RESULTS OF COMPARATIVE ANALYSIS OF MORPHOLOGICAL CHANGES IN THE KIDNEYS DURING ACUTE, SUB-ACUTE AND PROLONGED PERIOD OF SEVERE BRAIN INJURY.

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traumatic brain injury, kidneys, nephron, biopsy, Shumlyansky-Bowman's capsule, vascular glomerulus.

ABSTRACT

This article provides information on the results of assessment of the morphological features of 3-month rats and morphological features due to a severe head of brain. Morphological analysis of rats of rats was conducted in the 1st, 3rd, 7th, 14th, 21st and 28th day after the brain injury.

Annotation: In the context of the rapid development of technological development in the world, the formation of traumatic brain injuries and subsequent complications among other injuries has become an urgent problem at the level of the state and society [7,11,16,21,33,36, 37,48.]. As can be seen from a number of studies, it gained great importance, especially at the end of the 20th century. [1,4,7,10,18,19,32,34,38,41.].

Among a number of injuries, traumatic brain injury (TBI) is one of the main problems in the healthcare system and social significance of any country due to its frequent occurrence and severe complications [3,6,8,12,14,17, 30,34, 35.]. It is also one of the leading causes of death in humans compared to other injuries. Although traumatic brain injury is not inferior to cardiovascular, oncological and infectious diseases, it is significantly ahead of them in terms of premature mortality [13,15,20,23,26,43.]. Brain injury is reported to be 10 times more likely to cause death from cardiovascular disease and 20 times more likely to cause death from cancer among individuals aged 30–40 years [5,27,31,35,40,49]. Traumatic brain injury is the leading cause of death and disability among the population under 45 years of age [1,4,24,28,32,42,44,50].

Brain damage does not affect kidney function. The kidneys perform many tasks in the human body and are actively involved in almost all types of metabolism, maintaining homeostasis in the body . There are different types of kidneys_ It serves as an important link in the formation of adaptive reactions in the body in response to environmental influences , in response to changes that occur after pathological processes in other organs and systems [25,29,33,45,46 .].

One of the important organs that are subject to intense functional stress during a person's life under the influence of any external factors [2,9, 30,39,47] .

In this direction, secondary extraspinal complications after traumatic brain injury, in particular in modern nephrology, rarely achieve positive results in the treatment and improvement of the quality of kidney diseases, which in turn requires the development of new evidence-based treatment methods by specialists in this field.

Materials and methods. Three-month-old white rats with an average weight of 150 g were obtained for the study. All laboratory animals were kept in a vivarium in plastic cages lined with wood chips at room temperature with a 12-hour light-dark cycle in accordance with the standards for the care of laboratory animals. The animals of the experimental group were divided into 2 groups: the first group included animals without spinal cord injury (control, n=5), the second group (experimental n=5) included animals with mild spinal cord injury. During the study, a mild spinal cord injury was caused in white rats using a specially designed model using the "road traffic accident" technique.

During this experiment, all animals suffered mild to severe injuries. After injury, surviving animals were transferred to a special plastic cage and observed until the post-traumatic state was restored.

Results of the study: When analyzing changes in the kidneys of 3-month-old white rats after severe traumatic brain injury, the following data were obtained: Macroscopically, the kidneys of 3-month-old white rats in the experimental group are bean-shaped , Located in the lumbar region and externally covered with a smooth shiny capsule, macroscopically Apart from an increase in volume, no other visible pathological changes were found (Fig. 1).

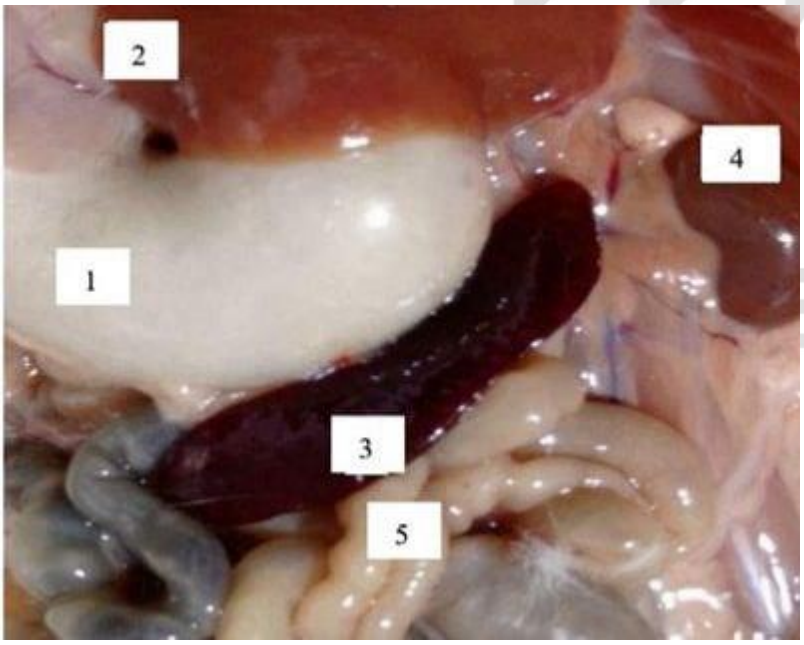

Figure 1 . Topographic location of the kidneys of 3-month-old white rats of the main group. 1-stomach, 2-liver, 3-spleen, 4-kidneys, 5-small intestine.

During the study, the body weight of three-month-old white rats with severe brain damage in the 2nd experimental group ranged from 130 g to 178 g , with an average of 156 g. it was noted that it was within normal limits.

Changes in the morphological and morphometric parameters of the kidneys of rats on the 1st day after severe brain damage were manifested in the dynamics of UV transmission as follows: the absolute mass of the kidneys was from 852.52 mg to 1388.77 mg, the average

mass was 1059.96 mg. ± 54.6 mg; kidney length - from 16.72 to 21.52 mm, average length - 19.3±0.3 mm; width – from 6.15 mm to 8.98 mm, average width – 7.57 ± 0.3 mm; thickness - from 5.51 mm to 9.54 mm, average thickness - 7.24 ± 0.4 mm; the volume of the right kidney ranged from 364.37 mm ^{3} to 962.182 mm ^{3,} the average amounted to 552.02±43.3 mm3 ·

The area of the kidney bodies is from 2169.6 μm2 to 2399.87 μm2 , the average is 2305.96±19.4 μm2 ; the area of the vascular tangle - from 1766.3 μm ^{2} to 2012.91 μm ^{2} , on average - 1910.01±21.8 μm ^{2} ; The area of the capsule cavity ranged from – 326.32 μm ^{2} to 386.23 μm ^{2,} on average equal to – – 349.63 ± 5.1 μm $^{2.}$

The diameter of the proximal convoluted tubules was from 29.66 to 38.12 μm, the average was 33.12±0.7 μm, the diameter of the tubular space was from 15.2 to 25.39 μm, the average was 18, was equal to 1±0. 7 microns.

The diameter of the distal convoluted tubules was from 26.36 μm to 32.9 μm, the average was 30.09±0.6 μm, the diameter of the tubular space was from 14.1 μm to 18.31 μm, the average was 16, it was equal to 2± 0.4. μm (Fig. 2).

Changes in the morphological and morphometric parameters of the kidneys of rats three days after severe brain damage were manifested as follows: the absolute mass of the kidneys increased from 917.3 mg to 1275.62 mg, the average mass increased from 1077.99 ± 32.2 mg, the length of the kidney - from 16.52 mm to 21.67 mm, average length – 18.66±0.6 mm; width - from 6.69 mm to 9.8 mm, average width - 7.91 ± 0.3 mm; thickness - from 5.88 mm to 8.92 mm, average thickness - 7.22±0.3 mm; the volume of the right kidney ranged from 354.6 mm ^{3} to 700.84 mm ^{3,} the average value was 555.83 ± 31.3 mm $^{3.}$

The area of the kidney bodies is from 2185.86 μm ^{2} to 2413.8 μm ^{2} , the average is 2309.39±24.0 μm ^{2} ; the area of the vascular tangle is from 1689 μm ^{2} to 2179 μm ^{2} , the average value is 1923.72 ± 39.5 μm ^{2} , the area of the capsule cavity is from 311.5 μm ^{2} to 389.2 μm ^{2} , the average value is 354.48 It was found that it is ±6.5 μm ^{2} ·

The diameter of the proximal convoluted tubules was from 30.64 μm to 39.46 μm, the average was 33.19±0.8 μm, the diameter of the tubular cavity was from 15.76 μm to 24.92 μm, the average was 18, it was 17± 0.8 μm. .

The diameter of the distal convoluted tubules was from 28.12 to 32.38 μm, the average was 30.19±0.4 μm, the diameter of the tubule cavity was from 14.87 to 17.83 μm, the average was 16, it was 22±0. 3 μm.

Changes in the morphological and morphometric parameters of the kidneys of rats seven days after severe brain damage were as follows: the absolute weight of the kidneys ranged from 734.52 mg to 1267.76 mg, the average weight was 1090.04 ± 51.2 mg; kidney length - from 17.66 mm to 20.98 mm, average length - 19.02±0.3 mm; width – from 5.75 mm to 9.46 mm, average width – 7.59 ± 0.3 mm; thickness - from 5.46 mm to 9.32 mm, average thickness - 7.47 ± 0.3 mm; kidney volume - from 380.1 mm ^{3} to 751.71 mm ^{3} , average - 565.75 ± 36.3 mm ^{3} .

The area of the kidney bodies is from 2187.4 μm ^{2} to 2425.32 μm ^{2} , the average is 2313.4±22.4 μm ^{2} ; the area of the vascular tangle is from 1687.75 μm ^{2} to 2278.5 μm ^{2} , on average - 1937.47±46.7 μm ^{2} ; It was noted that the area of the capsule cavity ranges from 327.2 μm2 to 427.67 μm2 , the average is 370.66±7.2 μm2 ·

· The diameter of the proximal convoluted tubules is from 30.38 μm to 37.1 μm, the average is 33.316±0.6 μm, the diameter of the tubular space is from 15.88 μm to 19.92 μm, the

average is 18.21±0.4 μm .

The diameter of the distal convoluted tubules was from 24.76 μm to 33.11 μm, the average was 30.35±0.7 μm, the diameter of the tubule cavity was from 13.71 μm to 19.77 μm, the average was 16, and was 39±0 .5 μm.

Fourteen days after severe traumatic brain injury, changes in the morphological and morphometric parameters of the kidneys of white rats were as follows: absolute kidney weight - from 787.62 mg to 1368.76 mg, average weight - 1110.46 ± 54.4 mg; kidney length - from 16.27 mm to 20.5 mm, average length - 18.51 ±0.4 mm; width – from 5.81 mm to 8.43 mm, average width – 7.22 ±0.3 mm; thickness - from 6.78 mm to 9.43 mm, average thickness - 8.19 ± 0.2 mm, kidney volume - from 447.47 mm ^{3} to 711.16 mm ^{3} , average - 573.5 ± 29, was equal to 8 mm $^{3.}$

The area of the kidney bodies is from 2219.83 μm ^{2} to 2431.33 μm ^{2} , the average is 2346.11 ± 19.9 μm ^{2} ; the area of the vascular tangle is from 1714.98 μm $^{2\ to}$ 2187.75 μm ^{2} , on average - 1950.04 ± 32.3 μm ^{2} ; The area of the capsule cavity ranged ^{from} 323.65 μm2 to 421.5 μm2, with an average of 385.03 ± 8.4 μm2.

The diameter of the proximal convoluted tubules was from 28.44 μm to 38.77 μm, the average was 34.32 ± 0.9 μm, the diameter of the tubular cavity was from 17.88 μm to 19.68 μm, the average was 18, 69 ± 0.2 μm . .

The diameter of the distal convoluted tubules was from 30.65 μm to 33.76 μm, on average - 32.19 ± 0.3 μm, the diameter of the convoluted tubule cavity - from 15.65 μm to 19.54 μm, on average - 17 .37 ±0.4 μm. .

Changes in the morphological and morphometric parameters of the rat kidneys twenty-one days after severe brain damage were as follows: absolute kidney weight - from 734.18 mg to 1277.1 mg, average weight - 954.77 ± 46.1 mg; kidney length - from 15.86 mm to 19.67 mm, average length - 18.26 ±0.3 mm; width – from 6.21 mm to 8.84 mm, average width – 7.24 ±0.3 mm; thickness – from 7.51 mm to 8.74 mm, average thickness – 8.13 ±0.1 mm; It was noted that the kidney volume ranged from 386.84 mm ^{3} to 762.98 mm ^{3} , the average - 566.66 ± 31.6 mm $^{3.}$

The area of the renal corpuscles is from 1952.82 μm ^{2} to 2448.5 μm ^{2} , the average value is 2268.77 ± 39.6 μm ^{2} , the area of the vascular tangle is from 1785.35 μm $^{2\ to}$ 2067.96 μm ^{2} , the average value is 1901 .41 ± 24.0 μm $^{2\ ;\ The\ area\ of\ the}$ capsule cavity ranged from 315.62 μm2 to 457.98 μm2 , with an average of $^{355.82}$ ± 11.3 μm2 .

The diameter of the proximal convoluted tubules was from 28.67 μm to 37.72 μm, the average was 33.5 ± 1.0 μm, the diameter of the tubular cavity was from 15.52 μm to 19.98 μm, the average was 18, was 12 ± 0 .4 μm.

The diameter of the distal convoluted tubules is from 28.71 μm to 36.83 μm, the average is 31.29 ±0.7 μm, the diameter of the tubular space is from 14.9 μm to 19.76 μm, the average is 16.6 - ±0 .4 μm.

Changes in the morphological and morphometric parameters of the kidneys of rats twenty-eight days after severe traumatic brain injury are presented below: absolute kidney weight - from 795.4 mg to 1156.3 mg, average weight - 1002.74 ± 38.2 mg; length of the right kidney – from 14.89 mm to 20.08 mm, average length – 17.09 ±0.6 mm; width – from 5.87 mm to 8.96 mm, average width – 7.45 ± 0.4 mm; thickness – from 7.32 mm to 8.96 mm, average thickness – 8.16 ±0.2 mm; the volume of the right kidney ranged from 371.09 mm ^{3} to 759.02

mm 3, the average value was 543.91 ± 36.7 mm 3.

the renal corpuscles ranges from 2016.43 μm2 to 2387.58 μm2 , with an average of 2245.82 ± 31.5 μm2 ; the area of the vascular tangle ranges from 1809.64 μm2 to 1979.43 μm2 , the average value is 1903.02 ± 16.1 μm2 ; It was noted that the area of the capsule cavity ranges from 318.2 μm 2 to 363.34 μm 2 , the average value is 337.88 ± 3.8 μm 2.

Table 1

Comparative characteristics of histomorphometric parameters of kidney nephrons after severe traumatic brain injury.

Bud elements from BMS next days	Average area of renal corpuscles (μm 2)	Average outer diameter of distal tubule (μm)	Mean outer diameter of proximal tubule (μm)
Norm	1993 , 04 ± 23 , 2	2 7.61 ± 0.2 _ _ _ _	31 , 1 ± 0 ,
1 day	2 305.96 ± 29.9 _ _ _ _	30.09 ± 0.5	33.12 ± 0.8
Day 3	2309.39 ± 24.0 _ _ _ _	30.19 ± 0.4 _ _	33.19 ± 0.8
Day 7	2313.41 ± 22.4 _ _ _ _	30 , 35 ± 0.7	33.32 ± 0.6
Day 14	2346.11 ± 19.9 _ _ _ _	32.19 ± 0.3 _ _	34.32 ± 0.9
Day 21	2268.77 ± 39.6 _ _ _ _	31.29 ± 0.7 _ _	33.5 ± 1.0
Day 28	2245.82 ± 31.5 _ _ _ _	29.45 ± 0.3 _ _	32.85 ± 0.3

The diameter of the proximal convoluted tubules is from 31.4 to 34.6 μm, the average value is 32.85 ± 0.3 μm, the diameter of the tubular space is from 16.16 to 20.39 μm, the average value is 17. It was 96 ± 0.5 μm.

The diameter of the distal convoluted tubules is from 28.76 μm to 31.68 μm, the average value is 29.45±0.3 μm, the diameter of the tubule cavity is from 14.16 μm to 19.63 μm, the average value is 15.83± 0.4 μm (1-table).

Thus, as a result of macroscopic, histological and histomorphometric studies, the experimental group suffered severe brain damage. A number of morphological changes were found in the kidneys of 3 -month-old white rats .

By visual assessment macroscopically severe head injury It was established that the

organometric indicators of the kidneys of 3 -month-old white rats at all points in time significantly exceeded the indicators of the control group due to the presence of edema (Fig. 2).

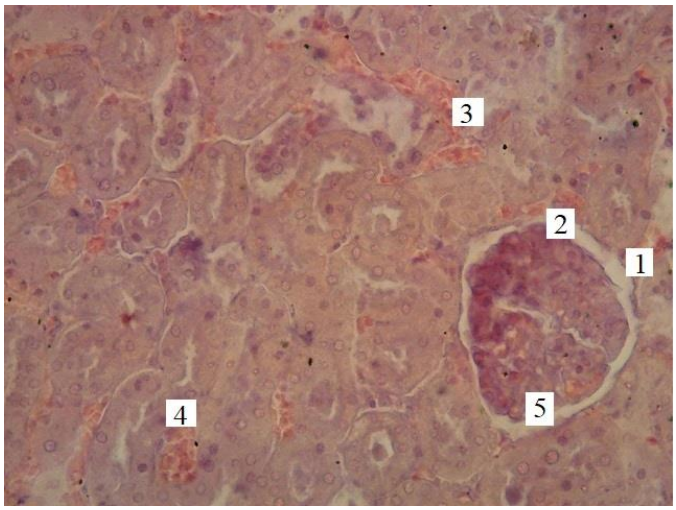

Figure 2. Cortical material of the kidneys of 3-month-old rats with severe traumatic brain injury in the experimental group. (Hematoxylin-eosin staining. OK 10 x OB 40. 1-kidney ball, 2-expansion of Shumlyansky-Bowman capsule, 3-zone of intertubular focal hemorrhage, 4-erythrocytes in the distal tubule, erythrocytes in the vascular tangle.)

Histological examination showed that 3-month-old rats with severe traumatic brain injury showed obvious changes in the structure of the kidneys . visible changes have occurred . Microscopic examination of rat kidneys on days 1, 3, 7, 14, 21, 28 after traumatic brain injury revealed a number of specific changes in the structure of nephrons . The basal layer of the kidney retained its structure in the nephrons and was enlarged due to the maximum expansion of the renal corpuscle , renal vascular ball and Shumlyansky- Bowman capsule, which were destroyed. was recorded . The experimental group had severe traumatic brain injury. Karyolysis of the proximal and distal cells of the convoluted tubules in the kidneys and medullary nephrons of white rats 3 months of age, the presence of erythrocytes in the tubules, the presence of areas of focal and diffuse bleeding between the tubules, darkening of the venous vessels due to the erythrocyte mass, the presence of interstitial edema was noted behind the tissues (Fig. 2).

Histomorphometric The results of the analysis showed that on the 14th day after severe traumatic brain injury, the area of the renal corpuscle, the area of the renal ball, the area of the Shumlyansky-Bowman capsule, the diameter It was established that the proximal and distal convoluted tubules, as well as the internal diameter of the nephron tubules increased to a critical level . From the 21st day, a tendency towards a decrease in morphometric parameters in nephron elements was noted. (Figure 2). Histologically, after severe traumatic brain injury, obvious changes in the elements of the renal nephrons were revealed, which was confirmed by histomorphometric indicators.

Conclusion: Thus, as a result of macroscopic , histological and histomorphometric studies , severe brain damage was established in the experimental group. obtained A number of morphological changes were found in the kidneys of 3 -month-old white rats , especially The maximum changes were obtained in the experimental group with severe traumatic brain

injury. significant changes were observed in the structure of the nephrons of the kidneys of white rats, and statistically significant differences were found for all studied indicators compared to the indicators of the control group of animals.

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