

Posterior Fossa Tumors among the Patients undergoing Diffusion Weighted Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy in a Tertiary Care Hospital

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ABSTRACT

Introduction: Posterior fossa brain tumors are much more common in pediatric than adult population, accounting for 54 to 70% of total brain tumors in former and only 15 to 20% in later. Magnetic Resonance Imaging plays an important role in tumor detection and characterization. Diffusion Weighted Magnetic Resonance Imaging with Magnetic Resonance Spectroscopy provides additional information in characterization of posterior fossa tumors. The main aim of the study is to posterior fossa tumors among the patient's undergoing diffusion weighted magnetic resonance imaging and magnetic resonance spectroscopy in a tertiary care hospital.

Methods: This was a descriptive cross-sectional study conducted in the department of Radiology, Bir hospital among the patients undergoing imaging of the brain. The patients undergoing Magnetic Resonance Imaging were included in the study. Among the cases of posterior fossa tumors presented for Magnetic Resonance Imaging at Bir Hospital underwent imaging in Philips Achieva 1.5 Telsa MR scanner machine using our institutional protocol. The ethical clearance from the Institutional Review Board of National Academy of Medical Sciences, letter reference number 910/2080/81 was taken.

Results: Among the total of 250 cases, 76 (30.4%) (24.7% to 36.1% at 95% Confidence Interval) patients had posterior fossa tumor. Out of 76 cases, 40 (52.6%) were female and 36 (47.4%) were male. Most cases were between 36-45 years. In our study, metastasis 19 (25%) was the most common posterior fossa tumor followed by vestibular schwannoma 15 (19.7%).

Conclusions: The prevalence of posterior fossa tumors was more in the adult population and lower in children compared to the study done in similar settings. Addition of Diffusion weighed imaging and Magnetic Resonance Spectroscopy sequences to the conventional Magnetic Resonance Imaging increases the diagnostic accuracy in case of posterior fossa tumors in both adults and children.

Keywords: *posterior fossa tumors, magnetic resonance imaging, diffusion weighed imaging, magnetic resonance spectroscopy*

INTRODUCTION

Posterior fossa denotes infra-tentorial compartment of the cranial vault located in sub-occipital region.¹ Annual incidence of brain tumors is 10-17 per 100000 population.² Out of 20508 total new cases of cancer in Nepal, brain tumors account for 1.3% of cases, 1.9% of cancer related deaths.³ Brain tumors account for 20% of all tumors in children.⁴ Posterior fossa brain tumors are much more common in

pediatric than adult population, accounting for 54 to 70% of total brain tumors in former and only 15 to 20% in later.⁵

Non-contrast Computed tomography is helpful in detection of mass, presence of calcifications and hemorrhage and adjacent bony changes.⁶ Magnetic Resonance Imaging (MRI) plays an important role in tumor detection, localization (intra-axial vs extra-axial; supratentorial vs infratentorial) characterization.^{6,7}

Diffusion weighted imaging (DWI) is helpful in differentiation of brain abscess from necrotic/cystic components of brain tumors.⁸ DWI plays an important role in distinguishing between epidermoid cyst and arachnoid cysts, as the former shows diffusion restriction and later doesn't.⁹

Magnetic Resonance Spectroscopy (MRS) provides analysis through the chemical composition and metabolic state of the tissues and is based on the state of cell membrane, neuronal damage as well as the energy usage by cells.^{8,10}

The main aim of the study is to find posterior fossa tumors among the patient's undergoing diffusion weighted magnetic resonance imaging and magnetic resonance spectroscopy in a tertiary care hospital.

METHODS

This was a cross-sectional study conducted in department of Radiology, National Academy of Medical Science (NAMS), Bir hospital, Mahabouddha, Kathmandu, Nepal after obtaining ethical clearance from the Institutional Review Board of NAMS, letter reference number 910/2080/81. The brain tumor with clinical or radiological suspicion tumors presenting for MRI at Bir Hospital were included in this study. Patients with clinical or laboratory features of encephalitis, infarction, congenital malformations of posterior fossa, posterior fossa space occupying lesions of sub-centimetric size, patients with recurrent/residual posterior fossa tumors and motion or other artifacts comprising the image quality were excluded from this study.

The sample size was calculated by formula:

$$n = Z^2 \times p \times q / e^2$$

$$= 1.96^2 \times 0.5 \times 0.5 / 0.07^2$$

$$= 196$$

Where,

n = required sample size

Z = 1.96 at 95% Confidence Interval

p = prevalence taken 50% for maximum sample size calculation

e = margin of error

The calculated sample size is 196. The sample size 250 was taken for the study. MRI of all the patients was done in Philips Achieva 1.5 Telsa (T) MR scanner machine with patient lying in supine position using head coil. All cases underwent routine scan initially according to our depart-

mental protocol that consists of Turbo spin echo (TSE) T1 weighted images (WI) in axial and sagittal plane, T2 TSE WI in axial and coronal plane, Fluid attenuation inversion recovery (FLAIR), GRE in axial plane and fat suppressed post contrast images in all three orthogonal planes following administration of 0.1mmol/kg of gadolinium based contrast agents. Axial diffusion weighted images were taken with ADC b-value of 0 and 1000 s/mm.² Multivoxel MRS was taken from the masses with long TE values of 288 msec respectively. Various MRI sequences including the parameters that were used are tabulated based on the parameters.

The image was analyzed with the following characteristics: The characteristics of the posterior fossa tumors that were evaluated include location, size, MR sequence signal intensity, margins, heterogeneity, post contrast enhancement pattern, perilesional edema, intracranial mass effects, involvement of any local structures and vascular invasion.

The ADC values of the tumors were calculated by placing the region of interest (ROIs) over the solid, enhancing, non-necrotic, and DWI-restricted parts of a solid-enhancing lesion. ROIs were placed in the enhancing wall of the lesions in case of cystic peripherally enhancing lesions. Thus, obtained mean ADC value by the MRI software was recorded. The MRS parameters were analyzed for Cho, Cr, NAA, lipid (lip), Lac and ratios of Cho/Cr.

RESULTS

Among the total brain tumor 250 patients undergoing MRI with MRS, posterior fossa tumor was present in 76 (30.4%) (24.7% to 36.1% at 95% Confidence Interval) patients. The age distribution of posterior fossa tumors is as follows (Table 1).

Table 1. Age and gender-wise distribution of the posterior fossa tumor. (n= 76)

Age group (in years)	n (%)
0-5	9 (11.8)
6-10	7 (9.2)
11-15	4 (5.2)
16-25	8 (10.5)
26-35	12 (15.7)
36-45	16 (21)
46-55	13 (17.1)
56 and above	7 (9.2)

The most common distribution of posterior fossa tumor was cerebellopontine angle 34 (44.7%) followed by fourth ventricle 18 (23.7%) (Table 2).

Table 2. Distribution of tumor within posterior fossa (n= 76).

Location	n (%)
Cerebellopontine angle	34 (44.7)
Fourth ventricle	18 (23.7)
Cerebellar hemisphere	15 (19.7)
Brain stem glioma	9 (11.9)

The posterior fossa tumor distribution regardless of age and sex was mostly metastasis followed by vestibular schwannoma (Table 3).

Table 3. Distribution of various posterior fossa tumor irrespective of age and sex (n= 76).

Masses	n (%)
Medulloblastoma	9 (11.8)
Pilocytic astrocytoma	8 (10.5)
Ependymoma	8 (10.5)
Metastasis	19 (25)
Hemangioblastoma	2 (2.6)
Vestibular Schwannoma	15 (19.7)
Meningioma	8 (10.5)
Epidermoid cyst	4 (5.4)
Arachnoid cyst	3 (4.9)

The mean ADC value of benign lesion was 1.83 mm²/s (Table 4).

Table 4. ADC value distributions of various posterior fossa masses (n= 76).

Nature of lesion (N)	Minimum ADC (mm ² /s)	Maximum ADC (mm ² /s)	Mean ADC (mm ² /s)
Benign (46)	1.6	3.1	1.83
Malignant (30)	0.69	1.21	0.794

MRS characteristics of posterior fossa masses, medulloblastoma has peak choline/creatinine and metastasis has also peak choline/creatinine (Table 5).

Table 5. MRS characteristics of posterior fossa masses (n=76).

Mass	Metabolite peak
Medulloblastoma	Choline/Creatine
Pilocytic astrocytoma	Choline/Creatine
Ependymoma	Choline/Creatine

Epidermoid	Lipid
Metastasis	Choline/Creatine
Hemangioblastoma	Lipid
Vestibular Schwannoma	Myoinositol
Meningioma	Glutamine/glutamate; Choline

DISCUSSION

The posterior fossa tumors, prevalence in child is between 54-70% and in adults the prevalence is 15-20% which is higher than observed in our study.¹¹ Total of 76 cases of posterior fossa tumor were present in our study, 17.1% of these cases were in 46-55 years of patients. Most common mass in posterior fossa was found to be metastasis and most common location of a mass in posterior fossa was found to be cerebellopontine angle.

Diffusion-weighted MRI with ADC values was able to provide additional information about tumor grades and tumor types, as well as differentiating tumors from other brain space-occupying lesions when used in combination with conventional MRI sequences. MRS is more able to characterize specific tumor types as it is based on analysis of chemical composition and metabolic activity of the tissue.¹² In our study, metastatic lesions showed reduced NAA level, elevated choline peak and Cho/cr ratio, which correlated with the study conducted by Meyer et al.¹³ and Tamilchelvan et. without evidence of elevated choline peak in perilesional edema. In another study, the most significant peak on spectroscopy was Cho in medulloblastoma and metastasis, ml in vestibular schwannoma, and lip in hemangioblastoma and metastasis.¹⁴ Similar findings were observed in our study.

Among the cystic lesion, diffusion-weighted imaging with ADC values was found crucial in differentiating arachnoid cysts from an epidermoid cyst as later one showed diffusion restriction with low ADC values.¹⁵

The mean ADC values for benign and malignant tumors were 0.794 and 1.84x 10⁻³ mm²/s in this study which were like that of study of Bose, et al.⁷ In this study, the mean ADC value was 1.92, 1.12 and 0.69 for JPA, ependymoma, and medulloblastoma, reflecting there is significant differences in mean ADC values that can be used for their differentiation. Mean ADC values in this study were also high in acoustic neuroma as compared to meningioma located in CP angle. Two cases of hemangioblastoma were included in this study, each containing mural nodule showing diffusion restriction. However, the mean ADC value was found to be higher than metastasis, medulloblastoma and ependymoma. These findings were like the study done

by Bose, et al.,¹⁰ Tantawy, et al.¹⁶ and Quadery, et al.¹⁷

Our study has certain limitations. Sample size in this study was limited, and the cases of posterior fossa tumor were heterogeneous in distribution. Multicentric study in the future could overcome such limitations.

CONCLUSIONS

In our study posterior fossa tumor prevalence is low-

er in children and higher in adults population compared to the study done in a similar setting. Better soft tissue contrast resolution and multiplanar multisequence makes MRI a good imaging modality in evaluation of the posterior fossa tumor. Addition of the DWI and MRS to conventional sequence increases the accuracy of the diagnosis of the posterior fossa tumors.

Conflict of Interest: None.

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