

RESULTS OF COMPARATIVE ANALYSIS OF MORPHOLOGICAL CHANGES IN THE KIDNEY DURING ACUTE, SUBACUTE AND LONG-TERM PERIOD OF SEVERE TRACUIOUS BRAIN INJURY

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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.

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

INTRODUCTION

During the rapid development of technical progress in the world, the formation of brain injuries and subsequent complications, along with other injuries, has become an urgent problem at the level of the state and society [7,11,16.]. It can be seen in a number of studies that it gained great importance especially at the end of the 20th century [1,4,7,10,18,19.].

Among a number of injuries, traumatic brain injury (TBI) is one of the main problems of any country's health system and social importance due to its frequent occurrence and serious complications [3,6,8.].

It is also one of the main causes of human death compared to other injuries. Although head injury is not inferior to cardiovascular, oncological and infectious diseases, it is far ahead of them in terms of the amount of early death [13,15.]. It has been reported that brain injuries are 10 times more likely to cause death after cardiovascular disease and 20 times more than death after cancer in people under 30-40 years of age [5.]. Traumatic brain injury is the leading cause of death and disability among people under the age of 45 [1,4.].

Brain damage does not affect the functioning of the kidneys. The kidney performs many tasks in the human body and actively participates in almost all types of metabolism, maintaining homeostasis in the body. It participates. There are different types of kidneys. It serves as an important link in the formation of adaptive reactions in the body in response to the effects of the external environment, in response to the changes that occur after pathological processes in other organs and systems [12,14,17.].

is one of the important organs that are subjected to intensive functional stress under the influence of any external factors during human life [2,9.].

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 methods of treatment for specialists in this field.

Materials and Methods: Three-month-old white rats with an average weight of 150 g were obtained for this study. All laboratory animals were housed in a vivarium in plastic cages lined with wood chips at room temperature with a 12-h light-dark cycle, in accordance with laboratory animal care standards. Animals of the experimental group were divided into 2 groups, that is, the first group included animals without spinal cord injury (control, n=5), and the second group (experimental n=5) included animals with mild spinal cord injury. In the study, a specially designed model was used to induce mild spinal cord injury in white rats using the "traffic accident" method.

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

Results of the study: In the analysis of changes in the kidney of 3-month-old white rats after severe brain injury, the following data were obtained: macroscopically, the kidneys of 3-month-old white rats of the experimental group are bean-shaped, It is located in the lumbar region and is covered with a smooth and shiny capsule from the outside, macroscopically other visible pathological changes were not determined, except for the increase in volume.

In the process of research Body weight of three-month-old white rats with severe brain damage in experimental group 2 is from 130 g to 178 g, with an average of 156 g. It was noted that it is in the range.

The changes in the morphological and morphometric parameters of the kidneys of rats on the 1st day after severe brain damage were shown in the dynamics of UV transmission as follows: the absolute weight of the kidneys - from 852,52 mg to 1388.77 mg, the average weight – $1059,96 \pm 54,6$ mg; kidney length - from 16,72 to 21,52 mm, average length – $19,3 \pm 0,3$ mm; width – from 6,15 mm to

8,98 mm, average width – $7,57 \pm 0,3$ mm; thickness - from 5,51 mm to 9,54 mm, average thickness – $7,24 \pm 0,4$ mm; the volume of the right kidney ranged from $364,37 \text{ mm}^3$ to $962,182 \text{ mm}^3$, the average was $552,02 \pm 43,3 \text{ mm}^3$.

The area of kidney bodies - from $2169,6 \mu\text{m}^2$ to $2399,87 \mu\text{m}^2$, average - $2305,96 \pm 19,4 \mu\text{m}^2$; the area of the vascular ball - from $1766,3 \mu\text{m}^2$ to $2012,91 \mu\text{m}^2$, on average - $1910,01 \pm 21,8 \mu\text{m}^2$; the area of the capsule space ranged from – $326,32 \mu\text{m}^2$ to $386,23 \mu\text{m}^2$, the average was equal to – $349,63 \pm 5,1 \mu\text{m}^2$.

The diameter of the proximal convoluted tubular tubules is from $29,66 \mu\text{m}$ to $38,12 \mu\text{m}$, the average is $33,12 \pm 0,7 \mu\text{m}$, the diameter of the tubule space is from $15,2 \mu\text{m}$ to $25,39 \mu\text{m}$, the average is 18 It was equal to $1 \pm 0,7 \mu\text{m}$.

The diameter of the distal convoluted tubules is from $26,36 \mu\text{m}$ to $32,9 \mu\text{m}$, the average is $30,09 \pm 0,6 \mu\text{m}$, the diameter of the tubular space is from $14,1 \mu\text{m}$ to $18,31 \mu\text{m}$, the average is 16 It was equal to $2 \pm 0,4 \mu\text{m}$ (Fig. 2).

Changes in morphological and morphometric indicators of rat kidneys three days after severe brain damage were shown as follows: the absolute weight of kidneys increased from $917,3 \text{ mg}$ to $1275,62 \text{ mg}$, the average weight increased from $1077,99 \pm 32,2 \text{ mg}$, kidney length - from $16,52 \text{ mm}$ to $21,67 \text{ mm}$, average length – $18,66 \pm 0,6 \text{ mm}$; width - from $6,69 \text{ mm}$ to $9,8 \text{ mm}$, average width - $7,91 \pm 0,3 \text{ mm}$; thickness - from $5,88 \text{ mm}$ to $8,92 \text{ mm}$, average thickness - $7,22 \pm 0,3 \text{ mm}$; the volume of the right kidney ranged from $354,6 \text{ mm}^3$ to $700,84 \text{ mm}^3$, the average was equal to $555,83 \pm 31,3 \text{ mm}^3$.

The area of kidney bodies is from $2185,86 \mu\text{m}^2$ to $2413,8 \mu\text{m}^2$, the average is $2309,39 \pm 24,0 \mu\text{m}^2$; the area of the vascular ball is from $1689 \mu\text{m}^2$ to $2179 \mu\text{m}^2$, the average value is $1923,72 \pm 39,5 \mu\text{m}^2$, the area of the capsule cavity is from $311,5 \mu\text{m}^2$ to $389,2 \mu\text{m}^2$, the average is $354,48$ It was found to be $\pm 6,5 \mu\text{m}^2$.

The diameter of the proximal convoluted tubules is from $30,64$ to $39,46 \mu\text{m}$, the average is $33,19 \pm 0,8 \mu\text{m}$, the diameter of the tubular cavity is from $15,76$ to $24,92 \mu\text{m}$, the average is 18 , It was equal to $17 \pm 0,8 \mu\text{m}$.

The diameter of the distal convoluted tubules is from $28,12$ to $32,38 \mu\text{m}$, the average is $30,19 \pm 0,4 \mu\text{m}$, the diameter of the tubule cavity is from $14,87$ to $17,83 \mu\text{m}$, the average is 16 , It was equal to $22 \pm 0,3 \mu\text{m}$.

Changes in the morphological and morphometric parameters of the kidneys of rats seven days after severe brain damage were shown as follows: the absolute weight of the kidneys was from $734,52 \text{ mg}$ to $1267,76 \text{ mg}$, the average weight was $1090,04 \pm 51,2 \text{ mg}$; kidney length - from $17,66 \text{ mm}$ to $20,98 \text{ mm}$, average length - $19,02 \pm 0,3 \text{ mm}$; width – from $5,75 \text{ mm}$ to $9,46 \text{ mm}$, average width – $7,59 \pm 0,3 \text{ mm}$; thickness - from $5,46 \text{ mm}$ to $9,32 \text{ mm}$, average thickness - $7,47 \pm 0,3 \text{ mm}$; kidney volume - from $380,1 \text{ mm}^3$ to $751,71 \text{ mm}^3$, average - $565,75 \pm 36,3 \text{ mm}^3$.

The area of kidney bodies is from $2187,4 \mu\text{m}^2$ to $2425,32 \mu\text{m}^2$, the average is $2313,4 \pm 22,4 \mu\text{m}^2$; the area of the vascular ball - from $1687,75 \mu\text{m}^2$ to $2278,5 \mu\text{m}^2$, on average - $1937,47 \pm 46,7 \mu\text{m}^2$; it was noted that the area of the capsule cavity is $327,2 \mu\text{m}^2$ to $427,67 \mu\text{m}^2$, the average is $370,66 \pm 7,2 \mu\text{m}^2$.

The diameter of the proximal convoluted tubules is from 30.38 μm to 37.1 μm , the average is 33.316 $\pm$ 0.6 μm , the diameter of the tubule space is from 15.88 μm to 19.92 μm , the average is 18.21 $\pm$ 0.4 μm .

The diameter of the distal convoluted tubules is from 24.76 μm to 33.11 μm , the average is 30.35 $\pm$ 0.7 μm , the diameter of the tubular space is from 13.71 μm to 19.77 μm , the average is 16, It was 39 $\pm$ 0.5 μm .

Fourteen days after severe head injury, changes in the morphological and morphometric parameters of the kidneys of white rats were shown as follows: absolute weight of kidneys - from 787.62 mg to 1368.76 mg, average weight - 1110.46 $\pm$ 54.4 mg; kidney length - from 16.27 mm to 20.5 mm, average length - 18.51 $\pm$ 0.4 mm; width – from 5.81 mm to 8.43 mm, average width – 7.22 $\pm$ 0.3 mm; thickness - from 6.78 mm to 9.43 mm, average thickness - 8.19 $\pm$ 0.2 mm, kidney volume - from 447.47 mm³ to 711.16 mm³, average - 573.5 $\pm$ 29, It was equal to 8 mm³.

The area of kidney bodies is from 2219.83 μm^2 to 2431.33 μm^2 , the average is 2346.11 $\pm$ 19.9 μm^2 ; the area of the vascular ball - from 1714.98 μm^2 to 2187.75 μm^2 , on average - 1950.04 $\pm$ 32.3 μm^2 ; the area of the capsule cavity ranged from 323.65 μm^2 to 421.5 μm^2 , the average was 385.03 $\pm$ 8.4 μm^2 .

The diameter of the proximal convoluted tubules is from 28.44 μm to 38.77 μm , the average is 34.32 $\pm$ 0.9 μm , the diameter of the tubular space is from 17.88 μm to 19.68 μm , the average is 18, It was equal to 69 $\pm$ 0.2 μm .

The diameter of the distal convoluted tubules is from 30.65 μm to 33.76 μm , on average - 32.19 $\pm$ 0.3 μm , the diameter of the cavity of the convoluted tubules is from 15.65 μm to 19.54 μm , on average – was equal to 17.37 $\pm$ 0.4 μm .

Changes in the morphological and morphometric parameters of the kidneys of rats twenty-one days after severe brain damage were shown as follows: the absolute weight of the kidneys - from 734.18 mg to 1277.1 mg, the average weight - 954.77 $\pm$ 46.1 mg; kidney length - from 15.86 mm to 19.67 mm, average length - 18.26 $\pm$ 0.3 mm; width – from 6.21 mm to 8.84 mm, average width – 7.24 $\pm$ 0.3 mm; thickness - from 7.51 mm to 8.74 mm, average thickness - 8.13 $\pm$ 0.1 mm; it was noted that the volume of the kidney is from 386.84 mm³ to 762.98 mm³, the average is 566.66 $\pm$ 31.6 mm³.

The area of renal corpuscles - from 1952.82 μm^2 to 2448.5 μm^2 , the average - 2268.77 $\pm$ 39.6 μm^2 , the area of the vascular ball - from 1785.35 μm^2 to 2067.96 μm^2 , the average value - 1901.41 $\pm$ 24.0 μm^2 ; the area of the capsule cavity ranged from 315.62 μm^2 to 457.98 μm^2 , the average was equal to 355.82 $\pm$ 11.3 μm^2 .

The diameter of the proximal convoluted tubules is from 28.67 μm to 37.72 μm , the average is 33.5 $\pm$ 1.0 μm , the diameter of the tubular cavity is from 15.52 μm to 19.98 μm , the average is 18, It was 12 $\pm$ 0.4 μm .

The diameter of the distal convoluted tubules is from 28.71 μm to 36.83 μm , the average is 31.29 $\pm$ 0.7 μm , the diameter of the tubular space is from 14.9 μm to 19.76 μm , the average is 16, 6 was $\pm$ 0.4 μm .

Changes in the morphological and morphometric parameters of the kidneys of rats twenty-eight days after severe brain damage are presented below: the absolute weight of the kidneys - from 795.4 mg to 1156.3 mg, the average weight - 1002.74 ± 38.2 mg; length of 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 was equal to $543.91 \pm 36.7 \text{ mm}^3$.

The area of renal corpuscles ranges from $2016.43 \text{ } \mu\text{m}^2$ to $2387.58 \text{ } \mu\text{m}^2$, the average is $2245.82 \pm 31.5 \text{ } \mu\text{m}^2$; the area of the vascular ball is from $1809.64 \text{ } \mu\text{m}^2$ to $1979.43 \text{ } \mu\text{m}^2$, the average value is $1903.02 \pm 16.1 \text{ } \mu\text{m}^2$; it was noted that the area of the capsule cavity is from $318.2 \text{ } \mu\text{m}^2$ to $363.34 \text{ } \mu\text{m}^2$, the average value is $337.88 \pm 3.8 \text{ } \mu\text{m}^2$.

Table 3

Comparative description of histomorphometric parameters in kidney nephrons after severe brain injury.

Kidney elements from BMSH next days	The average area of the renal corpuscle (μm^2)	Mean outer diameter of the distal tubule (μm)	Mean outer diameter of the proximal tubule (μm)
The norm	$1993,04 \pm 23,2$	$27,61 \pm 0,2$	$31,1 \pm 0,9$
Day 1	$2305,96 \pm 29,9$	$30,09 \pm 0,5$	33.12 ± 0.8
Day 3	$2309,39 \pm 24,0$	$30,19 \pm 0,4$	33.19 ± 0.8
Day 7	$2313,41 \pm 22,4$	$30,35 \pm 0,7$	33.32 ± 0.6
14th day	$2346,11 \pm 19,9$	$32,19 \pm 0,3$	34.32 ± 0.9
Day 21	$2268,77 \pm 39,6$	$31,29 \pm 0,7$	33.5 ± 1.0
Day 28	$2245,82 \pm 31,5$	$29,45 \pm 0,3$	32.85 ± 0.3

The diameter of the proximal convoluted tubules is from 31.4 to 34.6 μm , the average value is $32.85 \pm 0.3 \mu\text{m}$, the diameter of the tubular cavity is from 16.16 to 20.39 μm , the average value is $17.96 \pm 0.5 \mu\text{m}$.

The diameter of the distal convoluted tubules is from 28.76 μm to 31.68 μm , the average value is $29.45 \pm 0.3 \mu\text{m}$, the diameter of the tubule cavity is from 14.16 μm to 19.63 μm , the average value is $15.83 \pm 0.4 \mu\text{m}$.

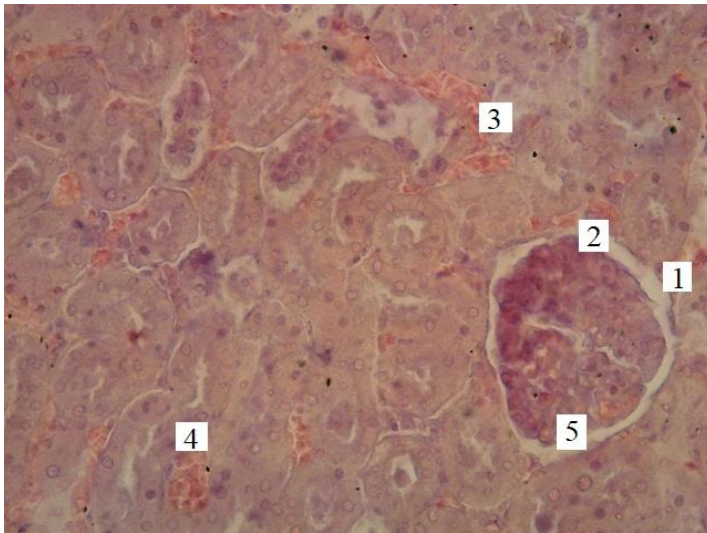


Fig 2. Cortical material of the kidneys of 3-month-old rats with severe head injury of the experimental group. (Stained with hematoxylin-eosin. OK 10 x OB 40. 1-kidney ball, 2-Shumlyansky-Bowman's capsule expansion, 3-intertubular focal hemorrhage zone, 4-erythrocytes in the distal tubule, erythrocytes in the vascular ball.)

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

In visual assessment, macroscopically severe head injury. Organometric parameters of the kidneys of 3-month-old white rats were found to be significantly larger than the values of the control group at all time points due to the presence of edema.

Histological examination showed that 3-month-old rats with severe brain damage had obvious changes in the structure of the kidney. Visible changes have occurred. A number of specific changes in the structure of nephrons were revealed when the kidneys of rats were examined microscopically on the 1st, 3rd, 7th, 14th, 21st, 28th days after brain injury.

The basal layer of the kidney has preserved its structure in the nephrons and is enlarged due to the maximum expansion of the kidney corpuscle, renal vascular ball, and Shumlyansky-Bowman capsule, which have been destroyed. The experimental group had a severe brain injury. Karyolysis of proximal and distal convoluted tubule cells in 3-month-old white rat kidneys and medullary nephrons, the presence of erythrocytes in the tubules, the presence of focal and diffuse hemorrhage zones between the tubules, dimming of the venous blood vessels due to the erythrocyte mass, behind the tissues the presence of interstitial edema was noted (Fig. 2).

Histomorphometric the results of the analysis showed that on the 14th day after a severe brain injury, the area of the renal corpuscle, the area of the kidney ball, the area of the Shumlyansky-Bowman capsule, the diameter of the proximal and distal convoluted tubules, and the inner diameter of the tubules in the kidney nephrons were found to have increased to a critical level. From the 21st day, the trend of decreasing morphometric indicators in nephron elements was noted. (Figure 3.4.2, Table 3). Histologically, after severe brain injury, obvious changes in renal nephron elements were detected, which was confirmed by histomorphometric parameters.

Conclusion: Thus, as a result of macroscopic , histological and histomorphometric studies, severe brain damage of the experimental group received A number of morphological changes were detected in the kidneys of 3- month-old white rats . especially Maximal changes were obtained in the experimental group with severe head injury significant changes were observed in the structure of kidney nephrons of white rats , and statistically significant differences were found in all studied indicators compared to the indicators of the control group of animals .

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