

## Dynamics of Platelet Activity in 5-6-year Old Children with Scoliosis against the Background of Daily Medicinal-prophylactic Clothes' Wearing for Half a Year

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### ABSTRACT

Five-six-year old children with scoliosis were noticed to have strengthening of platelets' aggregative features against the background of typical signs of their physical development inhibition. Daily wearing of medicinal-prophylactic clothes was applied to the observed children for removal of scoliosis and thrombocytopathy signs. The dynamics of morpho-functional indices and platelet activity was traced during 6 months of its wearing by children with scoliosis. In conducted research the children with scoliosis who daily wore the author's variant of medicinal-prophylactic clothes for half a year, were found to have evidence lowering of spinal curvature, increase of strength and tolerance of body muscles, gradual indices' weakening of platelet aggregation. We can consider that daily wearing of designed medicinal-prophylactic clothes for half a year can provide removal of scoliotic phenomena and lowering of platelet activity level in children with scoliosis. It brings accountable indices nearer to control values.

**Keywords:** Children, Preschool age, Scoliosis, Platelets, Aggregation, Medicinal-prophylactic clothes.

### INTRODUCTION

Active processes of growth in a child's body are often accompanied by various morpho-functional disturbances in locomotor apparatus. Scoliosis is the most widespread of them. Its prevalence remains very high among children in Russia<sup>1,2</sup>. The presence of scoliosis in a body nearly always leads to worsening of common vitality<sup>3</sup>. It is connected with the fact that scoliosis weakens functioning of most internals what is progressively aggravated with aging<sup>4,5</sup>. It is known that presence of scoliosis worsens functioning of a child's cardiovascular system and indices of blood system<sup>6,7</sup>. It was shown earlier that children with scoliosis had thrombocytopathy which promoted worsening of microcirculation and fast increase of hypoxia in their cells<sup>8</sup>. Developed in the result of it chronic oxygen deficiency in these children's tissues progressively

disturbed anabolic processes in them and negatively influenced long-term prognosis<sup>9</sup>.

High frequency of scoliosis occurrence in children and its danger (polymorbidity is developed against its background) keep the need to continue the search of effective approaches to spinal curvature correction. Their impact on platelets' activity should be necessarily taken into consideration<sup>10</sup>. Capabilities of different impacts on a body which could weaken platelets' aggregation, were studied earlier in clinic<sup>11,12</sup> and in experiment<sup>13,14</sup>. Their effectiveness was demonstrated. Children with scoliosis were managed earlier to lower platelet activity with the help of different variants of non-pharmacological impacts<sup>15</sup>. At the same time, we should take into consideration low attachment of children to regular medicinal physical training as it should be durable enough in order to achieve

positive results at scoliosis<sup>16</sup>. So, it becomes clear that continuation of correction variants' search is really urgent. The degree of children's attachment to correcting impact and possibility of positive influence on platelets' aggregation with its help are especially important in conducted search. Such variant of medicinal impact on children's bodies can become the basis for mass prophylaxis of scoliosis progression. It can also become the background of internals' health preservation of children with already developed scoliosis<sup>15</sup>. Wearing of medicinal-prophylactic clothes (MPC) can be considered as an alternative to medicinal physical training as far as impact on scoliosis manifestations is concerned. It is very important that children's attachment to MPC is incommensurably higher than to medicinal physical training<sup>17</sup>. At that, the impact of constant MPC wearing on platelets' activity remains practically unstudied. So, it is necessary to conduct additional researches. That's why we put the following aim in our research: to estimate dynamics' evidence of platelets' aggregation in 5-6-year old children with scoliosis of I-II degree who wear MPC daily for half a year.

## MATERIALS AND METHODS

The research was conducted on children living in Central Russia (Moscow city and Moscow region). We took 34 healthy children of both sexes at the age 5-6 years (height  $123.6 \pm 1.41$  cm, body mass  $24.2 \pm 1.38$  kg), and also 39 children of both sexes of the same age with scoliosis of I-II degree (height  $118.7 \pm 0.73$  cm, body mass  $21.2 \pm 2.10$  kg) at full absence of any accompanying diseases in them. Given research was approved by local Ethics Committee of Russian State Social University on May, 14<sup>th</sup>, 2015 (record 15). Both parents of each taken into the research child gave written informed agreement on participation of their children in the research. The children themselves agreed in oral form in the presence of their parents and witnesses.

Deviation degree of spinal column in children was determined with the help of a test with pasting of special cord with lead in the field of the 7<sup>th</sup> cervical vertebra by adhesive plaster [3]. The distance from the vertical position till acanthus was found with the help of this lead. It characterized the

degree of spinal curvature in frontal plane. The value of humeral index was calculated by dividing the value of a child's humerus width from the chest side (cm) on the value of humerus width from the back side (cm)<sup>17</sup>.

The degree of spinal mobility in examined children was estimated in the course of body tilts forward, backwards and sideward. In the course of body tilts forward at straightened legs we determined the distance from the middle finger of each hand till floor surface (cm). In the case of body tilts backwards we determined the difference of line length (cm) which connected the tops of acantha of the 7<sup>th</sup> cervical vertebra and initial part of intergluteal fold. The estimation was conducted in vertical position and at the tilt backwards. Lateral spinal mobility was found in the course of distance estimation from the ends of hands' middle fingers till floor at maximum tilt sideward from standing position. The more was the given difference, the more spinal mobility in frontal plane was<sup>3</sup>.

In our research we determined the activity of the processes of lipids' peroxidation (LPO) in blood plasma which was registered according to the content of thiobarbituric acid (TBA)-active products in it with the help of a set produced by the firm "Agat-Med" (Russia) and to the level of acylhydroperoxides (AHP)<sup>18</sup>. We also registered antioxidant activity (AOA) of blood<sup>19</sup>.

We determined molecules' concentrations of P-selectin and ðÀÑÀì-1 (Bender MedSystems GmbH, Austria) by enzymoimmunoassay in plasma.

After platelets' washing and resuspending we estimated quantitatively the levels of cholesterol (CS) by enzymatic colorimetric method with the help of a set produced by the firm "Vital Diagnostikum" (Russia) and common phospholipids (CPL) according to the quantity of phosphorus contents in them<sup>20</sup>.

The evidence of intraplatelet LPO processes was determined in washed and resuspended platelets according to concentration of malon dialdehyde (MDA) in the reaction of thiobarbituric acid reduction and quantity of AHP<sup>18</sup>.

Platelets' quantity in children's capillary blood was calculated with the help of Gorjaev's box. Platelets' aggregation (AP) was estimated by visual micromethod with application of ADP ( $0.5 \times 10^{-4}$  M), collagen (dilution 1:2 of the basic suspension), thrombin (0.125 un/ml), adrenaline ( $5.0 \times 10^{-6}$  M) and hydrogen peroxide ( $7.3 \times 10^{-3}$  M) as inductors<sup>21</sup>.

All the children from experimental group were recommended to wear daily medioprophyllactic clothes, designed by the author, for scoliosis correction<sup>22</sup>. Applied MPC contained a button band and a panel, was provided by elastic straps in the upper part. Their ends were connected with both panel sides. The panel was made of nonstretching

**Table 1: The dynamics of morpho-functional and hematological characteristics of examined children with scoliosis against the background of medioprophyllactic clothes' wearing**

Parameters	A group of children with scoliosis against the background of medioprophyllactic clothes' wearing, n=39, M±m			Control, n=34, M±m
	initial state	3 months	6 months	
Deviation of spinal column from the vertical position, cm	4.5±0.29	2.9±0.37 $p_1 < 0.01$	1.46±0.14 $p_1 < 0.01$	0.20±0.004 $p < 0.01$
Value of humeral index	0.72±0.16	0.76±0.09	0.82±0.06 $p_1 < 0.05$	0.90±0.06 $p < 0.01$
Degree of spinal column mobility in the course of tilts to the left side, cm	21.6±1.24	24.5±0.30	27.8±0.27 $p_1 < 0.05$	32.8±1.45 $p < 0.01$
Degree of spinal column mobility in the course of tilts to the right side, cm	22.4±1.34	24.7±0.24	27.9±0.17 $p_1 < 0.05$	32.5±2.44 $p < 0.01$
Degree of spinal column mobility in the course of tilts backwards, cm	14.5±0.72	16.3±0.41	18.7±0.38 $p_1 < 0.05$	22.6±0.72 $p < 0.01$
AP with ADP, s	32.7±0.12	37.0±0.09 $p_1 < 0.05$	41.2±0.10 $p_1 < 0.01$	43.6±0.09 $p < 0.01$
AP with collagen, s	24.6±0.16	27.2±0.14	31.6±0.14 $p_1 < 0.01$	33.2±0.08 $p < 0.01$
AP with thrombin, s	44.2±0.11	49.4±0.09 $p_1 < 0.05$	56.3±0.15 $p_1 < 0.01$	57.2±0.13 $p < 0.01$
AP with ristomycin, s	35.8±0.16	40.5±0.09 $p_1 < 0.01$	46.7±0.12 $p_1 < 0.01$	48.4±0.11 $p < 0.01$
AP with CH <sub>202</sub> , s	36.0±0.20	40.8±0.16 $p_1 < 0.05$	47.2±0.19 $p_1 < 0.01$	49.2±0.22 $p < 0.01$
AP with epinephrine, s	84.3±0.27	89.7±0.36 $p_1 < 0.05$	95.1±0.29 $p_1 < 0.01$	97.4±0.032 $p < 0.01$
P-selectin, ng/ml	107.8±0.42	101.4±0.46	96.0±0.38 $p_1 < 0.01$	92.1±0.34 $p < 0.01$
PECAM <sup>1</sup> , ng/ml	52.7±0.34	48.6±0.30	45.3±0.29 $p_1 < 0.01$	44.2±0.23 $p < 0.01$

Conventional signs: p – signification of parameters' differences of children with scoliosis and control group.  $p_1$  – dynamics' signification of accountable indices of children with scoliosis in the course of correction in comparison with the beginning.

material, and there were pockets with inflexible plates on it in the area of blade bones' inner corner. The ends of elastic straps were fixed to both panel sides on the level of blade bones, and pockets were attached to the reverse side of the panel. The panel and the button band were supplied with sleeves, a collar, a skirt or trousers of any material. Given MPC were put on in vertical position. The arms were drawn backwards with the help of elastic straps. Inflexible plates pressed the inner part of blade bones promoting flattening of the back. The presence of elastic belt didn't hamper normal breathing and, at the same time, promoted right fit of clothes on the body. The clothes were worn during the whole day. They were put off before going to bed. In given research all the children with scoliosis were recommended daily wearing of MPC during the whole day for 6 months.

The children from experimental group were observed and examined at the beginning and in 3 and 6 months of continuous MPC wearing. The control group was observed and examined once. Received in our research results were processes by Student's (t) criterion.

## RESULTS

Already in 3 months of continuous MPC wearing the children with scoliosis had lowering of deviation degree from the vertical position on 55.2%. It additionally decreased to the end of the research till 1.46±0.14 cm. In 3 months of MPC application the children with scoliosis had value lowering of humeral index on 5.5%. To the end of the research it reached the value 0.82±0.06 (table).

Application of MPC for 3 months provided the children with scoliosis with a tendency to the increase of spinal mobility in three planes which reached the level of static signification in 6 months of the research (to the right side till 27.9±0.17 cm, to the left side till 27.8±0.27 cm, backwards till 18.7±0.38 cm).

Daily wearing of MPC was accompanied by weakening of LPO processes in plasma of children with scoliosis. So, already in 3 months of observation the quantity of AHP and TBA products in plasma lowered from 2.21±0.18 D<sub>233</sub>/1 ml and 4.38±0.24

mkmol/l (control values – 1.65±0.14 D<sub>233</sub>/1 ml and 2.99±0.22 mkmol/l, respectively) till 1.98±0.18 D<sub>233</sub>/1 ml and 3.88±0.22 mkmol/l, respectively. By the 6<sup>th</sup> month of MPC application the content of AHP in plasma of children with scoliosis reached 1.82±0.17 D<sub>233</sub>/1 ml at the decrease of TBA-active compounds in it till 3.38±0.19 mkmol/l against the background of plasma AOA strengthening from 23.6±0.34% at the beginning till 26.1±0.24% by the end of observation (control values – 27.2±0.16%).

The children with scoliosis were noted to have gradual lowering of initially increased concentrations of accountable adhesion molecules in plasma in the result of MPC wearing (table). In half a year's MPC wearing the children with scoliosis were found to have reliably lowered levels of P-selectin and PECAM-1 on 12.3% and 16.3%, respectively. These indices nearly approached the control ones.

Already in 3 months of daily MPC wearing there was detected lowering of CS level to 0.96±0.007 mkmol/10<sup>9</sup> platelets and increase of CPL to 0.66±0.007 mkmol/10<sup>9</sup> platelets (initially 1.03±0.009 mkmol/10<sup>9</sup> platelets and 0.63±0.10 mkmol/10<sup>9</sup> platelets, respectively) in platelets' membranes of children with scoliosis. Continuation of MPC application allowed additional optimization of platelets' lipid composition (CS 0.84±0.007 mkmol/10<sup>9</sup> platelets, CPL 0.71±0.010 mkmol/10<sup>9</sup> platelets). Its value nearly approached the control one (CS 0.82±0.006 mkmol/10<sup>9</sup> platelets and CPL 0.74±0.008 mkmol/10<sup>9</sup> platelets).

Initially activated LPO in platelets of children with scoliosis (AHP 3.65±0.22 D<sub>233</sub>/10<sup>9</sup> platelets, MDA 1.66±0.11 nmol/10<sup>9</sup> platelets) weakened already in 3 months of daily MPC wearing. In 6 months of constant usage of MPC the contents of LPO products in platelets of children with scoliosis additionally lowered (AHP to 3.10±0.28 D<sub>233</sub>/10<sup>9</sup> platelets and MDA to 1.39±0.10 nmol/10<sup>9</sup> platelets, respectively) and nearly approached the control level (AHP 3.00±0.22 D<sub>233</sub>/10<sup>9</sup> platelets, MDA 1.31±0.08 nmol/10<sup>9</sup> platelets, respectively).

Application of MPC to children with scoliosis conditioned positive dynamics of platelet hemostasis. Platelets' quantity in their blood didn't change and remained on the normal level. At that,

initially accelerated platelets' aggregation in children with scoliosis began to get inhibited against the background of MPC. In the result of daily MPC wearing the observed children were registered to have AP inhibition in response to all the applied inductors to the level which was near to the control one. At that, the most evident reaction of their platelets was on collagen, ADP and ristomicin; AP was less active with H<sub>2</sub>O<sub>2</sub> and thrombin. The children with scoliosis wearing MPC had maximal duration of AP appearance in response to adrenaline – 95.1±0.29 s (table).

### DISCUSSION

Any body has its own unique genetic code where all its morpho-functional characteristics and possible predisposition to various pathology are hidden<sup>22,23</sup>.

Realization of this predisposition is mostly connected with environmental impacts on a body which cause development of different somatic disturbances<sup>24,25</sup> and their progression<sup>26</sup>. All this is justly enough for scoliosis which can develop in the course of active growth of a child's body at predisposition to it under the impact of unfavorable environmental factors. Preservation of researchers' attention to it is explained by wide prevalence of scoliosis among children in the whole world<sup>1</sup>.

It is known that scoliosis development in children worsens metabolism and processes of blood circulation, thus disturbing functioning of many internals<sup>6,7</sup>. An important role in development of these dysfunctions at scoliosis belongs to disturbances' development of regular blood elements' (including platelets) microrheological features<sup>8</sup>. Weakening of antioxidant protection of a body with the increase of LPO intensity in plasma and its cells is very significant in it. The products of lipids' peroxidation of plasma and platelets cause reconstructions in platelet membranes and worsen their functions. It is aggravated by CS growth in platelets' membranes of children with scoliosis and CPL decrease, promoting membrane-pathology development<sup>27</sup>. As the conducted research showed, it declared itself by the rise of platelets' ability to aggregation in children with scoliosis. Worsening of microcirculation in the internals and formation of predispositions to

inhibition of a child's growth were consequences of thrombocytopathy in a young body<sup>32,33</sup>.

Concentrations of molecules of cellular adhesion P-selectin and PECAM-1 in blood are very sensitive indices of platelet activity. These molecules have platelet and endothelial origin. Their concentrations point at the level of their expression and, thus, at the potential of interaction between platelets and endothelium. It allows considering them markers of platelets' ability to endothelial adhesion. Besides, it's acknowledged that levels' fluctuations of P-selectin and PECAM-1 concentrations are connected with changes in platelets' ability to aggregation and disaggregation. So, the rise of these molecules' plasma level can be considered one of the mechanisms of platelet activity strengthening in vivo<sup>34</sup>.

New forms of rehabilitation and social integration of different groups of sick persons and invalids are being now looked for more and more actively in the Russian society<sup>35,36</sup>. One of new rehabilitation variants is application of MPC<sup>37,38</sup>. Its design is being conducted in accordance with the last achievements of science<sup>39,40,41</sup>. Working out of MPC for children with scoliosis becomes very significant because of wide prevalence of this pathology<sup>42,43,44</sup>. At that, additional researches are necessary for final clarification of all the aspects of these clothes' positive impact on a child's body. It was just begun in the given research.

It was found out in the research that daily MPC wearing could lower LPO intensity in blood plasma and optimize disturbance of bearing. It improved functioning of the internals, providing decrease of negative stimulating impacts on the surface of platelets which were typical for scoliosis. At that, weakening of LPO activity in platelets' membranes provided activity optimization of platelets' enzymatic systems and receptors on their surface. Found lowering of plasmatic level of P-selectin and PECAM-1 in children with scoliosis daily wearing MPC, greatly contributed to lowering of platelet activity. It also pointed at minimization of risk episodes of capillary course' blocking by platelet thrombuses and formation of optimal conditions for metabolism in tissues of children with scoliosis<sup>34</sup>.

Found AP lowering in children with scoliosis against the background of daily MPC wearing by them can be estimated as consequence of LPO intensity decrease in plasma and platelets and minimization of platelet membrane-pathway accompanied by positive dynamics of receptor and postreceptor mechanisms in platelets<sup>45</sup>. Period increase of AP development under the impact of ristomicin in children with scoliosis against the background of MPC should be connected with content lowering of von Willebrand's Factor in blood against this background<sup>46</sup>. Increase of platelets' resistance to hydrogen peroxide (what can be judged by prolongation of AP period with H<sub>2</sub>O<sub>2</sub>) points at increased activity of platelets' antioxidation system. Reached significant AP weakening against the background of daily MPC wearing by children with scoliosis is evidently connected not only with LPO weakening in platelets' membranes, but it is also caused by lowering of enzymes' activity of their thromboxane formation. It is pointed by AP inhibition with weak inductors which is realized through the mechanism of thromboxane formation<sup>47</sup>.

It becomes clear that it is possible to weaken significantly LPO processes in plasma and platelets during 6 months of MPC application by 5-6-year old

children with scoliosis. Indices of their aggregation improve till the level which can be reached with the help of daily medicinal physical training for half a year and some courses of massage by this category of children [15]. It confirms high efficiency of the tested approach to removal of scoliosis signs. Reached indices' weakening of platelet aggregation (which mostly determines rheological blood features in capillaries) is the basis for strengthening of oxygen inflow to growing tissues and organs and provision of the ground for necessary metabolism level in them.

### CONCLUSION

Five-six-year old children with scoliosis of I-II degree are characterized by strengthening of lipids' peroxidation processes in plasma and platelets. It is accompanied by increase of platelet aggregation. Daily wearing of medicinal-prophylactic clothes for 6 months significantly improves somatometric indices of children with scoliosis weakening the processes of lipids' peroxidation in plasma and platelets. Besides, application of medicinal-prophylactic clothes to children with scoliosis leads to indices' improvement of platelets' aggregative activity bringing them nearer to the control level in 6 months.

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