

# Predictive Value of MRI and CT Findings in Childhood Medulloblastoma Studied in Thai Patients

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## ABSTRACT

**Objective:** To evaluate the prognostic value of CT and MRI findings in patients with medulloblastoma.

**Methods:** From 1998 to 2007, the MRI and CT of fourteen patients with medulloblastoma were retrospectively reviewed. The findings of cyst or necrotic portion, composition of calcification, hemorrhage and residual tumor after surgical removal were evaluated. Histopathologic findings were classified as large cell and non-large cell type. Outcomes of the disease were indicated by evidence of leptomeningeal seeding, a recurrence event and survival time after diagnosis.

**Results:** Only the large cell type of medulloblastoma was statistically significant in decreasing survival time. No other MRI or CT findings were statistically significant to predict outcomes of the disease.

**Conclusion:** The histologic type of medulloblastoma is a predictive indicator of the outcome of treatment regardless of imaging findings. However, the limitation of this study due to small sample size was considered.

**Keywords:** Medulloblastoma, CT, MRI, prognosis

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Medulloblastoma is the most common pediatric central nervous system malignancy and the most common primary tumor of the posterior fossa in children.<sup>1</sup> Some cases in adults with better prognosis were reported.

Medulloblastoma is divided into 4 pathological subtypes including classic type, desmoplastic type, extensively nodular with advanced neuronal differentiation type, and large cell type. The classic type is the most common type.<sup>2</sup> The large cell type is the least common type and appears to portend the worst prognosis.<sup>2</sup> The desmoplastic type is more common in adults than in children.

On magnetic resonance imaging (MRI), medulloblastomas are presented with either a homogeneous or more commonly heterogeneous signal intensity (SI) mass. In cases with heterogeneous SI, the mass may be cystic, necrotic, calcified, hemorrhagic or a mixture of these components.<sup>3</sup>

Cerebrospinal fluid (CSF) seeding was presented in 33% of all patients at the time of initial diagnosis

and detected on spinal MRI study or CSF cytology (3). The CSF seeding is one of the prognostic factors which decrease the 5-year-survival from 73% to 50%.<sup>4</sup> Recurrent disease is another negative prognostic factor and always occurs within 2 years after initial treatment.<sup>3</sup>

Classification of the patients into average and high risk group is useful for treatment planning. The average risks include age more than 3 years old at presenting symptom, posterior fossa location, total or near total tumor resection and no evidence of metastasis. The high risks include age less than 3 years old at presenting symptom, a location that is not posterior fossa, subtotal tumor resection and evidence of metastasis.<sup>5</sup>

The objective of this study was to evaluate MRI and CT findings for their prognostic value of medulloblastoma.

## MATERIALS AND METHODS

From 1998 to 2007, all patients diagnosed medulloblastoma in the authors' institute were searched for by using ICD 10 and retrospectively reviewed. Only patients with computed tomography (CT) or MRI of the

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brain before tumor resection and younger than 18 years old were enrolled. Patients who were lost to follow up were excluded. Age, sex, date at diagnosis, CSF cytology, treatment of choice, recurrent events and survival time were recorded. All patients were pathologically classified into classic type, desmoplastic type and large cell type by an experienced neuropathologist (T.S.). The extensively nodular with advanced neuronal differentiation subtype was not found in the present study. The patients were then grouped into large cell and non-large cell (classic and desmoplastic) types.

Brain and spine imagings were evaluated by an experienced neuroradiologist (O.C., 20 years experience). All patients with pre-operative MRI studies of the brain were interpreted as cyst or necrotic portion, composition of calcification and/or hemorrhage. Necrotic and cystic parts of the lesion could not be well distinguished on MRI images. They were thus classified into the same group. Four patients had additional CT scans before treatment, which were used for calcification detection. The leptomeningeal seeding was diagnosed by positive CSF cytology or positive findings from MRI of the whole spine. One patient with CSF cytology as a result of atypical cells with uncertain nature was classified into the positive group.

Residual tumors were evaluated by post-operative gadolinium-T1 weighted image (Gd-T1wi) and graded according to enhancement pattern into thin linear (grade 0), thick linear (grade 1), lobulated-line appearance (grade 2) and definite mass (grade 3). For one patient without post-operative MRI study, a post-operative CT study was evaluated for the residual tumor. For statistical analysis, the authors defined grade 0 as negative for residual tumor and grade 1-3 as positive for residual tumor.

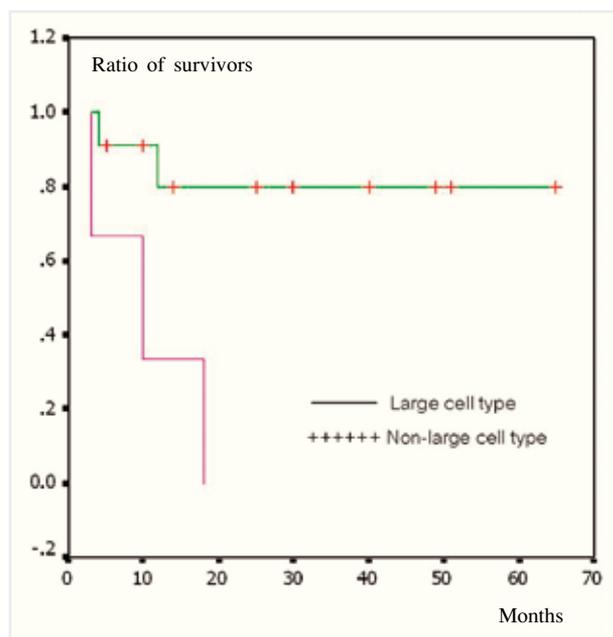
Clinical records of the patients were reviewed and finalized in September 2008 for evidence of recurrent and survival status (dead or not dead). Survival time was the time at diagnosis until the time of death or until the time of last observation in the survived patient (at least nine months for the last patient). Records from follow up images (CT or MRI) and laboratory study were evaluated for evidence of recurrence and CSF seeding.

**TABLE 1.** Summary data of 14 patients with medulloblastoma.

Patient age(yr) /sex	Path* type	post-op treatment	Calcifi cation	Hemor rhage	Cyst or necrosis	CSF seed	Residual Grade**	Recurrence	survival time (mo)
1. 8, M	C	RT+CMT	yes	yes	no	yes	0	no	12
2. 9, M	C	RT+CMT	no	yes	yes	no	0	no	25
3. 14, M	C	RT+CMT	no	no	yes	no	0	no	30
4. 9, F	L	RT+CMT	yes	no	no	yes	3	no	18
5. 6, F	C	RT+CMT	no	no	yes	no	1	no	51
6. 10, F	L	RT+CMT	no	yes	no	no	0	no	10
7. 9, F	C	RT+CMT	no	yes	no	yes	3	yes	65
8. 1, F	L	CMT	no	no	yes	yes	3	no	3
9. 2, M	D	RT+CMT	no	no	yes	no	0	no	40
10. 18, M	C	RT+CMT	no	no	yes	yes	0	no	49
11. 5, F	C	RT+CMT	no	no	yes	no	0	no	4
12. 5, F	C	RT+CMT	no	no	yes	yes	2	no	10
13. 7, F	C	RT+CMT	no	no	no	yes	0	no	14
14. 13, F	C	RT+CMT	no	no	yes	no	1	no	5

\*Pathological type: C; classic type, L; large cell type, D; desmoplastic type

\*\*Residual grade: 0; thin linear, 1; thick linear, 2; lobulated, 3; mass



**Fig 1.** Survival curve by large cell type vs. non-large cell type patient.

The evidence of leptomeningeal seeding, recurrent event and survival time were used to indicate outcomes of the disease.

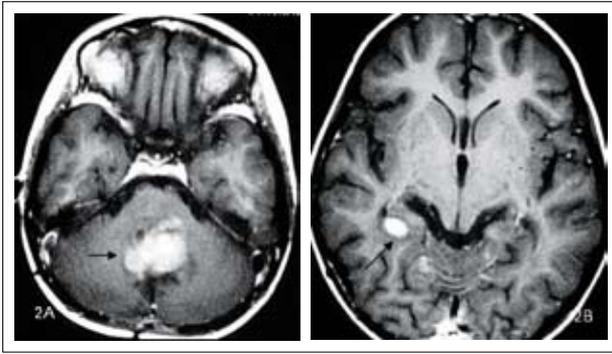
The Fisher exact test was used to analyze the relationship of various factors and outcomes of the disease and Kaplan-Meier was used for survival analysis.

This study was approved by the Institute Review Board for Human Research.

## RESULTS

There were fourteen patients (five male and nine female) with mean age 8 years old (range 1-18 years old) who fulfilled the criteria. The hard copy images in 7 cases and digital images on patients archival computer system in 7 cases were evaluated. (Table 1)

Leptomeningeal seeding was found in 7 patients, two of which had calcification in the preoperative tumors.



**Fig 2.** A 9-year-old female presented with ataxia. The axial Gd-T1weighted image of the brain showed midline lesion of tumor in posterior fossa (a) with right occipital lobe metastasis (b).

Statistical significance of the relationship of calcification and CSF seeding was observed. There was no significant prognostic factor on CT or MRI findings to the outcomes.

According to the pathological subtypes, there was only one desmoplastic type patient in this study. No significant relationship between pathological subtypes and leptomeningeal seeding was found. However, the authors found that the large cell type group was statistically significant in decreasing survival time ( $P = 0.0072$ , Log Rank test). (Fig 1 and Table 1)

Patient No.7 (Fig 2 and 3) with classic type medulloblastoma and intramedullary and supratentorial metastasis (right occipital region) had a recurrent event at 16 months after diagnosis. She was treated by



**Fig 3.** The same patient as in Fig 2; sagittal T2weighted image (a), and Gd-T1weighted image (b) of the whole spine showed intramedullary metastasis at conus medullaris. She developed recurrent disease in 16 months later.



**Fig 4.** A 1-year-old female presented with right hemiparesis and failure to thrive. Axial T1weighted image showed right cerebellar hemispheric mass with cystic component.

radiotherapy and survived until the last follow up period of this study (about 5.5 years).

All patients except one underwent post-operative chemoradiotherapy. The exceptional patient was treated by post-operative chemotherapy alone due to her age being 1 year. According to likely side effects of radiation on the immature developing central nervous system in very young children less than 2 years old, the patients will receive only chemotherapy with radiation



**Fig 5.** (a) sagittal T1weighted image, (b) sagittal Gd-T1 weighted image with fat suppression demonstrate leptomeningeal metastasis diagnosed from MRI study of the whole spine as enhancing CSF space.

delayed until the age of two.<sup>8</sup> This patient had a cerebellar hemispheric lesion, whereas the other cases had midline lesions. (Fig 4)

## DISCUSSION

Prognostic factors of medulloblastoma are important information for the treatment decision. The leptomeningeal seeding and a recurrent event were poorer prognostic factors according to some literatures in the past.<sup>3,4</sup> In the present study they were used to indicate poorer outcome of the disease together with the lowered survival time.

A study about the prognostic factors found that only an age of more than 14 years old and gross cystic or necrotic changes in the primary tumor were positive prognostic factors.<sup>6</sup> The other factors such as size of primary tumor, the degree of hydrocephalus at diagnosis, the presence of residual tumor in the post-operative CT/MRI, and the functional status of the patient prior to radiation treatment were not significant prognostic factors. In the present study, the cystic-necrotic and all other MRI findings were also found to be not significant prognostic factors. Calcification seems to be the only significant prognostic factor in the present study, because both patients with calcified lesions developed leptomeningeal seeding. However, the limitation of the study due to small sample size was considered, as the calcification was found in only two patients.

The large cell type of medulloblastoma was significantly linked with decreased survival time in the present study which is similar to previously reported literature.<sup>2</sup>

Patient No. 7 who had supratentorial and intramedullary metastases had developed recurrent disease, and this was notable at an unusual metastatic location. The intramedullary metastasis of medulloblastoma is extremely rare.<sup>9</sup>

Some authors demonstrated that neither MR imaging nor CSF cytological analysis alone was sufficient, but both should be used in combination to establish the diagnosis.<sup>7</sup> These are realized in the present study when the MRI of the whole spine of a patient who had obvious leptomeningeal metastasis was seen on

Gd-T1wi (Fig 5), although the CSF cytology result was negative.

## CONCLUSION

Only the large cell type of medulloblastoma had a predictive value to survival time in the present study. No MRI or CT finding was a significant prognostic factor. However, the limitation of this study due to small sample size was considered.

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