Stereotactic techniques for brain biopsies

Stereotactic techniques for brain biopsy, as well as for less common indications, are now well established in adult neurosurgery and are widely applied. In the paediatric age group, however, its potential has yet to be fully realised and many paediatric neurosurgical units still have little experience with stereotactic techniques. This is disappointing as the advantages of minimal brain traumatisation and a high degree of point target accuracy (to within 1–2 mm) have much to commend stereotaxy to a wide variety of paediatric neurosurgical problems.

Stereotaxy in children requires minimal technical modifications. Although local anaesthesia may be used in adults, this is inadvisable in children where compliance may be more problematic and general anaesthesia should always be used. The smaller size of the child’s head rarely causes a problem; indeed the skull reaches 80% of its adult size by the age of 2 years, and most stereotactic frames supply longer skull pins for paediatric uses. For very young children, under 2 years of age, where the skull is both small and very thin we avoid potential pin trauma to the soft and thin skull by using a plaster of Paris cap which is applied to the child’s head and the stereotactic frame fixed in turn to it with the ‘skull’ pins in the normal way. In general any target within the child’s cranium may be reached safely using stereotactic techniques. Stereotactic computed tomography, magnetic resonance imaging (MRI), and angiography may all be used to plan surgery. We have found MRI to be particularly useful in the paediatric age group because of the large number of lesions in the posterior fossa requiring biopsy.

At present the role of stereotactic neurosurgery in patients under the age of 16 years is largely within the field of paediatric neuro-oncology. Approximately 200 paediatric intracerebral tumours are diagnosed each year in the UK, and such tumours constitute the second commonest childhood cancer behind the haematological malignancies. The range of paediatric brain tumours differs from those in adults both with respect to the relative frequency of the histological types and, partly as a result of this fact, the intracranial position. Thus, intracranial tumours in adults are supratentorial in approximately 70%, whereas the same proportion are infratentorial in children. In addition midline tumours in both the infratentorial and supratentorial compartments are commoner in children. Thus medulloblastomas, pineal region tumours, and intrinsic brain stem tumours are relatively more common. Overall glial tumours account for 70–80% of paediatric brain tumours compared with 40–45% in adults. As with all intrinsic brain lesions it is our belief that histopathological confirmation of the neuroradiological imaging diagnosis is mandatory for rational patient management and for accurate assessment of any treatment given. Because of the common sites of paediatric brain tumours described above stereotactic methods are a particularly important means of obtaining histology. In our stereotactic practice less than 10% of procedures are performed on children (7.1% of the last 155 cases performed in the 18 months since January 1992). However when considering the management of posterior fossa lesions this figure increases to 23%.

Before modern stereotaxy the open methods of obtaining tissue from intrinsic brain stem lesions were unreliable and of high risk to the child. Conversely some patients were treated empirically without any attempt to obtain histology. However, at present the combination of high quality MRI and computed tomography with stereotactic methods provides a safe and reliable method of obtaining tissue. There have been two criticisms of stereotactic biopsy in this situation, namely that the small samples are not representative of the brain stem lesion and that knowledge of the histology does not affect subsequent management. We would disagree with both these points; firstly stereotactic biopsies may be positioned exactly to the appropriate imaging abnormality (such as computed tomography contrast enhancement or certain features of MRI), and, especially when the frontal route is used, multiple serial biopsies along the axis of the tumour may safely be taken. Secondly in our series of brain stem biopsies 15% produced surprising results that changed subsequent management, though only one (a cryptogenic arteriovenous malfunction in a 13 year old boy) was in the paediatric age group. Furthermore, advanced histopathological methods, including immunocytochemistry and cell culture performed on stereotactic biopsy samples, have increased significantly the body of scientific knowledge regarding these conditions, particularly as stereotaxy allows the accurate correlation of histology with neuroradiological imaging abnormalities.

Juvenile thalamic gliomas are a poor prognostic group. Radical stereotactic excision of these lesions has been attempted by some who have been able successfully to reduce the tumour burden with acceptable associated morbidity, although the balance of opinion indicates that such aggressive treatment does not affect outcome significantly. In any case stereotactic biopsy provides a safe
means of obtaining tissue and thus enabling the clinician to offer an accurate prognosis for the child.

Stereotactic brachytherapy has been used in children for over two decades in the treatment of cystic craniopharyngeomas,\(^{16}\) but has only been used rarely for other indications,\(^{17}\) though with successful results reported sporadically.\(^{18-20}\) It is likely that the use of this technique will increase in the future, especially in the treatment of locally recurrent disease after primary treatment.

Though stereotaxy in paediatrics has its main role in lesion biopsy the following applications indicate the wide potential of stereotactic techniques.

In children with slit ventricles stereotactic methods may be used to position the ventricular catheter in shunting procedures or to place an Omnamaya reservoir where this is required for intrathecal antibiotics or chemotherapy. In aqueductal obstructive hydrocephalus stereotactic localisation often accompanied by endoscopic visualisation have enabled the floor of the third ventricle to be safely approached via the foramen of Monro and fenestrated in third ventriculostomy procedures.\(^{21}\)

There are occasional cases where stereotactic methods are appropriate in the management of children with medically intractable movement disorders secondary to birth injury and neonatal hypoxia, particularly of tremor and dystonia types.\(^{22-23}\) Epilepsy is a condition that often affects children. In this age group stereotactic methods have been used mostly in the removal of epileptogenic lesions, for example dysembryoplastic neuroepithelial tumours, cavernomas,\(^{24-25}\) and more unusually the aspiration of epileptogenic arachnoid cysts.\(^{26}\) In rare instances it may be appropriate to place depth electrodes in the older child where the epileptic focus remains obscure. This is most safely done stereotactically.

The scope of stereotactic neurosurgery in the paediatric age group is potentially large and the use of this technique is likely to increase as the expertise becomes more widespread. Although its main role is likely to remain in the safe and reliable biopsy of intrinsic cerebral lesions, its application to a number of situations in paediatric neurosurgical practice will also be seen to be increasingly appropriate. Stereotaxy is not just a diagnostic tool, it can also assist in performing therapeutic procedures less invasively.

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