Circadian rhythm of mean arterial pressure in the acute period of concomitant severe traumatic brain injury

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Abstract

In group 1 (aged 19-40 years), combined severe traumatic brain injury (CSTBI) caused a transformation of about-week biorhythms into 5-6 day periods of fluctuations in the first two weeks after the injury. A stress reaction of hemodynamics, increasing on the 18-25th day of the acute period of CSTBI, was revealed in traumatized patients of group 2 (41-60 years old). In group 3 (61-84 years), 5-day cycles of AvBP fluctuations from the very beginning were more constant throughout the acute period of CSTBI. The stress response of the circadian rhythm AvBP prevailed in groups 2 and 3 of patients at a later date and was expressed in an increase in the amplitude of daily fluctuations. Monitoring AvBP in the peri-weekly biorhythm is an additional source of information that allows early detection of deviations, assessment of the effectiveness of intensive care in the acute period of CSTBI.

Keywords: circadian rhythm of mean arterial pressure, combined traumatic brain injury

Relevance. In the general structure of peacetime injuries, the proportion of combined and multiple injuries ranges from 5 to 12%, and among the most severe - up to 40%. An almost constant component of severe associated injuries is TBI, which occurs in such cases with a frequency of 50-72 to 80-82%. Multiple extracranial injuries in combination with TBI occur in 15% of cases. The positive dynamics of data on the treatment of STBI (a decrease in mortality in the United States and other Western countries with STBI to 30-40%), noted in the last decade, is largely associated with an increase in knowledge of pathophysiology acute STBI and the improvement of intensive treatment technologies during this period [1-3].

Due to the lack of information in the literature on the age-related characteristics of injuries associated with severe traumatic brain injury (STBI), we tried, based on a retrospective analysis, to identify the features in different age groups of the circadian rhythm of mean arterial pressure (AvBP).

Purpose. To study the circadian rhythm of mean arterial pressure in the acute period of combined severe traumatic brain injury.

Material and research methods. The indicators of a comprehensive examination of 30 patients with concomitant severe craniocerebral trauma (CSTBI) who were admitted to the ICU of the neurosurgical department of RSCEMA in the first hours after an accident - 28, catatrauma of 2 patients were studied. According to indications, 29 patients underwent invasive mechanical respiratory support (MRS) on admission. Monitoring was carried out by complex hourly recording of body temperature and hemodynamics parameters: Genuine blood pressure (GBP), Pulse blood pressure (PBP), Systolic blood pressure (SBP), Diastolic blood pressure (DBP), respiration. Mechanical respiratory support was initiated with artificial lung ventilation (ALV) for a short time followed by switching to SIMV. The severity of the condition was assessed using scoring methods for assessing the severity of combined injuries - the CRAMS scale, the assessment of the severity of injuries on the ISS scale. On admission, impaired consciousness in 29 injured patients was assessed on the Glasgow Coma Scale (GS) 8 points or less. Patients were considered in three age groups: group 1, 19-40 years old (13), group 2 - 41-60 years old (9), 3 - 61-84 years old (8 patients). Complex intensive therapy consisted in identifying and timely correction of deviations: MRS, after removing from shock anesthetic, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, surgical early correction to the extent possible, stress-protective therapy.

Result and discussion.

Dynamics of the mesor of mean arterial pressure in the acute period, in mmHg

Days	Group 1	Group 2	Group 3
1	92.1±2.7	90.2±8.0	97.3±6.0
2	88.3±1.8	95.7±3.8	92.0±2.7
3	90.9±2.4	93.3±3.3	90.5±2.3
4	96.6±2.0	94.9±3.9	93.5±2.2
5	93.9±1.7	97.1±2.8	96.4±4.5
6	94.4±1.8	94.3±1.9	95.8±2.4
7	94.8±1.5	94.2±2.9	91.2±2.3
8	94.3±2.1	92.5±2.2	90.2±4.2
9	92.4±2.7	91.0±3.7	91.8±3.1

10	96.4±2.8	92.1±2.1	92.8±3.5
11	91.8±1.6	91.8±2.2	89.6±3.8
12	92.2±2.1	88.9±3.2	91.4±3.0
13	90.3±2.4	89.1±2.6	84.4±2.5*
14	91.6±2.6	89.0±2.3	91.6±3.3
15	91.6±2.2	89.7±2.3	90.2±3.1
16	90.5±1.5	88.4±2.5	93.1±3.1
17	88.1±3.2	88.0±2.7	94.0±2.8
18	91.6±3.0	97.2±4.9	85.4±3.3*
19	88.2±2.6	94.2±3.8	87.9±3.0
20	87.6±2.4	93.1±5.4	91.2±3.1
21	90.8±2.3	92.9±4.3	92.8±4.5
22	92.1±4.0	96.8±4.9	92.5±5.6
23	88.5±3.1	91.9±3.4	87.7±5.1
24	89.0±2.7	93.4±3.0	94.6±4.8
25	89.2±4.0	100.9±5.8	93.9±5.4

*- deviation is reliable relative to the indicator in 1 day

On the first day, there were no significant differences depending on age, the mean BP in group 1 was 92.1±2.7. In group 2 - 90.2±8.0 mmHg, in group 3 – 97.3±6.0. In the dynamics of the acute period, a statistically significant change in the AvBP mesor was revealed only in group 3 on days 13 (by 11%, p <0.05) and 18 (by 12%, p <0.05). Fluctuations were observed during continuous vasoactive therapy.

Dynamics of the mesor of mean arterial pressure in the acute period CSTBI, mmHg

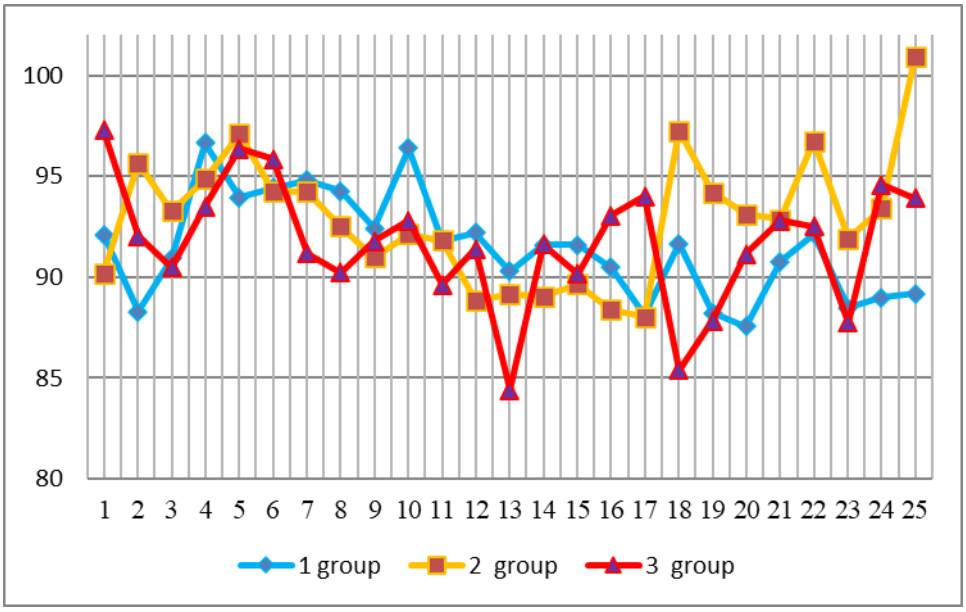

Fig.1

In the first group, changes in the AvBP mesoor occurred in waves with periods of fluctuations of 4-5 days. A significant difference in AvBP was revealed on days 2 and 4 of 8 mm Hg (p<0.05), on days 10 and 13 - 6.1 mm Hg (p<0.05), which corresponds to the transformation of about-

week biorhythms into 5 -6 daily periods of fluctuation in the first two weeks after injury. In the following days, changes in AvBP were represented by low-amplitude waves with the same wavelength of changes in the mesor of the circadian rhythm AvBP. In group 2, in the first two weeks, there was a tendency to the formation of five-day fluctuations, from 18 to 25 days, an increase in the amplitude of 5-day rhythms was found (up to 9.2 mmHg, $p<0.05$), which characterizes the stress reaction of hemodynamics, increasing on days 18-25 acute period of CSTBI in patients of group 2. In group 3, 5-day cycles of fluctuations in blood pressure with an amplitude of about 7 mmHg ($p>0.05$) were more constant from the very beginning throughout the acute period of CSTBI.

Dynamics of the amplitude of daily fluctuations in mean arterial pressure

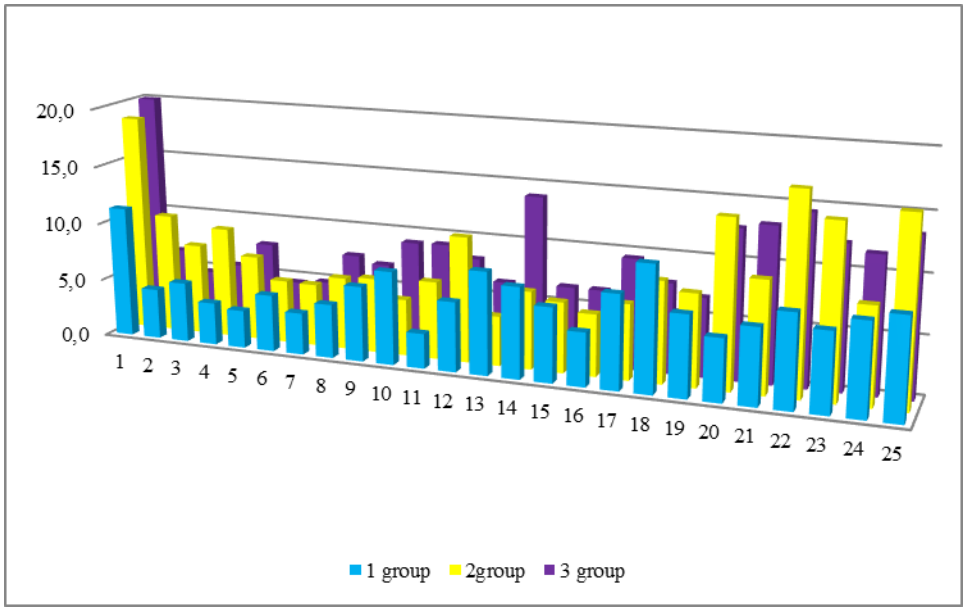

Fig.2

Changes in the amplitude of daily fluctuations in AvBP occurred in waves, averaging 7 mmHg in group 1, 13 mmHg in group 2, and 16 mmHg in group 3 with an oscillation period of 5, 4 days (fig. 2). Attention was drawn to the increase in the amplitude of daily fluctuations in AvBP on days 20-25 in group 2 (13-17 mmHg). The highest values of the amplitude of daily fluctuations of the indicator were observed in group 3 on day 1 (20 mmHg), on day 14 (13 mmHg), on days 20-25 (13-14 mmHg). Thus, the stress response of the circadian rhythm of blood pressure predominated in groups 2 and 3 of patients at a later date and was expressed in an increase in the amplitude of daily fluctuations. The latter may have been associated with the limitation of stress-protective sedative therapy in order to restore spontaneous breathing in patients.

Dynamics of the range of daily fluctuations in mean arterial pressure

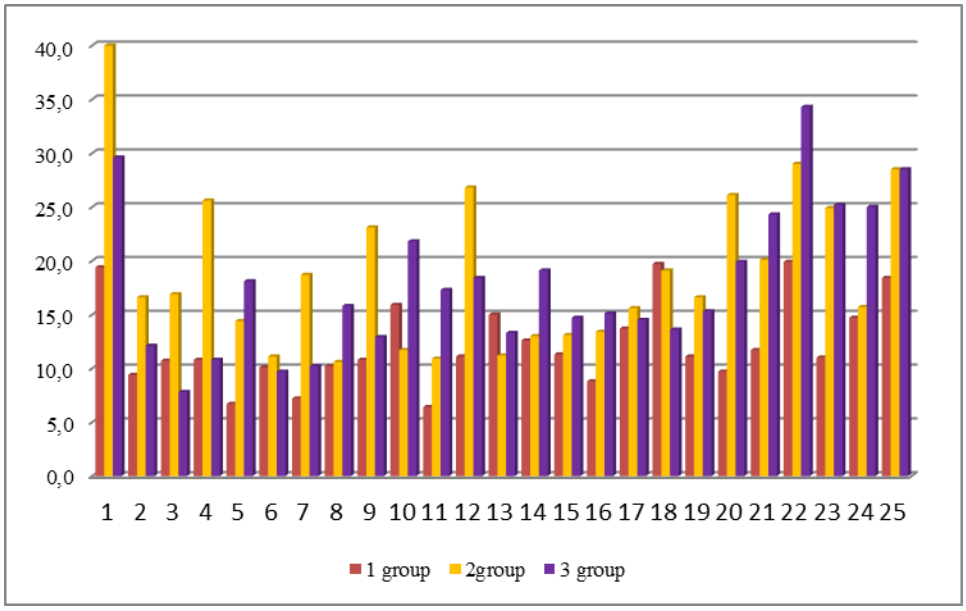

Fig.3

The range of daily fluctuations (the difference between the maximum and minimum AvBP value) in group 1 was 14 mmHg on days 1, 18, 22, in group 2 40 mmHg on day 1, 25 mmHg on day 4, 27 mmHg on days 12.20, more 25 mmHg on days 22, 25 (fig. 3). In group 3, the maximum range of daily changes in AvBP up to 34 mm Hg was detected on the 22nd day. The changes were of an oscillatory nature with a wavelength of 4 - 5 days. Thus, the stress response in the acute period of CSTBI was expressed in the transformation of the near-weekly rhythm of AvBP fluctuations into 4-5 days.

Average BP in the circadian rhythm for 1-8 days by groups, mmHg

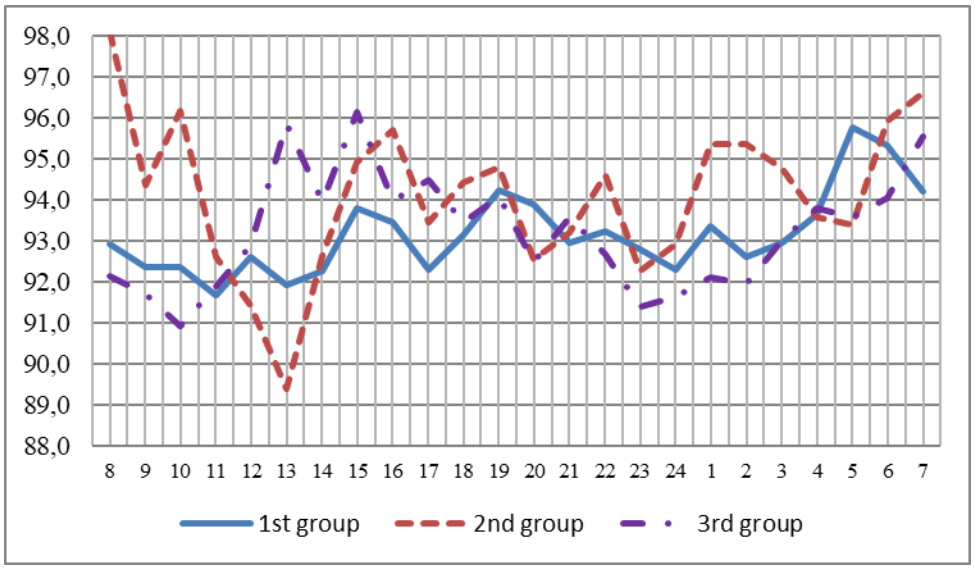

Fig.4

Indicator of average BP in circadian rhythm for 9-17 days by groups, mmHg

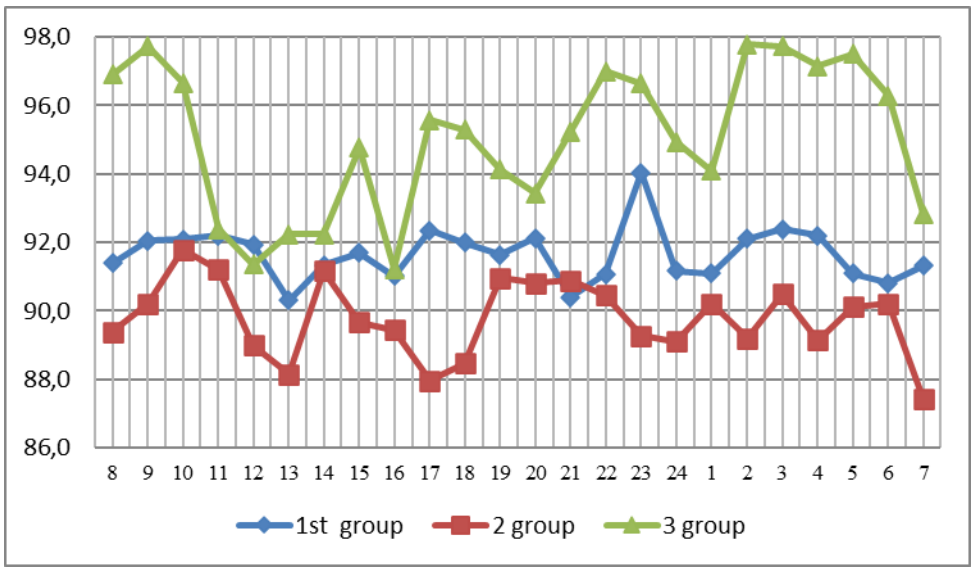

Fig.5

An attempt to differentiate changes in the first 8 days made it possible to reveal that the highest AvBP value was observed on day 1 at 8 a.m. (98 mmHg), which decreased to a minimum (89 mmHg) at 1 p.m. in patients of group 2, remaining at level 94 mmHg with a tendency to rise at night (1-3) hours. In group 2, during the first week after injury, an inversion of the AvBP circadian rhythm was observed in group 2. The tendency to an increase in AvBP at 13-15 o'clock in the afternoon to 96 mmHg, a decrease to 91 mmHg at 23 o'clock, indicating some tendency to maintain the circadian rhythm of AvBP at the physiological level in the first 8 days of intensive therapy. The minimum fluctuations in AvBP (within 1-3 mmHg) in patients of group 1 were most likely due to intensive stress-protective sedative therapy (fig. 4).

In the second week of treatment (9-17 days), the tendency to inversion of the circadian rhythm AvBP in groups 1 and 3 was more noticeable. Oscillations with a 5-6 hour wavelength became more distinguishable (increased amplitude) in group 2 during the daytime, and in group 3 in the evening and night hours, while a single increase by 4 mmHg was observed at 11 pm in group 1 (fig. 5).

Average BP in circadian rhythm for 18-25 days by groups, mmHg

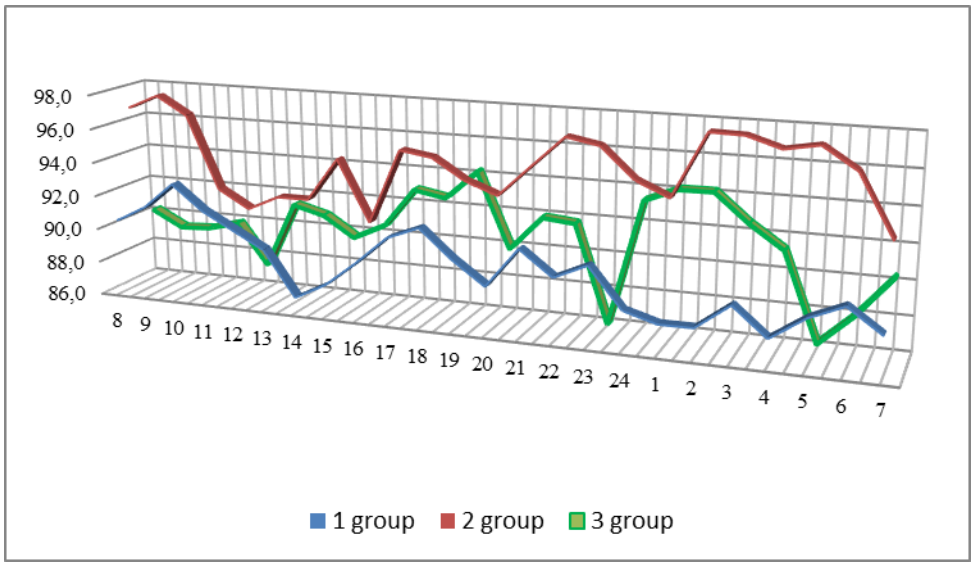

Fig.6

On the 18-25th day of the acute period of CSTBI in group 1, there was a tendency to the restoration of the physiological daily wave AvBP (91.5 mmHg at 9 am, 86 mmHg at 24-2 am). While in groups 2 and 3, the inversion of the AvBP circadian rhythm persisted (97 mmHg at 2-3 hours, 90 mmHg at 9 a.m. in group 2; 94 mmHg at 24-2 a.m., 87 mmHg at 11 a.m. at 3 group) (fig. 6). Thus, the control of hemodynamics in the weekly biorhythm of the studied indicator was

an additional source of information allowing early detection of deviations, assessment of the effectiveness of intensive therapy in the acute period of CSTBI.

Correlations of mean arterial pressure indicator in the acute period of CSTBI

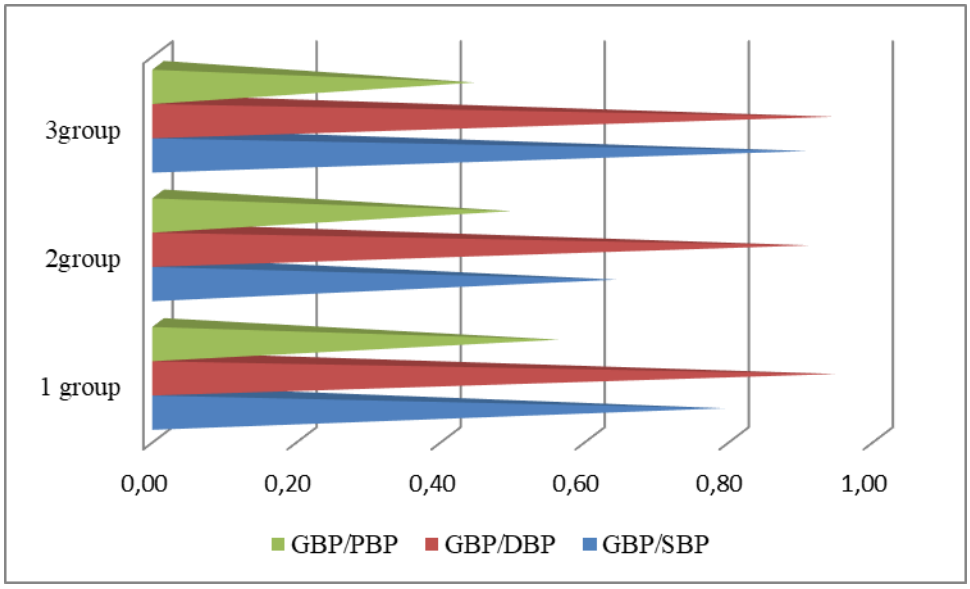

Fig.7

A direct strong correlation between AvBP and DBP (more than 0.8), significant with groups 1 and 3 (> 0.7) and slightly less significant AvBP and SBP (0.61) was found in group 2.

The severity and duration of displacements of the acrophase

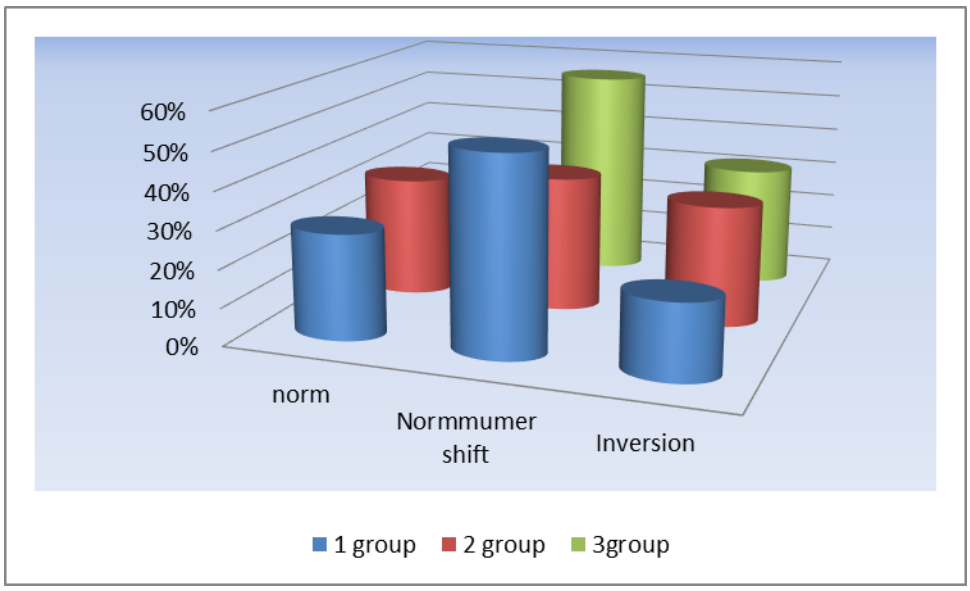

Fig.8

As shown in fig. 8, in all age groups, a moderate shift in the acrophase of the circadian rhythm AvBP prevailed, the duration of the inversion of the circadian rhythm AvBP was longer in groups 2 and 3 of the injured.

Conclusions. In group 1, CSTBI caused a transformation of about weekly biorhythms into 5-6 day periods of fluctuations in the first two weeks after injury. The stress reaction of hemodynamics, intensifying on the 18-25th day of the acute period of CSTBI, was revealed in the injured patients of group 2. In Group 3, the 5-day cycles of AvBP fluctuations from the very beginning were more constant throughout the acute period of CSTBI. The stress response of the circadian rhythm AvBP prevailed in groups 2 and 3 of patients at a later date and was expressed in an increase in the amplitude of daily fluctuations. Monitoring AvBP in the peri-weekly biorhythm is an additional source of information that allows early detection of deviations, assessment of the effectiveness of intensive care in the acute period of CSTBI.

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