bookbinders. A further series of photographs was then shown of dissections of the upper brain-stem showing the 5th nerves and the structures in the vicinity of the apex of the petrous bone. Serial photographs and radiographs had been taken while the crushing was in progress and again at the end of each procedure when the crushing force had been released. An attempt was then made to correlate the findings in these experiments with the clinical features of six patients with clinical and radiological evidence of petrous dislocation. It was concluded that, because of certain types of deformation of the base of the skull, the petrous bone might be dislodged in a postero-medial direction from its normal position due to opening of the petrosphenoid and petrosquamous sutures. As a result of this bony displacement, the 5th and 6th nerves might be damaged by stretching or by involvement in the fracture line. Extension of the fractures laterally into the middle ear produced deafness and facial weakness and the function of the temporomandibular joint might be disturbed by disruption of the petrosquamous fissure in the glenoid fossa. Medially the displaced petrous apex might damage the carotid artery and cause a carotid cavernous fistula. It was suggested that this syndrome and its variants might occur more frequently than had been hitherto suspected.

SURVEY AND FOLLOW-UP OF 225 CONSECUTIVE PATIENTS WITH A DEPRESSED SKULL FRACTURE

R. BRAAKMAN (Rotterdam) had undertaken a retrospective study of cases of depressed fracture of the skull who had been admitted to his department during the past 10 years. He included only those patients admitted within 48 hours of the accident and assessed their present condition in relation to the injury. The 225 cases under review were also compared with the 400 Glasgow cases reported by Miller and Jennett in 1968.

As in the Glasgow series 85% of the cases were male and of the 196 survivors information was available about 177; 44% were under 16 years of age. Only 14% of fractures were classified as closed, whereas Lewin had found closed and compound fractures in equal numbers. In this, and also regarding dural penetration, the Rotterdam and Glasgow figures were similar.

The incidence of epilepsy, both early and late, was less than in the Glasgow series, although the mortality rate was significantly higher. In relation to practical management, as a result of this study, they felt that bone fragments should usually be replaced. There were five infections in 109 cases with replacement and the same number in 56 cases where the fragments had been completely removed. Antibiotics were administered to some cases but not to others without any apparent plan or, as far as could be seen, any influence on the incidence of infection in the two groups.

REFERENCES

- Kriss, F. C., Taren, J. A., and Kahn, E. A. (1969). Primary repair of compound skull fractures by replacement of bone fragments. *J. Neurosurg.*, 30, 698.
Miller, J. D., and Jennett, W. B. (1968). Complications of depressed skull fracture. *Lancet*, 2, 991.

HEMICRANIECTOMY IN THE TREATMENT OF ACUTE SUBDURAL HAEMATOMA

J. RANSOHOFF and V. BENJAMIN (New York) gave an account of their experiences of a regime of treatment for patients with acute subdural haematoma demanding surgery for the preservation of life within the first 24 hours after injury. They referred to the very high mortality reported in this type of head injury, which, in their own department, previously amounted to 75% with very few patients restored to normal life. Death had resulted from brain-stem compression, torsion, and secondary haemorrhage, but, at necropsy, few had shown what had been regarded as primary brain-stem lesions. General factors over which the surgeon had no control were:

1. The severity of the initial brain injury.
2. The rapidity of haematoma expansion.
3. The age and poor general condition of the patient.

Factors which the surgeon should be able to influence were:

1. Delay in diagnosis and treatment.
2. Inadequate removal of clot and pulped brain.
3. Failure to control haemorrhage.
4. No provision for the accommodation of secondary cerebral oedema.

Diagnostic evaluation, including emergency cerebral angiography, proceeded simultaneously with general resuscitation, intubation, and respiratory assistance when necessary and the use of intravenous dehydrating agents (mannitol, 2 g/kg, intravenously). Operation was undertaken immediately on patients shown by angiography to have large, unilateral subdural haematomas. Essentially, this consisted of the removal, using the *an* drill, of a very large fronto-temporo-occipital bone flap through a skin incision from the glabella to theinion and thence laterally. The squamous temporal bone was removed to the base of the skull. An equally large dural flap was hinged medially. Clot and pulped brain (only) were removed and haemorrhage from bridging veins and lacerated brain controlled. Subsequently electrolytes and blood gases were controlled and tracheostomy performed in 48 hours if necessary. Corticosteroids and anticonvulsants were administered.

Twenty patients had been so treated during a two-year period. On admission 10 showed bilateral and five unilateral decerebration, and five made no response to stimulation. There were eight deaths, one coma vigil, and one hemiplegia. Eight patients (40%) returned to their pre-accident employment and two made a partial recovery. There were no survivors over the age of 65, with a haematoma larger than 500 ml., when treatment had been delayed or when in the immediate preoperative period both apnoea and bilaterally dilated and fixed pupils were present.

STEREOTAXIC TREATMENT OF PAIN

M. P. A. M. DE GROOD (Tilburg) outlined current views on the three main afferent pathways for pain.

1. The classical spinothalamic tract terminating in the posteroventral thalamic nuclei. Lesions in this group of

nuclei produced dissociated sensory loss and there were frequent recurrences of pain.

2. The palaeo-spino-reticulo-thalamic tract terminating in the thalamic intralaminar nuclei including n. centre median and parafascicularis.

3. Fibres passing from the posterior thalamus in the region of the n. limitans portae of Hassler to the second somatosensory cortex in the parietal operculum.

Eleven cases were described in which thermocoagulation lesions were produced stereotactically in either the second or third systems for painful lesions involving the brachial plexus in 10 cases and the sacral plexus bilaterally in one case. Preliminary stimulation studies produced a sensation of heat contralaterally from the posteroventral nuclei and of paraesthesiae from the intralaminar nuclei. Tegmental stimulation and lesions caused diplopia in the two patients so treated. All patients obtained some degree of relief, which in six cases was excellent. Survival time did not exceed six months and no conclusions were drawn in relation to the possible long-term effects of such procedures.

EXPERIMENTAL AND CLINICAL EVALUATION OF A BRITISH CRYOGENIC LESION MAKER

J. W. MCINTOSH (Stoke-on-Trent) described a cryogenic probe designed by H. G. Clark and Brodie Hughes, based on the Joule-Thomson effect, and manufactured by the Hymatic Engineering Company. The instrument consisted of a vacuum insulated probe 1.9 mm in diameter employing B.O.C. nitrogen at 2,000 lb/sq in. The escaping nitrogen gas passed through a heat exchanger to cool the entering gas. A copper-constantin thermocouple at the probe tip recorded temperature and the single control of the instrument was a reducing valve regulating gas pressure. The instrument had been tested by the makers at three times the normal working pressure.

The minimum temperature achieved using nitrogen was -100°C but the gas Argon would produce a lower temperature. The dimensions of the uninsulated tip of the probe were 1.9×2.4 mm, which produced an ellipsoidal volume of frozen tissue. Any application requiring a larger lesion, as in hypophysectomy, would require a probe of larger diameter. As constructed at present the instrument cannot be sterilized by autoclaving because of the low melting point of the solders used in its construction.

The probe was tested in a series of experiments in the cat brain based on a technique described by Mark and his colleagues (1961). This consisted of placing the tip of the probe by a stereotaxic technique at different distances from the Edinger-Westphal nucleus. The effect on the pupil of cooling at various temperatures was observed and recorded photographically. These experiments showed the reversibility of cryogenic lesions related to temperature and range from the surface of the probe and the size and shape of lesions at different rates of cooling. Satisfactory results of this technique using Leksell's stereotaxic instrument were described in 13 patients suffering from Parkinson's disease and one patient suffering from spasmodic torticollis.

REFERENCE

Mark, V. M., Chato, J. C., Eastman, F. G., Aronow, S., and Ervin, F. R. (1961). Localised cooling in the brain. *Science*, 134, 1520.

VISUAL IMPAIRMENT IN 'LOW PRESSURE' HYDROCEPHALUS

J. BLOCK (Dundee) discussed the possible mechanisms by which visual impairment results from opticochiasmatic arachnoiditis. Two patients were described in detail in whom progressive deterioration of visual acuity and fields, after a severe head injury in the first case and tuberculous meningitis in the second, suggested the diagnosis of arachnoiditis, which was confirmed at operation in the first case. However, in both cases ventriculography showed considerable ventricular dilatation. The first case showed high pressures, of the order of 400 mm CSF and bone changes of raised intracranial pressure, whereas the pressures recorded in the second case were normal. Vision in both patients was significantly improved by ventriculoatrial shunt. It was suggested that the effect was not due to a reduction of slightly raised 'general' intracranial pressure but that there may have been a local pressure effect in relation to the optic chiasm and nerves. Local cystic swellings of two types were described, either a distended third ventricle compressing and distorting these structures from above or an arachnoidal cyst filling from the basal cisterns and causing compression from below. Such an arachnoidal cyst had been demonstrated in the first patient and the residual bitemporal field defect was very suggestive of a lesion compressing the chiasm in the midline.

FIVE MODES OF SUBTRACTION USING ARTIFICIAL SLOW FLOW CAROTID ANGIOGRAPHY

H. VERBIEST (Utrecht) described special aspects of radiographic and photographic subtraction using a recently developed technique of percutaneous artificial slow flow carotid angiography. This method depended upon occlusion of the ipsilateral common carotid artery below the site of puncture by means of digital compression during the injection of the contrast medium and for three seconds thereafter. A distinction was made between angiographic subtraction and photographic (or electronic) subtraction.

Angiographic subtraction was related to the angiographic technique, selective suppression of vascular filling revealed abnormalities in the resulting vascular pattern and might also produce visualization of anastomosing vessels not seen in the routine angiograms. Although the latter was due to angiographic subtraction the result could also be termed an 'addition phenomenon'.

The following photographic subtraction techniques were described:

Subtraction of skull structures from the compression angiograms resulted in better visualization of the angiographic pattern.

Subtraction of compression angiograms from the routine arteriogram in cases of visualization of the middle and anterior cerebral arteries in the routine angiogram