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Original Article

Pituitary Dysfunction in Idiopathic Intracranial Hypertension: An Analysis of 80 Patients

Nandita Prabhat[1], Kirandeep Kaur[2], Aastha Takkar[1], Chirag Ahuja[3], Deeksha Katoch[4], Manoj Goyal[1], Pinaki Dutta[5], Anil Bhansali[5] and Vivek Lal[1]

[1]Department of Neurology, Hind Institute of Medical Sciences, Safedabad, Lucknow, India, [2]Department of Neurology, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India, [3]Department of Radio-diagnosis, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India, [4]Department of Ophthalmology, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India and [5]Department of Endocrinology, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India

ABSTRACT: ***Background:*** Empty sella is a commonly described imaging entity in patients with idiopathic intracranial hypertension (IIH). Though menstrual and hormonal disturbances have been associated with IIH, available literature lacks systematic analysis of pituitary hormonal disturbances in IIH. More so, the contribution of empty sella in causing pituitary hormonal abnormalities in patients of IIH has not been described. We carried out this study to systematically assess the pituitary hormonal abnormalities in patients with IIH and its relation to empty sella. ***Methods:*** Eighty treatment naïve patients of IIH were recruited as per a predefined criterion. Magnetic resonance imaging (MRI) brain with detailed sella imaging and pituitary hormonal profile were done in all patients. ***Results:*** Partial empty sella was seen in 55 patients (68.8%). Hormonal abnormalities were detected in 30 patients (37.5%), reduced cortisol levels in 20%, raised prolactin levels in 13.8%, low thyroid-stimulating hormone (TSH) levels in 3.8%, hypogonadism in 1.25%, and elevated levels of gonadotropins were found in 6.25% of participants. Hormonal disturbances were independent and were not associated with the presence of empty sella ($p = 0.493$). ***Conclusion:*** Hormonal abnormalities were observed in 37.5% patients with IIH. These abnormalities did not correlate with the presence or absence of empty sella. Pituitary dysfunction appears to be subclinical in IIH and responds to intracranial pressure reduction, not requiring specific hormonal therapies.

RÉSUMÉ : Dysfonctionnement hypophysaire dans le cas de l'hypertension intracrânienne idiopathique : une analyse de 80 patients. ***Contexte :*** Le vide de la selle turcique (*empty sella*) est une observation obtenue par IRM couramment décrite chez les patients atteints d'hypertension intracrânienne idiopathique (HII). Bien que les troubles menstruels et hormonaux aient été associés à l'HII, la littérature scientifique disponible manque d'analyse systématique des troubles hormonaux hypophysaires dans l'HII. En outre, la contribution du vide de la selle turcique aux anomalies hormonales hypophysaires chez les patients atteints d'HII n'a pas été décrite. Nous avons ainsi mené cette étude pour évaluer systématiquement les anomalies hormonales hypophysaires chez des patients atteints d'HII et leur relation avec le vide de la selle turcique. ***Méthodes :*** Au total, ce sont 80 patients atteints d'HII et n'ayant jamais reçu de traitement qui ont été recrutés sur la base d'un critère prédéfini. Tous les patients ont donc bénéficié d'un examen d'IRM cérébrale avec imagerie détaillée de la selle turcique et de l'établissement d'un profil hormonal hypophysaire. ***Résultats :*** Une selle turcique partiellement vide a été observée chez 55 patients (68,8 %). Des anomalies hormonales ont par ailleurs été détectées chez 30 patients (37,5 %) alors que des taux réduits de cortisol ont été observés chez 20 % d'entre eux. À noter aussi qu'on a relevé des taux élevés de prolactine (13,8 % des patients), des taux faibles de thyréostimuline (3,8 %), un hypogonadisme (1,25 %) et finalement des taux élevés de gonadotrophines (6,25 %). Les troubles hormonaux étaient indépendants et n'étaient pas associés à la présence du vide de la selle turcique ($p = 0,493$). ***Conclusion :*** Des anomalies hormonales ont été observées chez 37,5 % des patients atteints d'HII. Ces anomalies n'étaient pas corrélées à la présence ou à l'absence du vide de la selle turcique. Le dysfonctionnement hypophysaire semble donc être subclinique dans l'HII et répond à la réduction de la pression intracrânienne, et ce, sans nécessiter de thérapies hormonales spécifiques.

Keywords: Idiopathic intracranial hypertension; Pituitary dysfunction; Empty sella

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Corresponding author: Aastha Takkar, D.M. Associate Professor, Department of Neurology, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, India. Email: draastha49@yahoo.com

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Introduction

Idiopathic intracranial hypertension (IIH), also known as pseudotumor cerebri syndrome, is a disorder of uncertain etiology that is characterized by the presence of increased intracranial pressure (ICP) with a normal cerebrospinal fluid (CSF) composition and specific neuroimaging features.[1]

The annual incidence of IIH is 1–3/100,000/year in the general population, but it increases to approximately 12–28/100,000/year when adjusted for obese females of reproductive age.[2] Despite decades of extensive research, the etiology and pathophysiology of IIH are not fully established. Endocrinal dysfunction has been inferred because this condition is typically found in young and obese women, occasionally with menstrual irregularities or a history of oral contraceptive intake. Disturbance of the pituitary–adrenal axis has been implicated as a causative factor in isolated case reports.[3–5]

Neuroimaging peculiarities suggestive of increased ICP have been defined, including empty sella, tortuous optic nerves, prominent perioptic nerve sheath, and scleral flattening. Empty sella is an extremely common finding in IIH, and its prevalence ranges from 2.5% for completely empty sella to 94% for partially empty sella.[6] However, it has limited specificity, and the cause of empty sella is not completely understood. It is often found in healthy subjects, obesity, and many other conditions, including meningioma.[7]

Empty sella may occur in response to a chronic increase in intrasellar pressure due to increased ICP, which may cause expansion of the pituitary fossa. This intermittent increase in intrasellar pressure may cause structural and functional abnormalities of the pituitary.

Aims and Objectives

The current study investigated the incidence of pituitary hormonal disturbances in patients with IIH (presence of empty sella). We also determined whether the presence of empty sella in these patients was associated with hormonal dysfunction. All patients were followed up for a minimum of 6 months to determine whether the presence of hormonal changes and/or empty sella could serve as prognostic markers for visual outcome in IIH.

Patient and Methods

This prospective observational study was performed in the Department of Neurology of a tertiary care institute in northern India over a period of 1.5 years from July 2019 to December 2020. A total of 80 patients with IIH were included in the study based on predefined inclusion and exclusion criteria (Supplementary file A). The institutional ethics committee approved the study, and written informed consent was obtained from all participants before inclusion in the study.

Detailed history and physical examination were performed in all the patients. Lumbar puncture was performed under aseptic conditions in all patients after informed consent was obtained, and CSF pressure was measured using a disposable open manometer after proper positioning of the patient in the lateral decubitus position. Visual acuity was checked using Snellen's chart, and papilledema was graded using the Modified Frisen Scale (see supplementary material). All patients underwent a detailed magnetic resonance imaging (MRI) sella with whole brain and orbits with MR venography. Sellar appearance was graded as normal, partially empty when less than 50% of the sella was filled with CSF, or completely empty when greater than 50% of the sella was filled with CSF. Detailed hemogram and biochemistry investigations were performed in all recruited patients. Hormonal profiling was performed in female patients (on day 3 of the menstrual cycle), including plasma T3, T4, TSH (thyroid-stimulating hormone), FSH (follicular-stimulating hormone), LH (luteinizing hormone), 17β estradiol (E2), prolactin, cortisol, and testosterone in males using electroluminescence (Cobas-6000 Roche, Hitachi, Germany). The normal reference ranges and definition of hormonal dysfunction are provided in Supplementary file C.

All patients were treated with medical therapy in the form of acetazolamide (maximum dose 4 g per day), topiramate (maximum dose 200 mg per day), and/or furosemide (maximum dose 40 mg per day) based on standard treatment protocols.[8] Patients with worsening visual symptoms on medical therapy or very poor visual acuity at presentation were managed surgically using CSF diversion procedures. Endocrinology opinions were sought for the need for any hormonal therapy in patients with altered hormonal profiles.[9]

Not all of the patients were followed for a minimal period of 6 months because 14 patients were lost to follow-up. Neuroimaging was performed at 6-month intervals to delineate radiological changes with time and treatment. The hormonal profile was also repeated after 6 months.

Statistical Analysis

Statistical analyses were performed using Statistical Package for Social Sciences 23.0 for Windows. The demographic data are presented using the measures of central location, including mean, median, and range. Comparisons between discrete variables were performed using the chi-squared test, and continuous variables were compared using nonparametric tests, such as the Mann–Whitney test. A p value of ≤ 0.05 was considered statistically significant. No multiple comparison correction was performed.

Results

The mean age of the patients (SD) was 30.9 (8.84) years. The study group included 73 women (91%) and 7 men (8.8%). The mean duration between the onset of symptoms and the first presentation to our hospital was 21.39 ± 22.8 weeks, and most patients (n = 42, 52.5%) presented between 1 and 6 months after the onset of symptoms. The most common symptom at presentation was headache (n = 80, 100%), which was migrainous in character in 56 (70%) patients. Transient visual obscurations (TVOs) were present in 63 (78.8%) patients, and pulsatile tinnitus was present in 45 (56%) patients. Sixteen patients (20%) complained of visual loss, and 15 patients (18.8%) complained of diplopia at presentation. The baseline characteristics of the patients are presented in Table 1.

The mean body mass index (BMI) of patients was 25.98 ± 3.74 kg/m2 (range: 19.5 to 38.05). Sixty-one patients (76%) were overweight and obese based on the Asia Pacific Task Force recommendation (2000).[10] Recent weight gain was reported by 21 (26%) patients within 12 months of presentation, with an average weight gain of 5.33 ± 1.74 kg.

In addition to patients with known endocrinal abnormalities, female patients with polycystic ovary syndrome (PCOS) were excluded from the study based on ultrasound of the abdomen and pelvis (Supplementary file A). Despite these strict criteria, menstrual irregularities were noted in 22 (27.5%) patients, and the most common regularities were oligomenorrhea in 15 patients (18.7%), followed by menorrhagia (3.7%), hypomenorrhea (2.5%), and dysmenorrhea (2.5%) (Table 1).

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Table 1: Baseline data of patients at presentation

	N	Percentage
Gender		
Female	73	91.2
Male	7	8.8
Age in years (Mean ± SD)	30.9 ± 8.84	
Mean duration of disease in weeks (Mean ± SD)	21.39 ± 22.8	
BMI* in kg/m^2 (Mean ± SD)	25.98 ± 3.74	
Median (IQR) CSF[a] pressure in cm of water	28.5 (26.0, 32.0)	
Clinical features		
Headache	80	100
TVO[b]	63	78.8
Pulsatile tinnitus	45	56.3
Diplopia	15	18.8
Visual deficits	23	28.7
Visual field defects	48	60
Papilledema (Modified Frisen's grading)	76	95
Menstrual irregularities	22	27.5
Neuroimaging abnormalities		
Optic nerve tortuosity	66	82.5
Posterior scleral flattening	64	80
Optic nerve sheath distension	59	73.8
Partial empty sella	55	68.8
Transverse sinus stenosis	50	62.5
Hormonal abnormalities		
Reduced serum cortisol levels	16	20
Elevated serum prolactin levels	11	13.8
Reduced serum TSH levels	3	3.8
Hypogonadism	1	1.25
Hypergonadotropism	5	6.25
Single hormonal abnormality	20	25
≥ 2 hormonal abnormalities	10	12.5

*BMI = body mass index, [a]CSF = cerebrospinal fluid, [b]TVO = transient visual obscurations.

While only 20% of patients had vision loss as a presenting complaint, visual acuity was abnormal in 28.7% of patients (n = 23). Two patients (2.5%) had complete visual loss within 4 weeks of symptom onset and qualified as fulminant IIH. Automated perimetry was performed using Humphrey's Field Analyzer. Forty-eight patients (60%) had abnormal visual fields at presentation.

Seventy-six (95%) patients had papilledema, and four patients (5%) had no papilledema.[11] However, they fulfilled the criteria for the diagnosis of IIH without papilledema, and six patients (7.5%) had unilateral papilledema (Table 1).[1]

CSF opening pressure was noted in all patients. The median CSF pressure was 28.5 cm of water. Most patients (n = 56,70%) had CSF pressure between 25 and 30 cm of water. Twenty-two patients (27%) had CSF pressure between 31 and 40 cm of water, and only two patients (3%) had CSF pressure greater than 40 cm of water. None of the patients had ICP below 25 cm of water. Detailed blood and CSF analyses excluded all secondary causes for ICP (Table 1).

All patients underwent gadolinium-enhanced MRI of the sella on MR venography at baseline and at the 6-month follow-up. Neuroimaging was abnormal at baseline in 74 (92.5%) patients (Figure 1). The most common abnormality noted was tortuous optic nerves, which was seen in 66 (82.5%) patients, followed by posterior scleral flattening in 64 (80%) patients and peri-optic subarachnoid space (SAS) dilatation in 59 (73.8%) patients. Partial empty sella was found in 55 (68.8%) patients, and none of the patients had complete empty sella (Table 1).

None of the patients were symptomatic for biochemical hormonal abnormalities, but 30 patients (37.5%) had an abnormal hormonal profile. The most common abnormality was reduced cortisol levels, which was associated with a failed Adrenocorticotropic hormone (ACTH) stimulation test in 16 (20%) patients. Three of these patients had cortisol levels <100 nmol/L, and the remaining 13 patients had cortisol levels between 100 and 350 nmol/L. High prolactin levels were present in 11 (13.8%) patients. Three (3.8%) patients had hypothyroidism (increased TSH levels), and only one patient (1.2%) had hypogonadism/low estradiol with inappropriately low normal or normal LH and FSH levels. Five patients (6%) were in the perimenopausal age group and had increased levels of LH and FSH. Two of seven males who fulfilled the diagnostic criteria for IIH had reduced serum cortisol levels. A single hormonal abnormality was found in 20 (25%) patients, and 10 (12.5%) patients had two or more hormonal abnormalities (Table 1).

Correlation of Hormonal Abnormalities with Various Clinical Parameters

We compared various clinical parameters in patients with and without hormonal abnormalities, and none of the parameters were significantly associated (Table 2). Patients who presented late in their disease course had significantly more hormonal abnormalities ($p = 0.02$).

No significant correlation was noted between the presence of menstrual irregularities, obesity, and recent weight gain and abnormal hormonal profiles (Table 2).

A positive correlation was noted between increased CSF opening pressure and an abnormal hormonal profile ($p = 0.02$), as shown in Table 2. Hormonal abnormalities were more likely in patients with a CSF opening pressure greater than 28.5 cm of water (median CSF opening pressure in our study) ($p = 0.02$). The presence of a CSF pressure >28.5 cm of water had a sensitivity of 66.6% and specificity of 60% in predicting hormonal abnormalities in patients with IIH.

Abnormal cortisol levels were seen in 12 patients (21.8%) with partial empty sella and 4 patients (16%) with normal sella. However, abnormal LH and FSH levels were noted in the partial empty sella group (10.2%, n = 5, $p = 0.37$; 8%, n = 4, $p = 0.15$, respectively). No significant differences were noted compared with patients with normal sella (4%, n = 1; 0%, n = 0, respectively). Elevated TSH levels were also slightly more common in the subgroup with normal sella ($p = 0.93$) (Tables 3 and 4). Increased prolactin levels were more commonly found in patients with normal sella (20.8%, n = 5; 12%, n = 6; $p = 0.33$) (Tables 2 and 4).

Fourteen patients were lost to follow-up. Therefore, follow-up neuroimaging and hormonal profiling were performed in 66 patients. Four (6%) patients had complete resolution of

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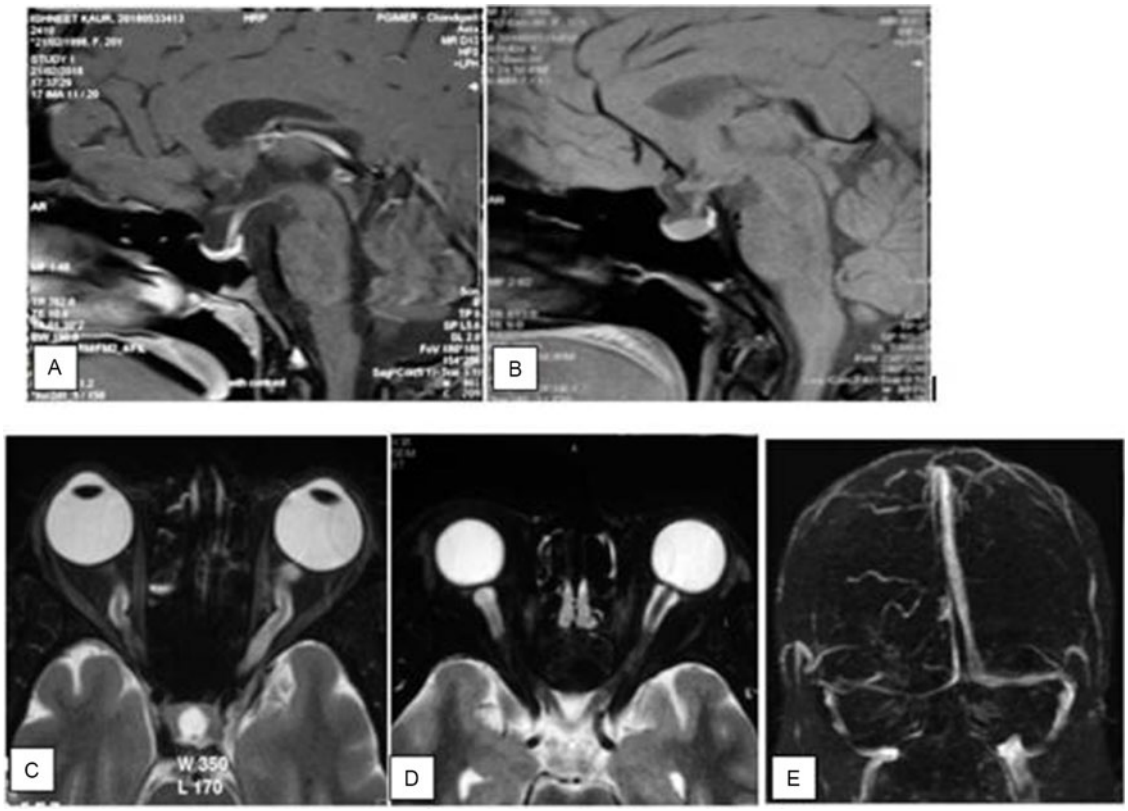

Figure 1: Neuroimaging abnormalities in IIH in our series: (A) partial empty sella in IIH; (B) normal sella in IIH; (C) optic nerve tortuosity with posterior sclera flattening in IIH; (D) perioptic subarachnoid space distension in IIH; (E) transverse sinus stenosis in IIH.

neuroimaging signs of elevated ICP. Partial empty sella was present in 47 (71%) patients at baseline and 45 (68%) patients at the 6-month follow-up. There was complete resolution of reduced serum TSH levels, cortisol levels, and hypogonadism in all patients on follow-up. Elevated LH and FSH persisted at the 6-month follow-up. High prolactin levels resolved completely in 11 of 12 patients. No hormonal treatment was given to patients because they were not symptomatic, and improvement in the hormonal profile was spontaneous with treatment of elevated ICP.

Discussion

Literature on hormonal abnormalities and their association with empty sella in patients with IIH is scarce.

The clinical profile in our cohort was similar to previous studies.[12–15] A total of 76.2% of patients were overweight and obese, with a mean BMI of 25.98 ± 3.73 kg/m2. Patients with known endocrine abnormalities and PCOS were excluded. Therefore, the general prevalence of obesity may be underestimated. The mean BMI (which is a known risk factor for IIH) was lower in our study than other studies. The BMI cutoff (overweight (23.0–24.99 kg/m2) and obesity (≥25 kg/m^2)) were also lower for the Asian population compared to other populations. Therefore, the observed BMI may be equivalent to other studies in terms of exposure or risk. The relationship between higher BMI and more severe disease is not within the scope of this study.

Menstrual irregularities were found in 22% of patients (after excluding patients with known endocrinal abnormalities). PCOS may be associated with hormonal abnormalities (and should be ruled out in patients with abnormal LH and FSH levels). Our strict exclusion of patients taking hormonal pills/steroids and patients with PCOS may have resulted in a reduced incidence of menstrual abnormalities.[12,13,16]

Various neuroimaging signs, including an empty sella, flattening of the posterior sclera, distension of the optic nerve sheath, and vertical tortuosity of the optic nerve, may help in establishing the diagnosis of patients with IIH. Neuroimaging was abnormal at baseline in 92.5% of patients, which was slightly higher than previous studies. Dedicated sellar imaging with whole brain and orbital screening with MR venography to detect even subtle signs of elevated ICP was performed, which may be the reason for the higher detection of neuroimaging signs in our study.[17] Notably, the neuroimaging signs have limited sensitivity and specificity. Empty (or partially empty) sella have been noted in 8% to 35% of the general population.[3] An another previous study noted the prevalence of partial empty sella in 23.3% of age- and gender-matched controls.[7]

Compression of the pituitary stalk secondary to increased ICP in IIH may affect hormonal regulation. Notably, only a few studies have been performed to look for pituitary hormonal abnormalities in patients with IIH. The evidence to support the hormonal hypothesis in IIH is observational and limited to isolated case reports.[4,5,18] This study is one of the first studies to observe the influence of IIH on pituitary hormones.

Hormonal abnormalities were noted in 37.5% of patients, with the most common abnormality being low serum cortisol levels (20%). A total of 13.8% of patients had elevated serum prolactin, but none of the patients had galactorrhea or other features of increased serum prolactin levels, and 1.2% had hypogonadism. The observed frequencies of reduced serum cortisol levels and elevated serum prolactin levels were higher than in previous

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Table 2: Clinical, cerebrospinal fluid, and neuroimaging predictors of hormonal dysfunction in IIH

Parameter		Hormonal abnormalities		
		Absent (n = 50)	Present (n = 30)	P value
Onset of symptoms to first presentation in weeks (Mean ± SD)		17.00 ± 17.8	28.70 ± 28.21	0.026*
Early morning headache		31 (62%)	19 (63.3%)	0.905
TVOs		39 (78%)	24 (80%)	0.832
Tinnitus		30 (60%)	15 (50%)	0.383
Diplopia		11 (22%)	04 (13.3%)	0.336
Menstrual irregularities		12 (24%)	10 (33.3%)	0.365
Obesity		27 (54%)	16 (53.3%)	0.954
Visual deficits		13 (26%)	10 (33.3%)	0.538
Papilledema		47 (94%)	29 (96.6%)	1.0*
CSF pressure in cm of water (Mean ± SD)		28.64 ± 3.44	31.38 ± 5.75	0.022*
CSF pressure above and below median value (28.5 cm water)	<28.5 cm of water	30 (60%)	10 (33.3%)	0.021*
	>28.5 cm of water	20 (40%)	20 (66.6%)	
Neuroimaging abnormalities	Partial empty sella	33 (66%)	22 (73.3%)	0.493
	Post. Sclera flattening	39 (78%)	25 (83.3%)	0.564
	Optic nerve tortuosity	40 (80%)	26 (86.7%)	0.447
	Optic nerve sheath distension	35 (70%)	24 (80%)	0.325
Correlation of partial empty sella with hormonal abnormalities		Partial empty sella		
		Absent (n = 25)	Present (n = 55)	P value
Hormonal abnormalities	Abnormal TSH	1	2	1.0
	Abnormal LH	1	5	0.660
	Abnormal FSH	0	4	0.304
	Abnormal prolactin	5	6	0.306
	Abnormal Cortisol	4	12	0.546

*Fisher's exact test.

Table 3: Comparison of various studies on hormonal abnormalities in partial empty sella and IIH

		Hormonal abnormalities				
		% of patients	Abnormal TSH	Abnormal LH/FSH	Abnormal prolactin	Abnormal cortisol
Studies on hormonal abnormalities in IIH	Sorensen et al.[24] (1986)	30%	0%	↓(30%)	0%	0%
	Klein et al. [19] (2013)	NA	NA	↑(11.7/14%)	↑(7.8%)	↓ (1.9%)
	Pollak et al.[20] (2015)	NA	↑(16%)	↓(11%), ↑(3%)	↑(6%)	↑(29%)
Current study (2019)	IIH without PES	32%	↑(4%)	↓(4%)	↑(20.8%)	↓(16%)
	IIH with PES	40%	↑(3.6%)	↓(1.25%), ↑(8.2%)	↑(12.2%)	↓(21.8%)
Studies in primary empty sella (not in IIH)	Rani et al. [23]	100%	↓ (50%)	↓(18.75%)	↑(18.75%)	↓(62.5%)
	Ghatnatti et al.[22]	50%	↓(4.1%)	↓(8.3%)	↑(20.8%)	↓(4.1%)
	Atci et al. [21]	40.9%	↓(2%)	↓(1.6%)	↑(28%)	↑(8%)
	De Marinis et al.[25]	25%	NA	NA	↑(10%)	↓(16.9%)

studies[19,20] (Table 3). Minor variation in pituitary hormone levels may be found in patients with IIH, but it is unlikely to be clinically significant and may resolve with the treatment of IIH. Therefore, testing for pituitary hormones may not be routinely needed even in the presence of empty sella.

We compared the presence of hormonal abnormalities in our study group with all of the clinical, biochemical, and radiological parameters to identify any association. The patients who presented late to our tertiary care center had significantly more hormonal abnormalities (p = 0.02). The timing of symptom onset may be

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Table 4: Depicting correlation of hormonal abnormalities with partial empty sella

Abnormal hormones (0 = absent, 1 = present)		Partial empty sella		P value
		Absent	Present	
Abnormal TSH	0	24 (96%)	53 (96.4%)	0.937
	1	1 (4%)	2 (3.6%)	
Abnormal LH	0	23 (95.8%)	44 (89.8%)	0.378
	1	1 (4.2%)	5 (10.2%)	
Abnormal FSH	0	24 (100%)	45 (91.8%)	0.15
	1	0 (0%)	4 (8.2%)	
Abnormal prolactin	0	19 (79.2%)	43 (87.8%)	0.335
	1	5 (20.8%)	6 (12.2%)	
Abnormal cortisol	0	21 (84%)	43 (78.2%)	0.546
	1	4 (16%)	12 (21.8%)	

confounded by memory bias and depend on an individual's threshold for pain sensitivity. Although it is difficult to interpret, it is likely that patients with long-standing elevated ICP may have prolonged effects of increased ICP on the pituitary stalk and more hormonal abnormalities. None of the other clinical parameters had any significant association with the hormonal profile. This result contrasts a study performed by Klein et al., who reported that increased levels of testosterone correlated positively with a young age of diagnosis.[19] Pollak et al. also demonstrated that the presence of increased cortisol correlated with visual outcomes and the rate of recurrence.[20] The sample size in these studies is too small to support any definitive conclusion, but these findings highlight the need for further exploration.

CSF pressure was significantly higher in patients with hormonal abnormalities than patients without hormonal imbalance (p=0.02). Only two patients in our study had a CSF opening pressure greater than 40 cm of water (6.7%). Among these patients, one patient had elevated serum prolactin and TSH levels, and the other patient had decreased serum cortisol levels.

Patients with partial empty sella were separately analyzed to look for any association with hormonal abnormalities. Partial empty sella was seen in 68.8% of patients in our study group. Forty percent of patients in the partial empty sella group had hormonal abnormalities, and reduced serum cortisol was the most common (21.8%), followed by elevated serum prolactin levels (12%). Though partial empty sella with IIH was not specifically studied, these results are similar to previous studies on endocrinal abnormalities in partial empty sella by Atci et al. and Ghatnatti et al.[21,22] (Table 3). Rani et al. found that the most common abnormality among 16 patients with hormonal dysfunction and partial empty sella was reduced serum cortisol levels (62.5%), followed by reduced serum TSH levels (50%).[23]

Notably, hormonal abnormalities were found in 32% of patients in the group with normal sella (Table 3). There were no differences in cortisol between patients with and without partial empty sella. Increased serum prolactin and TSH levels were more common (not statistically significant) in patients with normal sella than patients with partial empty sella. Although these findings need cautious interpretation, there may be transient functional deficits of the pituitary gland due to intermittent increases in intrasellar pressure, which causes hormonal abnormalities in these patients.

An important finding observed on follow-up was that the hormonal dysfunction in most patients normalized following the lowering of ICP alone (without any specific hormonal therapy), but the radiological finding of partial empty sella persisted in this subgroup with a frequency of 73% at baseline versus 64% at 6 months follow-up. These findings suggest that despite the presence of empty sella, the pituitary may only be affected functionally and not structurally in patients with IIH. Transient elevation of ICP, which is a cardinal feature of IIH, may be causative.

Conclusion

Pituitary hormonal abnormalities were observed in a subset of patients with IIH, and they may not correlate with the presence or absence of empty sella. The hormonal abnormalities seen in patients with IIH appear to be subclinical and do not require treatment with specific hormonal therapies. These abnormalities may be secondary to increased ICP and respond to the lowering of ICP alone. Empty sella is likely an anatomical variation or an incidental finding and should not be regarded as a diagnostic marker for IIH. Despite causing apparent compression of the pituitary gland, it may not reflect functional abnormalities in the hormonal profile of patients with IIH.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/cjn.2023.42.

Data Availability Statement. Data will be made available on reasonable request.

Statement of Authorship. Nandita: acquisition of data, analysis and interpretation of data, and manuscript preparation. Kirandeep: drafting and preparation of the article. Aastha: concept and design of study and drafting the article. Manoj, Chirag, Deeksha, Pinaki, and Anil: drafting the article and revising it critically for important intellectual content. Vivek: drafting the article and revising it critically for important intellectual content.

Consent to Participate Statement. A written informed consent was taken from all the participants included in the study.

Conflict of Interest. The authors have no conflicts of interest to declare.

Statement of Ethics. This study protocol was reviewed and approved by Institutional Ethics Committee, PGIMER, Chandigarh, approval number **11476-PG/1Trg/17985.**

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