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Efficacy of neuronavigation guided biopsy in deep seated brain lesions

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ABSTRACT

Localisation of brain lesions and prevention of damage to vital structures are important goals in the operation of brain pathologies, which can be aimed after the development of many techniques (e.g. angiography, MRI, sonography, frame base stereotaxy). In spite of current developments in radiological imaging techniques, accurate histological diagnosis is required to determine the appropriate treatment methods for intracranial lesions.

The study was conducted in the Department of Neurosurgery, Dr Ram Manohar Lohia Institute of Medical Sciences, over a period of 18 months. Descriptive statistics (frequencies and percentages) were used to interpret the collected data. After editing, data was entered into SPSS free versions for statistical studies. The results from various sites of the biopsy were compared based on sensitivity, specificity, positive and negative predictive values.

In this study, 4 patients were found to be below 20 years, 7 patients in the 20 – 40 years age group, 10 patients in the age group of 40 to 60 years and 4 patients were above sixty years. 22 (88%) patients were found to have positive yield when the biopsy was taken from the core area while 3 (12%) patients were not having any positive results from the biopsy. Sensitivity, specificity, positive predictive value, and negative predictive value of various sites of the biopsy were calculated Sensitivity of the periphery came out to be 68.2 % while specificity was 67.7%. The positive predictive value of the periphery was found to be 93.8 % while the negative predictive value was

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22.2%. The sensitivity of the contrast-enhanced area came out to be 72.7 %, with specificity being 67.7%. The positive predictive value of periphery in such cases was found to be 94.1 % and the negative predictive value was 25%. The most common system-related complication was the inability to show choline peak properly, which was present in 7 patients.

Hence, it can be concluded safely that the use of neuronavigation is beginning to have a vital role in a variety of intracranial procedures with precise localisation of both intracranial as well as spinal lesions and prevention of damage to vital structures intraoperatively thereby significantly reducing procedure-related morbidity and mortality.

Introduction

Recently, there has been an increasing trend in most branches of surgery towards a reduction in the morbidity of a procedure by limiting surgical entry. This usually involves the application of technology such as laparoscopic cholecystectomy in general surgery[1]. A new era of neurosurgery has recently been unveiled with advent of image guided surgery..

Nowadays, a lot of of patients suffering from neurological focal deficiency or symptoms of increasing intracranial pressure or even for patients with slighter symptoms are being correctly diagnosed due to advent of technique such as computed tomography (CT) scan and magnetic resonance imaging (MRI) [,2,3,]. Furthermore, advances in the therapeutic methods and increasing number of survival in patients with systematic diseases, resulted in the development of metastasis into the central nervous system or high incidence of CNS infections, which are partly due to high confrontation with immune system deficiency (due to Acquired Immunodeficiency Syndrome (AIDS) or following immunosuppressive treatment in the recipients of transplantation or in patients under chemotherapy for systematic cancer); diversity and the number of CNS neuro-pathologies has increased requiring the needs for the more accurate detailed differential diagnosis of histology and cytology of cerebral space-occupying lesions (SOLs)[4,5]. In most of the patients, it is possible to diagnose the brain lesions accurately through clinical and laboratory findings. Examples are multiple sclerosis, secondary infectious and parasite diseases, metastatic tumors and brain involvement of systemic disease. But ,numerous brain lesions that are diagnosed in CT scan or MRI are the only provable documents for the disease and their treatment designing depends on the histological diagnosis[6,7]

Materials and Method

The study was conducted in Department of Neurosurgery, Dr. Ram Manohar Lohia Institute of Medical Sciences, over a period of 18 months.Total of 25 patients admitted in Neurosurgical wards underwent thorough examination and investigation. The inclusion and exclusion criteria used for study are as follows:

Inclusion Criteria

- Deep seated Lesions situated in basal ganglia, internal capsule, corpus callosum, periventricular areas, brain stem
- Lesions located in eloquent areas.
- Lesions refractory to an empirical therapy given previously.
- Diagnosis could not be ascertained by radiology (e.g., multiple lesions)

Exclusion Criteria

- Large lesions in non-eloquent and easily accessible areas amenable to surgical excision.
- Lesions producing mass effect and neurological deterioration
- Lesions near the surface of brain

Contrast enhanced CT scans/ MRI of the patients was taken in neuronavigation protocol one day prior to surgery. Histological examination was performed in the Department of Pathology. Radiological support was provided by Department of Radio diagnosis at institute. CT and MRI were done according to feasibility based on location of tumor, status of stent or metallic stents. The data was stored in CD. DVD in DICOM format and transferred to workstation for planning. Descriptive statistics (frequencies and percentages) were used to interpret the collected data.. After editing, data were entered into SPSS Free versions for statistical studies and analysis of the data was done by comparing all the details in the form of tables, texts and charts. Finally,the results from various sites of biopsy were compared on basis of sensitivity, specificity ,positive and negative predictive value.

Results and Observations

Table 1. Sex ratio of patients

Sex	Number of patients
Male	15

Female	10
Total	25

Table 1 shows the distribution of patients according to gender between. 10 patients were found females and 15 patients were found male.

Table 2. Age distribution of patients

SN	Age distribution	Number
1	0-20	4
2	20-40	7
3	40-60	10
4	60 and above	4

Table 2 showing that 4 patients were below 20 years. 7 patients were found in 20 – 40 years age group, 10 patients were found in the age group of 40 to 60 years and 4 patients were above sixty years.

Table 3. Histological diagnosis

SN	Histology	Number
1	GBM	6
2	Grade 3 Astrocytoma	4
3	Low Grade glioma	3
4	TBM	4
5	Abscess	2
6	NHL	2
7	Demyelinating disease	1
8	Negative	3

Table 4. Histological diagnosis from various sites of biopsy

Table 4A. 22 (88%) patients having positive yield when biopsy was taken from core area 3 (12%) patients were not having any positive result of biopsy. Out of this 22 patients 13 (52%) were diagnosed to be glioma, 2 (8%) were having abscess, 2 (8%) were diagnosed as NHL, 4 (16%) were heaving TB and 1 (4%) patient was diagnosed as Demyelinating disease.

CORE	Freq.	Percent	Cum
No lesion	3	12.00	12.00
Glioma	13	52.00	64.00
Abscess	2	8.00	72.00
NHL	2	8.00	80.00
TB	4	16.00	96.00
Demyelinating disease	1	4.00	100.00
Total	25	100.00	

Table 4B. 16 (64%) patients having positive yield when biopsy was taken from periphery area 9 (36%) patients were not having any positive result of biopsy. Out of these 16 patients 9 (36%) were diagnosed to be glioma, 3 (12%) were having abscess, 2 (8%) were diagnosed as NHL and 2 (8%) were having TB.

PERIPHERY	Freq.	Percent	Cum
No lesion	9	36.00	36.00
Glioma	9	36.00	72.00
Abscess	3	12.00	84.00
NHL	2	8.00	92.00
TB	2	8.00	100.00
Total	25	100.00	

Table 4C. 17 (68%) patients having positive yield when biopsy was taken from periphery area 8 (32%) patients were not having any positive result of biopsy. Out of these 17 patients 11 (44%) were diagnosed to be glioma, 2 (8%) were having abscess, 2 (8%) were diagnosed as NHL and 2 (8%) were having TB.

CONTRAST ENHANCED PORTION	Freq.	Percent	Cum
No lesion	8	32.00	32.00
Glioma	11	44.00	76.00
Abscess	2	8.00	84.00
NHL	2	8.00	92.00
TB	2	8.00	100.00
Total	25	100.00	

Table 4D. Due to registration error and inability to get MRI in few patients, only 12 (48%) patients underwent biopsy from Choline Peak voxals. While in 13 patients study was not possible. Out of these 12 patients in 3 (12%) biopsy results came out as Glioma, while in 9 (36%) patients having no positive yield.

MRS MARKED SITE (VOXALS)	Freq.	Percent	Cum
No lesion	9	36.00	36.00
Glioma	3	12.00	48.00
NA	13	52.00	100.00
Total	25	100.00	

Table 5. Sensitivity, specificity, Positive predictive value, Negative predictive value of various sites of biopsy

Table 5A. Sensitivity of periphery came out to be 68.2 % while specificity was 67.7% and Positive predictive value was 93.8 % and Negative predictive value of periphery was 22.2%.

	Positive	Negative
Positive	15	1
Negative	7	2

Table 5B. Sensitivity of contrast enhanced area came out to be 72.7 % while specificity was 67.7% and Positive predictive value was 94.1 % and Negative predictive value of periphery was 25%.

	Positive	Negative
Positive	16	1
Negative	6	2

Table 6. Patient related complication

SN	Complication	Number
1	Unintentional ventricular puncture	1
2	Intraoperative haemorrhage	0
3	Post operative neurological deficit	0
4	Post operative seizures	0
5	Surgical site infection	0

During this study only one patient had unintentional ventricular rapture while no other complication such as post operative neurological deficit, seizures, Intraoperative haemorrhage or surgical site infection was noted. All biopsy were taken in single attempt.

Table 7. System related complication

SN	Complication	Number
1	Registration error	3
2	System shut down	0
3	Inability to show contrast film properly	0
4	Inability to show choline peak are properly	7

During this study the most common system related complication was Inability to show choline peak properly, which was present in 7 patients while registration error was the second most common system related complication present in 3 patients.

Discussion

Image guided neurosurgery (neuro-navigation) or frameless stereotactic surgery has made a tremendous impact in the recent years. It gives a patient specific three-dimensional (3-D) Anatomy for preoperative planning and intra-operative navigation thus helping the surgeon to perform complicated procedures with improved accuracy and safety[8] Stereotactic biopsy for intracranial lesions is a realistic relatively safe procedure and is also a very efficient method especially in patient who need histological confirmation for the treatment. The overall diagnostic accuracy varies from 80-99%[9] In this study, out of 25 cases 22 biopsy (88%) came out to be positive and 3 cases (12%) came out to be negative which was comparable to previous studies showing positive yield of 89% and negative yield of 11%[10] in deep seated lesions.

In one more study a diagnostic yield of 86.16%[11]was found which was comparable to present study and in two other studies on frameless navigation guided biopsy, positive yield of 99%[12,13] was found. There was a study based on frame-based navigation guided biopsy which was showing positive yield of 84.21%, which was comparable to present study with positive yield of 88%[14]. In previous studies, discrepansy was noted in results of biopsy taken from central hypodense and well contrast enhanced area .So we took biopsy from various sites to look for efficacy from different areas, biopsy from core revealed 22(88%) positive results while 3(12%) were negative.In positive 22 cases, 6 cases of GBM, 4 cases of grade 3 anaplastic or grade 3 giomas, 3 cases of Low Grade Gliomas, 4 cases of TBM,2 cases of NHL, 2 cases of abscess and 1 case of demyeliting disease while 3 having negative biopsy.Biopsy taken from periphery sites having 16 (64%) positive results while (36%) were negative in positive results 9 cases were glioma, 3 were abscess, 2 were NHL and 2 were T.B. In contrast enhanced area 17 cases (68%) were positive while 8(32%) were negative, in which 11(44%) were glioma, 2(8%) were NHL ,2 were abscess and 2 (8%) were TB.In MR marked (voxols) there were only 12 cases out of which 3 (25%) were positive and 9(75%) were negative and these are all gliomas.

In our study 22 (88%) patients were having positive yield which was taken from core region while on comparing periphery region biopsy from core region biopsy, periphery was having 16(68%) yield with sensitivity of 68.2% specificity of 67.7% positive and negative predictive value of 93.8 and 22.2% in comparision to core while contrast enhanced area having a positive yield of 17(72.5%) with sensitivity of 72.7% specificity of 67.7% positive and negative predictive value of 94.1% and 25% respectively. In comparision to core, only 12 cases underwent biopsy

of MRS with choline peak voxals as few patients were not co-operative so MRI was not possible in these cases and also in few patients there was problem in marking Choline Peak area accurately in neuro-navigation system.

The complications in this series range from registration error, accurately localizing Choline peak area on navigation machine, Unintentional ventricular puncture, intra-operative haemorrhage, post operative neurological deficit, post operative seizures, surgical site infection etc. Registration error of 2.2 to 6 mm have been reported by Roessler et al (1998)[15], in our system it provides more accurate localization but a registration error of 1 mm was considered to be acceptable in view of brain shift. In initial cases we also had difficulty in registering Choline peak voxals. In our series there was 1(4%) patient associated with unintentional ventricular puncture, 3 patients had problem of registration error and 7 patients had problem of inability to show Choline peak area properly.

In various other previous studies complication such as symptomatic haemorrhage, morbidity due to neurological deficit, and mortality was observed with rates of 5.1%, 3.7%, 0.6% respectively but in our study, we had no cases of symptomatic haemorrhage, neurological deficit associated morbidity and mortality.

Study limitations

Relatively low number of patients and short follow-up periods are the limitations of our study.

Conclusion

Neuronavigation guided biopsy has proved beyond benchmark of technology for various deep seated lesions along with added advantages of safety, cost effectiveness, accuracy, ease of use ,decreaed duration surgery, reduced post surgery complications such as neurological deficit, intracerebral haemorrhage and reduced hospital stay.

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