THE EFFECT OF ELECTRICAL SLEEP ON THE VISCOSITY OF BLOOD

FLORELLA MAGORA, C. HERSHKO AND H. B. ARONSON

SUMMARY

Exposure of thirty-three patients to one hour of electrical sleep current resulted in a decrease in the values of blood viscosity, haematocrit, haemoglobin and total plasma protein concentrations. Similar decreases in all these parameters were also observed in a control group of ten patients on whom the electrical current was not turned on. The decreased values in both groups seems, therefore, to be related to sedation and not to a specific action of the electrical current.

Electrical sleep has been reported to result in sedation. This effect was determined from clinical observations in man (Forster, Post and Benton, 1963; Magora et al., 1965; Wageneder, 1969) and from laboratory examination of gastric juice acidity in animals (Reigel et al., 1969; Wilson et al., 1969).

A decrease in blood viscosity and haematocrit values has been noted after the administration of droperidol (Aronson, Magora and London, 1970). This agent reduces sympathetic activity both by its central depressant effect which causes marked sedation and by its blocking of the receptors (Foldes et al., 1966; Yelnosky, Katz and Dietrich, 1963; Deligne, 1968). It was considered of interest to determine whether electrical sleep current which produces sedation without any known pharmacological action would alter blood viscosity and haematocrit in man.

METHODS

Thirty-three patients, five female and twenty-eight male, ranging in age from 22 to 58 years, were investigated. Twenty-seven of the patients came from the haematology out-patient clinic and six were patients from the electrical sleep clinic. All had either normal or slightly elevated haemoglobin, haematocrit and red blood cell values.

To obviate the effect of suggestion, all patients were told that they were having a particular blood examination. Only the patients who came from the electrical sleep clinic were aware that the blood investigation was related to their therapy.

The viscosity of blood was examined immediately before and after 1 hour of electrical sleep which was administered while the patients were lying in a quiet, dimly lit room.

The apparatus and method for electrical sleep used in this study have been described by Magora and associates (1967). A constant current stimulation of 1-2 mA intensity, 50 Hz and a duration of 2 msec was given through three electrodes. The anode electrode was placed in the area of the occipital fossa while the two cathode electrodes were placed on the fronto-parasagittal lines in such a manner that the passage of the electrical current from one electrode to another would be through the brain.

In ten of the thirty-three patients examined the same procedure was repeated without the electrical current being turned on, the patient being unaware of this difference.

The viscosity of blood was measured at constant temperature (37°C) in a Brookfield LVT cone-plate viscometer which permits measurements at five different shear rates ranging from 230 to 11.5 inverse seconds (Wells, Denton and Merrill, 1961).

All samples of blood were drawn from a large arm vein without the use of a tourniquet. Samples for blood viscosity measurements were transferred immediately. FLORELLA MAGORA, M.D.; C. HERSHKO, M.D.; H. B. ARONSON, M.B., CH.B., D.A., F.F.A.R.C.S.(I); Departments of Anaesthetics and Haematology, Hadassah University Hospital, Jerusalem, Israel.

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ferred to a tube containing 5 i.u. of dry heparin per ml of blood. Blood viscosity determinations were repeated three times and haemoglobin and haematocrits were examined in duplicate. Albumin, globulin and fibrinogen values were determined in twenty patients. The haemoglobin concentration was determined as cyanmethaemoglobin (Drabkin and Austin, 1932). The photometer was calibrated weekly by an international reference standard of haemoglobin-cyanide solution 59.0 ± 0.15 g/100 ml supplied by the International Committee for Standardization in Haematology (ICSH) (Spaander and Holtz, 1966). Haematocrit determinations were performed in a Clay-Adams micro-haematocrit centrifuge at 12,000 g for 3 minutes (Dacie and Lewis, 1968). Total serum proteins were determined by the standard biuret method. Samples for fibrinogen were placed in a separate tube containing dry oxalate and measured by the method described by Ratnoff and Menzie (1951).

RESULTS
A decrease in the viscosity of blood after 1 hour of electrical sleep was noted in twenty-seven of the thirty-three subjects at all shear rates. In three there was no change, and in the remaining three a slight increase in blood viscosity occurred.

Table I summarizes the effect of electrical sleep on the viscosity of blood in all thirty-three patients. The average values for blood viscosity, before and after electrical sleep, were calculated at each of the five shear rates examined. Significant decreases in blood viscosity ranging from 6.04 to 10.14 per cent were found after 1 hour of electrical sleep.

<table>
<thead>
<tr>
<th>Shear rate (sec⁻¹)</th>
<th>230</th>
<th>115</th>
<th>46</th>
<th>23</th>
<th>11.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before electrical sleep</td>
<td>5.03</td>
<td>5.46</td>
<td>6.47</td>
<td>7.59</td>
<td>7.24</td>
</tr>
<tr>
<td>SD</td>
<td>0.49</td>
<td>0.58</td>
<td>0.68</td>
<td>1.00</td>
<td>1.41</td>
</tr>
<tr>
<td>After electrical sleep</td>
<td>4.67</td>
<td>5.18</td>
<td>6.08</td>
<td>6.99</td>
<td>6.53</td>
</tr>
<tr>
<td>SD</td>
<td>0.53</td>
<td>0.64</td>
<td>0.83</td>
<td>1.05</td>
<td>1.44</td>
</tr>
<tr>
<td>% decrease</td>
<td>7.37</td>
<td>10.14</td>
<td>6.04</td>
<td>7.88</td>
<td>7.34</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Decreases after electrical sleep were also observed in haematocrit (average decrease 3.89 per cent), haemoglobin (average decrease 4.95 per cent) and in total protein concentration in the plasma (average decrease 2.63 per cent) (table II). All the above changes were statistically significant as shown by the Student t-test.

<table>
<thead>
<tr>
<th>HCT (%)</th>
<th>HB (g/100 ml)</th>
<th>Plasma proteins (g/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before electrical sleep</td>
<td>49.59</td>
<td>16.15</td>
</tr>
<tr>
<td>SD</td>
<td>4.19</td>
<td>1.96</td>
</tr>
<tr>
<td>After electrical sleep</td>
<td>47.33</td>
<td>15.31</td>
</tr>
<tr>
<td>SD</td>
<td>4.57</td>
<td>1.93</td>
</tr>
<tr>
<td>% decrease</td>
<td>3.89</td>
<td>4.95</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.05</td>
<td>P&lt;0.05</td>
</tr>
</tbody>
</table>

In the ten control patients studied without the electrical current connected, statistically significant decreases were also observed in blood viscosity (average decrease ranged from 4.51 to 12.25 per cent for the different shear rates), in haematocrit (average decrease 4.13 per cent) and in haemoglobin (average decrease 4.24 per cent).

DISCUSSION
The passage of electrical sleep current through the brain, using external electrodes, has been reported to produce sleep in 20-30 per cent and sedation in about 50 per cent of normal volunteers (Magora et al., 1965). Similar effects have also been produced in asthmatic and insomnia patients (Wageneder et al., 1969; Magora et al., 1967; Glazer, Ashkenazi and Magora 1969), and in spastic patients (Forster, Post and Benton, 1963; Forster et al., 1967).

Titaeva (1967) used electrical sleep to treat a large group of schizophrenic patients. By evaluating a combination of clinical signs, an association test, and e.e.g. recording in these patients, she concluded that (a) identical currents are capable of inducing different reactions such as sedation, sleep, well-being, or even excitation, depending on the initial state of the patient; (b) the changes arising during electric sleep therapy are not only related to the sedative action of the
current, but are also dependent on its direct action on structures of the sub-cortex and brain stem.

The attainment of sleep during electrical sleep therapy can be demonstrated by e.g. and by behavioural changes. What seems necessary, especially in those patients who do not sleep, is some form of laboratory test which could indicate whether other physiological changes take place under electrical sleep therapy.

Reigel and associates (1969) and Wilson and associates (1969) studied the neurophysiological, cardiorespiratory and gastrointestinal effects of electrical sleep currents in primates and man. Their finding of a decrease in total gastric acid production, in both normal and avoidance of shock conditions, was considered to be due to the sedative effect of electric sleep. Other parameters which could indicate a state of sedation and/or changes in sympathetic nervous system activity, seemed to be correlated with variations in plasma volume, blood viscosity and haematocrit. Weil and Chissey (1968) showed that a dilution of blood occurs following the administration of drugs such as guanethidine and phenoxybenzamine which interfere with sympathetic function. Aronson, Magora and London (1970) found a decrease in blood viscosity and haematocrit values 1 hour after the injection of droperidol, which has been attributed to the sedative effect of this drug.

The decrease in blood viscosity, at all shear rates, together with the parallel decreases in haematocrit, haemoglobin and total protein values, in this study indicate a dilution of blood following electrosleep. The haemodilution, which occurred without any associated blood loss or haemolysis, may be due to a redistribution of extracellular volume, fluid being shifted from the extravascular to the intravascular compartment.

The opposite effect was observed in patients during increased sympathetic nervous system activity, as seen in excitement or severe exercise (Kaltreider and Meneely, 1940). In other studies the administration of sympathomimetic amines resulted in a decrease in plasma volume (Kaltreider, Meneely and Allen, 1942) and therefore haemoconcentration (Cohn, 1966). Unpremedicated tense patients, under the stress of impending surgery showed no change or a slight increase in blood viscosity and haematocrit values (Aronson, Magora and London, 1970).

It is tempting to relate these changes in blood viscosity to an acute reduction in sympathetic nervous system activity during electrical sleep. However, the fact that similar changes were observed in the control group of patients who were resting in a relaxed atmosphere, seems to indicate that the decrease in blood viscosity is associated with sedation alone and is thus not due to a specific effect of the electrical current on the brain.

This study was performed in the surgical and anaesthesia research laboratories of the Hebrew University-Hadassah Medical School, Jerusalem.

REFERENCES


L'EFFET DU SOMMEIL ELECTRIQUE SUR LA VISCOSITE DU SANG

SOMMAIRE

Le fait de soumettre trente trois patients à une heure de sommeil par courant électrique cause une réduction des taux de viscosité sanguine, hématocrite, hémoglobine et concentration totale des protéines plasmatiques. Des réductions similaires de tous ces paramètres furent également observées chez un groupe de contrôle de dix patients, chez qui le courant électrique n'était pas branché. La réduction des valeurs dans les deux groupes semble donc avoir une relation avec la sédation et pas avec une action spécifique du courant électrique.

DIE WIRKUNG VON ELEKTRISCHEN SCHLAF AUF DIE VISKOSITAT DES BLUTES

ZUSAMMENFASSUNG

Bei 33 Patienten führte eine einstündige Anlegung eines elektrischen Schlafstromes zu einer Abnahme der Werte für Blutviskosität, Hämatozitr, Hämaglobin und der Werte für das Gesamtplasmaprotein. Ähnliche Verminderungen aller dieser Größen wurden auch bei einer Kontrollgruppe von 10 Patienten beobachtet, bei denen der elektrische Strom nicht eingeschaltet worden war. Die erniedrigten Werte scheinen deswegen in beiden Gruppen auf die Sédierung und nicht auf eine spezifische Wirkung des elektrischen Stromes zurückzuführen zu sein.