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Endocrine Dysfunction in Traumatic Subarachnoid Hemorrhage: A Prospective Study

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Abstract

Background This study has prospectively investigated pituitary function and their correlation with severity, pressure effect, and Glasgow outcome scale in the acute phase of traumatic subarachnoid hemorrhage (SAH). Most of the retrospective studies have demonstrated that traumatic SAH-mediated hypopituitarism could be more frequent than previously known.

Objectives The aim of the study is to find the prevalence of endocrine dysfunction in traumatic SAH and its correlation with severity of injury and final outcome.

Materials and Methods Eighty-four consecutive patients of traumatic SAH formed the study group. Apart from clinical assessment, noncontrast computed tomography of the head was performed on all patients on admission. The hormonal analysis (FT3, FT4, thyroid-stimulating hormone, growth hormone [GH], cortisol, prolactin, testosterone) was performed within 24 hours of traumatic brain injury and was repeated on the seventh day amongst the patients who survived.

Results Most common hormone to increase on day one was cortisol (48.78%), while on day seven follicle-stimulating hormones and cortisol (15.38%) showed increment in levels. Most common hormone to decrease on day one was FT3 (36.84%) and GH (36.26%), while on day seven testosterone (66.67%) and FT4 (30.76%) showed decreasing levels. Hormone most resistant to change was prolactin.

Conclusion Hormonal dysfunction is common in moderate to severe traumatic brain injury. There is a direct association between radiological grading (Fischer) of SAH and hormonal profile changes. Performance of hormonal analysis should be considered in patients with moderate to severe traumatic brain injury, preferably with high-grade SAH, so that appropriate hormonal replacement can be done to optimize the clinical outcome.

Keywords
- pituitary
- subarachnoid hemorrhage
- endocrine dysfunction

Key Message

Post-traumatic pituitary hormonal dysfunction is significantly associated with patient's final outcome and behavioral abnormality in later life. Therefore, this relationship needs to be defined and should be taken care of.

Introduction

Traumatic subarachnoid hemorrhage (SAH) is a potential cause of hypopituitarism. Most of the studies regarding the relationship between traumatic SAH and anterior pituitary function were retrospective. Some degree of hypopituitarism

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appears to occur in approximately 40% of the patients with moderate or severe head injury, with growth hormone (GH) and gonadotroph deficiencies being the most common. A high degree of injury severity and secondary cerebral insults are likely risk factors for hypopituitarism. Post-acute pituitary function testing may be warranted in most patients with moderate or severe head injury, particularly those with diffuse brain swelling and those sustaining hypotensive or hypoxic insults.[1,2] Both head injury and SAH pose significant risk to pituitary function, given the gland's bony encasement within the sella turcica, its delicate infundibular hypothalamic structures and its vulnerable vascular supply (►**Figs. 1** and **2**).[3,4]

In this prospective study, we sought to determine the rate and risk factors of acute pituitary dysfunction after head injury. It has been hypothesized that the most common deficiencies would be of the somatotroph and gonadotroph axis, as these cells are known to be particularly vulnerable to a variety of insults, including pituitary apoplexy, irradiation, and trauma. It has also been hypothesized that injury severity correlates with the extent of hormonal failure. The relationship between head injury and subsequent pituitary failure was first reported in 1918. Since the 1970s, there have been numerous case reports of both anterior and posterior pituitary dysfunction occurring post trauma (►**Fig. 3**).

The largest case series, published in 1986, included a literature review of 53 patients. The majority had experienced complete anterior gland failure. Specifically, all patients were GH and gonadotropin deficient, 95% were corticotropin deficient, and 85% were thyrotropin deficient. Sixty-two percent of the patients also had increased serum prolactin and 30% suffered permanent diabetes insipidus. Isolated or combined somatotroph and gonadotroph dysfunctions appear to be most common, whereas corticotroph, thyrotroph, and posterior pituitary deficiencies are uncommon.

Objectives of Study

1. To find the prevalence of endocrine dysfunction in traumatic SAH and its correlation with severity of injury.
2. To assess clinical correlation between endocrine dysfunction and mass effect.
3. To assess clinical correlation between endocrine dysfunction and final outcome.
4. To predict the role of hormone replacement to improve the final outcome.

Inclusion Criteria

The inclusion criteria are:

1. Participants 18 years or older.
2. Evidence of SAH on noncontrast computed tomography (NCCT) brain following trauma.

Exclusion Criteria

The exclusion criteria are:

1. Age of patient less than 18 years.
2. Patients having significant extracranial injury.
3. Patients already on hormone replacement treatment.
4. Patients not willing for study or not giving consent.
5. Patients with severe uncontrolled co-morbid medical illness.

Methodology

The study was conducted in Neurosurgery department of SMS Medical College and associated hospitals, a 3,000 bedded super specialty tertiary care center. Fifty patients with post-traumatic subarachnoid hemorrhage (n = 50) will constitute the study sample. The nature and purpose of the study was explained to the participants and written informed consent shall be obtained either by participants or attendants (►**Fig. 4**).

Apart from clinical assessment, all the patients admitted with head injury underwent NCCT head to look for the

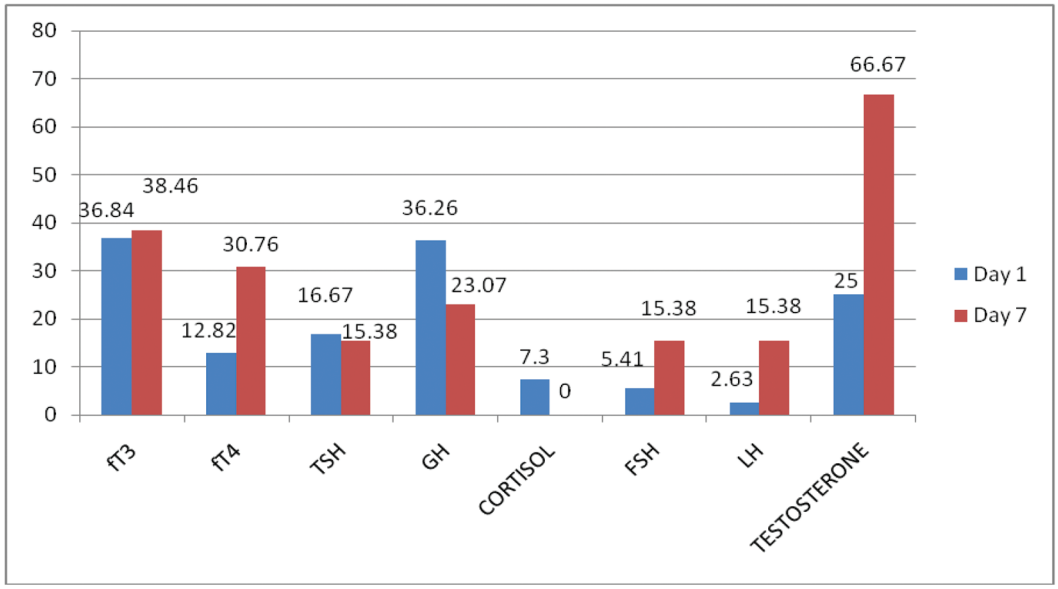

Fig. 1 Percentage of patients with traumatic SAH showing low hormone profile. SAH, subarachnoid hemorrhage.

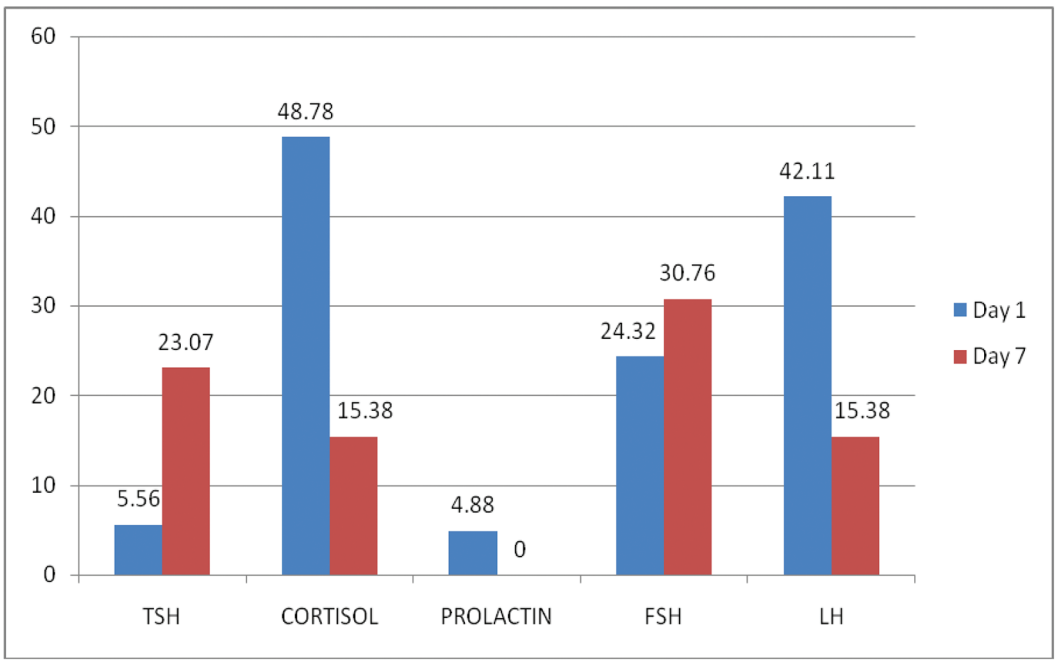

Fig. 2 Percentage of patients showing high hormone profile in acute phase of traumatic SAH. SAH, subarachnoid hemorrhage.

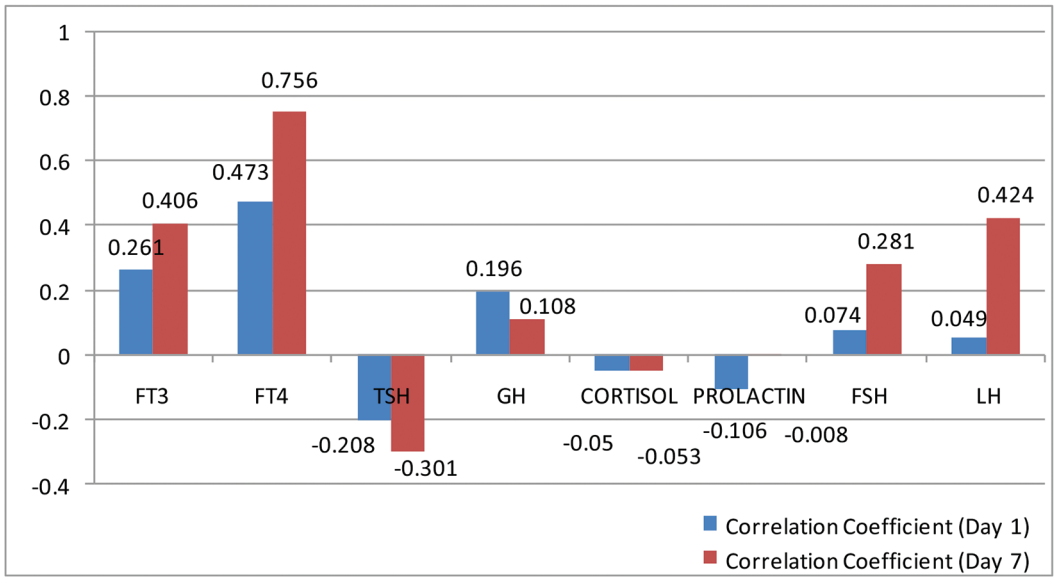

Fig. 3 Correlation of GCS and hormones in acute phase of traumatic SAH. SAH, subarachnoid hemorrhage.

presence of SAH along with other intracranial injuries, as extradural hemorrhage, subdural hemorrhage, intracranial hemorrhage, intraventricular hemorrhage, contusion, and bony injuries. NCCT head assessed the mass effect in the form of obliteration of basal cisterns and midline shift. Patients having SAH underwent cerebral CT angiography to rule out underlying aneurysmal dilatation of intracranial arterial system. The severity of SAH was classified using Hunt and Hess grading system and Fischer grading system. Patients having SAH underwent basal hormonal evaluation within 24 hours of admission. Basal hormonal evaluation included FT_3, FT_4, thyroid-stimulating hormone (TSH), GH, cortisol, prolactin, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and testosterone (only in male patients). These hormone levels were reassessed on day seven among the patients who survived. The final outcome of the patients was measured using Glasgow Outcome Score (GOS). The measures used in this study are Glasgow Coma Score (GCS), GOS, Hunt and Hess grade, and Fischer grade of SAH.

Results

A total of 84 patients were included in this prospective study. There were 56 males and 28 females, the average age being 40.21 years (range 18–78 years). Most common mode of traumatic SAH was road traffic accident comprising 92.85%

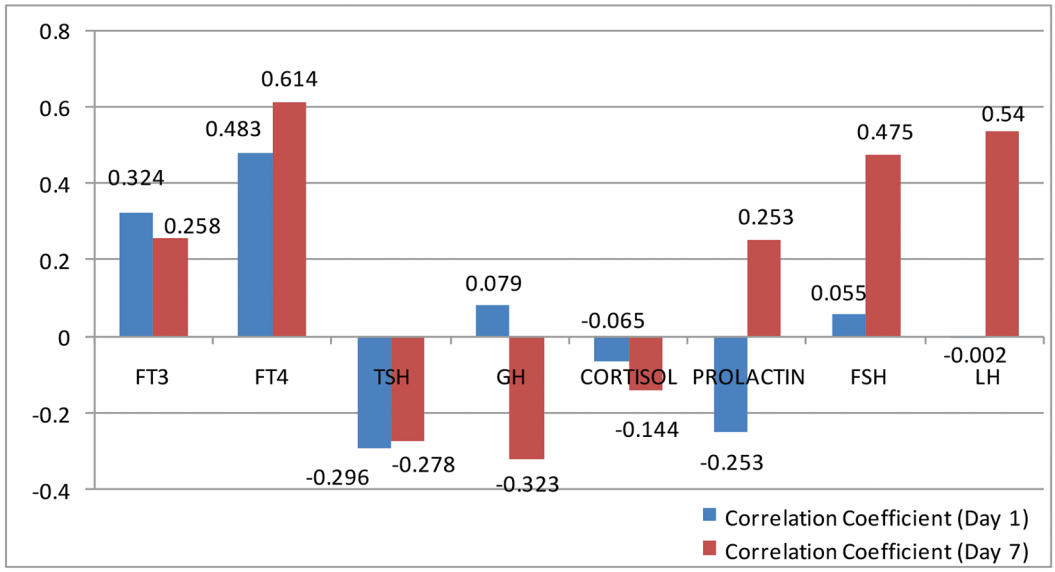

Fig. 4 Correlation coefficient of hormones and GOS in acute phase of traumatic SAH. GOS, Glasgow Outcome Score; SAH, subarachnoid hemorrhage.

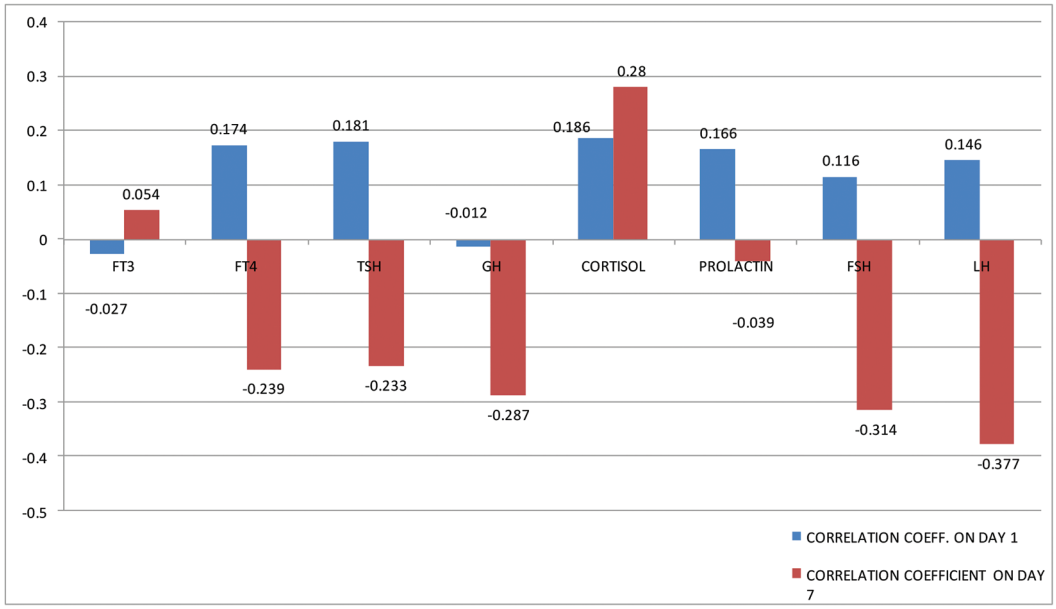

Fig. 5 Correlation coefficient of hormones with Fischer grade of SAH in acute phase of trauma. SAH, subarachnoid hemorrhage.

of all patients followed by fall from height (4.76%) and assault (2.38%). Of 84 patients 42.85% had mild, 40.47% had moderate, and 16.68% had severe head injury; 42.85% had pressure effect and 57.15% were without pressure effect; 39.47% had low-grade SAH, 60.53% high-grade SAH, and 10.53% patients had intraventricular hemorrhage, 69.05% had good GOS, and 30.95% had poor GOS. Eight of our patients of severe head injury died in acute phase. There was no statistically significant difference in mean age, FT3, FT4, TSH, cortisol, GH, prolactin, FSH, and LH levels between the patients with moderate and severe head injury (►**Fig. 5**).

On day one, percentage of patients showing low hormonal profile of FT3 was 36.84%, FT4 in 12.82%, TSH in 16.67%, GH in 36.26%, cortisol in 7.3%, FSH in 5.41%, LH in 2.63%, and testosterone in 25%. At the same time, patients showing high hormonal profile of TSH in 5.56%, cortisol in 48.78%, prolactin in 4.88%, FSH in 24.32%, and LH in 42.11%.

Of 76 patients on day seven, percentage of patients showing low hormonal profile of FT3 was 38.46%, FT4 30.76%, GH 23.07%, TSH, FSH, and LH 15.38%, and testosterone 66.67%, respectively. At the same time, percentage of patients showing high levels of hormone profile of TSH was 23.07%, cortisol and LH 15.38%, and FSH 30.76%, while there was no change in serum level of prolactin and GH.

Most common hormone to decrease significantly on day one was GH (36.26%) while cortisol was most common to increase significantly (48.78%). The most common hormone to decrease significantly on day seven was testosterone

(66.67%), followed by FT4 (30.76%), while most common hormone to increase significantly was FSH and cortisol (15.38%).

On day one 28.94% of the patients and on day seven, 23.08% of the patients had low T3 syndrome/Euthyroid sick syndrome, characterized by low FT3 with normal TSH and FT4 level.

None of patients had shown increase in FT3, FT4, GH or testosterone level or decrease in prolactin level during acute phase of traumatic SAH. The decrease in level of FT4, GH, FSH, LH, testosterone, and increase in level of TSH, cortisol during the acute phase of traumatic SAH was statistically significant ($p < 0.05$).

The decrease in the level of FT3 and increase in the level of prolactin during acute phase of traumatic SAH were not statistically significant. The hormone most resistant to alter during the acute phase of trauma was prolactin. Detailed profile of pituitary hormones in the acute phase of traumatic SAH is summarized in ►**Tables 1** to **4**.

On analysis of the hormonal trend from day one to seven, a decreasing trend of mean FT4, GH, FSH, LH, and testosterone level with normalization from initially elevated mean level of cortisol and prolactin was observed. Mean value of FT3 also showed improvement on day seven from initially decreased mean value on day one.

Table 1 Detailed hormone profile (in percentage) on day one and seven

Hormone	Level	Day 1 ($N = 84$)	Day 7 ($N = 76$)
FT3	Normal	63.16	61.54
	Decreased	36.84	38.46
	Increased	0	0
FT4	Normal	87.16	69.24
	Decreased	12.82	30.76
	Increased	0	0
TSH	Normal	77.77	61.55
	Decreased	16.67	15.38
	Increased	5.56	23.07
GH	Normal	63.74	76.93
	Decreased	36.26	23.07
	Increased	0	0
Cortisol	Normal	43.91	84.62
	Decreased	7.31	0
	Increased	48.78	15.38
Prolactin	Normal	95.12	100
	Decreased	0	0
	Increased	4.88	0
FSH	Normal	70.27	53.86
	Decreased	5.41	15.38
	Increased	24.32	30.76
LH	Normal	55.26	69.24
	Decreased	2.63	15.38
	Increased	42.11	15.38
Testosterone	Normal	75	33.33
	Decreased	25	66.67
	Increased	0	0

Abbreviations: FSH, follicle-stimulating hormone; GH, growth hormone; LH, luteinizing hormone; TSH, thyroid-stimulating hormone.

Correlation of Hormone Level with Severity of Head Injury

When we performed correlation of the hormonal changes with severity of trauma (GCS score) in acute phase of SAH, a positive correlation was observed between severity of injury and changes in levels of FT3, FT4, GH, FSH, and LH, while changes in TSH, cortisol, and prolactin levels were negatively correlated. Although the correlation was weak but, of all the pituitary hormones, FT4 showed the strongest correlation with the severity of trauma. The values of correlation coefficient of hormones on day one and seven are summarized in ►**Table 5**.

Correlation of Hormone Level with Final Outcome

In acute phase of traumatic SAH, FT3, FT4, GH, FSH, and LH showed positive correlation while TSH, cortisol, and prolactin showed negative correlation with the final outcome (GOS) of patient. Although the correlation was weak but of all the pituitary hormones, FT4 showed the strongest correlation with final outcome of patient. The values of correlation coefficient of hormones on day one and seven are summarized in ►**Table 6**.

Correlation of Hormone Level with Hunt and Hess Grade of SAH

In acute phase of traumatic SAH, FT3, FT4, GH, FSH, and LH showed negative correlation while TSH, cortisol, and prolactin showed positive correlation with grade of SAH (Hunt and Hess). Although the correlation was weak but of all the pituitary hormones, TSH showed the strongest correlation with grade of SAH. The values of correlation coefficient of hormones on day one and seven are summarized in ►**Table 7**.

Discussion

Post-traumatic neuroendocrine pathology may be a clinically significant complication following traumatic SAH. The majority of studies on pituitary dysfunction after traumatic brain injury (TBI) are retrospective. The present study is the prospective screening study from a single center, evaluating anterior pituitary function in the acute phase on day one and seven after traumatic SAH. We found substantial changes in basal pituitary hormone levels and investigated the possible relations between the pituitary hormonal changes and the severity and outcome of traumatic SAH. The pituitary gland responds to acute traumatic events and several changes in the circulating hormone levels become apparent during the first hours or days after injury, and may continue during the period of acute critical illness.[5] Recent increase in recognition of posttraumatic endocrine abnormality may be due to several factors: awareness of the condition, increasing incidence of traffic accidents, and prolonged survival with improved intensive care management.[6-8] There are several

Table 2 Detailed hormone profile (in percentage) in relation to severity of trauma in acute phase

Hormone	Level	Mild	(GCS = 13–15)	Moderate	(GCS = 9–12)	Severe	(GCS = 3–8)
		Day 1	Day 7	Day 1	Day 7	Day 1	Day 7
FT3	Normal	66.67	66.67	73.68	66.67	0	0
	Decreased	33.33	33.33	26.32	33.33	100	100
	Increased	0	0	0	0	0	0
FT4	Normal	93.33	100	84.21	50	75	0
	Decreased	6.67	0	15.79	50	25	100
	Increased	0	0	0	0	0	0
TSH	Normal	79.99	83.33	73.68	33.33	75	100
	Decreased	13.34	16.67	26.32	16.67	0	0
	Increased	6.67	0	0	50	25	0
GH	Normal	100	83.33	73.68	66.66	70	64
	Decreased	0	16.67	26.32	33.34	30	36
	Increased	0	0	0	0	0	0
Cortisol	Normal	53.33	83.33	36.85	83.33	25	74
	Decreased	6.67	0	5.26	0	0	0
	Increased	40	16.67	57.89	16.67	75	26
Prolactin	Normal	93.33	100	94.74	100	100	100
	Decreased	0	0	0	0	0	0
	Increased	6.67	0	5.26	0	0	0
FSH	Normal	66.67	53	78.95	50	50	44
	Decreased	0	16.67	5.26	50	25	56
	Increased	33.33	33.33	15.79	0	25	0
LH	Normal	46.67	50	78.95	83.33	75	71.5
	Decreased	0	16.67	5.26	16.67	20	28.5
	Increased	53.33	33.33	15.79	0	5	0

Abbreviations: FSH, follicle-stimulating hormone; GH, growth hormone; GCS, Glasgow Coma Score; LH, luteinizing hormone; TSH, thyroid-stimulating hormone.

Table 3 Detailed hormone profile (in percentage) in relation to Glasgow outcome score

Hormone	Level	Good GOS		Poor GOS	
		Day 1	Day 7	Day 1	Day 7
FT3	Normal	76	75	38.46	40
	Decreased	24	25	61.54	60
	Increased	0	0	0	0
FT4	Normal	92	75	76.92	60
	Decreased	8	25	23.08	40
	Increased	0	0	0	0
TSH	Normal	80	62.5	69.23	60
	Decreased	16	25	23.08	0
	Increased	4	12.5	7.69	40
GH	Normal	72	75	76.92	80
	Decreased	28	25	23.08	20
	Increased	0	0	0	0
Cortisol	Normal	52	87.5	23.08	80
	Decreased	4	0	7.69	0
	Increased	44	12.5	69.23	20
Prolactin	Normal	96	100	92.31	100
	Decreased	0	0	0	0
	Increased	4	0	7.69	0
FSH	Normal	72	62.5	69.23	40
	Decreased	4	12.5	7.69	60
	Increased	24	25	23.08	0
LH	Normal	60	62.5	61.54	80
	Decreased	4	12.5	0	20
	Increased	36	25	38.46	0

Abbreviations: FSH, follicle-stimulating hormone; GH, growth hormone; GOS, Glasgow Outcome Score; LH, luteinizing hormone; TSH, thyroid-stimulating hormone.

Table 4 Changes of hormone levels in relation to Fischer grade of SAH

Hormone	Level	Low Fischer Grade		High Fischer Grade	
		Day 1	Day 7	Day 1	Day 7
FT3	Normal	64.29	57.14	75	66.67
	Decreased	35.71	42.86	25	33.33
	Increased	0	0	0	0
FT4	Normal	92.86	57.14	66.67	83.33
	Decreased	7.14	42.86	33.33	16.67
	Increased	0	0	0	0
TSH	Normal	78.57	57.14	70	66.66
	Decreased	21.43	14.29	10	16.67
	Increased	0	28.57	20	16.67
GH	Normal	71.43	71.43	80	83.33
	Decreased	28.57	28.57	20	16.67
	Increased	0	0	0	0
Cortisol	Normal	42.86	85.71	40	83.33
	Decreased	7.14	0	0	0
	Increased	50	14.29	60	16.67
Prolactin	Normal	96.43	100	90	100
	Decreased	0	0	0	0
	Increased	3.57	0	10	0
FSH	Normal	75	57.14	60	50
	Decreased	3.57	14.29	10	50
	Increased	21.43	28.57	30	0
LH	Normal	57.14	57.14	70	83.33
	Decreased	3.57	14.29	0	16.67
	Increased	39.29	28.57	30	0

Abbreviations: FSH, follicle-stimulating hormone; GH, growth hormone; LH, luteinizing hormone; SAH, subarachnoid hemorrhage; TSH, thyroid-stimulating hormone.

Table 5 Correlation coefficient of hormones and GCS in acute phase of traumatic SAH

Hormones	Correlation coefficient (Day 1)	Correlation coefficient (Day 7)
FT3	**0.261**	**0.406**
FT4	**0.473**	**0.756**
TSH	−0.208	**−0.301**
GH	0.196	0.108
Cortisol	−0.050	−0.053
Prolactin	−0.106	−0.008
FSH	0.074	0.281
LH	0.049	**0.424**

Abbreviations: FSH, follicle-stimulating hormone; GCS, Glasgow Coma Score; GH, growth hormone; LH, luteinizing hormone; SAH, subarachnoid hemorrhage; TSH, thyroid-stimulating hormone.
Note: Bold values were only found statistically significant. Rest of the values were found insignificant statistically.

Table 6 Correlation coefficient of hormones and GOS in acute phase of traumatic SAH

Hormones	Correlation coefficient (Day 1)	Correlation coefficient (Day 7)
FT3	**0.324**	**0.258**
FT4	**0.483**	**0.614**
TSH	**−0.296**	**−0.278**
GH	0.079	**−0.323**
Cortisol	−0.065	−0.144
Prolactin	−0.253	−0.213
FSH	0.055	**0.475**
LH	0.002	**0.540**

Abbreviations: FSH, follicle-stimulating hormone; GH, growth hormone; GOS, Glasgow Outcome Score; LH, luteinizing hormone; SAH, subarachnoid hemorrhage; TSH, thyroid-stimulating hormone.
Note: Bold values were only found statistically significant. Rest of the values were found insignificant statistically.

mechanisms for hypothalamo–pituitary dysfunction due to traumatic SAH including hypoxic insult or direct mechanical injury to the hypothalamus, pituitary stalk, or the pituitary gland; compression from hemorrhage, edema, or increased intracranial pressure; and vascular injury to the hypothalamus or the pituitary gland.[1,9]

Based on the autopsy results in patients who died from TBI, there is an evidence of injury to the hypothalamus, the

Table 7 Correlation coefficient of hormones with Fischer grade of SAH in acute phase of trauma

Hormones	Correlation coefficient on day 1	Correlation coefficient on day 7
FT3	–0.027	0.054
FT4	0.174	–0.239
TSH	0.181	–0.233
GH	–0.012	–0.287
Cortisol	0.186	0.280
Prolactin	0.166	–0.039
FSH	0.116	–0.314
LH	0.146	–0.377

Abbreviations: FSH, follicle-stimulating hormone; GH, growth hormone; GOS, Glasgow Outcome Score; LH, luteinizing hormone; SAH, subarachnoid hemorrhage; TSH, thyroid-stimulating hormone.

pituitary gland, or the pituitary stalk in 26 to 86% of the patients.[10-13] Rotational acceleration–deceleration can stimulate shearing injury of axons and it is commonly seen in midline structures of the brain. This may represent a possible mechanism of hypothalamic pituitary dysfunction after TBI.[14] Nevertheless the exact mechanisms of TBI at molecular and cytokine level remain to be clarified.

Pituitary Thyroid Axis Abnormalities

Acute illness or trauma induces several changes in thyroid hormone levels within hours.[15] Wartofsky and Burman have reviewed the effects of severe illness on thyroid function.[16] Several names have been used for the same syndrome, including euthyroid sick syndrome, nonthyroidal illness, and low T3, and normal T4 syndrome.[5] Presence of low T3 syndrome and recovery over weeks have been demonstrated in a few studies.[17,18]

In our study, percentage of low T3 syndrome in the acute phase on day one and seven after traumatic SAH were 28.94 and 23.08%, respectively. In our study, there was a decreasing trend of serum T4 levels between day one and seven following injury and are comparable with study by Tandon et al.[19] Our results are comparable with those of Lieberman et al who found 11.6% of the patients to have low free FT4 without elevated thyrotropin levels, suggesting TSH deficiency. In contrast, Kelly et al[1] found only one patient (4.5%) with low T4 and TSH levels, also showed a blunted response to TRH stimulation. Free T3 and T4 was positively correlated with GCS and GOS on both day one and seven, whereas TSH were negatively correlated with GCS and GOS on both day one and seven. The strongest correlation of GCS and GOS was found with FT4.

Growth Hormone Abnormalities

Consistent with some,[1,2,10,20] but not with other[21] reports, this study clearly demonstrated that GH deficiency was the most common, 36.26% on day one, 23.07% on day seven after TBI. Serum GH is positively correlated with GCS on day one and seven. Long hypophyseal portal veins contribute 70% of the blood supply to the anterior pituitary. The somatotrophs and gonadotrophs are laterally placed, hence more frequently involved.[7] In acute phase of TBI, high or low basal GH levels associated with low IGF-1 levels have been demonstrated.[22-24] Peripheral resistance to GH action, manifested by high basal GH concentrations with low IGF-I concentrations, has been reported in patients with critical illness.[25]

Pituitary Adrenal Axis

Elevated serum cortisol levels (probably driven by corticotropin-releasing factor, cytokines, and noradrenergic system activation) during the initial phase gradually declining over a period of trauma have been previously reported in patients with mild and moderate TBI.[26,27] In our study 48.78% on day one and 15.38% on day seven had high plasma cortisol levels. This high level of cortisol secretion may contribute to the severe catabolic response with marked tissue wasting seen in head injury patients. According to King et al in their study on plasma cortisol levels after head injury, abnormally elevated levels of cortisol could be present as late as 4 months after head injury.[28] Desai et al found significant correlations between the Glasgow Coma Score and cortisol concentrations in patients who suffered head injury.[29] However, we found negative correlation between cortisol levels and the GCS in moderate to severe head injury, although others have demonstrated a correlation between GCS and initial cortisol levels and between cortisol levels and outcome.[26,27] But we found negative correlation with GOS on day one and seven.

Prolactin Abnormalities

Hyperprolactinemia occurred in 4.88% of our patients on day one, in contrast to those reported by Lieberman et al[2] who found 10% of the patients to have hyperprolactinemia. Hypothalamic and pituitary stalk lesions have been reported at autopsy in patients who died after TBI,[21] and lesions in either area could be responsible for the significant proportion of patients with hyperprolactinemia. Prolactin is the only pituitary hormone that is tonically inhibited by the hypothalamus. The presence of an increased plasma prolactin level could suggest hypothalamic damage.[5] Thus the normal serum prolactin levels in most of our patients were suggestive of a pituitary lesion. Edwards and Clark in their review on post-traumatic hypopituitarism have reported elevated prolactin in the majority of cases.[7] As the lactotrophs that secrete prolactin are located in the periphery of the gland, anterior pituitary necrosis could occur with destruction of other pituicytes, but leaving the lactotrophs relatively intact.[30] Few authors have reported low basal prolactin levels with an absence of response to TRH, indicating damage to lactotrophs with extensive anterior pituitary necrosis.[7,17] We found positive correlation between the severity of the TBI and the prolactin levels on day one, as demonstrated in previous studies.[31,32] Pituitary insufficiency may have serious consequences and may aggravate the physical and neuropsychiatric morbidity observed after head injury. Deficiency in thyroid hormones leads to

anergia, muscle weakness, and neuropsychiatric disorders. GH deficiency is associated with reduced lean body mass,[33] decreased exercise capacity,[34] impaired cardiac function,[35] and reduction in bone mineral density[36] which may be of particular significance in immobilized patients, as well as sleep disturbances, social isolation, reduced physical mobility, and general well-being.[37] In addition to these effects, which have direct consequences for post-TBI patients, GH deficiency has been associated with adverse metabolic changes that increase the risk of cardiovascular disease and possibly overall mortality.[38] Glucocorticoid deficiency can be life threatening, particularly in acutely ill patients, and may impair recovery and rehabilitation in the post-TBI period due to lethargy, muscle fatigue, and poor exercise capacity. All these effects can have the potential to impair recovery and rehabilitation and may contribute to the significant morbidity associated with TBI.

Conclusion

This study reveals that abnormalities in hormonal profile appear to be relatively common in moderate to severe TBI. There is a direct association between radiological grading (Fischer) of SAH and hormonal profile changes. Performance of hormonal analysis should be considered in patients with moderate to severe TBI, preferably with high-grade SAH, so that appropriate hormonal replacement can be done to optimize the clinical outcome.

Funding
None.

Conflict of Interest
None declared.

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