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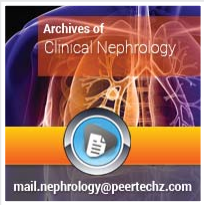

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Research Article

Studying the efficiency of carbon nano enterosorbents in the model of experimental renal failure

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Abstract

The current article examines the effectiveness of nanoenterosorbent to correct violations of the functional state of the kidneys in the experimental renal failure model. The obtained data open up opportunities for further research aimed at studying the possibility of using nanoenterosorbent in practical medicine as a new nanoenterosorbent and a means of drug delivery. The study was conducted in the following groups of animals: group 1 - control group; group 2 - an experimental model of acute renal failure; group 3 - nanoenterosorbent was administered intragastrically at a dose of 650 mg/kg per day to animals with acute renal failure. During the experiment for 3, 14 and 21 days, an analysis of biochemical parameters was obtained from each group. During the investigation, intragastric administration of the nanoenterosorbent did not reduce the dynamics of experimental uremia but reduced the concentration of level of molecular of average mass within 3 days, it also did not improve the functional state of the kidneys according to the readings of urea and creatinine for 14 days after the formation of renal failure, however, it statistically reduced endogenous intoxication according to EI data. Daily intragastric administration of nanoenterosorbent at a dose of 650 mg/kg after the formation of renal failure reduced uremia (urea, creatinine levels) and endogenous intoxication (level of molecular of average mass) after 21 days. Based on the studies, it was found that animals that received nanoenterosorbent at a daily dose of 650 mg/kg, show an optimal improvement in some biochemical parameters.

Introduction

Researchers have recently become interested in finding new materials suitable for medical use, in particular, there has been an increased interest in studying nanoenterosorbents and their properties for removing toxic compounds from the body (for example, metabolic products, heavy metals, radionuclides, xenobiotics, etc.).

In this regard, of undoubted excitement to specialists working in this field is a highly efficient carbon nanostructured nanoenterosorbent, which was synthesized under the leadership of Academician Z.A. Mansurov at the Gorenje Institute of Combustion Problems at Al-Farabi Kazakh National University (Almaty, Kazakhstan) based on plant raw materials.

However, it should be mentioned that no purposeful and systematic studies devoted to the study of the possibilities of using nanoenterosorbent as a new material for medical and biological purposes have been conducted before.

As a result of laboratory studies, it was found that the nanoenterosorbent has a pronounced universal sorption property. In addition, the nanoenterosorbent has the property to absorb excess bilirubin, cholesterol and lipid complexes, metabolites of nitrogen metabolism and substances of "average molecular weight" responsible for the development of metabolic toxicosis. Nanoenterosorbent can have antioxidant (blocks the action of aggressive free radicals) and adaptogenic properties – increasing the body's resistance to infections and adverse environmental factors.

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Since the nanoenterosorbent used is a completely new biochemical material that has no analogs in world practice so far and due to the lack of data on their effect on the physiological properties of the body, the interest in conducting such studies seemed quite logical and justified. Blood testing is an important diagnostic method for various pathological conditions of the body under the influence of various stress factors. Pathogenic effects on the body are mediated through the hematopoietic and immune systems, as one of the components determining the body's homeostatic reactions in the process of adaptation to changing living conditions, which finds expression in the development of clinical and hematological syndromes. In this regard, the purpose of our series of experiments was to identify diagnostically and prognostically significant indicators of biochemical reactions in the blood serum of rats. Despite the improvement of treatment methods, mortality in the development of Acute Renal Failure (ARF) remains high, reaching 20% in obstetric and gynecological forms, 50% in drug-induced lesions, 70% after injuries and surgical interventions and 80% - 100% in multiple organ failure [1-4]. Among the outcomes of acute renal failure, the most common is recovery: complete (in 35% - 40% of cases) or partial - with a defect (in 10% - 15%). Almost as often, a lethal outcome is observed: in 40% - 45% of cases [2,3].

Acute renal failure is an acute, potentially reversible loss of the excretory function of the kidneys, manifested by rapidly increasing azotemia and severe water and electrolyte disturbances. Among more than 100 known nephrotoxins, one of the first places is occupied by drugs, mainly aminoglycoside antibiotics, the use of which in 10% - 15% of cases lead to moderate renal failure and in 1% - 2% to severe acute renal failure [5-7]. Modern methods of treating acute renal failure are aimed at eliminating the factors that caused acute vascular insufficiency or hypovolemia, the abolition of pharmaceuticals that induce acute renal failure, removing shock and replenishing the volume of circulating blood, they resort to intravenous administration of large doses of steroids, macromolecular compounds, plasma, solution albumin, saline solutions are administered intravenously [8-10]. In the absence of the effect of conservative therapy, a continuation of treatment is considered futile and they switch to dialysis treatment.

In connection with the foregoing, the search and development of drugs to improve the quality and effectiveness of conservative therapy for acute renal failure and its consequences remain relevant today.

In this investigation, the aim was to study the effect of nanoenterosorbent on acute renal failure in animals.

Material and research methods

General characteristics of experimental animals

Weight 220 grams - 350 grams, outbred laboratory 3-month-old animals of both sexes were selected for the study, and their veterinary control was carried out. The animals were divided into three main groups: group 1 - the control group, the animals which were not exposed to any effects; group 2 - an experimental model with acute renal failure; group 3 - animals in which acute renal failure was experimentally induced, and nanoenterosorbent was administered daily intragastrically at a dosage of 650 mg/kg of body weight. The results of the conducted studies on mongrel mole rats of the same age indicate that the dynamics of the volume of nanoenterosorbent hydrosols consumed depends on the concentration of particles. Hydrosol with a particle concentration of 0.002 wt.% is consumed by experimental animals in smaller quantities compared to water consumption by control animals (at $p < 0.05$) during the entire study period. Hydrosols with a particle concentration of 0.01 wt.% and 0.05 weight.% in the initial period (1 - 2 months) are consumed in large quantities compared to the water consumption of control animals (at $p < 0.05$), after which there we can see a tendency to decrease fluid intake. The entire study on the effectiveness of carbon nanoenterosorbents in an animal model of acute renal failure is divided into three stages, including stage 1 - the asses of biochemical indicators of intoxication and kidney function on day 3; stage 2 - the study of biochemical indicators of intoxication and kidney function on the 14th day; Stage 3 - the asses of biochemical indicators of intoxication and kidney function on the 21st day. At the first stage of the study, modeling of acute renal failure was carried out, for which animals were kept for 24 hours without food, then applied only once 50% aqueous glycerol solution was injected intramuscularly at a dose of 10 ml/kg of animal body weight [11,12]. Blood samples were collected from the heart under ketamine/xylazine (0.1 ml/100 g, intraperitoneal) anesthesia in non-heparinized test tubes. The serums were separated after centrifugation at 3000 rpm for 15 minutes and were stored at 20 °C for biochemical determination. Blood sampling was carried out using a three-component system for blood sampling Puth (Korea), vacuum tubes for venous blood Gel + Clot activator, 5.0 cat nom BII03016. The total biochemical parameters such as protein, urea, creatinine, MSM and IU were determined. The determination of biochemical parameters was carried out on the automatic veterinary biochemical analyzer Dimension Xpand Siemens (Germany). The level of medium-mass molecules was carried out by the spectrophotometric method according to M.Ya. Malakhov [13-15].

As a result of the experiment, nonviable animals were immediately subjected to euthanasia in the form of the ethical rule of animal euthanasia. Biological waste generated through scientific activities and experiments with living organisms and biological tissues (materials) was destroyed by special incineration facilities provided for these purposes by other available technical methods until the formation of a non-combustible inorganic residue. Waste disposal is a set of measures, the correct implementation of which is a prerequisite for the veterinary and sanitary control of the Republic of Kazakhstan.

According to Table 1, the biomaterials of 90 laboratory animals were analyzed and 360 laboratory biochemical studies were performed.

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were carried out. Statistical processing of the results was carried out using the MS Office Excel 2007 program. The mean value, mean square and standard deviation, average errors and percent differences were determined. When determining the significance of the difference between the parameters of the comparison groups using the Fisher-Student test, the changes were considered significant at $p \leq 0.05$.

Results

Analysis of the results of the first stage of the study allowed us to confirm the presence of ARF in experimental animals (Table 2).

Table 2 shows that the development of acute renal failure in experimental animals is supported by the main biochemical indicators - urea and creatinine levels.

So, in animals of the intact group, on the model of acute renal failure and the group with acute renal failure against the background of the introduction of nanoenterosorbent at a dosage of 650 mg/kg of body weight, the level of total protein did not change statistically significantly and amounted to 70.1 ± 4.53 g/l, 67.6 ± 5.5 g/l, and 69.8 ± 4.56 g/l, respectively. The urea level of healthy animals was 7.95 ± 0.45 mmol/l, and the urea level of animals with acute renal failure was statistically significantly higher ($p \leq 0.001$) and reached 113.56 ± 13.9 mmol/l. Against the background of the introduction of nanoenterosorbent at a dosage of 650 mg/kg of body weight, no statistically significant changes were found, the urea concentration was 106.38 ± 12.16 mmol/l. According to the level of creatinine, it should be noted that in healthy animals, the indicator was within the physiological range and amounted to 63.39 ± 5.38 mmol/l, while in the group with acute renal failure and acute renal failure + nanoenterosorbent, this indicator was statistically significantly higher ($p \leq 0.001$) and reached 899.67 ± 67.84 and 842.0 ± 33.29 mmol/l, respectively. The determination of creatinine in blood and urine is used to estimate the level of glomerular filtration. In the framework of this work, after the development of acute renal failure in animals, the level of urea increased by 14 times and the level of creatinine increased by 13 times, which indicates the development of severe renal dysfunction in experimental animals and the development of uremia. Analysis of the total protein level in the experimental groups in Step 1 did not reveal any statistically significant differences. Along with indicators of kidney function, an analysis of the indicator of endogenous intoxication was carried out - the level of molecules of average mass by the spectrophotometric method according to M.Ya. Malakhova. The level of molecules of average mass in healthy animals was 29.0 ± 1.3 IU, in the group with acute renal failure 61.4 ± 2.69 IU, in the group treated with Nanoenterosorbent at a dosage of 650 mg/kg of body weight - 50.5 ± 2.01 IU. Statistical analysis of data on animals allowed us to establish an excess of the level ($p \leq 0.001$) of molecules of average mass by more than 2 times, which indicates the development of enthotoxicosis in animals with acute renal failure. Analysis of the experimental animal data administered by nanoenterosorbent did not reveal any statistically significant differences in total protein, urea and creatinine. In turn, the level of medium-mass molecules when the nanoenterosorbent was taken was statistically significantly lower, indicating an advantage of a possible detoxifying effect of the nanoenterosorbent.

In the second stage of the study, the biochemical parameters of the three groups of animals were analyzed on day 14 (Figure 1). On day 14 of the experimental study, statistically, significant differences remained in animals with renal pathologies, respectively, the formation of acute renal failure occurred. On the 14th day, the level of total protein in animals with acute renal failure was 60.84 ± 4.95 g/l, in the group with acute renal failure against the background of taking nanoenterosorbent at a dosage of 650 mg/kg body weight 66.31±4.33 g/l. In animals treated with a nanoenterosorbent at a dosage of 650 mg/kg of body weight, by day 14, there were no statistically significant changes in urea and creatinine in comparison with the group with acute renal failure, but the value of the average concentration of urea and creatinine was lower, which indicates to increase the filtration capacity of the kidneys, a slight improvement in the functional state of the kidneys.

The level of the molecular average mass indicator was statistically significantly ($p \leq 0.001$) lower in animals that received nanoenterosorbent in comparison with the group with acute renal failure and amounted to 49.12 ± 2.15 IU and 40.4 ± 1.61 IU, respectively.

Thus, the results of the study indicate that the nanoenterosorbent does not improve the functional state of the kidneys by the 14th day of the experiment, but can reduce endogenous intoxication, according to the MSM indicator. Data for the 3rd stage of the study are shown in Table 3.

According to the results presented in Table 3, it can be seen that on the 21st day of the experimental study, statistically, significant differences remained in animals with kidney pathology, but there were also differences between the group, which means the formation of Chronic Renal Failure (CRF).

Table 1: Groups of studied experimental animals.

Research stages	1 group (intact), n	2 group (ARF), n	3 group (ARF + nanoenterosorbent), n
1 stage - 3 days	10	10	10
2 stage - 14 days	10	10	10
3 stage - 21 days	10	10	10
Total:	30	30	30

Table 2: Biochemical parameters of blood serum of experimental animals of the 1st stage of the study.

Name of indicator	1 group (intact), n	2 group (ARF), n	3 group (ARF + nanoenterosorbent), n
Total protein g/l	70,1 ± 4,53	67,6 ± 5,5	69,8 ± 4,56
Urea, mmol/l	7,95 ± 0,45	113,56 ± 13,9*	106,38 ± 12,16
Creatinine, mmol/l	63,39 ± 5,38	899,67 ± 67,84*	842,0 ± 33,29
Level of molecular of average mass, IU	29,0 ± 1,3	61,4 ± 2,69*	50,5 ± 2,01**

Note: *- $p \leq 0.001$ in relation to intact; ** - $p \leq 0.001$ in relation to ARF
g/L - gram per litre, mmol/ L - millimoles per liter

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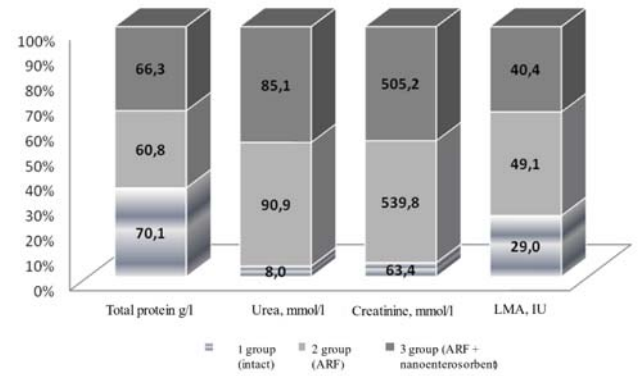

Figure 1: Biochemical parameters of blood serum of experimental animals in the 2nd stage of the study.

Table 3: Biochemical parameters of blood serum of experimental animals 3 stages of the study.

Name of indicator	1 group (intact), n	2 group (ARF), n	3 group (ARF + nanoenterosorbent), n
Total protein g/l	70,1 ± 4,53	67,60 ± 5,5	72,94 ± 4,76
Urea, mmol/l	7,95 ± 0,45	56,78 ± 6,59*	25,53 ± 2,92**
Creatinine, mmol/l	63,39 ± 5,38	359,87 ± 18,73*	168,40 ± 6,66**
Level of molecular of average mass, IU	29,0 ± 1,3	39,30 ± 1,72*	25,25 ± 1,01**

Note: *- p ≤ 0.001 in relation to intact; ** - p ≤ 0.001 in relation to ARF
g/L - gram per litre, mmol/ L - millimoles per liter, IU- International Unit

Discussion

So, in animals treated with nanoenterosorbent, by day 21, statistically, significant differences appeared in terms of uremia and intoxication. So the level of urea in the group with acute renal failure was 56.78 ± 6.59 mmol/l, and creatinine 359.87 ± 18.73 mmol/l, both indicators demonstrated the presence of renal failure. In turn, in the group of animals that received Nanoenterosorbent daily at a dosage of 650 mg/kg of body weight, these indicators were statistically significantly lower ($p \leq 0.001$) and amounted to 25.53 ± 2.92 mmol/l for urea, 168.40 for creatinine ± 6.66 mmol/l. The level of molecular average mass in this group was also statistically significantly lower ($p \leq 0.001$) and amounted to 25.25 ± 1.01 IU, which is actually a normal physiological indicator

Thus, it was found that daily intragastric administration of nanoenterosorbent at a dosage of 650 mg/kg of body weight for 21 days after the formation of acute renal failure statistically significantly ($p \leq 0.001$) reduces uremia (urea, creatinine levels) and endogenous intoxication (molecular of average mass).

According to the research results, an experimental model of acute renal failure was worked out and confirmed by laboratory data on white outbred rats, normative biochemical indicators of kidney function and MSM were obtained, the dynamics of the transition of acute renal failure to chronic renal failure against the background of acute intoxication was shown, as well as the positive effect of Nanoenterosorbent on uremia and intoxication.

The research made it possible to draw the following conclusions:

1. ARF in white outbred animals is accompanied by a statistically significant ($p \leq 0.001$) increase in the level of urea and creatinine, molecular of average mass;

2. Intragastric administration of nanoenterosorbent at a dosage of 650 mg/kg of body weight does not reduce the dynamics of development of experimental uremia, but statistically significantly ($p \leq 0.001$) reduces the concentration of molecular of average mass on the 3rd day after the formation of experimental acute renal failure;

3. Daily intragastric administration of nanoenterosorbent at a dosage of 650 mg/kg of body weight for 14 days after the formation of acute renal failure does not improve the functional state of the kidneys according to urea and creatinine, but statistically significantly ($p \leq 0.001$) reduces endogenous intoxication, according to molecular of average mass data;

4. Daily intragastric administration of nanoenterosorbent at a dosage of 650 mg/kg of body weight for 21 days after the formation of acute renal failure statistically significantly ($P \leq 0.001$) reduces uremia (urea, creatinine levels) and endogenous intoxication (level of molecular of average mass).

References

1. Chronic kidney disease and pregnancy: etiology, pathogenesis, classification, clinical picture, perinatal complications. IG Nikolskaya. Russian Bulletin of the Obstetrician-Gynecologist. 2012; 5: 21-30. Bibliography.29-30.

2. Spinal neurosurgical intervention in a patient with terminal renal failure on chronic hemodialysis / A Yu Lubnin. Anesthesiology and resuscitation. 2012; 3:S 11-14. Bibliography. 13-14 (29 titles).

3. Urosepsis in patients with chronic renal failure: risk factors, features of the clinical course and treatment tactics. M Krstic. Almanac of Clinical Medicine. 2012; 3: 28-34. Bibliography. 33-34 (26 titles).

4. Characteristics of glomerular hematuria in children / A.P. Potemkina [et al.] // Pediatric pharmacology. 2012; 3:46-50. Bibliography. 50 (19 titles).

5. Ignatova MS. Topical issues of pediatric nephrology. MS Ignatova. Nephrology. 2011; 15:1;11-16. Bibliography. 15-16 (27 titles).

6. Tussupbekova G, Yessimsiitova Z, Ablaikhanova N, A Rakhmetova. The Study of Hematological Parameters of Animals in the Application of Nanoenterosorbent Food Fiber// Journal of Pharmacy and Nutrition Sciences. 2019; 9(4): 222-228.

7. Clinical needs of nephrology in laboratory research: proc. report scientific-practical. conf. Ensuring the availability of modern clinical laboratory research: analytical capabilities, clinical needs, organizational and economic conditions. 4-6 Oct. 2011; Moscow. Clinical laboratory diagnostics. 2011; 10:12-14.

8. Kovaleva IuV, Kirichenko AA. [The renal artery resistive index is an integral marker of renal dysfunction in patients with chronic heart failure]. Vestn Rentgenol Radiol. 2012 Jul-Aug;(4):15-20. Russian. PMID: 23214025.

9. Yessimsiitova Z, Ablaikhanova N,Tussupbekova G. Efficacy of Application of Dietary Supplements in Acute Intoxication. Journal of Pharmacy and Nutrition Sciences. 2019; 9(4): 229–232.

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10. Malkoch AV. Nephropathy in celiac disease. AV Malkoch, SV Belmer. Attending physician. 2012; 8:19-21.Bibliography.21.

11. Xing R, Liu S, Yu H, Qin Y, Chen X, Li K, Li P. Protective effect of sulfated chitosan of C3 sulfation on glycerol-induced acute renal failure in rat kidney. Int J Biol Macromol. 2014 Apr;65:383-8. doi: 10.1016/j.ijbiomac.2014.01.038. Epub 2014 Feb 7. PMID: 24508919.

12. Guidelines for the experimental preclinical study of new pharmacological substances. EdRU Khabriev. Moscow: Medicine. 2005; 832.

13. Guidelines for the experimental (preclinical) study of new pharmacological substances. Moscow: Remedium. 2000; 398.

14. The choice of tactics of application and indications for the early onset of renal replacement therapy in patients with acute pancreatitis. VA Kislyakov. Nephrology and dialysis. 2010; 12:3; 197-205. Bibliography. 204 (19 titles).

15. Study of the effectiveness of enterosgel in experimental renal failure.LS Fira, IN Klishch, OM Oleshchuk, PG Likhatsky. Institute of Experimental Pathology, Oncology and Radiobiology. RE Kavetsky National Academy of Sciences of Ukraine. Kyiv. 2010.

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