

Hemodynamic Gradations With Combined Use Of Extracorporeal Detoxification Methods In Children With Renal Failure

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Abstract

Background: The objective of the study was to study the influence of the combined use of hemodialysis (HD), chemisorption (HS), and metabolic plasmapheresis (PP) for the hemodynamic and defective reduction of intoxication in children with ARF.

Methods: Investigations were performed in 63 children (at the age from 2 to 14 years old) with ARF that was developed as a result of prerenal (hypovolemia, septic shock) and renal (acute glomerulonephritis, pyelonephritis) factors. Depending on the devised detoxification methods, patients were divided into the control group (5) whom it was performed only HD-method and the control group (58) with the use of methods of gravitational surgery, such as HS, HD, and PP.

Results: General clinical presentation in all patients during admission was noted by the significance of intoxication syndrome, signs of respiratory, cardiovascular insufficiencies, in 84,2% of cases it was noted by mental confusion, in 72% of cases it was noted by anemic syndrome, in 78% of cases it was noted by hypoproteinemia and in 93% of cases it was noted by anuria. In 63 cases methods of complex treatment of children were performed once depending on the severity of the condition, a significant degree of the intoxication syndrome, and the level of changes in internal organs.

Conclusion: The influence of sorption methods of detoxification in patients with AKI has a significant advantage over the sessions mono hemodialysis. The corrective effect of complex therapy affects the restoration of organ functions, reduction of intoxication syndrome, and improvement of the clinical condition of patients.

Keywords: extracorporeal detoxification, hemodialysis, chemisorption, plasmapheresis, children, acute renal failure.

1. INTRODUCTION

Despite the improvement of the treatment methods of acute renal failure (ARF), the received results remain largely debated and require an optimal solution [1,2]. Scanty of information regarding the use of extracorporeal detoxification methods (ECD) in children with ARF is the leading position in order to study pathology in general and it has a priority level to reduce mortality. The system of regulatory mechanisms of the human body in response to the

changes of the renal functions is accompanied by the whole cascade of changes in metabolic processes that lead to hemodynamic and microcirculation disorders, disruption of detoxification properties, and disorder in electrolyte metabolism.[4,7] The leading space among pathological links of renal failure (RF) is the changes in detoxification, and hemodynamic that formed under the influence of the toxic agent (urea, creatinine) which is largely determined the duration character, and the outcome of the disease. Until the present time, it has not been solved a question regarding the effective use of the different methods of ECD depending on the forms and stages [8,10] of ARF. The methodology of individual indications for the complex use of these methods in children still remains some problems [12].

2. MATERIALS AND METHODS

Investigations were performed in 63 children (at the age from 2 to 14 years old) with ARF that was developed as a result of prerenal (hypovolemia, septic shock) and renal (acute glomerulonephritis, pyelonephritis) factors. Depending on the devised detoxification methods, patients were divided into the control group (5) whom it was performed only HD-method and control group (58) with the use of methods of gravitational surgery, such as HS, HD, and PP. The introduction of these ECD-methods has been caused by the severity of intoxication syndrome, which develops multi-organ failure (MOF). As a consequence of it, the main group of patients was divided into three subgroups, depending on the severity of the general condition and the ECD-method used: 1—a subgroup of (7)—with the use of HD and HS-methods; 2—subgroup (25)—with the use of HD and PP-methods; 3—subgroup (27)—with the use of HD, HS, and PP-methods.

We have studied parameters of central hemodynamic on Aloca apparatus (made in Japan) with determining diastolic (DBP), systolic (SBP) blood pressures, heart rate (HR); levels of urea (Ur) and creatinin (Cr) in the blood and in the urine by use of ureas method with reagents of La-Chemafirm (made in Czech Republic); levels of potassium and sodium were determined on “Microlit” apparatus (made in Hungary) with using of reagents of La-Chemafirm (made in Czech Republic); according to the levels of blood and urine creatine (Reberg’s test) it was calculated the changes of glomerular filtration rate (GFR) and tubular reabsorption (TR); ultra sound in investigation (USI) of kidneys was performed by use of “Acuson-128XP/10” apparatus (made in USA), with 3.5MHz transducer; echocardiographic method of investigation (EchoCR) was performed as a standard on «EY-405» apparatus of Hitachi firm (made in Japan) with the use of convex sensor with the frequency of 3,5 MHz; central venous pressure (CVP) was performed by the use of Valdman method.

3. RESULTS

General clinical presentation in all patients during admission was noted by the significance of intoxication syndrome, signs of respiratory, cardiovascular insufficiencies, in 84,2% of cases it was noted by mental confusion, in 72% of cases it was noted by anemic syndrome, in 78% of cases it was noted by hypoproteinemia and in 93% of cases, it was noted by anuria. In 63 cases methods of complex treatment of children were performed once depending on the severity of the condition, a significant degree of the intoxication syndrome, and the level of changes in internal organs.

The basic cause of the development of ARF in children was the generalization of infection in bronchopulmonary diseases with the development of acute pyelonephritis (22,2%) and acute glomerulonephritis (63,49%). Late treatment, latent clinical manifestation, the absence of the frank signs of renal injuries, iatrogenic situations were the reasons for the development of ARF.

The performed investigations have been determined the changes of the basic parameters of central hemodynamic in children with ARF (Table1) until ECD accompanied by the decreased results of heart rate in 8,2% in the first subgroup of the basic group, in 0,37% in the second subgroup and in 0,92% in the third subgroup relative to the analogical value in the control group. At the same time, the average index of SBP in the first subgroup was decreased by 0,27%, in 1,46% in the second subgroup, and by 14,94% in the third subgroup relative to the analogical value in the control group. The level of DBP in the first subgroup was the same as in the control group, in the second subgroup this level was decreased by 2,7%, and in the third subgroup, this level was decreased by 16,1% relative to the analogical value in the control group.

Considering the changes of the parameters (Table 2) reflecting the level of intoxication syndrome before performing ECD we could note that exactly these changes were the confirmation of this verity of the patients' condition in the groups is in the consequence of this it was carried out the distribution. On admission in patients with ARF of the first subgroup of the main group, it was determined the increased level of urea in 5,6%, in the second subgroup it was determined the increased level of urea in 82,8% and in the third subgroup it was determined the increased level of urea in 93,3% relatively to the analogical value in the control group. In one's turn, the analogical tendency was determined during the investigation of blood creatinine level, when in the first subgroup of the main group it was noted its increasing by 3,63%, in the second subgroup it was noted its increasing in 9,34%, and in the third subgroup it was noted its increasing in 13,8% from the results of the control group.

So, we could note that the indexes of the basic toxic metabolites in the control and main groups were initially increased and the range of values was predetermined the general patients' condition and the level of intoxication.

Elucidating the changes associated with the regulation of water-electrolyte metabolism we could note that in patients with ARF before performing ECD the sodium level was decreased in the first subgroup of the main group by 8,3%, in the second subgroup the sodium level was decreased in 3,6% and in the third subgroup the sodium level was decreased in 10,2% relatively to the analogical value in the control group. At the same time, potassium level was increased in 44,6% in the first subgroup, in 86,6% in the second subgroup, and in 131,1% in the third subgroup of patients relative to the analogical value in the control group.

So, it has been found that electrolyte metabolism in patients with ARF on admission was significantly disturbed and to a greater degree at the expense of the increasing potassium level which predetermined patients' condition.

Table1. The comparative characteristic of hemodynamic in patients with ARF before and after ECD (M±m).

Considering the trench of the received results of the performed treatment of patients with ARF it was carried out the analyses the data depending on the initial data.

It was obtained the significant changes (Table 1) of HR in postsorptional period in patients of the control group which was noted by the decrease in 10,22%; in the first subgroup it was decreased by 3,02%, in the second subgroup it was decreased by 13,6%, and in the third subgroup it was decreased in 9,7%. At the same time, it was determined the decreasing of this rate in 0,92% in the first subgroup, in 4,2% in the second subgroup, and in 0,36% in the third subgroup of patients relative to the analogical value in the control group.

The relative stabilization of DBP in postsorptional period in children with ARF was determined by decreasing in 14,9% in the control group, in 20% in the first subgroup, in 16,23% in the second subgroup, and in 10,8% in the third subgroup of patients relatively from the initial values. The analyses of the performed investigations have been showing the effectiveness of ECD when in the

first subgroup the level of SBP was decreased by 5,9%, in the second subgroup this level was decreased by 4,2%, and in the third group of patients, this level was decreased in 12,1% relatively to the analogical value in the control group. Changes in CVP have also had a significant character which was noted by the decreasing value in the postsorptional period in patients with ARF. In the control group after performed therapy, it was noted decreasing of CVP by 10,45%, in the first subgroup this value was decreased by 17,9%, in the second subgroup this value was decreased by 25,7% and in the third subgroup of patients, this value was decreased in 34,5%. The analysis of the comparability of the results has been determined that in the first subgroup of patients of the main group the decreasing of CVP was in 7,6%, in the second subgroup it was in 18,5%, and in the third subgroup of patients, it was in 25,9% relatively to the analogical value in the control group.

So, we could establish that in postsorptional period it was achieved the positive results of hemodynamic disorders during the use of ECD in the most severe group of patients with ARF.

Table 2. The comparative characteristic of biochemical indexes in patients with ARF before and after ECD (M±m).

The analyses of ECD-efficacious (Table 2) have been showing that in postsorptional period in patients with ARF it was significantly decreased intoxication syndrome caused by the accumulation of the toxic products in the circulated blood. The level of urea in the control group of patients with ARF was decreased after performing ECD in 24,9%, in the first subgroup this level was decreased by 58,4%, in the second subgroup this level was decreased by 67,7%, and in the third subgroup of patients, this level was decreased by 58,8%. During the comparison of the ECD effectiveness in the investigated groups, it was as curtained that the level of urea in the first subgroup of the main group patients with ARF was decreased by 41,5%, in the second subgroup this level was decreased by 21,4% and in the third subgroup of patients this level was decreased in 6,07%, relative to the analogical level in the control group.

The analyses of ECD-efficacious (Table 2) have been showing that in postsorptional period in patients with ARF it was significantly decreased intoxication syndrome caused by the accumulation of the toxic products in the circulated blood. The level of urea in the control

group of patients with ARF was decreased after performing ECD in 24,9%, in the first subgroup this level was decreased by 58,4%, in the second subgroup this level was decreased by 67,7%, and in the third subgroup of patients, this level was decreased by 58,8%. During the comparison of the ECD effectiveness in the investigated groups, it was ascertained that the level of urea in the first subgroup of the main group patients with ARF was decreased by 41,5%, in the second subgroup this level was decreased by 21,4% and in the third subgroup of patients this level was decreased in 6,07%, relative to the analogical level in the control group.

4. DISCUSSION

The most important circumstance was the decreasing level of potassium after performing ECD-methods in children with ARF. In the control group, the decreasing of this electrolyte was 26,6%, in the first subgroup the decreasing of this electrolyte was 18,18%, in the second subgroup the decreasing of this electrolyte was 69,4% and in the third subgroup of patients, the decreasing of this electrolyte was 72,1% relative to the initial results. But at the same time, the decreasing level also was reached in the first subgroup in 18,18%, in the second subgroup in 21,21%, and in the third subgroup of patients in 12,12% relative to the control levels of this electrolyte.

Consequently, the combined application of the ECD-methods was determined by the effective elimination of intoxication syndrome with sufficient elimination of the toxic metabolites from the blood circulation.

Considering the influence of the ECD-methods on the restoration of the renal functional disorders we could note that in postsorptional period the level of KF was significantly restored. So, in the control group, the level of KF was increasing dafter performing of ECD in 40,57%, in the first subgroup this level was increased by 58,34%, in the second subgroup this level was increased by 73,6%, and in the third subgroup of patients, this level was increased in 87,13% from the initial levels. During the comparisons of the effectiveness of ECD, it was noted that concerning to the findings in the control group in patients of the first subgroup of the main group with ARF the level of KF was decreased by 5,3%, in the second subgroup this level was decreased in 4,12% and in the third subgroup of patients this level was decreased in 18,32%.

The indexes of KR were distinctive in postsorptional period when in the control group restoration level of such index was 103,7%, in the first subgroup the level of this index was 131,23%, in the second subgroup the level of this index was 88,2%, and in the third subgroup, the level of this index was 58,1% relative to the initial findings. During the elucidation of the effectiveness of ECD-methods, it was determined that in the first subgroup the increasing level of KR was 15,6%, in the second subgroup the increasing level of KR was 8,32%, and in the third subgroup of patients, the increasing level of KR was the same in the comparison of the values of analogous level in the control group.

On the basis of the received results, we could establish that the combined ECD- methods are effectively used only after performing éances of HD in patients with ARF.

5. CONCLUSION:

The influence of sorption methods of detoxification in patients with AKI has a significant advantage over the sessions mono hemodialysis. The corrective effect of complex therapy affects the restoration of organ functions, reduction of intoxication syndrome, and improvement of the clinical condition of patients. There is no doubt that ECD methods have a certain focus and their application is possible in children with uncorrected conditions only by hemodialysis sessions. The developed methods showed significant positive changes in the level of metabolic exchange, reducing intoxication due to the progressive removal of products of residual metabolism, potassium, and other metabolites. Taking into account the impact on the body of each ECD technique, realizing their capabilities, attention was paid to the effectiveness of the methods in the group of the most severe patients with AKI. Thus, combined ECD methods are an integral part of the complex therapy of patients with AKI and can be recommended for the treatment of this category of patients.

According to this problem, it is known that in children with kidney failure, only one of the methods of extracorporeal detoxification has traditionally been used. Our study shows the effectiveness of the combined use of extracorporeal detoxification methods: hemodialysis, chemisorption, and plasmapheresis in children with renal insufficiency. We studied the efficiency of the application of EKD in hemodynamic indicators.

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№	Clinical sign	Groups of investigation			
		Control group HD n=5	1subgroup HD+HS n=7	2subgroup HD+HS n=26	3subgroup HD+HS+PP n=25

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№	Clinical sign	Groups of investigation				Groups of investigation			
		Before	After	Before	After	Before	After	Before	After
1	HR per minute	107,6±12,9	96,6±9,4	98,7±4,3	95,71±4,92	107,2±17,8	92,53±18,4	106,6±17,2	96,25±9,8
2	SBP mm.rt.s t.	143,2±27,9	130,0±21,6	142,8±13,8	120,8±13,8	141,1±4,9	120,5±9,9	121,8±19,6	114,1±8
3	DBP mm.rt.s t.	100,0±24,4	85,1±12,9	100,0±16,3	80,0±16,3	97,3±11,8	81,5±11,2	83,9±17,9	74,8±10,5
4	CVP mm.w.s t.	11,0±1,6	9,85±1,9	11,1±1,8	9,1±1,8	10,8±1,7	8,02±1,21	11,05±1,2	7,29±0,54

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Table1. The comparative characteristic of hemodynamic in patients with ARF before and after ECD (M±m).

Table 2. The comparative characteristic of biochemical indexes in patients with ARF before and after ECD (M±m).

		n=5		n=7		n=26		n=25	
		Before	After	Before	After	Before	After	Before	After
1	Urea mmol/l	28,5±0,1 4	21,4± 0,2	30,1± 12,8	12,5± 0,6	52,1± 6,8	16,8±8,3	55,1± 15,6	22,7± 9,3
2	Blood creatinin mkmol/l	477,9±16 ,5	331,4 ±70,1	480,3 ±187, 2	280,2 ±67,3	515,1 ±265, 2	315,3±12 7,3	525,1 ±273, 2	320,2 ±97,3
3	Sodium mmol/l	134,8±0, 6	124,8 ±0,6	133,2 ±32,2	119,5 ±44,2	156,2 ±25,8	115,2±44 ,3	174,2 ±43,2	118,3 ±31,5
4	Potassium mmol/l	4,5±0,2	3,3±0, 5	6,6±1, 2	2,7±0, 4	8,4±2, 1	2,6±0,4	10,4± 0,8	2,9±1, 3
5	KFml/min	62,1±15, 2	87,3± 14,3	58,1± 14,3	92,0± 16,3	48,2± 12,6	83,7±12, 6	38,1± 9,2	71,3± 18,5
6	KR%	37,4±13, 1	76,2± 11,2	38,1± 11,4	88,1± 12,4	44,1± 11,8	83,0±13, 2	48,2± 12,6	76,2± 12,7