



OBSERVATIONAL ANALYSIS OF STEREOTACTIC BIOPSY AT A PERIPHERAL NEUROSURGERY CENTRE: SHARING AN EXPERIENCE

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ABSTRACT **Background:** Stereotactic biopsy is a minimally invasive technique of surgical intervention for tissue diagnosis which is being used for deep seated tumors not easily accessible. Stereotactic biopsy is a three-dimensional cartesian coordinate system with software amalgamation used for localising lesions in the brain. This facility has recently been added at our peripheral set up about a year ago. **Methodology:** This is observational study including eight patients with ten biopsy samples with definitive diagnostic yield. **Results:** Ten biopsy samples were obtained from the eight patients; the results were positive in all. In two patients, two samples were obtained from two different area of the brain. **Conclusion:** Stereotactic biopsy is a safe procedure for deep seated lesions providing a good diagnostic yield. It can also help in multiple lesions in the same individual.

KEYWORDS : Brain biopsy, Stereotactic biopsy

INTRODUCTION

Stereotactic biopsy is a minimally invasive surgery for the location of deep seated lesions which are not amenable to open techniques. It uses three dimensional cartesian coordinate system

It uses either with a “frame” or “frameless” system. The frameless biopsy technique is as good as frame-based brain biopsy technique. The minimal invasive technique is safe and efficient depending on the surgeon preference and the location and size of the lesion.

Stereotactic neurosurgery has a rich history beginning with the first stereotactic frame described by Horsley and Clarke in 1908 First application of “modern” frame-based stereotaxy to humans was used by Spiegel and Wycis in 1947

In frame based stereotactic biopsy, frame is attached to the cranium. Prior contrast MRI and later CT of brain is done after fixing the frame to find out the exact position of the lesion with respect to the different points(fiducials) in the frame. The data is entered into a software and the exact location of the lesion in three different coordinates is calculated following which biopsy is performed. The main advantage of frame based stereotactic biopsy is that the rigid metal frame serves to maintain a fixed three-dimensional coordinate system. The assembly of the frame occasionally limits head positioning and partially interferes with craniotomy. According to the literature the success rate for obtaining a definitive diagnosis is >95% and also depends on the type of pathology.

There are few contraindications, especially in the small lesions and the patient having coagulation disorder, bleeding can at times be catastrophic in nature. The other complications and risks involve seizures.

This study shares the early experience of frame based stereotactic biopsy at our Neurosurgery centre in peripheral setup.

METHODOLOGY

This is a retrospective observational study conducted in the Department of Neurosurgery, data were collected from the hospital records. The first biopsy was performed in September 2022 and up to April 2023 eight cases were done with ten biopsy samples. The cases were selected for the sampling based upon the lesion location (Deep seated and eloquent areas). None of the cases were excluded from the study

The basic principles that we applied while planning a trajectory included:
Avoiding eloquent areas of brain and motor cortex to avoid deficits,

avoid vascular areas and approaching temporal lesions laterally and cerebellar lesions posteriorly.

Frame Application

Frame application is performed with the patient in the sitting position. We use Cosman-Roberts-Wells (CRW) frame-based system. This system uses a Cartesian coordinate system with X Y Z axis in different planes. The ring should be applied parallel to the cranial floor.

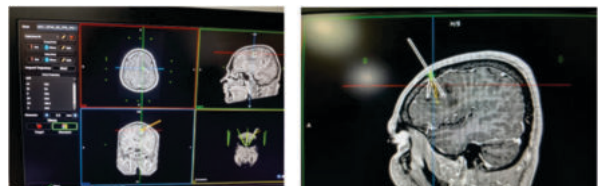


Fiducial marking

The fiducial marking is done with the markers present in CRW frame which is taken in the CT gantry. Fiducial coordinates are accordingly obtained.



Fusion of the images and target localisation



The nine fiducial rods are identified on the CT and with the fusion with MRI, the target is accordingly defined and localised. There is an inbuilt software which accordingly calculates the coordinates in respective X Y Z axis.

Frame assembly, application and taking biopsy



RESULTS

Between September 2022 and Apr 2023, eight patients underwent stereotactic biopsy at our institute. In our study, five were males and three were females with age ranging from 25 to 64 years (Mean = 44 years).

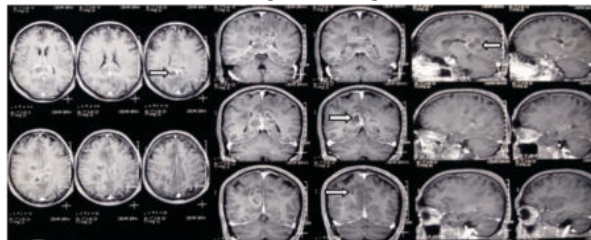
The STB was done for all the eight patients of diagnostic uncertainty. Of the eight patients, two patients had coumarate lesions having two different histological gradings and at different locations in brain parenchyma. Of the two coumarate lesions one showed high-grade features and the other low grade.

Histopathological results of the STB procedures of eight cases with ten specimens were five high grade gliomas, two low grade gliomas and two Lymphomas and one metastasis

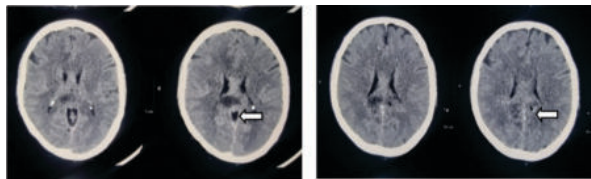
The location of the lesions were at splenium, parasagittal, frontal, thalamic, periventricular and multifocal lesions

There was 100% histopathological confirmation.

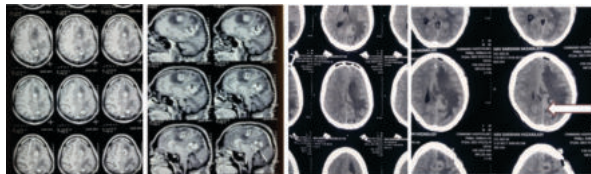
All underwent post-operative CT scan, which showed either air or a blood streak at the site of the target indicating a hit.



Lesion: Splenium Of Corpus Callosum



PREOP NCCT POSTOP NCCT (Air cavity at the target lesions)



Multiple lesions PRE-OP POSTOP (Blood)

Table 1

Location/ site	CASES	PERCENTAGE
Splenium	03	30
Thalamic	01	10
Periventricular	01	10
Parasagittal	01	10
Frontal	01	10
Multiple Lesions	03	30

Table 2

Pathological Diagnosis	CASES	PERCENTAGE
High grade glioma	05	50
Low grade glioma	02	20
Lymphoma	02	20
Metastasis	01	10

Table 3

Presenting symptoms	CASES	PERCENTAGE
Motor deficits	03	30
Headache	07	70
Seizures	02	20
Cognitive dysfunction	02	20
Aphasia	01	10

DISCUSSION

Lesions which are deep or located in the eloquent areas and those not exerting symptomatic mass effect, infiltrative lesion without clear margins for which open resection leads to significant morbidity or mortality, stereotactic biopsy is investigation of choice to obtain a tissue.

New approaches with evolving imaging modalities with software amalgamation helps in sampling of very small even deep-seated intracranial lesions with safety, accuracy, precision, and reliability.¹

The pathological entities most commonly biopsied are tumours, infections, inflammation, demyelinating diseases, and neurodegenerative diseases.²

This technique allows brain to be mapped in a three-dimensional coordinate system using preoperative imaging with amalgamation of magnetic resonance imaging (MRI) with computed tomography (CT) along with a radiopaque fiducial set and fixed frame by software system.

The target coordinates are selected based on the reference system to guide a biopsy needle through a small burr hole toward the intended target point.³

Stereotactic biopsy being minimally invasive technique still can have poor diagnostic yield because of inadequate sampling, glial tissue, and target deviation

Rieche et al. estimated the mortality rate of stereotactic, frame-based, performed brain biopsies to 1% (with a range in between 0% and 4%), whereas 3.5% (range 0–8.6%) developed symptomatic complications.⁴ In a further recent meta-analysis, comparing the safety and diagnostic yield of frame-based versus frame-less brain biopsies, Kesserwan et al. found no significant difference between the two modalities, with an estimated mortality of 2% for frame-base and 2.2% for the frame-less performed procedures.⁵

We obtained histopathological diagnosis in all cases, though we had a small cohort. Our figures are comparable to metanalysis in a large cohort study by Dhawan et al attributing diagnostic yield between 84 and 100% to the frame-based and between 86.6% and 100% to the frame-less procedures.⁶ Significant amounts of evidence shows that post procedure complications arise within first twelve hours with the majority occurring in first two hours post intervention.^{7,8}

Stereotactic biopsy can be of frame with pin fixation and frameless. The rigid frame is mounted onto the skull before image acquisition followed by biopsy. In the frameless type the image acquisition is scheduled separately from the surgical time.

Frame-based techniques have been considered the gold standard for many years, due to their superiority over freehand biopsy.⁹ The patient may be awake or under general anaesthesia during the complete process. The frame-based technique employs a three Dimensional coordinate system, in which a specific target localisation is carried out which is associated with a corresponding coordinate point relative to a reference point that is defined on the frame's orientation on preoperative imaging.¹⁰ Many versions of the stereotactic frames are available, however frame-based techniques remain limited by complexity to assemble and maintain the frame, the required length of a combined imaging and surgical time, and patient discomfort.¹¹

Frameless neuronavigational system works on pointer system, digitizer, work station and fiducials. The fiducials are placed on the scalp for preoperative imaging and used as references to allow for the definition and calibration of the surgical space relative to the patient's head on these images. The digitizer registers and transfers information to a workstation, which allows registered pointer and the biopsy probe to be projected in the preoperative images. This provides accurate intraoperative navigation and lesion targeting using preoperative images.¹² Surgery can be done under local or general anaesthesia and specimen acquisition can be done entirely frameless through electromagnetic guidance systems. Neuronavigation allow the imaging and planning to be separated from surgery in time and location. Patient can undergo imaging even days prior. This shortens procedural time which otherwise needed to apply rigid frame and makes operative planning more flexible thereby improving patient comfort, as patients are able to move freely with fiducials in place.¹³

Frameless techniques carry advantages to patients in terms of comfort. Frame-based approaches require fixation of the frame to the patient's head, and the patient must wear the rigid apparatus for imaging before being taken to the operating room. Although many studies report frame placement as "well tolerated," there have been a number of reports in functional neurosurgery that provides evidence that frame fixation is quite uncomfortable for the patients^{14, 15}

Rigid frame biopsy is considered to convey greater precision while targeting small deep-seated lesions. Frameless techniques requires more complex hand-eye coordination and may be more prone to drift and tremors.¹⁶ Very few studies have compared the two methods, demonstrating similar results for diagnostic yield and morbidity.¹⁷

Our centre uses the CRW system which is the most modern frame-based biopsy. As the volume of the cases are increasing, it can be utilized as regular procedure.

Stereotactic biopsy has higher rates in diagnostic accuracy with minimal side effects. Contraindications being tumour vascularity like metastatic renal cell carcinoma, choriocarcinoma, or metastatic melanoma because of inherently risk of bleed ¹⁸

Sampling errors do happen, and is a concern with stereotactic biopsies, particularly in non-enhancing lesions like low-grade gliomas.^{19, 20}

An inherent limitation of stereotactic biopsy localization is that the surgical coordinates are taken from preoperative imaging. Intraoperative brain shifts following dural opening can cause ambiguity within the navigational system with decrease in diagnostic accuracy. Large dural openings should be avoided and insert the biopsy needles through the smallest possible dural opening.²¹

The most common complication is intracranial haemorrhage. Current navigation systems and the software can be programmed in such a way avoiding blood vessels. Damage of pathologically friable vessels within the target lesion can cause haemorrhage, however, a speck of blood or air in the post op CT scan is confirmatory of the target being hit by the biopsy needle as was in our cases and depicted in the above figures. The rates of haemorrhage complications during stereotactic biopsy ranges from 0% to 11.5%.²² A second, less frequent complication of stereotactic biopsy is fresh neurological deficit caused by trauma to the surrounding brain parenchyma as a result of direct damage by the needle biopsy causing edema. No major complication was reported in our cases.

This could be due to the small size of sample.

CONCLUSION

STB is a highly safe method in diagnosing lesions, in which surgical excision/open biopsy present significant risks of morbidity and mortality. STB has a learning curve, especially in the handling of the software and fusion of images. The basic advantages of STB were realized with minimal morbidity and no mortality.

Conflict of Interest: None

Source(s) of support: None

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