Thalamic tumors in children: a reappraisal

STEPHANIE PUGET, M.D., 1 DARACH W. CRIMMINS, F.R.C.S.I., 5
MATTHEW R. GARNETT, F.R.C.S., 1 JACQUES GRILL, M.D., 1 RICARDO OLIVEIRA, M.D., 1
NATHALIE BODDAERT, M.D., 2 ALISON WRAY, F.R.A.C.S., 6
ARIELLE LEOUCH-TUBIANA, M.D., 1 THOMAS ROUEAU, M.D., 1 FEDERICO DI ROCCO, M.D., 1
MICHIEL ZERAH, M.D., 1 and CHRISTIAN SAINTE-ROSE, M.D. 1

Departments of Pediatric Neurosurgery, 1Neuroradiology, and 1Neuropathology, Hôpital Necker-Enfants Malades, and 4Department of Pediatric and Adolescent Oncology, Gustave Roussy Institute, Paris, France; 2Department of Neurosurgery, Leeds General Infirmary, Leeds, United Kingdom; and 3Royal Children’s Hospital, Melbourne, Australia

Object. Two to five percent of pediatric brain tumors are located in the thalamus. The optimal management for these tumors remains unclear. The aim of this study was to determine whether clinical and neuroimaging features could guide treatment, and to what extent these features, together with histological diagnosis and treatment modalities, influenced survival.

Methods. The records of 69 children who presented with a thalamic tumor between 1989 and 2003 were retrospectively reviewed. Three groups of tumors were analyzed separately: 1) unilateral thalamic tumors (54 lesions); 2) thalamopeduncular tumors (six); and 3) bilateral thalamic tumors (nine).

In the patients in whom a unilateral thalamic tumor was diagnosed, 33 had an astrocytic tumor. Of the 54 patients, 32 had a low-grade and 22 had a high-grade tumor. The survival rate was significantly better for patients with the following characteristics: symptom duration longer than 2 months (p < 0.001), lesions with low-grade histological features (p = 0.003), and tumor excision greater than 90% at surgery (p = 0.04). The perioperative morbidity and mortality rates were 37 and 4%, respectively. Fifty-four percent of the patients in this group had a long-term and independent survival. The thalamopeduncular tumors were mostly pilocytic astrocytomas, which had a good prognosis following surgery. The bilateral thalamic tumors in this series were mainly low-grade astrocytic lesions, and more than half of the children attained long-term survival (mean follow-up duration 4.5 years).

Conclusions. The majority of tumors arising in the thalamus are astrocytic, of which less than half are high-grade lesions. Histological evaluations should be performed in all patients in whom resection is being considered for discrete lesions. Long-term survival is possible in patients with these tumors.

KEY WORDS • thalamic tumor • glioma • pediatric neurosurgery

Up to 5% of pediatric intracranial tumors occur in the thalamic region. 6,28 The management regimen for children with tumors in this region is not clear-cut. The existing literature is sparse and difficult to interpret because many series combine both adult and pediatric populations, 2,16,23,32,34 or they include tumors arising in the basal ganglia and other diencephalic structures. 12,18-23,30 In the few series in which purely thalamic tumors in children are addressed, the cases are often confined to one histological group, usually astrocytic tumors. 1,6,8,14,17,28,35

A clear anatomical picture of these deeply seated lesions is now possible because of the recent improvements in imaging modalities. Although these advances make more aggressive surgery technically feasible, it is uncertain which children might benefit from a more radical surgical procedure. 7 In most pediatric tumors the interpretation of the clinical and neuroimaging features observed at presentation predicts the likely pathological findings and outcome. Unfortunately, the histological features of tumors in this region are diverse; hence a wide variation in clinical behavior and outcome is experienced. Questions remain whether surgery is necessary, feasible, or even safe in these children.

In this series we retrospectively reviewed the children presenting to our institution with thalamic tumors over a 14-year period. The aims were to identify prognostic factors and to clarify the behavior and response to treatment of this diverse group of tumors.

Abbreviations used in this paper: CT = computed tomography; ETV = endoscopic third ventriculostomy; ICP = intracranial pressure; MR = magnetic resonance; VP = ventriculoperitoneal.
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Clinical Material and Methods

Patient Population

Case notes and imaging studies were reviewed for all children presenting between 1989 and 2003 to Hôpital Necker-Enfants Malades with lesions in the thalamic region. Tumors arising from adjacent structures (basal ganglia, hypothalamus, optic pathways, pineal region, brainstem, and ventricles) were excluded. In addition, patients were excluded from the study if the greater part of their treatment had been performed elsewhere.

Clinical and Neuroimaging Data

Clinical data, including age at presentation, duration and type of symptoms, treatment received, and status at the end of the follow-up period were recorded. The patients who were still alive were categorized as having complete remission with no residual tumor, stable disease, or progressive disease at the last follow-up visit. All patients underwent neuraxis MR imaging prior to treatment and during the follow-up period, and in addition, most children had undergone a preoperative head CT scan. Heterogeneity, cystic nature of the lesions, presence of calcification, edema, and contrast enhancement were noted, as were features on T₁- and T₂-weighted MR imaging. The presence of hydrocephalus was noted, and tumor extension to other structures, if applicable, was carefully documented. All the neuroimages and histological specimens were interpreted by a single pediatric neuroradiologist and a pediatric neuropathologist, respectively.

Treatment Regimens

In patients who underwent surgery, the degree of resection was defined as partial (≤ 90%), subtotal (> 90%), or total on postoperative imaging. Various surgical approaches (anterior interhemispheric, posterior interhemispheric, transcortical, and transinsular) were used; the approach was determined according to the location of the tumor in the thalamus and surrounding structures.

Statistical Analysis

The chi-square test was used to compare survival status with age at presentation, duration of symptoms, tumor size, and extent of surgery. Overall survival was correlated with symptom duration, pathological findings (benign or malignant), and extent of resection (total/subtotal compared with partial/biopsy/none). These correlations were made using univariate analysis according to the Kaplan–Meier method; the power of the predicting factors was evaluated in a Cox model. Probability values of less than 0.05 were considered statistically significant. Statistical analysis was performed using commercially available software (SPSS, Inc.). Values are given as the mean ± standard deviation.

Results

Between 1989 and 2003, 1725 children presented to Hôpital Necker-Enfants Malades with new intracranial tumors; 69 of them (4%) had thalamic tumors and satisfied the entry criteria for the study. When reviewed as a series, it became apparent that from a surgical point of view these tumors fell into three categories, as follows: 1) unilateral thalamic tumors, originating from one thalamus with possible extension to adjacent structures; 2) thalampeduncular tumors, arising at the junction of these two structures with symmetrical supra- and infratentorial extension; and 3) bilateral thalamic tumors, originating from both thalami as opposed to tumors with contralateral extension. In our series, 54 children (78%) had unilateral thalamic tumors, six (9%) had thalamopeduncular tumors, and nine (13%) had tumors arising from both thalami.

Unilateral Thalamic Tumors

In this group of 54 patients there were 29 boys, and in 30 of the children the tumor was on the left side. The mean age at presentation was 9.5 ± 4.4 years (range 0–16 years), and the mean duration of symptoms was 147 ± 238 days (range 2–1093 days). Thirty-one children (57%) experienced symptoms for fewer than 2 months prior to presentation. The types of symptoms and neuroimaging features seen on MR and CT studies are shown in Tables 1 and 2. The most common presentation of children with this tumor was with symptoms of increased ICP and/or motor deficits. Presentation with sensory deficits was unusual. The mean tumor volumes, which were calculated based on the MR images, were 32 ± 31 ml (range 2–131 ml). In this subgroup, 34 patients (63%) required cerebrospinal fluid diversion (VP shunts in 24 and ETV in 10).

The treatment strategy for this subgroup is shown in Table 3. Forty-nine patients (91%) underwent surgery for the tumor, and in 25 of them a greater than 90% excision was achieved. Two examples of discrete unilateral thalamic tumors before and after complete resection are shown in Figs. 1 and 2, and an example of a diffuse unilateral thalamic tumor for which only a biopsy was performed is shown in Fig. 3. Of the 49 patients who underwent surgery, 31 experienced either improvement or no change neurologically, 16 were neurologically worse, and two died in the perioperative period. The histological results, which are summarized in Table 4, confirm that 33 (61%) of the 54 lesions were astrocytic. Twenty-four (44%) were low-grade and 22 (41%) were high-grade tumors. There were eight patients with no histological diagnosis; in three of them biopsy results were nondiagnostic, three were referred directly for radiotherapy at the beginning of the series without undergoing biopsy sampling, and for two a policy of observation was adopted. Postoperative radiotherapy and/or chemotherapy were used in patients with malignant tumors and in those with progressive low-grade tumors.

<table>
<thead>
<tr>
<th>Clinical Feature</th>
<th>Unilat Thalamopeduncular</th>
<th>Bithalamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>total patients</td>
<td>54</td>
<td>6</td>
</tr>
<tr>
<td>increased ICP</td>
<td>33 (61)</td>
<td>3 (50)</td>
</tr>
<tr>
<td>motor deficits</td>
<td>35 (65)</td>
<td>4 (67)</td>
</tr>
<tr>
<td>sensory deficits</td>
<td>4 (7)</td>
<td>1 (17)</td>
</tr>
<tr>
<td>visual deficits</td>
<td>23 (43)</td>
<td>3 (50)</td>
</tr>
<tr>
<td>other*</td>
<td>21 (39)</td>
<td>4 (67)</td>
</tr>
</tbody>
</table>

* Other symptoms consisted of involuntary movement, spasticity, seizures, behavioral problems, and central pain.
Of these 54 children, 37 remain alive and 17 have died (mean follow-up duration 4.9 years, median 3.6 years). The Kaplan–Meier curve (Fig. 4A) shows that the probability of a 5-year survival for children in this group was 66/100 (7%). When patients with low- and high-grade tumors were considered separately, the probability of a 5-year survival was 86/100 (7%) and 41/100 (11%), respectively (Fig. 4B). Similarly, when the patients who underwent a total or subtotal resection were considered separately from the ones with a partial resection or biopsy, the 5-year survival rates were 83/100 (6% and 48/100 (9%), respectively (Fig. 4C). Of the 37 survivors, 11 are in complete remission, 21 are alive with stable disease, and five have evidence of ongoing disease progression. Of these 37 patients, 29 are living independently. No patient was lost to follow up.

There was no correlation between age at presentation and survival, but presentation at a younger age was significantly associated with a higher incidence of benign tumors (p = 0.03). As shown in Table 5, patients with a low-grade tumor and with symptoms that had lasted for more than 2 months had a statistically significantly prolonged survival compared with patients who had a high-grade tumor (p = 0.003 for comparison of tumor grade, and p < 0.001 for duration of symptoms). In addition, the survival was significantly longer (p = 0.04) in those who underwent total or subtotal resection, compared with those in whom only a partial resection or biopsy procedure was performed. Furthermore, the patients with a tumor volume of 30 ml or less had a statistically significantly longer survival (p = 0.03) compared with those who had a tumor volume of greater than 30 ml. No significant differences in survival duration were found when comparing patients who had received radiotherapy and/or chemotherapy with those who had not.

A Cox regression analysis was performed using the variables that individually had an effect on survival (histological findings, duration of symptoms, tumor volume, and extent of resection). The two variables that remained significant prognostic factors after this analysis were the extent of surgery (total or subtotal resection compared with partial resection or biopsy sampling, p = 0.03) and the pathological type (low-grade compared with high-grade tumors, p = 0.03).

**Thalamopeduncular Tumors**

There was no gender predilection (three boys and three girls) for this subgroup of patients, and the mean age was 9.3 years (range 3–13 years). Motor deficits were the most common form of presentation (Table 1).

The MR images revealed that these were typically contrast enhancing, heterogeneous lesions with little surrounding edema (Table 6). All were hyperintense on T2-weighted MR imaging. Half of the lesions were cystic, and in five of
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six patients associated hydrocephalus was found at presentation. The tumors varied in volume from 1 to 78 ml. Examples of pre- and postoperative MR images of a cystic, enhancing, thalamopeduncular tumor are shown in Fig. 5.

All children with this tumor type required cerebrospinal fluid diversion; in five cases it was the first procedure and in one case it was done during the follow-up period (in three an ETV was performed and in the other three placement of a VP shunt was done). Five patients underwent surgery; two for biopsy sampling, one for a partial excision, and two for a subtotal, staged excision. The sixth patient did not undergo operation because of the surgeon’s clinical decision to observe expectantly. The predominant histological finding (in four of the five specimens) was pilocytic astrocytoma, with a malignant astrocytoma diagnosed in the remaining patient (Table 4). Radiotherapy was used postoperatively in three patients.

The child with the malignant astrocytoma has died, one child has progressive disease, and four have stable residual disease (mean follow-up duration, 4.9 years).

Bithalamic Tumors

In this subgroup the mean age was 9.6 years, and five of the nine patients were girls. The main clinical feature at presentation was motor disturbances, as in the other groups (Table 1). The features demonstrated on MR images are shown in Table 6. These tumors tended to be homogeneous (seven of nine), and fewer than half (four of nine) enhanced with addition of contrast material. Six of the patients had hydrocephalus. Examples of neuroimages obtained in a patient with a bilateral thalamic tumor are shown in Fig. 6.

All nine patients underwent surgery; in eight of them biopsy sampling was performed and one had a partial excision. Five patients required a VP shunt insertion to control hydrocephalus. The histological analysis of the tumors is shown in Table 4; seven patients had low-grade lesions, of

![Image 1](https://via.placeholder.com/150)

**TABLE 4**

<table>
<thead>
<tr>
<th>Histo Finding</th>
<th>Unilateral Thalamic</th>
<th>Thalamopeduncular</th>
<th>Bithalamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>pilocytic astrocytoma</td>
<td>9 (17)</td>
<td>4 (67)</td>
<td>1 (11)</td>
</tr>
<tr>
<td>low-grade astrocytoma</td>
<td>7 (13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>malignant astrocytoma</td>
<td>17 (31)</td>
<td>1 (17)</td>
<td>1 (11)</td>
</tr>
<tr>
<td>oligodendroglioma</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low-grade</td>
<td>2 (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>anaplastic astrocytoma</td>
<td>3 (6)</td>
<td></td>
<td>1 (11)</td>
</tr>
<tr>
<td>oligoastrocytoma</td>
<td>4 (7)</td>
<td></td>
<td>1 (11)</td>
</tr>
<tr>
<td>PNET</td>
<td>2 (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>neurocytoma</td>
<td>1 (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ganglioglioma</td>
<td>1 (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no histo assessment</td>
<td>8 (15)</td>
<td>1 (17)</td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>54 (100)</td>
<td>6 (100)</td>
<td>9 (100)</td>
</tr>
</tbody>
</table>

* PNET = primitive neuroectodermal tumor.
† Designates the 22 high-grade tumors.

![Image 2](https://via.placeholder.com/150)

**Fig. 2.** Low-grade mixed glioma demonstrated on MR images obtained in a 15-year-old girl. A: Axial T<sub>1</sub>-weighted image obtained after addition of contrast material, demonstrating a nonenhancing left-sided thalamic tumor that was removed in a staged procedure because of poorly defined tumor margins at surgery. B: Axial image demonstrating appearance of the lesion before the second procedure. C: Final MR image demonstrating a complete excision.

**Fig. 3.** High-grade astrocytoma demonstrated on MR images obtained in an 11-year-old girl. Coronal (left) and axial (right) T<sub>1</sub>-weighted images obtained after administration of contrast agent, demonstrating an enhancing and infiltrative right-sided thalamic tumor. The patient’s disease was managed by performing a stereotactic biopsy procedure to confirm the diagnosis, followed by chemotherapy and radiotherapy.
which five were fibrillary astrocytomas, and two had high-grade tumors. Radiotherapy was used postoperatively in four patients.

In this subgroup five patients remain alive with disease (mean follow-up duration 4.5 years), four of whom are independent, whereas four have died (including the two patients with malignant tumors). Two of the children with low-grade tumors died (both of them had received radiotherapy).

**Discussion**

Thalamic tumors account for 2 to 5% of all intracranial tumors in pediatric series.5,6,14,35 Despite the fact that this incidence is higher than that of, for example, craniopharyngiomas or pinealomas (2 and < 1%, respectively), there is a comparative paucity of published literature concerning the treatment of these lesions. In this series we have reviewed the patients presenting to our institution over a 14-year period with a newly diagnosed thalamic tumor. In total, 1725 patients with intracranial tumors were treated during this period, of whom 69 (4%) had a newly diagnosed thalamic tumor, which is in keeping with the previous reports in the literature.5,6,14,35 The previously published series of thalamic tumors are shown in Table 7.

The children in the current series generally presented with symptoms of increased ICP and, on examination, were found to have a motor deficit, which is in keeping with previous studies.1,15,25 Based on the MR images obtained in these 69 patients, we were able to divide the thalamic tumors into three groups, which included bilateral thalamic, unilateral thalamic, and thalamopeduncular lesions. In the current series, all of the bilateral thalamic tumors had a similar appearance on neuroimaging, with both thalami being symmetrically enlarged. These lesions were normally homogeneous on MR images, with minimal mass effect and often no surrounding edema, which is in keeping with previous descriptions.7,28 The unilateral thalamic tumors were, however, a more mixed group, with an almost equal distribution of lesions demonstrating homogeneous and heterogeneous signals on MR imaging. Fewer than half of these tumors were confined to the thalamus, with the remainder extending to the surrounding structures.

A subgroup of these unilateral tumors was identified that was called thalamopeduncular. These tumors probably

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**TABLE 5**

Univariate analysis of prognostic factors in the 54 patients with unilateral thalamic tumors*

<table>
<thead>
<tr>
<th>Prognostic Factor</th>
<th>5-Yr OS (%)</th>
<th>Mean OS</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>histo finding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low-grade</td>
<td>87.5</td>
<td>&gt;60 mos</td>
<td>0.003</td>
</tr>
<tr>
<td>high-grade</td>
<td>45.5</td>
<td>21 mos</td>
<td></td>
</tr>
<tr>
<td>symptom duration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥2 mos</td>
<td>95.7</td>
<td>&gt;60 mos</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;2 mos</td>
<td>48.4</td>
<td>22 mos</td>
<td></td>
</tr>
<tr>
<td>tumor vol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤30 ml</td>
<td>84.0</td>
<td>&gt;60 mos</td>
<td>0.03</td>
</tr>
<tr>
<td>&gt;30 ml</td>
<td>40.0</td>
<td>23 mos</td>
<td></td>
</tr>
<tr>
<td>extent of resection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total/subtotal</td>
<td>85.0</td>
<td>&gt;47 mos</td>
<td>0.04</td>
</tr>
<tr>
<td>other</td>
<td>47.1</td>
<td>24 mos</td>
<td></td>
</tr>
</tbody>
</table>

* OS = overall survival.
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arose at the junction of the thalamus and cerebral peduncle and invariably extended inferiorly into the cerebral peduncle and superiorly into the thalamus. These thalamopeduncular tumors were all high-signal lesions on T2-weighted MR images and normally enhanced after injection of contrast material. When the imaging appearances were reviewed for these three groups, there was no individual or even a set of features that could be used to predict either the type or grade of the tumor. Indeed, in the patients with unilateral pilocytic astrocytomas, only half of the tumors demonstrated the typical appearance of a cystic lesion, with an enhancing mural nodule and no surrounding edema.

Unilateral Thalamic Tumors

This group of tumors accounted for 78% of the patients in the current series. In this group, two factors were shown to influence outcome in a multivariate analysis, namely the grade of the tumor and the extent of resection. The patients in whom more than 90% of the tumor was resected had a significantly improved survival duration compared with the ones in whom 90% or less of the tumor was resected. In addition, the patients in whom low-grade tumors were found had a significantly improved survival duration compared with the ones who had a high-grade lesion. The effect that tumor grade may have on outcome has been described previously; however, the effect that extent of resection may have on outcome has not been described previously in patients with thalamic lesions.

In the patients with a unilateral thalamic tumor, 22 (41%) had a high-grade lesion, and all of these patients received adjuvant therapy after surgery. In this group the expected 5-year survival rate was 41%. This prolonged survival is in contrast to findings in previously reported series in which the survival duration after surgery in patients with a malignant tumor was approximately 1 to 2 years. It is possible that this improvement in outcome is related to the extent of surgery, in keeping with a report from the Children’s Cancer Group, which confirmed that, in patients with an intracranial malignant tumor, survival improved if the extent of tumor resection was greater than 90%.

In our series the larger extent of resection, whether it was in patients with a low- or high-grade lesion, improved prognosis. This implies that, if possible, a child with a symptomatic unilateral thalamic tumor should undergo a radical resection. Survival with severe disability would clearly not be the aim of radical surgery, however, and indeed in the current series 29 of the 37 long-term survivors were independent. There are several surgical routes that can be used to approach thalamic tumors. The particular approach should be selected based on the location of the tumor in the thalamus to minimize resection of unaffected brain. Moreover, because radical resection of these tumors has been reported to be difficult and the complication rate high, their excision in a staged procedure should be considered (Fig. 2). The use of a staged procedure is recommended either for the larger tumors in which highly functional tissue (pyramidal tract, basal ganglia, remaining thalamus) is stretched around the lesion and can easily be injured when attempting a one-stage removal, or for lesions with poorly defined boundaries. In
patients with diffusely infiltrating tumor, only stereotactic biopsy sampling was undertaken.

Administration of radiotherapy to histologically unconfirmed thalamic tumors has previously been advocated. There were three patients who received radiotherapy at the start of the series despite the lack of a histological diagnosis. This is now considered unacceptable, however. In a series of thalamic mass lesions in which stereotactic biopsy sampling was performed, eight (18%) of 44 were nonneoplastic, highlighting the need for tumor confirmation before instituting potentially harmful adjuvant therapies. In the current series, 25 of 54 patients underwent radiotherapy after surgery for their unilateral thalamic tumors. This adjuvant therapy was reserved, with the exceptions mentioned earlier, for patients with high-grade lesions or for those with tumors that showed clinical and neuroimaging evidence of progression.

Patients with a smaller tumor volume and a longer history of symptoms had a significantly better outcome compared with those who had a larger volume and a shorter history of symptoms. These findings are likely to reflect the tumor grade, in that a patient with a malignant tumor often presents with a short clinical history and on neuroimaging is often found to have a large lesion. This finding is in keeping with a previous report. Other clinical findings, for example symptoms of raised ICP, have also been associated with a worse outcome. In our study no other clinical (or indeed neuroimaging) finding correlated with outcome.

Thalamopeduncular Tumors

This subset of unilateral thalamic tumors is quite distinct from the thalamic tumors that extend into the midbrain. In the current series of 69 patients who presented with a thalam-
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<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>No. of Patients</th>
<th>Symptoms</th>
<th>Op</th>
<th>Grade†</th>
<th>Other Treatments</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frank et al., 1987</td>
<td>1 NA</td>
<td>motor 2, mental deterioration 1, personality changes 2, strabismus 2, hyperpia gia 1</td>
<td>STBx</td>
<td>LG</td>
<td>interstitial 131I RT</td>
<td>alive at 3 yrs</td>
</tr>
<tr>
<td>Partlow et al., 1992</td>
<td>3</td>
<td>motor 2, mental deterioration 1, personality changes 2, strabismus 2, hyperpia gia 1</td>
<td>STBx 3</td>
<td>2 LG, 1 HG</td>
<td>NR</td>
<td>all 3 alive at 1–3 yrs</td>
</tr>
<tr>
<td>Ruel et al., 1992</td>
<td>1</td>
<td>↑ICP 1, motor 1</td>
<td>STBx</td>
<td>LG</td>
<td>cisplatin &amp; RT</td>
<td>died at 8 mos</td>
</tr>
<tr>
<td>Reardon et al., 1998</td>
<td>12 NA</td>
<td></td>
<td>NA</td>
<td>9 LG, 3 HG</td>
<td>NR</td>
<td>1-yr prog 78%; 2-yr prog 100%; 11 dead w/in 2 yrs; LG tumors: 4-yr OS 0%</td>
</tr>
<tr>
<td>Yoshida et al., 1998</td>
<td>1</td>
<td>mental deterioration, motor, sensory, strabismus</td>
<td>VP shunt, STBx</td>
<td>LG</td>
<td>cisplatin, etoposide, &amp; RT</td>
<td>died at 8 mos</td>
</tr>
<tr>
<td>Di Rocco &amp; Iannelli, 2002</td>
<td>4 ↑ICP 3, motor 3, strabismus 1</td>
<td>STBx 3, PR 1</td>
<td>3 LG, 1 HG</td>
<td>3 RT (1 refused)</td>
<td>all pts w/ LG tumor dead w/in 7–12 mos; patient w/ HG lesion alive, tumor stable</td>
<td></td>
</tr>
<tr>
<td>Gudowius et al., 2002</td>
<td>2</td>
<td>motor 3, ↑ICP 2, mental deterioration 3</td>
<td>STBx 2</td>
<td>1 LG (Ki 67 &lt;5%), 1 HG (Ki 67 20%)</td>
<td>NR</td>
<td>NR</td>
</tr>
</tbody>
</table>

* Only patients younger than 16 years of age are shown from mixed series. Abbreviations: HG = high-grade; LG = low-grade; NA = not available; NR = not reported; prog = progression; STBx = stereotactic biopsy; † = increased.

Survival and can be achieved with minimal occurrences of morbidity and mortality. Tumors that are not safe to resect should be investigated using biopsy sampling to exclude nonneoplastic pathological entities and to direct future adjuvant therapies based on histological tumor types. Radiotherapy and chemotherapy should be reserved for patients with malignant lesions or tumor progression. Adjuvant therapies should not be considered without a histological diagnosis.

There are two subgroups of thalamic tumors. The first includes the thalamopeduncular tumors, which are generally benign pilocytic astrocytomas. These can be macroscopically excised and potentially have a good prognosis. The second subgroup includes the bithalamic tumors, which are often low-grade astrocytomas. Following biopsy sampling to confirm the histological type, these lesions can be observed expectantly, with more than half of the patients with tumors in this subgroup attaining a long-term survival.

Conclusions

Thalamic tumors in pediatric patients are generally astrocytic, and more than half are benign. In patients with unithalamic tumors, a short duration of symptoms, large tumors, incomplete resection, and high-grade histological type are all poor prognostic factors. There were no specific imaging features that were predictive of the histological type. Neuromaging could be used to determine resectability, however, particularly in well-defined lesions with no extension into adjacent structures. Total or subtotal resection is the goal; this extent of resection is associated with improved overall survival and can be achieved with minimal occurrences of morbidity and mortality. Tumors that are not safe to resect should be investigated using biopsy sampling to exclude nonneoplastic pathological entities and to direct future adjuvant therapies based on histological tumor types. Radiotherapy and chemotherapy should be reserved for patients with malignant lesions or tumor progression. Adjuvant therapies should not be considered without a histological diagnosis.

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Address reprint requests to: Christian Sainte-Rose, M.D., Service de Neurochirurgie Pédiatrique, Hôpital des Enfants Malades, 149 rue de Sèvres, 75743 Paris Cedex 15, France. email: christian.sainte-rose@nck.aphp.fr.