

Pathomorphological Changes in the Brain Cortex of Rats under Different Times of Exposure to Energy Drink

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Abstract In the 21st century, an urgent problem is the excessive popularity of energy drinks, which have a stimulating and tonic effect on the human nervous system. Energy drinks are non-alcoholic or low-alcohol highly carbonated drinks containing a large amount of caffeine and other biologically active substances. Currently, schoolchildren, students and ordinary people engaged in mental work in large numbers use them during a period of special workload at work or in school. There are quite a few reports in the available literature about the harmful effects of energy drinks on the body. This article presents the results of a study of the cellular and tissue structures of the brain of rats that were orally administered the Iguana energy drink for 30, 60 and 90 days. We have established, to varying degrees, alterative-dystrophic and necrobiotic changes in glial and ganglion cells and the vascular system of the brain of rats, which significantly depend on the timing of the intake of energy drinks.

Keywords Energy drinks, Caffeine, Biologically active substances a, Morphology, Nervous system, Cerebral cortex, Vascular system of the brain

1. Purpose and Objectives of the Study

Energy drinks are soft drinks that are typically high in caffeine and other stimulants, and may also be fortified with plant extracts and nutrients (such as vitamin B, taurine, and amino acids). These drinks are becoming more and more popular among teens and young adults in the US and around the world. [1]. The attraction and consumption of energy drinks among young people, especially students, is related to both the pleasant taste and the promise of being a stimulant that keeps them awake [2].

These drinks appeared on the market in the 1960s in Europe and Asia, and since the end of the last century they have spread throughout the world [3]. There are reports in the literature about the short- and long-term effects of energy drink consumption on the cardiovascular and central nervous systems. Energy drinks have been shown to cause a number of side effects, especially in young adults, including high blood pressure, serious cardiovascular disease, kidney disease, metabolic disturbances, poor sleep, seizures, and neuropsychiatric side effects [4,5,6,8]. The power engineer does not give energy, it only opens the energy channels of the organism itself. A person does not receive energy, but uses his internal resources.

Excessive consumption of energy drinks containing caffeine and taurine, which are potent psychoactive substances, can modify neurotransmission and inevitably

affect the functioning of the nervous systems. Disorders of the emotional sphere, the appearance of unmotivated fear, the development depression, sleep disorders, appetite, an increase in the frequency of committing antisocial acts. Toblin RL et al noted the appearance aggressive behavior, disobedience to orders and insomnia in conscripts after taking energy drinks [7].

Today, the opinions of scientists and specialists are divided: someone considers “energy drinks” to be completely harmless, like ordinary soda; others, on the contrary, argue that they can act like drugs, and are certainly addictive and addictive. Energy drinks have a negative impact not only on the cardiovascular system, but also cause disorders of the nervous system.

In order to identify the morphological aspects of the negative impact of this kind of drinks, we decided to study in an experiment in rats structural changes in the cerebral cortex during prolonged administration of the widely used Iguana drink.

2. Materials and Research Methods

This report presents the results of a study of structural changes in the cerebral cortex of 26 outbred white male rats weighing 220–250 g. The animals were kept under standard vivarium conditions, in ordinary cages with wire mesh at room temperature, regulated at $21^{\circ}\text{C} \pm 10^{\circ}\text{C}$, humidity from 45% to 50% and light/dark cycles (24/12 hours). They were fed a standard rat diet and given free access to water. The

animals were allowed to acclimatize to the experimental conditions by observing them for 10 days prior to the experiment. Animals _ was divided into 4 groups:

- Group I (control) included six rats.
- Group II (short-term group energy drink - Iguana), included seven rats given an energy drink at a dose of 7.5 ml / kg / day orally through a gastric tube for 1 month.
- Group III: included six rats treated with Iguana energy drink at a dose of 7.5 ml / kg / day orally through a gastric tube for 2 months.
- Group IV (long-term energy drink group): consisted of seven rats treated with an energy drink at a dose of 7.5 ml/kg/day orally via gavage for 3 months.

During the last days of the experiment, the rats were not given food at night, and then in the morning they were anesthetized with light inhalations of ether, and blood samples were taken directly from the heart for laboratory tests. Rats were slaughtered by decapitation, observing all the provisions of bioethics, the brain was removed, which was fixed in 10% neutral formalin and the cut pieces were embedded in paraffin. Histological sections were stained with hematoxylin-eosin, according to van Giesson and Nissl, who examined on a light microscope using lenses of various magnifications and microphotographed the necessary areas.

3. Research Results and Their Discussion

Microscopic examination of the cerebral cortex of rats treated with Iguana for 30 days showed uniform loosening in all parts of the brain, but most pronounced in the upper layers. The perivascular areas appeared to be moderately dilated, and the pericellular areas were significantly more dilated (photo 1). There were focal extravasates, that is, diapedetic petechial hemorrhages. Single lymphocytes were found in the walls of uneven blood-filled intracerebral capillaries. When staining the sections according to Nissl, there was not a rough and not a relief violation of the cytoarchitectonics of the cerebral cortex, which was expressed by a slight increase in the size of the cells with their hypochromia (photo 2). The tigroid substance looked slightly swollen and dull.

A study of the brain of rats treated with Iguana for 60 days showed a more significant loosening of the cell -tissue structures of the brain, which were distributed throughout all layers of the cerebral cortex. A more pronounced perivascular and much more pronounced pericellular edema was noted compared to the previous period of experiments. There were signs of dystonia of the walls of intracerebral capillaries (photo 3), which were expressed by uneven spasm and expansion, as well as a change in their shape. Such capillaries look slightly deformed and swollen. When stained according to Nissl the cytoarchitectonics of the cerebral cortex underwent more pronounced changes, which were characterized by a significant swelling of the nuclei of

neurons and uneven staining of their tigroid substance (photo 4).

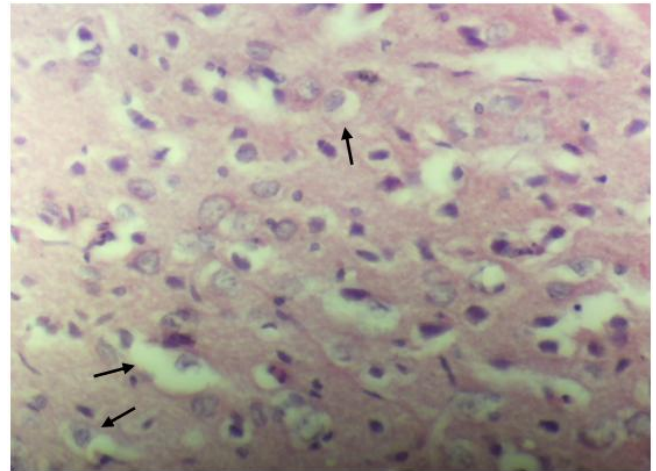


Photo 1. The cerebral cortex. Hematoxylin-eosin staining. Ob.40. Severe pericellular edema

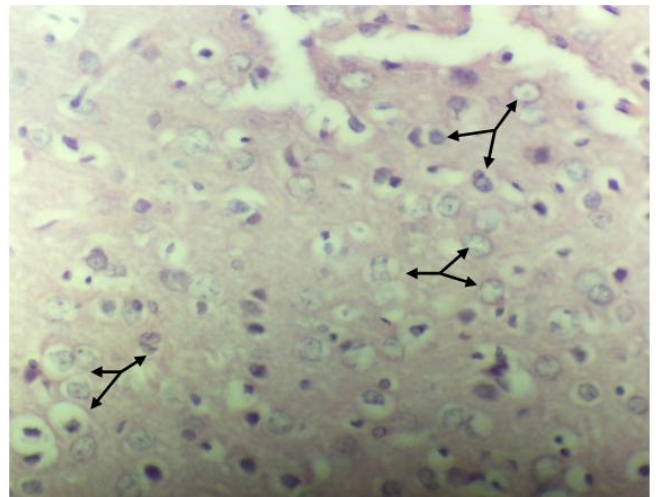


Photo 2. The cerebral cortex. Hematoxylin-eosin staining. Ob.40. Dystrophic swelling of cells with hypochromia of their nuclei

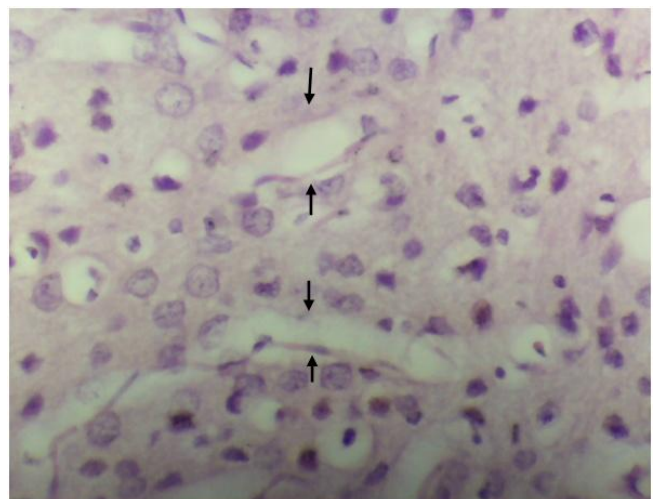


Photo 3. The cerebral cortex. Hematoxylin-eosin staining. Ob.40. Dystonia of the walls of intracerebral capillaries

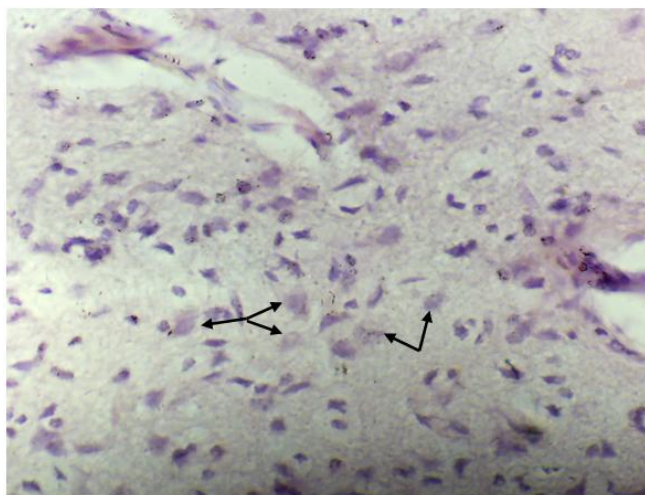


Photo 4. The cerebral cortex. Nissl coloring. Ob.40. Swelling of the nuclei of neurons and uneven staining of the tigroid substance

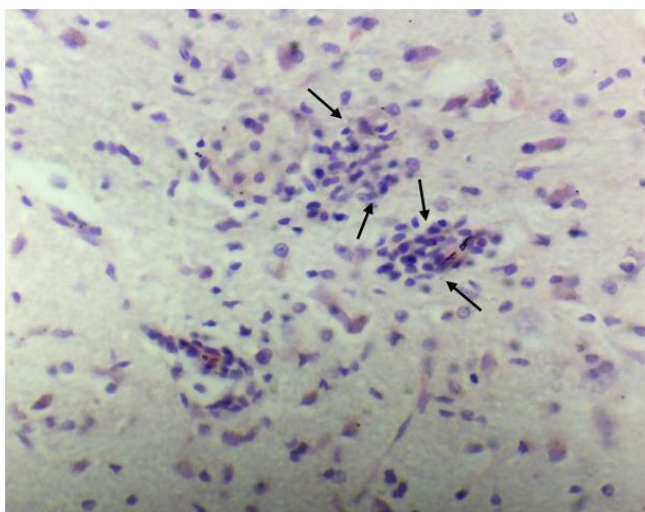


Photo 5. Cortex. Hematoxylin-eosin staining. Ob.40. Lymphoid cell infiltrates in the walls of blood vessels

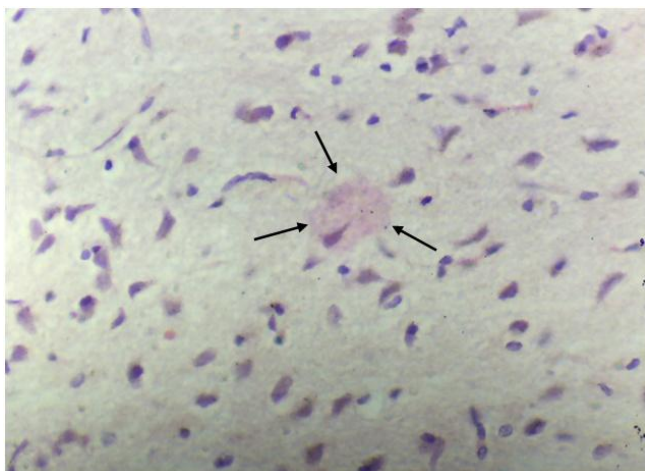


Photo 6. The cerebral cortex. Nissl coloring. Ob.40. Hypochromia of the nucleus and fine-grained change in the tigroid substance

The study of the cellular and tissue structures of the cerebral cortex in rats treated with Iguana for 90 days

revealed coarser and significantly relief changes in all layers and in all histotypic areas of the brain. Focal loosening and “falling out” of cells against the background of a pronounced and widespread perivascular and pericellular edema of the brain tissue with significant swelling of the brain substance, quite frequent extravasations of the perivascular location and lymphoid cell infiltrates in the walls of the capillaries against the background of their severe dystonia were revealed (photo 5). When stained according to Nissl, more pronounced alternative - dystrophic changes in neurons were noted, cells were detected focally - shadows without nuclei, which were more clearly distinguished by hypochromia of the nuclei and fine-grained transformation of the tigroid substance of the cells (photo 6).

A comparative study of vascular -tissue changes and cytoarchitectonics of the cerebral cortex in experimental and control rats showed a significant and significant difference in the nature and prevalence of alternative-dystrophic and necrobiotic changes in the histoarchitectonics of the brain, which were not found in control rats and undoubtedly developed in experimental animals.

It should be especially emphasized that the morphodynamics of the detected alternative changes in brain cells and tissues, dystonic -reactive changes in the vascular -capillary network of the brain increased in relief and significantly from a month to a two-month period and then to a three-month period of experiments.

Thus, microscopic examination of the cerebral cortex of rats subjected to oral exposure to the energy drink -Iguanas showed that the main pathomorphological changes occur in the walls of blood vessels. The brain tissue around the capillaries is subjected to severe edematous loosening. Cells in the brain shrivel and are sparsely arranged by the end of the experiments.

Loosening of the brain substance and pronounced perivascular edema and less noticeable pericellular edema progressed towards the end of the experiments. Such puffiness is significantly pronounced in the temporal and parietal lobes of the cortex.

In the vessels of the brain, especially capillaries, dystonia and focal deformation of their walls progress by the deadline. Longitudinal sections of the capillaries show either cone-shaped expansions or narrowed intercepts. Extravasates occur, that is, hemorrhages in all layers of the cortex, both in the perivascular spaces and in the substance itself. In 4-5 cm layers of the cortex, there are many wrinkled cells, cells with thickened and corkscrew-shaped processes. Attention is drawn to the presence of a mass of cells containing large and small vacuoles in the protoplasm, mainly in 2-3-4-6 layers of the cortex. Vacuoles give the cells a "lacy" appearance. Along with this, cells with two nucleoli are very often found in all lobes of the cortex.

4. Conclusions

Based on the obtained results of histological examination,

it can be concluded that with prolonged use of an energy drink a number of significant alterative-reactive changes can occur in vessels and layers cerebral cortex. The adverse side effects of this common energy drink increase with the duration of exposure. Significantly significant, widespread and relief changes in experimental rats and their absence in control animals demonstratively show their damaging side effect on the brain structures of animals.

The data obtained from the results of the conducted studies can be used in the implementation of solving important social problems related to the regulation of energy drinks in society.

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