Arch Psychiatr Nervenkr (1982) 231:227-234

Archiv für Psychiatrie und Nervenkrankheiten
Archives of Psychiatry and Neurological Sciences

The Effect of Cervical and Vestibular Reflexes on Eye Movements in Huntington's Chorea

H. C. Leopold, M. Doerr, G. Oepen, and U. Thoden

Abteilung Klinische Neurologie und Neurophysiologie der Universität, Hansastraße 9, D-7800 Freiburg i. Br., Federal Republic of Germany

Summary. In 8 patients with manifest Huntington's Chorea vestibulo-ocular (VOR) and cervico-ocular (COR) reflexes were compared with eye movements during active head turnings. Seated patients were stimulated with their eyes closed by sinusoidal swings around the vertical axis at frequencies of 0.05, 0.1 and $0.2\,s^{-1}$ with amplitudes of 20, 40 and 60°.

1) With all stimuli and in all patients a weak nystagmus was elicited in the direction of head movements, superimposed on larger slow eye deviations.

2) The averaged total saccadic amplitudes were smaller than in normals, increased with stimulus amplitudes and were smallest for COR, followed by VOR and active head movements.

3) The gain (peak velocity of slow phase of nystagmus to peak stimulus velocity) was only slightly below norm values and decreased with increasing stimulus frequency and amplitude.

4) The peak amplitudes of average slow eye deviations increased with stimulus amplitudes. In VOR they were comparable to norm values but were below them during COR and active head movements.

5) In normal subjects these slow eye deviations were compensatory to head movements in VOR but anticompensatory in COR and during active head movements. In choreic patients during COR and more often during active head movements these slow eye movements were compensatory for the head turning.

Key words: Vestibulo-ocular reflex – Cervico-ocular reflex – Eye movements during active head turnings – Huntington's Chorea

Zusammenfassung. Bei 8 Patienten mit manifester Chorea Huntington wurden vestibulo-oculäre (VOR) und cervico-oculäre (COR) Reflexe mit Augenbewegungen während aktiver Kopfdrehung verglichen. Gereizt wurde sitzend bei geschlossenen Augen mit sinusförmigen Pendelreizen um die vertikale Körperachse (0.05, 0.1 und 0.2 Hz, 20, 40 und 60°).

Supported by Sonderforschungsbereich "Hirnforschung und Sinnesphysiologie" (SFB 70) der Deutschen Forschungsgemeinschaft (DFG)

0003-9373/82/0231/0227/$ 01.60

1. Es findet sich mit allen Reizarten ein häufig nur schwach ausgeprägter Nystagmus in Richtung der Kopfdrehung, der größere langsame Schlagfeldverlagerungen überlagert.

2. Die gemittelten Gesamtamplituden der Nystagmussaccaden sind geringer als bei Normalpersonen, steigen mit der Reizamplitude leicht an und sind bei langsamen Kopfbewegungen für den COR am niedrigsten, größer für den VOR und am besten ausgeprägt bei aktiven Kopfdrehungen.

3. Das Verhältnis von Maximalgeschwindigkeit der langsamen Nystagmusphase zur maximalen Reizgeschwindigkeit (gain) liegt für alle Reizarten nur wenig unter den Normalwerten und fällt mit steigender Reizfrequenz und Amplitude ab.

4. Die Maximalamplituden der langsamen Schlagfeldverlagerungen steigen mit zunehmender Reizamplitude. Für den VOR zeigen sie den Normalen vergleichbare Werte, liegen aber für den COR und während aktiver Kopfdrehungen wesentlich niedriger.

5. Bei Normalpersonen sind diese Schlagfeldverlagerungen beim VOR der Kopfdrehung kompensatorisch entgegengerichtet und bewegen sich beim COR und während aktiver Bewegungen in Richtung des Kopfes. Bei Choreatikern findet sich hingegen häufig auch beim COR und aktiven Kopfdrehungen eine kompensatorische, also dem Kopf entgegengerichtete Augenbewegung.

Introduction

The eyes move voluntarily in two basically different ways, either with fast saccadic or slow tracking movements, following visual targets. As distinct neuronal mechanisms regulate each of these two types of ocular motility normal eye movement depends upon the integration of these two systems.

Horizontal saccades are probably generated in a rather complex neuronal network of the paramedian pontine reticular formation in the region of the abducens nucleus [7]. This saccadic system can be selectively disturbed early in drug intoxication [2] as well as in different degenerative diseases [9, 15]. In choreic patients it is emphasized that the saccadic system is impaired early in the course of the disease, whereas the ability to produce smooth pursuit movements is generally preserved [1, 3, 4, 5, 10, 11, 13].

For the investigation of neck-to-eye reflexes choreic patients are therefore a model for a prevailing lesion of the saccadic system. In healthy adults large anticompensatory saccades are elicited by stimulation of neck afferents and interfere with the vestibulo-ocular reflex in active head movements [6]. Therefore in choreic patients marked changes in cervico-ocular reflex and vestibulo-ocular reflex could be expected.

Patients and Methods

Eight patients (mean age 43.5 years, range 28–65 years) with a clinically manifest Huntington's Chorea were studied. The disturbed eye movements of 6 of them were recently described [10]. The technique of stimulation and recording of vestibulo-ocular reflex, of cervico-ocular reflex and of

Table 1

Choreic patients	Disturbance of voluntary and optokinetic saccades	
	Horizontally	Vertically
1. K.G., ♂, 46 yrs.	+++	++
2. K.K., ♀, 31 yrs.	++	++
3. L.K., ♂, 41 yrs.	++	++
4. E.E., ♀, 51 yrs.	+	++
5. E.H., ♀, 40 yrs.	+	++
6. H.J., ♂, 65 yrs.	+	(+)
7. H.I., ♀, 47 yrs.	+	(+)
8. K.I., ♀, 28 yrs.	–	(+)

active head movements was reported in a previous paper [6]. All eye movements were recorded with closed eyes using direct current electro-oculography, during vestibulo-ocular, cervico-ocular reflex and active head movements with sinusoidal stimuli of 20, 40 and 60 degrees of amplitude at frequencies of 0.05, 0.1 and 0.2 s^{-1}.

It should be pointed out, that all eye movements are related to head movements. In COR only the trunk is moved with the head fixed, but for better understanding the eye movements are compared with head position against the moving trunk.

Results

1. Disturbance of Eye Movements in Choreic Patients

The disturbance of horizontal and vertical voluntary and optokinetically induced saccadic eye movements is listed in Table 1. Only 2 of the patients in this study were not mentioned previously, but their data were within the range of changes typical for choreic patients [10].

2. Eye Movements During Vestibulo-Ocular Reflex (VOR), Cervico-Ocular Reflex (COR) and Active Head Movements

With all modes of stimulation the nystagmus in direction of head movements was reduced in frequency, amplitude and saccadic velocity as compared to normals [6] and therefore it was often difficult to analyse. However, some small beats of nystagmus were found in all subjects.

Thus it seemed that shifts of eye position (Schlagfeldverlagerung) dominated eye motility in these reflex mechanisms. They were also reduced in amplitude for COR and active head movements in comparison to normals (Fig. 1).

3. Quantitative Analysis of Nystagmus

The *total saccadic amplitudes* averaged over 5 periods were mean values of all patients. They increased only slightly with stimulus amplitudes up to 60 degrees, at least for the higher frequencies of 0.1 and 0.2 s^{-1}. Generally they were significantly smaller than control values [6]. As in controls the values for COR were lowest, and

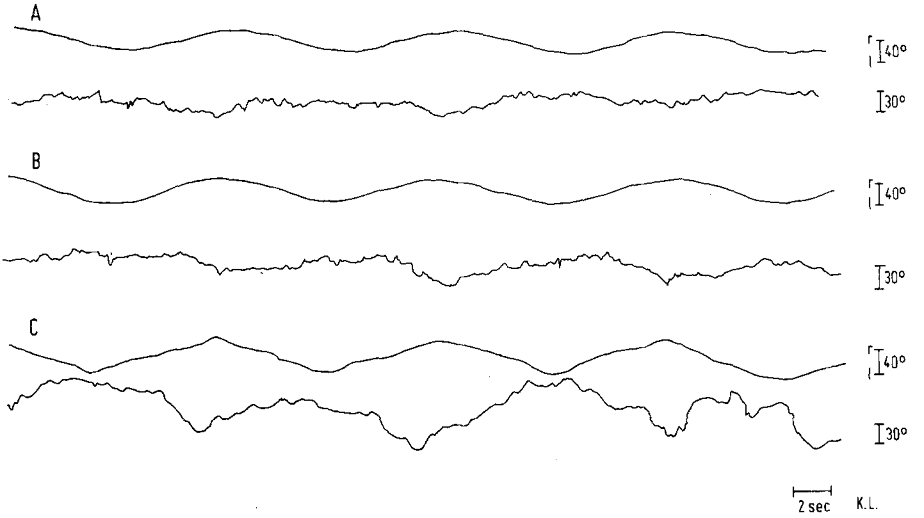

Fig. 1A–C. Eye movements during vestibulo-ocular reflex (**A**), cervico-ocular reflex (**B**) and active head movements (**C**, *lower traces*) of one patient with severe Huntington's Chorea. Turn table position (**A**), position of the fixed head against the turning trunk (**B**) and head position in active head movement (**C**) in the *upper traces*

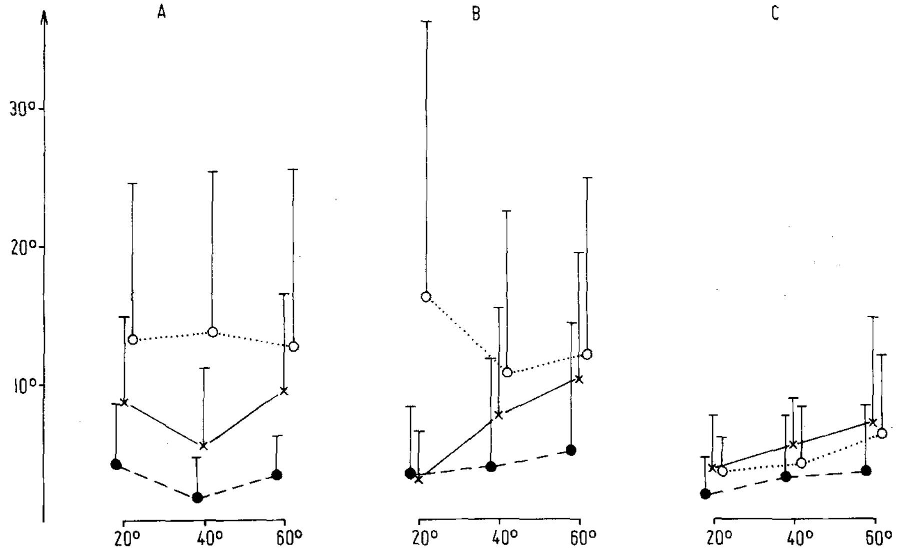

Fig. 2A–C. Total saccadic amplitudes averaged over 5 periods at frequencies of $0.05\,s^{-1}$ (**A**), $0.1\,s^{-1}$ (**B**) and $0.2\,s^{-1}$ (**C**) for VOR (+), COR (●) and active head turnings (○). Mean values of 8 patients, vertical bars indicate standard deviations of these values

the values for VOR and active head movements were slightly higher. At 0.05 and $0.1\,s^{-1}$ the total saccadic amplitudes of active head movements were markedly above those of VOR, whereas at $0.2\,s^{-1}$ the mean values of active head movements were in the range of VOR. The very high values during active head movements up to 60°, as seen in the control group [6], were never found in choreic patients (Fig. 2).

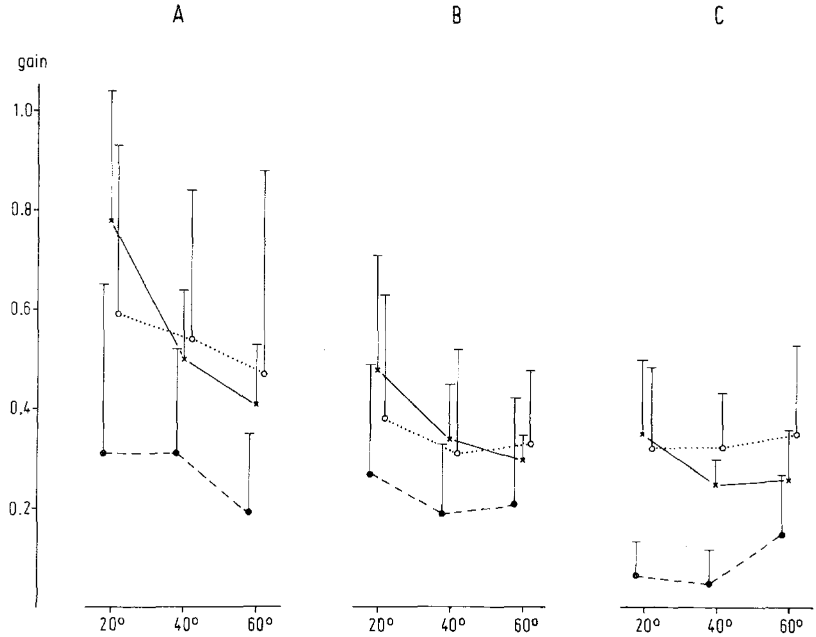

Fig. 3. Gain of peak slow phase velocity of nystagmus to peak stimulus velocity. Symbols as in Fig. 2

The *gain*, defined as the relation between peak slow phase velocity of nystagmus to peak stimulus velocity, was only slightly lower than in normals and decreased with increasing stimulus frequencies similar to the controls [6]. For all frequencies the gain fell with increasing stimulus amplitudes, at least for VOR and active head movements. While the gain of active head movement in controls was always above the values of COR and VOR, in choreic patients this difference was not significant. The gain of COR always showed the lowest values. The gain of VOR and active head movements was markedly higher, but without any clear difference between either (Fig. 3).

4. Shift of Average Eye Position

These deviations were also found in choreic patients with a high variability. In VOR the amplitudes were similar to those found in normals, but the higher values in normal subjects for COR and more so for active head movements were not found in Huntington's Chorea [6]. With higher frequencies (0.1 and $0.2\,s^{-1}$) average eye movement amplitudes increased constantly with stimulus amplitudes (Fig. 4).

In the control group the phase difference between the maximum of stimulus and of overall eye deviation was generally around 180° for VOR and about 0° for COR and active head movements [6].

In patients with Huntington's Chorea the eye movements in COR, but more clearly in active head movements were not so regularly anticompensatory as in normals and may even be compensatory in comparison to those found in VOR (Fig. 5).

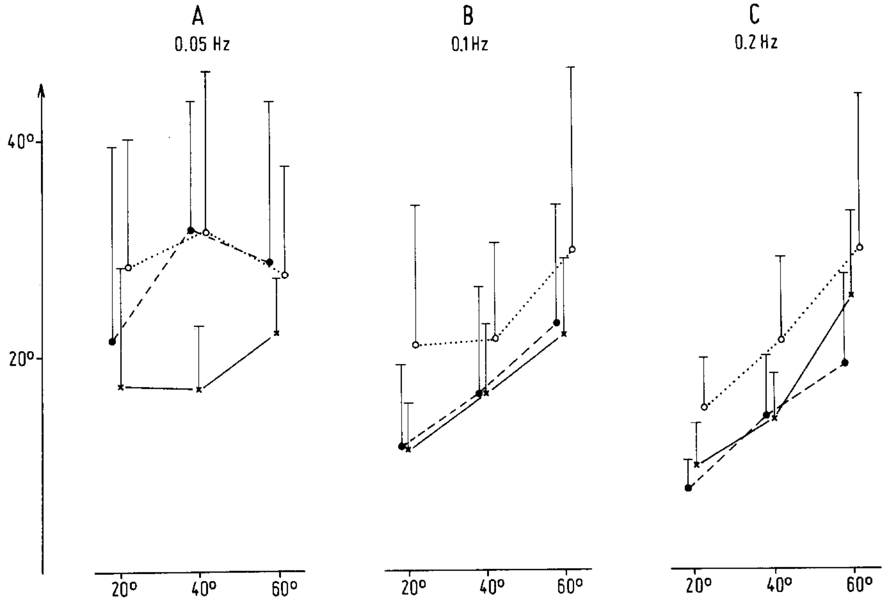

Fig. 4. Maximum amplitudes of average eye deviations averaged over 5 periods. Symbols as in Fig. 2

Discussion

In a recent study [10] it was demonstrated that rapid and saccadic eye movements were altered early in the course of Huntington's disease. This was confirmed in this study by two facts. The total saccadic amplitudes for VOR, COR and active head movements were significantly smaller than in normals. Moreover the typical large saccades at the beginning of neck-to-eye reflexes and more distinctly in active head movements were only rarely found. Probably due to this fact the slow deviations of averaged eye position, anticompensatory for head movements, were much smaller in COR and active head movements. Often, during active head movements only a compensatory slow deviation of the eyes was observed. As compensatory slow eye movements probably were due to the vestibulo-ocular reflex mechanisms [6] it may be inferred that the neck-to-eye reflexes were altered in Huntington's Chorea more than the VOR and that in the course of the degenerating disease only the vestibulo-ocular reflex was able to survive. It thus seems that polysynaptic neuronal mechanisms of the saccadic system and polysynaptic parts of the COR are altered earlier.

It was demonstrated in decerebrate cats [8] that neck afferents on the abducens motoneurons interact with vestibulo-abducens reflex, and postulated that the cervico-abducens and vestibulo-abducens reflex pathways converge upon common excitatory or inhibitory interneurons in the vestibular nuclei. Although the precise tract and the location of synapses along the pathway from the spinal cord to the vestibular nuclei remains to be studied, in cats it may not be multisynaptic but a relatively direct route.

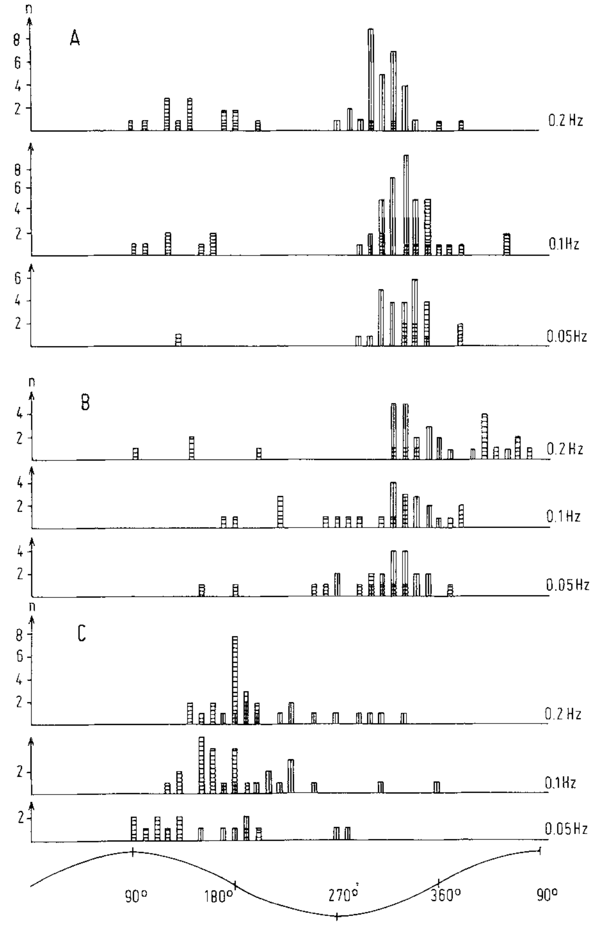

Fig. 5A–C. Distribution of maximum amplitudes of slow eye deviations with respect to head position for active head movements (**A**), cervico-ocular reflex where the lower trace indicates the relative head movement with respect to the turning body (**B**) and for vestibulo-ocular reflex (**C**) The lower trace indicates head position. The vertical bars indicate the number of measurable events over 5 periods for the different frequencies. (|||) 10 normal persons; (≡) 8 choreic patients

In comparison to this data, our findings in humans are in favour of a more polysynaptic cervico-ocular reflex route to the abducens motoneurons, which is altered by the neuronal degeneration of Huntington's Chorea.

To date the exact mechanisms of the slow average eye deviations are unknown. It is probable that the imagination of a moving visual object influences these eye movements and modifies the gain of COR in a similar way as shown for the VOR [12] and active head movements [14].

Moreover these eye deviations depend critically on the state of alertness [6] and increase with drowsiness. Therefore it may be precipitate to discuss in detail their mechanisms in healthy persons and in pathological conditions before further studies are completed.

References

1. André-Thomas M, Abely X, Ajuriaguerra J de, Eullier L (1945) Troubles de l'élévation des globes oculaires dans un cas de Chorée de Huntington. Rev Neurol 77:248–250
2. Aschoff JC (1968) Veränderungen rascher Blickbewegungen (Saccaden) beim Menschen unter Diazepam (Valium). Arch Psychiatr Nervenkr 211:325–332
3. Avanzini G, Girotti F, Caraceni T, Spreafico R (1979) Oculomotor disorders in Huntington's Chorea. J Neurol Neurosurg Psychiat 42:581–589
4. Bruyn GW (1969) Huntington's Chorea: Historical, clinical and laboratory synopsis. In: Vinken PJ, Bruyn GW (eds) Handbook of neurology, vol 13. North-Holland Publ Comp, Amsterdam, pp 298–378
5. Dereux J (1945) Chorée chronique et paralysie hypertonique du regard. Rev Neurol 77: 207–208
6. Doerr M, Leopold HC, Thoden U (1981) Vestibulo-ocular reflex (VOR), cervico-ocular reflex (COR) and its interaction in active head movements. Arch Psychiatr Nervenkr 230: 117–127
7. Henn V, Büttner U, Büttner-Ennever J (1978) Supranucleäre Organisation der Okulomotorik. In: Kommerell G (Hrsg) Augenbewegungsstörungen. JF Bergmann, München, S 129–143
8. Hikosaka O, Maeda M (1973) Cervical effects on abducens motoneurons and their interaction with vestibulo-ocular reflex. Exp Brain Res 18:512–530
9. Kirkham TH, Kannin DF (1979) Slow saccadic eye movements in Wilsons disease. J Neurol Neurosurg Psychiat 37:191–194
10. Oepen G, Clarenbach P, Thoden U (1981) Disturbance of eye movements in Huntington's Chorea. Arch Psychiatr Nervenkr 229:205–213
11. Petit H, Milbled G (1972) Anomalies of conjugate ocular movements in Huntington's Chorea. Adv Neurol 1:287–294
12. Sharp JA, Goldberg HJ, Lo AW, Herishanu YO (1981) Visual-vestibular interaction in multiple sclerosis. Neurology 31:427–433
13. Starr A (1967) A disorder of rapid eye movements in Huntington's Chorea. Brain 90: 545–564
14. Takahashi M, Uemura T, Fujishiro T (1980) Studies of the vestibulo-ocular reflex and visual-vestibular interactions during active head movements. Acta Otolaryngol 90:115–124
15. Weerden TW van (1978) Differentialdiagnose supranukleärer Störungen der Okulomotorik. In: Kommerell G (Hrsg) Augenbewegungsstörungen. JF Bergmann, München, S 169–173

Received July 9, 1981