

CT-Guided Needle Procedures for Brain Lesions: 20 Years' Experience

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Abstract

Objective: To assess free-hand needle procedures with CT guidance for biopsy and drainage of brain lesions.

Method: A series of 184 operations was carried out on 120 patients over a 20-year period. Sixty (60) cases of suspected neoplasm were biopsied; 40 cases of intracerebral hemorrhage and 20 cases of intracranial suppuration underwent drainage.

Results: The morbidity and mortality of the methods described were quite low due to steroid therapy, prophylactic antibiotics, and careful preparation of the access site. There was one complication of postoperative hemorrhage in a patient with metastatic melanoma.

Conclusions: The simple and accurate techniques presented continue to have widespread application in the practice of neurosurgery and compare quite favorably with techniques using more elaborate equipment, stereotactic frames, and intraoperative monitoring. **Key Words:** Computerized tomography, brain neoplasm, cerebral hemorrhage, brain abscess, brain biopsy.

SHORTLY AFTER THE ADVENT OF computerized tomography (CT), Maroon (1) performed needle biopsy on brain tumors and monitored the technique by intraoperative imaging. Drainage of intracerebral abscesses (2, 3) and hematomas (4) was subsequently reported at other major medical centers. Additional small series appeared in the medical literature (5–10) until 1992, when three neurosurgeons in suburban practice published articles on a series of 147 patients (11, 12). The author has personally performed 184 free-hand procedures with CT guidance over a 20-year period. The purpose of the study described here was to assess this procedure, based on the author's experience.

Materials and Methods

The patients were divided into three groups: 60 cases of suspected neoplasm, 40 cases of

intracerebral hemorrhage, and 20 cases of intracranial suppuration. Most of the hematomas and abscesses required more than one tap, but only 5 tumors required a second biopsy.

After review of the initial diagnostic CT, a limited study was repeated for the purpose of marking the scalp over the intracranial mass. Indelible ink recorded the laser beam in plane with the scan that visualized the largest diameter of the mass. The trephine site was placed as close to the lesion as possible, but within the hairline and away from sensitive areas of the cortex.

In the operating room, a burr hole was made under local anesthesia, in most cases; general anesthesia was employed when the patient could not cooperate. The dura was incised in a cruciate fashion, and the pia-arachnoid was coagulated with a bipolar forceps before being opened with a small scalpel. Biopsy or drainage of a mass close to the surface was attempted immediately in 79 cases. After closure of the skin, 41 patients with deep-seated lesions were taken back to the CT scanner and underwent a third imaging procedure to visualize the relation of the burr hole to the

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mass and to monitor insertion and placement of the needle. Correct positioning of the needle was accomplished on the first try about 80% of the time; a second pass was successful in the remaining cases. The closed skin of the incision held the needle steady during the procedure. Serial scans evaluated any intraoperative bleeding.

For biopsy of a suspected neoplasm, the software component of the CT scanner measured the depth and angle of the mass lesion from the surface of the scalp over the burr hole (Fig. 1A). A 13-gauge Field-Lee needle, consisting of four coaxial components, provided a guillotine-like effect when the inner hollow cannula with a window was withdrawn in conjunction with suction provided by a glass syringe. Taking out the metallic components during the procedure allowed the plastic radiopaque sleeve to be viewed with little artifact (Fig. 1B). The small amount of air which entered the needle provided accurate localization of the exact biopsy site. A frozen section confirmed the histologic diagnosis of brain tumor.

Evacuation of an intracerebral hematoma (Fig. 2A) was accomplished by a 13-gauge, two-hole Cone ventricular needle in conjunction with a glass syringe for suction. Drawing from opposite sides of the blunt needle and at two separate depths minimized the need for repositioning to empty the collection of blood. The artifacts created by the stainless steel needle did not interfere with monitoring of the drainage (Fig. 2B). Removal of 30–50 cc of semisolid clot was readily accomplished.

The capsule and cerebritis surrounding a brain abscess were best demonstrated by intravenous injection for CT imaging (Fig. 3A). The same two-hole Cone needle was used to draw off

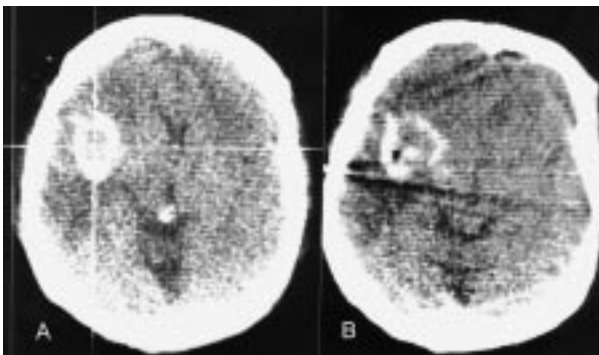


Fig. 1. (A) Highly dense circumscribed lesion after intravenous injection of contrast media. Only the transverse measurement was available (note lines), but any angulation could be easily calculated. (B) Low density of air shadow within tumor (small black area) identifies site of biopsy.

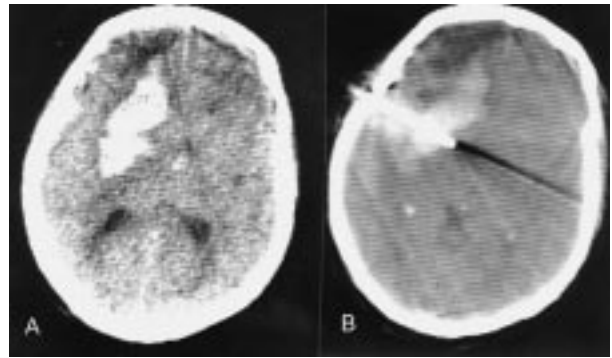


Fig. 2. (A) Large, irregular, high-density area of hemorrhage (white irregular mass) in hypertensive patient; no contrast media was necessary. (B) Metallic artifact has been reduced by manipulating the window of the scanner (out of focus).

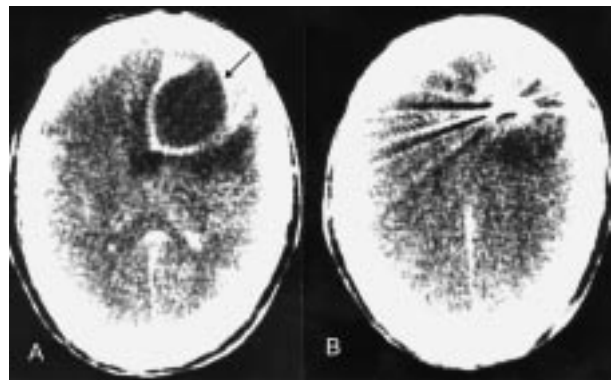


Fig. 3. (A) Right frontal abscess 50 cc in volume (black circular area — arrow), outlined by enhancing white rim. (B) Needle artifact does not interfere with location of tip (out of focus).

purulent material (Fig. 3B). Gram stain was performed immediately, and aerobic as well as anaerobic cultures were begun. The amount of residual air or air-fluid level documented emptying and shrinkage of the abscess cavity.

All of the patients received high-dose steroid therapy. Intraoperative prophylactic antibiotics were employed in the clean cases. Therapeutic doses of broad-spectrum antibiotics were begun as soon as the diagnosis of brain abscess was suggested on initial CT scans.

Results

Of the 62 suspected tumors in 60 patients, 57 were diagnosed by needle biopsy (Table 1). Early treatment with radiation and chemotherapy was instituted in 55 cases of confirmed tumor. In five cases, the specimens were suggestive of a primary neoplasm after two separate biopsies per case, but gliosis could not be ruled out; the patients underwent subsequent craniotomy and excision of low-grade astrocytomas.

TABLE 1
Sixty-two Mass Lesions in 60 Patients (67 Procedures)

33 gliomas
16 metastases
6 cerebral infarcts
1 meningioma
1 cysticercus cyst
5 gliosis (biopsied twice)

Forty cases of intracerebral hematoma required 75 drainage procedures (Table 2). The second needle procedure was scheduled 24 hours after the first drainage in 35 cases. Twenty patients improved after evacuation and 20 were unchanged.

All of the brain abscesses (Table 3) resolved after drainage and 8 weeks of appropriate antibiotic therapy dictated by serial culture and sensitivity testing. Seventeen large lesions were drained twice, and one solitary lesion required only one procedure. Two patients developed multiple small areas of intracerebral purulence after undergoing extensive craniectomies for subdural empyema and infectious sinusitis; 7 separate abscesses were drained once each and did not recur. The cultured organisms varied, but half of the pathogens were anaerobic.

There was one complication of postoperative hemorrhage in a 24-year-old woman with metastatic melanoma in the right frontal lobe. Four hours after biopsy, her level of consciousness suddenly became obtunded. Follow-up CT (Fig. 4) revealed bleeding within the tumor; she expired before surgical intervention could be attempted.

Discussion

Seeding of a brain tumor or an abscess along the needle tract has not occurred during a one-year

TABLE 2
Forty Cases of Cerebral Hemorrhage (75 Procedures)

34 hypertension
4 aneurysmal bleeding
1 cerebral vasculitis
1 hypervascular neoplasm

TABLE 3
Twenty Cases of Intracranial Abscess (42 Procedures)

17 large lesions (drained twice)
1 solitary lesion (drained once)
7 small lesions (drained once in 2 patients)



Fig. 4. Non-contrast study showing area of biopsy (air shadow — arrow) in the middle of extensive intratumoral bleeding (large white mass) with substantial midline shift.

follow-up period. Postoperative hemorrhage resulting in operative mortality was recorded in 2 cases out of the 128 free-hand, CT-guided procedures (1.6%) previously reported in the literature (8, 13) and in 1 case out of the 201 cases (0.5%) performed with needle-stabilization devices (14). Increased intracranial pressure provides a tamponade effect to control bleeding from the needle, which was observed in 11 of my own cases but not seen at the needle tip on CT scans. Clinically insignificant hematomas were documented in several series (4, 13–15). Steroid therapy reduces the chance of neurological deterioration following manipulation of the edematous brain, but increased neurological deficits have been reported (1, 13–15). In my own series of 184 procedures, one death occurred due to postoperative hemorrhage.

A correct histologic diagnosis was made for 55 of the 60 patients with suspected brain tumors. The other 5 patients underwent open biopsy after 2 attempts 24 hours apart. Pathologists were available for frozen section at both community hospitals. Two specimens were sufficient in more than 90% of the cases. The tissue sample obtained in a 13-gauge needle was free of crush artifact on the permanent slides. Using a needle biopsy to establish the diagnosis allows most patients to choose between undergoing radiation, chemotherapy, or further cranial surgery, if necessary.

Radiologists marked the scalps of all the patients and provided depth and angulation mea-

surements for needle placement. Special positioning of the head was not required in any of our cases. Although the trephine site was slightly off target in 20% of our procedures, serial CT scanning established the exact relation to the mass lesion, and the burr hole allowed for angulation of the needle.

Evacuation of hematomas due to hypertensive intracerebral hemorrhage remains somewhat controversial. If the patient has signs of increased intracranial pressure and a midline shift on CT, there is agreement that at many major medical centers neurosurgical intervention requires an extensive craniotomy. However, formal operation on the swollen hemorrhagic brain is no more likely to favorably influence the clinical outcome than one or two needle aspirations of 30–50 cc of semisolid clot (16). If the patient's blood pressure can be stabilized and there is no neurological deterioration, evacuation of a large hematoma may be expected to reduce the noxious effects of extravasated blood and hasten neurological recovery.

None of my patients with a cerebral abscess underwent craniotomy for excision or marsupialization. Aspiration of pus decompressed the brain and provided the means of identifying the organism in all of my cases. Follow-up CT studies over many months documented resolution of the lesion. The source of intracranial suppuration could be ascertained in only nine patients.

The overall morbidity and mortality (0.5%) of the methods described were quite low, due to steroid therapy, prophylactic antibiotics, and careful preparation of the access site. CT control of direct free-hand placement of needles for biopsy and drainage of intracerebral lesions compares quite favorably with more elaborate equipment (13, 14), stereotactic frames (17), and intraoperative ultrasound monitoring (18). The simple and accurate techniques presented continue to have widespread application in the practice of neurosurgery.

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