

Genesis of Hypertension in Obese Children Associated with the Insulin Resistance

Zhanar Zhenisovna Nurgaliyeva¹, Lidiya Kikbaevna Khituova¹, Pakytkanym Kabdukaevna Ishuova², Gulshat Matayevna Kulniyazova³ and Svetlana Grigoriyevna Davydovich³

¹Kazakh National Medical University named after S.D.Asfendiyarov
The Republic of Kazakhstan, 050000, Almaty s., Tole-Bi Street 88

²Scientific Center of Pediatrics and Children's Surgery
The Republic of Kazakhstan, 050040, Almaty s., Al-Farabi Street 146

³The West Kazakhstan State Medical University named after Marat Ospanov
The Republic of Kazakhstan, 030012, Aktobe, Maresyev str. 68

Abstract: Obesity and the associated insulin resistance, hyperinsulinemia and a metabolic disorder, as a consequence of it, substantially contribute to the genesis of the hypertension. The influence of the insulin resistance in the 127 obese children with metabolic syndrome on the genesis of hemodynamic disorders, including the hypertension, was studied. In case of the complete metabolic syndrome the hypertension was observed in 73% of the children, at the same time in 63% of cases it was a sustained hypertension.

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1. Introduction

The excess incidence of obesity, hypertension (H) and Diabetes Mellitus (DM) [1,2] considerably contributes to the pathology of the cardiovascular system (CVS). In recent decades the risk factors stated above were combined into a so called "metabolic syndrome" (MS), which pathogenetic basis is formed by the insulin resistance (IR). According to the data of multicenter international studies the MS adult prevalence rate varies from 10 to 40% [3,4,5]. According to the data of various authors the MS child prevalence rate varies from 4% to 28,7% in general population and it is notably higher among the obese children and adolescents [6,7,8].

IR contributes to increase of the total peripheral vascular resistance (TPVR) and being accompanied by the hyperinsulinemia (HI), generates H by: increasing sodium reabsorption in the kidneys' proximal tubules followed by the hypervolemia, rise of sodium and calcium content in the vessel walls; then the sympathetic regulation intensifies, thus cardiac output, vasospasm and TPVR increase even more; the smooth muscle cell growth is simultaneously enhanced, which in turn results in the luminal occlusions [2,9].

It is found that the mentioned above predictors of the cardiovascular pathology are often detected in children and adolescents. However up to the present day the issue of the IR influence on the children's cardiovascular system pathology has been understudied. At this age there are no clinically

significant atherosclerosis, age-associated metabolic disorder, lasting bad habits, which consequences provide a framework for the cardiac pathology in adults [10,11]. The research objective is the study of the insulin resistance influence on the blood pressure indexes in obese children and adolescents.

2. Data and Methods of Research.

127 obese children (the average BMI is – $26,84 \pm 2,21$) at the age from 6 to 15 years (the average age is $11,45 \pm 0,49$ years) were inspected according to the uniform protocol, where the anthropometric data with a determination of the body mass index (BMI), HR, BP were considered, the levels of immunoreactive insulin (IRI), total cholesterol, triglycerides, lipofractions, microalbuminuria were determined. For the purpose of the carbohydrate metabolism study all examined took a standard glucose tolerance test. IR was verified in case of the hyperinsulinemia (HI) and increase of the HOMA index (HOMA-IR - Homeostasis Model Assessment of Insulin Resistance). The criteria suggested by the WHO working group (1998) [3] were used for the MS diagnosis. The MS form was determined as well. The presence of 2-3 components (including IR) indicated the partial MS, the presence of 4 and more disorders indicated the complete MS (Bolotova N.V., Averyanov A.P., Lazebnikova S.V., 2003) [12].

3. Results.

IR was identified in 64 (50,39%) examined children, at the same MS was diagnosed in 58 (45,7%) patients. The complete MS was identified in 30 (23,6%) children, the partial MS - in 28 (22,1%) ones.

Subject to the represented data the following groups are formed: 1-st – obese children without MS are 69 (54,3%); 2-nd– patients with the partial MS are 28 (22,1%); 3-d – the sick with the complete MS are 30 (23,6%).

Among the children with the complete MS the incidence of its particular components (IR, disorder of the carbohydrate metabolism and the lipid profile indexes) was identified oftener than in the group of children without MS and the one with the partial MS. Among the 30 examined children with the complete MS (4 and more symptoms) HI was determined in 73,3%, hypercholesterolemia – in 50,0%, hypertriglyceridemia – in 26,7%, the increase of a very low density lipoprotein level – in 43,3%, the reduction in a high-density lipoprotein level – in 3,3%, microalbuminuria – in 43,3% cases. The HR values within the expected range for age were identified in 56 (44,1%) obese children, the resting tachycardia was typical for the rest. The BP levels, fixed within the expected range for age were identified in 69 (54,3%) obese children, the rest had the excess BP levels. Among the children without MS H was identified in 27 (39,1%±5,9) children, among the children with the partial MS H was identified in 10 (35,7%±9,1) children, among the children with the complete MS H was identified in 22 (73,3%±8,1) ones. Accuracy of the H incidence in the 3-d group relating to the compared groups is - $p < 0,01$. The average HR values and blood pressure indexes among the children of the 3-d group exceeded the ones of the compared groups (Table 1).

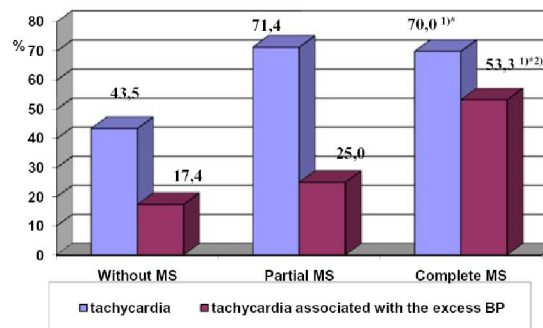
Table 1. The hemodynamic indexes of the cardiovascular system in the examined children of the compared groups (M ± m)

Index	1-st group (n=69)	2-nd group (n=28)	3-d group (n=30)
	M ± m	M ± m	M ± m
HR	87,35± 1,25	91,11± 1,95	90,33± 1,61
Level of SBP	115,64± 1,92	118,82± 3,73	127,27± 2,55*
Level of DBP	75,00 ± 1,42	79,82± 2,75	82,50± 2,01**

Note: differences between 1-st and 3-d groups are significant (* - $p < 0,001$, ** - $p < 0,01$).

The data represented at the Picture 1, emphasize the excess incidence of tachycardia in the children with IR, which may be caused by the instability of the autonomic sympathetic regulation of

both central genesis and at the receptor level. The significant incidence of tachycardia ($p < 0,01$) which exceeds almost twice the data of the children without MS and tachycardia associated with the excess BP level ($p < 0,05$), which indicate the adrenal system concerned due to HI were typical for the children with the complete MS.



Picture 1. Incidence of tachycardia and associated excess BP levels in the observed children (%)

Note: 1) - differences between 1-st and 3-d groups are significant (*- $p < 0,01$);
2) - differences between 2-nd and 3-d groups are significant (*- $p < 0,05$);

For the children with the complete MS the high BP values were fixed more often, it was of stiff nature and conformed to the sustained H. For the children with the partial MS, H the high BP levels were fixed in less per cent of cases, it might be because of the initial presentation of MS. For the children without MS the labile H was more often fixed it might be caused by the instability of the autonomic nervous system associated with the obesity (Table 2).

Table 2. Characteristics of H in the examined children of the compared groups (%)

	1-st group		2-nd group		3-d group	
	Absolut e count (n=69)	%	Absolut e count (n=28)	%	Absolut e count (n=30)	%
Labile Hypertension	13	18,8±4,7	3	10,7±1,94	3	10,0±1,8 ¹⁾ *
Sustained Hypertension	14	20,3±4,8	7	25,0±2,9	19	63,3±8,8 ¹⁾²⁾ *

Note: 1) - differences between 1-st and 3-d groups are significant(* - $p < 0,01$);2) – differences between 2-nd and 3-d groups are significant (* - $p < 0,01$).

Frequent physical variations of the HR, blood pressure indexes in the children with the complete MS are associated with IR followed by the compensatory HI.

4. Discussion.

As mentioned above IR is a pathogenetic basis for the genesis of the cardiovascular and endocrine disorder, the latter could in its turn result in the cardiovascular complications. The compensatory HI impairs the CVC functions. The CVC activity variations in the examined children have certain relations in the compared groups. The presence of tachycardia spoke for the activation of the sympathetic nervous system in the children with IR, at the same time among the children with MS tachycardia is fixed significantly oftener in the children with the partial MS - in 20 (71,4%±8,5) patients, in the children with the complete MS - in 21 (70,0%±8,4) patients compared with the children without MS (43,5%±5,9) ($p < 0,01$). It is in keeping with the data of V.V. Anikin, V.V. Savin (1999), who upon the variation pulsometry of the 110 patients suffered from angina associated with DM type 2 determined sympathicotonia in 82,7%, parasympathicotonia in 12,7% and normotonia in 4,6% only.

The average HR indexes conformed to tachycardia in all the compared groups, at the same time the average HR values in the children of the 2-nd group were just higher, it might be concerned with the instability of the metabolic processes, SNS, and relatively low average values of the pulse pressure. It should be noted that there was a significant preponderance of the incidence of tachycardia associated with H in the children of the 3-d group compared with the children of both the 1-st group (53,3%±9,1 and 17,4%±4,6 respectively; $p < 0,01$), and the 2-nd one (53,3%±9,1 and 25,0%±8,2 respectively; $p < 0,05$).

H was identified in 46,5%±4,4 obese children, which significantly exceeded the H prevalence rate among healthy children as reported by Abdrahmanov K. B. (2001) $8,9 \pm 0,9\%$ [13]. At the same time H was significantly oftener fixed in the children with the complete MS (73,3%±8,1), than in the children without MS (39,1%±5,9) ($p < 0,02$) and in the children with the partial MS (35,7%±9,1) ($p < 0,01$).

The rise of the BP levels was confirmed by the significant preponderance of the average indexes of both SBP ($p < 0,001$), and DBP ($p < 0,01$) in the children with the complete MS. The average BP indexes in the children with the partial MS held intermediate position compared with the other two groups.

To sum up the mentioned above it could be inferred that that IR with the compensatory HI resulting in alteration of the performance of many organs and systems is essential for the genesis and progression of the cardiovascular changes in the children with MS. As HI/IR progressing and blood insulin level increasing the activation of the neuro-humoral and proliferative factors resulting in its turn in the gradual BP level increasing is carried out. These changes could for a long time develop subclinically and asymptotically. Only the early IR detection, CVS targeted study, pathogenetic care of the metabolic disorder reverse the MS components, including H and the myocardial changes.

5. Conclusions.

1. Hypertension among the obese children was identified significantly oftener (54,3%±4,4 more), than in population of the non-obese children. On rising of the insulin resistance in the obese children the hypertension incidence increases up to 73,3%±8,1.

2. The early diagnosis of the insulin resistance associated with the children's obesity predetermines the timely prevention of the cardiovascular system's disorder in the future.

Corresponding Author:

Dr.Nurgaliyeva
Kazakh National Medical University named after S.D. Asfendiyarov, Tole-Bi Street 88,
050000, Almaty s., The Republic of Kazakhstan.

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