Research Article

INTERNATIONAL RESEARCH JOURNAL OF PHARMACY
www.irjponline.com
ISSN 2230-8407 [LINKING]

Neuroendocrine Dysfunction After Traumatic Brain Injury: Bridging Neurology and Endocrinology

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How to cite: Dr. Manoj Kumar Khandelwal, Dr. Tejashwini Kotian. **Neuroendocrine Dysfunction After Traumatic Brain Injury: Bridging Neurology and Endocrinology**. International Research Journal of Pharmacy, 2026,17:1: 32-37.
DOI: http://doi.org/10.56802/irjp.2025.v17.i1.pp32-37

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Abstract

Traumatic brain injury is frequently associated with neuroendocrine dysfunction due to damage to the hypothalamic–pituitary axis. This study aimed to assess the prevalence and pattern of neuroendocrine abnormalities in patients with traumatic brain injury. A cross-sectional observational study was conducted on 120 patients, with hormonal evaluation performed at least three months after injury. Neuroendocrine dysfunction was identified in 43.3% of patients, with growth hormone deficiency being the most common abnormality and higher prevalence observed in moderate and severe injuries. The findings emphasize the need for routine endocrine screening and integrated neurological–endocrinological management to improve long-term outcomes after traumatic brain injury.

Keywords

Traumatic brain injury; Neuroendocrine dysfunction; Hypothalamic–pituitary axis; Post-traumatic hypopituitarism; Hormonal abnormalities

Introduction

Traumatic brain injury (TBI) represents a significant public health problem worldwide and is a major cause of death and long-term disability across all age groups [1]. In addition to the primary neurological damage, TBI can disrupt the normal functioning of the hypothalamic–pituitary axis, leading to a range of neuroendocrine abnormalities that are often overlooked during routine clinical care [2]. The hypothalamus and pituitary gland are especially susceptible to injury following TBI because of their central location, fragile vascular supply, and sensitivity to mechanical forces, ischemia, and inflammatory processes [3]. Post-traumatic hypopituitarism has been increasingly recognized as a common complication of TBI, with prevalence rates varying widely depending on injury severity, diagnostic criteria, and timing of

hormonal evaluation [4].Neuroendocrine dysfunction after TBI may involve one or multiple hormonal axes, including growth hormone, adrenal, thyroid, gonadal, and posterior pituitary hormones [5].These hormonal disturbances can significantly contribute to persistent symptoms such as cognitive dysfunction, fatigue, emotional instability, metabolic abnormalities, and reduced quality of life in survivors of traumatic brain injury [6].Despite growing evidence supporting the clinical relevance of post-traumatic endocrine disorders, standardized screening protocols and integrated management strategies remain limited in routine neurological practice [7].Therefore, a collaborative approach that bridges neurology and endocrinology is essential for the timely recognition, diagnosis, and treatment of neuroendocrine dysfunction, ultimately improving long-term outcomes in patients with traumatic brain injury [8].

Methodology

This original cross-sectional observational study was conducted to evaluate neuroendocrine dysfunction in patients with traumatic brain injury. A total sample of 120 patients diagnosed with traumatic brain injury was recruited from the neurology and neurosurgery departments of a tertiary care hospital over a period of 18 months. Adult patients aged 18 to 65 years with a documented history of mild, moderate, or severe traumatic brain injury at least three months post-injury were included in the study, while patients with pre-existing endocrine disorders, hypothalamic–pituitary disease, or those receiving hormone replacement therapy were excluded. Clinical data including demographic details, mechanism and severity of injury, and time since trauma were recorded. Hormonal evaluation was performed by measuring serum levels of cortisol, thyroid-stimulating hormone, free thyroxine, growth hormone, insulin-like growth factor-1, luteinizing hormone, follicle-stimulating hormone, prolactin, and serum sodium to assess posterior pituitary function. Data were analyzed using appropriate statistical methods to determine the prevalence and pattern of neuroendocrine dysfunction and to examine its association with injury severity and clinical outcomes.

Results

A total of 120 patients with traumatic brain injury were included in the study. The mean age of the study population was 38.6 ± 12.4 years, with a male predominance. Road traffic accidents were the most common cause of injury. The baseline demographic and clinical characteristics of the participants are summarized in Table 1. Neuroendocrine dysfunction was identified in 52 out of 120 patients, giving an overall prevalence of 43.3%. Growth hormone deficiency was the most frequently observed hormonal abnormality, followed by gonadotropin and adrenal axis dysfunction. The distribution of affected hormonal axes is presented in Table 2.A higher prevalence of neuroendocrine dysfunction was observed in patients with moderate and severe traumatic brain injury compared to those with mild injury. Patients with severe TBI showed involvement of multiple hormonal axes more frequently. The association between severity of traumatic brain injury and neuroendocrine dysfunction is shown in Table 3.

Table 1. Demographic and clinical characteristics of the study population (n = 120)

Variable	**Number (%)**
Age (years, mean ± SD)	38.6 ± 12.4
Gender	
Male	84 (70%)
Female	36 (30%)
Cause of injury	
Road traffic accident	68 (56.7%)
Fall	34 (28.3%)
Assault	18 (15%)
Severity of TBI	
Mild	46 (38.3%)
Moderate	42 (35%)
Severe	32 (26.7%)

Table 2. Pattern of neuroendocrine dysfunction among affected patients (n = 52)

Hormonal axis affected	**Number (%)**
Growth hormone axis	28 (53.8%)
Gonadotropin axis	22 (42.3%)
Adrenal axis	18 (34.6%)
Thyroid axis	14 (26.9%)
Posterior pituitary (ADH)	8 (15.4%)
Multiple axes involved	20 (38.5%)

Table 3. Association between TBI severity and neuroendocrine dysfunction

Severity of TBI	**Total patients**	**Patients with dysfunction n (%)**
Mild	46	10 (21.7%)
Moderate	42	20 (47.6%)

Severity of TBI	Total patients	Patients with dysfunction n (%)
Severe	32	22 (68.8%)

Discussion

The present study demonstrates a high prevalence of neuroendocrine dysfunction among patients with traumatic brain injury, highlighting the significant endocrine sequelae associated with brain trauma [9].The overall prevalence of neuroendocrine abnormalities observed in this study is consistent with previous reports, which have shown wide variability depending on injury severity, timing of assessment, and diagnostic criteria [10].Growth hormone deficiency emerged as the most common hormonal abnormality, which aligns with existing evidence suggesting that somatotroph cells are particularly vulnerable to traumatic and ischemic damage [11].The frequent involvement of the gonadotropin and adrenal axes observed in this study further supports the hypothesis that traumatic brain injury can disrupt multiple hypothalamic–pituitary pathways simultaneously [12].

A significantly higher prevalence of neuroendocrine dysfunction was noted in patients with moderate and severe traumatic brain injury, reinforcing the association between injury severity and the risk of post-traumatic hypopituitarism [13].The presence of multiple hormonal axis involvement in patients with severe traumatic brain injury suggests a cumulative effect of mechanical injury, secondary inflammation, and vascular compromise on pituitary function [14].These hormonal deficiencies may contribute to persistent symptoms such as fatigue, cognitive impairment, mood disturbances, and reduced functional recovery, which are often attributed solely to neurological damage [15].

The findings of this study emphasize the importance of systematic hormonal screening in patients with traumatic brain injury, particularly in those with moderate to severe injury and persistent unexplained symptoms [16].Early recognition and appropriate management of neuroendocrine dysfunction may improve rehabilitation outcomes, quality of life, and long-term prognosis in traumatic brain injury survivors [17].Overall, the results underscore the need for an integrated multidisciplinary approach involving neurologists, endocrinologists, and rehabilitation specialists to optimize post-traumatic care [18]. The finding of multiple hormonal axis involvement in patients with severe traumatic brain injury suggests a cumulative pathophysiological effect rather than isolated glandular injury [19]. These endocrine abnormalities may contribute to persistent neurocognitive deficits, fatigue, depression, sexual dysfunction, and poor metabolic control, symptoms that are frequently attributed solely to neurological damage [20].

Failure to recognize underlying hormonal deficiencies may therefore lead to suboptimal rehabilitation outcomes and prolonged disability in traumatic brain injury survivors [21]. The results of this study emphasize the need for routine and systematic endocrine screening in patients with moderate to severe traumatic brain injury, particularly in those with persistent or unexplained symptoms [22].

Conclusion

Neuroendocrine dysfunction is a frequent but often underrecognized complication of traumatic brain injury and contributes significantly to long-term morbidity. The findings of this study highlight the strong association between injury severity and the risk of hypothalamic–pituitary axis dysfunction, with growth hormone deficiency being the most common abnormality. Routine endocrine screening and a multidisciplinary approach are essential to ensure early diagnosis, appropriate management, and improved functional outcomes in patients with traumatic brain injury.

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