Posterior fossa stereotaxic biopsy using the Brown-Roberts-Wells stereotaxic system

Technical note

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Stereotaxic biopsy has been shown to be a reliable means of diagnosing posterior fossa lesions. The authors describe a technique for infratentorial trans cerebellar stereotaxic access to posterior fossa parenchymal lesions using the Brown-Roberts-Wells apparatus in its standard commercial configuration. The necessity for tissue diagnosis of these lesions is briefly discussed.

KEY WORDS □9 posterior fossa □9 stereotaxic biopsy - brain-stem neoplasm □9 brain neoplasm

COMPUTER-GUIDED stereotaxy is rapidly becoming a common method for diagnosing intracranial lesions, especially in patients for whom an open procedure entails undue risk. However, technological difficulties and concerns regarding surgical risk have tended to limit its use in the posterior fossa. For instance, brain-stem lesions are not uncommonly diagnosed and treated solely on clinical and radiographic grounds, and it has been argued that obtaining tissue is not warranted in certain of these lesions. The risk that such empirical therapy may be inappropriate is well recognized. There can be little argument that tissue diagnosis optimizes treatment and prognostic decisions.

Published reports of posterior fossa stereotaxic biopsies describe several trajectories. Brain-stem lesions have been approached: 1) from the right frontal area with the probe transversing the intracranial neuraxis; 2) transtentorially through the posterior cerebral hemisphere; or 3) infratentorially. While the Brown-Roberts-Wells (BRW) stereotaxic system is widely distributed, its use for posterior fossa biopsies has been reported in only seven cases, in each of which the transtentorial trajectory was used.

The authors describe a technique by which the standard commercial BRW stereotaxic system can be used to biopsy brain-stem or cerebellar lesions via a direct infratentorial trajectory. This method of posterior fossa biopsy employing the BRW system has not been previously reported and, in the authors’ experience, has proved to be fast and safe.

Technique

A commercial BRW system was used to obtain biopsy specimens of posterior fossa lesions in two children and two adults using an infratentorial corridor (Table 1). Angiography was performed to rule out a vascular lesion in one patient whose preoperative computerized tomography (CT) scan suggested hemangioblastoma (Case 3). The entire procedure, including head-frame placement and CT scanning, was conducted under general anesthesia in the two children. Biopsy was carried out under general anesthesia in one adult (Case 4) and under local anesthesia in the other (Case 3).

All biopsy procedures were performed with the patient in the prone position. Because the Mayfield headrest adapter is located posteriorly on the base frame, the frame was rotated 180° prior to skull fixation to enable prone positioning (that is, the posterior aspect of the frame was anterior: Fig. 1). The infratentorial approach required that the base frame be placed extremely low posteriorly; therefore, this portion of the frame (the actual anterior part of the ring) was positioned low on the posterior cervical region, while the anterior portion of the frame (the actual posterior part of the ring) was placed approximately at the level of
FIG. 1. The Brown-Roberts-Wells head frame is rotated 180° so that the anterior portion is posterior (arrow). The patient is positioned prone on the operating table by attaching the frame to the Mayfield headrest.

the nose, with vertical support pins in the supraorbital region (Fig. 1). Care was taken to avoid placing the skull pins into the mastoid processes or over the transverse sinus.

After the base ring was in place, patients were positioned supine in the CT scanner and scans 3 or 5 mm thick were obtained through the region of interest. A target point, as well as an entry point if desired, was chosen. The localizing fiducial artifacts were then marked, and their CT coordinates were recorded in the manner usual for the commercial BRW system. Digital scout films of the skull with a cursor line marking the CT image containing the target and entry points were used to assist in choosing a trajectory passing below the transverse sinus. Even though the base frame was rotated in the scanner, the target and entry points were correctly referenced to the frame because the linear transform from the CT scan to the BRW system coordinates is independent of the actual CT data points.

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Once in the operating room, patients were positioned prone on the operating table with the shoulders supported by a laminectomy frame or fusion rolls. The head was fixed with the neck flexed so that the suboccipital scalp was roughly parallel to the floor (Fig. 1). In Case 3, where the patient was awake, a free airway was ascertained.

To avoid the transverse sinus, an entry point below the superior nuchal ridge was chosen. A trajectory was selected such that the biopsy probe would traverse the cerebellum and, if the target was in the brain stem, enter the brain stem through the cerebellar peduncles (usually the middle cerebellar peduncle). This precludes crossing more than one pial plane and avoids arteries and cranial nerves in the arachnoid cisterns of the posterior fossa. We have constructed a simple Plexiglas arc that fits onto the base ring and allows a probe to be directed to an entry point on the scalp. The arc coordinates of this probe could then be transformed via a simple algorithm into the BRW system coordinates of the entry point so marked. Alternatively, the BRW arc system itself can be used to mark the entry point and the entry point coordinates read from the phantom base.

The computers provided with the commercial BRW system were used to calculate the biopsy probe trajectory (defined as alpha, beta, gamma, and delta angles and depth) passing to the target through the predetermined entry point. The arc angles and depth were set and verified with the phantom base.

The suboccipital region was then prepared and draped for surgery such that access to the BRW base ring was preserved. The arc was placed on the ring and, after injecting the scalp with local anesthesia, a stab wound was made at the point of probe entry. An \( \frac{1}{8} \)-in. twist-drill hole was made through the skull and the dura was perforated. Biopsies were taken using a Nashold biopsy probe with a 1-cm side-biting window. In each case, a frozen tissue section was examined prior to terminating the procedure in an attempt to confirm that abnormal tissue had been obtained.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Presenting Signs &amp; Symptoms</th>
<th>Location of Lesion</th>
<th>Histological Diagnosis</th>
<th>Preoperative Diagnosis</th>
<th>Treatment</th>
<th>Clinical Status*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4, F</td>
<td>rt hemiparesis, gait ataxia</td>
<td>lt pons &amp; midbrain</td>
<td>primitive neuroepithelial tumor</td>
<td>brain-stem glioma</td>
<td>radiation &amp; chemotherapy</td>
<td>11 mos: alive, improved</td>
</tr>
<tr>
<td>2</td>
<td>11, M</td>
<td>dysarthria, rt hemiparesis</td>
<td>lt pons</td>
<td>low-grade astrocytoma</td>
<td>pontine glioma</td>
<td>radiation</td>
<td>12 mos: alive, progressing</td>
</tr>
<tr>
<td>3</td>
<td>63, M</td>
<td>rt hemiparesis, dysarthria</td>
<td>rt cerebellum</td>
<td>radionecrosis</td>
<td>lymphoma, abscess radionecrosis</td>
<td>steroids</td>
<td>6 mos: alive, improved</td>
</tr>
<tr>
<td>4</td>
<td>23, F</td>
<td>diplopia, lt facial weakness</td>
<td>lt pons, middle cerebellar peduncle, medulla</td>
<td>low-grade astrocytoma</td>
<td>brain-stem glioma</td>
<td>radiation</td>
<td>24 mos: alive, stable</td>
</tr>
</tbody>
</table>

* Time from onset of initial symptoms.
Posterior fossa stereotaxic biopsy

FIG. 2. Preoperative computerized tomography (CT) scan (left) and magnetic resonance image (right) in a 4-year-old girl (Case 1), suggesting brain-stem glioma. Biopsy via the infratentorial route through the left brachium conjunctivum proved the lesion to be a primitive neuroepithelial tumor. The cursor position on the stereotaxic CT scan represents the biopsy site.

Results

The patient operated on under local anesthesia (Case 3) suffered no undue discomfort. Three patients were clinically unchanged postoperatively; one of these (Case 4) suffered transient worsening of her horizontal diplopia. The biopsy results and postoperative course are listed in Table 1. Permanent sections of the tissue were diagnostic in all patients. Frozen sections obtained at biopsy suggested the diagnosis in all but one patient (Case 4), whose permanent pathological sections were later interpreted as showing low-grade infiltrating astrocytoma. Tissue diagnosis was confirmatory in the two patients with brain-stem gliomas (Cases 2 and 4), and the biopsy tissue was necessary for diagnosis in the other two patients. One child (Case 1) was believed preoperatively to have a brain-stem astrocytoma and was found to have a primitive neuroepithelial tumor. Biopsy of the cerebellar lesion in Case 3 yielded evidence of radionecrosis.

Discussion

Posterior fossa stereotaxic biopsy entails little risk and appears to have a high yield of tissue. The transfrontal approach requires traversing a vast amount of brain as well as the lateral ventricle, and the interpeduncular cistern must be meticulously avoided. In addition, cerebellar lesions are poorly accessible via this route. Transtentorial routes to the cerebellum and brain stem also require that the probe cross several pial planes as well as the tentorium, increasing the risk of hemorrhage.

The infratentorial route to posterior fossa points is the most direct. Coffey and Lunsford reported three cases using the Leksell system, and Abernathey, et al., described 26 cases with the less widely used Todd-Wells system. There are no previous reports of infratentorial transcerebellar posterior fossa biopsies using the BRW system. We favor the currently described method for several reasons. First, the infratentorial route to the cerebellum and brain stem avoids the ventricular system and crosses only the cerebellar pial plane, reducing the potential for hemorrhage and neurological injury. Second, the prone position (after reversal of the head frame) reduces the risk of air embolization and allows a comfortable operating position for the surgeon. Finally, the commercial BRW system is widely available and is fast and easy to use.

The direct transcerebellar route provides access to most of the structures within the posterior fossa. The goal of our trajectory is to enter the cerebellum and approach the lesion without traversing another parenchymal surface. This requires that the lesion be in the cerebellum or within the brain stem in such a location that it can be reached via the cerebellar peduncles, predominantly the middle cerebellar peduncle. This corridor, under the transverse sinus through the cerebellar peduncles, intersects the brain stem from the caudal midbrain to the rostral few millimeters of the medulla. The upper midbrain and most of the caudal medulla could be reached only by crossing arachnoid spaces in the tentorial incisura or lateral regions of the posterior fossa, endangering important vessels and cranial nerves. Thus, posterior fossa lesions safely accessible via this route are predominantly those involving the cerebellum, pons, and limited regions of the caudal midbrain and rostral medulla. Lesions in the rostral midbrain and those restricted to the medulla have been approached transfrontally.

It has been argued that imaging studies of brain-stem gliomas provide the necessary information for treatment planning. In particular, diffuse nonenhancing brain-stem gliomas have often been found to be high-grade lesions, requiring no tissue for devising a ra-
tional course of therapy. Three of the patients described here had diffuse pontine tumors as depicted on CT scans and magnetic resonance (MR) images. Biopsy demonstrated that two had low-grade infiltrating gliomas (Cases 2 and 4) and the third had a primitive neuroectodermal neoplasm (Case 1). It is for patients such as these that tissue diagnosis is crucial for effective treatment.

Diagnosis based on any subtotal histological examination of a lesion raises the issue of sampling error, and stereotaxic biopsy of brain-stem tumors is no exception. It is known that CT with contrast enhancement generally represents the highest grade of a tumor. It is also known that the tissue located in the epicenter of the CT image of neoplasm is representative of the tumor type.

In the current small series, rather than random sampling of the lesions, these principles were used in choosing areas for biopsy. The sites targeted were those that appeared most malignant on CT or MR imaging, or were near the epicenter of the tumor (Fig. 2). It is believed that this targeting scheme significantly reduces the risk of false diagnosis of low-grade tumors. In addition, Hood, et al., have found a high correlation between clinical course and diagnosis obtained by stereotaxic biopsy in patients with brain-stem gliomas, suggesting that a diagnosis obtained in this manner is accurate.

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References


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