Complications of CT-guided stereotactic biopsy of intra-axial brain lesions

MARK BERNSTEIN, M.D., F.R.C.S.(C), AND ANDREW G. PARRENT, M.D., F.R.C.S.(C)
Division of Neurosurgery, The Toronto Hospital, University of Toronto, Toronto, Ontario, Canada

A series of 300 consecutive stereotactic biopsies for intra-axial brain lesions performed by one neurosurgeon was critically analyzed regarding complications of the procedure. Complications were incurred by a total of 19 patients (6.3%). Five patients (1.7%) died following the procedure, all due to intracranial hypertension: one from subarachnoid hemorrhage, one from intracerebral hemorrhage, and three from increased edema without hemorrhage. The three patients who died without hemorrhage all had marked intracranial hypertension at the time of biopsy. All five patients who died harbored a glioblastoma multiforme. The surviving 14 patients (4.7%) with complications suffered increased neurological deficit due to hemorrhage. In 10 (3.3%), the deficit was mild and/or transient; in the other four (1.3%), a major deficit was incurred which markedly affected the remainder of the patient’s life. Therefore, mortality or major morbidity was seen in 3.0% of patients and minor morbidity in 3.3%. Stereotactic biopsy is a very effective procedure with a complication rate significantly lower than that of craniotomy (particularly in the population of patients selected for stereotactic biopsy), but in a small number of patients the outcome is devastating.

Key Words: stereotactic surgery • biopsy • intra-axial brain neoplasm • complication

Stereotactic biopsy is an effective procedure that allows for accurate localization and sampling of an intrinsic brain lesion. The procedure is ideal for situations in which knowledge of the pathology of a brain lesion is required to guide further decision-making regarding therapy but also in the presence of one or more of the following factors: 1) the patient is too old and/or infirm to tolerate craniotomy; 2) the lesion is deep, diffuse, predominantly cystic, located in eloquent cortex, or multiple; and/or 3) cytoreductive surgery is not needed to adequately treat the suspected pathology. Because stereotactic biopsy is generally performed using local anesthesia and because only a small opening in the cranium is required, it is easy for neurosurgeons and other physicians, as well as patients, to underestimate the potential complications. However, the procedure is “blind” and is used primarily in patients who have deeply situated intra-axial, locally aggressive lesions; therefore, one would anticipate a significant incidence of morbidity, particularly related to hemorrhage.

The published articles on stereotactic biopsy quote variable complication rates; some do not comment at all on the morbidity of the procedure and those that do tend not to present an in-depth analysis of complications and their likely pathophysiology. This led us to undertake a critical analysis of a series of 300 procedures performed by one neurosurgeon in a consistent manner to accurately assess the morbidity and mortality rates of stereotactic biopsy of intra-axial brain lesions.

Clinical Material and Methods

Patient Population

All but two of the 300 patients were adults between the ages of 18 and 88 years, with a mean age of 54 years; the two children were aged 2 and 6 years. Sixteen patients (5.3%) had acquired immune deficiency syndrome at the time of biopsy and three others (1%) were immune-suppressed organ transplant recipients. There were multiple lesions in 42 cases (14%). The lesion was supratentorial in 289 (96%) and infratentorial in the other 11 (4%). Of the supratentorial lesions, 87% involved the cortex and subcortical white matter (including the corpus callosum) and 13% involved the thalamus, basal ganglia, or deep midline structures. The pathology of the lesion was neoplastic in 85% of cases and inflammatory or infectious in 10%; in 14 cases (4.7%), a definitive diagnosis could not be made on the basis of the tissue obtained from stereotactic biopsy. Of the tumors, 74% were gliomas, 14% metastases, and...
6% primary lymphomas; the remaining 6% were miscellaneous lesions, such as pineocytomas and germinomas.

**Stereotactic Biopsy**

Indications for stereotactic biopsy (as opposed to craniotomy) were as outlined above. Both lesion- and patient-specific features were considered in recommending a patient for stereotactic biopsy. A total of 300 patients fulfilled one or more of the above-mentioned criteria in the practice of one neurosurgeon (M.B.) between April, 1986, and July, 1993. All but two procedures were performed awake patients with the aid of local anesthesia and mild sedation. The Brown-Roberts-Wells stereotactic frame with computerized tomography (CT) localization was used in all cases. A simple twist-drill hole was made in the skull and a tissue sample was obtained utilizing a side-cutting biopsy cannula or biopsy forceps, depending on tissue consistency. A frozen section was obtained in all cases except those in which the patient was known to be human immunodeficiency virus (HIV)-positive. All patients who were neurologically well and did not suffer complications were discharged from the hospital 1 day after biopsy.

**Complications**

Five patients died as a direct result of the procedure, for a mortality rate of 1.7% (Table 1); all five harbored a glioblastoma multiforme. One 79-year-old man with a dominant temporal lobe tumor suffered a massive subarachnoid hemorrhage (SAH) during the procedure (Fig. 1); autopsy revealed that a sulcal subarachnoid artery had been disrupted by the biopsy device. Another patient, an 80-year-old woman with a dominant frontal lobe tumor, developed a huge frontal intracerebral hemorrhage (ICH) and became comatose; had she been younger, an urgent craniotomy would have saved her life, but her family requested no active treatment. Three other patients, aged between 45 and 60 years, deteriorated from intractable intracranial hypertension following biopsy of large bilateral glioblastomas involving the corpus callosum. All three were already suffering from intracranial hypertension before biopsy, and in all three an emergency postbiopsy CT scan showed no change compared to the prebiopsy scan. No surgical therapy was considered appropriate and all three patients died; autopsy revealed transtentorial herniation in each case, with no hemorrhage being found in the tumors.

Fourteen patients (4.7%) suffered nonfatal hemorrhage (Table 1): 13 an intracerebral hemorrhage and ICH, and one an SAH. The histology in these 14 patients was glioblastoma in five, toxoplasmosis (HIV- positive) in two, viral infection in two, astrocytoma in one, mixed oligodendrogloma-astrocytoma in one, metastatic melanoma in one, pineocytoma in one, and lymphoma in one. Six lesions were superficial and six deep. Emergency craniotomy was performed in three patients. In 10 patients (3.3%), the new deficit was mild and/or transient and had no significant impact on the patient’s functional status or length of survival. In the other four (1.3%), a major new deficit resulted (hemiplegia and/or aphasia) which markedly impaired the quality and duration of the patient’s life (Fig. 2).

Of 19 complications, 12 occurred in patients harboring malignant brain tumors, four in patients with nonbacterial cerebral infections, and three in patients with low-grade tumors (a pineocytoma, an astrocytoma, and a mixed oligodendrogloma-astrocytoma). Regarding the timing of deterioration following stereotactic biopsy, in 16 of the 19 patients the complication was clinically evident within minutes to a few hours of the biopsy. In three patients, the immediate postoperative period was unremarkable but neurological deterioration occurred 8 hours, 24 hours, and 48 hours postbiopsy, respectively. There was no difference in complication rate when comparing the use of biopsy forceps (approximately one-third of cases) versus the side-cutting biopsy cannula (approximately two-thirds of cases). We cannot comment on the relationship between angiographic tumor vascularity and complica-

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**TABLE 1**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Cases</th>
<th>Cause*</th>
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<tbody>
<tr>
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<td>5</td>
<td>1 ICH, 1 SAH,</td>
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<tr>
<td></td>
<td></td>
<td>3 no clot</td>
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<td>increased neurological deficit</td>
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<td>9 ICH, 1 SAH</td>
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<tr>
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*ICH = intracerebral hemorrhage; SAH = subarachnoid hemorrhage.

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**Fig. 1.** Unenhanced axial computerized tomography scan in a 79-year-old man obtained 30 minutes after stereotactic biopsy of a left temporal glioblastoma demonstrating massive subarachnoid hemorrhage. A faintly enhancing tumor is visible (arrow). The patient had presented with mild dysphasia and seizures only and died shortly after this scan was obtained.
Complications of stereotactic biopsy of brain lesions

![Computerized tomography (CT) scans in a 55-year-old retired policeman. Left: Contrast-enhanced CT scan obtained after new-onset grand mal seizures and normal neurological examination. The crosshairs mark the target for the stereotactic biopsy. Right: Unenhanced CT obtained 1 hour postbiopsy at which time the patient was comatose and had right-sided hemiplegia. Emergency craniotomy was performed for evacuation of the clot and tumor. The patient awoke with aphasia and right-sided hemiplegia and survived for 2 years in that state following cranial irradiation. Histological examination of the tissue removed at the initial biopsy and subsequently at craniotomy revealed a low-grade mixed oligodendroglioma-astrocytoma.](image)

Mortality and major morbidity following stereotactic biopsy was seen in 3.0% of 300 cases in our series; minor morbidity was seen in 3.3% of patients. The overall complication rate was therefore 6.3%. These rates are at the high end of quoted complication rates from other series in the literature, in which morbidity and mortality rates vary from 0% to 24%. A meta-analysis of almost 5000 published cases of stereotactic biopsy yields an overall complication rate of approximately 5%. Series with 300 or more cases had complication rates of 0.6%, 1.2%, 5.3%, 5.5%, 7.2%, and 7.2%. The largest published series had complication rates of 0.6%, 1.2%, 5.3%, 5.5%, 7.2%, and 7.2%. This could be interpreted as demonstrating that surgical experience may be a less important determinant of outcome than the biology of the lesions undergoing biopsy or other factors such as differences between surgeons regarding the definition of what constitutes a reportable complication.

The risk factors for operative complications from stereotactic biopsy would be expected to be histology, location, and presence of increased intracranial pressure (ICP). Malignant lesions with neovascularization and/or abnormal blood vessel structure, such as malignant glioma and lymphoma, should be more prone to bleed and/or to produce increased edema following blind manipulation. In the present series, the complication rate for patients with glioma, lymphoma, and metastasis was 6.4%, 6.3%, and 2.8%, respectively. Patients with viral inflammation, particularly HIV-positive patients, might also be expected to have a high risk of deterioration following needle biopsy of brain lesions. In the present series, the neurological deficit worsened following the procedure in two (12.5%) of 16 such patients. However, two published series on this specific subgroup of patients have reported complication rates associated with stereotactic biopsy of 4% and 6%. Regarding location, biopsy of brain-stem lesions and those in eloquent cortex might be expected to be more prone to result in neurological deterioration. The likely increase in perilesional edema following needle biopsy as well as the actual volume of the inserted biopsy device could combine to precipitate a decrease in function of neurons or white-matter tracts with easily recognizable effect (as opposed to neurons and white matter in the nondominant frontal or temporal lobe). The latter concept is supported by the experience of Bouvier, et al., in which 26% of patients with periradial lesions suffered transient neurological worsening following stereotactic biopsy. In one series of stereotactic biopsy of brain-stem lesions, eight (24.2%) of 33 patients suffered complications. The present series includes 11 infratentorial lesions, of which nine were within the brain stem; none of these patients incurred neurological worsening following transfrontal stereotactic biopsy.

Patients with intracranial hypertension and decreased intracranial compliance are less able to absorb a small volume increment of intracranial contents as compared to patients with normal or only mildly elevated ICP. Therefore, a small increase in edema, a small hemorrhage, and/or the volume of the biopsy device inserted into the brain could all precipitate transient brain herniation. This occurred in three patients in the present series, with resulting mortality; all three had large bilateral glioblastomas and were mildly confused (two patients) or drowsy (one patient) at the time of biopsy. There are various explanations for the wide range of complication rates quoted in the literature. The most obvious is variability in surgical judgment, experience, and skill. While stereotactic biopsy does not require microsurgical expertise in the same way as operations like craniotomy for aneurysm repair, the selection of the patient for stereotactic biopsy, the target(s) for biopsy, the trajectory, and the biopsy device all require knowledge and experience combined with a dedicated intellectual interest in stereotactic neurosurgery and/or neuro-oncology. Another explanation is that there may be an inherent difference in the reporting of complications. Some complications might not be recorded as such by some authors because they are minor and/or transient and do not significantly impact on the patient's future. There were 10 such cases in the present series; if they had not been reported, our overall complication rate would be reduced from 6.3% to 3.0%. For example, transient headache without neurological deficit with a documented small intraluesional hemor-
rhage or SAH accounted for the reported complication in three of our 10 patients with minor morbidity.

Stereotactic biopsy is a widely used, effective, relatively low-risk procedure for determining the pathology of intra-axial brain lesions in elderly or infirm patients and/or for lesions for which craniotomy would pose a prohibitively high risk of morbidity. However, mortality and morbidity can result from the procedure and must be rigorously recognized and reported so that the true incidence of complications is known to every neurosurgeon performing it. With this knowledge, the surgeon can make fully informed recommendations to patients regarding appropriate therapy of their brain lesion.

References


M. Bernstein and A.G. Parrett

Manuscript received October 14, 1993.
Address reprint requests to: Mark Bernstein, M.D., F.R.C.S. (C), Division of Neurosurgery, The Toronto Hospital-Western Division, Suite 2-405, McLaughlin Pavilion, 399 Bathurst Street, Toronto, Ontario M5T 2S8, Canada.