



Universiteit  
Leiden  
The Netherlands

## **Pituitary Adenoma Apoplexy in an Adolescent: A Case Report and Review of the Literature**

Zijlker, H.; Schagen, S.; Wit, J.M.; Biermasz, N.; Furth, W. van; Oostdijk, W.

### **Citation**

Zijlker, H., Schagen, S., Wit, J. M., Biermasz, N., Furth, W. van, & Oostdijk, W. (2017). Pituitary Adenoma Apoplexy in an Adolescent: A Case Report and Review of the Literature. *Journal Of Clinical Research In Pediatric Endocrinology*, 9(3), 265-273.  
doi:10.4274/jcrpe.4420

Version: Not Applicable (or Unknown)  
License: [Leiden University Non-exclusive license](#)  
Downloaded from: <https://hdl.handle.net/1887/114793>

**Note:** To cite this publication please use the final published version (if applicable).

# Pituitary Adenoma Apoplexy in an Adolescent: A Case Report and Review of the Literature

Hero Zijlker<sup>1</sup>, Sebastian Schagen<sup>1</sup>, Jan Maarten Wit<sup>1</sup>, Nienke Biermasz<sup>2</sup>, Wouter van Furth<sup>3</sup>, Wilma Oostdijk<sup>1</sup>

<sup>1</sup>Leiden University Medical Center, Department of Pediatrics, Leiden, The Netherlands

<sup>2</sup>Leiden University Medical Center, Department of Medicine, Division of Endocrinology, Leiden, The Netherlands

<sup>3</sup>Leiden University Medical Center, Department of Neurosurgery, Leiden, The Netherlands

## What is already known on this topic?

Pituitary apoplexy (PA) is a rare clinical syndrome in adolescents that can cause a life-threatening situation. PA is frequently seen in non-functioning adenomas and often results in headache and visual impairments.

## What this study adds?

Our study is to help physicians in differentiating between a PA and a pituitary abscess, to create an overview of the possible clinical symptoms seen in PA, and to create awareness for a possible adrenocorticotrophic hormone-deficiency.

## Abstract

We present a 13-year-old boy who was admitted with complaints of a state of progressive sleepiness and a sudden headache with vomiting and fever. Laboratory testing showed hypoglycemia, multiple pituitary hormonal deficiencies, and an elevated C-reactive protein level. A cranial magnetic resonance imaging (MRI) showed an opaque sphenoid sinus and an intrasellar mass suggesting hemorrhage, so that we suspected pituitary apoplexy (PA) originating from a non-functioning adenoma, although a pituitary abscess could not completely be excluded. The boy was treated with antibiotics, hydrocortisone, and levothyroxine. Due to his rapid clinical improvement, no surgery was performed and we considered the diagnosis of PA as confirmed. At follow-up, the MRI scan showed a small residual lesion. Pituitary deficiencies of growth hormone, adrenocorticotrophic hormone (ACTH), thyroid-stimulating hormone, and vasopressin persisted. A literature search of all well-documented cases of PA in children or adolescents ( $n = 30$ , 13 boys and 17 girls) indicated that this condition is rare below 20 years of age but must be considered when a patient experiences headache with or without visual disturbances, even in the presence of clinical and laboratory signals suggestive of pituitary abscess. MRI neuroimaging is helpful in the differential diagnosis. In both conditions, the possibility of ACTH deficiency should always be considered, investigated, and treated. In cases without severe neuro-ophthalmological deficits and/or with a rapid and positive response to acute medical management, one can abstain from surgical treatment.

**Keywords:** Pituitary adenoma, apoplexy, panhypopituitarism, adolescents, pituitary abscess, headache, magnetic resonance imaging

## Introduction

Neoplasms of the pituitary gland are extremely rare in childhood and adolescence (1:1.000.000) (1). Of all pituitary neoplasms, less than 10% are diagnosed in children and adolescents. Most of these are craniopharyngiomas (80-90%) and relatively few (3% of all intracranial neoplasms)

are adenomas. Of all adenomas in patients younger than 20 years, approximately 97% secrete hormones and 16% develop pituitary apoplexy (PA) (2).

PA is a clinical syndrome caused by hemorrhage or infarction of the pituitary gland and is predominantly seen in patients with pituitary adenomas, probably due to their relatively high metabolism, limited blood flow, and high



**Address for Correspondence:** Wilma Oostdijk MD, PhD,  
Leiden University Medical Center, Department of Pediatrics, Leiden, The Netherlands  
**Phone:** +31 71 526 28 24 **E-mail:** w.oostdijk@lumc.nl **ORCID ID:** orcid.org/0000-0003-0180-2470

©Copyright 2017 by Turkish Pediatric Endocrinology and Diabetes Society

The Journal of Clinical Research in Pediatric Endocrinology published by Galenos Publishing House.

**Conflict of interest:** None declared

**Received:** 27.02.2017

**Accepted:** 28.05.2017

intratumoral pressure when compared to other primary central nervous system tumors (3). PA occurs relatively often in large macroadenomas (4). Since non-functioning adenomas (NFAs) are on average larger than endocrine active adenomas, PA is relatively more frequently observed in NFAs (2,4). The presenting symptoms include sudden and severe headache, visual disturbances, and various neurological signs (4). In adults, PA is more common in males between 50-69 years and precipitating factors include angiography, cardiac surgery, anticoagulant therapy, and dynamic hormonal testing or gonadotropin-releasing hormone (GnRH) agonist treatment. However, little is known about this condition in patients younger than 20 years.

In 1972, Dawson and Kothandaram (5) were the first to describe an adolescent with PA. Since then, only a few case reports and individual cases extracted from larger case series have been reported in the literature. In 2015, Jankowski et al (6) presented a case series of nine adolescents with PA, comparing symptomatology, neuroimaging, pathology, and outcomes to those in adults.

In this paper, we report a case of a 13-year-old boy presenting with sudden and severe headache. Additional investigations suggested PA originating from a non-functioning adenoma (NFA), although initially a pituitary abscess [accounting for less than 1% of all pituitary lesions (7)] could not be completely excluded. We reviewed the literature and summarize the clinical, biochemical, and imaging characteristics of all reported cases of PA in patients younger than 20 years. Pediatricians should be aware that this condition which is frequently accompanied by adrenocorticotropic hormone (ACTH) deficiency, although extremely rare, can occur in children and adolescents and that the differential diagnosis with pituitary abscess can be difficult.

## Case Report

A 13-year-old boy, with an uninformative previous medical history, presented at the pediatric clinic of a general hospital with complaints of severe fatigue which had lasted for several months. Four days prior to admission, he had become progressively sleepy and experienced a sudden and severe stabbing frontal headache with vomiting and phonophobia. At physical examination, he had a normal level of consciousness, fever up to 38 degrees Celsius, and no neurological abnormalities. He had no visual disturbances and normal extra-ocular movements. His linear growth and pubertal development had been unremarkable; at admission, his height standard deviation score (SDS) was 0.0 (8). His body mass index was 20 kg/m<sup>2</sup> (+ 1.0 SDS) (9) and Tanner stage was G3P3A2 with testes of 12 mL (assessed with the

Prader orchidometer). Initial laboratory results demonstrated a normal white blood cell count (9.2x10<sup>9</sup>/L; 54% neutrophils), an elevated serum C-reactive protein (CRP) (201 mg/L) and hypoglycemia (2.8 mmol/L). Despite normal neurological examination, increased intracranial pressure due to a brain tumor or abscess was considered because of the severe headache and vomiting. For this reason, broad-spectrum antibiotics were immediately administered intravenously and he was referred to our academic hospital.

Magnetic resonance imaging (MRI) of the cerebrum showed a sellar mass with suprasellar extension (2.5x2.0 cm) and slight optic chiasm compression (Figure 1). The mass appeared heterogeneously hyperintense on T1-weighted imaging (T1WI) and hypointense to isointense on T2-weighted imaging (T2WI). Also sphenoid sinus mucosal thickening and rim enhancement of the mass after gadolinium contrast were noted. These MRI findings were highly suggestive of hemorrhage that most likely originated from a pre-existing pituitary adenoma.

The endocrine investigations (Table 1) demonstrated central hypothyroidism, hypocortisolism, and hypogonadism, as well as low serum insulin-like growth factor (IGF)-I and IGF

**Table 1. Hormonal values of our case at presentation and 3 months later**

	At presentation	After 3 months	Normal values
LH (U/L)	1.3	2.1	2.0-9.0
FSH (U/L)	1.8	3.8	1.5-12.5
ACTH (8 a.m.) (ng/L)	10		0-75
Cortisol (8 a.m.) (µmol/L)	0.213	0.386	0.1-0.6
Cortisol in ACTH-test (0.58 ug/m <sup>2</sup> )	0.036* → 0.321**		> 0.50 **
TSH (mU/L)	0.134	0.318	0.3-4.8
ft <sub>4</sub> (pmol/L)	6.6	15.9	12-22
hGH (µg/L)	0.73	0.21	0.00-2.42
IGF-I (nmol/L)	5.2	15.9	18.5-74.1
IGF-I (SDS)	-4.1	-2.4	
IGFBP-3 (mg/L)	2.1	5.4	2.6-6.3
Prolactin (µg/L)	2.4	3.2	4.0-15.0
Testosterone (nmol/L)	< 0.1	8.9	8-31
Osmolarity (mOsmol/kg)	354	573	50-1200
Sodium (mmol/L)	137	143	136-144
Potassium (mmol/L)	3.9	4.2	3.6-4.8

\*At baseline, \*\*after 30 minutes

LH: luteinizing hormone, FSH: follicle-stimulating hormone, ACTH: adrenocorticotropic hormone, hGH: human growth hormone, IGF-I: insulin-like growth factor, IGFBP-3: insulin-like growth factor binding protein-3, SDS: standard deviation scores, ft<sub>4</sub>: free thyroxine

binding proteins-3 levels suggestive of growth hormone (GH) deficiency. A stress dose of hydrocortisone was immediately administered followed by substitution with hydrocortisone and levothyroxine. We considered PA originating from an NFA most likely, based on the specific MRI findings.

Because we could not completely exclude pituitary abscess, immediate surgical intervention was considered. However, rapid clinical improvement was noted after administration of broad-spectrum antibiotics, and hydrocortisone was started. One day after initiation of treatment, the fever disappeared and CRP levels gradually declined to 48 mg/L on the fourth post-treatment day. CRP levels were completely normalized after 2 weeks. Surgery was eventually not performed due to the boy's rapid clinical improvement, the sella enlargement, which is unusual for pituitary abscess, and the sphenoid sinus mucosal thickening seen on the MRI, which suggested a possible infectious process on the surgical route. The combination of MRI findings and clinical course has made the diagnosis of PA virtually certain, although not histologically confirmed. Remarkably, diabetes insipidus (DI) developed three days after admission despite conservative treatment.

The patient was discharged after five days with oral broad-spectrum antibiotics, hydrocortisone, levothyroxine, and vasopressin. A small residual lesion was seen on the MRI three months later (Figure 1), which resolved after 6

months. The thyroid-stimulating hormone (TSH) and ACTH deficiencies persisted. GH deficiency was diagnosed by a very low (GH peak 0.9 ug/L) response to GH stimulation tests, so that GH substitution was started. The pituitary-gonadal axis was not affected (normal pubertal GnRH test) and puberty progressed normally. Genetic evaluation showed no abnormalities in the *MEN1* gene.

### Literature Search

A literature search was performed in databases Pubmed, Embase, Web of Science, Medline, and Cochrane to identify all cases of PA originating from an adenoma in patients younger than 20 years. Only publications written in English were included.

Cases found in larger case series with no or scarce individual descriptions were excluded (n = 36) (2,10,11). This resulted in 30 cases published between 1972 and 2016: 16 case reports and 14 cases extracted from 6 case series (Table 2) (5,6,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30). The total group consisted of 13 boys and 17 girls with a mean age of 15.3 years (range 6-19 years, median 16 years).

### Discussion

PA in children and adolescents is a rare entity that requires rapid and adequate treatment to prevent a life-threatening situation. Based upon our literature search, various aspects are discussed.

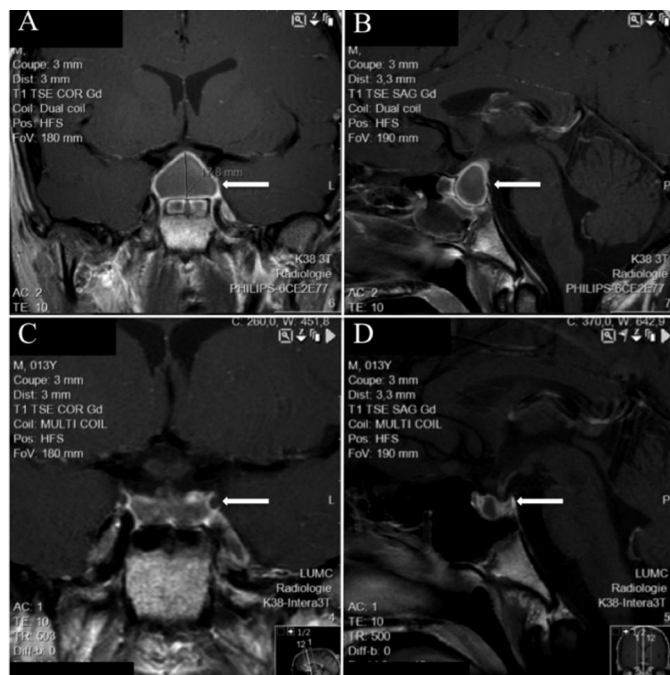
#### Non-Functioning Pituitary Adenomas and Pituitary Apoplexy

Only 3% of all pituitary adenomas in patients younger than 20 years are NFAs (2). This low percentage can be explained by the slow growth of pituitary adenomas and data suggesting that 85-90% of normal pituitary gland and optic chiasm have to be compromised to develop endocrine insufficiencies and visual deficits, respectively (31).

So far, only four extensively described cases of patients younger than 20 years with PA originating from a NFA have been published (13,18,22,23). Based upon these data, we conclude that PA originating from a NFA is an extremely rare entity in this age group, despite the fact that PA is likely to occur in NFAs.

#### Adrenocorticotropic Hormone Deficiency

A corticotropic deficiency can lead to serious hemodynamic instabilities causing a life-threatening situation and this was seen in 50-80% of the adult patients with PA (4). No accurate data are available for determining the prevalence of corticotropic deficiencies in children and adolescents with PA. However, 43% (5,12,13,14,16,17,18,19,22,23,25,27,29) of the reported cases received steroid replacement



**Figure 1.** Magnetic resonance imaging: T1-weighted imaging. At presentation: coronal (A) and sagittal (B) view showing rim enhancement and sphenoid sinus mucosal thickening. Three months later: coronal (C) and sagittal (D) view showing substantial mass reduction

**Table 2. Summary of clinical and pathological characteristics of cases younger than 20 years with pituitary apoplexy**

Case no.	1 <sup>st</sup> Author (reference) Year of publication	Age Sex	Clinical signs and symptoms	Visual disturbances	Endocrine function and symptoms
1	Dawson and Kothandaram (5) 1972	17 F	Headache, fever, URI, confusion (1 week), neck stiffness, hemiparesis, unconscious	Decreased visual acuity, nerve III and VI palsy, acute eyelid edema, papilledema	Amenorrhea
2	Rovit and Fein (20) 1972	18 F	Headache, lethargy, moribund (6 hours, after pneumoencephalography), neck stiffness	Decreased visual acuity (6 hours), nerve III-V palsy	Cushing's syndrome, total adrenalectomy, galactorrhea
3	Sakalas et al (21) 1973	6 M	Headaches, fever (18 months), lethargic and sleepy (3 weeks), neck stiffness	Photophobia (18 months), progressive visual loss (3 weeks), blindness, dilated pupils and unresponsive to light	Gigantism
4	Arisaka et al (12) 1983	11 M	Headache, vomiting, and fever (12 days)	Decreased visual acuity (12 days), bitemporal hemianopsia and bilateral optic atrophy	Gigantism, precocious puberty, galactorrhea
5	Kaplan et al (15) 1983	17 F	Headache (chronic)	None	Amenorrhea, galactorrhea
6	Kaplan et al (15) 1983	15 F	Headache (chronic)	None	Growth faltering, pubertal delay
7	Lever et al (27) 1986	19 F	Headache, nausea, vomiting fever (following TRH stimulation), neck stiffness	Photophobia, diplopia (following TRH stimulation)	Gigantism, acromegaly, irregular menstruation, galactorrhea
8	Pozzati et al (26) 1987	15 M	Headache, nausea, vomiting, lethargy, neck stiffness	Diplopia, nerve III and VI palsy, central facial weakness	None
9	Vidal et al (23) 1992	16 F	Headache, stupor, neck stiffness (1 day)	Photophobia (1 day)	Amenorrhea (5 months), panhypopituitarism
10	Mizutani et al (18) 1993	11 M	'Visual symptoms'	Gradual decrease of visual acuity for 2 years, bitemporal hemianopsia	None
11	Kulah et al (17) 1995	17 M	Headaches, mild degree of mental dullness (4 months)	None	Growth faltering, pubertal delay, hypopituitarism
12	Sugita et al (11) 1995	14 F	Headache (3 weeks)	Progressive bilateral visual loss (2 weeks), decreased bilateral visual activities, bitemporal hemianopsia	None
13	Pinto et al (19) 1998	14 F	Headache, fever, vomiting, asthenia (after 6 months of bromocriptine)	Diplopia	Amenorrhea, hypopituitarism
14	Dourakis et al (13) 2002	15 M	Headache, vertigo, fever (4 days), neck stiffness	Photophobia (4 days)	Growth faltering, pubertal delay, hypopituitarism
15	Rotman-Pikielny et al (28) 2003	19 F	Headache, fever (2 days after CRH stimulation), nausea, vomiting, neck stiffness	Ptosis, nerve III palsy, diplopia, photophobia	Cushing's syndrome, amenorrhea, galactorrhea, fatigue
16	Knoepfelmacher et al (16) 2004	17 M	Headache, nausea, vomiting, asthenia (after 1 year of cabergoline)	None	Pubertal delay, hypopituitarism
17	Satyarthee and Mahapatra (22) 2005	13 M	Headache (6 hours), meningeal irritability	Decreased visual acuity (6 hours), bitemporal hemianopsia	Normal hormonal status

**Table 2. Continued**

18	Kamboj et al (14) 2005	18 M	Headache, nausea, lethargy, disoriented, fever (3 days)	Unequal but reactive pupils, acutely deterioration of vision and pupillary responses	Hypopituitarism
19	Balarini Lima et al (30) 2008	15 F	Headache (after 32 weeks of cabergoline)	Left-sided blindness, loss of left visual field	Puberty arrest, amenorrhea, hypogonadotrophic hypogonadism
20	Wang et al (24) 2011	15 F	'Endocrine symptoms'	None	Amenorrhea (3 years), acromegaly, hypogonadism
21	Jankowski et al (6) 2015	14 M	Headache, nausea, vomiting (6 days)	Photophobia (6 days)	Weight gain, rapid height increase, sleep disturbance, behavioral problems, dysphoric mood
22	Jankowski et al (6) 2015	18 F	Headache, nausea, vomiting, dizziness (15 days)	None	Galactorrhea
23	Jankowski et al (6) 2015	16 F	Headache, dizziness (4 days)	Photophobia (4 days)	Galactorrhea, amenorrhea, fatigue
24	Jankowski et al (6) 2015	14 M	Headache, dizziness (5 months)	None	Fatigue
25	Jankowski et al (6) 2015	16 F	Headache, nausea (2 months)	Decreased visual acuity	Galactorrhea
26	Jankowski et al (6) 2015	16 F	Headache (3 days)	None	Amenorrhea, galactorrhea
27	Jankowski et al (6) 2015	18 F	Headache, dizziness (5 months)	Peripheral field deficit L > R (5 months)	Amenorrhea, galactorrhea
28	Jankowski et al (6) 2015	17 F	Headache (1 year)	Peripheral field deficit L > R (5 months)	Amenorrhea, galactorrhea
29	Kumar and Sharma (25) 2016	18 M	Headache, vomiting (5 days)	Decreased visual acuity (5 days), bilateral papilledema, bitemporal hemianopsy	Acromegaly, hypopituitarism
30	Özçetin et al (29) 2016	9 M	Fever (3 days), vomiting, somnolence	Progressive loss of vision, blindness, nerve VI palsy	SIADH
	Our case	13 M	Headache, vomiting, phonophobia, fever (4 days)	None	Fatigue, hypopituitarism

F: female, M: male, URI: upper respiratory infection, TRH: thyroid-releasing hormone, SIADH: syndrome of inappropriate antidiuretic hormone secretion, CRH: corticotropin-releasing hormone

therapy, indicating that corticotropic deficiency is commonly seen in young patients with PA. Even if serum cortisol and its response to an ACTH injection appear normal in the acute situation, an ACTH deficiency can become apparent in subsequent days.

Due to the severity of a possible hemodynamic instability seen by an Addisonian crisis, every patient with signs or symptoms of PA should immediately be treated with steroids (4). Our patient immediately received hydrocortisone after hypocortisolism was noticed. In the following days,

his clinical condition improved rapidly. However, since antibiotics were also administered, it was hard to say which component of the treatment led to his improvement.

#### **Differentiation Between Pituitary Apoplexy Originating from Adenoma and Pituitary Abscess**

The differentiation between PA and pituitary abscess is of vital importance because of the contrasting therapeutic consequences: pituitary abscess is an indication for immediate operation, while an expectative policy would usually be the best option in patients with PA. Based on the literature, four

elements are discussed for the differential diagnosis between PA and pituitary abscess: 1) Clinical presentation, 2) Infection parameters, 3) Endocrine function, 4) Neuroimaging.

### **Clinical Presentation**

Liu et al (7) described the largest series (33 patients; mean age 42 years; range 12 to 63 years) of patients with pituitary abscess so far. In their cohort, the most common clinical symptoms were headache (70%), with no common pattern, and visual disturbances (27%). Headache with a sudden onset can also occur in patients with pituitary abscess (32). In the reports on young individuals we reviewed, headache was also the most common described symptom (90%), with a sudden onset in one third of them. Despite the frequently described sudden onset, no common pattern of headache was observed. Visual disturbances were described in 73% of cases.

Regarding the strong clinical similarities between PA and pituitary abscess, no differentiation between these two conditions could be made based on clinical presentation.

Furthermore a low 'PA Score' (0 out of 10 points), based on the absence of visual symptoms and his normal level of consciousness (33), was found in our patient. This clinical tool did not help us differentiate the two conditions.

### **Infection Parameters**

Initial laboratory results demonstrated a normal white blood cell count, an elevated serum CRP, and hypoglycemia in our patient, which together with the elevated body temperature was initially considered highly suggestive of pituitary abscess. However, in the literature, a 57-year-old man was described with a presentation similar to that of our patient (34). In that patient, there was a strong suspicion of bacterial meningoencephalitis due to the combination of fever, meningeal irritation, elevated CRP (109 mg/L), and neutrophilic leukocytosis (13.600/mm<sup>3</sup>, 66% neutrophils). MRI imaging showed a sellar mass which initially was defined as a secondary pituitary abscess. However, cerebrospinal fluid contained no microbes, and during surgery, biopsy was obtained that demonstrated PA originating from an adenoma. Also, the presence of fever appears to have a low discriminative power, since this was reported in one third of the cases in young individuals with PA in 18% of patients with pituitary abscess (7). Despite the difference in age in comparison with our patient, we conclude that a very elevated CRP, leukocytosis, and fever can also occur in PA.

### **Endocrine Function**

Our patient's endocrine analysis demonstrated hypopituitarism. This endocrine condition was reported

in 26% of the reviewed cases and in 85% of cases with pituitary abscess (7). In patients with pituitary abscess, 70% presented with DI (7). In contrast, less than 5% of the cases with PA described by Briet et al (4) presented with DI and none of the reviewed were young cases. DI is a condition that usually develops after pituitary surgery (35). It is noteworthy that DI may be masked by secondary adrenal failure and develop after steroid or thyroid replacement. From the reviewed cases, seven (23%) developed DI - five of them were operated and 2 were treated conservatively (Table 3). Persistent DI was described in 3 cases and transient - in 1. Description of DI in the other 3 cases is inconclusive. Eight of nine cases originally described by Jankowski et al (6) are included in our study. Four of them developed transient DI and 1 developed persistent DI. DI after conservative treatment of PA has sporadically been documented in the literature. Only two non-surgically treated cases included in our group developed DI (13,18).

We conclude that endocrine function tests are necessary but can hardly assist in differentiating PA from pituitary abscess.

### **Neuroimaging**

The MRI showed a space-occupying lesion at the site of the sella turcica in our patient.

The typical cystic features of pituitary abscess are hypointense on T1WI but hyperintense on T2WI. Rim enhancement can be seen after gadolinium in 64% of pituitary abscesses (7). The remaining 36% had hypointense to isointense signaling on T1WI and isointense to hyperintense signaling on T2WI. The MRI performed in our patient showed a heterogeneous hyperintense signal on T1WI, hypointense to isointense signal on T2WI with rim enhancement after gadolinium, as well as sphenoid sinus mucosal thickening. These T1WI and T2WI features were consistent with a hemorrhage (36), although rim enhancement after gadolinium is more often seen in pituitary abscess (64%) than in PA (36%).

In our reviewed young patients, all MRI findings were suggestive of hemorrhage within an adenoma. Also, compression of the surrounding structures was stated in 15 cases, involving the optic chiasm in 14, the infundibulum in 4, and the hypothalamus in one. Furthermore, sphenoid sinus mucosal thickening was observed in our patient, a finding that could suggest an inflammation of the sinus and may constitute a potential cause of a secondary pituitary abscess (37,38). However, mucosal thickening was also seen in 2 of the 9 adolescent patients with PA investigated by Jankowski et al (6) and is probably due to venous engorgement secondary to PA. Thus, when a patient has

**Table 3. Summary of pathological characteristics, treatment and follow-up data of cases younger than 20 years with pituitary apoplexy**

Case no.	Adenoma type	Surgery	Residual symptoms and endocrine sequelae	Endocrine replacement
1	Unknown	-	Normal vision, ophthalmoplegia and hemiparesis resolved	Unknown
2	ACTH	+	Patient died just after surgery	-
3	GH	+	DI, improved vision and pupil response of left eye, blindness of right eye	Unknown
4	GH + PRL	+	DI, vision recovered, growth faltering, hypopituitarism	+
5	PRL	+	Normal menses	-
6	PRL	+	Impaired menses	+
7	GH	-	DI, acromegaly facial symptoms and galactorrhea resolved, hypopituitarism	+
8	Unknown	-	Gradual improvement of condition, DI, ophthalmoplegia and facial paresis resolved, hypopituitarism	+
9	NFA	+	Photophobia resolved, normal pituitary function	-
10	NFA	+	Rapid recovery, DI, visual fields almost full range	+
11	PRL	+	Endocrine and subjective symptoms improved, hypopituitarism	Unknown
12	GH + PRL	+	Vision improved, normal pituitary function	-
13	PRL	-	Resolved functional and ophthalmic signs, hypopituitarism	+
14	NFA	+	Symptoms improved pre-operatively, DI, hypopituitarism	+
15	ACTH	-	Cushing's and subjective symptoms resolved, hypopituitarism	+
16	PRL	-	Normal pubertal development, panhypopituitarism	+
17	NFA	+	Improvement of vision and field defects, headache resolved	+
18	PRL	+	Vision and mental status improved, panhypopituitarism	+
19	PRL	+	Absent mammary development	+
20	GH	+	Impaired menses	+
21	ACTH	+	No residual symptoms, normal pituitary function, photophobia resolved	-
22	PRL	+	No residual symptoms, normal pituitary function	-
23	PRL	+	Normal pituitary function, headaches, mood disturbance and anxiety, photophobia resolved	-
24	PRL	+	No residual symptoms, normal pituitary function	-
25	PRL	+	No residual symptoms, normal pituitary function, normal visual acuity	-
26	PRL	+	No residual symptoms, normal pituitary function	-
27	PRL	+	No residual symptoms, normal pituitary function, slight improvement of visual fields	-
28	PRL	+	Mild intermittent headaches, normal pituitary function, slight improvement of visual fields	-
29	GH	-	No residual symptoms, normal visual fields	+
30	GH	+	DI, hypopituitarism	+
Our case	NFA	-	No residual symptoms, hypopituitarism	+

ACTH: adrenocorticotrophic hormone, NFA: non-functioning adenoma, GH: growth hormone, PRL: prolactin, DI: diabetes insipidus



either PA or pituitary abscess, the differentiation should be made by MRI neuroimaging. Clinical presentation, PA Score, infection parameters, and endocrine function are not helpful in the differentiation of these two conditions. In our patient, based on the MRI neuroimaging findings, PA was more likely than pituitary abscess.

### Treatment

We did not find any publication comparing the outcome of different therapeutic strategies in patients with PA younger than 20 years. In adults, Singh et al (39) analyzed the outcomes of case series of different treatment options of PA (57 males; 30 females; mean age 51 years; range 15 to 91 years). They concluded that the outcome of most patients was excellent and that no statistically significant differences existed between the surgically and conservatively treated patients. All patients with endocrine deficiencies or electrolyte disturbances were acutely managed with hormonal and electrolytes substitution. Most of the patients who received early surgery (surgery within a median time of 5 days, range 3 to 10 days) had severe neuro-ophthalmological deficits at presentation. On the other hand, patients who lacked severe neuro-ophthalmological deficits, including patients with reduced consciousness, or patients with a rapid response to acute management, were adequately managed conservatively. In line with this advice, our patient was not subjected to a surgical intervention because of his rapid clinical improvement with antibiotics, hydrocortisone, and levothyroxine substitution.

Out of the 30 reported young cases, 23 underwent surgery, mostly via the transsphenoidal route (78%). Nine of these patients received endocrine replacement therapy. Of these 9 patients, 1 died shortly after surgery and there was no mention of symptom relief in 5. Seven cases were managed conservatively, of whom 6 received endocrine replacement therapy.

Our patient received prolonged endocrine replacement therapy due to persisting hormonal deficiencies and this was also seen in 15 reported cases (50%), illustrating the high risk of permanent damage of the pituitary gland caused by PA.

### Conclusions

PA is a rare condition seen in patients younger than 20 years, but must be considered when a patient experiences headache with or without visual disturbances, even in the presence of clinical or laboratory findings suggestive of an infection. There should be a high index of suspicion for ACTH deficiency which must be promptly treated with stress doses of hydrocortisone. Differentiation between pituitary

abscess and PA is difficult. Type of headache, elevated CRP, endocrinological status, and fever do not differentiate between the two conditions. MRI neuroimaging is helpful in making the diagnosis since differences exist in T1W1 and T2W1 images of patients with hemorrhage and abscess. We agree with Singh et al (39) that without severe neuro-ophthalmological deficits or with a quick response to the acute management, patients can be treated conservatively. Furthermore, multiple persistent pituitary deficiencies, including DI, are a common outcome.

### Acknowledgements

We thank Dr. D.A.J.P. Haring, pediatrician in the Alrijne Hospital (Leiden) for referring the patient to our hospital and for providing clinical and laboratory information.

### Ethics

**Informed Consent:** Written informed consent for publication of the data was given by the patient and his parents.

**Peer-review:** Externally peer-reviewed.

### Authorship Contributions

Concept: Hero Zijlker, Design: Wilma Oostdijk, Jan Maarten Wit, Nienke Biermasz, Wouter van Furth, Sebastian Schagen, Data Collection and Processing: Hero Zijlker, Analysis and Interpretation: Hero Zijlker, Wilma Oostdijk, Literature Research: Hero Zijlker, Writing: Hero Zijlker.

**Financial Disclosure:** The authors declared that this study received no financial support.

### References

1. Keil MF, Stratakis CA. Pituitary tumors in childhood: update of diagnosis, treatment and molecular genetics. *Expert Rev Neurother* 2008;8:563-574.
2. Mindermann T, Wilson CB. Pediatric pituitary adenomas. *Neurosurgery* 1995;36:259-269.
3. Oldfield EH, Merrill MJ. Apoplexy of pituitary adenomas: the perfect storm. *J Neurosurg* 2015;122:1444-1449.
4. Briet C, Salenave S, Bonneville JF, Laws ER, Chanson P. Pituitary Apoplexy. *Endocr Rev* 2015;36:622-645. Epub 2015 Sep 28
5. Dawson BH, Kothandaram P. Acute massive infarction of pituitary adenomas. A study of five patients. *J Neurosurg* 1972;37:275-279.
6. Jankowski PP, Crawford JR, Khanna P, Malicki DM, Ciacci JD, Levy ML. Pituitary tumor apoplexy in adolescents. *World Neurosurg* 2015;83:644-651. Epub 2014 Dec 18
7. Liu F, Li G, Yao Y, Yang Y, Ma W, Li Y, Chen G, Wang R. Diagnosis and management of pituitary abscess: experiences from 33 cases. *Clin Endocrinol (Oxf)* 2011;74:79-88.
8. Schönbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, HiraSing RA, van Buuren S. The world's tallest nation has stopped growing taller: the height of Dutch children from 1955 to 2009. *Pediatr Res* 2013;73:371-377. Epub 2012 Dec 10

9. Cole TJ, Roede MJ. Centiles of body mass index for Dutch children aged 0-20 years in 1980—a baseline to assess recent trends in obesity. *Ann Hum Biol* 1999;26:303-308.
10. Kinoshita Y, Tominaga A, Usui S, Arita K, Sakoguchi T, Sugiyama K, Kurisu K. Pituitary adenomas in childhood and adolescence with a focus on intratumoral hemorrhage. *Pituitary* 2014;17:1-6.
11. Sugita S, Hirohata M, Tokutomi T, Yamashita M, Shigemori M. A case of pituitary apoplexy in a child. *Surg Neurol* 1995;43:154-157.
12. Arisaka O, Hall R, Hughes IA. Spontaneous endocrine cure of gigantism due to pituitary apoplexy. *Br Med J (Clin Res Ed)* 1983;287:1007-1008.
13. Dourakis SP, Papanicolaou IS, Kontogeorgos G, Tolis G. Pituitary non-secreting macroadenoma apoplexy in an adolescent, patient report and review of the literature. *J Pediatr Endocrinol Metab* 2002;15:1549-1552.
14. Kamboj MK, Zhou P, Molofsky WJ, Franklin B, Shah B, David R, Kohn B. Hemorrhagic pituitary apoplexy in an 18 year-old male presenting as non-ketotic hyperglycemic coma (NKH). *J Pediatr Endocrinol Metab* 2005;18:611-615.
15. Kaplan B, Day AL, Quisling R, Ballinger W. Hemorrhage into pituitary adenomas. *Surg Neurol* 1983;20:280-287.
16. Knoepfelmacher M, Gomes MC, Melo ME, Mendonca BB. Pituitary apoplexy during therapy with cabergoline in an adolescent male with prolactin-secreting macroadenoma. *Pituitary* 2004;7:83-87.
17. Kulah A, Erel C, Memis M, Sav A. Arrested puberty associated with apoplectic prolactinoma in a male adolescent. *Childs Nerv Syst* 1995;11:124-127.
18. Mizutani T, Teramoto A, Aruga T, Takakura K, Sanno N. Prepubescent pituitary null cell macroadenoma with silent macroscopic apoplexy: case report. *Neurosurgery* 1993;33:909-910.
19. Pinto G, Zerah M, Trivin C, Brauner R. Pituitary apoplexy in an adolescent with prolactin-secreting adenoma. *Horm Res* 1998;50:38-41.
20. Rovit RL, Fein JM. Pituitary apoplexy: a review and reappraisal. *J Neurosurg* 1972;37:280-288.
21. Sakalas R, David RB, Vines FS, Becker DP. Pituitary apoplexy in a child. Case report. *J Neurosurg* 1973;39:519-522.
22. Satyarthee GD, Mahapatra AK. Pituitary apoplexy in a child presenting with massive subarachnoid and intraventricular hemorrhage. *J Clin Neurosci* 2005;12:94-96.
23. Vidal E, Cevallos R, Vidal J, Ravon R, Moreau JJ, Rogues AM, Loustaud V, Liozon F. Twelve cases of pituitary apoplexy. *Arch Intern Med* 1992;152:1893-1899.
24. Wang XL, Dou JT, Lü ZH, Zhong WW, Ba JM, Jin D, Lu JM, Pan CY, Mu YM. Spontaneous remission of acromegaly or gigantism due to subclinical apoplexy of pituitary growth hormone adenoma. *Chin Med J (Engl)* 2011;124:3820-3823.
25. Kumar S, Sharma S. Pituitary apoplexy causing spontaneous remission of acromegaly following long-acting octreotide therapy: a rare drug side effect or just a coincidence. *Oxf Med Case Reports* 2016;2016:81-83.
26. Pozzati E, Frank G, Nasi MT, Giuliani G. Pituitary apoplexy, bilateral carotid vasospasm, and cerebral infarction in a 15-year-old boy. *Neurosurgery* 1987;20:56-59.
27. Lever EG, Butler J, Moore P, Cox TC, Maccabe JJ. Infarction of a growth hormone-secreting macroadenoma during a TRH test. *Acta Endocrinol (Copenh)* 1986;112:172-179.
28. Rotman-Pikielny P, Patronas N, Papanicolaou DA. Pituitary apoplexy induced by corticotrophin-releasing hormone in a patient with Cushing's disease. *Clin Endocrinol (Oxf)* 2003;58:545-559.
29. Özçetin M, Karacı M, Toroslu E, Edebali N. A pediatric case of pituitary macroadenoma presenting with pituitary apoplexy and cranial nerve involvement: case report. *Turk Pediatri Ars* 2016;51:162-165.
30. Balarini Lima GA, Machado Ede O, Dos Santos Silva CM, Filho PN, Gadelha MR. Pituitary apoplexy during treatment of cystic macroprolactinomas with cabergoline. *Pituitary* 2008;11:287-292.
31. Abe T, Ludecke DK, Saeger W. Clinically nonsecreting pituitary adenomas in childhood and adolescence. *Neurosurgery* 1998;42:750-751.
32. Vates GE, Berger MS, Wilson CB. Diagnosis and management of pituitary abscess: a review of twenty-four cases. *J Neurosurg* 2001;95:233-241.
33. Rajasekaran S, Vanderpump M, Baldeweg S, Drake W, Reddy N, Lanyon M, Markey A, Plant G, Powell M, Sinha S, Wass J. UK guidelines for the management of pituitary apoplexy. *Clin Endocrinol (Oxf)* 2011;74:9-20.
34. Huang WY, Chien YY, Wu CL, Weng WC, Peng TI, Chen HC. Pituitary adenoma apoplexy with initial presentation mimicking bacterial meningoencephalitis: a case report. *Am J Emerg Med* 2009;27:517.
35. Randeve HS, Schoebel J, Byrne J, Esiri M, Adams CB, Wass JA. Classical pituitary apoplexy: clinical features, management and outcome. *Clin Endocrinol (Oxf)* 1999;51:181-188.
36. Pötin M, Tampieri D, Rufenacht DA, Mohr G, Garant M, Del Carpio R, Robert F, Delavelle J, Melanson D. The various MRI patterns of pituitary apoplexy. *Eur Radiol* 1999;9:918-923.
37. Chong VF, Fan YF. Comparison of CT and MRI features in sinusitis. *Eur J Radiol* 1998;29:47-54.
38. Shono T, Nishio S, Muratani H, Yasuda T, Fukui M, Moutai K. Pituitary abscess secondary to isolated sphenoid sinusitis. *Minim Invasive Neurosurg* 1999;42:204-206.
39. Singh TD, Valizadeh N, Meyer FB, Atkinson JL, Erickson D, Rabinstein AA. Management and outcomes of pituitary apoplexy. *J Neurosurg* 2015;122:1450-1457. Epub 2015 Apr 10