Analysis of Circadian Brain Temperature Rhythm in Traumatic Brain Injury

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Introduction

The improvement of intensive care and surgical intervention has allowed many patients to survive severe head injury, and previous studies have developed some clinical parameters which can predict the conscious and functional recovery. These included Glasgow coma scale (GCS), age, electroencephalogram (EEG), image findings, papillary response and light reflex, and somatosensory evoked potentials (SSEP). Among these tests, some had better sensitivity for unfavorable or favorable outcome. Hypothermia has been applied in patients of brain injury; however, the rhythmic variation and its prognostic value of brain temperature after head injury have never been studied.

Methods

This study describes diurnal brain temperature patterns in comatose patients hospitalized for head injury (n = 108). The criteria used to select cases in the present study included: moderate to severe TBI (GCS 3-13), Age 18 or older; surgery including ICP monitoring and brain temperature recording. TBI was defined by the patient diagnosed to have at least one of the following diagnoses due to head injury: subdural hematoma, epidural hematoma, cerebral contusion, subarachnoid hemorrhage, and diffuse axonal injury. Patient with history of pre-existing brain diseases such as brain tumor, stroke, meningitis, or traumatic injuries including rib fracture, hemothorax, liver or spleen laceration, bony fracture except skull bone, or who survived less than 3 days after surgery were also excluded. In addition, we excluded the patient with diagnosed infection within 72 hours after admission, and those who had signed do-not-resuscitate order. Temperature mesor, amplitude, and acrophase were estimated from recorded temperature measurements using cosinor analysis. The association of these patterns with clinical parameters, mortality, and 6-month functional outcome was examined.

Results

108 patients were included in this study with their clinical parameters shown in Table 1. Analyzed by the cosinor analysis, 59.3% of the patients had presence of circadian rhythm in brain temperature in the first 72 hours. The mean mesor was 37.39 (±1.21) ºC. The amplitude was diminished with a mean of 0.28 (±0.25) ºC. Shift of temperature acrophase was also observed. Univariate analysis demonstrated some early parameters after head injury were correlated with 6-month functional outcome (Table 2). Analyzed by multivariate logistic regression, the final best predictive model included initial GCS, age and circadian rhythm of brain temperature (Table 3).

Conclusions

Analysis of brain temperature rhythm in traumatic brain injury provided additional predictive information in relation to outcome. Further research is needed to understand the pathophysiology of brain temperature regulation following head injury.

Table 1

Table 1 Clinical parameters of patients (n=108)

Sex, n (%)	
Male	74 (68.5)
Female	34 (31.5)
Age, years	
Mean	52.3
Median	52
Range	18-80
Diabetes mellitus	
Yes	17 (15.7)
No	91 (84.3)
Hypertension	
Yes	26 (24.1)
No	82 (75.9)
Diagnosis	
Subdural hematoma	57 (52.8)
Epidural hematoma	15 (13.9)
Contusion	15 (13.9)
Others, including two or more	21 (19.4)
Initial Glasgow Coma Scale score	
Mean (SD)	6.9
Median	7
Range	3-10
Six-month Glasgow Outcome Scale	
1	20 (18.5)
2	19 (17.6)
3	24 (22.2)
4	23 (21.3)
5	22 (20.4)
Mean (SD)	3.1

Table 2

Table2 Univaraiate analysis for functional outcome

	unfavorable n = 63	favorable n = 45	p^a	Dead n = 20	Alive n = 88	p
Sex (0/1)	26/37	8/37	<0.01	7/13	27/61	0.71
Age	60.0 (17.9)	41.5 (19.4)	<0.01	65.2 (15.8)	49.4 (20.5)	<0.01
DM (0/1)	49/14	42/3	<0.05	16/4	75/13	0.56
HTN (0/1)	43/20	39/6	<0.05	15/5	67/21	0.92
GCS	6.6 (2.5)	8.7 (2.7)	<0.01	6.2 (2.8)	7.7 (2.8)	<0.05
WBC>10,000 (0/1)	21/42	9/36	0.13	5/15	25/63	0.76
Sugar>120 (0/1)	10/53	20/25	<0.01	4/16	26/62	0.39
ICP (24h)>20mmHg (0/1)	43/20	34/11	0.41	8/12	69/19	<0.01
CPP (24h)	77.1 (17.2)	80.5 (11.3)	0.24	63.0 (19.03)	82.1 (11.4)	<0.01
Mesor	37.2 (1.5)	37.7 (0.5)	<0.05	36.0 (2.2)	37.7 (0.5)	<0.01
Rhythm of brain temperature (0/1)	33/30	12/33	<0.01	12/8	33/55	0.07

[a] p-values were accessed by t-test for continuous variables and chi-square test for dichotomous variables

Table 3

Table 3 Multivariate Logistic regression

	Functional outcome (favorable/unfavorable)		Mortality (alive/dead)	
	Coefficient	OR (95% CI)	Coefficient	OR (95% CI)
Age	-0.07**	0.94 (0.90-0.97)	-0.04*	0.96 (0.93-1.00)
GCS	0.43**	1.53 (1.21-1.93)		
Sugar>120				
Yes	-1.57*	0.21 (0.06-0.76)		
No		1		
ICP (24h)>20 mmHg				
Yes	-0.98	0.38 (0.07-2.10)		
No		1		
CPP (24h)	0.03	1.21 (0.97-1.09)		
Mesor			1.13**	3.08 (1.66-5.71)
Rhythm of brain temperature (P<0.05)				
Yes	1.67**	5.28 (1.61-17.64)	0.47	1.59 (0.47-5.40)
No		1[a]		1

[a]1 denotes reference category.
* *P<0.05*
** *P<0.01*

Learning Objectives

1.The characteristics of brain temperature rhythm in patients of traumatic brain injury.

2.The predictive value of brain temperature rhythm in patients of traumatic brain injury.