EFFECT OF COMPRESSION OF SPINAL CORD ON BRAIN RHYTHMS

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Summary : Electroencephalographic changes were studied in anaesthetised rats, subjecting them to the mechanical compression of spinal cord. The EEG waves that were studied-Alpha, Theta, and Delta. The changes in these waves and shift from one pattern to another after the compression of the spinal cord at the Lumbar level. These waves were subjected Fourier analysis. The results show remarkable changes in wave patterns and a shift in the dominating wave pattern. With 50% compression the EEG showed a slight increase in the amplitude in all three wave forms - with Delta wave pattern being more dominant. At 100% compression there is a marked decrease in the Delta amplitude compared to normal. We tried to observe the changes in activity of the brain - the effects of spinal lesion and its relationship with tonic activity changes in EEG.

key words : brain rhythm evoked potential delta theta alpha waves dft fft fourier analysis

INTRODUCTION

Shaul Feldman and Wagman (10) observed the effect of Pentobarbital on evoked potentials in brain of monkey. Potentials evoked in some areas of the brain by peripheral stimulation are markedly depressed by pentobarbital. This effect of drug on the reticular formation has been attributed to the blocking of interneuronal systems and has been postulated as a basic mechanism in anesthesia.

Namerow (9) studied somatosensory evoked potentials following cervical cordotomy. Suppression of the cortical electrical activity and resistance of the cortical vessels to collapse were investigated under various pressures applied locally by an inflatable balloon over the cerebral cortex of dogs. The locally applied pressure and the transmitted intracranial pressure were used to produce suppression. The supression of the cortical activity is proportional to the pressure applied. It is concluded that the suppression of cortical activity is as a result of changes in the local bloodflow which is turn, a result of local compression and tissue distortion.

Croft *et al.* (1) have applied graded pressure on the spinal cord and produced reversible blocking of the evoked potentials. With this type of trauma, blocking of motor transmission through the cord parallelled the block of sensory transmission and each seemed to be a sensitive indicator of spinal cord function. Mark *et al.* (4) found that there was not a proporrtional relationship between stimulus intensity and amplitude of cortical somatosensory evoked potentials. It is well known that the early cortical evoked responses are little affected by sleep or barbiturate anesthesia. The loss of spinal transmission cannot be secondary to deforming mechanical pressure. Gelfan (2) and Martin (5) have opined that the changes in cortical evoked potentials could be used to predict the extent of Neurological defects following spinal cord injury by sudden inflation of Fogatry balloon in epidural space cephalad to a laminectomy. In this study we tried to evaluate the changes in brain rhythms after the compression of the spinal cord by a mechanical device.

MATERIAL AND METHODS

For the present study albino rats were used, weighing less than 200 *gms*. The total number of rats utilised were 15. The rats were anesthetised with nembutal (dosage 35 *mgm/kg* of body weight) administered intraperitoneally. After anesthetisation skin over the skull was cut and the skull was exposed. The rats' heads were fixed stereotaxically and two surface metal electrodes were placed on either side of the sagittal suture, lying over the parietal lobes, (Fig. 1).

The electrodes were connected to the recording system (ie 4 channel Polyrite). Initially the pen recorder and amplifier system were tested and calibrated, the normal electro-encephalogram was recorded for a few seconds. The calibration once done, was not disturbed throughout the aeries of experiments. (Calibration : one centimeter stroke of the writing pen was equal to 100 micro volts).

The normal EEG was recorded at two different chart speeds-ie 25 and 59 mm/s. Then the rats were dissected for the exposure of the spinal cord at L1 and L2 level, and care was taken not to damage the dural covering of the cord. Now the compression setup was fixed to the body of rats. The setup was designed as such that it holds the vertebral column firmly between its two plates and does not allow the vertebral column to collapse during compression. The ventral portion of the vertebral acts as a container to the cord over which the cord can be compressed by the screw. The part of the device which compresses the cord is tiny plate attached with a screw. When the screw is turned ten full turns it maximally compresses the between it and vertebral column. This was taken as 100% compression and five turns of the screw was taken as 50% compression. The compression was expressed in terms of percentage only. After each stage of compression three samples of EEG were recorded. As an initial step 50% compression was done, immediately the EEG was recorded and the recordings were repeated at an interval of 5 and 10 minutes. The same steps were taken with 100% compression.

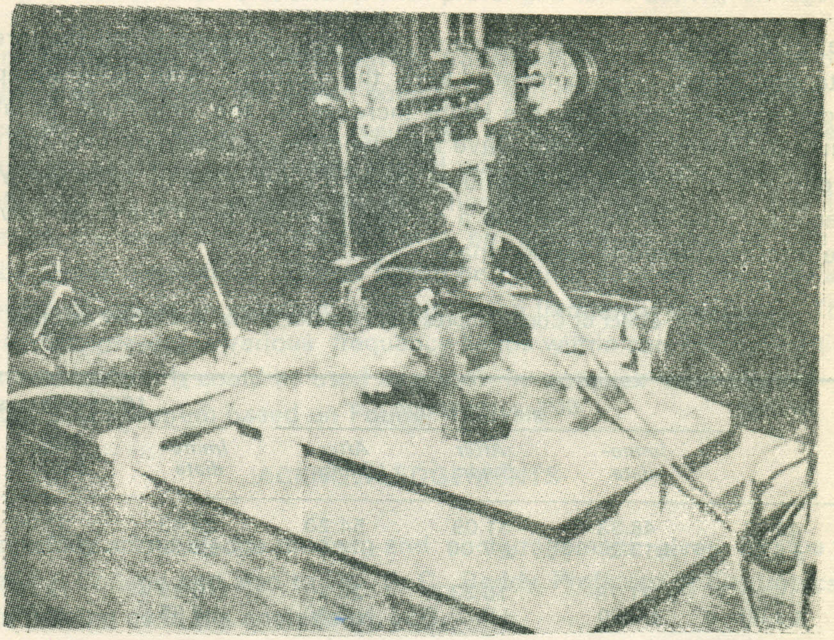

Fig. 1 : Anesthetised rat fixed to the stereotaxic instrument — metal surface electrodes placed on the skull— and the compression assembly fixed to the vertebral column.

The graphic records were first analysed manually and then the data was fed to the computer for the purposes of discrete fourier transform (DFT) method by Fast fourier transform (FFT). In the manual analysis, a uniform strip of graph was taken for each experimental group as follows : (1) Normal, (2) 50% compression immediately (3) after 5 min (4) after 10 min (5) 100% compression immediately (6) after 5 min (7) after 10 min, and specific transparent scale was prepared by dividing 1 sec distance into 28 equal parts and with the help of this the voltages were noted down. These were then fed to a digital computer to get the DFT coefficients. The DFT's for each rat were calculated. We have limited our interest to the frequency range of alpha wave pattern and below. These DFT coefficients were then subjected to spectral analysis (12). The mean values were calculated and the coefficients were subjected to 't' test for finding out the statistical significance. The 't' test was performed for the following three frequencies ie delta theta, and alpha of EEG. The mean values and the P values are indicated in the table given below.

RESULTS AND DISCUSSION

The EEG analysis clearly indicates changes particularly for the three waves ie, delta, theta, and alpha, when compared with the normal. With 50% compression the EEG recorded immediately showed a slight increase in the amplitude in all the three wave forms and however the delta wave form being most dominant over the others. The EEG recorded after a duration of 5 minutes showed a decrease in delta wave forms, but the EEG recorded after 10 min showed a definite increase in all the three wave forms and delta wave form continued to be dominant.

TABLE I : Effect of Cord compression on delta, theta, and alpha rhythms.

Frequency	*Normal*	*50% compression*			*100% compression*		
		Imme-diate	*After 5 min*	*After 10 min*	*Imme-diate*	*After 5 min*	*After 10 min*
Delta	40.37 ±6.50	48.33 ±13.2	31.09 ±7.00	54.20 ±14.00	23.43 ±3.30*	67.06 ±20.00	47 07 ±17.00
Theta	15.20 ±3.50	21.78 ±7.90	15.23 ±6.20	26.40 ±5.90	16.85 ±6.95	19.75 ±4.60	15.07 ±4.00
Alpha	16.64 ±7.20	26.07 ±11.10	17 08 ±8.00	27.84 ±10.20	21.01 ±11.10	36.19 ±20.10	22 62 ±9 60

Values are mean ± standard error from fifteen rats.
*Indicates significant P Value less than 0.02.

The immediate record of EEG with 100% compression shows a marked decrease in delta amplitude compared to normal record. This change is statistically significant (P is less than 0.02). Whereas after 5 min duration there is a maximal increase of delta and alpha wave form, the change being statistically not significant The theta wave form remained almost the same. After 10 min duration all these wave forms more or less returned to the normal level but the change remained statistically not significant. Probable causes of this change cannot be explained however it might be suggested here as by (6) and also the acute compression force exerted on the cord may cause mechanical deformation which may become significant if the injury caused is much severe. Moreover

Thomas *et al.* (11) studied cortical evoked potentials in cats after creating a spinal cord injury. With this type of trauma they have noted a block in sensory transmission. Hukuda and Wilson (3) concluded that compression can be an additive force to vascular insufficiency which can manifests itself as neurological disorders on cervical spondylotic patient. Melzack *et al.* (8) observed prolonged changes in activity of the brain— the effects of spinal lesion and its relationship with prolonged tonic activity changes in EEG.

Mcdonald and Sears (7) viewed that the transmission through a region of demyelination of larger area can block the action potentials, and if lesion is smaller the transmission can occur with low velocity. As a result, our experiments show that, even though of acute nature the EEG can be definitely altered with spinal cord compression. However, the results obtained are not significant but the changes are remarkable and lucid. We suggest, in short, the wave form of the EEG may be difficult to analyse into dominant frequencies by simple inspection. Hower based on Fourier analysis one can assess the relative amounts of activity in selected divisions of the frequency spectrum. The relative amount of activity present in various frequency bands within short sampling time can be determined numerically. It could be used as a tool in complex neurological conditions to measure the EEG spectrum based on Fourier analysis.

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