

Original Article

Efficacy of Electromagnetic Based Neuronavigation-Guided Biopsy of Supratentorial Lesions of the Brain at Jinnah Hospital Lahore

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ABSTRACT

Objective: The study aims to establish the efficacy of electromagnetic-based neuro navigation-guided biopsy of supratentorial lesions (including deep-seated, multiple, and suspicious lesions) in selected patients.

Materials & Methods: After being admitted to the neurosurgery department, all patients who satisfied the inclusion criteria were recruited for the research. Patients received neuroimaging in the form of CT/MRI brain with contrast using the neuronavigation protocol, and the data was uploaded to the Medtronic neuronavigation system. Under general anesthesia, all patients had a biopsy. On the console, the surgical trajectory for the biopsy was planned. Following the AxiEM system's usual operating protocols, a Sedan needle was used to biopsy lesions after its stylet was replaced with an EM stylet.

Results: Out of 19 patients, 11 (60%) were male and 8 (40%) female while age ranged from 13 to 70 years. Out of 19 patients, 4 patients (21%) had parietal, occipital, and thalamic lesions respectively. 4 patients (21%) had low-grade glioma (grade 2) and 3 (15.7%) patients had Burkitt lymphoma, adenocarcinoma (likely from lungs), and blue cell tumor respectively. As regards complications, 2 patients (10.5%) developed hemorrhage, 1 patient (5.26%) developed postoperative cerebral edema, and 1 patient (5.26%) expired.

Conclusion: Electromagnetic neuronavigation using the biopsy needle (Sedan needle) is a safe and effective neuronavigation system. It offers a high degree of accuracy required for the establishment of a definitive diagnosis and adequate treatment.

Keywords: Electromagnetic, Neuronavigation, Supratentorial, Biopsy, Axi-EM System.

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INTRODUCTION

The outcome in patients with brain tumors depends upon the extent of surgical resection.

Various tools can be used during surgery which can help in maximum safe resection. These include neuronavigation, intraoperative CT/MRI and 5-ALA.^{1,2,3}

Neuronavigation-guided biopsy proved itself much superior to other technologies available for various deep-seated lesions.^{4,5} It has the additional advantages of safety, cost-effectiveness, accuracy, ease of use, decreased duration of surgery and fewer postoperative complications, and reduced hospital stay^{6,7}.

Electromagnetic-based neuronavigation helps in the biopsy of deep-seated, multiple, and suspicious lesions of the brain by establishing the relationship between the device and image space. This technique is much safer than conventional approaches in modern practice.^{7,8}

Our setup has a resource constraint, due to the non-availability of the biopsy needle in the Medtronic system we devise the usage of a sedan needle instead of a Medtronic biopsy needle. It is a novel step in the country to the best of our knowledge of using this custom-made alternate biopsy needle.

Our study aims to establish the efficacy of electromagnetic-based neuronavigation-guided biopsy of supratentorial lesions (including deep-seated, multiple, and suspicious lesions) in the selected patients.

MATERIALS AND METHODS

Study Setting and Duration

The study was conducted at the Department of Neurosurgery, Jinnah Hospital, Lahore, from January 2022 to December 2022.

Inclusion Criteria

Patients of both genders aged 13 – 70 years having deep-seated supratentorial lesions (single or multiple) and the size of the lesion less than 3 cm were included in the study.

Exclusion Criteria

Patients with infratentorial lesions, patients with KPS scores less than 70, those with comorbidities, and with known primary lesions were excluded from the study.

Nineteen patients met the inclusion criteria and were included in the study. The data was analyzed for age, gender, location of the lesion, duration of surgery, histopathology, complications, multidisciplinary treatment, and post-biopsy management plan.

Surgical Procedure

All patients who met the inclusion criteria were enrolled in the study, after admission in the neurosurgery department. Patients underwent neuroimaging in the form of CT/MRI brain with contrast with neuronavigation protocol and data was transferred to neuronavigation system (Medtronic). All patients underwent a biopsy under general anesthesia. The surgical trajectory for biopsy was planned on the console. After following the standard operating protocols of the AxiEM system Sedan needle was used for the biopsy of lesions after replacing its stylet with EM stylet. The sedan needle is 190mm in length and 5mm side cut with an internal diameter of 2mm for adequate biopsy.

RESULTS

Age

Age ranged from 13 – 70 years. The majority of patients were adults while only 2 were below 20 years of age.

Gender

Out of 19 patients, 11 (60%) were male and 8 (40%) female.

Location of the Lesion

It was observed that out of 19 patients, 4 patients

(21%) had parietal, occipital, and thalamic lesions respectively while 3 (15.7%) were in the temporal lobe and 2 (10.5%) were deep-seated (Table 1).

Table 1: Location of the Lesion.

Location of Lesion	Frequency (n)	Percentage
Parietal lobe	4	21.0%
Occipital lobe	4	21.0%
Thalamic	4	21.0%
Temporal lobe	3	15.7%
Deep-seated (other than thalamus)	2	10.5%
Frontal lobe	1	5.26%
Pineal Region	1	5.26%
Total	19	100%

Duration of Surgery

The duration of surgery ranged from 30 – 105 minutes. The duration of surgery was up to 50 minutes in all cases except 2 patients in which there were some technical issues with the equipment which led to the delay.

Table 2: Histopathology Report.

Histopathology	Frequency (n)	Percentage %
Low-grade glioma (Grade 2)	4	21.0%
Adenocarcinoma, likely from the lungs	3	15.7%
Burkitt's lymphoma	3	15.7%
Blue cell tumor	3	15.7%
Biopsy report negative/non-conclusive	2	10.5%
Tuberculoma	1	5.26%
Glial tissue	1	5.26%
High-grade glioma grade 4	1	5.26%
Gata 3 positive, likely from Ca breast	1	5.26%
Total	19	100%

Histopathology

Out of 19 patients, 4 patients (21%) had low-grade glioma (grade 2), and 3 (15.7%) patients had Burkitt lymphoma, adenocarcinoma (likely

from lungs), and blue cell tumors respectively (Table 2).

Complications

Out of 19 patients, 2 patients (10.5%) developed hemorrhage, 1 patient (5.26%) developed postoperative cerebral edema, and 1 patient (5.26%) had an infection. The mortality was 5.26% because one patient expired (Table 3).

Table 3: Complications.

Complications	Frequency (N)	Percentage
Hemorrhage	2	10.5%
Oedema	1	5.26%
Infection	1	5.26%
Neurological deficit	0	0%

Multidisciplinary Treatment

Out of 19 patients, 16 underwent multidisciplinary treatment in collaboration with the medical oncology department. Out of 19 patients, 15 patients (78.9%) underwent postoperative chemotherapy, 14 (73.68%) underwent radiotherapy, and 3 (15.7%) underwent complete surgical excision (Table 4).

Table 4: Post-Biopsy treatment.

Post Biopsy Treatment	Frequency (N)	Percentage
Chemotherapy	15	78.9%
Radiotherapy	14	73.68%
Surgical Excision	3	15.7%

DISCUSSION

The outcome in patients with brain tumors depends upon the extent of surgical resection. Various tools can be used during surgery which can help in maximum safe resection. These include neuro navigation, intraoperative CT/MRI and 5-ALA.^{4,5}

Neuro navigation-guided biopsy proved itself

much superior to other technologies available for various deep-seated lesions. It has the additional advantages of safety, cost-effectiveness, accuracy, ease of use, decreased duration of surgery and fewer postoperative complications, and reduced hospital stay.^{6,7}

Electromagnetic-based neuronavigation helps in the biopsy of deep-seated, multiple, and suspicious lesions of the brain by establishing the relationship between the device and image space. This technique is much safer than conventional approaches in modern practice.^{7,8}

Our setup has a resource constraint, so we used electromagnetic rather than optical-based neuronavigation using the biopsy needle (Sedan needle). The AxiEM is a fast, effective, and safe frameless neuronavigation system (Fig. 1). It has a high degree of accuracy which is required for definitive diagnosis and optimal treatment,

improving patient outcomes.

We identified rare pathology like Burkitt lymphoma in 3 of our patients which got benefited from chemotherapy. Primary central nervous system (CNS) lymphoma is a rare disease, most commonly seen in immunocompromised patients. Most of these tumors are non-Hodgkin-type and are high-grade. Primary Burkitt lymphoma of the CNS in immunocompetent individuals has been rarely reported.^{7,8}

In the study, out of 16 patients having positive yield, 2(8%) patients were diagnosed with non-Hodgkin lymphoma (NHL) while in our study, 3 (15.7%) patients were diagnosed with Burkitt lymphoma. One of the patients in our study expired, diagnosed with Burkitt lymphoma, during his stay in the oncology department while undergoing chemotherapy.^{9,10}

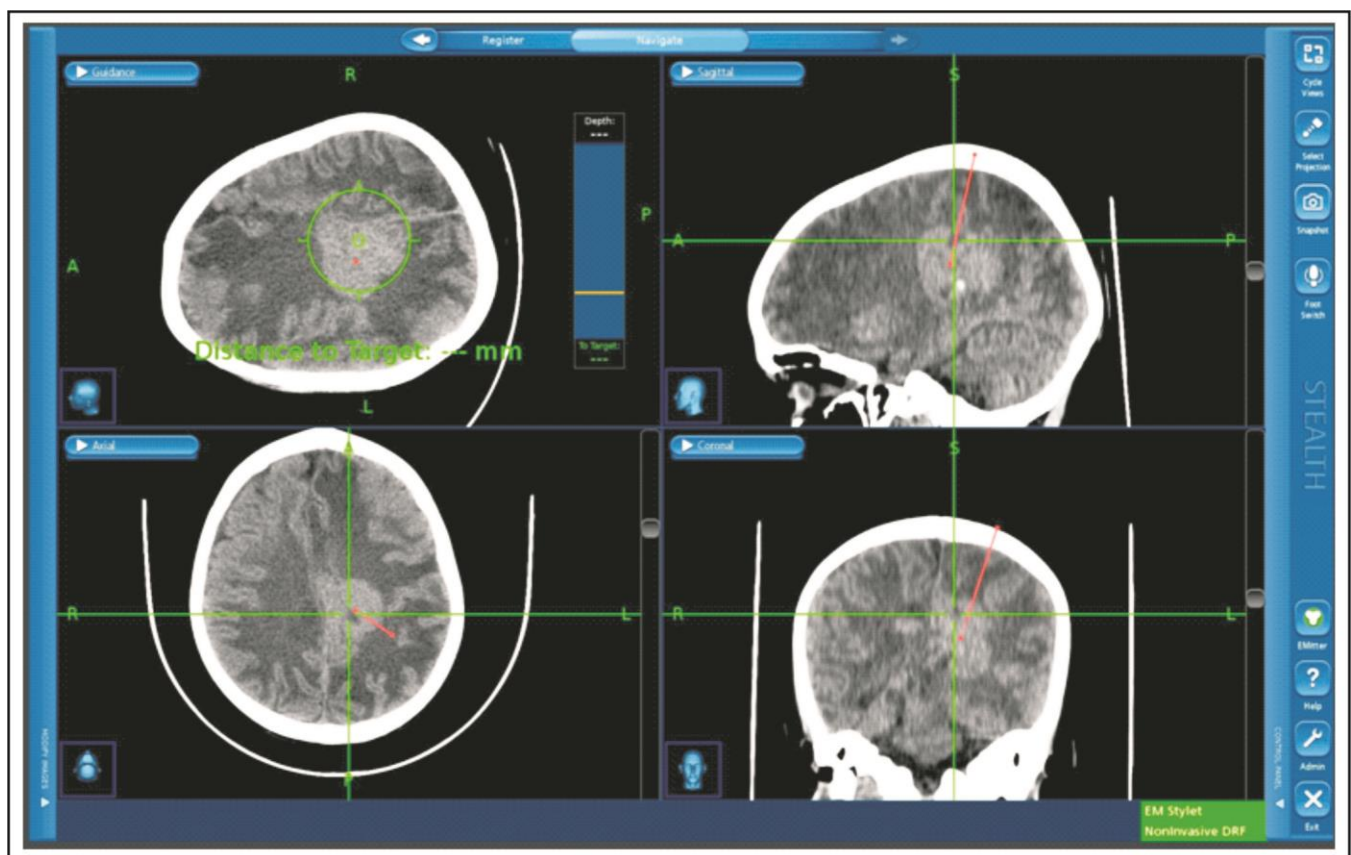


Figure 1: Planning neuronavigation (image shared with the patient's consent).

Non-small cell lung cancer (NSCLC) has a high risk of brain metastases reaching 44% in brain autopsy.¹¹ Compared with other primary cancers, lung cancer develops intracranial metastases relatively early and often presents with neurologic symptoms on initial diagnosis.¹² Whole-brain radiation therapy (WBRT) supplemented with steroids leads to improvement in neurologic symptoms and performance status of the patient.¹³ Administration of WBRT to control local brain metastases has proved to be beneficial, and in combination with systemic chemotherapy prolongs the survival of patients. There was metastatic adenocarcinoma in 3 (15.7%) of our patients, most likely from the lungs, and got multidisciplinary treatment.

85% of histopathology reports in our study were cancerous, 5.26% were diagnosed as tuberculomas and 5.26% revealed just glial tissue. Out of 19 patients, 2 biopsies were non-conclusive (10.5%).

In a study conducted in India, 9 (36%) biopsies were negative¹⁰ while our study had a 10.5% yield of non-conclusive biopsies. The negative yield is comparable with the results available in the region of the subcontinent which suggests that sedan needles can be used as a way out for resource constraint institutions.

Tuberculosis is quite common in developing countries. It usually presents as meningitis but occasionally as focal intracranial lesions, especially in immunocompromised patients. Intracranial tuberculoma, either single or multiple, is included in the differential diagnosis of other focal mass lesions.^{14,15,16} Early diagnosis and adequate treatment of brain tuberculoma result in better outcomes. Hence, its recognition is of paramount importance. In our study, one patient (5.26%) was diagnosed with tuberculoma and was treated with antituberculous therapy while in another study, the tuberculomas were 8%.¹⁰

The incidence of brain metastases appears to be rising as a result of superior imaging modalities, earlier detection, and more effective

treatment of systemic disease. Therapeutic approaches to brain metastases include surgery, whole-brain radiotherapy (WBRT), stereotactic radiosurgery (SRS), and chemotherapy. Patients benefit from a multidisciplinary approach focusing on the integration of surgical, radiation, and chemotherapeutic options. It helps to prolong survival with good neurologic and neurocognitive function and improves the quality of life. Sixteen patients in our study underwent multidisciplinary treatment including an oncologist, radiation oncologist, pulmonologist, interventional radiologist, and hematologist.

LIMITATIONS

Our study has a limitation of the small sample size and we did not use optical-based neuronavigation.

RECOMMENDATIONS

According to our study, we recommend that it is safe and efficacious to use electromagnetic-based neuronavigation brain biopsy for lesions less than 3cm and if the primary is not known.

CONCLUSION

Electromagnetic neuronavigation using the biopsy needle (Sedan needle) is a safe and effective neuronavigation system. It offers a high degree of accuracy required for the establishment of a definitive diagnosis and adequate treatment.

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Additional Information

Disclosures: Authors report no conflict of interest.

Ethical Review Board Approval: The study conformed to the ethical review board requirements.

Human Subjects: Consent was obtained from the patient/attendant.

Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Usman Ahmad Kamboh	1. Study design and methodology.
2.	Mehwish Manzoor	2. Paper writing.
3.	Hafiza Arisha Fayyaz	3. Data collection and calculations.
4.	Zaid Sami	4. Analysis of data and interpretation of results.
5.	Mehreen Mehboob	5. Literature review and referencing. Final review.
6.	Manzoor Ahmad	6. Editing and quality insurer. Analysis of data.