Dynamic of bio-geometric profile indicators of children's with functionally one ventricle posture at stage of physical rehabilitation

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Abstract

Purpose: to assess dynamic of bio-geometric profile quantitative indicators in children with functionally one ventricular at stages of physical rehabilitation.

Material: 35 patients were examined during hospital stay and when leaving hospital. Indicators were registered with the help of photo metering and program Ergotherapy.

Results: in children we registered great number of posture disorders in frontal (94.3%) and sagittal planes (97.1%). In frontal plane the angles, pointing at significant asymmetry of upper limbs in respect to horizontal plane, were increased. In sagittal plane we received angles, which pointed at presence of thoracic kyphosis and lumbar lordosis. After surgery and stationary stage of rehabilitation static changes were registered in insignificant quantity of the studied angles. After post-clinical physical rehabilitation stage we registered reduction of angles' values and their approaching to norm.

Conclusions: physical rehabilitation at stationary and port clinical stages with the help of correcting exercises positively influence on restoration of posture after surgery and its improvement in the future.

Keywords: congenital heart disease, circulation of Fontane, posture, static stereotype.

Introduction

To day in Ukraine all known in the world cardio-surgeries in cases of the heaviest congenital heart diseases (CHD) are practiced [5]. Abnormalities with functionally one ventricular (FOV) are considered to be the heaviest; for them mixing of arterial and venous blood is characteristic. That is why, study of different physical health aspects of patients and influence of surgery and physical loads on it is very relevant.

Scientists note that patients with FOV lag in physical development [3] have reduced functional potentials of respiratory system [9, 12, 19, 22] and tolerance to physical loads [11, 14, 24, 30]. As on to day the problems of physical rehabilitation of children with CHD are paid insufficient attention to. In the past century fundamental works on these problems were fulfilled by O.I. Yankelevich [7] and L.V. Petrunina [6]. In English scientific sources the quantity of works on physical health, motor functioning and sports problems in persons with CHD is much greater. Such works deepened knowledge at the account of researches of patients with different diseases, age and creation of appropriate recommendations.

The most wide-scale studies of physical loads' influence in cardio-rehabilitation programs for persons with CHD were made by J. Rhodes [26-28] – increase of peak VO_2 and maximal load for long period; P. E. Longmuir [20, 21] – long term improvement of physical fitness indicators; L. M. Bradley [10] – improvement of peak VO_2 and endurance; I. C. Balfour [8] - improvement of peak VO_2; B. Goldberg [16] – improvement of maximal power and workability, influence on peak VO_2 was absent; H. D. Ruttenberg [29], P. M. Fredriksen [13] – improvement of endurance, influence on peak VO_2 was absent.

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Study of bio-geometric profile of posture permits to find the following:

- Parameters of children's postures for working out post-surgery rehabilitation program [25];
- Parameters of static balance, which characterize the level of deviation in development children's [23] and adults [18] physical qualities;
- Correction of cardio-rehabilitation program for adults [15, 17].

But influence of physical loads on children's with CHD posture has not been studied yet. Other authors received results of dynamic of respiratory system's functional state in physical rehabilitation process [1], indicators of life quality and quantitative assessment of posture [4].

The purpose of the research: to assess dynamic of bio-geometric profile quantitative indicators in children with functionally one ventricular at stages of physical rehabilitation.

Material and methods

Participants: in the research 35 patients with CHD participated: 23 boys and 12 girls (age from 6 to 14 years). The children were hospitalized for surgery (haemo-dynamic correction) in "Scientific-practical medical center of pediatric cardiology and cardio-surgery MHP of Ukraine". After rehabilitation course 31 patients were examined (those, who fulfilled rehabilitation completely). The parents gave consent for their children's participation in the research.

Organization of the research: we used quantitative assessment of posture bio-geometric profile (photo metering with program «Ergotherapy»). It was fulfilled trice: in the day of hospitalizing, after clinical stage of rehabilitation (in day of leaving hospital) and after post-clinical stage of physical rehabilitation. Norms of angles

values were 0°, distances L_1 and L_2 shall be equal.

Statistical analysis: the materials of the research were processed in program of statistical analysis IBM SPSS 21. Mathematical processing of numerical data was fulfilled with the help of variation statistic. Analysis of quantitative indicators distribution's correspondence to the law of normal distribution was checked by Shapiro-Wilk test (W). For quantitative indicators with normal distribution we found mean value ($\bar{x}$) and mean square deviation (S). For quantitative indicators with distribution, differing from normal we found median (Me) and upper/lower quartiles (25%; 75%). For assessment of difference's significance (providing normal distribution of the results of the research) we used Student's t-test (for independent or dependent groups). For indicators with distribution, differing from normal we used Wilcoxon's criterion (for dependent groups).

Results

Among the tested patients 33 children had posture disorder in frontal plane and 34 children – in sagittal plane. According to the received average statistic results, as on the moment of hospitalizing of children with CHD angle β_1 was 1.34±0.70°; Me was (25%; 75%) 1.29 (0.67; 1.84)°. Angle β_2 (formed by line of horizon and line between acromions) was 3.10±1.60°; Me (25%; 75%) – 2.79 (2.00; 4.26)°. Angle β_3 (formed by horizon line and segment, connecting points of shoulder blades' lower angles) was 4.65±2.33°; Me (25%; 75%) – 4.32(3.04; 5.96)°. Angle β_4 (formed by line of horizon and segment, connecting head mass center and point between legs' sphirions) was 0.63±0.26° with Me (25%; 75%) – 0.60 (0.44; 0.83)°.

We did not find confident difference between L_1 and L_2 ($p>0.05$), that points at absence of confidence prevalence by quantity of curvatures to one of sides. But there was present statistically confident difference between indicators L_{bl} (*distance between radial point and center of llium crest at the side of bulge)* and L_{conc} (*distance between radial point and center of llium crest at the side of concavity)* ($p<0.001$), that is a result of scoliotic changes in posture.

In sagittal plane (at the beginning of hospital stay period) we also received angle values, differing from norm. Mean statistic value of angle α_1 (formed by vertical line and segment between head mass center and acromion) exceeded norm and was 5.86±3.55° with Me (25%; 75%) at levels 5.30 (3.65; 8.24)°. Angle α_2 (formed by vertical line's crossing the segment between acromion and infra-thoracic points and characterizing thoracic segment of backbone) was 8.27±4.31°. With it, Me (25%; 75%) values were 7.96 (5.14; 11.52)°. Angle α_3 (increase of which depends on expressiveness of thoracic kyphosis and lumbar lordosis) was 6.06±3.64° with Me (25%; 75%) – 4.93 (3.54; 8.89)°. Angle α_4 (formed by vertical line's crossing the segment between center of llium crest and trochanterica) was 7.38±4.51°. Indicators Me (25%; 75%) were at level 7.32 (3.81; 11.06)°. Output values of other angles of sagittal planes also differed from normal.

It should be noted that application of physical rehabilitation technology started before surgery and continued after it and after leaving hospital. More detail description of physical rehabilitation is given in scientific literature [2].

Analysis of experimental data showed that bio-geometric profile indicators in frontal plane (see table 1) changed at different stages of the research.

By our results (see fig. 1) we can conclude that be the moment of hospital leaving only angles β_2 ($p<0.05$) and β_4 ($p<0.01$) statistically confidently increase. Thus, mean value of angle β_2 increases by 0.40° (12.9% to 3.58°). Angle β_4 increases by 0.17° (30.0% to 0.80°). It should also be noted that reduction of angle β_3 is not statistically confident. But the value of this angle shows the possibility of certain improvement of posture under influence of physical rehabilitation. It should be considered that surgery causes traumas of chest in children.

After some period of time we registered statistically confident improvement of all angles in frontal plane ($p<0.01$) Comparing with initial data. In particular, angle β_1 reduced by 0.40° (to 0.94°). Angle β_2 decreased by 1.14° (to1.96°). Angle β_3 reduced by 2.21° (to 2.44°); angle β_4 – by 0.19° (to 0.44°). It is interesting that the greatest changes were in angle β_3 – it reduced by 47.5%. Alongside with it, angle β_1 reduced by 29.9% and angle β_2 – by 36.8%. Angle β_4 reduced by 30.2%. Statistical; indicators Me (25%; 75%) were 1.87 (1.39; 2.37)° for angle β_2 and 2.31 (1.52; 3.37)° for angle β_3.

Reduction of angles in frontal plane statistically significantly reflected only in increasing of L_{conc} to 5.84 cm ($p<0.01$). Thus, L_Δ (module of difference between L_1 and L_2) confidently reduced by 0.82 cm to 0.52 cm ($p<0.01$).

In the process of physical rehabilitation changes of angles took place also in sagittal plane (see table 2). It was found that in period of stationary stage and at leaving hospital only angles α_2 ($p<0.05$) and α_4 ($p<0.01$) changed statistically confidently. Thus, mean value of angle α_2 increased by 1.14° (3.8% to 9.41°). Angle α_4 reduced by 1.62° (22.0% to 0.80°).

In post-stationary period we registered statistically confident improvement of all angles in sagittal plane ($p<0.01$). In particular, angle α_1 reduced by 2.82°(to 3.04°). Angle α_2 decreased by 2.83° (to 5.44°). Angle α_3 decreased by 1.47° (to 4.59°) and angle α_4 – by 0.58° (to 6.80°). Angle α_5 reduced by 0.59° (to 3.76°) and angle α_6 – by 0.88° (to 2.97°). Angle α_7 reduced by 1.01° (to 2.09°).

It should be noted that angle α_1 changed most of all – it reduced by 48.1%, while angle α_2 – by 34.2%, angle α_3 – by 24.3%, angle α_4 – by 7.8%, angle α_5 – by 13.6%, angle α_6 – by 22.9% and angle α_7 – by 32.6%. Statistically significant indicators Me (25%; 75%) were 5.73 (2.88; 7.78)° for angle α_2 and 6.45 (3.23; 10.22)° for angle α_4.

Discussion

Demand in some reviewing of methodological approaches to patients' with heavy heart diseases health

Table 1. Mean statistic indicators of bio-geometric profile of children with functionally one ventricular in frontal plane at different stages of the research

Bio-geometric profile indicators of posture	In hospital (n=35)		When leaving hospital (n=35)		In post clinical period (n=31)	
	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S
β_1, °	1.34	0.70	1.38	0.80	0.94**	0.46
β_2, °	3.10	1.60	3.58*	1.16	1.96**	0.60
β_3, °	4.65	2.33	4.33	1.79	2.44**	1.16
β_4, °	0.63	0.26	080**	0.23	0.44**	0.31
L_1, cm	6.24	1.89	6.47	1.74	6.20	1.25
L_2, cm	5.76	1.65	5.89	1.57	6.01	0.93
L_{bl}, cm	6.67	1.74	6.93	1.53	6.36	1.21
$L_{conc,}$ cm	5.33	1.55	5.43	1.46	5.84**	0.93
L_Δ, cm	1.34	1.15	1.50	0.85	0.52**	0.44

Notes: β1, ° – angle, formed by vertical line and segment between head MC and vertebra C7; β2, ° –angle formed by horizontal line and segments between acromions; β3, ° –angle formed by horizontal line and segments between bottom angles of shoulder blades; β4, ° – angle formed by vertical line and segment between vertebra C7 and point between sphirions; L1 – distance between left radial point and center of left llium crest; L2 –the same to the right; Lbl – distance between radial point and center of llium crest on bulge side; Lconc – distance between radial point and center of llium crest on concave side; LΔ – module of L1 and L2 difference; * –difference between indicators is statistically significant, comparing with indicators at hospital stay period at p<0.05; ** – p<0,.1.

Table 2. Mean statistic indicators of bio-geometric profile of children with functionally one ventricular in sagittal plane at different stages of the research

Bio-geometric profile indicators of posture	In hospital (n=35)		When leaving hospital (n=35)		In post clinical period (n=31)	
	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S
α_1, °	5.86	3.55	5.79	2.84	3.04**	1.13
α_2, °	8.27	4.31	9.41*	3.77	5.44**	3.05
α_3, °	6.06	3.64	6.46	2.87	4.59**	2.22
α_4, °	7.38	4.51	5.76**	3.59	6.80**	3.92
α_5, °	4.35	2.39	4.44	1.86	3.76**	1.70
α_6, °	3.85	1.82	4.17	1.70	2.97**	1.52
α_7, °	3.10	1.94	3.33	1.62	2.09**	1.22

Notes: α_1, ° – angle, formed by vertical line and segment between head mass center (MC) and acromion; α_2, ° – angle, formed by vertical line and segment between acromion and infra-thoracic point;; α_3, ° – angle, formed by vertical line and segment between between infra-thoracic point and center of llium crest; α_4, ° – angle, formed by vertical line and segment between center of llium crest and trochanterica; α_5, ° – angle, formed by vertical line and segment between trochanterica and tibiala point; α_6, ° – angle, formed by vertical line and segment between tibiala point and Sphirion; α_7, ° – angle, formed by vertical line and segment between acromion and trochanterica; * – difference is statistically significant, comparing with indicators in stationary clinical period at p<0.05; ** – p<0.01.

protection and improvement has been recognized long before. Recent decade application of physical exercises and physical training in case of congenital heart diseases have been recognized as necessary and important therapy. Posture is one of the most important sides of patients' physical health.

The received indicators of posture bio-geometric profile point at significant prevalence of posture disorders in children with functionally one ventricular in frontal (94.3%) and sagittal (97.1%) planes.

In period of leaving hospital we registered statistically confident worsening of angles β_2, β_4, α_2. It permits to say that stationary clinical period of physical rehabilitation was rather effective. During this period a number of negative factors influenced: sternotomy; long lasted drainages; pain and stiffness; sparing regime for arm with venous catheter. All these cause worsening of posture.

Results of all physical rehabilitation course witness about reduction of backbone curvatures and improvement of posture bio-geometric profile.

The received results prove statistical data about significant prevalence of posture disorders among children with CHD. In the work of O.I. Yankelevich [12] it is noted that posture disorders were found in more than 50% of examined before hospitalizing children with CHD: scoliotic posture; slouch; scoliosis of 1st, 2nd and 3rd category. In the research of L.V. Petrunina [7] percentage of children with posture disorders was 54.7%. it resulted from congenital defect of muscular skeletal apparatus of backbone thoracic section, which usually accompanies congenital heart diseases. The author notes that scoliotic posture was detected in 36.8% of children with defect of atrial membrane, in 38.0% of children with defect of inter-ventricular membrane and in 33.4% of children with tetralogy of Fallot. Slouch was registered in 52.75%, 47.5% and 37.4% according to the mentioned groups of children.

Thus, study and consideration of posture condition, when building individual rehabilitation programs for children with CHD, is a substantiated and necessary pre-condition.

Conclusions

Among children with FOV there are many disorders of static stereotype. In the studied group of children there were disorders in frontal plane 94.3% and in sagittal – 97.1%. It is a combined result of low physical condition, a number of surgeries with sternotomy and congenital defect of muscular skeletal apparatus. Such facts condition need in application of physical rehabilitation program with special exercises, oriented on posture correction.

The received results of dynamic of posture bio-geometric profile's indicators point that application of correcting physical exercises, general and breathing exercises facilitates restoration of muscular strength and static stereotype at stationary clinical rehabilitation stage. At post clinical stage is facilitates their improvement.

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Conflict of interests

The authors declare that there is no conflict of interests.

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