Effect of systolic blood pressure in acute severe concomitant traumatic brain injury on circadian rhythm in children

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Abstract

On the first day, the SBP circadian rhythm mesors in children of the 3rd group turned out to be higher than in the first one by 13 mmHg and in the second by - 9 mmHg. The severity of the patients' condition was mainly determined by the severity of the brain injury. In case of impaired consciousness 10±0.4 points, the severity of trauma according to PTS 4±0.2 points, the duration of mechanical ventilation was up to 2±0.9 days and the duration of treatment in the ICU was up to 7.7±1.7 days. The severity of the condition caused by CTBI was expressed in a tendency to arterial hypertension in the first 9 days, which was due to the compensatory nature of the hyperdynamic type of blood circulation, aimed at restoring oxygenation of the damaged primary and secondary brain damage.

Keywords: circadian rhythm, systolic pressure, severe concomitant traumatic brain injury, children.

Relevance. The combination of TBI with damage to other organs and systems exacerbates the severity of brain damage. On the one hand, this is due to the inadequacy of systemic compensatory reactions in the shock period, and on the other hand, to direct or indirect damage to various organs or systems. Intensive therapy aimed at compensating for multisystem disorders may conflict with the regularities of the course of sanogenic and reparative processes in the CNS. According to many authors, a moderate increase in mean arterial pressure should be maintained in patients with acute brain injury. The use of controlled hyperdynamia in TBI is widely practiced but remains controversial.

Lack of information on the topic prompted us to study one of the priority tasks of intensive care (severe concomitant traumatic brain injury) of SCTBI in the acute period.

Purpose of the work. To study and assess the circadian rhythm of systolic blood pressure in the acute period of severe concomitant traumatic brain injury in children over 7 years old

Material and research methods. We studied the indicators of a comprehensive examination of 18 school-age patients (7-18 years old) with severe concomitant traumatic brain injury (SCTBI) admitted to the intensive care unit (ICU) of the neurosurgical department of the Republican Scientific Center for Emergency Medical Aid (RSCEMA) in the first hours after road traffic accident (RTA) - 15, catatrauma - 3 patients. Continuous hourly monitoring of systolic blood pressure (SBP), as well as other hemodynamic parameters was performed within 30 days after CSTBI. According to the indications, the patients were started on admission to the invasive mechanical respiratory support (MRS). Mechanical respiratory support was started in mechanical ventilation (CMV) mode for an extended period of time, followed by transfer to SIMV. The severity of the condition was assessed using scoring methods for assessing the severity of concomitant injuries - the PTS (PediatricTraumaScore) scale (Tepas J.J. etal. 1985), the assessment of the severity of injuries on the ISS scale, the severity of acute cerebral failure according to the Glasgow coma scale. On admission, impaired consciousness in 14 injured patients was assessed on the Glasgow Coma Scale (GS) 8 points or less. Patients were considered in three groups according to the duration of intensive care in the ICU. Group 1 (tab. 1) with the duration of intensive therapy (7.7±1.7 days) included 4 children aged 11.5±3 years, 2 - with the duration of stay in the ICU 14.8±2 days consisted of 6 patients of average age 10.6±0.9 years, 3 - 8 patients 12.7±2.8 years, the duration of treatment in the ICU from 21 to 30 days (2 patients were in the intensive care unit for 55 and 84 days). Complex intensive care consisted in identifying and timely correction of deviations: MRS, after removing from shock anesthetic, anti-inflammatory, hemostatic, antibacterial, infusion therapy, correction of protein, water-electrolyte balance disorders, surgical, as far as possible, early correction, stress-limiting, cytoprotective therapy. According to the PTS classification, the interpretation was: if the total score on a scale of 9-12 points is a minor injury, 6-8 points is a potential threat to life, 0-5 points is a life-threatening condition, o points is a fatal situation. The probability of death according to PTS (<8) requires hospitalization from a specialized department, 4 points - the probability of death is 50%, with<1 the probability of death is>98%. The use of the scale for assessing the severity of injuries ISS allowed for a more differentiated assessment of the severity of injuries. ISS scale analysis: 1-9 points - mild injury; 10-15 points - moderate severity; 16-24 points - heavy; over 24 is extremely heavy. Mortality at 16-24 points -5-7%; > 24 points — over 30%. Duration of hospital stay: 1-9 points — about 4 days; 10-15 points - 6-7 days; 16-24 points - 8-10 days; > 24 points - over 12 days. The introduction of the scales made it possible to clearly

delineate the severity of the shock and, depending on this, to determine the further tactics of action.

Results and discussion. The need for specialized care for admission in an extremely serious condition was associated with a combination of STBI, severe cerebral contusion (SCC), closed severe traumatic brain injury (CSTBI), open severe traumatic brain injury (OSTBI), subarachnoid hemorrhage (SAH), intraventricular hemorrhage (IVH) with injuries of other organs, fractures of the ribs, limbs, facial bone skeleton (tab. 2).

Table 1.

Characteristics of patients with severe concomitant traumatic brain injury over 7 years old

Groups	1	2	3
Num. of patients	4	6	7
Days at the ICU	7.7±1.7	14.8±2.2	34.6±14.1
Age, years	11.5±3	10.6±0.9	12.7±2.8
GS, points	10±0.4	8.2±0.9	7.8±0.7
ALV, days	2±0.9	10.7±2.6	22.2±4.5
PTS, points	4±0.2	1±0.3	1±0.25
ISS, points	52±8	60±13	47.8±8.5

Table 2.

Types of traumatic injuries

Damage types	Group 1 (4)	Group 2 (5)	Group 3 (8)
CSTBI	50% (2)	-	75% (6)
SCC	75% (3)	80% (4)	62% (5)
Light CC	25% (1)	-	25% (2)
OSTBI	50% (2)	100% (5)	25% (2)
SAH	50% (2)	80% (4)	62% (5)
Imbibed by the blood of the brain	50% (2)	25% (1)	37% (3)
Intracerebral hematoma	50% (2)	25% (1)	37% (3)
Subdural hematoma	25% (1)	-	25% (2)
IVH	25% (1)	-	25% (2)
Dislocation syndrome	25% (1)	-	37% (3)
Facial bone fracture	50% (2)	75% (3)	25% (2)
Fracture of the pelvic bones	-	25% (1)	25% (2)
Fracture of the	-	80% (4)	37% (3)

humerus, femur, shin bones			
Lung contusion	50% (2)	50% (2)	-
Pneumothorax	25% (1)	25% (1)	-
Crushing injury of the liver	25% (1)	-	-
Ruptured kidney	25% (1)	-	-
Hemoperitoneum	25% (1)	-	-
Retroperitoneal hematoma	25% (1)	-	12% (1)
Laceration of the thigh	25% (1)	25% (1)	12,5% (1)

The severity of the patients' condition was determined mainly by the severity of the brain damage (tab. 1). In case of impaired consciousness 10±0.4 points, the severity of trauma according to PTS 4±0.2 points reduced the duration of ALV to 2±0.9 days and the duration of treatment in the ICU to 7.7±1.7 days (tab. 1).

With a comparatively less pronounced traumatic effect on the brain, timely etiopathogenetically determined measures were able to bring patients out of the state of severe traumatic shock in a fairly short time, timely surgical correction of bone fractures, effective intensive therapy of bruises of parenchymal organs, and compensation of blood loss (tab. 2).

The efficacy of treatment for severe cerebral contusion (CC) was more favorable with open TBI, as evidenced by shorter recovery times in group 1 7.7±1.7 days, in group 2 14.8±2.2 days, ALV duration in 1 group 2±0.9, in group 2 10.7±2.6 days than with CSTBI (tab. 1). While the duration of intensive therapy in group 3 patients was significantly longer and amounted to 34.6±14.1 days ($p < 0.05$), ALV 22.2±4.5 days ($p < 0.05$) (tab. 1).

It is known that the initial severity of the condition is in direct proportion to the volume of traumatic injuries that cause more severe stress mobilization of defense systems. One of them is the response of the circadian rhythms of the body's hemodynamic parameters. In this regard, an attempt was made to study and assess the dynamics of the circadian rhythm of SBP depending on the severity of the condition of injured children over 7 years old.

Table 3.

Dynamics of the mesor of the circadian rhythm SBP in children over 7 years of age

Days	Group 1	Group 2	Group 3
1	104.2±6.3	108.3±8.7	117.4±4.6*
2	104.9±2.9	116.0±4.1	112.0±2.2*
3	108.1±2.5	114.8±3.0	117.2±1.9*

4	110.3±2.1	114.6±3.6	117.7±3.5*
5	107.0±2.0	118.8±2.6*	117.9±2.9*
6	112.5±1.8	119.3±3.5*	112.6±3.0
7	107.4±2.3	114.3±3.1*	115.5±3.2*
8	100.1±4.9	115.8±3.2*	115.8±2.1*
9	100.9±2.0	117.4±2.6*	116.4±2.7
10		113.7±2.5	119.7±2.8
11		113.8±2.5	120.9±2.3°
12		120.9±2.7	116.7±1.8
13		114.6±3.2	113.3±2.1
14		114.4±2.8	112.2±2.0
15		122.8±11.3	117.5±2.1
16		141.0±12.7	118.3±1.4°
17			113.5±1.4
18			112.7±1.8
19			120.1±1.8
20			116.0±1.7
21			113.8±2.6
22			115.4±2.6
23			116.9±1.6
24			115.5±1.4
25			117.4±1.9
26			114.6±2.1
27			120.5±1.6
28			119.2±2.5
29			119.2±2.7
30			118.6±3.1

*-reliable relative to the indicator in group 1

°-reliable relative to the indicator in group 2

On the first day (tab. 3), the SBP circadian rhythm mesor in children of the 3rd group turned out to be more than the indicator in the first by 13 mmHg and more than in the second by - 9 mmHg, remaining within the permissible norm. As shown in table 2, the mesor of the circadian rhythm SBP in group 2 was higher than in the first on days 5-9 by 11-7-15 mmHg higher than in the first ($p<0.05$, respectively). And in patients of the 3rd group it is higher than in the first one on the 1-8th day by 13-7-15 mmHg ($p<0.05$, respectively). Thus, the severity of the condition caused by CTBI was expressed in a tendency to arterial hypertension in the first 9 days, which was due to the compensatory nature of the hyperdynamic type of blood circulation, aimed at restoring oxygenation of the damaged primary and secondary brain damage.

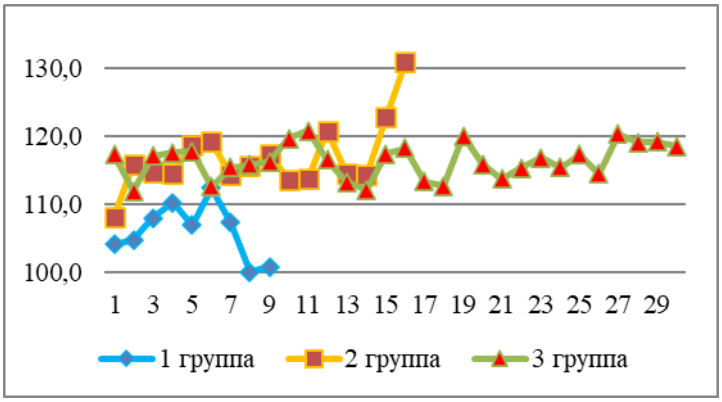

Fig. 1 Dynamics of the systolic pressure mesor

On the 11th day, in group 3, a significantly higher by 7 mmHg ($p < 0.05$) increase in SBP mesor was found relative to that in group 2 (fig. 1).

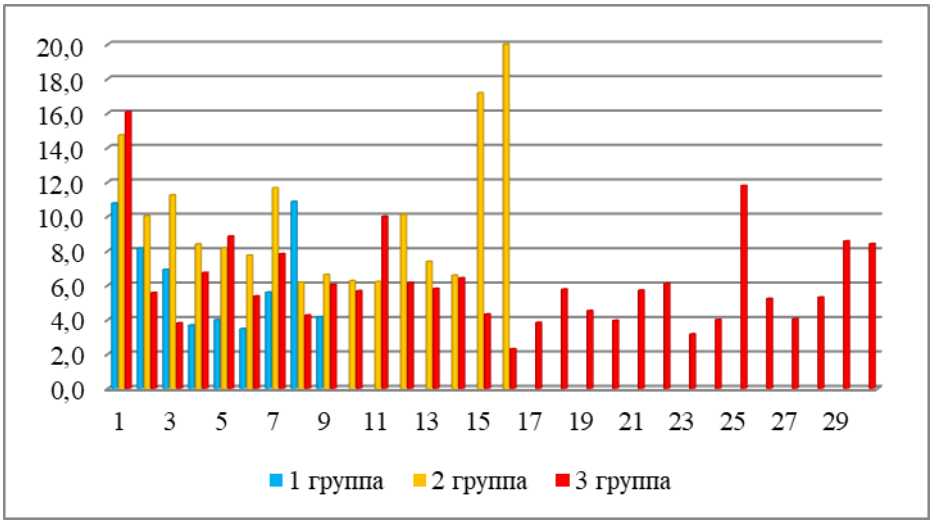

Fig. 2 Dynamics of the amplitude of daily fluctuations in SBP

The increase in SBP in group 2 on day 16 was due to a decrease in drug sedation before transfer to the specialized department, indicating that the stability of cardiac output had not yet been restored (fig. 2). The revealed hemodynamic feature in group 2 was confirmed by daily fluctuations of SBP up to 40 mmHg per day (fig. 3).

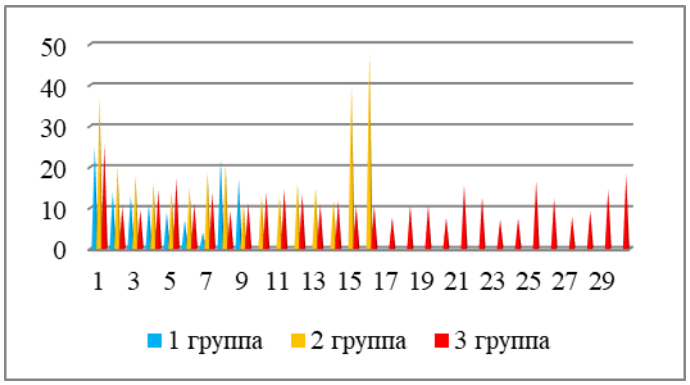

Fig. 3. Change in daily fluctuations in SBP

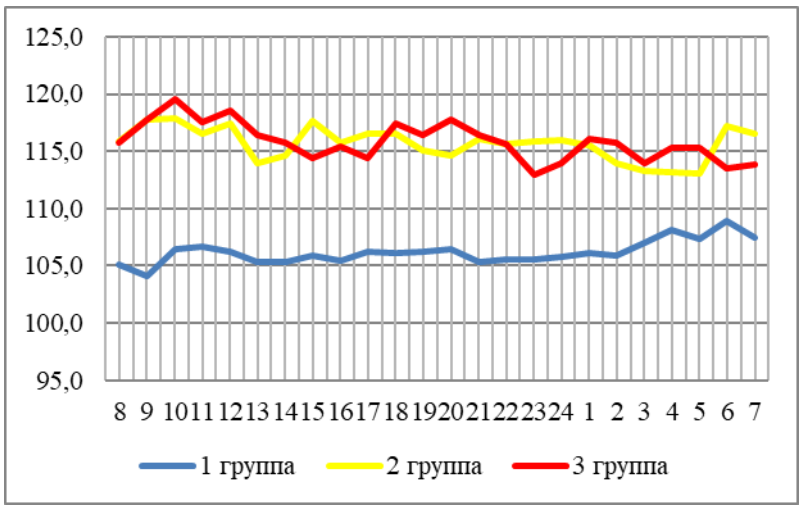

Fig. 4. Effect of SCTBI severity on SBP mean circadian rhythm in the first 9 days after injury

Attention is drawn to the fact that the average indicators of hourly monitoring throughout the day were consistently significantly lower in group 1, relative to data in groups 2 and 3 (fig. 4).

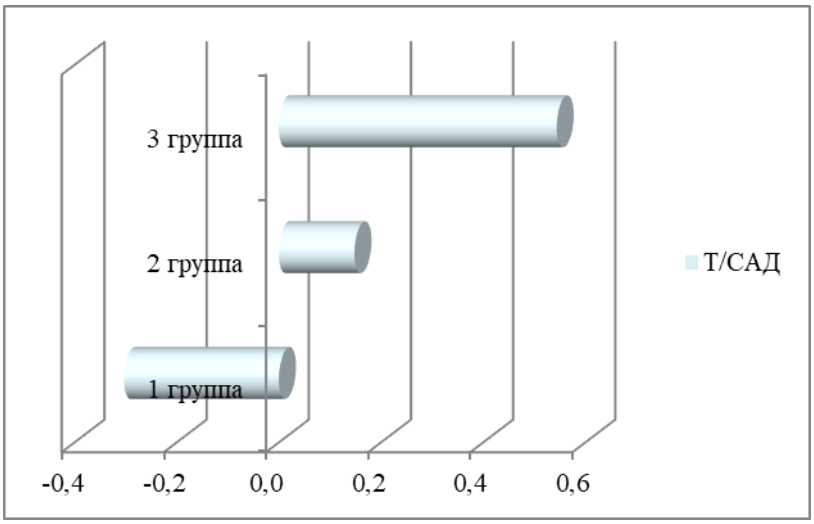

Fig. 5 Correlation of SBP and body temperature in a circadian rhythm

A fairly strong (0.52) direct correlation between SBP and body temperature was found in group 3 (fig. 5).

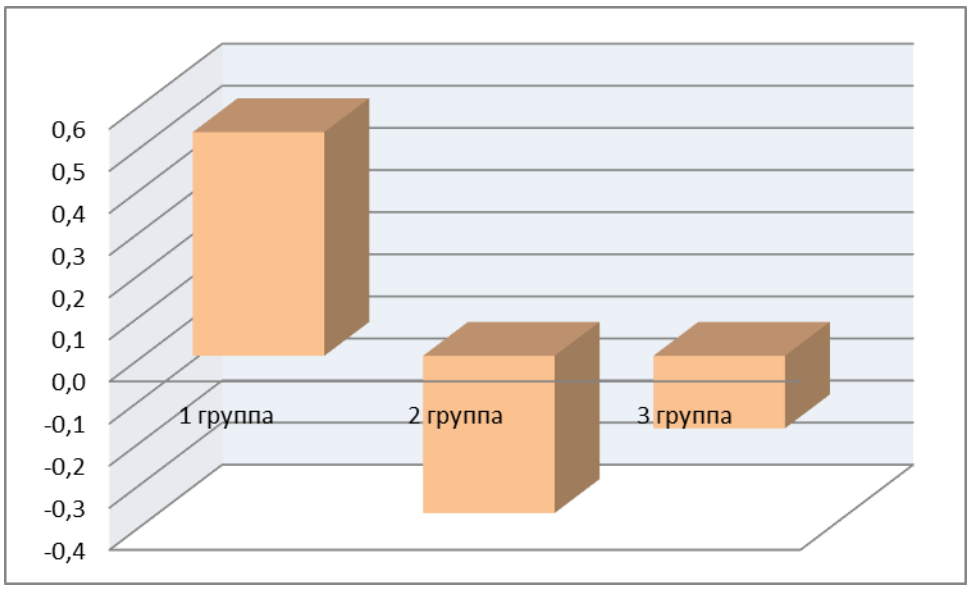

Fig. 6 Correlation between changes in body temperature and SBP in the first 9 days after injury.

However, in the first 9 days, a moderate direct correlation was found between the dynamics of body temperature and the mesor of the circadian rhythm SBP in the first group, but it turned out to be the most pronounced in comparison with groups 2 and 3 (fig. 6).

Conclusion. On the first day, the SBP circadian rhythm mesor in children of group 3 turned out to be more than the indicator in the first by 13 mmHg and more than in the second by - 9 mmHg. The severity of the patients' condition was predominantly determined by the severity of the brain damage. In case of impaired consciousness 10±0.4 points, the severity of trauma according to PTS 4±0.2 points, the duration of ALV was 2±0.9 days and the duration of treatment in the ICU was up to 7.7±1.7 days. The severity of the condition caused by CTBI was expressed in a tendency to arterial hypertension in the first 9 days, SBP instability (increase in the amplitude of daily fluctuations), which was due to the compensatory nature of the hyperdynamic type of blood circulation, aimed at restoring oxygenation of the damaged primary and secondary brain damage.

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английском языке)	
Название статьи (на русском языке) *(!!!)	Влияние на циркадный ритм систолического артериального давления острой тяжелой сочетанной черепно-мозговой травмы у детей
Название статьи (на английском языке) *(!!!)	
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