Incidental findings of mass lesions on neuroimages in children

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Increasing use of neuroimaging in children has led to more incidental findings of CNS mass lesions, the management of which is uncertain. The authors' aims in this study are to describe these mass lesions and their evolution, as well as to discuss the management options and determine the prevalence of incidental CNS mass lesions at their pediatric clinic. A retrospective study was undertaken in children with primary CNS tumors who were younger than 18 years old and were admitted to the University Children's Hospital of Zurich, Switzerland, between January 1995 and December 2010. In 19 (5.7%) of 335 patients with newly diagnosed CNS tumors, the diagnosis of a CNS mass lesion was an incidental finding. Reasons for obtaining neuroimages in these 19 patients were head trauma (in 6 patients); research protocols (in 3); nasal/orbital malformations (in 2); endocrinological and psychiatric evaluations (in 2); and vertebral bone anomaly without neurological signs, absence seizures, congenital ataxia, recurrent vomiting, developmental delay, and "check-up" at the explicit request of the parents (in 1 patient each). Seven patients underwent immediate surgery for low-grade glioma (4 patients) and craniopharyngioma, ependymoma, and choroid plexus papilloma (1 patient each); and 12 were treated conservatively or were observed. Ten of 12 conservatively treated patients remained stable (median follow-up time 1.8 years) and the other 2 underwent delayed surgery because of tumor progression (medulloblastoma in one patient and fibrillary astrocytoma in the other).

Clinicians are increasingly challenged by the discovery of incidental CNS mass lesions. A subgroup of such lesions (with typical imaging patterns such as tectal glioma and dysembryoplastic neuroepithelial tumor) can be monitored conservatively, clinically, and radiographically. Future prospective studies are needed to define optimal management strategies based on larger collections of natural histories, as well as to assess the true prevalence of incidental CNS mass lesions. *(DOI: 10.3171/2011.9.FOCUS11121)*

Key Words • **incidental finding** • **magnetic resonance imaging** • **brain imaging** • **children** • **brain tumor**

In recent decades, the increasing use of CT and MR imaging of the CNS has led to the more frequent discovery of unexpected results. Incidental findings (also called "incidentalomas") are defined as previously undetected abnormalities that are unrelated to the purpose of the examination. This phenomenon, as well as the prevalence and the nature of the lesions, have been reported in several publications, mainly those involving adults.[1,4,9,12,20,21] In their meta-analysis, Morris et al.[15] found an overall prevalence of 2.0% (range 1.1%–3.1%) of nonneoplastic incidental brain findings and an overall prevalence of 0.7% (95% CI 0.47%–0.98%) of neoplastic incidental brain findings.

Only recently, studies have been published on CNS incidentalomas in children. These studies have reported variable rates of incidental findings, which are most often benign and do not need referral. Most lesions described are extracerebral lesions (for example, fluid-filled paranasal sinuses), cerebral malformations (for example, Chiari I malformation), or cysts (for example, a pineal or arachnoid cyst). A minority consist of vascular malformations (for example, cavernoma or developmental venous anomaly), tissue changes, or tumoral lesions, accounting for less than 1% of all the incidental brain findings.[6,8,11,14,18] The nature and the spontaneous evolution of these neoplastic lesions, as well as their appropriate management, remain under debate in view of limited literature reports and personal experience.

The aims of this study are to describe incidental CNS mass lesions and their evolution, to discuss management options, and to determine the prevalence of incidental CNS mass lesions in our pediatric clinic.

Abbreviations used in this paper: DNT = dysembryoplastic neuroepithelial tumor; LGG = low-grade glioma; NF1 = neurofibromatosis Type 1.

Methods

A retrospective study was undertaken in children 18 years old and younger with primary CNS tumors, who were admitted consecutively to the University Children's Hospital of Zurich, Switzerland, between January 1995 and December 2010. Medical case notes, referral letters, neurosurgical records, histopathology reports, follow-up data, and survival outcomes were reviewed. An incidental finding is generally defined as being unexpected and without any correlation with the patient's history and clinical examination. In this specific context, we use the following inclusion criteria for an "incidental mass lesion:" 1) imaging evidence of a clearly space-occupying lesion, without or with a characteristic neuroimaging pattern in favor of a specific tumor type (that is, craniopharyngioma, dysembryoplastic neuroepithelial tumor, or tectal glioma); or 2) imaging evidence of a permanent lesion that does not correspond to the usual appearance of an inflammatory (as seen in multiple sclerosis or acute disseminated encephalomyelitis), residual (such as postischemic or posttraumatic), hamartomatous, or migrational (as heterotopia) lesion. Excluded from this study were children with neurocutaneous disorders (NF1, NF Type 2, or tuberous sclerosis).

Results

Patient and Tumor Characteristics

Between January 1995 and December 2010, a total of 24,047 neuroimaging studies (12,725 brain MR images, 9161 brain CT scans, and 2161 spinal MR images) were obtained at the University Children's Hospital of Zurich, Switzerland. Since some children underwent more than 1 neuroimaging examination (for example, postoperative and/or oncological follow-up investigations), the number of patients is smaller (estimated to be approximately 15,000).

In the same period, 335 patients with a primary CNS tumor were admitted. The tumor characteristics of these patients are summarized in Table 1. The median age at diagnosis for all patients was 7.6 years (range 0.0–18.4 years). Two hundred three patients (61%) were boys and 132 (39%) were girls. Diagnoses were established by histological assessment of a tumor specimen obtained at surgery in 297 patients (89%) and by typical imaging findings in 20 patients (6%) (for example, diffuse intrinsic pontine glioma). In 4 patients (1%) with large tumors and poor general condition, no biopsy was undertaken and the histology remains unknown. In 16 patients (5%) in good general condition, no biopsy was undertaken, and the patients were monitored using a wait-and-see policy.

In 19 (5.7%) of 335 patients with newly diagnosed CNS tumors, the diagnosis of a CNS mass lesion was an incidental finding (Table 2). The median age at diagnosis for patients with incidentalomas was 7.5 years (range 1.0–14.9 years). Reasons for obtaining neuroimages in these 19 patients were head trauma (in 6 patients); research protocols (in 3); nasal/orbital malformations (in 2); endocrinological and psychiatric evaluations (in 2); and vertebral bone anomaly without neurological signs, absence seizures, congenital ataxia, recurrent vomiting, developmental delay, and "check-up" at the explicit request of the parents (in 1 patient each). Therefore, no patient had an imaging finding related to and/or explaining an underlying neurological disorder. In retrospect, the indication for neuroimaging in the patients in Cases 2 (anxiety disorder), 3 ("check-up" at the request of the parents), and 4 (absence seizures) is debatable.

Seven patients underwent immediate surgery for LGG (4 patients) and craniopharyngioma, ependymoma, and choroid plexus papilloma (1 patient each); and 12 were treated conservatively or with observation. Ten of these 12 conservatively treated patients remained stable (median follow-up time 1.8 years, range 0.3–16.3 years) and the remaining 2 patients underwent delayed surgery because of tumor progression (medulloblastoma in one patient and fibrillary astrocytoma in the other).

The following comments are intended to illustrate the rationale behind the treatment decisions.

TABLE 1: Location und histology of 335 consecutively diagnosed CNS tumors*

Location & Tumor Histology	No. of Tumors (%)
infratentorial	145 (43)
medulloblastoma	50 (15)
cerebellar LGG	29 (9)
brainstem glioma	36 (10)
ependymoma	12 (3)
other	11 (3)
tumors of unknown histology	7 (2)
supratentorial hemispheric	121 (36)
LGG	35 (10)
HGG	19 (5)
choroid plexus tumor	2 (0.6)
ependymoma	8 (2)
PNET	7 (2)
neuronal/mixed neuronal-glial tumor	19 (5)
meningioma	11 (3)
other	15 (4)
tumors of unknown histology	5 (1)
supratentorial midline	56 (17)
craniopharyngioma	16 (5)
germ cell tumor	8 (2)
LGG	16 (5)
PNET	3 (0.9)
other	13 (4)
tumors of unknown histology	0 (0)
spinal cord	13 (4)
LGG	6 (2)
ganglioglioma	2 (1)
other	4 (1)
tumors of unknown histology	1 (0.3)

* HGG = high-grade glioma; PNET = primitive neuroectodermal tumor.

TABLE 2: Incidental findings of CNS mass lesions and patient characteristics*

Case No.	Age at Diagnosis (yrs), Sex	Reason for Neuroimaging	Location	Size (mm)	Histology	Initial Management	Clinical Course	FU Time Since Diagnosis (yrs)
1	7.5, M	head trauma	cerebellum/brainstem	ax 20 × 20	medulloblastoma	observation (1.5 yrs)	delayed subtotal resection, radio-chemotherapy; SD	3.8
2	14.9, M	anxiety disorder	cerebellum	cor 23 × 18	LGG	observation	SD	1.7
3	5.2, M	"check-up" due to parental request	cerebellum	ax 11 × 10	LGG†	observation	SD	1.3
4	8.1, F	absence seizures	cerebellum	ax 29 × 22	pilocytic astrocytoma	primary subtotal resection	SD	2.1
5	1.0, M	developmental delay	4th ventricle/cerebellum	cor 35 × 60	choroid plexus papilloma	primary total resection	CR	5.4
6	2.1, M	head trauma	4th ventricle	ax 25 × 25	anaplastic ependymoma	primary total resection, radio-chemotherapy	CR	9.3
7	14.6, F	research protocol: cardiac malformations	tectum mesencephali	ax 11 × 10	LGG†	observation	SD	1.5
8	14.3, M	orbital trauma	tectum mesencephali	cor 32 × 30	pilocytic astrocytoma	primary subtotal resection	SD	5.2
9	5.4, F	evaluation for tall stature	pons	ax 26 × 15	LGG†	observation	spontaneous regression	4.1
10	1.0, M	research protocol: HIE	occipital	ax 24 × 21	fibrillary astrocytoma	biopsy	delayed total resection due to tumor progression; CR	11.7
11	10.8, M	head trauma	occipital	cor 30 × 21	DNT†	observation	SD	9.7
12	1.5, M	head trauma	temporoparietooccipital	ax 90 × 70	desmoplastic ganglioglioma	primary total resection	CR	9.6
13	13.1, M	research protocol: cardiac malformations	lat ventricle	cor 15 × 12	neurocytoma†	observation	SD	1.6
14	2.1, M	nasal fistula	thalamus	cor 7 × 5	LGG†	observation	SD	1.8
15	11.8, M	recurrent vomiting	thalamus	ax 4 × 3	LGG†	observation	SD	0.3
16	9.1, F	congenital cerebellar ataxia	thalamus	ax 6 × 3	LGG†	observation	slow progression, 2nd lesion subthalamic	5.8
17	1.2, M	orbital lymphangioma	sellar/suprasellar	ax 37 × 23	mature teratoma	observation (3.8 yrs)	delayed subtotal resection; SD	5.6
18	10.8, M	orbital trauma	suprasellar	sag 20 × 20	craniopharyngioma	primary total resection	CR	8.1
19	12, M	vertebral malformation	intramedullar	sag 25 × 10	LGG†	observation	slow progression	16.3

* ax = axial; cor = coronal; CR = complete remission; FU = follow=up; HIE = hypoxic/ischemic encephalopathy; sag = sagittal; SD = stable disease.

† Assumed diagnosis based on neuroimaging findings.

Incidental Lesions With Subsequent (Immediate) Surgical Intervention (7 patients)

Case 4. This patient underwent examination elsewhere for absence seizures. The cerebellar hemispheric tumor found on MR imaging was not considered responsible for the seizures. Although there was no CSF obstruction and the neurological examination findings were normal, the parents opted for surgical exploration. As expected, the histological examination confirmed pilocytic astrocytoma.

Case 5. The MR imaging findings in this patient, who underwent investigation for general developmental delay, were suggestive of a choroid plexus tumor, which was surgically treated in view of its considerable size. As expected, the developmental delay did not improve.

Case 6. This patient underwent MR imaging after a fall from a considerable height. The fourth ventricle was occluded and, thus, in our view, surgical removal was indicated.

Case 8. This patient was hit by a snowball in the orbital region. Papilledema was confirmed by an ophthalmologist. A large tectal tumor and early signs of supratentorial ventricular dilation prompted surgery before clinical signs of increased intracranial pressure were evident.

Case 10. This patient underwent follow-up in the context of a research protocol for perinatal hypoxic/ischemic encephalopathy. A subcortical lesion was first detected at 1 year of age and was assumed to be an LGG. The lesion increased in size over the next few months. The parents finally agreed to biopsy and surgical removal.

Case 12. This patient was seen after a fall in a play group. Neurological examination findings were normal, but the patient was markedly macrocephalic. Magnetic resonance imaging revealed a large space-occupying lesion with midline shift. An operative procedure was performed with excellent results.

Case 18. This patient was found to have a craniopharyngioma on MR images obtained for orbital trauma. Findings on neurological, ophthalmological, and endocrine evaluations were normal. An interdisciplinary discussion concluded that surgical intervention was indicated.

Incidental Lesions Managed Conservatively (10 patients)

Cases 2 and 3. In these patients, a cerebellar tumor was found incidentally on neuroimages obtained for anxiety (Case 2) and for a "check-up" at the explicit wish of the parents in view of an "extreme sport" adventure (Case 3). Given that the MR imaging patterns in both patients were typical of LGGs with no evidence of CSF obstruction (Fig. 1) and that the neurological examination findings were normal, we observed these patients by conducting regular clinical and neuroimaging investigations.

Cases 7 and 13. These patients underwent neuroimaging in the context of a comprehensive outcome study of congenital cardiac malformations. The lesion in the patient in Case 7 was compatible with a tectal LGG not leading to aqueductal obstruction; therefore, we only ob-

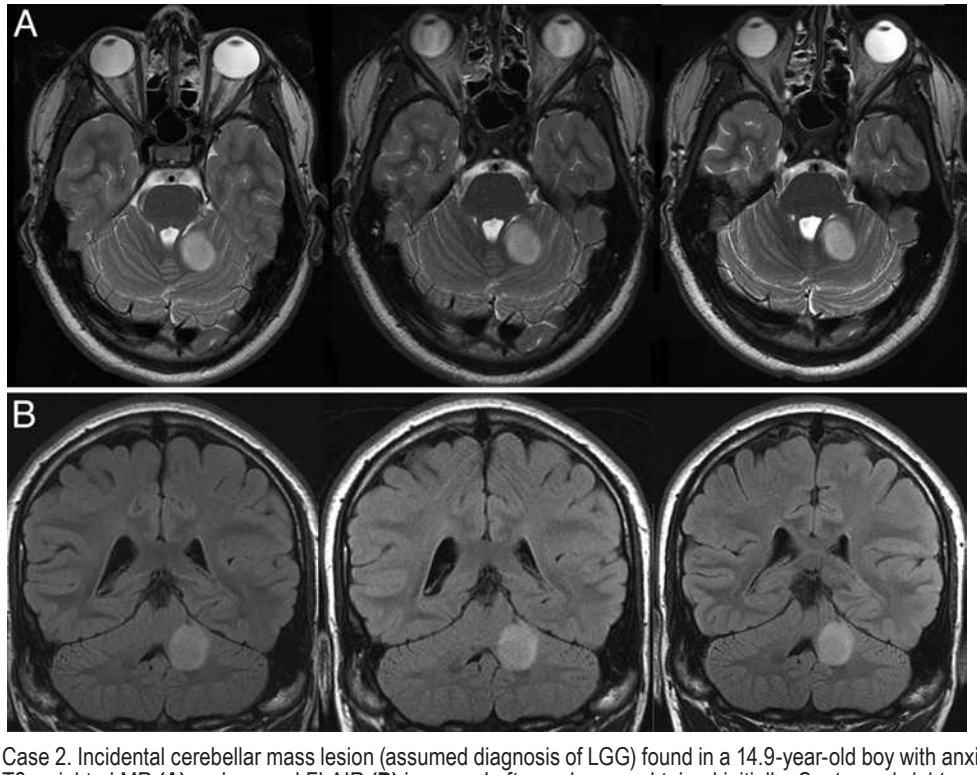

Fig. 1. Case 2. Incidental cerebellar mass lesion (assumed diagnosis of LGG) found in a 14.9-year-old boy with anxiety disorder. Axial T2-weighted MR **(A)** and coronal FLAIR **(B)** images. *Left panels* were obtained initially. *Center* and *right panels* show the lesion after a period of 5 and 13 months, respectively, of wait-and-see.

served this patient. The lesion in the patient in Case 13 (Fig. 2) was suggestive of a neurocytoma. A diagnostic (stereotactic or open) biopsy was considered to carry a substantial risk of surgical morbidity. Observation with repeat (every 6 months) clinical and MR imaging investigations proved justified.

Case 9. In this patient, neuroimaging was requested by an endocrinologist in view of the patient's tall stature. The brainstem appeared mildly enlarged with ill-defined, rather diffuse T2-weighted signal abnormalities reminiscent of "unidentified bright objects" as often seen in cases of NF1. However, there were no clinical signs of NF1, and findings from the neurological examination were normal. Two years later, MR imaging findings were unchanged, and on a third MR imaging study obtained 2 years later, the lesion was no longer evident. We have no explanation for this observation.

Case 11. The lesion found in this patient, who was evaluated after he fell off his bicycle, had the characteristic imaging pattern of a DNT (Fig. 3). As this was an incidental finding, conservative management was suggested. In the subsequent 9.7 years, the patient has remained well and never experienced a seizure.

Cases 14–16. These patients were found incidentally to harbor small thalamic lesions (Fig. 4), not explaining the clinical picture or corresponding to findings seen as residual findings (that is, postischemic), such as heterotopia or gliosis, but being compatible with an LGG. A diagnostic biopsy was not considered justified, balancing the diagnostic benefit against the potential morbidity of the diagnostic procedure. These children will continue to be managed conservatively.

Case 19. This patient had vertebral anomalies at the cervicothoracic junction. He underwent initial examination elsewhere for a vague suspicion of closed spinal dysraphism. Spinal MR imaging was suggestive of a cystic neoplastic lesion. Findings on neurological examination were normal. The patient was lost to follow-up but was again seen 16.3 years later. He was a healthy, active student. Additional MR imaging revealed an increase in the size of the lesion, which was considered to be an LGG (Fig. 5). In view of normal findings on the neurological examination, the patient opted for further observation.

Incidental Findings Initially Observed, With Delayed Intervention (2 patients)

Case 1. This patient underwent cranial CT scanning at 7.5 years of age after mild head trauma. The images revealed an ill-demarcated vermian lesion with small focal calcifications. Magnetic resonance imaging confirmed a lesion with extension in the brainstem; there was no CSF obstruction and no contrast enhancement. Computed tomography scanning had already been performed 1 year previously, after a fall on the playground. Findings on this CT scan, which were considered normal at that time, were in retrospect identical to the findings on the recent CT scan. In view of this apparently prolonged stable situation in a boy with normal findings on neurological examinations, a conservative attitude was adopted, with imaging follow-up investigations performed every 6 months. A year and a half later, slow motor deterioration was noted, accompanied by tumor progression. Surgical exploration revealed a medulloblastoma. In view of extension into the brainstem, only partial removal was achievable.[22]

Case 17. This patient was initially investigated at the age of 1.2 years for an orbital process with fluctuating

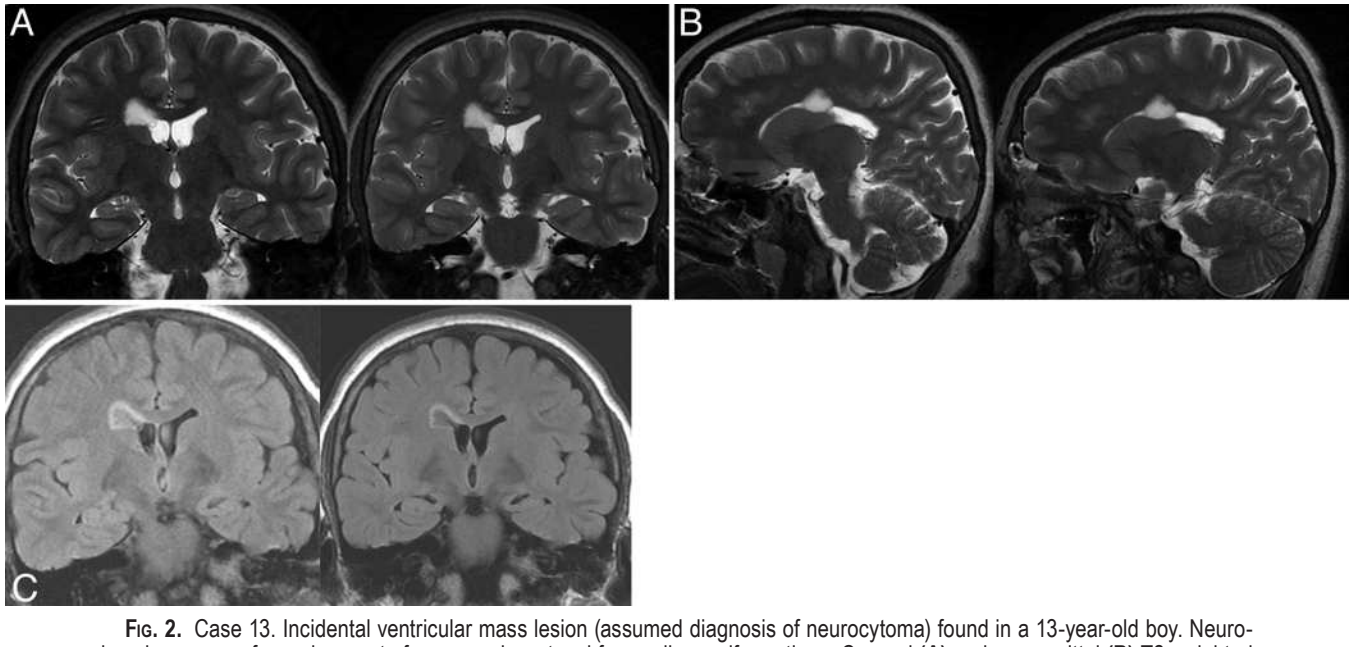

Fig. 2. Case 13. Incidental ventricular mass lesion (assumed diagnosis of neurocytoma) found in a 13-year-old boy. Neuroimaging was performed as part of a research protocol for cardiac malformations. Coronal **(A)** and parasagittal **(B)** T2-weighted MR and coronal FLAIR **(C)** images. *Left panels* were obtained initially. *Right panels* show the lesion after a period of 6 months of wait-and-see.

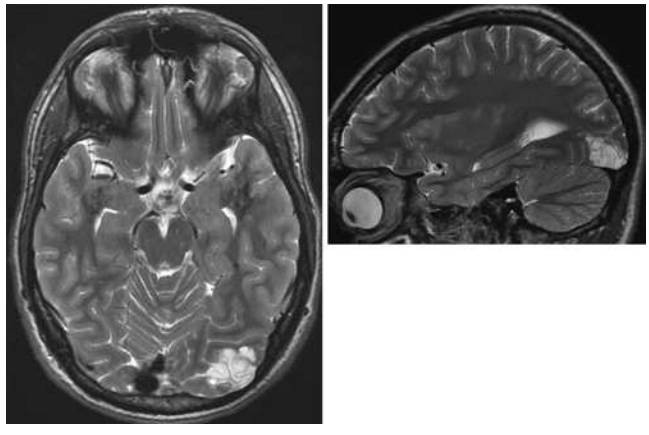

Fig. 3. Case 11. Axial **(left)** and sagittal **(right)** T2-weighted MR images showing an incidental occipital mass lesion (assumed diagnosis of DNT) that was found in a 10.8-year-old boy after a traffic accident.

proptosis. Magnetic resonance imaging revealed a cystic orbital lesion that was later confirmed as lymphangioma, and a partially calcified multicystic sellar/parasellar lesion most likely corresponding to a mature teratoma. In view of normal neurological, ophthalmological, and endocrine assessments, the patient underwent regular clinical and neuroimaging investigations. The lesion remained unchanged on imaging. At the age of 5 years, the lesion was subtotally removed, at the explicit request of the parents, by a transsphenoidal approach. Histology confirmed a mature teratoma.

Discussion

Advancements in diagnostic imaging have revolutionized the practice of modern medicine.[6] Neuroimaging, in particular, facilitates more accurate diagnosis of CNS disorders and neuroanatomical variants. Recommendations for the use of neuroimaging are based on the principles of evidence-based medicine. Observation of current practice patterns, however, indicate that neuroimaging overuse is common in the clinical evaluation of certain symptoms such as headache in children.[5]

There is a current lack of neuroimaging data that can provide baseline images of "normal" brains at various ages and upon which the possible clinical significance of incidental findings can be evaluated.[10] Projects are under way to address this need.[4]

There is only sparse literature on incidental CNS mass lesions in children (Table 3). Analyzing the brain

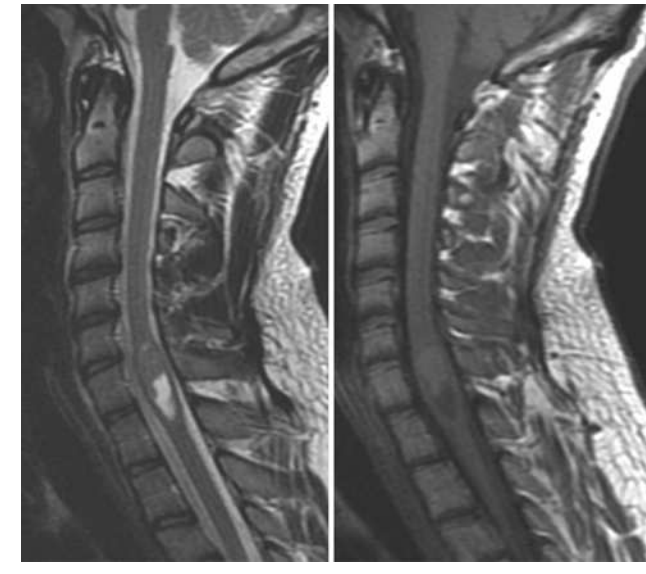

Fig. 5. Case 19. Sagittal T2-weighted **(left)** and T1-weighted **(right)** MR images showing an incidental intramedullar mass lesion (assumed diagnosis of LGG) in a 12-year-old boy who was found to have a vertebral fusion anomaly.

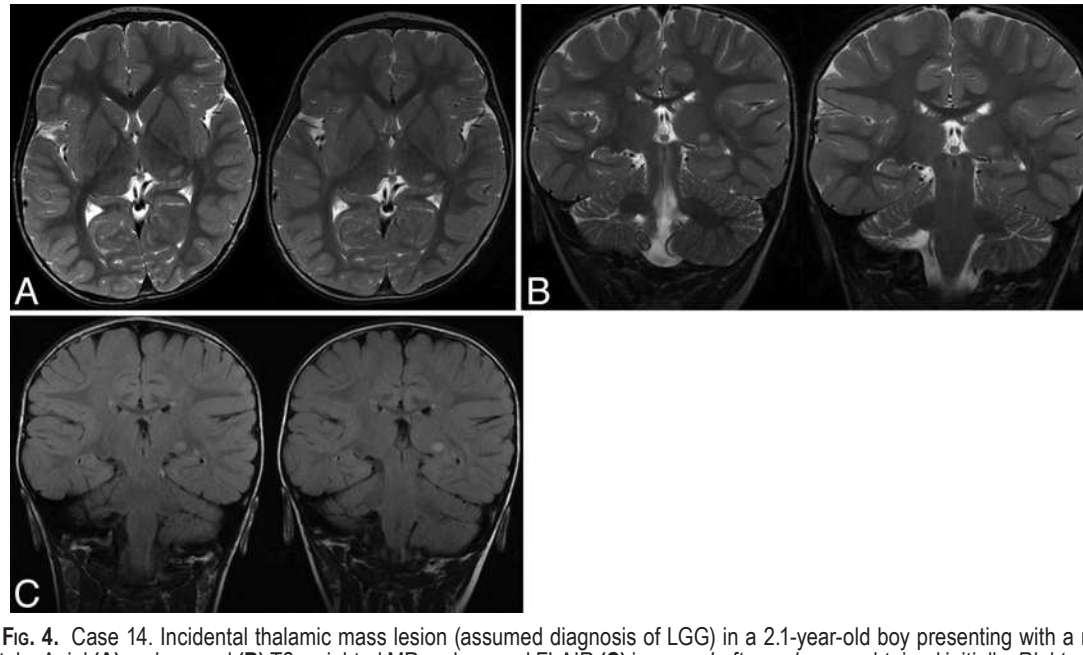

Fig. 4. Case 14. Incidental thalamic mass lesion (assumed diagnosis of LGG) in a 2.1-year-old boy presenting with a nasal fistula. Axial **(A)** and coronal **(B)** T2-weighted MR and coronal FLAIR **(C)** images. *Left panels* were obtained initially. *Right panels* show the lesion after a period of 16 months of wait-and-see.

TABLE 3: Pediatric incidental CNS mass lesions reported in the literature*

Authors & Year	Population	Study Period	Indications for Imaging	No. of Incidental CNS Mass Lesions
De Braganca et al., 2010	312 children w/ posterior fossa masses reviewed by the pediatric neuro-oncology team at Memorial Sloan-Kettering Cancer Center	1993–2010	head trauma (2), seizures (2), headache (1), NF-1 surveillance (1), endocrinopathy (1),	7
Keating et al., 2010	unspecified no. of brain tumor patients (0.3–21 yrs old) treated at Children's National Medical Center (Washington, DC) & Dana Children's Hospital (Tel Aviv)	2005–2010	head trauma (9), seizures (2), headache (2), genetic workup (1), developmental disorder (1), endocrinological evaluation (1), Lyme disease (1), unknown (7)	24
Seki et al., 2010	110 neurologically healthy children, 5–8 yrs old, seen at the Research Institute of Science & Technology for Society, Tokyo	2006–2008		0
Jordan et al., 2010	953 patients, 5–14 yrs old, w/ sickle cell anemia or sickle β-null thalassemia, screened with MRI of the brain for the Silent Infarct Transfusional Trial at the School of Medicine of The Johns Hopkins University, Baltimore	2005–2008	research protocol	4
Gupta et al., 2010	771 patients, aged 0–18 yrs old, w/ developmental delay (363), autistic spectrum disorder (55), & healthy controls (353) seen at Temple University Children's Medical Center, Philadelphia	2003–2007		0
Pirotte et al., 2010	442 patients, 4–15 yrs, w/ newly diagnosed brain lesions reviewed at Erasme Hospital, Brussels	1995–2007	seizures (21), headache (13), sinusitis (8), head trauma (7), viral meningitis (4), suspicion of Chiari malformation (2)	55*
Gupta & Belay, 2008	666 patients, 0–21 yrs old, seen by neurology & general pediatrics teams at the Temple University Children's Medical Center, Philadelphia	2003–2005		0
Graf et al., 2008	185 otherwise healthy children w/ headache, seen by the neurology & radiology teams at the Children's Mercy Hospitals & Clinics, Kansas City	2000–2004		0
Kim et al., 2002	225 healthy children, 0.1–18 yrs old, reviewed at Stanford, CA	1997–2000		0

* This total includes 20 nontumoral lesions (dysplasia, vasculitis, gliosis, cavernoma, and sarcoidosis).

MR imaging of school-aged children with sickle cell disease, Jordan et al.[11] found a total prevalence of incidental findings of 6.6%. The majority of these incidental findings are without clinical impact (for example, cavum septum pellucidum, pineal cyst, arachnoid cyst, and other variants). Potentially urgent or serious abnormalities were present in 0.6%. In children with posterior fossa brain tumors, 7 (2.2%) of 312 were found to be incidentalomas.[3]

In the present study, analyzing 335 tumors of the CNS, we found 19 (5.7%) incidental mass lesions. In the entire cohort of children undergoing neuroimaging at our institution, the prevalence of incidental CNS mass lesions is estimated to be approximately 0.1%.

Clearly, the incidental finding of a mass lesion requires further evaluation. However, the optimal management strategies are largely unknown and are certainly debatable in view of limited published and personal experience. When the diagnostic benefit is balanced against the potential morbidity of the diagnostic procedure in an asymptomatic child, neurosurgery is not necessarily justified for all incidental CNS mass lesions. We favor an individual management strategy following an interdisciplinary discussion, with full comprehension by the parents being essential. It must be acknowledged that a wait-and-see approach may be accompanied by uncertainties that may have significant psychological repercussions on the parents and child.

We have opted for surgical intervention for large space-occupying lesions, impending CSF obstruction, documented tumor growth, and at the request of the parents. However, we have found conservative management (including regular clinical and neuroimaging follow-up, usually every 6 months) justified in children with either a typical neuroimaging pattern of the incidentaloma (for example, DNT, cerebellar LGG, or teratoma) or with small thalamic or periventricular lesions. This management algorithm is summarized in Fig. 6. Clearly, this is work in progress and needs revisions/emendations based on further experience. So far, we have not encountered any psychological or compliance problems with this approach.

This management option has also been chosen by other authors in individual patients; when a DNT was an incidental imaging diagnosis in the absence of epilepsy, surveillance with serial imaging was used.[16] Similar management was adopted for a tectal glioma that was diagnosed incidentally on imaging. This tumor was smaller than 2 cm in diameter and did not exhibit tumor extension or contrast enhancement.[2] Meanwhile, conservative management of tectal gliomas is a well-accepted treatment strategy by many neurosurgeons.[19]

In patients with medulloblastoma the median interval from onset of symptoms to histologically confirmed diagnosis ranges from several days to months. As most posterior fossa tumors are removed upon detection, very little is known about their natural growth rate. To our knowledge, such a long observation period of the growth of a primary medulloblastoma as described in the patient in Case 1 has not been described before.

Limitations of the Study

Limitations of this study include the fact that not all neuroimaging studies were performed after contrast injection and that many neuroimaging studies were performed using CT scanning only. Further limitations are the retrospective nature of the study, the relatively long study period, possible selection and referral bias, and a relatively short follow-up for some of the patients.

Conclusions

Incidental CNS mass lesions should be anticipated in the use of neuroimaging in clinical practice and in the design of research protocols. Information on the natural course and prognosis of these lesions is needed to define

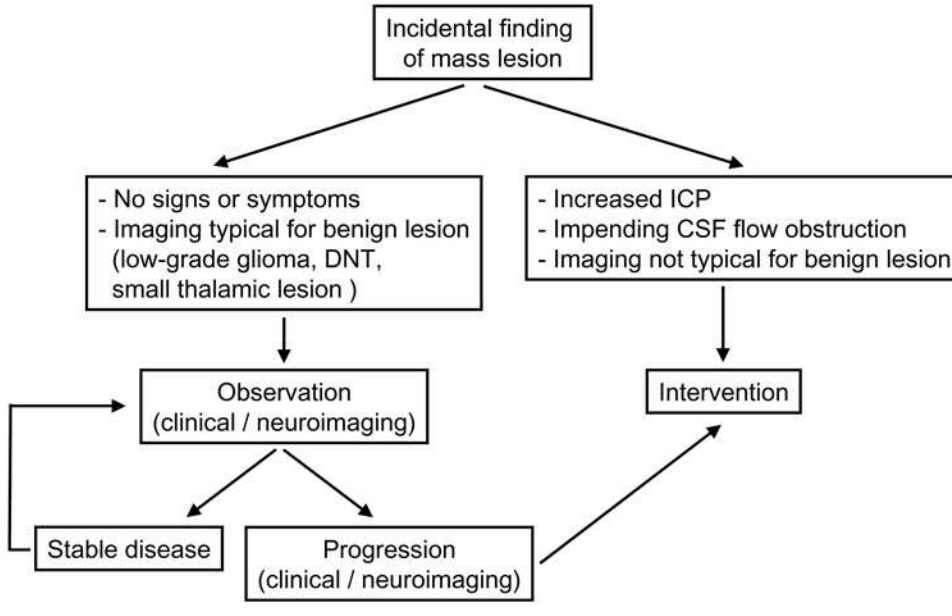

Fig. 6. Flow chart showing the suggested preliminary management algorithm for incidental findings of mass lesions. ICP = intracranial pressure.

clinical management. Future prospective studies are required to determine the true prevalence of this problem and to develop optimal management strategies based on larger collections of natural histories of incidental CNS mass lesions.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Grotzer, Boltshauser. Acquisition of data: all authors. Analysis and interpretation of data: Grotzer, Perret, Boltshauser, Scheer. Drafting the article: Grotzer, Perret, Boltshauser. Critically revising the article: Grotzer, Boltshauser, Kellenberger, Scheer. Reviewed submitted version of manuscript: Perret, Boltshauser. Approved the final version of the manuscript on behalf of all authors: Grotzer. Study supervision: Grotzer.

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