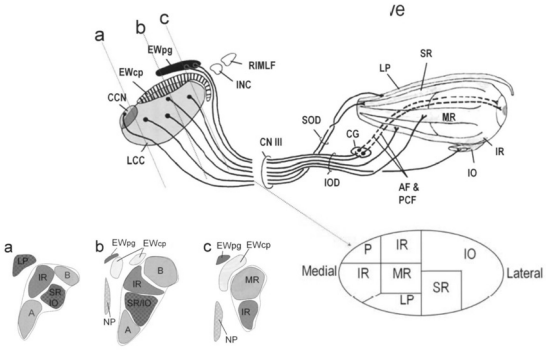
SY Oh et al, J Neurol Sci, 2009

Paroxysmal OTR



SY Oh et al, J Neurol Sci, 2009

CN III Nucleus and fascicles



Differential diagnostic considerations in oculomotor nucleus, fascicular and nerve lesion

Rectus superior muscle (crossed innervation)

Levator palpabrae muscles (single caudal subnucleus)

Pupillary constrictors (various subnuclei dispersed)

Medial rectus muscle (3 subnuclei)

Oculomotor nucleus lesion

- Unilateral oculomotor lesion with contralateral superior rectus muscle paresis and bilateral ptosis
- Bilateral oculomotor nerve lesion with or without INO and sparing of levator function
- Bilateral ptosis and sparing of rostral oculomotor nucleus

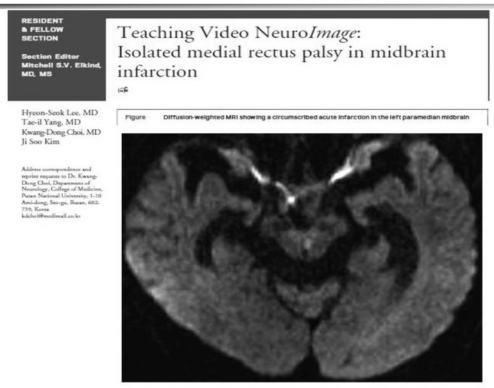
Fascicular lesion

- Complete oculomotor lesion – all contralateral muscles spared
- Isolated inferior oblique muscle paresis
- Unilateral dilated, fixed pupil
- Paresis of inferior oblique, superior rectus, medial rectus, levator palpebrae with sparing of inferior rectus muscle and pupil
- Paresis of inferior oblique, superior rectus, medial rectus, levator, inferior rectus muscles and pupillary sparing

Additional damage to neiboring structures causing complex syndrome

- Red nucleus (Claude syndrome)
- Subthalamic nucleus (Benedikt syndrome)
- Brachium conjunctivum below decussation: (Nothnagel syndrome)
- Peduncular lesion (Weber syndrome)

Medial rectus palsy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Section Editor Mitchell S.V. Elkind, MD, MS

Teaching Video NeuroImage: Isolated medial rectus palsy in midbrain infarction

Hyeon-Seok Lee, MD
Tae-il Yang, MD
Kwang-Dong Choi, MD
Ji Soo Kim

Figure Diffusion-weighted MRI showing a circumscribed acute infarction in the left paramedian midbrain

DDx with Skew deviation

- Elevated eye is intorted
- Head tilt toward undermost eye if exist
- Comitant, negative Bielschowski head-tilt test

S.-H. Lee et al. / Clinical Neurology and Neurosurgery *112 (2010) 68–71*

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- Red nucleus (Claude syndrome)
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- Peduncular lesion (Weber syndrome)

Summary

- Supra nuclear vertical, torsional gaze palsy and nystagmus : riMLF, INC, PC
- Oculomotor nucleus, fasciculus : exceptional findings on a singular eye movements
- Trochlear nucleus and fasciculus : DDx with skew deviation