Original Article

Comparison of Stereotactic and Ultrasound-guided Biopsy of Solid Supratentorial Tumor: A Preliminary Report

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Abstract

Introduction: The computed tomography (CT) guided stereotactic biopsy (STB) is considered as method of choice for biopsy of intracranial mass lesions. However, it's disadvantages are frame fixation, time requirement for transportation between CT scan suit to the operation theater with added much higher equipment cost in the relatively resource scarred developing country. Ultrasound-guided biopsy (USGB) is relatively simpler, economical, less time consuming, and real-time procedure. **Clinical Materials and Methods:** Thirty-seven consecutively admitted patients with supratentorial brain tumors, who underwent biopsy of the lesion using CT compatible stereotactic and ultrasound-guided (USGB) procedure formed cohort of the study. Based on location and size of the lesions, the cases were divided into two groups, superficial and deep. Twenty-two patients underwent ultrasound-guided biopsy and 15 with STB. **Results:** The diagnostic yield of STB was 93% and 91% for ultrasound-guided biopsy. The mean operation time of STB group was 149.00 min and 94 min for USGB, which was statistically significant. Two cases in each group developed hematoma; however, one case in USGB group needed surgical evacuation. The real-time monitoring detected two hematoma intraoperatively, which were further also confirmed on postoperative CT scan head. **Conclusions:** The ultrasound-guided biopsy procedure (USGB) was simple, relatively shorter time-consuming procedure and equally efficacious and utilizing economical equipment and can act as a safer alternative to CT STB process for biopsy of the intracranial mass lesion. Furthermore, USGB also provided intra-operative real-time monitoring, which provided clue for close monitoring in the postoperative period after completion of biopsy to look for development of fresh hematoma development not only at the biopsy site but also along the biopsy track and adjoining area. Perhaps, a longer period of ultrasonic monitoring following the procedure would be of greater help to detect hematoma formation, which is one of the most common complications of the biopsy procedure.

Keywords: *Computerized tomography guided stereotactic biopsy, operating-time, supratentorial brain lesions, ultrasound-guided biopsy*

Introduction

Despite the development of new radiological diagnostic techniques, there is still no way of making an accurate diagnosis for a large number of the intracerebral lesions without histopathological examination.[1,2] Both computed tomography (CT)-guided stereotactic biopsy (STB), and USGB are established method of performing biopsy of cerebral lesions.[3-8] However, only little nonrandomized comparative study is available.[3,9] However, paucity of literature regarding the best method of biopsy, in term of diagnostic yield, operative time, associated complication and facility for real-time monitoring. There is no consistent proof that one procedure is better over another.[10-17] This study was undertaken to objectively compare the overall efficacy between USGB and STB in relation to the accuracy of lesion pick-up and time consumed.

Clinical Materials and Methods

The study group comprises 37 patients, who were admitted and underwent biopsy for CT scan head and/or magnetic resonance imaging (MRI) proven intracranial noncystic supratentorial tumor, since 2000 March, however project is continuing. However, all cystic, infratentorial lesion, and brainstem tumors were excluded. Based on the size and location, the patients were allocated into two groups, superficial and deep. Further each group was sub-divided into two sub-groups [Table 1].

The deep group included tumors whose epicenter was located within the basal nuclei including thalamus, putamen,

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Table 1: Distribution of groups

Groups	Sex	Computed tomography-stereotactic biopsy	Ultrasound-guided biopsy
Deep lesions	Male	7	14
	Female	7	3
Superficial lesions	Male	1	4
	Female	-	1
Total (*n*=37)		15	22

caudate nucleus and internal capsule and/or, at the depth of more than one-third distance between the surface of the brain and the center of the brain [Figure 1].

Superficial group included lesions in the cortical, sub-cortical area or when cente of the tumor was external to two-third the distance between surface and center of the brain. These cases were assessed for eligibility, out of screened total 39 cases. However, follow-up records for two patients were not available and hence excluded from the study and remaining 37 were included the current study. As after getting admitted every patient, a detailed written consent was obtained in each case after proper fully explaining the nature of biopsy, complications, advantages, and disadvantages. After this, cases were taken up for biopsy procedure under local or general anesthesia depending on condition of patient and desire of patients [Figure 2].

Computed tomography-guided stereotactic biopsy and ultrasound-guided biopsy methods

The CT-guided STB was performed with the CT compatible head frame of the Leksell stereotactic apparatus model-D and Backlund biopsy kit in conjunction with a Picker USA 1991 (PQ-2000) model CT scanner. Following frame fixation in the operation theater, the patient was shifted to the CT console for calculation of, co-ordinates. The patient was then shifted back to the operation-theater [Figure 2]. A burr-hole was placed over appropriate place according to trajectory and biopsy was performed [Figure 3].

Ultrasound-guided biopsy was performed using a real-time Panther ultrasound Scanner 2002 (Advanced, Diagnostic Imaging, B – K Medical, Analogic Corporation Centennial Drive Peabody, MA, USA)l)® with 6.5 MHz transducer. A burr hole was performed over the appropriate area after scalp incision. Under ultrasonographic visualization, the cannula with stylet *in situ* was passed along the trajectory. Once the target area reached, the stylet removed from cannula, and the biopsy forceps was passed and multiple biopsies obtained under continuous real-time monitoring. After obtaining adequate tissue samples, the cannula was removed. The real-time monitoring of the biopsy area were further continued for at least 15 min to observe for any hematoma formation in each cases undergoing USGB. As a part of the protocol, a noncontrast CT scan

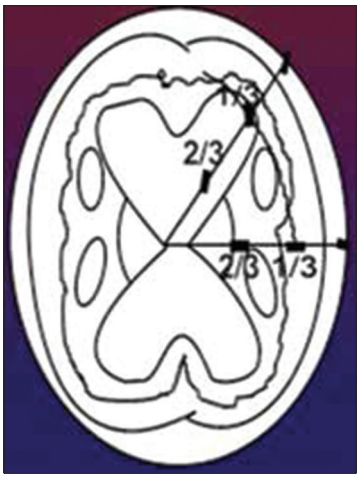

Figure 1: Schematic diagram showing the reference line which is made by joining the center of the cranium to the surface of brain (not calvarium). Line is divided into three equal parts, and lesions located deeper to the junction of outer one-third with middle one-third is considered as deep seated lesions, while those located outside to junction is considered as superficial lesion

was performed in all patients within 6-8 h after the procedure [Figures 4 and 5].

Results

A total of 37 patients who underwent biopsy were included in the current study. Twenty-two patients had biopsy procedure under USGB and 15 underwent STB. The age of the patients ranged from 5 to 65 years with a mean of 33 years and median of 35 years. There were 26 males and 11 females. A total of 14 patients underwent USGB procedure under local anesthesia, and 8 cases required general anesthesia. In STB group, 11 cases out of total 15 cases underwent biopsy procedure under local anesthesia and rest four required general anesthesia.

The mean operation time of STB was 149.00 min and mean operation time of USGB was 94 min [Table 2]. The difference was statistically significant ($P < 0.001$).

STB was contributory in 14 of 15 (93%) cases [Table 3]. In one case, the biopsy material showed normal brain tissue. While the USGB, was contributory in 20 of 22 (91%) cases. In one case, the sample was inadequate for processing and in another sample showed evidence of only normal brain tissue. In the case, where the biopsy was normal brain tissue, the patient developed a post-procedural hematoma after 7 days necessitating surgery. The biopsy revealed glioblastoma multiforme. Finally, two cases where the histopathology was noncontributory (one case each from USGB group and STB group), were subjected to direct radiotherapy/chemotherapy. As radiology of both patients were strongly suggestive of high-grade malignancy.

Complications

In USGB Group, a total three patients developed post procedure hematomas [Table 4]. There was one major

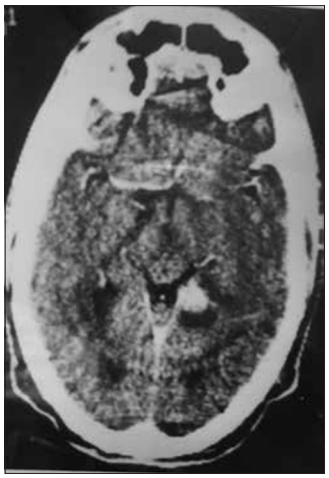

Figure 2: Contrast enhanced computed tomography scan head, axial section image, showing small enhancing lesion in the left temporal region adjoining temporal horn of lateral ventricle, under stereotactic biopsy group, whose histopathology was astrocytoma, histopathology was suggestive of non-Hodgkin's lymphoma (pre-biopsy)

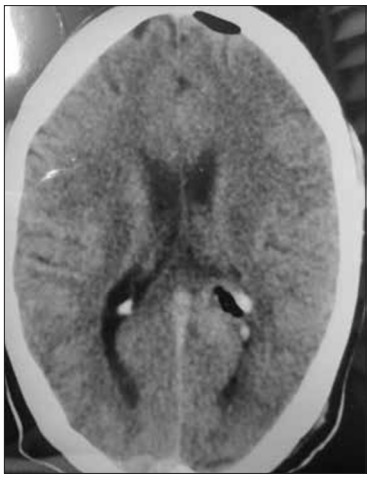

Figure 3: Contrast enhanced computed tomography scan head, axial section image, showing small enhancing lesion in the left temporal region adjoining temporal horn of lateral ventricle, presence of multiple air pocket at the site of stereotactic biopsy postbiopsy (same case in Figure 2)

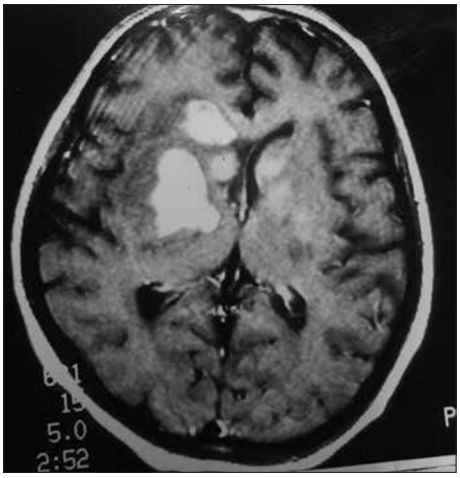

Figure 4: Contrast enhanced magnetic resonance imaging axial section image showing deep seated multiple mass lesions in the periventricular region, underwent ultrasound-guided biopsy, histopathology was suggestive of non-Hodgkin's lymphoma (preoperative)

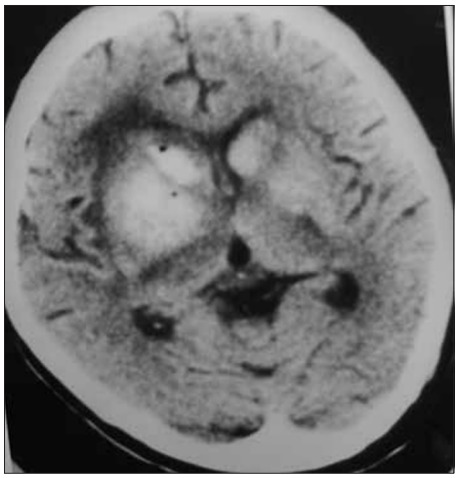

Figure 5: Postbiopsy, noncontrast computed tomography, axial section image showing multiple mass lesions in the periventricular region with presence of multiple air pocket at the site of biopsy following ultrasound-guided biopsy, histopathology was suggestive of non-Hodgkin's lymphoma (same case in Figure 4)

Table 2: Operating-time distribution of biopsy procedures

Groups	Computed tomography-stereotactic biopsy		Ultrasound-guided biopsy		*P*
	Mean time	SD	Mean time	SD	
Deep lesions	146	38	94	23	0.001
Superficial lesions	225	-	97	45	

SD – Standard deviation

hematoma with fresh appearance of neurological deficit requiring surgical evacuation. Two were minor (only a small bleed, <1 cm in size at the operative site) and were managed conservatively. Surprisingly, the major hematoma could not be detected per-operatively. However, both the minor hematomas were picked-up very well during the biopsy and further confirmed by CT scan. One patient developed seizure on the first postoperative day and was managed with antiepileptic drugs. A case, which underwent surgical evacuation of major hematoma, expired in the postoperative period due to a severe chest infection and acute renal failure.

In the STB group, a total of three patients developed post procedure minor hematoma, and all were managed conservatively [Table 4]. Three patients showed mild transient worsening of neurological deficits, of which two had hematoma and the rest one had worsening of cerebral edema on the post-procedure CT scan.

Discussion

STB[2-5,13,15,18-24] has been demonstrated to be a low-risk procedure and may be performed with extreme

Table 3: Histopathology of biopsy specimens

Histopathology	Computed tomography-stereotactic biopsy	Ultrasound-guided biopsy
Astrocytoma	10	15
Lymphoma	2	2
Metastatic	1	1
Oligodendroglioma	0	1
Calcified material	1	0
Necrotic tissue	0	1
Noncontributory	1	2

Table 4: Complications associated with two biopsy methods

Complications	Computed tomography-stereotactic biopsy	Ultrasound-guided biopsy
Intra-tumoral hematoma	3	3
Neurological worsening	3	2
Headache	2	4
Seizure	1	1

accuracy (1 mm variance), especially with use of recent system compatible with CT scan and/or MRI. On the other hand, ultrasound-guided biopsy is also safe, cheap, quick, simple to perform, and technically reliable real-time method for superficially located lesions as well as for deep-seated lesions, independent of size.[1,6,8-10,14,16,17]

In 1994, Iacoangeli *et al*.[19] studied a total of 12 patients, of which 7 patients underwent STB-guided and 5 USGB procedures for acquired immune deficiency syndrome related focal cerebral lesions. The diagnostic yield was 92% for both types of the biopsy procedures and concluded both techniques proved safe and reliable. Lorenzo *et al*.[3] studied 18 patients with STB and 23 with USGB in 1991, and noticed shorter mean operating-time for USGB as compared to STB (56 vs. 236 min). In this series, the mean operating time for USGB was significantly shorter (94 min for USGB, and 149 min for STB). The mean operating time-period for USGB in our series is higher than quoted in Lorenzo's series. This may be due to the fact our patients were monitored for at least 15 min ultrasonically following the biopsy. However, definition of time-period was not provided in the Lorenzo's series. Other series comparing USGB with STB had small sample size in the study. Fugita *et al*.[9] has studied 19 patients in 1999, of which, seven patients underwent STB, 8 with USGB, one neuronavigator guided and the rest three with combination of ultrasound- and neuro-navigator guided biopsy for cerebral lesions. The diagnostic yield was 86% for STB, 75% USGB, and 100% all cases who underwent neuronavigator alone and combined with ultrasound-guided procedures.

The diagnostic yield for USGB are reported to vary in the ranges from 75% to 92%.[1,3,6-10] Pick-up rate for USGB in the present study was 91%, and this is comparable with those quoted in the literature. The diagnostic yield for STB varied in the literature from 86 to 95%.[1,3,9,12,18] In 1993, Rajshekhar *et al*.[11] demonstrated positive yields of 92.8% in their study involving 407 cases. However, smaller series, for example, Lorenzo *et al*. demonstrated a diagnostic yield of 94% in the series of 18 cases carried out in the year - 1991.[3] Fujita *et al*. also showed a positive yield of only 86% in their study of seven cases, who underwent STB in1999.[9] Pick-up rate in our current series for STB was 93% in the present study is comparable to the figures available. The total number of patients in the current study is small. The study is being continued further, and with the availability of more number of cases, the comparison would become more objective. Aker *et al*. retrospectively reviewed 130 cases, who underwent STB of brain mass. The overall diagnostic yield of the procedure was 94%.[21]

Yuen *et al*. compared the risk of hemorrhage in 54 cases, who underwent stereotactic brain biopsies using either 2.5-mm or 1.8-mm diameter biopsy needle. A total of 29 cases underwent biopsy with 2.5-mm and the rest 25 cases utilizing 1.8-mm needle, and the diagnostic yields were 90 and 96%, respectively. Yuen *et al*. further concluded thinner needle was associated comparatively lesser risk of bleeding.[22]

Lorenzo *et al*. used STB for lesion sizes 15 mm or less posterior fossa Lesions, while USGB used for supratentorial lesions with a size greater larger than 15 mm.[3] The diagnostic yield was 94% for the STB-guided procedures and 91% for USGB group. However, in the current study both methods of biopsy were utilized for the supratentorial lesion. Safety for the two procedures was similar to the current study, author also concluded USGB procedure are relatively more rapid, simpler, and economical to perform, however, STB could be reserved and utilized for lesion requiring mandatory and absolute accuracy.[3]

Rajshekhar concluded STB can be used for the diagnosis of intrinsic brain masses which are unsuitable for radical excision as histology, location, or number.[20] It can aid in determining the histology of all brain stem masses in adults and focal brain stem lesions in the pediatric population. STB is the method of choice for biopsy of pineal region harboring primary cerebral lymphoma, germinoma and deep-seated and eloquent region inflammatory masses.[20] Rachinger *et al*. reviewed 46 with radiologically suspected brainstem glioma, who underwent STB and histological examination was positive in 43 cases only Perioperative morbidity was 2.5%. Rachinger *et al*. further concluded STB is a safe method to obtain a valid tissue diagnosis carrying no mortality and without any permanent morbidity.[24]

However, in this study, posterior fossa mass and brainstem lesions were excluded, so for supratentorial

mass lesion, USGB may be safer option, especially in the resource-starved developing countries with limited CT scan availability and huge patient load for routine imaging, such center may not be able to extend support and facility for biopsy related procedure.

The other attractive aspect of USGB is the ability for real-time monitoring for picking-up of intra-operative hematoma formation. The two minor hematomas could be picked up on ultrasound monitoring. This was further confirmed by postoperative CT scan. Perhaps a longer period of ultrasonic monitoring following the procedure would be of greater help to detect hematoma not only at the biopsy site but also along the biopsy track. It is equally important to differentiate between post-biopsy changes on ultrasound, which sometimes may be confused for a hematoma.[1] Unfortunately, one major hematoma formation could not be picked-up during the intra-operative monitoring. This could be a shortcoming of the initial learning curve or hematoma might develop later in the postoperative period and picked in CT scan carried out at 6 hours following her surgical biopsy procedure.

The major complication rate following USGB varied in the literature from 5 to 8%.[3,7,16] However, in the present series the incidence of the major complication was 9%. One case required surgical evacuation of hematoma. The complication rate (for hematoma) the following STB varies in the literature between 0.9 and 8%.[3-5] Field *et al*.[5] reported an incidence of 8% hematoma formation, mostly major in their study demonstrated on immediate post-biopsy CT scanning. Shakal and Mokbel analyzed 150 cases for STB of intra-axial brain lesions. A total of 114 cases underwent CT-guided biopsy and rest 36 cases with MRI-guided and biopsy yield was 98%. In the postoperative period, CT scan revealed hemorrhage in 7 patients (4.7%), of which only two cases were symptomatic.[23]

In the present study, only three cases developed hematoma formation either in the tumors or in the track. All hematoma were minor, demonstrated on CT scan. All cases were managed conservatively. Although two of them, had also minor worsening in the neurological deficit, responded well to the conservative therapy. However, the incidence of complications was more in the early phase of the study and with accumulating experience showing declining pattern.

The limitation of the current study includes single institutional study, comparatively small sample size, as the current study is continuing with the recruitment of more cases in the every group may acquire adequate sample size. However, a larger multicenter study with adequate sample size is ideally required for drawing final conclusions.

Conclusions

The diagnostic yield was 93% for CT-guided STB procedures and 91% for ultrasound-guided biopsy. The USGB procedure was useful in real-time monitoring, and picking-up of intra-operative hematoma formation during the biopsy procedure itself, which is not possible with STB. The mean operation time for STB was 149.00 min, and for USGB was 94 min. The time-duration requirement for the USGB was significantly less than for STB ($P < 0.001$). The pick-up rate of STB was also comparable to USGB. The ultrasound-guided biopsy procedure is simple, equally effective alternative to CT STB and provides much economical alternative to STB in the developing resource-limited country, where excessive patient loads on CT scan for routine imaging may put an additional load in carrying out STB guided biopsy. However, the sample size is small and mostly representative of larger sized lesions. This is a pilot study, which is being continued with the inclusion of more cases, especially with smaller-sized lesions, the role of USGB would become much more precise and clear.

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Conflicts of interest

There are no conflicts of interest.

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