COMPARISON OF THE ELECTROENCEPHALOGRAPHIC PATTERNS DURING STEROID AND BARBITURATE NARCOSIS

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A STEROID compound 21-hydroxy-pregnane-3, 20-dione sodium succinate (Viadril) has been used as an intravenous anaesthetic. The changes in the electroencephalogram produced by this agent have been observed by Boyan et al. (1955) to be similar to the changes reported by Kiersey et al. (1951) with thiopental sodium narcosis.

This study was undertaken to compare the electroencephalographic pattern of Viadril with that of short- and ultra-short-acting barbiturates and at the same time establish criteria for judging the depth of narcosis for these agents by employing the electroencephalograph. For comparison with Viadril ethyl-1, methyl butyl barbituric acid (pentobarbitone); isoamyl-ethyl-thio-barbituric acid (thiamylal); and an (N-) substituted barbiturate N-methyl - cyclohexanyl - methyl-barbituric acid (hexobarbitone) were selected.

METHOD

Thirty-six patients undergoing relatively minor surgical procedures were observed during this study. All patients were premedicated with atropine 0.4 mg and an appropriate dose of a narcotic one-half to one hour prior to anaesthesia. A 4-litre to 2-litre flow of nitrous-oxide oxygen was administered during the placement of frontocentral No. 25 needle electrodes. The patient was then allowed to breathe room air until no effect of nitrous oxide was apparent. Electroencephalographic tracings were recorded on a Grass III D electroencephalograph at a paper speed of 30 mm per second and calibrated for 50 microvolts at 7 mm deflection or 100 microvolts at 10 mm deflection. Oxygen was administered by mask and the intravenous agent in normal saline and water was injected intermittently until the desired level was observed on the electroencephalogram. A study of the patterns obtained in this series was then made by an examiner without knowledge of the agent used.

RESULTS

The changes in electroencephalographic pattern produced by the intravenous agents studied are similar. Therefore one description of the pattern of electroencephalographic changes will suffice for Viadril (fig. 1), pentobarbitone (fig. 2), thiamylal (fig. 3) and hexobarbitone (fig. 4).
FIG. 1
Electroencephalographic pattern of hydroxydione (Viadril) anaesthesia

FIG. 2
Electroencephalographic pattern of pentobarbitone
Fig. 3
Electroencephalographic pattern of thiamylal

Fig. 4
Electroencephalographic pattern of N-methyl-cyclohexenylmethylbarbituric acid (hexobarbitone)
The patterns have been arbitrarily arranged into four or five levels for ease in description and interpretation. Gradations appear between each pattern so that the change from one pattern to the next is gradual.

The first change that is observed from the awake pattern is an increase in frequency to 20 to 30 cycles per second. There may be a slight increase in amplitude. The patient at this time is drowsy.

As the amount of drug given is increased the pattern becomes of greater amplitude, spiky in nature and up to 200 microvolts in amplitude. The frequency is compound and consists of 20 cycle activity superimposed on slower 8 to 12 cycle activity.

The third level is characterized by silent areas or periods of "burst suppression" lasting one to three seconds. These silent periods were achieved with all agents studied. The areas of activity or "bursts" are composed of mixed frequencies, mainly 6 to 10 c/s with superimposed low voltage fast waves.

By increasing the amount of the agent administered level IV may be obtained. This level is arbitrarily set as having "burst suppression" of between 3 and 10 seconds duration. Patients with this degree of cortical depression will move upon surgical stimulation unless nitrous oxide is added to the inhaled oxygen.

Level V (level IV on the Viadril chart, fig. 1) is arbitrarily assigned to the electroencephalographic pattern observed when the duration of cortical suppression persists for 10 seconds or longer.

When the electroencephalographic patterns were compared it was not possible to detect characteristic changes that could be attributed to any one agent. All the intravenous agents studied produced the same change in the electroencephalographic pattern. However, at deeper levels it was possible to distinguish pentobarbitone records since the return from pattern four or five to pattern two was much slower than with other drugs studied.

**DISCUSSION**

The initial increase in frequency we have described with these intravenous agents has been observed by Brazier and Finesinger (1945), Derbyshire et al. (1936), Kiersey et al. (1951), Cohn and Katzenelbogen (1942), and Gibbs et al. (1937), as well as with diethyl ether anaesthesia by Bellville and Artusio (1955) and Gibbs et al. (1937). However, the fast activity produced by the intravenous agents appears to be less rhythmic and not as regular as the pattern observed during ether analgesia. The patients who exhibit this pattern (level I) with the intravenous agents may be conscious and react to pain in contrast to patients who are free of pain during ether analgesia. This lends support to the thesis of Derbyshire, Rempel, Forbes and Lambert (1936) that pentobarbitone suppresses cortical activity without blocking sensory paths leading to it, whereas ether blocks sensory paths before cortical activity is suppressed.

The mechanism of production of the initial increase in cortical frequency has not been entirely explained. Brazier and Finesinger discussed the possibility that it might be due to a change in membrane permeability or due to a depressant effect of the barbiturate on the dehydrogenase system. Torda (1953) attempted to relate
the increase in frequency and amplitude to acetylcholine content of the brain.

The slow waves that appear with surgical anaesthesia have been attributed to an alteration in function at the level of the reticular formation by French et al. (1953). It has been found that lesions in the reticular formation produce slowing of the cortical frequencies and a state of unconsciousness. Slowing is not necessary before unconsciousness is produced for it is possible with the intravenous agents as well as with ether to have unconsciousness without the presence of slow frequencies in the electroencephalogram.

The burst suppression or lack of cortical activity produced by the intravenous agents studied may be due to a direct effect of these agents on the cortex. Henry and Scotville (1952) have shown suppression burst activity similar to that obtained with thiopentone anaesthesia to arise from the isolated cortex. They postulate that suppression burst activity may be due to release of the cortex from the influence of the reticular activating system.

According to Gordan et al. (1951) the steroids act at a different site on the main line of biological oxidation than the other anaesthetic agents. However, except for its slow onset Viadril acts clinically, essentially like the intravenous barbiturates. Furthermore the electroencephalographic pattern changes appear to be similar.

Dawson and Walter (1944) have shown the limitations of visual analysis of the electroencephalogram. It appears from our studies that more detailed and precise studies of electroencephalographic changes during anaesthesia are necessary if the electroencephalogram is going to be of aid in understanding mechanisms involved in anaesthesia and narcosis. Important changes in electroencephalographic activity now occurring may escape interpretation that could be detected by electroencephalogram frequency spectrum analysis correlated with plasma oxygen, carbon dioxide and anaesthetic concentration.

SUMMARY

The changes in the electroencephalogram produced by 21-hydroxy-pregnane-3, 20-dione sodium succinate (Viadril); ethyl-1, methyl butyl barbituric acid (pentobarbitone); isoamyl-ethyl-thio-barbituric acid (thiamyl); and N-methyl cyclohexanyl - methyl - barbituric acid (hexobarbitone) are similar.

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REFERENCES