

# Frameless Stereotactic Biopsy of Intracranial Lesions: Evaluation of Efficacy and Complications

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## ABSTRACT

**Objective:** Frameless stereotactic biopsy has been shown in multiple studies to be a safe and effective procedure for the diagnosis of brain lesion. In this study the authors will evaluate the safety of the procedure and associated complications including neurological deficits in our set up of developing countries. **Methods:** Forty two patients with different brain lesions were biopsied using frameless stereotactic procedure between the periods of March 2009 – March 2014 for the assessment of diagnostic yield and related complications. **Results:** During the study period, forty two patients were biopsied for the evaluation of the complications related to the biopsy site. Neurological decline occurred in 1 patient. A higher number of needle passes was associated the presence of a postoperative hematoma. Infection occurred in one patient and overall diagnostic yield was 95%. **Conclusion:** Frameless stereotactic biopsy is a safe and effective method of tissue diagnosis for small lesions located in the eloquent and non-eloquent region of brain. With careful planning, frameless biopsy remains a valuable and safer tool for diagnosis of brain lesion, independent of the location of these lesions.

**Key words:** Brain, Biopsy, Frameless, Stereotaxy, Diagnosis, Outcome

## INTRODUCTION

**B**rain biopsy procedure have evolved over the last three decades, in conjunction with the ability to image brain directly, beginning in the mid 1970's with the biopsy sampling of the lesion in the brain, using computed tomographic (C.T) scanning.<sup>1,2</sup> In the early 1980's, C.T scanning has been incorporated into stereotactic procedures because it allowed both the translation of three dimensional database into three dimensional coordinate system of a stereotactic frame and direct visualization of lesion in the brain without confirming their position based on shift of the ventricles as seen on pneumoencephalography or ventriculo-graphy.<sup>3,4,6,7</sup> Later in that decade, magnetic resonance imaging became incorporated into stereotaxy for both brain biopsy procedure and volumetric tumor resection.<sup>5,7,8,12,13</sup>

Frameless stereotactic system have been under development since 1980. These system require

preoperative imaging that is oriented with a constant set of fiducial markers and is performed either several days or immediately before the planned operative procedure. Optical ultrasound or electromagnetic sensors are used to detect the movement of surgical instrument during the operative procedures. Disadvantages associated with the frameless navigational system include fiducial registration inaccuracy and the potential of brain shift with subsequent displacement of the mass that is undergoing biopsy sampling or resection.<sup>9-13</sup> More recently magnetic resonance imaging has been adapted for the use in the operative setting. Lesion of the brain can be sampled in an interactive fashion without fear of displacing the target which can happen with both frame based and frameless stereotactic procedure. The position of the biopsy needle directly relevant to the target can be confirmed during the procedure, which has the potential of increasing diagnostic yield compared with the conventional stereotactic system.

Interventional magnetic resonance (MRI) image guided brain biopsy procedures are performed in a free hand fashion, with the ability to direct the passage of biopsy needle through the brain.<sup>12,13</sup>

## MATERIALS AND METHODS

### Brain biopsy procedure

In all cases IGS (image guided surgery) protocol CT and MRI scans, without and with contrast were acquired, pre operatively, by a 1.5 telsa MRI imaging unit (GE medical system). Imaging studies were obtained day before surgery. General anesthesia was induced. The patients head was fixed in a three point Mayfield clamp secured to operating table. Intraoperative image guideline was achieved by wand/probe based navigation system (Treon Stealth –Medtronic). Preoperative images were transferred to IGS work station. This system calculates positioning accuracy by giving a root square error and uses a matching algorithm to register successfully skin contour mapping. As the register process was completed and its accuracy confirmed, the biopsy guide was attached to the Mayfield clamp. The biopsy needle allows targeting of the lesion in a three dimensional orientation according to a straight trajectory which was planned with navigation system software by defining an entry and a target point. A 2 cm incision was made at the defined stereotactic site, burr hole was made dura was incised with 11 number surgical blade. The biopsy needle was then pushed down towards the target lesion at the previously determined distance. Acquired biopsy sample were placed in containers and samples were sent for histopathology.

## RESULTS

After approval by the institutional review board 42 patients underwent frameless image guided stereotactic brain biopsy procedure at Shaikh Zayed Hospital, Lahore. The age range for the 42 patients was from (16-84) years with a mean age of 45 years. There were 26 males (61.9%) and 16 females (38.1%) in the study. Twenty three lesions were located in the left hemisphere and nineteen lesions were located in the right hemisphere. Among all the

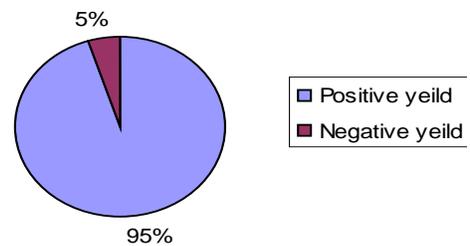
left hemisphere lesions, 12 lesions were located in the frontal lobe, 8 lesions were located in the temporal lobe and 3 lesions in parietal lobe and 1 lesion was located in the occipital lobe. In the right hemisphere 8 lesions were located in the frontal lobe, 2 lesion located in the temporal lobe, 5 lesion in parietal lobe, 3 lesion in the occipital lobe. The most common presenting symptoms were seizures headache, altered mental status and neurological deficits.

**Table 1: Types of tumors and their distribution.**

Diagnosis	No. of lesion	Percent
Glioblastoma multiform	10	23.8%
Metastatic	8	19%
Low grade glioma	15	35%
Ependymoma	3	7%
Oligodendroglioma	3	7%
Abscess	1	2%

**Table 2: List of complications**

Complications	No. of patients	Percent
Hematoma	2	4.7%
Neurological deterioration	1	2.0%
Infection	1	2.0%



**Fig. 1: Diagnostic yield of the study.**

The biopsy revealed low grade glioma in 15 patients (35%), glioblastoma multiformae in 10 patients (23%), metastatic lesion in 8 patients (19%), ependymoma in 3 patients (7%), oligodendroglioma in 3 patients (7%) and abscess in 1 patient (2%) (Table 1). The overall diagnostic yield was 95% (Fig. 1). The complication observed in 3 patients, 2 patients develop postoperative hematoma which required evacuation, 1 patient developed wound infection and in 1 patient

neurological decline was observed. The patient requiring evacuation later on died after neurological decline (Table 2).

## DISCUSSION

Stereotactic biopsy techniques have been widely utilized in the sampling of intracranial lesion for many decades.<sup>1,2</sup> These techniques provide a means of sampling lesion from small isolated intracranial lesion for histopathology analysis. Preoperative diagnosis of intra axial lesions based solely on clinical and radiological presentation may be incorrect in one third of patients.<sup>1,3</sup> Hence histopathology analysis is critical in guiding therapeutic interventions.<sup>2,4</sup> Traditionally the frame based method have been the gold standard for the sampling of intracranial lesion.<sup>5,6,7</sup> Recently frameless image guided stereotactic procedure has been increasingly used. This technique requires the use of preoperative imaging to provide spatial reconstruction and neuronavigation in the operating room, which permits precise targeting of the desired intracranial lesion, without the use of traditional stereotactic frame for three dimensional positioning and targeting.<sup>12,13</sup>

In our series of frameless stereotactic biopsy procedure performed during the year 2009-2014 at Shaikh Zayed Hospital, the diagnostic yield was 95% with the morbidity rate of 8.7% and mortality rate of 2.3%. These results were compared with data in the recent literature of stereotactic biopsy procedures. In a recent study, Hall<sup>8</sup> reported a diagnostic yield rate of 91%, overall morbidity rate of 35% and a mortality rate of 7%. In the analysis of risk factors for non-diagnostic biopsy we found that a smaller sized lesion and deep seated locations together were associated with non-diagnostic tissue sampling. These results confirmed the notion that stereotactic brain biopsy procedure is safe and effective method sufficient to guide treatment in majority of intracranial lesions.

Patients in our study had an age range of 17 to 84 years. The most common presenting symptoms were seizures, headache and change in mental status. Ninety eight percent of the lesions were diagnosed on the first biopsy procedure. The most common diagnosis was low grade astrocytoma

(35%) followed by others, show in table. The overall diagnostic yield was 95% for the biopsy. The majority of lesions were consider unresectable by the surgeons because of the location in the eloquent area of the brain. Additionally lesions were consider unresectable due to presence of multiple lesion and deep location. Patients with resectable lesion typically underwent biopsy because of their age, health and other comorbid conditions. The complication rate was 8.7% for the 42 patient's. Amongst the complication, two patients developed hematoma that required operative evacuation and one patient develop infection. Of the two patients who require evacuation, one expired after neurological decline and one patients died after 2 week. However we did not observe increased incidence of neurological decline in patients whose lesion were in thalamus, basal ganglia or in deeper structure compared with the patients whose lesion were superficially present.

The higher resolution imaging modalities combined with intraoperative neuronavigation frameless technique facilitate safe biopsy sampling of the deep eloquent tissue. Some authors hold the view that more rigid frame used in the frame based system offers greater precision particularly in targeting deep seated intracranial lesions (3, 9, 10, and 11). Regardless of the frame type, the use of intraoperative MRI image guided stereotaxy is as effective as traditional frame based technique, when combined with preoperative lesion targeting. The analysis did not indicate small size of the lesion or deep seated location to be the independent predictors of non-diagnostic biopsy. Hence a small size deep seated lesion should not be considered a risk factor for non-diagnostic tissue biopsy procedure. Frameless stereotaxy allows to collect multiple biopsy samples of larger lesions. It also provides a simple needle tract over a greater distance across the lesion. Thus we gather tissue sample across the spectrum of pathological tissue, increasing the likelihood of obtaining a specimen representative of the desired lesion.

## CONCLUSION

Frameless sterotaxy biopsy procedure was found comparable to or better than published studies

on stereotactic biopsy sampling with regards to diagnostic yield and complication rates however smaller and deep seated lesion together represents risk factor for non-diagnostic tissue yield. MR imaging guided stereotaxy is as effective as conventional frame based technique with preoperative lesion targeting.

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