Simplified and accurate CT-guided needle biopsy of central nervous system lesions

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Computerized tomography-directed needle biopsy of intracranial lesions, when correctly performed, offers a high diagnostic yield for both benign and malignant lesions, with relative safety. The simple method described stresses how careful positioning of the patient simplifies the mechanics of the procedure. This non-stereotaxic approach has wide application.

KEY WORDS - computerized tomography • needle biopsy • brain tumor • arteriovenous malformation • radiation necrosis

The technique of percutaneous needle biopsy of a variety of tissues has become an alternative to open biopsy in many clinical situations. This has been increasingly applied to the brain as computerized tomographic (CT) scans have allowed earlier diagnosis and more precise localization of intracranial lesions. Continued development of stereotaxic devices, which interface with CT scanners, will further involve the radiologist in the biopsy of brain lesions. In many instances, however, biopsy can be performed safely and accurately without a stereotaxic device.

Two features distinguish biopsy of brain lesions from those in other areas, such as the abdomen. It is vital to biopsy brain lesions with precision, minimizing needle manipulation and redirection, to avoid irreversible damage to neural tissue. Also, an access site, either a burr hole or preexisting craniotomy defect, is required for placement of the needle. We describe below a relatively simple method of percutaneous needle biopsy which we have used successfully for the diagnosis of a variety of pathological entities.

Clinical Material and Methods

This series of brain biopsies was carried out in a wide-aperture CT scanner.* The portal of needle entry was either a preexisting burr hole or craniotomy defect. In some patients, a burr hole was made on the day prior to the CT biopsy, after an appropriate site was determined from a previous CT scan. Consultation between the radiologist and neurosurgeon was essential in selecting the most benign needle path when a burr hole was to be placed prior to biopsy. A twist-drill hole represents another option for a portal of entry, but the bone defect may be more difficult to locate because of its smaller size. Software programs available on some CT scanners, which transfer an area marked on an axial scan to a lateral scout view of the skull, facilitate this determination. Sagittal and coronal reformations, when available, were also helpful. Early in our experience, a regular dose of contrast medium was used, but in later procedures a double dose of contrast material was infused to permit better and longer visualization of the lesion in question.

The patient was positioned in such a manner (prone, supine, decubitus, or angulated) so that the bone defect was in either the 12 o'clock, 3 o'clock, or 9 o'clock position within the CT aperture. Contiguous 10-mm slides were then taken through the skull defect and the lesion without changing the orientation of the defect. The patient was then repositioned, if necessary, so that the lesion (preferably, its epicenter) would be in the same plane as the skull defect, and so that a line between the defect and the lesion was roughly perpendicular or parallel to the tabletop. Relatively simple changes in the patient's head position (flexion,
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<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>CT Appearance of Lesion Biopsied</th>
<th>Clinical Diagnosis</th>
<th>Biopsy Complication</th>
<th>Biopsy Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25, M</td>
<td>enhancing parietal lobe mass</td>
<td>metastatic embryonal cell carcinoma vs. radiation necrosis</td>
<td>none</td>
<td>radiation necrosis</td>
</tr>
<tr>
<td>2</td>
<td>58, F</td>
<td>large lt suprasylvian enhancing cystic mass</td>
<td>biopsy-proven glioblastoma 4 mos previously</td>
<td>none</td>
<td>cyst drainage; mild improvement in speech and decrease in seizure activity</td>
</tr>
<tr>
<td>3</td>
<td>21, M</td>
<td>enhancing rt frontal lobe mass</td>
<td>lymphoma</td>
<td>small hematoma at biopsy site: asymptomatic &amp; self-limited</td>
<td>cryptic AVM</td>
</tr>
<tr>
<td>4</td>
<td>50, M</td>
<td>irregular enhancing mass with central low-density area</td>
<td>probable glioma</td>
<td>none</td>
<td>glioblastoma multiforme</td>
</tr>
<tr>
<td>5</td>
<td>31, M</td>
<td>hemorrhage with ring enhancement</td>
<td>AVM vs. tumor</td>
<td>none</td>
<td>vascular malformation (follow-up magnification angiography showed small venous angioma)</td>
</tr>
<tr>
<td>6</td>
<td>23, M</td>
<td>irregular enhancing mass with central low-density area</td>
<td>probable glioma</td>
<td>none</td>
<td>glioblastoma multiforme</td>
</tr>
</tbody>
</table>

* Abbreviations: CT = computerized tomography, AVM = arteriovenous malformation.

Illustrative Cases

**Case 1**

This 25-year-old man with known metastatic embryonal cell carcinoma was treated for brain metastasis (seen on CT scan) with radiation and chemotherapy. Six months later, he developed headaches and difficulty in controlling the right side of his body. The CT scan showed an enhancing mass in the right parietal lobe, the site of the previous metastasis. Because there was concern as to whether this represented recurrent tumor or radiation necrosis, the patient underwent craniotomy for diagnosis. Tissue obtained from that procedure was nondiagnostic. Over the next 2 months, the patient was treated with increased doses of dexamethasone, but developed progressive seizures, refractory to medication. A CT scan at that time showed a right parietal lobe mass of slightly larger size. A CT-directed needle biopsy yielded tissue showing astrocytosis, demyelination, and necrosis consistent with radiation necrosis (Fig. 1).

**Case 2**

This 21-year-old man had nodular sclerosing Hodgkin's disease, stage IIISA, with known recurrent disease. He presented for evaluation after he had experienced his first seizure. A hemorrhagic lesion in the right frontal lobe, showing ring contrast enhancement, was seen on the CT scan (Fig. 2). Surgical aspiration through a burr hole yielded 22 ml of brownish fluid, which was indicative of a hematoma. Tissue specimens demonstrated increased cellularity, with reactive astrocytes and macrophages, but no evidence of tumor. Magnification arteriography performed because of possible vascular malformation was negative except for the mass effect. Tissue obtained from the CT-
Computerized tomography (CT)-guided biopsy in a case of radiation necrosis. Left: A burr hole in the right occipital bone was aligned with the lesion on the same CT slice, and the distance was measured from the skin. The needle path, parallel with the CT tabletop, was determined by patient positioning. Right: A CT scan taken with the needle in place and the distance measured. The display window was adjusted to show the needle to best advantage. The two side holes of the Cone ventricular needle can be identified within the lesion.

Discussion

Although the CT scan allows earlier diagnosis and accurate localization of intracranial lesions, the CT findings are not specific. A histological diagnosis may be required before appropriate therapy can be initiated. In immunocompromised hosts, there may be a question of tumor diagnosis versus the possibility of infection. On occasion, the lesion in question may be unsuspected and quite unrelated to the patient’s underlying disease. In suspected brain abscess, valuable information regarding the organism and its antibiotic sensitivity may be obtained. A not-infrequent dilemma occurs when trying to distinguish radiation necrosis from recurrent tumor at a site previously treated with high doses of irradiation. Using a wide-

Fig. 2. Computerized tomography (CT)-guided biopsy in a case of cryptic arteriovenous malformation. Left: A CT section through the existing right frontal burr hole and the lesion. The patient was positioned so that the needle path was perpendicular to the CT tabletop; the distance was measured from the skin. Center: Scan taken with the needle in place; the tip is in the area of contrast enhancement. Typical metallic artifact was seen. Right: Scan taken 30 minutes after biopsy showed a stable hemorrhage within the lesion, obliterating the previous lucent center. The patient, however, was asymptomatic and further action was not necessary.
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aperture CT scanner, a relatively simple technique is available for biopsy of brain lesions.

The CT-directed needle biopsy of intracranial lesions has been previously described, including "free hand" techniques for needle placement. Radiopaque markers outside the skull have been used as reference points to determine the location of a lesion. Some methods have employed a goniometer to determine the correct degree of needle angulation between the burr hole and the lesion. Angling the needle, however, introduces potentially serious errors in direction. The method we describe simplifies the CT biopsy procedure. Central to this method is proper positioning of the patient so that the needle can be directed simply either parallel or perpendicular to the CT tabletop. We have been able to accomplish this on each patient by simple maneuvers of head positioning. Depth of needle placement can be measured directly from the CT scan, and the needle position can be verified with the needle in place. The double dose of contrast material allows prolonged visualization of the lesion even in the presence of artifacts produced by the metallic needle. A plastic needle would circumvent this problem.

In directing the needle toward a lesion, the area of contrast enhancement, when present, was the key to obtaining diagnostic tissue specimens. The technique of infusing double-dose contrast material, in addition to allowing improved visualization, often showed the lesion to be of greater extent than was previously suspected. Directing the needle into the lucent center of a lesion may result in decompression of cystic fluid, necrotic material, or old hemorrhage, but the chance of aspirating nondiagnostic tissue is greater. An area of enhancement should, therefore, be sought for biopsy. The ability of CT to directly confirm needle position within an area of enhancement offers an advantage over needle biopsies performed in the operating room without a stereotactic device.

The procedure of CT-directed needle biopsy is a relatively safe one, and applicable to a variety of lesions as demonstrated in this series. None of the patients in our series suffered untoward clinical effects from the procedure. The main complication of concern in the literature is that of hemorrhage at the site of needle biopsy. The high morbidity and mortality seen in needle biopsy series prior to the advent of CT for needle guidance and detection of post-biopsy hematomas is in contrast to the relative safety reported with CT guidance. The patient with the cryptic AVM did have some intracerebral bleeding following the procedure as demonstrated on the CT scans; however, this was self-limited and asymptomatic. Even if bleeding does not occur, the patient's symptomatology occasionally could be exacerbated by a mild, transient increase in edema. This did not occur in our series, but pretreatment with corticosteroids can minimize this possibility.

References


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