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ORIGINAL ARTICLE

Proportion and Pattern of Selective Micronutrient and Macronutrient Deficiency in Traumatic Brain Injury Patients admitted in Neurosurgery ICU

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ABSTRACT

Background: Traumatic brain injury (TBI) often leads to changes in body composition, including the loss of lean body mass, which increases the risk of adverse clinical outcomes such as infections, prolonged ICU stays, and higher mortality rates. These complications may be exacerbated if there is a deficiency of crucial micronutrients and macronutrients.

Methods: This prospective observational study was performed in the Department of Neurosurgery, SMS Medical College, Jaipur, between July 2021 and March 2022. We recruited 200 TBI patients aged 15 to 80 years who had a post-resuscitation Glasgow Coma Scale (GCS) score of 3–8 (severe TBI). The "Malnutrition Universal Screening Tool" (MUST) was used to categorize nutritional status, while serum levels of electrolytes (sodium, potassium, calcium, phosphate, and vitamin B12) were measured. Data were collected at admission and at various intervals (24 hours, weekly) based on the study protocol. Statistical analysis was performed using SPSS 22.00.

Results: Among the 200 participants, 68.5% were male. Age distribution showed that 62% were 31–45 years old, with a predominant etiology of road traffic accidents (69.5%). TBI severity categorization yielded mild in 26%, moderate in 30.5%, and severe in 43.5% of cases. Daily energy, protein, carbohydrate, and fat intake were significantly lower than recommended dietary allowances ($p < 0.05$). Macronutrient inadequacy for energy, protein, carbohydrates, and fiber was reported in 93.5%, 69%, 4.5%, and 71.5% of patients, respectively. Sodium levels were significantly associated with TBI severity, and mean calcium levels were lower in severe TBI cases, whereas potassium and phosphate showed no significant correlation with severity ($p > 0.05$).

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Conclusion: Identifying and correcting malnutrition (including both macro- and micronutrient deficiencies) upon admission may reduce complications in TBI. Appropriate nutritional interventions, coupled with close monitoring of electrolytes, have the potential to improve outcomes in this population.

KEY WORDS

• Traumatic brain injury • Micronutrient • Macronutrient • ICU • Malnutrition • Glasgow coma scale

INTRODUCTION

Traumatic brain injury (TBI) is defined as intracranial damage resulting from an external force. Acute TBI refers to the first seven days post-injury, while subacute TBI spans from day eight to three months.[1] Patients requiring emergency department care for TBI often need at least an overnight hospital stay for observation, with more severe or complicated cases extending the duration of admission.[2] Malnutrition remains a frequent outcome in hospitalized settings; estimates suggest 20% to 50% of hospitalized patients may be malnourished, although the exact prevalence for TBI populations is less well-established.[2,3]

Physiologically, trauma leads to a spectrum of metabolic disruptions, hormonal fluctuations, and systemic inflammatory responses.[3] Energy expenditure may rise by 87% to 200% compared with normal needs and remain elevated for around 30 days due to metabolic shifts.[4] Concurrently, hormone production (including corticosteroids and other counter-regulatory hormones) along with cytokines may provoke a hypermetabolic state.[5,6] Other systemic challenges can complicate caloric requirements.[7] This hypercatabolic environment results in hyperglycemia, protein depletion, and a higher demand for calories.[8]

The principal consequences of significant traumatic injury include weight loss, reduction of lean body mass (particularly skeletal muscle), negative nitrogen balance, and retention of water and sodium.[2] These factors elevate the risk of immune suppression, infection, and multi-organ dysfunction, thereby contributing to prolonged ICU or hospital stays and higher mortality.[9]

AIMS AND OBJECTIVES

Primary Objective:

- To determine the proportion of selected micronutrient and macronutrient deficiencies in TBI patients.

Secondary Objectives

1. To explore the pattern of these selected micronutrient and macronutrient deficiencies among TBI patients.
2. To analyze the relationship between micro- and macronutrient deficiencies with respect to the type of traumatic brain injury.

MATERIAL AND METHODS

A prospective observational study was conducted in the Department of Neurosurgery, SMS Medical College, Jaipur, following approval from the Institutional Ethics Committee. Written informed consent was obtained from each participant. The study period extended from July 2021 to March 2022.

A total of 200 traumatic head injury patients, aged 15 to 80 years, with post-resuscitation GCS scores between 3 and 8 (severe TBI) were included. Patients with a history of significant end-organ dysfunction, hypertension, known endocrine disorders, allergies, pregnancy, or ongoing chronic diuretic therapy were excluded. The recruitment continued until the required sample size was reached or until a maximum of nine months from the date of ethics approval.

Severity of Injury: GCS was used to classify TBI into mild (≥13), moderate (9–12), and severe (≤8).[11] The head CT scan was utilized to assess the injury type.

Nutritional Status: The Malnutrition Universal Screening Tool (MUST)[1] was applied to evaluate nutritional risk. Scores ≥ 2 indicated a high malnutrition risk.

Electrolyte Measurements: Serum sodium and potassium were tested upon emergency admission (prior to IV fluids) and again after 24 hours. Calcium, phosphate, and vitamin B12 levels were checked concurrently at 24 hours post-resuscitation. Lab criteria defined normal reference ranges as:

- Sodium: 130–145 mEq/L
- Potassium: 3.5–5.5 mEq/L
- Calcium: 8.8–10.5 mg/dL
- Phosphate: 2.5–4.5 mg/dL

Values that fell outside these parameters were considered abnormal. Laboratory measurements were repeated weekly until patient discharge.

Data Analysis: The collected data were entered into a spreadsheet and analyzed using SPSS version 22.00 for Windows (SPSS Inc., Chicago, USA). Means and standard deviations were computed for each group, applying one-way ANOVA for group comparisons. Student's t-test and chi-square tests were used where necessary, with a significance threshold set at $p < 0.05$.[17]

RESULTS

A total of 200 participants were included, of whom 68.5% were male and 31.5% were female. The largest age category was 31 to 45 years (62%), and the most common TBI etiology was road traffic accidents (69.5%). Among all cases, mild TBI was recorded in 26%, moderate TBI in 30.5%, and severe TBI in 43.5% (Table 1).

Table 1: Demographic Characteristics of The Study Population

Variables	N=200	%
Gender		
Male	137	68.5
Female	63	31.5
Age Group (in years)		
15-30	61	30.5
31-45	104	62
>45	35	17.5
TBI		
Mild	52	26
Moderate	61	30.5
Severe	87	43.5
Etiology		
RTA	139	69.5
Fall from Height	61	30.5

*statistically significant

All the nutrients intake viz. energy (kcal/d), protein (gm/d), CHO (gm/d) and fat (gm/d) was found to be significantly less among the TBI subjects when compared to recommended daily allowance (RDA) as $p<0.05$ (table 2).

Table 2: Nutrients Intake of TBI

Nutrients	Mean	SD	RDA		pvalue
			Mean	SD	
Energy (kcal/d)	2104.37	34.69	2363.81	42.95	0.038*
Protein (gm/d)	79.62	6.83	91.04	4.78	0.007*
CHO (gm/d)	331.57	7.01	248.45	6.22	<0.01*
Fibre (gm/d)	24.49	2.38	-	-	-
Fat (gm/d)	20.06	0.78	61.68	0.41	<0.01*

*statistically significant

It can be appreciated from table 3 that energy, protein, CHO and fat intake were negatively affected by the severity of trauma.

Table 3: Nutrients intake according to severity of TBI

Nutrients	Mild		Moderate		Severe		pvalue
	Mean	SD	Mean	SD	Mean	SD	
Energy (kcal/d)	2358.2	30.87	2139.13	37.64	1945.41	32.81	0.028*

Macronutrients inadequacy viz. energy (kcal/d), protein (gm/d), CHO (gm/d) and fibre (gm/d) inadequacy was reported among 93.5%, 69%, 4.5% and 71.5% of the subjects respectively (table 4).

Table 4: Proportion of subjects having macronutrients inadequacy

Variables	N=200	%
Energy (kcal/d)	187	93.5
Protein (gm/d)	138	69
CHO (gm/d)	9	4.5
Fibre (gm/d)	143	71.5

It was found that serum sodium was significantly directly correlated with the severity of trauma. Mean calcium level was found to be least in severe TBI subjects followed by moderate and mild. When mean calcium level was compared according to severity of TBI using ANOVA test, significant difference was found. No significant association was found between the severity of TBI and serum potassium as well as phosphate level (table 5).

Table 5: Electrolytes and other parameters according to severity of TBI

Variables	Mild		Moderate		Severe		p-value
	Mean	SD	Mean	SD	Mean	SD	
Serum Sodium (MEq/L)	138.92	11.53	147.31	10.27	164.58	12.44	0.007*
Serum Potassium (MEq/L)	3.98	1.72	4.31	1.39	4.49	1.87	0.09
Calcium	8.9	2.12	8.26	1.85	7.08	2.06	0.021*
Phosphate	3.11	0.55	3.36	1.03	3.32	0.97	0.22

*statistically significant

DISCUSSION

The brain's macro and micronutrient requirements have been widely acknowledged, including the recommendation for diets rich in vitamins, minerals, antioxidants, and essential fatty acids.[12] This investigation aimed to examine both macro and micronutrient deficiencies in TBI patients and their relationship to different TBI types and severities. Our cohort comprised 200 individuals, of whom 68.5% were men. Over half fell into the 31–45 age range, aligning with the high prevalence of work-related or vehicular trauma.

In this study, 43.5% of participants were classified with severe TBI. These data mirror findings by Krakau *et al.*[13,6] indicating that a substantial proportion of TBI admissions are severe (GCS 3 to 5). Severe TBI often correlates with poorer clinical and nutritional outcomes.[1] Dhandapani *et al.* also demonstrated a significant association between low admission GCS and malnutrition risk in TBI patients.[14]

All assessed nutrient intakes were significantly below recommended daily standards. Greater deficits were observed among those with more severe injuries, possibly attributable to extended healing times, difficulty with oral intake, or neuromuscular challenges impacting swallowing. Macronutrient inadequacies were identified in 93.5% for energy, 69% for protein, 4.5% for carbohydrate, and 71.5% for fiber, reinforcing previous work by Ghazi Daradkeh *et al.*[15] and Hadis Sabour.[16] Reduced fiber intake was similarly reported by Walter et al.[17] and Tomey *et al.*[18], who advocated nutritional education to improve fiber consumption.

Deficient nutrient intake in TBI can result from multiple factors: appetite suppression due to physiological and psychological stress, mechanical or neurological impediments to swallowing, and various metabolic or endocrine alterations that disrupt feeding behaviors.[1-2] Dysphagia is frequently noted in severe TBI, with an incidence of up to 60% in adults and nearly 68% in pediatric cases.[2] The complexity of swallowing mechanics, particularly following neurologic damage, necessitates careful dietary management.[1,2] A prior study by Krakau *et al.*[13] linked dysphagia to undernutrition and subsequent complications, echoing the notion that malnutrition considerably impairs recovery.[1] Stratton *et al.*[15] and Denes *et al.*[20] reported that severe head injuries often lead to malnutrition, resulting in increased infection risk and extended hospital stays.

Our findings also showed a direct correlation between rising serum sodium levels and

worsening TBI severity. Mean calcium concentrations were significantly lower in severe TBI compared to other categories. Conversely, potassium and phosphate displayed no relevant statistical association with TBI severity, which is consistent with earlier reports of variable outcomes related to these electrolytes.

Despite its strengths, our study has limitations. Some participants could not accurately recall dietary intake, potentially underestimating their actual consumption. Furthermore, the single-center design and sample size may limit broad applicability. Nonetheless, these findings highlight the integral role of nutrition in TBI management.

CONCLUSION

This investigation reveals that energy, protein, and fiber intake are frequently inadequate among TBI patients, especially those with severe injury as indicated by lower GCS. A significant number of patients also exhibit electrolyte abnormalities, such as elevated sodium and decreased calcium. Early nutritional assessment[1] and tailored interventions to address both macro and micronutrient needs may be crucial to preventing malnutrition-related complications in TBI care.

Competing interests: None

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