

Sympathoadrenal System Activity of Various Puberty Stages Boys

Alevtina V. Krylova, Tatyana A. Anikina, Alexey A. Zverev,
Marcel M. Zayneev and Timur L. Zefirov
Kazan Federal University, Kremliovskaya St., 18, 420008 Kazan, Russian Federation

Abstract: The catecholamin egestion dynamics analysis and DOFA for teenagers of different sexual maturity level and hormonal and media link becoming of the Sympathoadrenal System (SAS) in the course of boys puberty is carried out. Researches showed that SAS activity for teenagers in the course of puberty changes undulantly. The intensive increase of adrenaline egestion is revealed for boys of 3 puberty stages, the maximal increase of noradrenaline is noted for boys of 4th Puberty Stage (PS) then intensively decreases on 5th PS. Increase in dopamine and DOFA egestion reflect increase of reserve abilities of SAS on 5th puberty stage. Formation of SAS hormonal link for teenage boys happens earlier than that of the medial link: increase of SAS hormonal link activity is noted for boys on 1-2 PS and decreases on 3-4 PS where activity of SAS medial link is higher. On 5th PS the relative stability of all studied parameters which size during this period comes nearer to definitive level reflecting the relative SAS maturity for boys and particular degree of SAS formation processes completeness within the studied age range takes place.

Key words: Sympathoadrenal system, catecholamins, DOFA, puberty stages, maturity

INTRODUCTION

Sympathoadrenal system is the leading link in mechanisms of organism adaptation to environment factor influence, sharing the neuro and humoral regulation of all body functions. The greatest activity of SAS is revealed during the period of intensive puberty processes and interfaced to neuro-endocrinal reorganization of teenage organism. Terms of puberty have considerable individual boundaries as a result, teenagers of one calendar age have different level of sexual (biological) maturity. In a number of works (Dudnikova and Nesterova, 2011; Krylova and Biktemirova, 2014; Krylova, 2005) dependence of Catecholamins (CA) egestion is indicated for age and puberty, the maximal activity of SAS during the pubertal period is stated. Nevertheless, the data characterizing stage-by-stage formation of SAS for teenagers during puberty did not find reflection in literature; this SAS formation is not uniform and very specific. The objective is to study sympathoadrenal system activity change for boys of different puberty stages.

MATERIALS AND METHODS

For the most part healthy boys at the age of 11-16 years, pupils of comprehensive school of the Kazan city were examined. The total of the examined teenagers made 146 people. Puberty of teenagers was estimated by

technique of D. Tanner. For SAS condition assessment we determined the level of Catecholamins (CA) egestion: Adrenaline (A), Noradrenaline (NA), Dofamine (DA) and their predecessor-Dioxyphenyl Alanine (DOFA). Catecholamins and DOFA in batchwise morning urine determined by Fluorimetric Method by E.Sh. Matliny in modification by Menshikova (1987). Statistical processing of research results is carried out with use of intrasystem parametrical and correlation analysis method of the studied indexes interrelations was held. For reliability assessment of distinctions reference values of student criterion were used.

RESULTS AND DISCUSSION

For the purpose of SAS functional condition assessment for teenage boys of 11-16 years the analysis of Catecholamins (CA) egestion was carried out: Adrenaline (A), Noradrenalinum (NA), Dofaminum (DA) and DOFA (D) in state of quiet wakefulness on different puberty stages.

The absolute value of CA egestion, the relative size (on 1 kg of body weight) and ratios of catecholamins and DOFA on every PS were analyzed.

Our observation showed that A egestion for boys on different puberty stages changes multi-directionally (Table 1 and Fig. 1). The periods of egestion increase are replaced by the periods of its decrease and some stabilization of indexes. Reliable increase of A egestion is

Table 1: Indexes of catecholamins and DOFA egestion for boys on 1-5 puberty stages (M±m: mg min⁻¹)

Stage of puberty	Adrenalin	Noradrenaline	Dopamine	DOPA
1	4.91±0.19	13.02±0.28	109.07±7.650	32.56±1.24
2	6.86±0.22*	16.20±1.00*	115.67±6.390	37.60±1.23*
3	10.05±0.33*	20.20±1.16*	150.84±8.110*	42.47±2.12
4	8.20±0.47*	26.99±1.37*	167.89±8.630	48.78±2.01
5	5.97±0.32*	20.05±1.32*	225.73±10.32*	66.97±2.14*

*Distinctions are true for the previous puberty stage ($p \leq 0.05$)

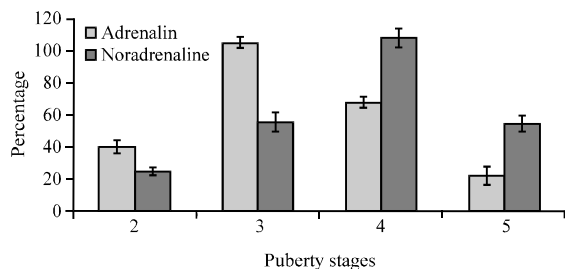


Fig. 1: Increase of adrenaline and noradrenaline in comparison to the 1st puberty stage (%)

observed from 1 to 2 PS (increase makes 39.72%, $p < 0.01$) and from 2-3 PS (increase 46.50%, $p < 0.01$). This is the most significant increase in A egestion within the studied age range. In the subsequent groups decrease of egestion is noted from 3-5 PS the A egestion decreases by 37.51% ($p < 0.01$). Thus, the maximal size of A egestion is revealed for boys of 3rd PS.

Dynamics of NA egestion has undulant character (Table 1 and Fig. 1). The NA egestion from 1-4 PS increases more than twice, reaching for boys of 4 PS a maximum level (increase makes 107.30%, $p < 0.01$), then intensively decreases on 5 PS (by 34.61%, $p < 0.01$). The fact draws attention that the A egestion reaches the maximal value on 3 PS, NA egestion only on 4 PS.

The DA egestion increase for boys from 1-5 PS makes 107.09% ($p < 0.01$), i.e., the DA egestion for the studied period increases twofold. In all age groups, starting from 3 PS, DA egestion level is higher, than for boys of 1 PS. This distinction increases with age (Table 1 and Fig. 2). Change of DA egestion also happens non-uniformly. The most intensive increase is revealed from 2 to 3 PS (37.41%, $p < 0.01$) and from 4 to 5 PS (31.21%, $p < 0.01$). For school students of 5 PS the DA egestion reaches definitive level.

DOFA egestion as well as DA, increases with age. On 2 PS the DOFA egestion is higher, than for boys of 1 PS (Tab 1, Fig. 2). It should be noted that the increase in DOFA egestion for boys of 1-4 PS occurs rather evenly, the egestion increase between PS 11-14% averages is noted. DOFA egestion increases more on 4 to 5 PS (increase of 35.71%) where it reaches the maximal value. It

Table 2: Indexes of catecholamins and DOFA egestion on 1 kg of body weight for boys of 1-5 puberty stages (M±m: ng min⁻¹ kg⁻¹)

PS	Adrenalin	Noradrenaline	Dopamine	DOPA
1	0.13±0.01	0.36±0.02	3.04±0.43	0.91±0.06
2	0.17±0.01*	0.39±0.02	2.78±0.54	0.90±0.07
3	0.22±0.01*	0.43±0.02	3.27±0.93	0.92±0.10
4	0.16±0.01*	0.52±0.02*	3.21±0.41	0.93±0.08
5	0.09±0.01*	0.31±0.04*	3.47±0.59	1.03±0.07

*Distinctions are true for the previous puberty stage ($p \leq 0.05$)

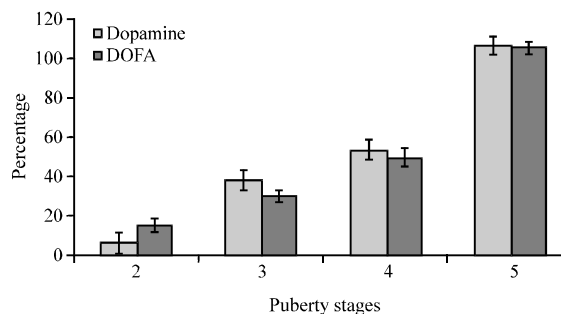


Fig. 2: Increase of Dopamine and DOFA for 1 puberty stage (%)

is remarkable that the intensive increase in DOFA falls on the period of decrease in A and NA egestion, confirming DOFA role as catecholamin predecessor.

In our researches the relative size of CA and DOFA egestion calculated on 1 kg of body weight was also analyzed (Table 2). The analysis of the relative values allows to estimate specific features of activity and reserve opportunities of SAS and to level influence of the anthropometric parameters considerably differing for teenagers with different PS on SAS indicators.

According to our data the intensive increase in the relative values of A egestion is noted on 1-3 PS on 5 PS it authentically decreases. The relative value of NA egestion also changes undulantly, reaching the maximal value for boys of 4 PS on 5 PS decrease is noted ($p < 0.05$). It should be noted that the relative size of A egestion for boys on 5 PS is lower, than for boys of 1 PS whereas on absolute values of A egestion distinctions in their level did not show. The absolute value of NA egestion for boys of 5 PS is much higher, than on 1 PS which is not traced in dynamics of the relative egestion values. In A and DOFA egestion on 1 kg of body weight the same orientation as in dynamics of absolute measures is revealed: the maximal values of egestion are present for senior school students.

The observed tendency is explained by decrease in absolute values of CA and DOFA egestion taking place against the considerable increase of teenage boys body weight.

Analyzing the ratio of CA and DOFA egestion, we studied change of the following coefficients:

Table 3: Ratio of catecholamins and DOFA for boys of 1-5 puberty stages

Stage of puberty	A+NA+DA	A+NA	NA/DA	NA/A
	DOFA	DA		
1	3.89	0.16	0.12	2.66
2	3.70	0.20	0.14	2.36
3	4.26	0.20	0.13	2.01
4	4.16	0.21	0.16	3.29
5	3.75	0.12	0.09	3.35

A+NA+DA/DOFA, A+NA/DA, NA/DA, NA/A. According to the standard representations, these coefficients indirectly reflect processes of CA formation dynamics: the coefficient of A+NA+DA/DOFA reflects accumulation of DOFA, coefficients of A+NA/DA of NA/DA-transition of DA to NA. Decrease in the first coefficient and increase in the second is the indicator of SAS reserve opportunities increase reflecting accumulation of DOFA and the reinforced transition of DA to NA. The coefficient of NA/A allows to judge on condition links of SAS. The increase in NA/A ratio signifies the increase of medial link activity, decrease of SAS hormonal link priority (Table 3).

According to our data the greatest value of A+NA+DA/DOFA coefficient is observed for boys on 3 and 4 PS and makes 4.26 and 4.16, respectively. In other age groups it is much lower and makes only 3.75 for boys on 5 PS. Distinction of indexes in 1 and 2 PS school student groups is not great and on 5 PS the size of this coefficient is almost stable. The considerable size of A+NA+DA/DOFA coefficient revealed for boys on 3-4 PS signifies probably of reduced DOFA accumulation for these school students, therefore, it is lower in comparison with other age groups and SAS reserve opportunities.

The analysis of A+NA/DA I of NA/DA ratios for boys on 1-5 PS shows that the size of these coefficients gradually grows from 1-3-4 PS, reflecting intensive a and NA formation, the increase in activity of SAS links and then decreases on 5 PS.

It is natural that the maximal value of these coefficients is noted during the same age periods where the maximal A and NA egestion values were observed.

The analysis of NA/A coefficient change for school students depending on age is of special interest. According to our data the lowest values of NA/A coefficient are observed for boys on 1-3 PS with a minimum index-on 3 PS (2.01) which corresponds to the A egestion maximal period and the greatest activity of SAS hormonal link. For boys on 4-5 PS the ratio of NA/A is much higher (3.29-3.35) which reflects increase in activity of its medial link. Observed dynamics probably signifies about non-simultaneous development of SAS links, confirming the fact of hormonal link earlier formation.

Thus, increase of SAS hormonal link activity is noted for boys on 1-2 PS and decreases on 3-4 PS where activity of SAS medial link is higher. On 5th PS the relative stability of all studied parameters which size during this period comes nearer to definitive level reflecting the relative SAS maturity for boys and particular degree of SAS formation processes completeness within the studied age range takes place. The period 3-4 PS is nodal, critical in development of SAS. The SAS hormonal link is formed before the medial.

It is well-known that the correlation analysis method characterizes degree of close communications between the analyzed indicators. It is successfully applied in physiological researches in assessment of the various functional condition indexes depending on age or for various organism conditions. SAS indexes interrelations dynamics studying helps to find out system functionality, to isolate SAS separate links role in adaptive reactions to revolting influences.

In literature two correlation types are noted: "rigid" and "flexible". The first reflect rigid determinacy of components. Such correlation nature has the constraining impact on index dynamics; at the same time it is a necessary condition for protection against over-straining and system uneconomical functioning. The second are characterized as variables, strengthening or easing of which depends on state and requirements of the organism.

The coefficient of correlation/g/is the abstract number ranging from 1 to +1. The stronger the correlation between signs, the higher is the coefficient. At positive correlation when great values of one sign correspond to great values of another, the correlation coefficient gets a positive sign (+) and ranges from 0 to +1. At the negative correlation when great values of one sign correspond to smaller value of another, the correlation coefficient is followed by the negative (-) sign and ranges from 0 to -1.

In our researches the SAS indexes interrelations analysis was carried out (A, NA and DOFA). According to our SAS indexes correlation data for teenagers are dynamic. For boys of 1-2 and 5 PS strong correlations of A-NA ($r = +0.85$), NA-DA ($r = +0.76$), DA-DOFA ($r = +0.72$), A-DA ($r = +0.81$), NA-DOFA ($r = +0.71$) are noted, the CA reflecting all bio-synthesis link. For boys of 3-4 PS only correlations of A-NA ($r = 0.70$) and A-DA ($r = 0.68$) remain. Perhaps, easing of CA and DOFA anchoring strength reflects the relative decrease in SAS reserve opportunities for these puberty stages.

- For boys of the studied age the greatest increase range in adrenaline egestion is observed from 1-2 and from 2-3 puberty stages. The maximal size of egestion is revealed for boys on 3 PS

- Noradrenalinum egestion for boys reaches the maximal values on 4 stages and intensively decreases on 5 puberty stages
- Change of Dofaminum egestion also happens non-uniformly. The most intensive increase is revealed from 2-3 and from 4-5 puberty stages. For school students of 5 PS the DA egestion reaches definitive level
- The increase in DOFA egestion for boys on 1-4 PS occurs rather evenly. Egestion increases from 4-5 PS, reaching the maximal value
- For boys of 3-4 puberty stages the significant increase in A+NA+DA/DOFA coefficient is revealed which signifies the decrease in DOFA accumulation for school students and lower in comparison with other age groups, reserve opportunities of sympathoadrenal system

CONCLUSION

Results of our researches showed that for boys of 1-2 PS SAS hormonal link is prevailing. On 3-4 PS the role of medial link increases, reserve opportunities of SAS decrease. Formation of SAS hormonal link for teenage boys happens earlier, than that of the medial link: on 5 PS the priority of medial link against increase of SAS reserve opportunities is noted. The quantity and durability of SAS indexes correlations considerably change on observed onto-genesis link. Nevertheless, nature of correlation dynamics in our opinion is very

specific and quite natural which allows to reveal value and interference of separate parameters and links on different stages of SAS system formation.

ACKNOWLEDGEMENT

The study is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

REFERENCES

- Dudnikova, E.V. and E.V. Nesterova, 2011. Role of SAS in Pathogenesis of Child Acid-Related Diseases. In: Treatment and Prophylaxis, Dudnikova, E.V. and E.V. Nesterova (Eds.). SAS., USA., pp: 26-30.
- Krylova, A.V. and R.G. Biktemirova, 2014. Change of SAS Activity for Teenagers on Different Puberty Stages. In: IV Congress of Physiologists of the CIS, Krylova, A.V. and R.G. Biktemirova (Eds.), Publishing House Quality, Sochi, Moscow, pp: 186.
- Krylova, A.V., 2005. Adaptive reactions of cardiovascular and sympathoadrenal system of teenagers on different stages of puberty. Proceedings of the Scientific Works of 1st Congress of Physiologists of the CIS, September 19-23, 2005, Sochi, Dagomys, pp: 152-153.
- Menshikova, V.V., 1987. Laboratory Research Techniques in Clinic. Medicine Press, Moscow, Pages: 368.