BLOOD PRESSURE AND CEREBROSPINAL FLUID PRESSURE STUDIES DURING LUMBAR AIR ENCEPHALOGRAPHY

T. V. CAMPKIN AND J. M. TURNER

SUMMARY

Blood pressure and cerebrospinal fluid pressure changes were studied during lumbar air encephalography under general anaesthesia. Two anaesthetic techniques were used. In one group spontaneous respiration with nitrous oxide, oxygen and halothane was used and in the other controlled ventilation with nitrous oxide and oxygen was maintained. Larger falls in blood pressure, on sitting up, were seen in the spontaneous respiration group and cerebrospinal fluid pressures were also higher in these patients but never rose to dangerous levels. It is concluded that a technique of controlled ventilation with nitrous oxide and oxygen is preferable during lumbar air encephalography.

Lumbar air encephalography may be performed under general anaesthesia or local analgesia. With the patient in the sitting position, air in incremental amounts is injected into the lumbar subarachnoid space. It rises to the cisterna magna and by appropriate positioning of the head can be directed to fill all parts of the ventricular system of the brain and, being radiolucent, it provides valuable information concerning the size and symmetry of these structures. Some air also passes supra-tentorially over the cerebral hemispheres and, in patients with cerebral atrophy, enlargement of the subarachnoid and cerebral fissures will be apparent. Radiographs are taken with the patient in the erect, supine and prone positions.

The investigation under local analgesia is unpleasant for the patient because of its protracted nature and the frequent changes of position that are necessary. Although some cerebrospinal fluid is removed, its replacement by air in the subarachnoid space often causes severe headache, nausea and arterial hypotension. Numerous films are required and inadvertent movement of the patient during the procedure may produce unsatisfactory radiographs. For these reasons general anaesthesia has been routinely employed in this unit for a number of years.

General anaesthesia, in the sitting position, however, may be complicated by the development of arterial hypotension particularly in the elderly and hypertensive, in patients on concomitant drug therapy, and in those who have been immobilized in bed for prolonged periods. The first objective of this investigation, therefore, was to determine the general anaesthetic technique which caused the least disturbance in arterial blood pressure.

A second objective was to determine the cerebrospinal fluid (c.s.f.) pressure during the investigation. The effect of hypercapnia and volatile anaesthetic agents on cerebral blood flow and intracranial (c.s.f.) pressure are well documented (Kety and Schmidt, 1948; McDowall, Barker and Jennett, 1966) and we expected to find variations in the c.s.f. pressure dependent upon the technique of general anaesthesia that was employed.

METHODS

Forty-eight patients, twenty-three female and twenty-five male were randomly divided into two groups. Their ages ranged from fourteen to seventy-one years and they suffered from a variety of neurological symptoms but no patient had clinical evidence of raised intracranial pressure. Final diagnoses are shown in table I.

Premedication, prior to the investigation, varied at the discretion of the different anaesthetists. In some patients no premedication was given, while others received atropine 0.6 mg only, droperidol 5–10 mg or a mixture of atropine and droperidol.


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TABLE I. Final diagnosis in patients undergoing air encephalography.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of patients</th>
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<tbody>
<tr>
<td>Cerebral atrophy</td>
<td>23</td>
</tr>
<tr>
<td>Demyelinating disease</td>
<td>3</td>
</tr>
<tr>
<td>Supratentorial S.O.L.</td>
<td>4</td>
</tr>
<tr>
<td>Pituitary tumour</td>
<td>2</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>4</td>
</tr>
<tr>
<td>Low pressure hydrocephalus</td>
<td>1</td>
</tr>
<tr>
<td>Temporal lobe epilepsy</td>
<td>2</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>2</td>
</tr>
<tr>
<td>N.A.D.</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
</tr>
</tbody>
</table>

One of two anaesthetic techniques was used in all cases. In twenty-two patients (Group 1) spontaneous respiration was maintained following induction with thiopentone 150–250 mg and suxamethonium 50 mg. The larynx and trachea were thoroughly sprayed with lignocaine 4% solution and the trachea intubated with a cuffed flexometallic tube. Anaesthesia was thereafter maintained with nitrous oxide 7 L/min oxygen 3 l./min and halothane 0.5 to 1.0 per cent.

In Group 2 which comprised twenty-six patients, a technique utilizing controlled ventilation was employed. Anaesthesia was induced with thiopentone 150–250 mg and pancuronium 6–8 mg, the trachea intubated, and ventilation controlled with nitrous oxide 7 l./min and oxygen 3 l./min using a Manley ventilator with 5 cm H₂O negative (subatmospheric) phase.

The systolic and diastolic arterial pressures were recorded using a Recklinghausen Oscillotometer. The arterial pressure was recorded in the ward, immediately prior to anaesthesia, after induction of anaesthesia while still supine, and again after adoption of the sitting position. Readings were taken thereafter at five minute intervals throughout the investigation.

Electrocardiograph leads I, II, III or V5 were observed continuously on a Cardiac Recorder oscilloscope throughout the procedure.

Cerebrospinal fluid pressure measurement.

After positioning the patient upright, a lumbar puncture needle was inserted into the third or fourth lumbar interspace. A disposable three-way tap was connected to the needle and a six foot length of fine manometer tubing (Portex) attached to one port. Care was taken to avoid any leakage of c.s.f. and air was injected via the second port of the three-way tap.

In the conscious patient in the sitting position c.s.f. pressure is approximately atmospheric at the foramen magnum (Gilbert, Brindle and Galindo, 1966), a level which corresponds with the external auditory meatus. This was confirmed in one patient (not included in the series) in whom the investigation was performed under local analgesia, and the external auditory meatus was therefore subsequently used as the zero level for measurements in anaesthetized patients.

After spinal tap the initial c.s.f. level above or below the external auditory meatus was recorded before the introduction of air or removal of any c.s.f. Subsequent readings were made at intervals after the injection of air and a final reading was recorded after 27–30 ml of air had been injected and before the patient was placed in the supine position.

Blood gas measurement.

Blood was withdrawn from the radial artery into a heparinized glass syringe at the same time as the first c.s.f. pressure recording. Arterial Pco₂, pH and standard bicarbonate were measured within twenty minutes by the Astrup technique.

RESULTS

Arterial blood pressure.

The mean fall in systolic arterial pressure following adoption of the sitting position is shown in table II. Hypotension developed in the majority of those patients breathing spontaneously in whom anaesthesia was maintained with nitrous oxide, oxygen and halothane. The least fall in systolic pressure in this group was observed in patients who were given atropine only as premedication (mean fall 34 mm Hg) and the largest fall (mean 50 mm Hg) in those who had not been given premedication. There was no important difference, although this was not statistically determined, in the hypotension

<table>
<thead>
<tr>
<th>Table II. Premedication and mean fall in systolic arterial pressure on adoption of sitting position during air encephalography.</th>
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<tbody>
<tr>
<td>Spontaneous respiration</td>
</tr>
<tr>
<td>No. of cases</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Nil</td>
</tr>
<tr>
<td>Atropine only</td>
</tr>
<tr>
<td>Atropine and droperidol</td>
</tr>
<tr>
<td>Droperidol</td>
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that occurred in patients who were given droperidol only or a mixture of atropine and droperidol.

Systolic pressure falls were considerably less in Group 2 patients in whom controlled ventilation with nitrous oxide and oxygen was maintained (mean fall 11 mm Hg). In this group, however, the only two patients who received atropine alone as premedication showed the largest falls in blood pressure.

Cerebrospinal fluid pressure and arterial $P_{CO_2}$

Spontaneous respiration. In all patients in Group 1 the arterial $P_{CO_2}$ was elevated above the normal value of 40 mm Hg and in two patients levels above 70 mm Hg were recorded. The initial cerebrospinal fluid pressure in this group ranged between 0 and 320 mm H$_2$O with a mean value of 175 mm H$_2$O. A progressive rise in pressure (mean value 256 mm H$_2$O) occurred during the investigation in the course of which 27-30 ml of air was injected and 10-15 ml of c.s.f. were removed. Figure 1 depicts the relationship between initial c.s.f. pressure and arterial $P_{CO_2}$ in this group of patients.

Controlled ventilation. In all patients in Group 2 the arterial $P_{CO_2}$ levels were lower than during spontaneous respiration and ranged between 21 and 40 mm Hg. Initial c.s.f. pressures were also lower in this group with a mean value of 42 mm H$_2$O and the relation between c.s.f. pressure and arterial $P_{CO_2}$ is depicted in figure 2. In two patients (not included in figure 2) the pressures differed very widely from the mean. In one of these, who suffered from low pressure hydrocephalus, the initial c.s.f. pressure was -120 mm H$_2$O, while in a second patient, who was straining at the time, the pressure was 440 mm H$_2$O. Injection of pancuronium 2 mg produced an immediate fall to 135 mm H$_2$O.

The mean rise in c.s.f. pressure seen during the course of the investigation was 130 mm H$_2$O in Group 2, a value substantially less than that observed in patients breathing spontaneously.

DISCUSSION

Soon after the investigation commenced it became apparent that arterial hypotension developed to a lesser degree during controlled ventilation with nitrous oxide and oxygen than in those in whom spontaneous respiration was maintained. This finding was not unexpected since the possibility of hypotension when halothane is used in the sitting position is well-recognized. Ignoring any effect of premedication, the mean fall in systolic pressure in Group 1 was 34 mm Hg compared with a mean value of 11 mm Hg in Group 2. The influence of premedication, the choice of which varied according to the preference of different anaesthetists, is uncertain because of the comparatively small number of patients in each group. It did appear, however, that the use of atropine alone in spontaneously breathing patients reduced the fall in arterial pressure which occurred when the sitting-up position was assumed. This was not confirmed in the only two patients in IPPV Group who received atropine alone for premedication. The use of atropine in these two patients was fortuitous and not related to their general condition or neurological status.

Pancuronium was deliberately chosen as the
muscle relaxant in patients anaesthetized using an IPPV technique. One of the authors had used this relaxant for three years during controlled ventilation anaesthesia for posterior fossa craniotomy in the sitting position, and in this position it has been found that the fall in arterial pressure is minimal with this agent compared with that when tubocurarine is used.

Apart from the choice of anaesthetic technique, elevation or bandaging the legs to improve venous return may also help to reduce hypotension during encephalography but neither method was used in the patients in this series.

With the exception of five patients (one in Group 1 and four in Group 2) general anaesthesia always produced an initial c.s.f. pressure which was higher than normal and this elevation of pressure was much greater in the spontaneously breathing group than in the controlled ventilation group. We attribute the higher values in the spontaneously breathing patients to the combined effects of hypercarbia and halothane on cerebral blood flow and c.s.f. pressure. However, in some patients in both groups we observed pressure values which differed widely from the mean. The patient with low pressure hydrocephalus has already been cited and in addition four further patients, in all of whom there was radiological evidence of cerebral atrophy, showed c.s.f. pressures that were lower than expected.

Pressures higher than expected were also occasionally seen and the high reading in the patient who was straining has been mentioned. Minor degrees of straining are less easy to detect and may have accounted for some unduly high readings. Although care was taken to ensure that the head harness was not too tight, it is possible also that in some patients a degree of jugular compression occurred, thus performing a Queckenstedt manoeuvre and elevating c.s.f. pressure.

A sustained rise in pressure occurred in all cases during the investigation but this rise was less in patients in whom controlled ventilation was employed. The rise in c.s.f. pressure seen during the procedure conforms the findings of other authors (Saidman and Eger, 1965; Gordon and Greitz, 1970) who reported that the inclusion of nitrous oxide in the anaesthetic mixture causes elevation of c.s.f. pressure during air encephalography. The greater rise in pressure in this series observed in spontaneously breathing patients can be attributed to the added effect of hypercarbia and halothane.

In the majority of neurosurgical units lumbar air encephalography is not undertaken in patients with raised intracranial pressure (air ventriculography being the alternative investigation) and a rise in c.s.f. pressure to dangerous levels is never seen.

Early in the investigation it was clear that the incidence of headache and vomiting after air encephalography was not related to the technique of general anaesthesia which was used despite the higher c.s.f. pressures recorded in the spontaneously breathing patients. Wolfson, Siker and Gray (1970) in a study of unanaesthetized patients undergoing lumbar air encephalography found an overall incidence of headache of 80 per cent during the first two days after the investigation. This was of varying type, some patients having pure spinal headache due to c.s.f. leakage and being relieved by lying flat. Non-spinal headache and mixed types also occurred. In this investigation the added effect of general anaesthesia made it impossible to associate headache with one particular anaesthetic technique.

General anaesthesia for air encephalography employing controlled ventilation with nitrous oxide and oxygen does have advantages. Arterial hypotension in the sitting position is substantially reduced and recovery from anaesthesia is rapid. In the authors' opinion controlled ventilation with nitrous oxide and oxygen is the general anaesthetic technique of choice during lumbar encephalography.

REFERENCES

PRESSE SANGUINE ET PRESSION DU LIQUIDE CEPHALORACHIDIEN, ETUDIEES DURANT L'ENCEPHALOGRAPHIE LOMBAIRE A L'AIR

SOMMAIRE
Les modifications de la pression sanguine et de la pression du liquide cérébrospinal ont été étudiées durant l'encephalographie lombaire à l'air, sous anesthésie
On a maintenu dans un groupe la respiration spontanée avec protoxyde d'azote, oxygène et halothane, et dans l'autre groupe la ventilation contrôlée avec protoxyde d'azote et oxygène. Des chutes plus fortes de la pression sanguine ont été observées à la position assise dans le groupe de respiration spontanée et la pression du liquide céphalorachidien était également plus élevée chez ces patients mais n'atteignaient jamais un taux dangereux. On conclut qu'une technique de ventilation contrôlée avec protoxyde d'azote et oxygène est à préférer durant l'encéphalographie lombaire à l'air.

STUDIEN ÜBER BLUTDRUCK UND LIQUOR CEREBROSPINALIS-DRUCK WÄHREND LUMBALER LUFTENCEPHALOGRAPHIE

ZUSAMMENFASSUNG

ESTUDIOS SOBRE LA PRESION ARTERIAL Y LA PRESION DEL LIQUIDO CEFALORRAQUIDEO DURANTE LA ENCEFALOGRAFIA LUMBAR CON AIRE

RESUMEN
Los cambios de la presión arterial y de la presión del líquido cefalorraquideo fueron estudiados durante la encefalografía lumbar con aire bajo anestesia general. Fueron utilizadas dos técnicas anestésicas. En uno de estos grupos fue utilizada la respiración espontánea con óxido nitroso, oxígeno y halotano y en el otro grupo una ventilación controlada con óxido nitroso y oxígeno. En el grupo con respiración espontánea fueron observados descensos mayores de la presión arterial al levantar el paciente en la cama y las presiones del líquido cefalorraquideo también fueron más elevadas en estos pacientes, aunque nunca alcanzaron niveles peligrosos. Se concluye que una técnica de ventilación controlada con óxido nitroso y oxígeno es preferible durante la encefalografía lumbar por aire.

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