Saccadic Lateropulsion and Upbeat Nystagmus: Disorders of Caudal Medulla

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A patient developed a primary position upbeat nystagmus and a left saccadic lateropulsion. Magnetic resonance imaging demonstrated a probable cavernoma at right caudal paramedian medullary level. Anatomical correlations are discussed. Saccadic lateropulsion is attributed to olivocerebellar pathway impairment but usually is described in more rostral medullar lesions. Our case would still support this hypothesis because the lesion could have involved the olivocerebellar pathway at its very caudal level. Upbeat nystagmus could be attributed to impairment of the nucleus intercalatus and/or cell groups of the paramedian tract.

Saccadic lateropulsion is a well-known clinical symptom in which a tonic lateral bias affects saccades. This bias results in hypermetria of ipsiversive saccades, hypometria of contraversive saccades, and ipsiversive deviation of vertical saccades.1,2 Saccadic lateropulsion has been attributed to dysfunction of ipsilateral caudal fastigial nucleus, which controls activity of brainstem saccadic premotor structures.3,4 This symptom is most often observed in Wallenberg’s syndrome or in other lesions in the caudal cerebellum that impair afferent pathways to fastigial nucleus.5 We report the case of a patient who presented with contralesional saccadic lateropulsion caused by a well-defined vascular lesion involving unexpectedly the right medulla at its caudal and paramedian level. This patient also presented with upbeat nystagmus. The tiny size of the lesion on magnetic resonance imaging may allow us to discuss neural correlates of these ocular motor disorders.

Fig 1. (A) Transverse section of patient’s T2* magnetic resonance imaging showing a 2mm diameter hyposignal in right medulla at its paramedian and caudal level. Another hypointense signal is visible at the outside left border of medulla, which can be attributed to the left vertebral artery. (B) Reproduction of a photomicrograph of appropriate transverse section of adult medulla (from Crosby and colleagues6 with permission). The reproduction of the lesion area show that nucleus intercalatus (top) and olivocerebellar fibers (bottom) could have been involved.

Case Report
A 38-year-old man was admitted to the hospital because of vertigo of sudden onset with nausea, vomiting, and postural instability. These symptoms lasted a few hours and were followed by vertical oscillopsia. At the time of examination, extraocular movements were full. There was a large-amplitude, vertical upbeat nystagmus present in primary position of gaze. Nystagmus was increased in up gaze, decreased in down gaze and convergence, and not modified by lateral gaze, tilt of the head, or head-shaking test. Ocular motor examination
also showed a marked hypermetria of saccades to the left, hypometria to the right, and leftward incurvation of vertical saccades. These symptoms were suggestive of a left saccadic lateropulsion. Saccadic lateropulsion was not accompanied by body lateropulsion, skew deviation, or tilt of subjective visual vertical. Neurological examination was otherwise normal. T2 magnetic resonance imaging showed a 2mm diameter hyposignal in the right medulla at its paramedian and caudal level. Hyposignal increased on T2* scan. T1 scan was normal. This radiological aspect was suggestive of a small cavernoma without evidence of recent bleeding (Fig
Brain magnetic resonance imaging was otherwise normal. The axial magnetic resonance images were compared with the appropriate section of an anatomical atlas of the brainstem (see Fig 1B). 

Five weeks after onset, eye movement examination disclosed similar upbeat nystagmus, whereas horizontal left deviation of vertical saccades was the only remnant of saccadic lateropulsion. Three months after onset, examination showed only a mild upbeat nystagmus.

Materials and Methods

Eye Movement Recording

Eye movements were recorded with infrared videooculography (Synopsis S.A., Marseilles, France). During the examination, the patient sat in a rotating chair, with the head maintained in headrest. For saccades, high-frequency (200 Hz sampling) infrared videooculography was used (Visuo200). The patient wore a helmet on which a camera was fixed 10 cm from the nose and oriented to record both eyes at the same time. Saccades were elicited by light-emitting diodes presented on a ramp located 1.5 m in front of the patient. Light-emitting diodes evoked 40-degree horizontal saccades (±20 degrees) and 25-degree vertical saccades (±12.5 degrees). For slow eye movements, low frequency (50 Hz sampling) infrared videooculography was used (VNG Ulmer Synopsis S.A., Marseilles, France). The patient wore a mask, with a camera fixed in front of the right eye. After calibration, spontaneous nystagmus was recorded in total darkness in primary, lateral, and convergence eye position and in different head positions, after a 30-second hyperventilation task and after a 20-second head-shaking test. Thereafter, horizontal (0.1 Hz, 35-degree amplitude) and vertical (0.1 Hz, 28-degree amplitude) smooth pursuit was elicited. Finally, optokinetic nystagmus (20 degrees/sec velocity), sinusoidal vestibuloocular reflex (VOR; 0.25 Hz, 60 degrees/sec peak velocity), visuovestibular interaction (VVOR; 0.25 Hz, 60 degrees/sec peak velocity), and postrotatory VOR (60 degrees/sec of constant velocity for 1 minute, 100 degrees/sec of deceleration) were elicited in the horizontal plane.

Eye Movement Analysis

Using contrast image detection, software (VNG Ulmer and Visuo200) calculated horizontal and vertical position of the center of pupil on line. The parameters used were the latency, peak velocity, and gain (amplitude of initial eye movement/amplitude of target movement) of horizontal and vertical saccades; the horizontal and vertical slow phase velocity of spontaneous nystagmus; and the gain (peak slow phase velocity/peak stimulus velocity) for horizontal and vertical smooth pursuit, optokinetic nystagmus, VOR, and VVOR. The time constant of the decreasing slow phase velocity of post-rotatory VOR was calculated as the time needed to reach 37% of initial slow phase velocity. Normative data (mean ± 2 standard deviation) were obtained from 20 normal subjects (8 men, 12 women) comparable in age (mean age, 41 years; range, 34–47) to that of our patient.

Results

Eye movements were recorded 5 days after the vascular event.

Recording of saccadic eye movements confirmed left saccadic lateropulsion (Fig 2). Saccades to the right were slightly hypometric (0.90), whereas saccades to the left were significantly hypermetric (1.05; see Fig 2A). No vertical movement was observed during horizontal saccades. Vertical saccades were significantly hypometric both for upward (0.73) and for downward (0.67) eye movements (see Fig 2B). During vertical saccades, a leftward horizontal deviation of 2 to 3 degrees was observed (see Fig 2C).
Upbeat nystagmus was present in primary position in darkness (slow phase velocity, 16 degrees/sec). It was enhanced by up gaze (to 21 degrees/sec) and decreased by down gaze and convergence (to 3 degrees/sec). It was not modified by 30-second hyperventilation, head shaking test, or by varying head positions. Slow phases of horizontal and vertical nystagmus decayed mostly linearly. Horizontal pursuit showed a symmetrical and normal gain. Vertical pursuit showed absent slow phases for upward eye movements and normal gain for downward eye movement. Optokinetic nystagmus showed a slight symmetrical decrease in gain (0.49). VOR showed normal gain. VVOR gain was impaired for rotation to the left side (0.14) but not for rotation to the right side (0.09). Postrotatory VOR showed a longer time constant after rotation to the left (right deceleration; 19 sec) than after rotation to the right (left deceleration; 7 sec).

**Discussion**

We report on a patient presenting with saccadic lateropulsion, upbeat nystagmus, absent downward smooth pursuit, and asymmetrical postrotatory VOR time constant, as the only symptoms of a small and well-defined lesion located at caudal medullary level. Hypermetria of ipsilateral saccades, hypometria of contralateral saccades, and ipsilateral horizontal deviation of vertical saccades characterize saccadic lateropulsion. This syndrome has been reported earlier as manifestation of Wallenberg's syndrome. Similar ocular movement abnormalities have been described with lesions of ipsilateral caudal fastigial nucleus in monkeys and cats. From anatomical and physiological studies, Waespe and Wichmann proposed that in Wallenberg's syndrome disruption of olivocerebellar climbing fibers at the level of lateral medulla would indirectly increase the inhibition of ipsilateral fastigial nucleus (Fig 3).

We suggest that in our patient, the lesion could have disrupted the same olivocerebellar pathway, but before crossing the midline, explaining contralateral saccadic lateropulsion (see Figs 1 and 3). Indeed, the olivocerebellar pathway crosses the brainstem midline at a caudal medullary level, then traverses and surrounds the opposite olive and ascends in the medial and lateral part of the inferior cerebellar peduncle. Thus, this clinical-anatomical case gives additional support to the olivocerebellar pathway involvement in saccadic lateropulsion. Other cases of contralateral saccadic lateropulsion have been described with lesions involving rostral cerebellum. According to the authors, these lesions could have disrupted the crossed efferent pathway from the contralateral fastigial nucleus. These fibers, contained in the uncinate fasciculus, cross within the cerebellum and arch around the superior cerebellar peduncle to project to paramedian pontine reticular formation. Therefore, the presence of contralateral saccadic lateropulsion with a lesion both of caudal medulla or rostral cerebellum is compatible with the hypothesis of fastigial nucleus involvement in this symptom, the lesion disrupting either afferent pathways before crossing or crossed efferent pathway of this cerebellar nucleus (see Fig 3).

Our patient also showed primary position upbeat nystagmus. This uncommon ocular motor disorder usually is described in lesions of lower brainstem, ventral tegmentum, anterior vermis of cerebellum, and midbrain. In lesions of lower medulla, primary position upbeat nystagmus may be related to impairment of one of the perihypoglossal nuclei, the nucleus intercalatus. Some authors suggested that the nucleus intercalatus might contribute to vertical oculomotor integrator so that its lesion might explain primary position upbeat nystagmus with exponentially decreasing waveform. The more caudal part of cavernoma could have involved the nucleus intercalatus in our case (see Fig 1). However, in our patient slow phase was linear, suggesting a central vestibular or smooth pursuit dysfunction for this abnormal eye movement, compatible with impaired downward pursuit. An alternative explanation would be that the lesion of our patient has involved cell groups of the paramedian tract, which are known to participate in vertical eye position, through their projection to cerebellar flocculus. Indeed,
caudal cell group of the paramedian tract lies close to another perihypoglossal nucleus, the nucleus prepositus hypoglossi. Furthermore, the presence in our patient of asymmetrical time constant of postrotatory VOR may be related to the involvement of the nucleus prepositus hypoglossi that might be involved in the horizontal velocity storage integrator.\textsuperscript{21}

This work was supported by Projet de Recherche Clinique des Hospices Civils de Lyon (HCL/P/99 201, C.T.).

We thank Dr Savet for referring the patient.

References


Herpes Vector–Mediated Expression of Proenkephalin Reduces Bone Cancer Pain

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Received Feb 21, 2002, and in revised form Jun 18. Accepted for publication Jun 21, 2002.

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