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Stereotactic brain biopsy: Study about 100 cases and literature review

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Abstract

Introduction: A stereotactic brain biopsy is a procedure in which a small piece of an aberrant brain lesion is taken for microscopic examination. If an unidentified mass is discovered on imaging, this process may be used to precisely diagnose it. In the event that the biopsy specimen is a tumor, the type of tumor and whether it is benign or malignant can be identified using specific microscopic patterns. Treatment can be guided by the information provided by the biopsy results. A stereotactic device precisely guides the placement of surgical instruments during the procedure by using a coordinate-based navigation system that is equipped with the patient's brain images (MRI, CT). Depending on the lesion's location, size, and surgeon preference, stereotaxis can be "framed" or "frameless."

Patients and methods: The objective of this study is to carry out a retrospective descriptive analysis of a series of 100 cases followed for brain lesions and benefiting from a stereotactic biopsy, collected at the neurosurgery department of the IBN SINA hospital in RABAT, during the period from 2016 to 2020, in order to implement the contribution and impact of stereotactic biopsy in the management of brain lesions.

Results: The patient ages were with an average of 53 years, and a predominance of males. Clinical presentations were dominated by neurological deficits (33%), followed by headaches (30%) and intracranial hypertension syndrome (18%). Lesions were solitary in 79% of cases; among them, 75% were glial tumors, 7% metastases, 5% craniopharyngiomas, and 3% tuberculomas. SBB achieved a diagnostic success rate of 98%. One complication was observed, but no mortality was recorded. Post-operative control scans revealed only transient and benign pneumocephalies.

Conclusion: Stereotactic biopsy is not just a technique; it represents the promise of a future where neurosurgery is less invasive, more targeted, and decidedly safer. It represents a central pillar of modern neurosurgery, a technique that combines scientific rigor and advanced technologies.

Keywords: Stereotaxic Biopsy; Intracranial Brain Lesions; Glial Tumors; LEKSELL Frame

1. Introduction

The brain biopsy is an essential neurosurgical procedure that provides a histo-molecular diagnosis and guides the management of brain tumors, in the context of outpatient surgery. This is one of the most common cranial neurosurgery procedures. Complications following brain biopsies are rare, but like all neurosurgical procedures, they carry certain risks, such as the occurrence of epileptic seizures, brain edema or infection. The most specific and frequent complications and adverse effects are sample negativity (blank biopsies) requiring a second biopsy [1], and cerebral hemorrhage which can cause serious consequences [2]. They adversely affect the prognosis, extend hospital stays and generate additional costs for the health system [3]. The diagnostic yield of brain biopsy has also improved with the

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increase in the precision of stereotaxic techniques and imaging and the development of new intraoperative diagnostic tools. In order to obtain a histological diagnosis without causing complications, new trends are emerging.

2. Material and methods

This retrospective study, covering 100 cases of SBB conducted in the Neurosurgery Department of Avicenne Hospital in Rabat, spans a period of 55 months (2016-2020). Data were collected from medical records and compiled into an exploitation sheet, including epidemiological, clinical, radiological, histopathological, and follow-up information, ensuring a comprehensive analysis of SBB's role in managing brain lesions

3. Results

Between January 2016 and January 2020, 100 cases of SBB were performed at the Neurosurgery Department of ibn Sina Hospital in Rabat, spanning a 55-month period. Data were collected from medical records and a data sheet, including epidemiological, clinical, radiological, pathological, and evolutionary information, providing a comprehensive analysis of the implications of SBB in the management of brain injuries, with the following results:

- Patient ages ranged from 17 to 88 years, with a mean of 53 years, and a male predominance (sex ratio of 1.7).
- The most common medical histories: high blood pressure (hypertension) and diabetes, with respective rates of 22% and 31%. - Clinical presentations were dominated by neurological deficits (33%), followed by headaches (30%) and intracranial hypertension syndrome (18%).
- Lesions were single in 79% of cases; among them, 75% were glial tumors, 7% were metastases, 5% were craniopharyngiomas, 4% were large B-cell lymphomas, and 3% were tuberculomas.
- All patients underwent CT imaging using a LEKSELL® stereotaxic frame, and samples were collected using staged rosettes, ensuring representativeness of the samples for anatomopathological analysis.
- BST achieved a diagnostic success rate of 98%.
- One case of complication was observed, consisting of an extradural hematoma requiring immediate surgery. No mortality was recorded.
- Postoperative follow-up CT scans revealed only transient and benign pneumocephalus.

These results, consistent with the literature, confirm the reliability and safety of SBB for optimal management of intracranial lesions, enabling tailored and specific therapeutic orientations for each lesion type. Through advanced imaging, rigorous sampling methodology, and thorough histopathological analysis, SBB establishes itself as an essential tool for the management of intracranial lesions.

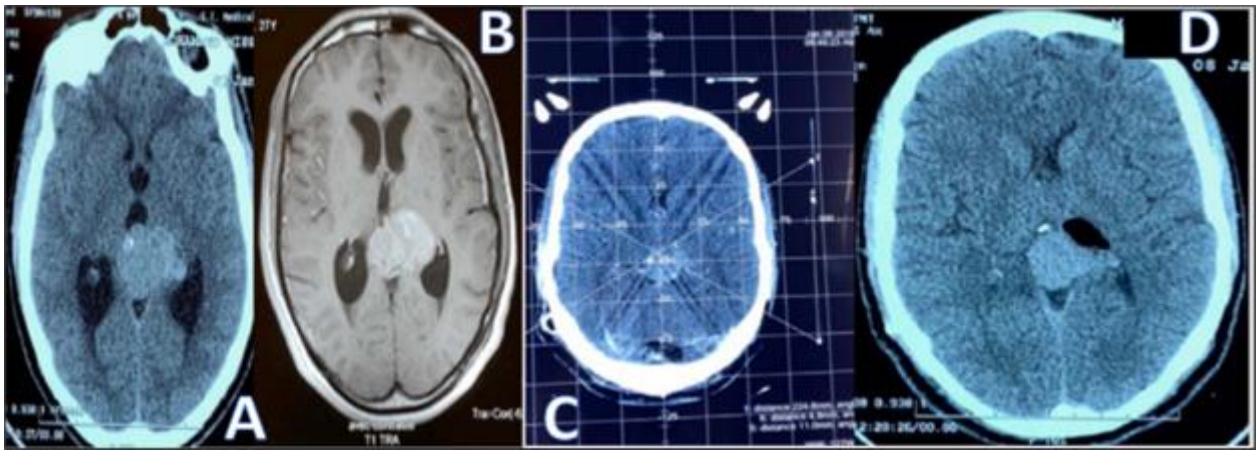

Figure 1 Patient of our study with pineal region process, A: Brain CT shows a process in the pineal region with the onset of hydrocephalus. B: Brain MRI shows the same tumor process enhanced after gadolinium injection.C: frame-in-place locator scann, biopsy target chosen in a contrast-enhanced area. D: Follow-up CT scan shows pneumocephalus at the biopsy site

4. Discussion

Stereotactic brain biopsy relies on careful planning, requiring precise target identification, made possible by modern imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI). These tools provide precise spatial coordinates to ensure the effectiveness and safety of procedures. A significant advantage is that it can be done under anesthesia. These techniques have benefited from progress in imaging and planning software, which have facilitated the reconstruction of the trajectory and therefore improved safety of the procedure. We are currently using the Leksell Surgi Plan® software from the ELEKTA company which has allowed us to properly plan the stereotaxy trajectory with a good study of the structures to be crossed [4].

The indications for stereotaxic biopsy are relatively broad, due to its essential role in obtaining a histological diagnosis when a conventional surgical approach is unfeasible, whether due to the patient's condition or the nature of the suspected condition. Stereotaxic biopsy thus proves to be a valuable alternative, allowing for a targeted and less invasive procedure. [5]

For tumors located deep within the brain (such as those of the thalamus, midbrain, or brainstem) or in areas known to be at risk, the literature shows that MRI alone is often insufficient to establish a definitive histological diagnosis.

This is particularly true for tumors located in the posterior part of the third ventricle or the epiphyseal region, where only certain lesions show specific imaging findings (e.g., colloid cysts or teratomas). Apart from these rare exceptions, current neuroimaging generally only allows for a diagnostic presumption, based on a set of clues, rather than histological certainty [6].

In many cases, stereotactic brain biopsy (SBB) provides a precise diagnosis that decisively guides therapeutic management and provides prognostic information for patients. Thus, a diagnosis of germinoma located in the pineal region, or more rarely in the infundibular recess, immediately leads to a chemotherapy and radiotherapy protocol, restricted to specific areas. This strategy is considered after verifying the absence of tumor dissemination in the cerebrospinal fluid (CSF) or along the spinal axis, both of which are necessary to limit the extent of treatment [7]. For malignant non-Hodgkin lymphomas, the diagnosis also requires specific management, including radiotherapy and antimitotic chemotherapy, administered systemically and, depending on the case, intraventricularly. The protocol is adapted according to the patient's age and clinical needs [8].

A diagnosis of brain metastasis, particularly when the primary tumor site remains unknown, requires rapid and targeted therapeutic management based on the presumed nature of the initial tumor. From a neurosurgical perspective, the choice between a direct approach and stereotactic radiosurgery is often considered, particularly when the lesion is small and well-circumscribed.

Glial lesions pose another diagnostic challenge, given the prevalence of low-grade lesions, such as pilocytic astrocytomas, which are common in young patients. Histological confirmation by SBB is often reassuring, as although these tumors are intensely vascularized and exhibit notable contrast enhancement after gadolinium injection on MRI, they are distinguished by their benign nature. Some of these tumors exhibit a central necrotic component and mixed features (cystic and solid), which, on initial examinations, may appear more derogatory [9-10].

The diagnosis obtained using BST can thus lead to significant adjustments in the treatment plan and prognostic outlook. In the presence of benign and well-circumscribed lesions, particularly in young patients, complete surgical excision is often preferred. This approach avoids the risks associated with external beam radiotherapy, even limited, which can cause neuroendocrine and neurocognitive side effects. Although these astrocytomas are generally radiosensitive, complete excision, guided by stereotactic mapping, is recommended when feasible. If a small tumor remnant is identified during postoperative assessments, radiosurgery or interstitial radiotherapy may be proposed to complete the treatment [11-12].

5. Conclusion

Following advanced imaging, rigorous sampling methodology and anatomo-pathological analysis, the Stereotactic brain biopsy has established itself as an essential tool for the management of intracranial lesions and represents a central pillar of modern neurosurgery, enabling adapted and specific therapeutic orientations for each type of lesion.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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