Original Research

Comparison Of Intracranial Blood Pressure (ICP) Monitored Versus Non Monitored Severe Traumatic Brain Injury (TBI) Patients

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Abstract:

Background:

This study aimed at comparing mortality and morbidity in TBI patients, with and without ICP monitoring.

Method: This study was designed as a retrospective case-control study. The study compared mortality and morbidity (bleeding and meningitis) outcomes, length of hospitalization, and trends of Glasco coma scale changes in patients who underwent ICP monitoring (case group, n=11) with non-monitored (control group, n=11) patients. These subjects were matched for age and sex.

Results: Groups were matched for age and demographic variables (P>0.05). However, initial GCS in case group was significantly lower than controls (P=0.009). So assuming that this variable is a confounding factor, other comparisons were made by adjusting the initial GCS. ICP monitoring had a statistical association with mortality (OR= 22.80, 95% CI: 2.28-227.76; p<0.0001), but not with meningitis. After adjusting for baseline GCS, there were no differences between adjusted and non-adjusted results; but small sample size restricts this statement. The adjusted means of GCS on day 1 for case group and control group were 9.04 and 12.44, respectively (p=0.045). The adjusted means of GCS on day 2 for case group and control group were 10.27 and 13.23, respectively (p=0.073).

Conclusion: The retrospective case control design failed to assess the hypothesis of associations between ICP monitoring and outcomes of TBI, in our small sample size study.

Keywords: Mortality, Morbidity, TBI Patients, With and Without ICP Monitoring

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Introduction

Traumatic brain injury (TBI) causes a major share of mortality rates related to accidents and is responsible for long-term disability in many accident victims (1). In cases of moderate to severe head trauma, intracranial pressure (ICP) might get increased (2). Increased ICP is directly associated with higher mortality and morbidity rates, and overcoming elevated ICP has been a major strategy of TBI management for many years (1). The pathophysiology of ICP elevation in TBI is related to cerebral edema and the state of a high ICP leads to hypoxia of brain cells at first and ischemic injury if remaining untreated. In progress, more elevated ICP may cause brain tissue herniation, insufficient cerebral perfusion, ischemia, and even death (3-4). Approximately 50% of comatose TBI patients have elevated ICP as demonstrated by computed tomography (CT). Early diagnosis of ICP elevation can significantly improve the prognosis of a TBI patient (3-5). ICP monitoring is a tool that records the dynamic changes of ICP (4-6). However, the effectiveness and safety of ICP monitoring in TBI patients is a topic of debate, as some studies have reported beneficial effects on reducing mortality and predicting prognosis, while others have conflicting results (2). Therefore, in this study, we decided to compare the mortality and morbidity in people who are monitored. Receive ICP and people who are treated with other conventional methods.

Methods

The present case-control study was conducted at Sina Hospital in Tehran in 2019. The patients entered the study after obtaining informed consent from their family or their selves. Those who were under ICP monitoring during their stay in the hospital entered the study as the case group and the control group was including patients without ICP monitoring. As logically patients in need of ICP monitoring have more severe TBI, to match the controls, we selected patients who had any sequence of decreased GCS to 8 or below in first day of admission as controls.

Also, the patients who died on the first day were excluded from the study. Patients of the case and control groups were tried to be matched according to age and sex.

From the beginning and in the continuation of ICP monitoring, the clinical decisions were made by neurosurgeons, based on the guidelines of TBI management. Therapeutic interventions had to be started in the first 12 hours after the injury. The measured ICP pressure was recorded using an intraventricular catheter. ICP was measured in a scheduled manner during consecutive hours. Normal ICP was defined as 0-20 mmHg. In the study participants who were not monitored for ICP, changes in the level of consciousness, breathing pattern alterations, papilledema, opisthotonus posture, and Cushing's phenomenon (characterized by high blood pressure and bradycardia) were considered indicative of intracranial hypertension. For individuals with resistant intracranial hypertension (i.e., with pressures exceeding 25 mm Hg or persistent symptoms), a craniotomy may be necessary to alleviate the pressure.

Data were statistically analyzed by SPSS software. Regarding the qualitative variables, the frequency was calculated, and regarding the quantitative variables, the mean, range and standard deviation were calculated. ANOVA was used to compare the study groups for continuous data. Due to the difference in baseline GCS and as we were not successful in finding subjects with low GCS and not monitored for ICP, we adjusted the day one and two GCSs for the baseline GCS, by ANCOVA test. Repeated measure ANOVA was used to compare trends of GCS change among the study groups. Also, $P<0.05$ was considered statistically significant. Finally, the extracted data were analyzed using SPSS 20 software.

Results

A total of 22 patients (13 males, 9 females) were included in the study, with 11 patients in each group (case vs. control). There were 13 (59.1%) male participants. 22.7% of patients died. Meningitis occurred in 13.6%, bleeding in 13.64%, and 72.7% had no complications or morbidities (table 1).

While study groups were matched for gender (P=0.9) and age (P=0.09), control group patients were having significantly higher GCS values (P=0.02). So, we used ANCOVA test to justify this confounding factor. The adjusted means of GCS on day 1 for the case group and control group were 9.04 and 12.44, respectively (p = 0.045).

The adjusted means of GCS on day 2 for the case group and the control group were 10.27 and 13.23, respectively (p = 0.073). These results suggest that there were significant differences in the mean GCS on day 1 between the case and control group after adjusting for baseline GCS as a covariate. However, there was not a significant difference in the mean GCS on day 2 between the two groups after adjusting for baseline GCS. Mean hospitalization length was also higher in case group patients (P=0.02).

ICP monitoring was associated with a higher rate of mortality (P<0.001), while not associated with bleeding or meningitis rates (P>0.05). The logistic regression model with ICP monitoring and baseline GCS as predictors showed that ICP monitoring was significantly associated with mortality (p < 0.0001), with an odds ratio of 22.80 (95% CI: 2.28-227.76). Also, the logistic regression model with ICP monitoring and baseline GCS as predictors showed that there was no trend towards an association between ICP monitoring and meningitis (p = 0.075), with an odds ratio of 12 (95% CI: 0.91-157.91). There were no differences between adjusted and non-adjusted results. This might be due to the fact that the sample size was small.

Repeated measure ANOVA showed a significant different trend of GCS changes in patients who were ICP monitored versus non monitored patients (P<0.001), figure 1.

Discussion

Our study found that being in need of using ICP monitoring device was linked to higher mortality rates and longer hospital stays compared to non-ICP monitored patients. ICP monitoring was significantly associated with mortality. However, patients with low GCS values were more likely to be ICP monitored, which may have influenced these results. We attempted to address this confounding factor by adjusting for the baseline severity of the trauma, but we found no significant change between the adjusted and non-adjusted results. It's possible that the small sample size contributed to this lack of significant difference. In a study that examined 2134 patients, According to Han et al., ICP monitoring can reduce mortality rates in TBI patients compared to those without monitoring (2). However, a study involving a sample of 1646 patients demonstrated that the studied subjects experienced higher mortality rates and worse neurological outcomes after ICP monitoring (4).

The management of intracranial pressure (ICP) in patients with traumatic brain injury (TBI) remains a controversial topic. Although the Brain Trauma Foundation recommends initiating treatment in patients with ICP >20 mmHg to reduce the need for craniotomy, there is no consensus on whether aggressive treatment and ICP monitoring can improve patient outcomes (2). Some experts believe that maintaining ICP at 20 mmHg or less is not superior to imaging measures and clinical examination in patients with TBI (1, 2, 3). However, increased ICP is the leading cause of death in TBI patients who arrive at the hospital alive, and those who respond well to ICP-lowering treatments tend to show better

outcomes in terms of cerebral perfusion pressure (4, 5). The Brain Trauma Forum (BTF) guidelines provide some indications for ICP monitoring in severe TBI, but the clinical benefit in TBI patients has not been confirmed (2). According to the guidelines, ICP monitoring is recommended in patients with severe TBI (GCS ≤ 8) and in the presence of abnormal brain CT scan. ICP monitoring is also recommended in patients with TBI without abnormal findings in CT despite at least two of the following criteria: age 40 years, disturbed movement status, or systolic blood pressure less than 90 mm Hg (3). The lack of information on important markers such as age, severity of injury, hypoxia, and temporal changes in the management of TBI patients limits the interpretation of available literature related to intracranial pressure (2). While the potential benefits of ICP monitoring in TBI patients have been proposed theoretically, further research is needed to confirm its clinical benefit (2).

Conclusion

While we found that monitoring for ICP changes was associated with higher mortality rates and longer hospitalization length compared to non-ICP monitored patients, this statement is fully affected by the confounding factor that patients with low GCS values are more being ICP monitored and naturally have higher mortality rates. However, our effort for adjusting for baseline severity of trauma showed was no change between adjusted and non-adjusted results. This might be due to small sample size. So, further studies are needed.

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Table & Figure

Table 1: Comparison of case (ICP monitored) and controls (non ICP monitored)

		Total	Case	Control	P-value
n		22	11	11	-
Gender	**Male, n (%)**	13(59.09%)	7(63.64%)	6(54.55%)	0.9
	Female, n (%)	9(40.91%)	4(36.36%)	5(45.45%)	
Age, years, mean±SD		62.3±19.189	54.89±20.03	46.67±18.54	0.09
Length of ICU stay, days, mean±SD		14.45±7.443	18±7.758	10.909±5.33	0.02
GCS at arrival, mean±SD		10.14±3.745	8.18±3.37	12.3±2.94	0.008
GCS on the first day, mean±SD		10.48±4.343	9±4.01	12.1±4.20	0.103
GCS on second day, mean±SD		11.47±3.67	9.9±3.69	13.22±2.91	0.045
Bleeding, n (%)		3(13.64%)	2(18.18%)	1(9.09%)	0.781
Meningitis, n (%)		3(13.64%)	3(27.27%)	0(0%)	0.075
Mortality, n (%)		5(22.73%)	0(0%)	5(45.45%)	<0.0001

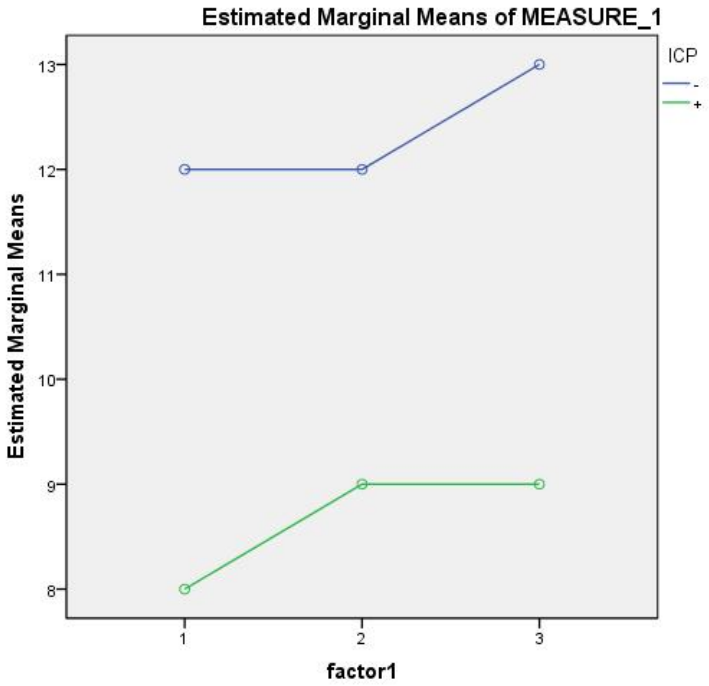

Figure1: Trend of GCS changes in patients who were ICP monitored versus non monitored patients