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Original Article

Venture in 101 Cranial Punctures: A Comparative Study between Frame-based versus Frameless Biopsy of 101 Intracranial Space Occupying Lesion

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Abstract

Background: Presumptive diagnosis based solely on the clinical picture and imaging is not sufficient to provide appropriate treatment with certainty and hence histopathological confirmation of intracranial space occupying lesion (ICSOL) is essential. Needle biopsy via stereotactic frame-based or frameless neuronavigation technique is efficient procedure. The objective of this study is to compare their accuracy and efficacy and safety. **Methods:** This is a retrospective comparative study conducted among 101 biopsies of ICSOL. Patients data were retrieved from medical record. Data were analyzed in SPSS ver. 20. P value of <0.05 was considered significant. **Results:** Out of 101 patients, Frame-based stereotactic biopsy was done among 55 patients (54.4%) while 46 patients (45.6%) underwent frameless stealth neuronavigation guided biopsy. Male to female ration was 2.1:1. Age ranged from 5 to 82 years. 54.5% (55 patients) have deeper location of tumor while 45.5% (46 patients) have lobar location of tumor. Frontal (16.8%) and Thalamic (13.8%) were the common site. Mean size of tumor was 3.09±0.85cms. There was statistically significant difference in operative duration among study groups. Overall Diagnostic yield was 89.1%. Glioma was the most common (50.5%) diagnosis. Glioblastoma WHO Grade IV was 37.6% followed by lymphoma (12.8%). **Conclusion:** Needle biopsy via stereotactic frame-based or neuronavigation frameless technique is a safe and efficient procedure having high diagnostic yield. Reasons for negative biopsy could be missed target or retrieval of gliotic tissue.

Keywords: Biopsy, brain lesion, frame-based, frameless, neuronavigation, accuracy

Introduction

Presumptive diagnosis-based solely on the clinical picture and imaging is not sufficient to provide appropriate treatment with certainty. Histopathological confirmation of intracranial space occupying lesion (ICSOL) is essential to draw management plans and institute appropriate treatment. Biopsy through stereotactic technique (SB) is interesting choices. SB of brain lesion has been widely and safely performed procedure since it was first introduced in the late 1970s.[1] SB is indicated in every progressive, unverified intracranial lesion to obtain a histopathological diagnosis in cases where surgical resection is not preferred treatment. SB ascertains the histological diagnosis of brain lesions with low risk and high accuracy.[2] Reported series show various results of diagnostic yield. The present study was carried out to compare the diagnostic accuracy of frame-based and frameless technique and compare their effectiveness.

Methods

This is a single-center retrospective analytical cross-sectional nonprobability purposive study conducted in our center among 101 patients during a period of 5 years from 2014 to 2018. All patients who underwent stereotactic biopsy of ICSOL through frame-based or frameless technique were included in the study. Those patients who denied consent for surgery were excluded from the study. Ethical clearance was approved by the Institutional Review Committee of our center.

Biopsy technique

In our unit, we use two techniques: frame-based stereotactic and frameless neuronavigation-guided biopsy. A biopsy is done by dedicated neurosurgeons. The selection of technique was based on the surgeon preference.

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Technique of frame-based biopsy

For frame-based biopsy, Cosman-Robert-Wells (CRW) frame was used. The patient was assessed clinically and available records such as computed tomography (CT) scan and chest X-ray evaluated. Coagulation profile is checked. Head of the patient was shaved or washed with antiseptics, and base ring of Brown-Roberts-Wells system was secured into the outer table of the skull with four screws after infiltrating the required points with 2% lignocaine [Figure 1a]. The patient was shifted to CT scanner [Figure 1b]. The localizing ring was attached to the base ring before CT scanning.

Contrast-enhanced CT was done in each patient. Areas with contrast enhancement were selected while areas of most suspicion were selected for nonenhancing lesion. Pixel coordinates of nine localizer rods were derived and recorded. Patient was shifted to the operation room.

X and Y coordinates were calculated with Radionic Sterocalc, and three scales (anteroposterior, lateral, and vertical) were calculated. Calculation was calibrated to phantom target [Figure 1c]. Patient head is prepped and draped. Entry point was infiltrated with 2% lignocaine, incised, and small burr hole made with Hudson perforator or Manman perforator. Durotomy was made with electrocautery. CRW frame was mounted on the head. A side cutting biopsy needle was used, and an average of four specimens was obtained through single trajectory and sent for histopathological analysis [Figure 1d]. Wound closed with one or two stitches and base ring removed and patients sent back to the Intensive Care Unit for monitoring.

Duration of procedure recorded from starting of frame fixation till closure of the wound was retrieved from anesthesia chart.

Technique of stealth neuronavigation frameless biopsy

Image acquisition was done from magnetic resonance imaging image loaded compact disc and patient registered in stealth, neuronavigation system, an infrared led-based system. Head of patient was shaved after general anesthesia and head fixed with three pins clamp on Mayfield [Figure 2a]. Taylor–Haughton line drawn and tumor marked on the scalp with the neuronavigation guidance. Technique was similar to Dorward technique of neuronavigation-guided biopsy.[3] Entry point selection was done to achieve the shortest safe path toward target lesion [Figure 2b]. All calculation was done to avoid vascular structure along the trajectory. Skin incision was done and burr hole was created with Manman air-driven drill. Durostomy was done [Figure 2c] and four specimens were retrieved with the help of 14-gauge navigation cannula [Figure 2d]. Biopsy specimens sent for histopathological analysis. Wound closed with one or two stitches and observed in the Intensive Care Unit for monitoring. The duration of procedure recorded from starting of Mayfield three pin fixations to closure of the wound was retrieved from anesthesia chart.

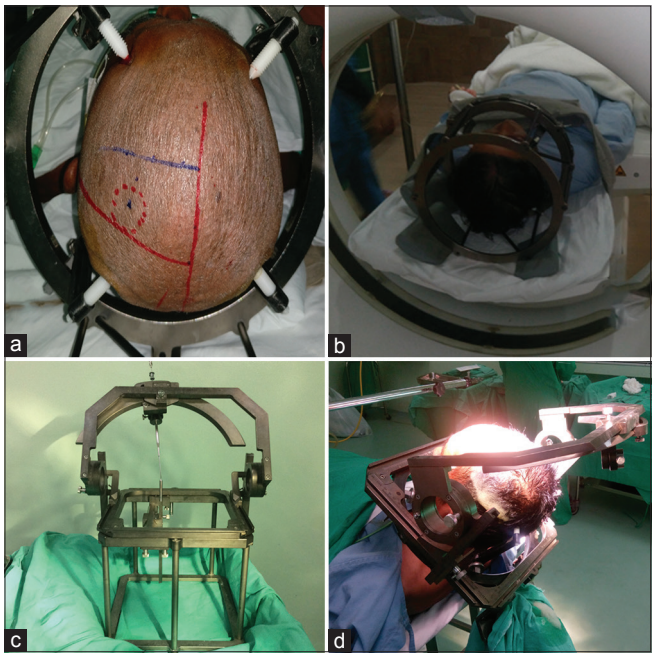

Figure 1: (a) Localizer ring secured in the outer table of the skull, (b) Patient in CT console with frame fixed on the head, (c) Rectilinear phantom pointer (RLPP) with CRW stereotactic frame calibrated to phantom target, (d) CRW frame is mounted on patient head for biopsy of target lesion

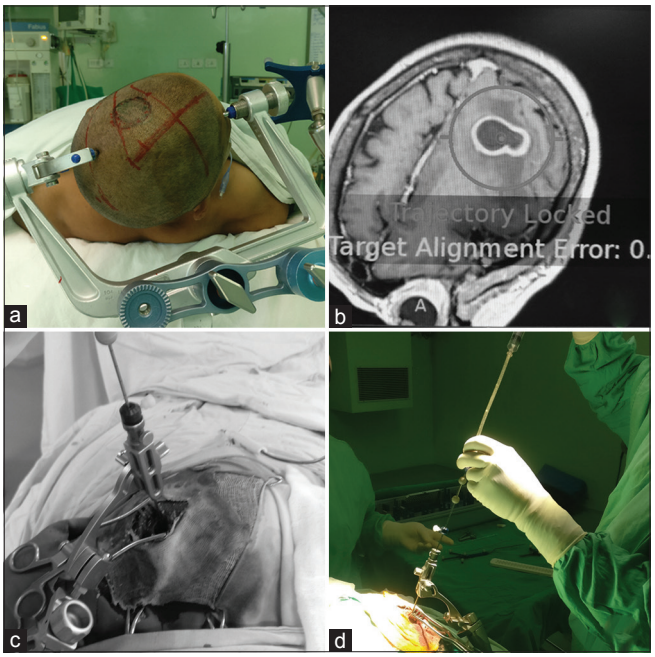

Figure 2: (a) Head fixed with three pins clamp on Mayfield, (b) Target lesion is navigated and locked for biopsy from shortest safe route, (c) Burr hole and durostomy before biopsy, (d) Delivering Biopsy specimen for Histopathological examination

Results

Of 101 patients, most of them were male 68.3% (69 patients). Age ranged from 5 years to 82 years with the mean age of 46.12 ± 18.56 years. Most ICSOL were supratentorial while only one was infratentorial tumor. About 54.5% (55 patients) have deeper location of tumor while 45.5% (46 patients) have lobar location of tumor. Frontal (16.8%) and thalamic (13.8%) were the common sites. Right side was 54.4% (55 patients) while left was 44.6% (45 patients). The mean size of tumor was 3.089 ± 0.8497 cm with a range from 2 cm to 7 cm while 78.2% of tumor were of size <2 cm and 21.7% of tumor were ≤2 cm size [Table 1].

Frame-based stereotactic biopsy was done among 55 patients (54.4%) while 46 patients (45.6%) underwent frameless neuronavigation-guided biopsy. Overall, mean operative duration was 155.89 ± 46.12 min; moreover, there was statistically significant in operative duration among study groups (186.36 ± 26.4 min vs. 119.45 ± 37.26 min in frame-based vs. frameless group with $P < 0.05$) Overall, diagnostic yield was 89.1%. There was no statistically significant difference in diagnostic yield of both technique ($P = 0.995$) [Table 2].

Histopathological examination (HPE) revealed diverse pathology with glioma being the most common (50.5%)

Table 1: Result in 101 brain biopsies of intracranial space occupying lesion

Variables	Total patients (*n*=101)	Frame based (*n*=55)	Frameless (*n*=46)	*P*
Demographic profile				
Mean age	46.12±18.56	48.05±17.43	43.80±19.76	0.40
Sex				
Male	69 (68.3)	39	30	0.54
Female	32 (31.7)	16	16	
Tumor topography and lesion characteristics				
Location				
Supratentorial	100	55	45	0.272
Infratentorial	1	0	1	
Depth				
Lobar	46	22	24	0.221
Deep	55	23	22	
Site				
Periventricular	11	5	6	0.578
Thalamic	14	8	6	
Diffuse	9	6	3	
Cerebellar	1	0	1	
Temporal	7	4	3	
Frontal	17	6	11	
Parietal	19	12	7	
Callosal	7	5	2	
Multi focal	12	8	4	
Pineal	1	0	1	
Occipital	3	1	2	
Laterality				
Right	55	29	26	0.457
Left	45	26	19	
Midline	1	0	0	
Size (cm)				
≤2	22	17	5	0.015
>2	79	38	41	
Size of tumor				
2.0	22	17	5	0.15
3.0	55	29	26	
4.0	19	8	11	
5.0	4	1	3	
7.0	1	0	1	
Mean size of lesion (cm)	3.089±0.8497	2.87±0.73	3.34±0.92	0.076
Mean operative duration (min)	155.89±46.12	186.36±26.4	119.45±37.26	0.000
Mean duration of hospital stay (days)	11.83±10.13	10.63±9.6	13.26±10.63	0.20

Table 2: Diagnostic yield of frame-based versus frameless biopsy procedure

	Frame-based stereotactic biopsy	Frameless neuronavigation biopsy	*P*
Number of biopsy	55	46	0.995
Positive biopsy	49	41	
Diagnostic accuracy (%)	89.1	89.1	

Table 3: Histopathology conclusion of biopsy specimens

Histopathology report	Total patients (101)	Frame based (55)	Frameless (46)
Neoplastic			
Glioblastoma WHO Grade IV	38	18	20
Lymphoma	13	7	6
Diffuse astrocytoma, WHO Grade II	7	5	2
Metastatic adenocarcinoma	6	5	1
Anaplastic astrocytoma WHO Grade III	4	2	2
Pleomorphic xanthoastrocytoma WHO II	1	0	1
Oligodendroglioma WHO II	1	1	0
Metaplastic meningioma Grade I	1	0	1
Angiomatous meningioma Grade II	1	1	0
Infective			
Abscess	9	4	5
Tuberculosis	4	2	2
Cryptococcal	1	0	1
Neurocysticercosis	1	1	0
Other			
Radionecrosis	1	1	0
Organizational changes in hematoma	1	1	0
DNET	1	1	0
Inconclusive	11	6	5

DNET – Dysembryoplastic neuroepithelial tumor

[Table 3]. Of 101 biopsies, histopathology revealed glioblastoma WHO Grade IV among 37.6% (38 patients), lymphoma (12.8%), diffuse astrocytoma (7%), metastasis (6%), and few cases of anaplastic astrocytoma, oligodendroglioma, metaplastic meningioma, and angiomatous meningioma. Similarly, among infective pathology, abscess was most common histological findings accounting (8.9%) while tuberculosis (3.9%), cryptococcal (0.9%), and neurocysticercosis (0.9%) were sparsely diagnosed. Preoperative diagnosis was revised with a new diagnosis in 18.8% of cases (19 patients) while similar pathological type is revealed in 70.3% of cases (71 patients) while histopathology was reported negative in 10.9% (11 patients). There was no statistical significant difference in diagnostic yield of both technique [Table 2]. Among those with inconclusive HPE report, six were gliosis (5.9%), one (0.9%) was chronic inflammatory neuroparenchyma (no evidence of tuberculosis), and four were normal brain (3.9%) [Table 4]. Overall, postoperative morbidity was 4.9%. Two patients developed seizure among frame-based stereotactic group while tract hematoma was present in one case of each study group which were managed conservatively. One patient in frameless neuronavigation group developed neurological deficit. The mean duration of hospital stay was 11.83 ± 10.13 days (range: 4–42 days). There was no statistical significant difference in hospital stay among two groups (mean ± standard deviation 10.63 ± 9.6 vs. 13.26 ± 10.63 days in frame-based vs. frameless group; $P = 0.20$) [Table 1]. There was no mortality in any groups.

Table 4: Inconclusive diagnosis (*n*=11)

Histopathology report	Frame-based stereotactic biopsy	Frameless neuronavigation biopsy
Normal	2	2
Gliosis	3	3
Chronic inflammatory neuroparenchyma	1	1
Total	6	5

Discussion

SB is a safe and efficient procedure, particularly in cases with lesions in which a craniotomy and resective surgery are not indicated primarily. The principle of stereotactic biopsy of ICSOL had evolved over years ever since Horsly and Clarke[4] performed the first stereotactic brain biopsy on the cerebellum of a rat and Spiegel and Wycis, later in 1947, displayed their first human SB using three-dimensional coordinate system using intracranial

landmark defined by pneumoencephalography.[5] Maroon *et al*. first reported CT-guided stereotactic system in 1977.[6] In most such cases, conclusive diagnosis can be established by SBs alone.[7,8] In reported series, accuracy of stereotactic biopsy has shown a great variation ranging from 60% to 98%.[9]

Demographics

Most of our patients were male (68.3%) which were similar to the study done by Tsermoulas *et al*.[10] Our series did not show any difference in the diagnostic accuracy with the gender of the patients similar to various study.[11,12] The mean age of our patients was 46.119 ± 18.55 years. Age factor did not have statistically significant association with the diagnostic yield in this study, though a study done by Tsermoulas *et al*.[10] showed more likelihood of diagnostic yield in older patient compared to younger patient.

Diagnostic yield

In this study, the overall diagnostic yield was 89.1% with similar yield in both the group (89.1%). There was no statistically significant difference in accuracy of frameless or frame-based technique in this study. In most cases, conclusive diagnosis can be established by stereotactic biopsy alone.[7] Our study did not show any difference in diagnostic yield with respect to the side and location of tumor. Some studies showed anatomical site to be significant in diagnostic yield while few other did not show any difference.[13]

In a meta-analysis done by Hall.[14] among 7471 patients diagnostic yield of frame-based biopsy was 91%, similarly Jain *et al*.[15] showed overall accuracy of 80.2% (84.2% in frame based and 87% in frameless biopsy technique) while Livermore and Woodworth *et al*.[16] had diagnostic yield of 94.9% and 90%, respectively [Table 5]. In this study, HPE revealed diverse pathology with glioma is the most common (50.5%), glioblastoma WHO Grade IV among 37.6% (38 patients), lymphoma (12.8%), diffuse astrocytoma (7%), metastasis (6%), and few cases of anaplastic astrocytoma, oligodendroglioma, metaplastic meningioma, and angiomatous meningioma. In a study done by Jain *et al*.,[15] of 130 biopsies, 70% were gliomas, 5.4% were lymphomas, and 4% were infective while a study done by Joshi *et al*.[17] among 40 patients revealed gliomas in 72.5% of patients and lymphomas in 5% patients. In this study, histopathology was reported negative in 10.9% (11 patients). Reason for negative report was due to missed target acquiring normal brain for histology or retrieval of glial tissue/nonspecific chronic inflammatory tissue from target. A study done by Jain *et al*.[15] had overall negative result in 16% (21 patients of 130). Histology was normal brain in 8.5% of 130 patients, gliosis in 3%, and inadequate tissue in 3% of cases in their study.

Table 5: Comparison of diagnostic yield with other studies

Study	*n* (FB/FL)	Frame based (%)	Frame less (%)	Overall (%)
Bishokarma S *et al*.	101 (55/46)	89.1	89.1	89.1
Hall 1998[14]	134	96		96
Jain *et al*.,2006[15]	110 (95/15)	84.21	87	80.2
Livermore LJ *et al*., 2014[19]	351 (256/95)	94.5	95.8	94.9
Woodworth *et al*., 2006[16]	270 (160/110)	89.1	91.25	90.2

FB: Frame-based, FL: Frameless Technique

Morbidity

Needle biopsy through frame-based or frameless technique is a safe and efficient procedure. However, it has a morbidity rate ranging from 0.9% to 15% and mortality rate between 0% and 4.2% in reported series.[2,18] Hemorrhage at the biopsy site is reported as most common complication following needle biopsy.[9] In a study done by Kreth *et al*.,[18] 0.9% developed hemorrhage-related complication. In this study, overall postoperative morbidity was 4.9%. Two patients (1.97%) developed seizure among frame-based stereotactic group while tract hematoma was present in one case of each study group which were managed conservatively. One patient in neuronavigation developed neurological deficit. As reported by Krieger *et al*.,[9] of 3500 stereotactic biopsies, they had one procedure-related death, seven significant hemorrhages including subdural and epidural hematomas, five seizures (1.4%), and two infections.

Conclusion

Needle biopsy through frameless or frame-based technique is a safe and efficient procedure. Both techniques have a high diagnostic yield. Reasons for negative biopsy were missed target or retrieval of gliotic tissue from the target lesion. High-volume prospective study is recommended to attest these inferences.

Limitations

This study inherent the limitation of retrospective study. There is also the issue of sample bias with regard to the decision as to which biopsy technique to use is not allocated randomly.

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Conflicts of interest

There are no conflicts of interest.

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