

Adequacy of Sample for Histopathology of Intracranial Lesions Taken from Frame-Based and Frameless Navigation Guided Biopsy

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ABSTRACT:

Introduction: Neuronavigation-guided biopsy (Frameless and Frame-based stereotactic) is a simplified procedure that helps neurosurgeons to precisely obtain the biopsy of intracranial lesions to establish the complex histopathological diagnosis. The small tissue sample acquired when viewed against the vast heterogeneity of lesions and the rapidly progressive nature of few tumours make the adequacy of sample an important parameter in determining the effectiveness of the procedure, which also has profound financial and disease-related impact on the patients' life.

Methods: A prospective observational study was done in 49 patients who underwent frameless and frame-based biopsies at National Neurological Referral Centre, Bir Hospital in one year. The objective of this study was to determine the rate of adequate sample for histopathological examination from intracranial lesions.

Results: A total of 36 (73.5%) patients underwent frameless biopsy and 13 (23.5%) patients underwent frame-based stereotactic biopsy of intracranial lesions. Overall diagnostic yield was 89.8% with Frameless procedure giving histopathological diagnostic yield of 91.66% and frame-based procedure had diagnostic yield of 84.61%. Hematoma occurred in 2 patients and seizure in one patient. Majority of histopathological diagnosis was glioblastoma (44.9%).

Conclusion: Neuronavigation guided biopsy sample of intracranial lesions obtained for histopathological diagnosis is adequate in establishing the final histopathological diagnosis which helps in enhancing patient management and outcome.

Keywords: Navigation biopsy, Sample adequacy

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INTRODUCTION

The concept of stereotaxis in neurosurgery began by Horsley and Clarke in 1908. The practical application of stereotaxis started in 1947 when Spiegel and Wycis began their pioneering work. The image-guided surgical navigation lead to the development of new methods of less invasive surgery of the nervous system.¹⁻² Frame based navigation system requires rigid frame to be bolted around the skull for patient image registration. Stereotaxy comprises complex

ergonomics and access is based on single trajectory.³⁻⁵ Brain shift in intracranial lesions is also major setback in neuronavigation.¹⁰ Neuronavigation guided intracranial and spinal surgeries are also a common procedure at our centers.

The small tissue sample acquired when viewed against the vast heterogeneity of lesions and the rapidly progressive nature of few tumours make the adequacy of sample an important parameter in determining the effectiveness of the procedure. Study

correlating the diagnostic adequacy of samples taken via this procedure with the final histopathological diagnosis reported by pathologists at our center has not been done.

A recent article was published on March 2021 on neuronavigation guided intracranial and spinal surgeries performed at NNRC and National Trauma Center which involved 60 cases of intracranial tumors and 5 cases of spinal pedicle screw placement which were done with accurate approach and higher precision.¹¹ Similarly, a retrospective (2016-2018) study on Frameless neuronavigation guided biopsy of intracranial space occupying lesion, published by Upendra Devkota Memorial National Institute of Neurological and Allied Sciences in 2019 stated diagnostic accuracy of 89.1%, inconclusive histopathology in 10.9% cases and complication rate was 4.3%: one tract hematoma and one new neurological deficit.¹²

Study done by Deepali et. al at All India Institute of Medical Sciences revealed a diagnostic yield of 80.2%. This was a comparative study of frameless, frame based and ultrasound guided biopsy of intracranial lesions. Maximum diagnostic yield was achieved in frameless stereotactic biopsy (87%).¹⁴ Similarly a study done by Department of Neurosurgery and Pathology in 2018 at Hospital de San José, Fundación Universitaria de Ciencias de la Salud (FUCS), Bogotá, Colombia showed that the final pathology was determined in 87% in stereotactic frame based biopsy.¹⁵ A single centered study of frame-based stereotactic biopsy done in University of Gothenburg, Sweden published on Jan 2021 stated that the concordance between image-based and histopathological diagnoses varied between 53.3% and 87.5%. The diagnostic yield was 95.2% with overall morbidity of 10.4%, a mortality rate of 0.8%, minor complications of 4.0% and clinically significant complications of 6.4%.¹⁶

MATERIALS AND METHOD

A cross sectional observational study was done on 49 patients for one year who underwent navigation-guided biopsy of intracranial lesions (Frameless and Frame-based) at the National Neurosurgical Referral Centre, Bir Hospital, NAMS. Sample size was calculated based on the prevalence method. Data obtained through

patient interviews and hospital records were recorded in performed pro forma.

All patients admitted in NNRC with intracranial lesions undergoing Frame/Frameless navigation guided biopsy with lesions located in deeper areas and eloquent areas of the brain, unresectable intracranial tumors, patients with diagnostic dilemma and with poor performance status who are not fit for surgery were included in the study. Those with coagulation disorder, not willing to give consent for the study, and who had prior tumor resection were excluded.

Study details

All the patients were assessed clinically and radiologically (MRI brain and CT scan of head). Pre-operative navigation CT protocol of the same patient was done to use intraoperative neuronavigation. All patients underwent either stereotactic frame-based or frameless biopsy and the sample was sent for histopathological diagnosis to the Department of Pathology at Bir Hospital. The intraoperative time, findings of the procedure and intraoperative complications were noted. On the first postoperative day, a review CT scan was done. Patients would be monitored for seizure or hematoma, the most common complications. Conservative management were done for hematoma and seizures were managed with anti-seizure medications. Data was collected for a period of one year.

Statistical Analysis All data were analyzed using SPSS version 22.0, entered in Microsoft excel. All qualitative data were analysed using Chi-square test. (Significance level <0.05).

RESULTS

The clinical characteristics of the patients are shown in Table 1. 36 (73.5%) patients underwent frameless biopsy and 13(23.5%) patients underwent frame based stereotactic biopsy of intracranial lesions over the period of one year.

Table 1: Demographic and clinical characteristics

Demographic Variables	Mean \pm SD
Age	45.30 \pm 18.04 (Range = 13-78 years)
Gender	n(percentage)

Male	
Female	28 (51.7 %)
	21 (48.3 %)
Clinical Variables	n(percentage)
Location of lesion	
Right hemisphere	44.9%
Left hemisphere	36.7%
Thalamic	6.1 %
Brainstem	6.1 %
Corpus callosum	4.1%
Periventricular	2%
Cortical lesions	75.5 %
Deeper lesions	24.5 %
Frameless biopsy	36 (73.5%)
Frame based biopsy	13 (23.5 %)

Histopathological characteristics:

Mean volume of the lesion sample was 0.167 ± 0.26 SD cubic cm with range of 0.006 cubic cm to 1.2 cubic cm. Only 10.2% of samples obtained from navigation guided biopsy were reported as inadequate, and the histopathological diagnosis were given to 89.8%. Among the frameless biopsies, 3 out of 36 were

inadequate (8.3%), whereas 2 out of 13 (15.38%) were inadequate in frame based stereotactic biopsy. (Table 2)

Patient outcome:

All patients were discharged from the hospital with complications seizure in one patient (2%) and hematoma in two patients (4%) only. Mean length of hospital stay was 3.30 ± 0.82 SD days (Range: 2-5days). The diagnostic yield of frameless navigation guided biopsy was 91.66% and that of frame based stereotactic biopsy was 84.61%. (Table 5)

Table 2: Adequacy of sample

Variable	Mean \pm SD (Range)
Mean volume of sample	0.167 ± 0.26 cm ³ Range = 0.006 - 1.2 cm ³
Adequacy of sample	Percentage)
Frameless biopsy	
Adequate sample	33 (91.7 %)
Inadequate sample	3 (8.3 %)
Frame based biopsy	
Adequate sample	11 (84.62 %)
Inadequate sample	2 (15.38 %)

Table 3: Risk factor analysis of factors affecting the navigation biopsy diagnostic yield

Age(years)		Odds ratio	Confidence interval	P value
<40	80 % (16/20)	0.33	0.15 - 0.70	< .01
>40	90 % (26/29)			
Gender				
Male	87 % (24/28)	0.70	0.34-1.35	>0.05
Female	88 % (18/21)			

Table 4: Histological diagnoses made on tissue samples acquired by navigation biopsy

Diagnosis	Frameless	Frame based
Diagnostic biopsy	33/36 (91.67%)	11/13 (84.6%)
Glioblastoma	20 (55.55%)	6 (46.1%)
Diffuse astrocytoma	4 (11.11%)	3 (23.07%)
Anaplastic astrocytoma	4 (11.11%)	1 (7.6%)
Oligodendroglioma	1 (2.7%)	1 (7.6%)
Low grade glioma	1 (2.7%)	
Metastatic brain tumor	1 (2.7%)	
Lymphoma	1 (2.7%)	
Neurocysticercosis	1 (2.7%)	

Non definitive diagnosis	3/36 (8.3%)	2/13 (15.38%)
Inflammatory cells	0	1
Necrosis	1	
Glial tissue	2	1

Table 5: Statistical analysis of the biopsy yield of the two methods

Comparison groups	OR	95% CI	p-value
Frameless vs frame based	2.38	0.56-3	0.23

DISCUSSION

The study done at our center in 49 patients who underwent neuronavigation guided biopsy of intracranial lesions during a period of one year. Mean age of 45.30 ± 18.04 SD (Range :13-78 years). Out of 49 patients, 28 (51.7%) were males. 44.9% were right sided lesions while 36.7% were left sided lesions, 6.1% were thalamic and brainstem lesion each. Similarly 4.1% were corpus callosal lesion and 2% were periventricular lesions. Majority (75.5%) were cortical lesions and 24.5% were deeper lesions. Thirty-six (73.5%) patients underwent frameless biopsy and thirteen (23.5%) patients underwent frame based stereotactic biopsy of intracranial lesions.

Mean volume of the lesions was 0.167 ± 0.26 SD cubic cm with range of 0.006 cubic cm to 1.2 cubic cm. The mean volume of the sample has not been discussed in other studies; however, our study showed the volume of sample is not statistically significant in defining adequacy of sample.

Only 10.2% of samples obtained from navigation guided biopsy were reported as Inadequate, however, 89.8 % were given histopathological diagnosis. The diagnostic yield of Frameless biopsy was 91.66% whereas that of Frame-based biopsy was 84.61%. The results are comparable with studies done previously which establishes the adequacy of sample obtained for histopathological diagnosis via navigation guided biopsy at our centre.

There are various studies comparing the frame based and frameless stereotaxy for brain biopsy in terms of morbidity, mortality and diagnostic yield.¹⁷⁻²¹ Our results indicate that there is no significant

difference in the diagnostic yield between frame based versus frameless stereotactic procedures which corroborates with findings from most of the previous studies.

Dammers, et al. found no difference in frame-based and frameless stereotactic brain biopsy with a combined 89.4% diagnostic yield and no difference in complication rates comparing the two methods.¹⁷ Woodworth, et al. also reported similar findings, showing a 90% combined diagnostic yield with no differences between frame-based or frameless techniques.²¹

But it has to be noted that the study sample was very small compared to other studies conducted elsewhere. Besides the sample size included for frame-based methods was also small. This might be because of a smaller number of patients included for the method. Frame based method is technically time consuming and requires more skill on part of the surgeon. So probably with increasing experience we might be able to perform more cases using this method in the future. So, a study with more number and comparable sample size might have to be conducted in the future for comparing the two methods.

CONCLUSION

Both frame based and frameless systems are useful tools for obtaining biopsy of different brain lesions. They provide a reasonable level of accuracy and the tissue volume obtained for histopathological examination is adequate.

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