© Aeolus Press
Neuro-ophthalmology 0165-8107/91/US$ 3.50 (Accepted 2 October 1990)

Suppression of congenital nystagmus by cutaneous stimulation ◊

L.F. DELL'OSSO[1, 3], R.J. LEIGH[1, 2, 3] and R.B. DAROFF[1, 2, 3]

[1]*Ocular Motor Neurophysiology Laboratory and* [2]*Neurology Service, Veterans Affairs Medical Center; and the* [3]*Departments of Neurology, Case Western Reserve University and University Hospitals of Cleveland; Cleveland, OH, USA*

ABSTRACT. Based on the authors' finding that congenital nystagmus (CN) could be suppressed by contact lenses, they investigated the effects on the CN waveform of cutaneous stimulation of the ophthalmic division of the trigeminal nerve. Significant (> 50%) damping of the CN was found for each of the following stimuli: touching the upper eyelid; rubbing the forehead lightly; pressing on the forehead; vibration on the forehead at both 30 and 110 Hz; and both supra- and sub-threshold electrical stimuli to the forehead. These robust responses suggest that proprioception is important in both the suppression (and possibly generation) of CN and normal ocular motor control.

Key words: congenital nystagmus; damping; afferent stimulation; proprioception

That contact lenses could, by their very presence on the eyes, damp congenital nystagmus (CN)[1] raised the possibility that other afferent stimuli to the ophthalmic division of the trigeminal nerve might have a similar effect. Because of their low mass and the highly overdamped nature of the ocular motor plant, an increase in inertial load could not be the mechanism by which damping is achieved with contact lenses. The mechanism might be some form of biofeedback of the CN waveform since the lens motion sensed by the inner eyelid is equivalent to eye motion. Alternatively, the afferent stimulation provided by the contact lens could cause a change or 'recalibration' of the dynamic properties of the extraocular muscles (unrelated to the actual waveform) that renders them less responsive to the neural signal responsible for the CN. This latter explanation is suggested by the additional observation that merely touching the upper eyelid with a cotton swab also damped the CN[1].

We preliminarily tested this latter hypothesis by applying several types of stimulation to the forehead of a subject with CN while he was looking at a light-emitting diode target at primary position in a darkened room. We applied the following stimuli: (1) touching the upper eyelid with a cotton swab; (2) rubbing the forehead lightly with a cotton swab; (3) pressing on the forehead with a cotton swab; (4) vibrating the forehead at

◊ This work was supported in part by the Department of Veterans Affairs NIH grant EY06717 and Evenor Armington Fund.

* *Reprint requests and correspondence to:* L. F. Dell'Osso, Ph.D., Ocular Motor Neurophysiology Laboratory, Veterans Affairs Medical Center (127A), 10701 East Boulevard, Cleveland, OH 44106, USA. Telephone (216) 421-3224

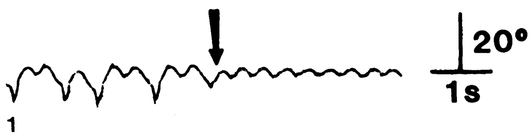

Fig. 1. Eye position record showing the effect of applying (at arrow) a 110 Hz vibratory stimulus to the forehead of a subject with congenital nystagmus.

30 Hz; (5) vibrating the forehead at 110 Hz; (6) applying an electrical stimulus below perceptual threshold to the forehead; and (7) applying a suprathreshold electrical stimulus to the forehead. Stimuli 2-7 were applied above each eye in turn and stimuli 6 and 7 were also applied across the forehead above the two eyes.

We found a significant damping of nystagmus with all stimuli (>50% reduction of CN amplitude) and this damping persisted for several seconds after the cessation of the stimuli. Fig. 1 shows the response to a vibratory stimulus and Fig. 2 to an electrical stimulus. They are both representative of the immediate responses to all the stimuli used.

This is a very robust effect on an ongoing ocular motor oscillation by a non-specific stimulus unrelated to the oscillation. As such, it has several implications concerning both the role of afferent stimuli in the control of eye movements and the possible therapeutic applications of this stimulation to other forms of nystagmus in addition to CN.

How could cutaneous stimulation of the eyelid and forehead influence the amplitude of CN? These areas of skin are supplied by the ophthalmic division of the fifth nerve, which, in monkeys, also carries extraocular proprioception to the spinal trigeminal nucleus[2]. Although extraocular proprioception is not thought to be important in the programming of voluntary saccades and probably does not contribute to a stretch reflex[3] proprioception may play a role in the 'calibration' of eye position[4].

Fig. 2. Eye position record showing the effect of applying (at arrow) a pulsatile electrical stimulus to the forehead of a subject with congenital nystagmus.

We postulate that cutaneous stimulation reduces the amplitude of CN by temporarily interfering with a proprioceptive calibration signal but such a suggestion remains speculative until further data are available. Possible parallels exist between the effect of cutaneous stimulation and those of convergence or acupuncture[5] in damping both CN and some forms of acquired nystagmus. Convergence signals increase the innervational level and may alter the 'operating point' of the plant, decreasing its response to the oscillatory signal. Acupuncture of the neck muscles results in stimulation that is fed back to the trigeminal nucleus where it may affect the plant in a similar manner. Alternatively, trigeminal proprioceptive feedback itself may be a factor in generating the CN oscillation and its alteration by cutaneous stimulation could be interfering with that generation.

Whatever the mechanism of action of either trigeminal afferents or cutaneous trigeminal stimulation, the distinct effect of the latter may have therapeutic applications in cases of CN (to increase visual acuity by damping the CN) and acquired nystagmus (to reduce oscillopsia by damping the nystagmus). Determination of the characteristics of an optimal signal (or signals for different types of oscillations) for suppression is required, as is the development of a simple, unobtrusive delivery method. Finally, the possible suppression effect of cutaneous trigeminal stimulation on saccadic oscillations should also be investigated.

REFERENCES

1. Dell'Osso LF, Traccis S, Abel LA, Erzurum SI: Contact lenses and congenital nystagmus. Clin Vis Sci 3:229-232, 1988
2. Porter JD: Brainstem terminations of extraocular muscle primary afferent neurons in the monkey. J Comp Neurol 247: 133-143, 1986
3. Keller EL, Robinson DA: Absence of a stretch reflex in extraocular muscles of the monkey. J Neurophysiol 334:908-919, 1971
4. Steinbach MJ: Proprioceptive knowledge of eye position. Vis Res 27:1737-1744, 1987
5. Ishikawa S, Ozawa H, Fujiyama Y: Treatment of nystagmus by acupuncture. In: *Highlights in Neuro-Ophthalmology. Proceedings of the Sixth Meeting of the International Neuro-Ophthalmology Society (INOS)*, pp 227-232. Amsterdam: Aeolus Press 1987