Electrocardiographic Changes in Patients with Isolated Traumatic Brain Injury and Their Correlation with Outcome

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Abstract

Objectives Electrocardiography (ECG) can be used as an inexpensive tool to identify high-risk patients who are at risk of developing cardiac dysfunction following traumatic brain injury (TBI). In the present article, we report our experience with the incidence of electrocardiographic changes in patients with TBI patients and their correlation with overall outcome.

Materials and Methods All the patients who were admitted with the diagnosis of TBI under neurosurgery were included in the study. Clinical details and 12 lead ECG details for any ECG abnormalities (rhythm abnormalities, conduction abnormalities, QRS ST complex abnormalities, nonspecific ST changes, QT interval abnormalities, and data regarding outcome) were recorded. The data were entered into a spreadsheet and analyzed using StatsDirect version 3 statistical analysis software. Data were expressed using descriptive statistics—frequency and percentage for categorical variables. Pearson chi-square test was used to identify significance. p < 0.05 was considered significant.

Results A total of 109 patients and same number of admission ECGs were available for interpretation. Mild head injury was most common (65.1%) followed by severe (18.3%) and moderate (15.6%) head injuries. ECG results were normal in 97 patients and were abnormal in 12 patients. Statistical analysis showed that the correlation among severity of the head injury, ECG results, and outcome was significant. However, there was no significant correlation between QTc and outcome, and correlation between severity of head injury and outcome.

Keywords

- traumatic brain injury
- ► cardiac function
- electrocardiography
- ► QTc interval

Conclusion The present study highlights the need to recognize the importance of ECG as a simple tool to identify the cardiovascular changes in patients with TBI. However, there is a need to conduct further prospective studies to supplement these findings with changes in the levels of cardiac enzymes or associated echocardiography abnormalities and their correlation with ECG findings and overall outcome.

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Introduction

Traumatic brain injury (TBI) is a leading cause of morbidity and mortality and is a major public health issue.^{1–4} Many studies have identified cardiovascular abnormalities (particularly electrocardiographic changes) as a cause of poor outcome particularly in patients with severe brain injury.^{5–14} It has been suggested that electrocardiography (ECG) can be used as an inexpensive tool to identify high-risk patients who are at risk of developing cardiac dysfunction following TBI.¹⁵ In the present article, we report our experience with the incidence of electrocardiographic changes in patients with TBI patients and their correlation with overall outcome.

Materials and Methods

The present retrospective study was conducted at the Departments of Neurosurgery and Cardiology, Narayana Medical College & Hospital, Nellore. All the patients who were admitted with the diagnosis of TBI under neurosurgery were included in the study. After obtaining the institute ethical committee approval, data were retrieved from the case records of the patients in a predesigned pro forma. The details regarding age, gender, any history of hypertension, and diabetes mellitus were collected. Clinical details including pulse, blood pressure, Glasgow coma scale score, and serum levels of sodium, potassium, chloride were noted. Twelve lead ECG details for any ECG abnormalities in the form of rhythm abnormalities (atrial fibrillation, premature ventricular contraction, sinus arrhythmia, atrial flutter), conduction abnormalities (left bundle branch block, right bundle branch block, atrioventricular [AV] block), QRS ST complex abnormalities (old myocardial infarction [MI], acute MI, nonspecific ST changes, myocardial ischemia), and QT interval abnormalities (short QT interval, prolonged QT interval) were obtained.

Statistical Analysis

The data were entered into a spreadsheet and analyzed using StatsDirect version 3 (StatsDirect Ltd., Cheshire, United Kingdom) statistical analysis software. Data were expressed using descriptive statistics—frequency and percentage for categorical variables. Pearson chi-square test was used to identify significance; p-value < 0.05 was considered significant.

Results

A total of 109 patients were included in the study and the same number of admission ECGs was available for interpretation. The mean age was 34.39 years (minimum 3 years, maximum 70 years, standard deviation \pm 15.4). Majority of the patients were young adult males (**-Table 1**). Total 72.5% of the patients had heart rate in normal range; in 14.7% patient, it was less than 60 beats/minute and in 12.8% patients, the heart rate was more than 100 beats/minute (**-Table 2**). Mild head injury was most common (65.1%)

Table 1	Age and gender distribution of traumatic brain injury
patients	(n = 109)

Age range (y)	Gender		Total
	Female	Male	
0–10	1	3	4
11–20	4	18	22
21–30	0	27	27
31–40	3	17	20
41–50	4	16	20
51–60	1	10	11
61–70	0	3	3
> 71	0	2	2

followed by severe (18.3%) and moderate (15.6%) head injuries (**¬Table 2**). Most of the patients had serum sodium and potassium in normal range (73.4 and 59.6%, respectively) (**¬Table 3**). ECG results were normal in 97 patients and were abnormal in 12 patients. The details are shown in **¬Table 4**. Statistical analysis showed that the correlation among severity of the head injury, ECG results, and outcome was significant (**¬Table 5**). However, there was no significant correlation between QTc and outcome, and correlation between severity of head injury and outcome (**¬Table 5**).

Discussion

A variety of neurological conditions and intracranial lesions have been shown to be the cause of cardiac dysfunction and myocardial damage (both in clinical and experimental models) with increased mortality.^{16–26} The effect of TBI on cardiovascular functions and its correlation with outcome in humans largely remains unknown and under investigation.²⁷ Acute brain injury including TBI can activate an intense neuroinflammatory response, releasing the immunologically active mediators (cytokines, adhesion molecules, and many multifunctional peptides) from brain to the systemic

Table 2 Details of heart rate and severity of the head injury of the patients (n = 109)

	Number of patients (%)	
Heart rate (per min)		
< 60	16 (14.7)	
61–100	79 (72.5)	
> 100	14 (12.8)	
GCS severity ^a		
Severe head injury (GCS = $3-8$)	20(18.3)	
Moderate head injury (GCS = $9-12$)	17 (15.6)	
Mild head injury (GCS = $13-15$)	71 (65.1)	

Abbreviation: GCS, Glasgow coma scale.

^aData for one patient were missing

Serum electrolytes (mEq/L)	Number of patients (%)		
Sodium range			
< 135	12 (11)		
136–145	80 (73.4)		
> 145	8 (7.3)		
Missing	9 (8.3)		
Potassium range			
< 3.5	21 (19.3)		
3.6-4.5	65 (59.6)		
> 4.5	13 (11.9)		
Missing	10 (9.2)		

Table 3 Details of the serum sodium and potassium values of the patients (n = 109)

Table 5 Details of correlation among severity of head injury, ECG results, QTc interval, and outcome, and correlation between severity of head injury and QTc interval

		Outcome		Total	<i>p</i> -Value ^a
		Dead	Alive		
GCS	3–8	8	12	20	0
severity ^b	9–12	3	14	17	
	13–15	1	70	71	
ECG	Normal	7	90	97	0
results	Abnormal	5	7	12	
QTc	Normal	10	89	99	0.341
interval	Prolonged	2	8	10	
GCS	3-8	16	4	20	0.136
severity	9–12	15	2	17	
	13–15	67	4	71	

Abbreviations: ECG, electrocardiography; GCS, Glasgow coma scale.

 $^{a}p < 0.05$ was considered significant.

^bData for one patient were missing.

circulation.^{10,28-32} This mechanism is a protective phenomenon which is primarily meant for maintenance of cerebral perfusion particularly in the presence of raised intracranial pressure in severe brain injury patients.⁷ In unfavorable circumstances, this response can initiate a

Table 4 Details of ECG findings and ECG results of the traumatic brain injury patients (n = 109)

ECG findings	Number of patients (%)		
Conduction			
Normal	101 (92.7)		
Right bundle branch block	4 (3.7)		
AV block	1 (0.9)		
Other	3 (2.8)		
QRS ST complex			
Normal	92 (84.4)		
Nonspecific ST changes	9 (8.3)		
Old MI	5 (4.6)		
Acute MI	1 (0.9)		
Other	2 (1.8)		
Rhythm			
Normal sinus	106 (97.2)		
Sinus tachycardia	3 (2.8)		
QTc interval			
Normal	99 (90.8)		
Prolonged	10 (9.2)		
ECG results			
Normal	97 (89)		
Abnormal	12 (11)		

Abbreviations: AV, atrioventricular; ECG, electrocardiography; MI, myocardial infarction.

Prognosis

Although many studies describe the correlation between severity of the brain injury and electrocardiographic changes,^{36,38} it is unclear whether it is the severity of the brain injury or it is neurogenic cardiac injury which is mainly responsible for poorer outcome.^{8,14,39} Gregory and Smith⁷ have reported that prolongation of the QTc interval can be a manifestation of neurogenic cardiovascular dysfunction and it is not clear whether it is life threatening on its own or rather it is the severity of the underlying brain injury which is fatal. We also observed prolonged QTc in patients with TBI in our study; however, there was no statistically significant correlation between prolonged QTc and outcome. However, as we observed in the present study that the overall outcome of these patients is determined by the severity of the underlying TBI.^{3,4,8,9}

Conclusion

Neurogenic cardiac injury and associated electrocardiographic abnormalities can be associated with increased morbidity and mortality following TBI. The present study highlights the need to recognize the importance of ECG as a simple tool to identify the cardiovascular changes in patients with TBI. However, there is a need to conduct further prospective studies to supplement these findings with changes in the levels of cardiac enzymes or associated echocardiography abnormalities and their correlation with ECG findings and overall outcome.

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