Results of the 123rd meeting of the Society of British Neurological Surgeons, Birmingham, United Kingdom, 3–6 November 1993

IMPLANTATION OF HUMAN FETAL VENTRAL MESENCEPHALON TO THE BILATERAL CAUDATE NUCLEI IN ADVANCED PARKINSON’S DISEASE
PO Byrne, Y Caglar, A Detta, ER Hitchcock. Birmingham, UK

Twelve patients had bilateral caudate nucleus implants of late stage fetal mesencephalon as the fourth series of a study of experimental surgery by transplantations for advanced Parkinson’s disease. Patients with an age range of 55–67 years were operated upon in the latter part of 1991. Subsequently they have been systematically followed up in terms of preoperative and postoperative clinical assessment and the results of those available for follow up to date were outlined. The results refer to timed motor performance tests, CAPIT core assessment, Northwestern University disability scores and Schwab and England ratings obtained preoperatively with drug regimens adjusted to maximum efficacy and then at time intervals postoperatively; in addition, side effects occurring in individual patients were analysed.

The results of this fourth experimental series were discussed with reference to earlier series and factors important in human fetal cell transplantation for neurodegenerative disorders with their attendant problems were discussed.

DYNAMIC OXYGEN MICROPOLAROGRAPHY OF PERITUMOURAL WHITE MATTER: THE INFLUENCE OF ODEMA ON TISSUE OXYGENATION
GS Cruickshank, R Ramping. Glasgow, UK

Dynamic oxygen micropolarography of malignant brain tumours has shown that a high proportion have a large hypoxic volume and that this correlates with the relative resistance of these tumours to radiotherapy. The spatial resolution of this technique allows a unique analysis of the factors affecting the oxygen supply at the microenvironmental level rather than other methods which integrate values over a large tissue volume.1 In this study we have used this technique to examine the oedematous peritumoural white matter to determine the influence of oedema on the local oxygen tension of this area, as this is the logical site for therapeutic intervention after surgery.

Peroperative oxygen tension (pO₂) measurements were made in 24 patients undergoing routine craniotomy for tumour decompression. A 300 μm polarographic probe with a 12 μm oxygen sensitive tip, was advanced under computerised step control using ultrasonic guidance. A number of static probe measurements were also made to provide pseudostop-flow assessments of relative oxygen consumption (VO₂). Morphometric measurements on tumour and peritumoural biopsies were performed using standard techniques.

pO₂ frequency histograms of 192 readings (six probe passes of 32 readings 700 μm apart) were plotted at 2.5 mmHg intervals. There was a surprisingly high incidence of low pO₂ values (18% < 2.5 mmHg) by comparison with that reported in normal white matter (< 2.5 mmHg).2 Median and low pO₂ values were correlated with intercapsular distance in peritumoural white matter (r = 0.87) but not so clearly in tumours. Maximum pO₂ levels recorded in peritumoural white matter were equivalent or better than that seen in tumours. VO₂ values varied between 6 and 12% only, in peritumoural white matter.

Higher percentages of low pO₂ values in the peritumoural region are of clinical and therapeutic significance. Increased intercapsular distance correlates with lower pO₂ values but the small variation in VO₂ levels suggests that peritumoural hypoxia is more related to impaired capillary patency than altered or increased oxygen uptake in the expanded intercapillary space. Peritumoural oedema and its effects do not seem to be a limiting factor for oxygen supply to tumours, and thus a cause of tumour hypoxia.


DYNAMIC MAGNETIC RESONANCE IMAGING FOR MEASUREMENT OF REGIONAL HAEMODYNAMICS AFTER TRANSIENT CEREBRAL ISCHAEMIA
R Macfarlane, LM Hamberg, E Tasdemiroglu, JW Belliveau, B Rosen, MA Moskowitz. London, UK and Boston, USA

Because alterations in cerebral blood volume (CBV) are not necessarily coupled to those of cerebral blood flow (CBF) under pathological conditions, a noninvasive technique able to measure regional and temporal changes of each parameter simultaneously might aid investigation of perturbed cerebrovascular states.

Gadolinium-DTPA was injected as a bolus into the femoral vein of seven anesthetised cats placed in the bore of a 4.7 T MRI, while rapid sequence images were acquired every 1·3 s. After a baseline study, global cerebral ischaemia was induced for 10 minutes. Further imaging sequences were repeated at intervals after reperfusion. CBV changes were calculated relative to the baseline and, after direct measurement of vascular transit time (VTT), the CBF index (CBFI) was computed.

Relative CBV (rCBV) and CBFI rose sharply during the early reperfusion period. Both fell to near-basal levels at 45 minutes. Thereafter CBV rose slowly, whereas CBFI continued to fall. At three hours, CBV fell 1·6 times basal (p < 0·05), whereas CBFI had returned to pre-ischaemic values. VTT fell from 4·4 to 1 s at 30 minutes, was near-normal at one hour, but increased to 6·7 s at three hours (p < 0·05). CBF results were comparable with those obtained in previous radionuclide studies.2

It is concluded that dynamic susceptibility-contrast MRI provides a noninvasive, in vivo method for determination of CBF and CBV.

Meningioma-induced fibrinolysis
JD Palmer, DA Francis, JL Francis, F Iannotti. Southampton, UK.

Fibrinolysis enhances surgical bleeding. Brain tumours, particularly meningiomas, have a high content of tissue plasminogen activator (tPA) which can convert plasminogen into plasmin and hence stimulate fibrinolysis. Thus drugs such as aprotinin, which blocks plasmin, may reduce bleeding in neurosurgery. Brain also has a high content of tissue factor, which initiates blood coagulation. Surgery may release tissue factor into the circulation resulting in local activation of coagulation and secondary fibrinolytic activation with consumption of clotting factors and bleeding. Preoperative samples from 12 patients with a meningioma (group A) and five patients with an acoustic schwannoma (group B) were frozen to –70°C. Molecular markers of activation of coagulation (prothrombin F1.2) and fibrinolysis (tPA, and total fibrinogen—degradation products) were measured by enzyme linked immunosorbent assay (ELISA). The table shows that in nine of group A (75%) and in two of group B (40%) the total degradation products were markedly raised (bold figures). In five of group A (42%) there was evidence of raised tPA but in none of group B. In eight of group A (66%) and in one of group B (20%) the prothrombin F1.2 was significantly raised.

This study demonstrates that activation of coagulation and fibrinolysis is present preoperatively in both groups, which provides a rationale for the use of antiplasmin agents in neurosurgery.

<table>
<thead>
<tr>
<th>Meningioma</th>
<th>Acoustic schwannoma</th>
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<tbody>
<tr>
<td>n</td>
<td>1</td>
</tr>
<tr>
<td>PFI.2 (nmol/l)</td>
<td>2-89</td>
</tr>
<tr>
<td>tPA (ng/ml)</td>
<td>50-4</td>
</tr>
<tr>
<td>TDP (ng/ml)</td>
<td>2522</td>
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Comparision of magnetic resonance angiography, duplex ultrasound and digital subtraction angiography in the assessment of extracranial internal carotid artery stenosis
GR Young, PRD Humphreys, MDM Shaw, TE Nixon, EFJ Smith. Liverpool, UK.

We undertook a triple-blind comparison of duplex ultrasound, intra-arterial digital subtraction angiography (DSA) and 2D and 3D time-of-flight magnetic resonance angiography (MRA), using a Siemens 1.5 T Magnetom scanner, in the assessment of the extracranial internal carotid artery. Patients were screened with ultrasound to exclude those with less than 30% stenosis of the symptomatic carotid artery. Seventy consecutive patients referred for angiography, with symptoms of carotid territory ischaemia, underwent investigation. A total of 137 vessels were studied by all three techniques. Three cut-off values were chosen, 30%, 70%, and 100% stenosis. Assuming DSA to reflect the true situation, the sensitivity and specificity for diagnosing stenosis greater than or equal to 70% by MRA were 90% and 95% respectively, with positive predictive value 96% and negative predictive value 90%. When only those vessels in which ultrasound and MRA were in agreement were considered (96% of the total) the sensitivity, specificity, positive and negative predictive values were 94%, 95%, 95%, and 94% respectively. Corresponding results for diagnosing complete occlusion were 80%, 99%, 99%, and 98% for MRA alone and 92%, 100%, 100%, and 99% for the 97% of vessels in which MRA and ultrasound were in agreement. It is predicted that investigation with MRA together with ultrasound will largely replace the need for DSA when assessing suitability for prophylactic carotid endarterectomy.

Plain man’s guide to os odontoides
HA Cremin, JM Stevens, BE Kendall. London, UK.

Abnormalities of the odontoid process may be associated with atlantoaxial subluxation and neuroaxial compression. There have been numerous explanations, ranging from (a) anomalous segmentation during embryological development; (b) a congenitally short transverse ligament which, in effect, divides the odontoid process during development; (c) fracture with subsequent remodelling. This last mechanism might not account for the abnormalities seen in young children delivered normally.

The purpose of this study has been to evaluate a variety of abnormalities of the odontoid process, and, in doing so, we have developed a new simpler theory of its causation. Sixty-two patients were examined by high definition CT or MRI in flexion and extension. Some have been studied before and after surgery, and followed up radiologically for up to a decade. This has been combined with a detailed review of the phylogenetic and embryological literature.

We have been able to show that in post-traumatic cases, the transverse ligament, wholly or in part, is interposed in the ununited lesion. In congenital malformations, the abnormality is also associated with soft tissue interposition and, in some, in whom posterior fusion has been carried out early, there is subsequent fusion of an apparent bony bridge.

Our conclusion is that in os odontoides: (a) the dens forms normally but ossifies abnormally because of abnormal motion; (b) the os is the result, rather than the cause of instability; and (c) hypoplasia of the intact dens is a different congenital malformation, associated with atlantoaxial assimilation and fusion of cervical vertebrae (the Klippel-Feil type of deformity).

Subicular fenestration for lumbar stenosis: clinical follow-up
A Dailey, HT Marsh. London, UK.

Subicular fenestration or selective laminotomy has been advocated as an alternative to full decompressive laminectomy for lumbar canal stenosis. The goals are to reduce perioperative discomfort and maintain spinal anatomy. Over a five-year period, 44 patients with symptoms of lumbar canal stenosis and claudication were selected for microscopic lumbar fenestrations. The most common level of decompression was L4/5 with 29 patients (66%) undergoing surgery at this level. Multilevel decompressions were performed in 14 patients (32%).

Complete follow up including repeat patient interview, or review of current medical notes, was available in 39 patients (88%) and ranged from one to six years. Nearly 90% had complete or near complete resolution of symptoms at six months. The preliminary results of long-term follow-up, however, show that over 50% (14/25) have suffered recurrence of their original symptoms from six months to five years after surgery. To date, 11 of these 14 patients have undergone complete re-investigation and five of the patients who had early relief of pain have gone on to laminectomy. The large number of patients with recurrent symptoms show that fenestrations only briefly halt the degenerative processes and that full decompressive laminectomy provides a better long-term solution to the problem of lumbar canal stenosis.

Using the operating microscope and limited surgical exposures we have found that early mobilisation and short stays in hospital (less than four days) are easily achieved with laminectomy.

Who is to blame for the morbidity of acute cauda equina syndrome?
GC Stephenson, R Myles Gibson, VKH Sonntag. London, UK and Phoenix, Arizona, USA.

Acute cauda equina compression by a lumbar disc may have a devastating effect on the quality of the life of those afflicted and its management is increasingly becoming the subject of patients’ complaints and litigation. The initial manifestations of this condition may remain unrecognised by the nonspecialist until severe neurological deficit or incontinence develops.

This study reviewed the records of 45 consecutive patients presenting over an eight-year period all of whom were surgically treated. The follow up ranged from 18 months to eight years (mean 4.5 years) and the average age at presentation was 41 years. Of the 45 patients, 21 deteriorated following admission to hospital or after having been seen at least once by a medical practitioner. The causes of this deterioration were examined and guidelines regarding early diagnosis and management were proposed.

Spina bifida and syringomyelia
C Hardwicke, B Williams. Haywards Heath and Birmingham, UK.

Seventeen cases of syringomyelia associated
with spina bifida were presented. Thirteen patients had hindbrain herniation (HHB), four with Chiari type 1 and nine with type 2. Eight of the HHB related cases also had hydrocephalus. Four of the patients had a distal form of syringomyelia with cord tethering but no HBH or hydrocephalus. Nine of the HHB related cases underwent surgical treatment; six had shunts for hydrocephalus alone; one had a shunt followed by HBH decompression. Untethering procedures of the cord followed by HBH decompression. Of the non-HHB related group, one underwent syringopleural shunting and the other three have been treated conservatively. All patients who underwent HHB decompression improved, except one who had untreated hydrocephalus. All patients who had treated hydrocephalus from birth and developed syringomyelia did poorly. The patient with the distal syrinx, treated with a syringopleural shunt improved.

It was concluded that, firstly, when syringomyelia and hydrocephalus are present, the hydrocephalus should be treated first, as the syrinx may improve with this alone and it may be dangerous to perform untethering of the cord. If both conditions are present, hydrocephalus is adequately treated, and, secondly, that in the distal syrinx group without HBH or hydrocephalus, the filling mechanism is likely to be the tethering of the cord itself. Untethering of the cord with or without drainage of the syrinx is the preferred treatment in these patients.

NONOPERATIVE ADMISSIONS TO A REGIONAL NEUROSURGICAL UNIT: ARE THEY JUSTIFIED? IK Pople, RJ Nelson. Bristol, UK

The aim of this audit was to find out how many patients are discharged from our neurosurgical unit without having an operation and whether these admissions are all clinically justified. During 12 months, 2509 patients were admitted, of whom 1637 (65%) had an operation. A further 530 (21%) patients had an inpatient neuroradiological investigation (CT myelogram, or cerebral angiogram). Of the remaining 342 patients, 119 had a head injury and 223 were admitted for assessment of spinal disease, intracranial malignancy, suspected ventricular shunt malfunction, secondary malignancy in the spine, cerebrovascular disorders, and other miscellaneous conditions. Last-minute cancellation of a planned operation (unfit for anaesthetic, no theatre time, patient refused operation, or spontaneous resolution of symptoms) occurred in 41 patients, and only 13 were admitted for nonsurgical care of a postoperative complication. After studying the nonoperative cases in detail, it was concluded that relatively few patients (1–2% of all admissions) were admitted unnecessarily, and that nonoperative admissions constitute an important and substantial part of the workload of a neurosurgical service. This should be recognised when contracts are negotiated between purchasing authorities and specialist surgical units in trust hospitals.

A 30-YEAR AUDIT OF THE MANAGEMENT OF CRANIOPHARYNGIOMA IN NORTHERN IRELAND

I Bailey, B Mathew, D McAuley, D Hadden. Belfast, UK

Sixty-two patients have been diagnosed as having a craniopharyngioma in Northern Ireland in the last 30 years (population 1.6 million people). Fifty-seven patients had surgery and five had a presumptive diagnosis based on skull radiography. The sex incidence was equal. Thirty-five per cent presented aged 14 or younger, 17% between 15 and 25 and 48% were older than 25. Seventy-seven per cent of the children presented with symptoms of raised intracranial pressure compared with only 48% of patients above 25 years (p = 0.05). Visual deterioration was the presenting symptom in 61% of cases. No patients presented with endocrine problems. Changes on the skull radiograph were more common in patients aged less than 25 (p = 0.0026). Art studies in the early series revealed false negatives or negatives. The first generation of CT scanners missed 12% of craniopharyngiomas which were subsequently discovered on air studies. Thirty-three (58%) patients had preoperative endocrine investigations and all were found to have hormonal abnormalities.

Preoperative shunts were performed in 25% of children and 14% of older patients. Subtotal or radical surgical removal was achieved in 50% of patients irrespective of age. Five patients died in the first month after primary surgery and two patients after revision surgery. There was no significant difference in the number of surgical explorations in the three age groups (mean: 1.98, median = 2, range: 1–6). Lasting visual improvement occurred after surgery in 25% of patients. Radiotherapy was given postoperatively in 33%.

At follow-up, 65% of patients in the series are still alive. Thirty patients remain with pituitary function, 34% have abnormal function and 53% have frank hypopituitarism. Forty-two per cent are functionally blind. Children had significantly worse vision post-operatively (p = 0.037). Adjuvant DXT did not significantly improve outcome nor increase the chance of hypopituitarism or visual loss.

It was concluded that the management of craniopharyngioma still remains a real challenge.

ENDOSCOPIC MANAGEMENT OF PINEAL TUMOURS

HB Coakham, IK Pople, DR Sandeman. Bristol, UK

The histological nature of pineal region tumours critically determines optimal treatment. Most authorities argue that all pineal tumours should be biopsied as they have previously been achieved by stereotactic biopsy which can occasionally be hazardous in the pineal region, or by direct open surgery which may not always be necessary, particularly in cases of undifferentiated germinoma. Many cases of pineal tumour are admitted with acute hydrocephalus as emergencies.

We have developed a management system using transvenricular endoscopic biopsy and third ventriculostomy. This one step procedure is minimally invasive and achieves two goals of safe adequate biopsy and immediate treatment of hydrocephalus while definitive histology and CSF marker studies are awaited. During this period immunohistology and electron microscopy is also performed.

A 3 mm rigid solid lens endoscope (Stortz) is introduced via a right frontal burr hole, passed through the foramen of Monro for biopsy of the tumour under direct vision, avoiding obvious blood vessels. This is followed by endoscopic third ventriculostomy carried out with diathermy fenestration and more recently Fogarty balloon catheter dilatation. Alternatively an Omaya reservoir is placed in the burr hole and may be revised to a VP shunt if necessary.

Tumour types we have successfully managed by this technique are pineoblastoma, pineocytoma, germinoma, teratoma, astrocytoma, and carcinoma (15 cases in total). The more recent five cases have received third ventriculostomies. According to current management protocols and depending on histology, tumours were then treated by either resection via the parafalcine transtentorial approach or by radiation or chemotherapy. There were no significant complications, and long term follow up data was presented.
CLINICOPATHOLOGICAL EXPERIENCE OVER 30 YEARS WITH PINERAL REGION TUMOURS IN NORTHERN IRELAND

B Mathew, B Herron, B Clements, M Mirakhur, T Fannin. Belfast, UK

Pineal region tumours constitute only 0.4-1.1% of intracranial tumours. In Northern Ireland there are 1-6 million people served by one neurosurgery unit and 26 patients with pineal region tumours have been identified and carefully followed up.

The purpose of the present retrospective review was to establish a clinicopathological correlation of survival with histological type of tumour. The paraffin blocks had been stored and were re-studied using H&E, immunocytochemistry and electron microscopy. Tumours were classified according to the 1990 WHO classification.

There were a total of 24 pineal region tumours and two suprasellar germinomas which are frequently classified with pineal region tumours because of their common germ cell origin. There were 22 men and four women. The mean age was 27.5 (range 6-62 years). All 24 pineal region tumours had symptoms/signs of raised intracranial pressure and required initial shunting. The two patients with suprasellar germinomas presented with visual loss.

In 22 patients a tissue diagnosis was obtained, 16 by craniotomy, three by stereotaxy, one by cytology and two by post-mortem examination. Open biopsies were performed in the prone position by the suboccipital transtentorial approach. On six occasions biopsy via the open approach was abandoned because of difficulty with retraction. There was minimal operative morbidity but two patients died postoperatively (one stereotactic biopsy causing haemorrhage from a hypernephroma secondary to a transtentorial approach). All patients except one with a teratoma received radiotherapy. The table shows histology and three-year survival (where available).

<table>
<thead>
<tr>
<th>Histology</th>
<th>No (%)</th>
<th>3-year survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pineal parenchymal</td>
<td>11 (50)</td>
<td>71 (n=7)</td>
</tr>
<tr>
<td>Pineoblastoma</td>
<td>6 (27)</td>
<td>60 (n=5)</td>
</tr>
<tr>
<td>Pineocytoma</td>
<td>4 (18)</td>
<td>100 (n=1)</td>
</tr>
<tr>
<td>Pineoblastoma</td>
<td>1 (5)</td>
<td>100 (n=1)</td>
</tr>
<tr>
<td>Germin cell tumours</td>
<td>7 (32)</td>
<td>40 (n=5)</td>
</tr>
<tr>
<td>Germinoma</td>
<td>4 (18)</td>
<td>50 (n=2)</td>
</tr>
<tr>
<td>Teratoma</td>
<td>3 (14)</td>
<td>100 (n=1)</td>
</tr>
<tr>
<td>Astrocytoma</td>
<td>1 (5)</td>
<td>100 (n=1)</td>
</tr>
<tr>
<td>Ependymoma</td>
<td>2 (9)</td>
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</tr>
<tr>
<td>Metastatic</td>
<td>(hypernephroma)</td>
<td>(n=1)</td>
</tr>
<tr>
<td>No histology</td>
<td>4 (18)</td>
<td>25 (n=4)</td>
</tr>
</tbody>
</table>

n = Number with three year follow up.

The low incidence of germinoma and the longer survival for pineal parenchymal tumours (see note). The management of patients by ‘blind’ irradiation without a histological diagnosis needs to be questioned.

MININGOMAS OF THE CEREBELLOPOITINE ANGLE: A REPORT OF 41 CASES

NWM Thomas, TT King. London, UK

Meningiomas of the cerebellopontine angle (CPA) are rare. This retrospective study presents 41 cases from a total of 625 tumours operated upon by one surgeon with the results and tumours based upon their anatomical distribution and correlating this with outcome.

Tumours were divided into six groups: lateral, internal auditory meatal, midpetrosal, posterior, Meckel’s, and petroclival. Four different approaches were used either singly or in combination. Twenty-one patients had a total removal, 10 subtotal, and three were treated conservatively. There were no operative deaths. A good result (return to normal life) occurred in 30 cases, a fair outcome in seven, and a poor outcome in five. There were two deaths from late recurrence. Median follow up was 8-5 years.

Most tumours lateral to the internal auditory meatus had a complete removal, with a good outcome. The rate of removal and cranial nerve deficits were more common with medial tumours but incomplete removal did not correlate with early recurrence. Poor outcome was related to cranial nerve deficits and brainstem damage.

LATERAL APPROACHES TO FOREMAGNUM TUMOURS

B George, G Lot. Paris, France

Foreman magnus tumours are operated on via three main approaches: anterior (transoral), posterior (midline posterior) and lateral approaches (anterolateral and posterolateral approaches). The anterolateral approach is also used to expose the vertebral artery in the lateral, inferior, and medial to the internal jugular, the accessory nerve is dissected free, and the vertebral artery is exposed above C1 and between C1 and C2. After opening the transverse foramen of C1, the vertebral artery is displaced medially, giving access to the condyle, C1 lateral mass, and C1-C2 joint.

The posterolateral approach is a lateral enlargement of the standard posterior opening, allowing the control of the vertebral artery in its C1 groove, which provides access to the condyle and C1 lateral mass. The anterolateral approach was mainly reserved for osseous (n = 18) and extradural nonosseous (n = 14) tumours. The posterolateral approach was used for intradural tumours (n = 42).

The benefits of the lateral approaches were discussed from a series of 230 foreman magnus tumours.

ACUTE INTRAOPERATIVE BRAIN HERNIATION COMPLICATING ELECTIVE NEUROSURGERY: NEURORADIOLOGICAL FINDINGS

PATHOPHYSIOLOGICAL MECHANISMS AND MANAGEMENT CONSIDERATIONS

R Viswanathan, IR Whittle, Edinburgh, UK

Profound and acute intraoperative brain herniation is most commonly seen following evacuation of a post-traumatic acute subdural haematoma. The pathophysiological mechanisms probably relate to dysautoregulation of cerebral blood flow and hydrostatic brain oedema and the outcome in such cases is invariably death. Acute intraoperative brain swelling following an elective craniotomy is, however, a much rarer event. The aim of this report, which describes seven such cases, is to describe mechanisms and present profound and acute brain herniation during elective surgery, recommend some management guidelines, and describe the postoperative complications encountered.

Preoperatively four patients with anterior circulation aneurysms were WFNS grade I or II; two patients with tumours (pineoblastoma and astroblastoma) had, despite preoperative steroids, fixed focal deficits, but no impairment of conscious state; one patient with cerebellar AIDs (with minimal mass effect) had a Glasgow coma score of 15 but general psychomotor slowing. Intraoperative monitoring of multiple parameters, by a consultant neuroanaesthetist, was unremarkable before open brain herniation. Herniation occurred following intraoperative aneurysmal rupture, before arachnoidal dissection (three patients) and during clip placement (one patient), follow- ing the latter a recurrent, C12, very vascular hemispheric astroblastoma; after resection of the pineal tumour, and after an uncomplicated AIDs lesion biopsy. In all cases, except one, the operation was abandoned, acute medical measures to reduce intracranial pressure undertaken, the scalp closed in a single layer over the herniating brain, an intracranial pressure monitor inserted, immediate postoperative CT performed and the patient transferred to the intensive care unit for elective ventilation and monitoring.

Postoperative CT scans revealed intra-axial and subarachnoid haemorrhage with paradoxically minimal or no intra-parenchymal haemorrhage, acute brain swelling, or midline shift. Intracranial pressure monitoring was generally unremarkable. All patients recovered from the acute ictus. One patient with an aneurysm rebleed and died three days later. Three had successful aneurysm clipping with two patients resuming their prior employment. The other three patients all recovered, although one had a field defect from occipital lobe damage. Two patients required a second procedure (duroplasty and closure of pseudomeningocele) and died. Overall outcome was remarkably good considering the dramatic and apparently catastrophic nature of the open brain herniation. It is postulated that closure of the scalp to limit brain herniation and prevent pial rupture together with optimal postoperative control of intracranial pressure minimised postoperative morbidity. It would appear that there are fundamental flaws in pathophysiological mechanisms, neuroradiological findings, and outcome between open brain herniation occurring in posttraumatic and elective neurosurgical patients.

SHORT-COURSE ANTIMICROBIAL THERAPY FOR BRAIN ABSCESS AND SUBDURAL EMPYEMA

EM Brown, G Strangelis, A Jamjoom, HB Griffith. Bristol, UK

It is widely (and empirically) recommended that patients with intracranial sepsis (brain abscess and subdural empyema) should receive antibiotics for eight weeks or longer. Although there is no theoretical, experimental, or clinical evidence to justify these prolonged courses, neither have there been reliable, objective criteria that enable the patient’s response to be monitored and which indicate when treatment should be discontinued. We report our experience in pathophysiological mechanisms, neuroradiological findings, and outcome between open brain herniation occurring in posttraumatic and elective neurosurgical patients.
have been treated according to these criteria; all underwent neurosurgical procedures. Of the 19 patients who were evaluable, the median duration of treatment was 14 days (range 11–75 days); the follow-up period ranged from 18–54 months, during which time there were no relapses. One patient died from a massive pulmonary embolism before completing the course of treatment and in three patients, therapy was prolonged because of undiagnosed deep vein thrombosis (one patient), failure to eradicate the underlying aural pathology (one) and intercurrent infection (one). It was concluded that patients with intracranial sepsis can be treated successfully with courses of antibiotics which are administered for significantly shorter periods than those currently recommended.

**ANTI-MICROBIAL PROPHYLAXIS IN NEUROSURGERY AND FOLLOWING HEAD INJURY**


Antibiotics are extensively used within neurosurgical practice in an effort to reduce the rate of postoperative infection. Uniquely, support for the efficacy of prophylactic antibiotics does not exist. This is not because there have been too few attempts to resolve the issue, but because virtually all of the many clinical trials suffer from flaws in design or execution, the most important of these being the failure to achieve statistical significance. Against this background, the benefits of prophylactic antibiotic use in neurosurgery need to be assessed. The Working Party, comprising members of the Society of British Neurological Surgeons and the British Society for Antimicrobial Therapy, reviewed the extensive literature on the use of prophylactic antibiotics in three areas of neurosurgery: (a) clean non-implant procedures; (b) CSF shunt surgery; and (c) skull fractures. Our conclusions and recommendations are as follows: (1) The weight of evidence suggests that antibiotics exert a protective effect in clean nonimplant surgery; a single dose of a first or second generation cephalosporin is an appropriate regimen. (2) For CSF shunt surgery not even a tentative recommendation can be made regarding the use of prophylactic antibiotics. (3) There is no conclusive evidence in the literature to support antibiotic prophylaxis in patients with skull fracture and CSF leak. The risk of CNS infection due to resistant organisms led to the conclusion that antibiotic prophylaxis should be withheld in this situation.

**THE EFFECT OF CSF PROTEINS UPON BACTERIAL ADHESION TO SHUNT MATERIAL**

HL Brydon, R Hayward, W Harkness, R Bayston. London, UK

The role that proteins play in bacterial adhesion to prosthetic materials has not been proven. For each paper that states that certain proteins promote bacterial adhesion, there is another that draws the opposite conclusion. All of this work has been performed using plasma proteins, however, and the effect of CSF upon neurosurgical prosthetic infections has not been studied. There is some evidence that the concentration of the protein may alter the result, therefore a correlation between work on plasma and CSF cannot be assumed. In this study the effect of individual protein solutions (in CSF concentrations) and patient's CSF upon the adhesion to silicone rubber catheters was analysed.

**LENGTHS OF CIRCULATION PATHWAYS DURING IMPLANTATION OF CSF PROSTHESES**

G O'Reilly, B Williams. Birmingham, UK

A series of 22 patients with hydrocephalus were treated by a shunt system incorporating a variable pressure Sophia valve or by ventriculoljugular shunting against the direction of blood flow using the El-Shafei system. One patient had sequential insertion of two Sophia valves and an El-Shafei conduit. Patient selection was reserved to those whose hydrocephalus was such that shunting with conventional unipressure valves was deemed hazardous. None of the eight patients who had ventriculoljugular shunting by the El-Shafei method demonstrated clinical or radiological improvement subsequent to shunt insertion. Of the 16 Sophia devices inserted only seven resulted in a satisfactory clinical outcome. It was suggested that the value of the Sophia and El-Shafei shunt systems in treating difficult cases of hydrocephalus remains to be proven.

**UNITED KINGDOM CSF SHUNT REGISTRY AND SHUNT EVALUATION UNIT**

JL Pickard, RD Ashpole, H Whitehouse, M Czosnyka. Cambridge, UK

Approximately 3000 shunt operations are performed in the United Kingdom per year (1500 new, 1500 revisions) at a total cost of over £6 million. Some 80% of shunts fail by 12 years. Many patients have a poor outcome in vivo do not behave consistently nor according to the manufacturer's own specifications. If liability for product failure is to fall only on the manufacturer, strict record keeping is crucial under the Consumer Protection Act. On behalf of the Council of the Society of British Neurological Surgeons, the Executive Committee of the British Association of Paediatric Surgeons, the United Kingdom Hydrocephalus Group and the Association of Spina Bifida and Hydrocephalus, funding has been secured from the Department of Health and the East Anglian Regional Audit Committee to establish the following. (1) The United Kingdom CSF Shunt Registry, equivalent to the United Kingdom Heart Valve Registry, based on completion of a simple card at the time of operation for entry into the Dendrite Patient Analysis and Tracking System. (2) The United Kingdom CSF Shunt Evaluation Unit, which will prepare detailed evaluation reports of the hydrodynamic properties for every type of shunt valve currently available and also has the facilities for the testing of explanted valves with appropriate safety precautions.

The way in which each initiative will function was outlined to encourage feedback by the Society.

**RECURRENT CRANIOSYNOSTOSIS**

AD Hockley, M Briggs. Birmingham and Oxford, UK

After an apparently successful correction for craniosynostosis, a small but significant number of patients later develop recurrent deformity needing reoperation. Analysis of 219 cases treated in the Birmingham and Oxford craniofacial units since 1979 demonstrates a higher re-operation rate in syndromal or unilateral coronal synostosis treated below the age of 6 months. Total shunt rates of 15% were higher repeat fronto-orbital advancement. For single suture involvement the re-operation rate was 3% and for multiple it was 5%. In Apter's syndrome the re-operation rate was 16% with initial surgery performed in the first three months of life there is a significantly higher re-operation rate of 23% falling to 17-9% for surgery between ages three and six months. After six months of age the rate did not exceed 5%.

Unless there is major raised intracranial pressure or exorbitism, it is recommended that fronto-orbital advancement is deferred to at least 12 months of age. Where presence of raised pressure, a preliminary posterior skull release can be helpful in allowing a planned anterior correction later with less risk of recurrent deformity.

**AETIOLOGY OF HERNIATION OF THE HINDBRAIN IN CRANIOSYNOSTOSIS: PRELIMINARY OBSERVATIONS**

DNP Thompson, RD Hayward, WJ Harkness, BM Jones. London, UK

Herniation of the hindbrain is recognised in association with craniosynostosis. Moreover the concept of acquired hindbrain herniation is reported and has been observed in our practice. This retrospective study aimed to identify some of the aetiological factors responsible for this deformity. The results of MRI and continuous intracranial pressure monitoring were reviewed in a total of 33 patients. Two groups were identified; group 1 (n = 21) where there had been no previous vault surgery and group 2 (n = 12) where vault expansion surgery had been performed. Hindbrain herniation was identified in eight (38%) of patients in the unoperated group— all of whom had abnormal intracranial pressure. Among the operated group hindbrain herniation was identified in eight cases (87%), six of whom had abnormal intracranial pressure.

Hindbrain, defined in this series as the need for shunt placement (38%) occurred in one patient in group 1 and in seven patients in group 2; furthermore, herniation of the hindbrain was an invariable accompaniment to all these cases of hydrocephalus.

An index of posterior fossa size relative to...
the rest of the cranial vault was developed using the distance from the foramen magnum to the torcular expressed as a percentage of the distance from the foramen magnum to the nasion assessed on midline sagittal MRI scans.

In group 1 the posterior fossa size was 13-1% in cases with herniation of the hindbrain compared with 16-1% in those without. In group 2 the values were 12-4% and 14-2% respectively.

The results confirm the high incidence of hindbrain herniation in craniosynostosis. Furthermore they suggest the incidence may be higher in neonates who have undergone vault expansion surgery. The anatomical constraints imposed by posterior fossa size, raised intracranial tension, and impaired cerebrospinal fluid circulation all appear to predispose toward herniation of the hindbrain. Potential underlying mechanisms were discussed.

ACCUARATE 3D COMBINATION AND DISPLAY OF MR, CT, AND MRA IMAGES FOR SURGICAL PLANNING


Magnetic resonance (MR), x-ray CT, and angiographic images respectively depict soft tissues, bone, and blood vessels. None on its own is sufficient for the preoperative assessment of skull base lesions. We have developed and evaluated a computational technique for the 3D combination and display of multimodality images for planning skull base surgery.

Sixteen patients (seven with acoustic neuromas, one with a plasmacytoma, one with a cholesterol cyst, six with meningiomas (five subfrontal and suprasellar, one petrous apex) and one with a glomus jugulare tumour underwent MR, CT, and, where appropriate, MR angiography (MRA). The images are presented using anatomical landmarks rather than an external frame. Two techniques were used for displaying the resulting images: (a) multiple slices of overlaid bone from CT and soft tissue from MR; (b) pseudo-3D movie sequences showing bone from CT, lesions, and optic nerves from MR, and blood vessels from MRA. Possible advantages of the combined images compared with conventional viewing were investigated. For the first eight patients, the overlaid slices were evaluated retrospectively by independent observers. For the second eight, overlaid slices and 3D rendered displays were assessed prospectively, both by the operating and by independent surgeons, and the results validated with operative findings.

In the first eight patients there was an improvement in clarity of the image information and hence in the surgeons' confidence. A more rigorous assessment of the second eight showed a significant improvement in the depiction of tumour-bone relationships (overlaid slices) and of tumour-vasculature relationships (3D rendered displays), both at p < 0.05. The operative findings confirmed this.

The combined images provide a clearer representation of anatomical structural relationships, further indices need to be devised for an objective assessment of the impact of this.

INITIAL STUDIES CHARACTERISING A CLINICALLY RELEVANT RODENT MODEL OF DIFFUSE HEAD INJURY

PFX Statham, IR Piper, PAT Kelly, JW Ironside, IM Ritchie, D Weir, JD Miller. Edinburgh, UK

Using an experimental model of closed head injury, this study aims to characterise the baseline status of cerebral blood flow (CBF) and neuropathology during the first six hours after injury.

Anaesthesiologist Sprague-Dawley rats (n = 26), were subjected to either sham or global closed head injury using an "impact acceleration" model. A 450 g weight was dropped from a height of either 1 m (moderate injury) or 2 m (severe injury) onto the intact skull which is protected by a metal plate to prevent skull fracture. The head was free to move on a foam cushion providing the acceleration and deceleration components of the injury. Mean arterial pressure (MAP) was measured continuously and blood gas samples were taken at intervals through a femoral cannula. The hydrogen clearance technique was used for repeated half-hourly CBF measurements at eight time points from 90 to 300 minutes after injury. After six hours animals were perfusion-fixed for neuropathological investigation.

With severe injury, MAP dropped from a mean (SD) of 100 (20) to 48 (4) mmHg recovering to a plateau level of 91 (21) mmHg with a recovery time of 12 (3) minutes after injury. Moderate injury also produced hypotension but with a significantly shorter recovery period of 4 (2) minutes (p < 0.001). By 2.5 hours and continuing through to five hours after injury, hyperaemia was present with CBF significantly higher (p < 0.05) than control levels for both the moderate and severe injury. Using H&E staining techniques, no major cell loss was found in any brain region, although subtle ischaemic/hypoxic cell damage was found in the mid-dorsal hippocampus at six hours after injury. Using histochemical markers for cytoskeletal proteins ubiquitin and the 68 kDa neurofilament, subunit, no major reactive axonal change could be detected by six hours after injury. Future studies will address the significance of superimposed secondary insults and therapeutic intervention on both the development of post-traumatic reactive axonal swelling and ischaemic cell damage.

CONTINUOUS ASSESSMENT OF GLOBAL CEREBRAL BLOOD FLOW USING LASER DOPPLER FLOWMETRY IN PATIENTS WITH HEAD INJURY

PJ Kirkpatrick, M Czosnyka, P Smielewski, S Picknell, JD Pickard. Cambridge, UK

The pathophysiological events affecting global cerebral blood flow (CBF) during the acute stages after severe head injury are dynamic and can fluctuate rapidly. To recognize and potentially act on such events, a reliable real time assessment of CBF is needed. Using laser Doppler flowmetry (LDF, Moor's Instruments model MBF-3B), we continuously monitored cortical red cell flux (CRCF) during the period of ventilation in 14 patients with severe head injuries. Our pooled data demonstrated a constant CRCF for cerebral perfusion pressure (CPP) above 75 mmHg, a small rise in CRCF at a CPP between 59 and 74 mmHg, and a continuing fall in CRCF as CPP fell below 58 mmHg (fig). The method was also used to monitor the cerebral haemodynamic response to therapeutic agents. A consistent increase in CRCF (10%; p < 0.04) occurred following 200 ml bolus of 20% hypertonic with a fall in cerebrovascular resistance of 5% (p < 0.04) that was independent of systemic arterial blood pressure. It was concluded that LDF provides a means of detecting spontaneous events that affect CBF globally, and allows accurate monitoring of the cerebral circulation during potential therapeutic intervention.

DOES OUTCOME AFTER HEAD INJURY CORRELATE WITH THE INTRACRANIAL PRESSURE WAVE PULSE WAVEFORM?

E Guazzo, M Czosnyka, H Whitehouse, P Kirkpatrick, P Smielewski, JD Pickard. Cambridge, UK

It is well documented that the pulse amplitude of the intracranial pressure (ICP) waveform increases proportionally with mean ICP. Our aim was to investigate whether the reported upper breakpoint of the relationship between the amplitude of the fundamental harmonic component of ICP pulse (AMP) and mean ICP correlates with the outcome after head injury.

ICP was measured continuously (2306 hours) in 52 ventilated patients with head injury using a Camino transducer (33) or subdural catheter (19). They included 38 males and 14 females with a mean age of 30 years (range 6-75 years). All patients had suffered severe head injuries with a mean Glasgow coma score of six (range 3-13), with only five patients having an initial assessment score after resuscitation greater than eight. Outcome was assessed on the Glasgow outcome scale, a mean of 12 months after the injury (range 4-19 months). The ICP waveform was analysed online and stored in a computer system. Ten-minute averages of AMP vs mean ICP were then analysed using the analysis of variance method.

The relationship between AMP and mean
ICP for all patients is presented in the top figure. AMP decreases with mean ICP until 45 mmHg, above this breakpoint it starts to decrease significantly (p < 0.05). The patients were divided into three groups according to Glasgow outcome score: GOS 1 and 2 (26 patients), GOS 3 (16 patients), GOS 4 and 5 (10 patients). The AMP/pressure relationship in these groups are presented in the lower figure. The positions of the upper breakpoints differ significantly (p < 0.01). The groups with worse outcomes have upper breakpoints at lower ICPs.

It was concluded that the upper breakpoint of the amplitude-pressure relationship correlates with outcome in patients with head injury.


PHYSICAL AND COGNITIVE SEQUELAE OF TREATING LOW GRADE ASTROCYTOMAS WITH RADIOTHERAPY
RD Chaderton, CGH West, S Schuller, K Rhee, DC Quirke. Manchester, UK

Forty-nine patients were recalled from the Manchester Children’s Tumour Register and underwent detailed physical and psychological assessment between four and 38 years after diagnosis; 25 of them had received radiotherapy, 17 had not. Age and sex characteristics of the groups were similar, the median radiation dose in the second group was 40 Gy (range 30-45). Neurological examination at the time of recall was compared retrospectively with that at the time of presentation and immediately after completion of treatment. Detailed psychometry was carried out at the time of recall with emphasis on general intelligence, memory, and information processing.

Radiotherapy was shown to confer no long-term physical penalty on patients, but there was a significant fall in full scale IQ, with a mean reduction of 15.7 (95% CI 5.2 to 26.2; p = 0.001). There was also a significant reduction in learning and information processing abilities. There is no correlation between this deterioration and the site of the tumour or the extent of tumour resection.

One of the complications of aneurysmal subarachnoid haemorrhage is the associated syndrome of delayed cerebral ischaemia (DCI) in which patients deteriorate neurologically after an interval and may die or be left seriously disabled. Cerebral angiography frequently shows focal arterial narrowing ("vasospasm") and cerebral blood flow studies demonstrate an ischaemic brain. Numerous drugs have been used to attempt to reverse the vasospasm and improve the cerebral ischaemia. None have been shown to have any effect on either, although nimodipine, a calcium antagonist, has been shown to improve the clinical outcome.1 The prostaglandins are a relatively new series of drugs with vasoreactive properties. One of the family, prostacyclin, is a very potent vasodilator. A pilot study using iloprost, a stable derivative of prostacyclin, was described assessing results clinically and with isotope cerebral blood flow measurements. Eleven patients were treated. There were no deaths. Clinical deterioration was reversed in eight or halted in three patients. In one patient, a focal weakness became worse. Cerebral blood flow studies all showed a focal deficit before treatment excluding one who did not have a pretreatment scan. All improved; three returned to normal, two showed hyperperfusion. Improvement in cerebral blood flow has never been previously reported.


THERAPEUTIC WINDOW FOR INTRAVENOUS CALCITONIN-GENE-RELATED PEPTIDE IN A RAT MODEL OF FOCAL CEREBRAL ISCHAEMIA
JP Holland, SGC Syderseff, BA Bell. London, UK

We set out to determine the therapeutic window for an intravenous infusion (100 ng/kg per minute) of calcitonin gene-related peptide (CGRP) in a rat model of focal cerebral ischaemia. Ischaemic cerebral blood flow (CBF) was measured using hydrogen clearance and the volume of ischaemic neuronal injury was quantified using conventional histological techniques.

When initiated 4 hours before the ischaemic insult, CGRP maintains local CBF at higher levels (35-6 (SD 1-9) ml/100 g per minute compared with 13-3 (SD 1-8) ml/100 g per minute in untreated animals) and reduces the volume of ischaemic neuronal injury by 57%. When started one hour after the onset of ischaemia, CBF increased significantly to 27-6 (SD 2-1) ml/100 g per minute and ischaemic neuronal injury was reduced by 40%. When the CGRP infusion was begun two hours after the onset of ischaemia, however, although CBF improved to 23-9 (SD 3-3) ml/100 g per minute, there was no significant improvement in the volume of ischaemic neuronal injury.

These findings confirm the efficacy of an intravenous infusion of the peptide provided it is given within one hour of the onset of a focal cerebral ischaemic event.

EFFICACY OF TREATMENT OF DELAYED CEREBRAL ISCHAEMIA IN ANEURYSMAL SUBARACHNOID HAEMORRHAGE WITH PROSTACYCLIN DERIVATIVE (ILOPROST)
PA Stanworth, DN Taylor, J Barham. Coventry, UK

One of the complications of aneurysmal subarachnoid haemorrhage is the associated syndrome of delayed cerebral ischaemia (DCI) in which patients deteriorate neurologically after an interval and may die or be left seriously disabled. Cerebral angiography frequently shows focal arterial narrowing ("vasospasm") and cerebral blood flow studies demonstrate an ischaemic brain. Numerous drugs have been used to attempt to reverse the vasospasm and improve the cerebral ischaemia. None have been shown to have any effect on either, although nimodipine, a calcium antagonist, has been shown to improve the clinical outcome. Therefore the prostaglandins are relatively new series of drugs with vasoreactive properties. One of the family, prostacyclin, is a very potent vasodilator. A pilot study using iloprost, a stable derivative of prostacyclin, was described assessing results clinically and with isotope cerebral blood flow measurements. Eleven patients were treated. There were no deaths. Clinical deterioration was reversed in eight or halted in three patients. In one patient, a focal weakness became worse. Cerebral blood flow studies all showed a focal deficit before treatment excluding one who did not have a pretreatment scan. All improved; three returned to normal, two showed hyperperfusion. Improvement in cerebral blood flow has never been previously reported.


EXPRESSION OF INTERLEUKIN 1β AND ACTIVATION OF INFLAMMATORY CELLS DURING FOCAL CEREBRAL ISCHAEMIA IN RATS
F Iannotti, S Kida, E Hillhouse, R Weller, AL Bets. Southampton, UK

Interleukin 1β (IL-1β) plays a central role in inflammation by causing activation of inflammatory cells. This study was designed to determine whether IL-1β is involved in the response of the brain to ischaemia. Rats were anaesthetised with halothane, the middle cerebral artery was occluded, and animals were sacrificed 0-5, 4, 24, 48, and 72 hours later. IL-1β was measured in tissue extracts using an enzyme-amplified immunometric assay that was specific for rat IL-1β. In separate animals, the brains were perfusion fixed and inflammatory cells were identified using immunostaining with ED-1 for microglia and ED-2 for perivascular cells. The IL-1β content of brains from sham-operated controls was 63 (SD 4) pg/mg protein. Tumor necrosis factor activated microglia and approximately 15 perivascular cells per section. In cortical tissue surrounding the ischaemic core, IL-1β showed an initial peak of 195 (SD 35) pg/mg protein at 0-5 hour and a peak level of 141 (SD) at 48 hours (n = each four). Perivascular cells increased to 50-60 by four hours and remained at this level. ED-1 positive microglia were first detected at 24 hours and increased to 200-300 by 72 hours. Thus, IL-1β is expressed in cerebral tissue where progressive ischaemic damage is known to occur. Its presence before the appearance of increased perivascular cells or microglia suggests that it could play a role in activating these inflammatory cells.

INDUCTION OF IL-1α IN HUMAN CEREBRAL CORTEX FOLLOWING ANEURYSMAL SUBARACHNOID HAEMORRHAGE
KV Poulton, RH Lye, D Rawluk, H Reid, D Sandeman, PA Dyer. Manchester, UK

Activation of the immune system may occur in patients with delayed ischaemic neurological deficit (DIND) after aneurysmal subarachnoid haemorrhage.1 Astrocyte proliferation is promoted by interleukin-1 (IL-1); macrophage class II human leukaocyte (HLA) antigens are also involved. Protein kinase C is activated during subarachnoid haemorrhage and it induces macrophage secretion of IL-1. Therefore patients with subarachnoid haemorrhage were tested for intracerebral HLA Class II antigens and local formation of IL-1α (a subunit of IL-1). Perioperative or postmortem brain biopsies from eight patients with subarachnoid haemorrhage were used. Consecutive tissue sections were stained using antibodies to HLA-DR (class II HLA), IL-1α and the astrocyte marker glial fibrillary acidic protein (GFAP). In situ hybridisation with probes for the IL-1α gene identified IL-1α messenger RNA, thus localising active IL-1α production. In two patients areas rich in HLA Class II antigens and astrocytes were identified. IL-1α (messenger RNA and protein) was also detected in these two patients. Findings were compared with clinical outcome; one patient died after onset of DIND and the other after a recurrent haemorrhage. IL-1α messenger RNA was...
detected in a third patient who had a good outcome. These preliminary findings demonstrate intracerebral IL-1α production in some patients after subarachnoid haemorrhage which may account for the astrocyte proliferation sometimes observed.


RADIOSURGERY FOR ARTERIOVENOUS MALFORMATIONS: A HEMODYNAMIC FOLLOW UP STUDY

AH Huneidi, C Nimmon, F Afshar, PN Plowman, KE Britton. London, UK

This study had two objectives: (a) haemodynamic assessment of cerebral arteriovenous malformations (AVM); (b) to predict the outcome of an AVM to treatment with stereotactic radiosurgery (SRS). Seventy patients (mean age 37.3 ± 5.6 years) with a cerebral AVM, had dynamic cerebral blood flow measurements using radio-labelled human serum albumin (76HSA; 500 MBq, iv; SA: 1 Gbq/ml; QC: 0-95). Arterial input (M) and transit (T) times were measured in real time. Patients were assessed before SRS (LINAC) and at three to six month intervals thereafter, for a period of 18 (SD 7) months at a rate of 2-2 (SD 1-3) studies per patient. Response to SRS was indicated by changes in the “steal index” and “cerebral reserve” as functions of appearance (M) and transit (T) times respectively.

Two types of AVM were identified: (a) Fast Flow AVM (61% with affected to non-affected flow ratio of 1:31 (SD 0-04) and a mean transit time ratio of 0.85 ± 0.03, (p < 0-001); and (b) Slow Flow AVM (39%) with a flow ratio of 0-92 (SD 0-06) and a mean transit time ratio of 1:13 ± 0-03, (p < 0-001). Fast flow AVMs showed a better response according to the steal and reserve indications, whereas slow flow AVMs did not. Two conclusions that slow flow AVMS are less responsive to SRS. A haemodynamic follow up of cerebral AVM can be of value in predicting the response to stereotactic radiosurgery.

INTRAOPERATIVE CONFIRMATION OF FUNCTIONAL MRI OF MOTOR CORTEX

VGR Kumpay, WJ Harkness, A Connelly, GD Jackson. London, UK

The extent of surgical removal of lesions in or adjacent to the motor cortex is usually restricted by concerns to limit the potential postoperative functional deficit. Intra-operative functional mapping using cortical stimulation under either general or local anaesthesia is one answer to this. Methods for identifying the location of the motor cortex in relation to the lesion preoperatively have, until now, been unavailable. Two cases were reported in which preoperative functional MRI was carried out using a Siemens 1-5 T system. Imaging was performed using a flash sequence with data being obtained in the resting state and during motor activation. Activation images were obtained by subtracting resting state images from those during motor activity. Cortical stimulation using an Ojemann stimulator at the time of surgery verified the preoperative localisation. This preoperative cortical mapping allows more accurate surgical planning, reduced surgical morbidity and improved preoperative patient counselling.


A SIMPLE EX VIVO TECHNIQUE FOR TEACHING IMAGE GUIDED STEREOGRAPHIC NEUROSURGICAL METHODOLOGY

MG O’Sullivan, R Sellar, J Ironside, IR Whittle. Edinburgh, UK

Most surgeons learn the practical aspects of image guided stereotactic neurosurgery using the classical apprenticeship approach to surgical teaching. Unfortunately such an approach may not be available and has inherent limitations. As a result trainee surgeons may be slow to familiarise themselves with the various practical and executive aspects of image guided stereotactic surgery.

A simple teaching model that allows an ex vivo “hands on” type approach to the learning of the technical, computerised, and executive aspects of image guided stereotactic neurosurgery is described. This simple model uses a cadaver skull, a specially prepared cadaver brain, and a modified stereotactic probe that enables deposition of 1-8 mm diameter ball bearings at target points. Using this, cadaveric–brain preparation surgery can familiarise themselves with application of a stereotactic frame, fiducial and target point acquisition, and computation of both arc and probe depth settings.

The technique was initially developed for an experimental study evaluating the accuracy of thalamic and pallidal target localisation using the functionally aligned–Wells axial GE8800 CT imaging. It was found, however, to be particularly useful for teaching trainee neurosurgeons “hands on” stereotactic methodology. The model could be applied to any stereotactic system and exercises such as stereotactic ventricular cannulation, estimation of the anterior and posterior commissural points, and the location of functionally important thalamic and pallidal nuclei can be performed. The last exercise, in combination with study of a human brain stereotactic atlas, provides excellent teaching and topographical familiarisation of the functionally important thalamic nuclei. Other additional practical teaching exercises were described.


VALIDATION OF CT TARGETING FOR FUNCTIONAL STEREOTAXIC WITH POSTOPERATIVE MRI

RD Page, JB Miles. Liverpool, UK

CT imaging has been common neurosurgical practice since the early 1970s, but its acceptance for functional stereotactic surgery has been surprisingly slow, with few units actively practising the technique. The stereotactic facility in our unit was specifically designed for use with CT, including its use for functional work. It would appear necessary to justify this choice and the accuracy of MRI has enabled us to assess the accuracy of lesion placement postoperatively. In this study 13 patients underwent thalamotomy for movement disorders using the Dervin Miles Dervin (DM) frame. The accuracy of the thalamotomies was determined by measuring the centre of the lesions on MRI scans. For the anterior-posterior co-ordinate, the centre of the lesion was within 1 mm, two within 3 mm and three outside 3 mm. For the lateral co-ordinate, six were within 1 mm, five within 3 mm and two outside 3 mm. For the height co-ordinate six were within 1 mm, four within 3 mm and three outside 3 mm. It should be noted, however, that it is still of paramount importance to test for the appropriate site with functional testing and the electrode moved away from the standard target if necessary.

The results confirm that CT guidance is accurate enough for functional work and it is possible to conclude that there is little justification for continuing the use of ventriculography with its acknowledged disturbing effect on patients when CT offers a satisfactory and less upsetting alternative.

EFFECTS OF CORPUS CALLOSUM DIVISION ON MEDICALLY INTRACTABLE EPILEPSY

SE Sakas, JP Phillips. Dublin, Eire

A series of 20 patients who underwent corpus callosotomy for medically intractable epilepsy was reported. The mean age of patients at the time of onset of seizures was nine years and at the time of callosotomy it was 26 years. The most common seizure types were generalised tonic-clonic (90%), akinetic or tonic-atonic associated with falls (drop attacks) (65%), absences (60%), and complex partial seizures (40%). The most common EEG abnormality was either multiple spike and wave activity in seven patients (35%), generalised or multifocal spike and slow wave activity in six patients (30%), one EEG normal (5%), and other abnormalities occurred in six (30%). The follow up was 5-6 (SD 0-6) years. Fourteen patients (70%) experienced significant sustained reduction in the severity and frequency of their seizures; two patients have remained free of generalised and partial seizures. The types of seizure associated with improved outcome were drop attacks 85%, generalised tonic-clonic seizures 78%, complex partial seizures (30%), and absences 60%. No definite relationship was established between preoperative EEG patterns and callosotomy-induced seizure control in this series, and CT and MRI data did not carry prognostic value. There was no mortality and the most frequent complications were a transient mild left hemiparesis in 35%. This study confirms the efficacy of corpus callosum division as a surgical option for selected patients with medically intractable epilepsy. Furthermore, our results suggest that the history and clinical classification of the seizures, the CT and MRI data were of value and are valid selection criteria for patients referred for this operation.
STEREOTACTIC GUIDED CRANIOTOMY FOR Cavernous Angiomas Presenting With Epilepsy
ATH Casey, N Kitchen, DGT Thomas, W Harkness. London, UK

With the wider availability of MRI, angiographically occult vascular malformations are being recognised with increasing frequency in those patients with medically refractory epilepsy. Surgical resection is the best treatment, but because these lesions are usually small and can be located in eloquent areas, stereotactic resection should be considered. Stereotactically guided resection of pathologically verified cavernous angiomas was performed in nine patients presenting with epilepsy (seven men, two women, mean age 34 years). Eight patients presented with medically refractory epilepsy (five complex partial seizures, three grand mal seizures) and the other patient presented with repeated intracerebral haemorrhages and epilepsy. All patients had normal neurological examinations, and were assessed by CT, MRI angiography, Wada, and neuropsychological testing. Operative resection was guided by stereotactic localisation using the Leksell or CRW stereotactic systems. Peroperative electrocortigraphy, cortical stimulation with speech mapping, and ultrasonography were employed in selected cases.

MRI findings typically consisted of mixed T1 and T2 signals with a rim of low density suggestive of haemosiderin deposition. Pathological findings were also indicative of previous haemorrhagic episodes. Following resection of these lesions all patients experienced improved epilepsy control (mean follow up 19.6 months). It was concluded that stereotactically guided resection offers significant advantages in the management of angiographically occult vascular malformations. Surgical indications would include medically refractory epilepsy, repeated haemorrhage and those cases where there is diagnostic uncertainty.

IMAGE-GUIDED INTRACRANIAL ANEURYSM SURGERY
TAD Cadoux-Hudson, RJ Nelson, HB Coakham, DR Sandeman, E Cause, T Lewis. Bristol, UK

Most intracranial aneurysms have a well defined anatomical position and may be approached via standard surgical exposures. Rarer aneurysms of the distal anterior and posterior circulations may be difficult to locate using conventional angiography alone, often necessitating extensive dissection in the subarachnoid space and cerebral fissures. These problems may be partly overcome by the use of stereotactic angiography. We describe an alternative method of aneurysm localisation using an image-guided mechanical arm registered intraoperatively to three-dimensional reconstructions of conventional CT or MRI scans (ISG Technologies). Using this system, intracranial localisation can be achieved with an accuracy of ± 2 mm.

We report the management of five patients with distal aneurysms of the middle cerebral, pericallosal, superior cerebellar, and anterior inferior cerebellar arteries. Intraoperative image guidance allowed for accurate planning of the surgical approach, minimal brain exposure and retraction, identification and control of proximal vessels before exposure of the fundus, and a shorter operating time. All five patients made an uncomplicated recovery with no increased postoperative neurological deficit.