OPERATIVE SURGERY

Fundamental International Techniques

Neurosurgery

THIRD EDITION

Edited by

Lindsay Symon

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Introduction

The 6 years which have passed since the appearance of the second edition of this volume have seen continuing advance in a number of neurosurgical fields. The development of thermocoagulation in the treatment of trigeminal neuralgia, appearing at the same time as the increasing use of selective retrogasserian section by posterior fossa or subtemporal route, has meant the virtual replacement of the standard Frazier operation and in many clinics the virtual abandonment of surgery for tic douloureux. The various approaches to this problem have been presented by authors particularly experienced in each technique, and the final place of various methods with their indications will become apparent with the passage of time.

The present edition has taken the opportunity to provide a review of necessary adjuncts to glioma surgery which have emerged from chemotherapeutic laboratories.

I am much indebted to the various authors who have updated and revised their contributions and am happy to introduce a number of new contributors from Europe and the United States whose particular experience is evident in their chapters.

The quality of illustration in the volume bears testimony to the remarkable work of a succession of medical artists whose names are given at the end of each chapter. No praise is too high for their efforts.

LINDSAY SYMON

OPERATIVE SURGERY

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OPERATIVE SURGERY

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Control of Intracranial Tension

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INTRODUCTION

Significant advances in anaesthesia and pharmacology, allied to wider appreciation of the physiological background, have in recent years appreciably lessened the problems of management of raised intracranial tension. Success in management of neurosurgical patients, however, and the successful completion of any operation on the brain, still depend upon the control of intracranial tension.

In pre- and postoperative periods, the inelastic skull dictates that swelling around disease or the site of operation has no access to a surface or an elastic walled cavity, but results in a considerable rise in intracranial pressure. This, in turn compressing low pressure areas of the vascular system or of the cerebrospinal fluid pathways, may result in further secondary pressure increases.

Considerable changes in intracranial blood volume take place under the influence of alteration in blood gas tensions (particularly arterial pCO_2); such changes may be accompanied by large alterations in intracranial pressure (Risberg and Sundbarg, 1968); indeed, active changes in the vascular system are more common in practice than obstruction of the effluent veins, although such obstruction may give rise to raised pressure.

Cerebral oedema, partly a process of cellular imbibition, partly a process of egress of fluid into the interstitial spaces particularly in white matter, may occur in the open skull with great rapidity and occasion the prolapse of important functional areas through the wound. Subsequent rupture of pia mater and distortion of white matter may adversely affect the functional results of operation.

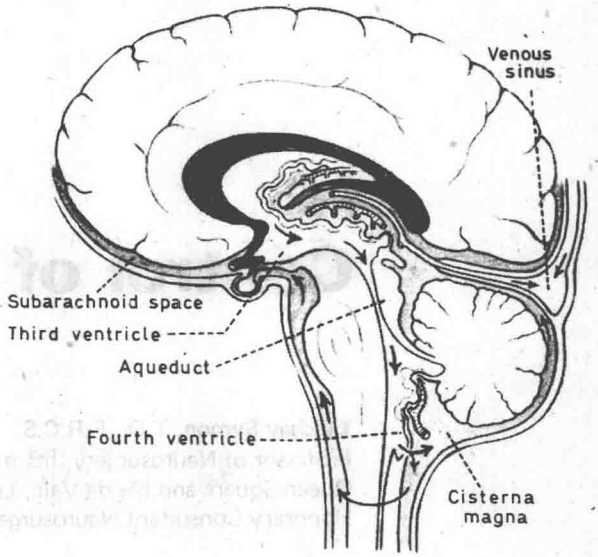
The anatomical circumstances of the circulation of the cerebrospinal fluid make it clear that small lesions in the posterior fossa or peri-aqueductal zone soon result in the damming back of the fluid from both lateral ventricles, which, with the persistent filtration power of the choroid plexuses, results in a rise of pressure whose magnitude depends upon the rapidity of the process. In rapidly growing lesions, or particularly postoperatively, such obstruction to cerebrospinal fluid allows little scope for secondary adaptive mechanisms, and the resulting acute rise in intracranial pressure constitutes one of the most serious neurosurgical emergencies.

In this brief review, these three main factors – changes in the cerebral circulation, development of cerebral oedema and obstruction of the cerebrospinal fluid pathways – will be seen to emerge as dominant in the production of rapid changes in intracranial pressure.

1

Circulation of cerebrospinal fluid

Cerebrospinal fluid from the lateral and third ventricles passes down the aqueduct, emerges into the cisterna magna from the fourth ventricle and circulates over the top of the hemispheres in the subarachnoid space. From there it is absorbed into the venous sinuses.



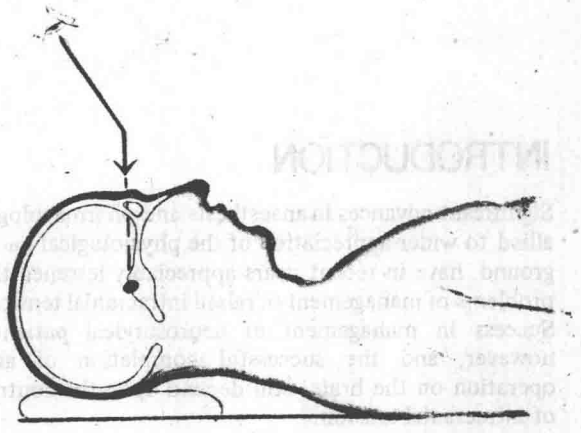
1

CONTROL OF VASCULAR FACTORS–VENOUS PRESSURE AND PERFUSION

Positioning of patient

The venous system of the brain, neck and thorax has no functioning valves; a major factor in the level of intracranial venous pressure is therefore the height of the head above the right atrium. The influence of posture depends on two factors: the height of the head above the right atrium, greater if the patient is placed in the sitting position than if he is prone; and the original level of cerebral venous pressure. If the original cerebral venous pressure is normal, the assumption, for example, of the sitting position may produce a negative pressure if a vein is opened, with the consequent danger of embolization with air.

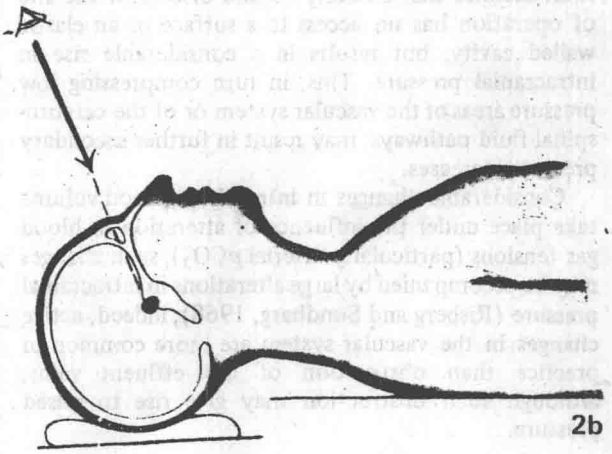
The majority of intracranial operations are conducted with a modest amount (approximately 20–30°) of foot-down tilt. By the abolition of this modest tilt, one has the capacity to provide swift autotransfusion in the case of sudden or unexpected hypotension.



2a

2a & b

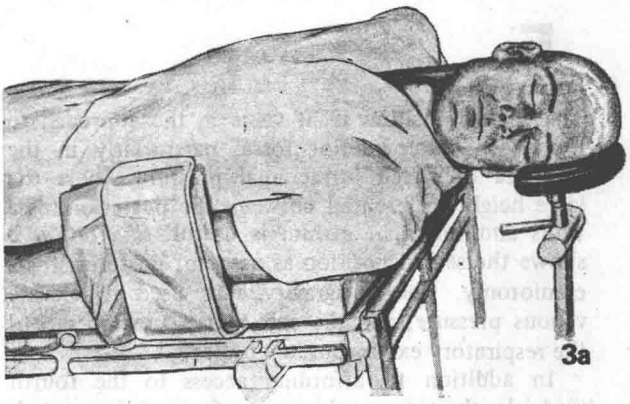
The position of the lesion which is to be reached must be remembered, and head position is planned so that optimal access is obtained. The position of the operator in relation to the pituitary fossa makes access difficult. Slight extension of the head allows a more direct subfrontal approach. The supine position with adequate rotation of the head allows access to frontal, parietal and temporal lesions, and variation of the extent of neck flexion permits comfortable access to the hemisphere and parasagittal zone as far back as the postparietal region.



2b

3a & b

It is important to remember that brachial plexus traction is easily produced in an unconscious patient and therefore lateral rotation of the head should be accompanied by elevation of the occipital shoulder on sandbags, with prevention of undue lateral flexion of the neck.



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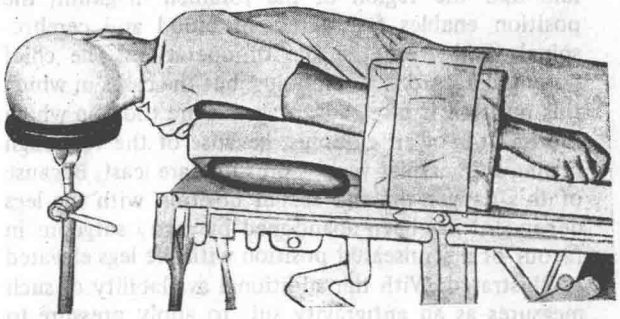

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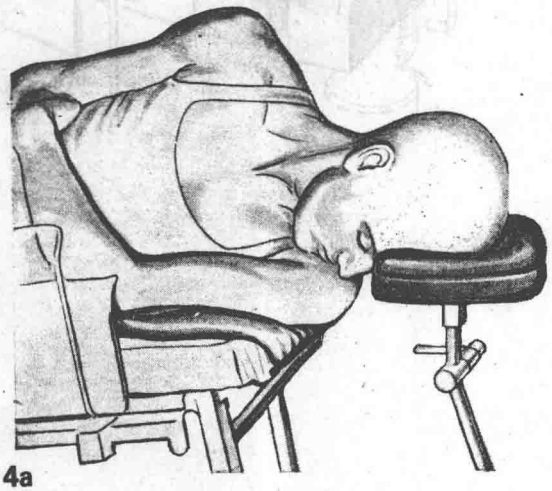

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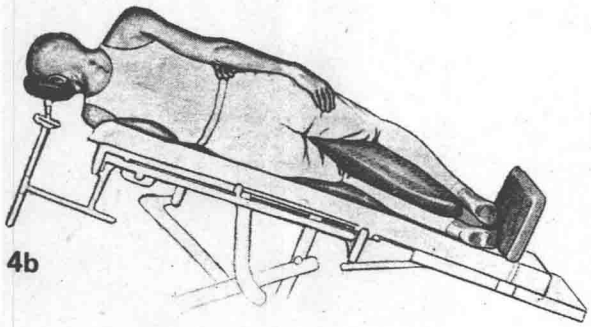


4b

4a&b

For occipital lesions and certain lesions in the posterior fossa, particularly in the cerebellopontine angle, a lateral position of the body with varying degrees of rotation and lateral flexion of the head to produce a greater or lesser degree of brow-down posture and to open up and elongate the upwards-facing lateral aspect of the posterior fossa and neck may be preferred. The advantage of this position is that, unlike the prone position, it permits free and unimpeded respiration. It demands careful protection of the downward prominences, shoulder, greater trochanter and the circumflex, radial and lateral popliteal nerves. The weight of the thorax is taken upon an axillary pillow with careful padding of points of contact on the downward arm, which is relieved of weight-bearing capacity, while other pressure areas are protected by soft Sorbo rubber sponges. Slight traction upon the upward shoulder prevents it riding upwards to obscure the posterior fossa; care is necessary in this manoeuvre to avoid traction-injury of the brachial plexus.

The fully prone position is little used in intracranial surgery since access to the posterior fossa is limited, although with careful support of the pelvis and thorax to leave the abdomen free, it is possible to prevent a rise in central venous pressure resulting from thoracic or abdominal compression and the position is therefore a popular one for operations upon the spine from the cervical level downwards.

5

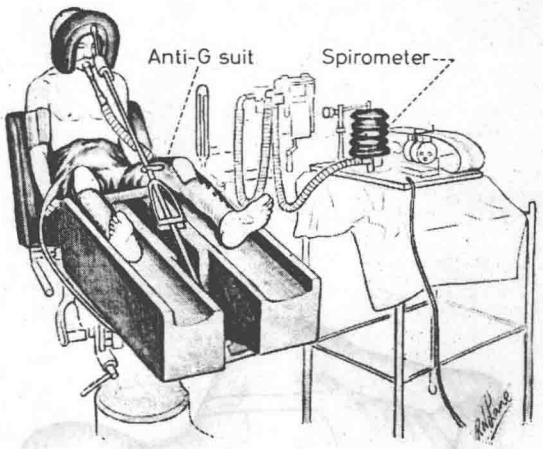
The seated position is of value in the approach to lesions in the posterior fossa, particularly in the presence of raised intracranial pressure where the large height differential between the posterior fossa veins and the right atrium is useful. *Illustration 5* shows the seated position as used for posterior fossa craniotomy. The antigravity suit, used to elevate venous pressure, and the spirometer, used to record the respiratory excursions, are indicated.

In addition to affording access to the fourth ventricle, the upper and lower surfaces of the cerebellum and the region of the foramen magnum, the position enables free egress of blood and cerebrospinal fluid from the site of operation. The chief potential hazard is air embolus, but the cases in which this position is most advantageous are those in which the hazards of air embolus, because of the very high resting intracranial venous pressure, are least. Because of this danger the full seated position with the legs dependent has been abandoned by many surgeons in favour of a semiseated position with the legs elevated as illustrated. With the additional availability of such measures as an antigravity suit to apply pressure to the venous beds of the legs and abdomen, and with the capacity to load the expiratory resistance in the airway circuit (Hewer and Logue, 1962), the central venous pressure may be rapidly increased if cranial venous pressure becomes so low as to render air embolism likely.

A helpful routine is to elevate the central venous pressure intermittently as dissection through the layers of the wound proceeds so that the veins are temporarily distended in each layer. Open veins are readily detected and occluded by diathermy, silver clips, or plugging with bone wax or Surgicel. Elevation of central venous pressure for 3–4 min proves quite adequate for such safety precaution; maintenance of appreciably raised central venous pressure for longer periods is to be avoided.

The more usual current practice in the use of the seated position combines the antigravity suit with the use of positive end-expiratory pressure of up to 10 cm H_2O on artificial ventilation when the central venous pressure, measured in the superior vena cava, is observed to be low. Where raised intracranial pressure is no problem, the central venous pressure may be raised by the addition of a fluid load of about 0·5–1 litre of Hartmann's solution; this is of particular value in dehydrated patients, for example, elderly cases with cerebellar tumour who may have been vomiting for some time.

The sitting position may also be used in the approach to occipital lesions, where especial care is necessary in the area of the mastoid emissary veins and large dural sinuses to prevent air embolism.

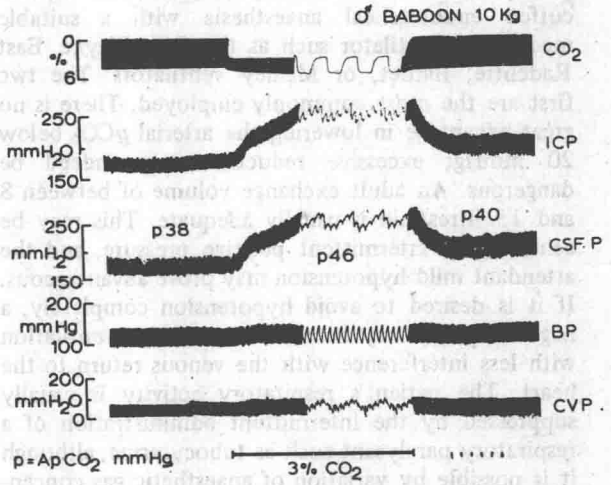


5

6 & 7

Control of respiration as an adjunct to the management of intracranial pressure

Alteration of the arterial pCO_2 is now recognized as the chief extraneous factor available to modify cerebral blood flow. Increase in arterial pCO_2, besides causing increases in cerebral blood flow, increases intracranial pressure because of increased blood content within the brain. The accompanying illustrations show that elevation of the arterial pCO_2 increases both the pressure within the closed skull and also the cortical venous pressure directly measured. *Illustration 6* shows the effect of 3 per cent CO_2 in inspired air on central venous pressure (CVP), systemic arterial pressure (BP), cerebrospinal fluid pressure in the cisterna magna (CSFP), extradural intracranial pressure recorded by transducer in the closed skull (ICP) and end-tidal CO_2 concentration (CO_2) in a baboon. *Illustration 7* shows the effect of increase in arterial pCO_2 from 37·5 to 48 mmHg (SBP = systemic arterial pressure; MCAP = arterial pressure in a parietal branch of middle cerebral artery; MCVP = venous pressure in a parietal branch of middle cerebral vein emerging from cortex; $ETCO_2$ = end-tidal CO_2 record). The increase in brain bulk which retention of CO_2 can produce is so great that many neurosurgical operations are now conducted with the arterial pCO_2 artificially lowered by mechanical hyperventilation. Indeed this is now the most generally applicable method of control of intracranial pressure during the neurosurgical operation itself.



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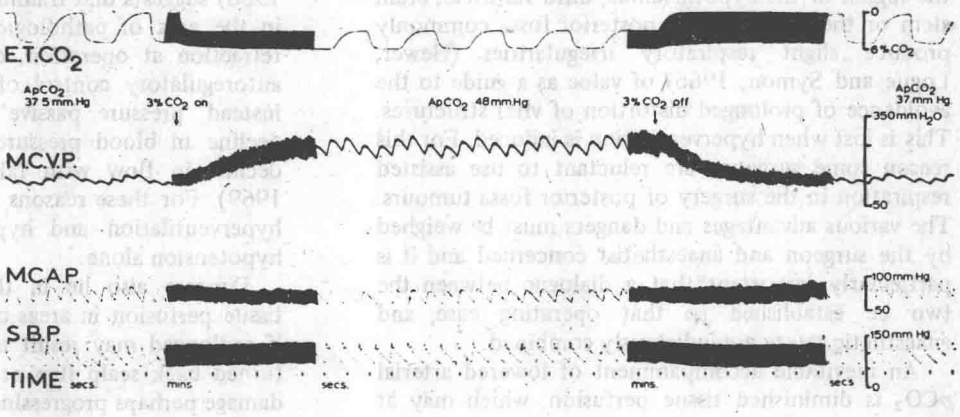

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