Short report

EEG and serum prolactin studies in relation to transcutaneous stimulation of central motor pathways

SG BOYD, LVK DE SILVA*

From the Departments of Clinical Neurophysiology & Clinical Biochemistry, The Hospital for Sick Children, Great Ormond Street, London, UK.

SUMMARY Eight adult volunteers had EEG recordings and serial serum prolactin estimations performed both before and after a session of transcutaneous stimulation of the central motor pathways using the technique of Merton and Morton. No significant changes in either the EEG traces or in the serum prolactin values were detected.

The ability to study function in central motor pathways, using techniques of transcutaneous stimulation through the intact scalp, is an important recent development in clinical neurophysiology. In a conscious subject, a single large shock from a purpose-built device is applied to the scalp over the motor cortex with disc or pad electrodes. The resulting contraction in peripheral muscles can be recorded using conventional apparatus.¹ Studies on normal adults^{2,3} and on patients with multiple sclerosis⁴ have recently been published.

The technique appears to be safe, and no adverse effects have been reported from amongst the several hundred subjects who have been tested. In addition, some of the original investigators have themselves received hundreds of stimuli without ill-effect. However, there have been no studies to delineate possible transitory physiological effects of transcutaneous stimulation.

Electroencephalograms (EEGs) taken immediately after unilateral electro-convulsive therapy (ECT) show marked slowing (1-4 Hz activity reaching

50-200 μ V) on the side of stimulation which persists for at least half an hour.^{5,6} A ten to fifty-fold increase in prolactin secretion 15 minutes after ECT has also been documented.^{7,8} Generalised tonic/clonic and complex partial seizures have been shown to produce significant (two to three fold) rises in serum prolactin in both adults⁹⁻¹³ and in children¹⁴ and this finding is being used widely in clinical practice to discriminate between seizures and pseudo-seizures. The optimum time for estimating the prolactin level has been determined to be 15-20 minutes following the seizure.^{9-11,13}

Before the technique of transcutaneous stimulation is adopted as a routine procedure, particularly in children, it was considered worthwhile to study EEG and serum prolactin responses to transcutaneous stimulation in a group of healthy adult volunteers.

Methods

Eight healthy adult volunteers aged 24 to 55 years were studied. There were two males and six females. All were members of staff of the department or were medical colleagues. None were receiving medication. All gave informed consent, and the protocol for the study was approved by the Standing Committee on Ethical Practice of the Hospital for Sick Children. The EEGs were recorded from silver/silver chloride electrodes using previously described techniques,¹⁵ and included overbreathing for three minutes and photic stimulation at a wide range of flash frequencies.

Immediately prior to the session of transcutaneous stimulation, the EEG headbox was disconnected from the appara-

*Present Address: King Abdul Aziz Naval Base Hospital, Jubail, Saudi Arabia.

Address for reprint requests: Dr SG Boyd, Department of Clinical Neurophysiology, The Hospital for Sick Children, Great Ormond Street, London WC1N 3JH, UK.

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Table

Subject (no)	Age (yr)	No. of stimuli to scalp	Range of values of serum prolactin (mU/l) pre-stimulus	post-stimulus
1	24	10	326-370	289-318
2	26	4	160-219	138-196
3	32	5	567-581	471-578
4	34	3	77-84	77-84
5	47	10	171-175	99-196
6	49	13	688-689	410-536
7	54	5	127-156	100-140
8	55	5	65-82	53-71

tus to ensure isolation from the earth lead of the EEG machine. Transcutaneous stimulation of the motor cortex was then performed using a Digitimer D180 stimulator in accordance with methods described previously.¹ Stimulus intensity was increased until consistent supramaximal responses were recorded. The rate of stimulation was between 1 per 5 s and about 1 per 30 s. The number of stimuli was kept in line with that usually employed in routine diagnostic sessions and no attempt was made to subject the volunteers to large numbers of stimuli. (table)

Within half a minute of completing the session of stimulation, the EEG was reconnected and recording was continued for a further 30 mins. Hyperventilation and photic stimulation were repeated.

A cannula was sited in a forearm vein at the time of electrode placement, and was kept patent throughout the procedure with heparin. Blood samples for baseline serum prolactin estimation were obtained both 30 minutes before and also immediately prior to transcutaneous motor tract stimulation. Following the series of stimuli, further samples were obtained at five minute intervals for a period of thirty minutes. The first ml of each sample was discarded to avoid contamination with heparin. Serum prolactin was measured by radioimmunoassay using ¹²⁵I and Guildhay G/R/51-VABC antisera. A second antibody was used for separation. Between assay coefficient of variation was 8.3, 11.2 and 10.6% at prolactin concentrations of 242, 599 and 1328 mU/l respectively.

Results

The EEGs were reported independently by two experienced electroencephalographers. No differences were detected between the pre- and post-stimulation records, either in the resting record or in relation to hyperventilation and photic stimulation.

The baseline serum prolactin concentration was 283 ± 225 mU/l (mean ± SD). Prolactin concentration after the stimulus remained at 233 ± 170 mU/l (mean ± SD), during the thirty minutes the subjects were observed. None showed an increase in prolactin concentration over the baseline value (table). There was no significant difference between the mean prolactin concentrations before and after the stimulus.

Discussion

No previous studies of the effects of transcutaneous stimulation on the EEG have been reported. Although it was not practicable to record the EEG at the moment of the transcutaneous stimulus, the fact that no sustained EEG alteration occurs, (when using the numbers of transcutaneous stimuli with the stimulus intensities normally employed in clinical studies) is in marked contrast to the EEG changes reported after unilateral ECT. This is not surprising when the relative amounts of energy delivered to the patients are considered in the two situations. Assuming that there is no resistance in the electrode wires or in the scalp, and that all the energy is delivered to the patient, the maximum output of the Digitimer D180 (using a nominal time constant of 50 µs) would be about 0.25 joules, compared with the estimated 25-50 joules used in the ECT sessions recorded by Kriss *et al.*⁶

Many conditions of mild to moderate "stress" have been shown to increase the serum prolactin. These include drugs such as butyrophenones, methyl dopa and chlorpromazine, as well as anaesthesia and surgery.¹⁶ It is thought that prolactin secretion in all these situations (including ECT and seizures) is related to suppression of dopamine secretion in the arcuate and periventricular nuclei of the medial basal hypothalamus.^{8,13} No such rise in serum prolactin has been demonstrated in the present study, and it seems that transcutaneous stimulation of the motor tracts does not alter this dopamine system (either directly as a consequence of stimulation, or indirectly as a "stress" effect) at least using conventional clinical diagnostic techniques. It would obviously have been difficult to carry out this study in normal children, but there is no reason to suppose that EEG effects or prolactin would be affected any differently in a paediatric population.

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