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PECULIARITIES OF FUNCTIONAL HEMISPHERIC ASYMMETRY FORMATION IN CHILDREN AND ADOLESCENTS WITH HYPERTENSION

Objective: Peculiarities and age dynamics of hemispheric asymmetry investigation in children and adolescents with hypertension. Materials and methods: 196 children and adolescents aged 10 to 17 years (15,0 ± 1,4), including 98 patients with arterial hypertension (AH) (15,1 ± 1,5) and 98 healthy children of the control group (14,9 ± 1,3). The number of boys in the comparison group and the main group of patients with AH was respectively 60 (61.2%) and 59 (60.2%), girls - 37 (37.8%) and 39 (39.8%). **Results**: The majority of children and adolescents with hypertension sensorimotor asymmetry differed by low intensity, indicating a decline in the dominance of the left hemisphere. Accumulation of ambi- and left lateral features traced mainly in motor (53.6%) and auditory (60.2%) system, while asymmetry in the visual analyzer did not differ from the control group. Differences in the degree of hemispheric asymmetry increases in the ontogeny compared to control group. **Conclusions:** Identification of specificity hemispheric interaction in patients with hypertension (low asymmetry and its weak performance in ontogeny) can be considered not only as a pathological consequence of hypertension, but also as a compensatory mechanism for the redistribution of loads to the right hemisphere in terms of the functional deficit of the left hemisphere. It can be assumed that the rear parts of the brain may play a significant role in the processes of adaptation and compensation of occurring disorders in hypertension.

Keywords: functional brain asymmetry, hypertension, ontogeny, children and adolescents.

Feasibility

Disorders of hemispheric interaction remain a poorly studied domain of somatic pathology, including hemispheric interaction in patients with arterial hypertension (AH). AH ranks high among cardiovascular diseases in adults, but its root causes are based on childhood and adolescence (1). The brain is known to be a target organ damaged the earliest by AH [2-4]. There is current evidence of a link between manifestation of hemispheric asymmetry and condition of adaptive regulatory systems [5-7]. In this connection, several authors consider hemispheric asymmetry as one of the cardiovascular disorders, including arterial hypertension, driving mechanisms [8-10]. Hemispheric interaction alteration associated with the right hemisphere domination in AH was observed in children (11) and adults (8). These data made possible to consider this shift as one of the key factors of AH pathogenesis. Nevertheless, on the currently available information basis, it is impossible to conclude whether these alterations in hemispheric asymmetry are present in patients from the beginning, or appear at a later stage as arterial hypertension develops. by Research of the development of functional hemispheric asymmetry at early stages of arterial hypertension in childhood and adolescence may facilitate to answer this question. However, there are scarce publications in this area [12-13].

In this connection, the purpose of our study was to identify developmental dynamics and age-related features of hemispheric asymmetry in children and adolescents with arterial hypertension.

Methods

Study design.

A control group study with no interference in clinical practice performed. The study included patients with AH (with existing outcome), who formed the main group, and practically healthy children and adolescents included into the control group. Differences in functional hemispheric asymmetry of the main and control group studied. The study based on cross section method.

Compliance criteria

Children and adolescents were included into the main group based on clinical and instrumental criteria, in accordance with the contemporary classification developed by expert group of All-Russian Research Society of Cardiologists and Association of Children's Cardiologists of Russia, which was approved in 2003 (14). All patients with arterial hypertension have undergone differential diagnosis on compulsory basis to identify cases of symptomatic arterial hypertension. If the latter confirmed, the child or adolescent excluded from the main group. Other criteria for selection of adolescents into the main group involved age and gender, which had to be appropriate to the main group, as well as absence of acute pathology, aggravation of chronic sites of infections during the study, and absence of chronic diseases and genetic predisposition to arterial hypertension. Another mandatory condition was to obtain informed consent of the child and parent for participation in the study.

Conditions of study

Patients of the main group studied at outpatient clinic of Federal State Budgetary Research Institution "Scientific Centre of Family Health and Human Reproduction Problems". The control group formed randomly among students of Irkutsk city Municipal Secondary Schools No. 39 and 44, and Municipal Autonomous Educational Institution "Lyceum of Irkutsk State

University". All participating children and adolescents informed about the purpose of the study, and they confirmed their correct understanding of the purpose.

Duration of study

The entire duration of study amounted to three years. Tests to examine an individual child or adolescent lasted for 40 to 55 minutes. Testing procedures in both main and control group conducted before noon (10-12 hr AM).

Study outcome

Main outcome of the study was identification of the deviation in development of functional hemispheric asymmetry in children and adolescents with AH.

Recording methods outcome

Methods used to analyze the condition of sensorimotor hemispheric asymmetry in children and adolescents: evaluation of hand asymmetry by self-assessment test based on Annet's [15] questionnaire, motor tests to determine the dominant hand, and tapping-test (measurement of the maximum rate of hand motions). Tests performed with psycho-physiological hardware and software complex "Functional asymmetries" (by LLC Research and Methodology Center "Analytic", Omsk). Hand asymmetry factor was calculated based on the formula: **Kdom = (Er – El) / (Er + El + Eo) x 100,** where : **Er –** number of events indicating domination of right hand**, El – left and Eo –** no domination of either hand is observed [16].

Functional asymmetry was determined through a set of tests, including tests to identify the dominant eye (Rosenbach test, "terrestrial telescope" and "aiming" tests) and dominant ear ("whisper", "clock beating", and "telephone" tests [17]. A score-based grading system used to assess the extent of asymmetry, which enabled to rank the children by the manifestation degree of functional asymmetry. Maximum score was 5 (for right-handed) and minimum score - 0 (for left-handed).

Ethics expert review

The protocol of study was approved by local ethics committee (Committee on Biomedical Ethics of "Scientific Centre of Family Health and Human Reproduction Problems", Minutes No.7 dated 12.09.2012)

Statistical processing of data

Data statistical analysis made with Statistica 6.1 package (StatSoft, USA). Methods of parametric and non-parametric statistics used: Student's t-criterion, Fischer, Levin, Tyuki F-criterion for samples of equal and non-equal scope. Differences in the indicator of comparison (average value, variance) considered significant if changes detected by any of the indicators. If differences in two criteria found simultaneously, Tyuki's compensation factor used. Differences in percentage or relative values compared with use of Z-criterion and Fischer's method of angular transformation of selected fractions [18-20]. The required size of random non-repeated sample given the known size of general combination and known variance of the analyzed attribute was determined with formula: $n = \underline{t^2 x N x S^2} / \Delta x x N + t^2 x S^2$

where:

n – scope of sample totality;

N – scope of general totality;

S^2 – sample variance;

Δx - maximum error.

The following parameters may be accepted in the study to determine mean accuracy - $\Delta x \approx 0.1$-0.3 (10-30%); t - probability indicator (1.96 for 95% confidence interval – used for majority of studies (21). Values of t = 1.96; Δx=10% are adopted. Therefore, for general totality of 50,920 (children and adolescents aged 10-17 in Irkutsk city) sample size equals to 96. For general totality of 355 (Irkutsk city children and adolescents with AH aged 10-17), sufficient sample size equals to 76. Real samples consisted of 98 patients with AH and 98 practically healthy children and adolescents in control group. Total sample size amounted to 196.

Results

Study participants

The study scheme was based on single-stage testing of the condition of functional hemispheric asymmetry in 196 school students of Irkutsk city aged 10 to 17 (average age 15.0±1.4). These included 98 (average age 15.1±1.5) diagnosed with arterial hypertension, who were included into the main group, 59 boys (60.2%) and 39 girls (39.8%). Control group composed of 98 practically healthy children and adolescents of gender and age compatible to those of members of the main group: average age in the group amounted to 14.9±1.3, including 60 boys (61.2%) and 37 girls. (37.8%). All tested children classified into three age subgroups, which correspond to early, middle and late adolescence (22-23). The first subgroup consisted of children aged 10-12 years, the second group -13-15 years and the third group - 16-18 years. The lower limit of the age range – 10-12 years coincided with the start of AH development and transition to early adolescence, while the upper limit - 16-18 years coincided with the end of adolescent age.

Results

Key results of the study

Particular distribution of lateral features enabled their grouping by different hand asymmetry types (Table 1). Right lateral features were dominant in the control group: 60.8% of children received 4-5 points based on hand tests. Patients with AH demonstrated symmetrical profile of asymmetry: 49.4% scored 2-3 points. The number of left-handed members in two groups was virtually equal, and they spread uniformly across the groups (4.2% and 3.8%). Statistically significant differences ($p = 0.031$ and $p = 0.036$) were found by domination of right lateral or symmetrical features between the main group and control group. Mean value of hand asymmetry in the main group was low, being equal to 33. Meanwhile in the control group the same value amounted to 50 ($p = 0.047$). Dominant right foot was determined in 70.1% children and adolescents of the control group and in 51% of patients of the main group (significance of difference $p = 0.002$). On the contrary, dominant left foot occurred more frequently in the main group than in the control group ($p = 0.008$).

In relation to auditory system, patients with AH had predominantly left type of lateralization: number of individuals with dominant left ear reached 42.8% vs. 26.8% in the control group ($p = 0.008$) (Table 2). Right ear was dominant in only 39.8% of children and adolescents with arterial hypertension. Meanwhile, control group demonstrated evident dominance of the right ear at 63.9% ($p < 0.001$).

Hemispheric asymmetry in the vision system in children and adolescents with AH did not reveal any considerable differences with the control group, which is different to hand and auditory asymmetry. Distribution pattern of individuals with different types of vision asymmetry was virtually identical in the two groups, and no significant distinctions detected (Table.3).

Consolidated data on sensorimotor asymmetry obtained in the course of analysis of perceptive and motor asymmetries confirmed the regularities in formation of lateralization in children and adolescents with AH. The difference between data variance in the control group and main group was insignificant ($F=1,117$, $p=0,586$), however, asymmetry expressed in score points was different: in the main group- 4.8±1.4 and in control group – 6.4±1.4 ($\chi2 =50.6$, $p < 0.001$). Accordingly, in the main group of patients with AH, the process of sensorimotor lateralization demonstrated low development of hemispheric asymmetry. This also confirmed by specificity in ontogenetic development of functional hemispheric asymmetry in children and adolescents with AH, as shown in Table 4.

No significant deviations in lateral preferences were found between the main and control group within the first subgroup (10-12 years old), i.e. patients with AH and healthy children did not differ by the extent of hemispheric asymmetry development. In the second subgroup (13-15 years old), the dynamics of asymmetry development was different. In control group, asymmetry manifestation continued to increase, while in patients with AH it remained virtually unchanged. Due to this, the spread between features of hand and sensorimotor lateralization between main and control groups reached the level of high statistical significance ($p<0.01$; $p< 0.001$). Boys with AH revealed more sustained differences in hemispheric asymmetry features, while girls demonstrated a combination of significant differences in hand asymmetry and lack of significance in sensorimotor asymmetry.

In the third subgroup (16-17 years old), differences in manifestation of hemispheric asymmetry between patients with AH and healthy adolescents continued to increase. This differentiation based on different development strategies of hemispheric asymmetry in children and adolescents of the main and control groups. In particular, members of control group demonstrated continued progressive lateralization of functions. In patients with AH, the process of lateral preferences developing targeted on asymmetry stabilizing at a relatively low level of manifestation. This explains further continued growth of difference in asymmetry features between the main and control group along the age line.

Discussion

Change of auditory dominance in more than one-half of tested children and adolescents with AH and considerable decline of the right hand coefficient may indicate the chronic deterioration of the functional condition of frontotemporal areas in the left hemisphere, in response to pathological impact of arterial hypertension. It is apparent that absence of deviations in development of visual asymmetry in patients with AH indicates at relatively good preservation of rear parts of the brain in the development process of arterial hypertension. We can assume that rear parts of the brain may play a significant role in the processes of adaptation and compensation of occurring disorders in hypertension.

The discovered specific features of hemispheric interaction in patients with AH caused by low development of asymmetry can be considered not only as a pathological consequence of hypertension, but also as a compensatory mechanism for the redistribution of loads to the right hemisphere in terms of the functional deficit of the left hemisphere. A similar effect is observed in adult patients, when aggravation of circulation disorders and associated cortical neurodynamics during the development of arterial hypertension weakens the left hemisphere domination and increases the right hemisphere domination [10].

Disturbance of normal development of hemispheric asymmetry in patients with AH inevitably caused instability of asymmetry and cognitive functions high liability. Assessment of lateral preferences profile in ontogeny, which reflects the development level of spatial and functional organization of brain systems, yields an opportunity to acquire deeper understanding of developmental features of cognitive functions [24,25]. In particular, low domination of left hemisphere in ontogeny and its association with gradual decline of IQ proved [26], while accumulation of left and symmetric lateral features in children and adolescents deteriorates their learning abilities [27]. Accordingly, alteration of hemispheric functional sensorimotor asymmetry and reconfiguration of hemispheric interaction in patients with arterial hypertension should be consider as an element of the pathological system in progress.

Disturbance of normal regularities in development of lateral organization profile in patients with AH enables to consider the disintegration of interaction between brain structures as the base mechanism of systemic transformation , which cause the development of arterial hypertension.

Of high importance is the fact the according to existing publications [28], left hemisphere domination in absence of pathology corresponds to higher efficiency of adaptive self-regulation mechanisms, while increased functional activity of the right hemisphere reduces their efficiency. This feature accounts for the specificity of hemispheric interaction asymmetry development in children and adolescents with AH.

Conclusion

In majority of children and adolescents with hypertension, sensorimotor asymmetry was low, associated with accumulation of ambi- and left lateral features, which manifested mainly in motor and auditory system. This is an evident sign of the decline of left hemisphere's domination in these systems in patients with AH. Alterations in development of functional hemispheric asymmetry in the course of ontogeny in patients with AH were manifested in the form of higher mixed lateralization (high number of left lateral features) and reduced dynamics of lateral preferences, which progressed significantly with age in the control group. The discovered specificity of functional hemispheric asymmetry and transformation of hemispheric interaction in patients with AH may consider both as development of a pathological system and as processes of compensation and adaptation targeted to overcome the existing disorder.

REFERENCES

1. Leont'eva I.V. *Lektsii po kardiologii detskogo vozrasta* [Lectures on Pediatric Cardiology]. Moscow, Medpraktika-M, 2005. 536 p.

2. Ostroumova O.D., Smolyarchuk E.A., Polikarpova O. The brain as a target organ of hypertension. *Farmateka = Pharmateca*. 2010; 20: 48–53.

3. Seeman T. Arterial hypertension in children and adolescents. *Cas. Lek. Cesk*. 2006; 145 (8): 625–632.

4. Golovchenko Yu.I., Treshchinskaya M.A. Pathogenetic features of circulatory hypoxia of the brain in hypertension. *Novosti meditsiny i farmatsii = News of medicine and pharmacy*. 2012; 10 (416):11–17.

5. Kolisnik I.I., Dzyatkovskaya E.N., Dolgikh V.V. Physiological stress resistance schoolchildren differing hemispheric asymmetry of the brain. *Byulleten' VSNTs SO RAMN = Bulletin of ESRC of SD of RAMS*. 2001; 1 (15): 84–85.

6. Arkelov G.G., Shott E.K., Lysenko N.E. Features of the stress response in right-handers and left-handers. *Vestnik Moskovskogo universiteta = Bulletin of Moscow university*. 2004; 2: 3–14.

7. Leutin V.P., Nikolaeva E.I. *Funktsional'naya asimmetriya mozga: mify i deistvitel'nost'* [Functional brain asymmetry: myths and reality]. St. Petersburg, Rech', 2005. 368 p.

8. Vinokur V.A. Effect of changes in inter-hemispheric asymmetry of the brain and brain bioelectrical activity in the development of cardiovascular disease. *Vestnik RAMN = Annals of RAMS*. 2005; 10: 8–12.

9. Kolyshkin V.V. Functional asymmetry of the brain and its role in the genesis of hypertension. *Fiziologiya cheloveka = Human physiology*. 1993; 19 (5): 23–30.

10. Shpak L.V., Smirnov S.A. *Gemodinamicheskie osnovy mezhpolusharnoi asimmetrii u bol'nykh s arterial'noi gipertenziei. Mat-ly Vseross. nauch.-obrazovat. foruma Kardiologiya-2012* [Hemodynamic Foundations of Asymmetry in Patients with Hypertension. Proceedings of the All-Russian Scientific and Educational Forum «Cardiology-2012»]. Moscow, 2012. 166 p.

11. Kolesnikova L.I., Dolgikh V.V., Leont'eva I.V., Bugun O.V. *Essentsial'naya arterial'naya gipertenziya u detei i podrostkov: kliniko-funktsional'nye varianty* [Essential Hypertension in Children and Adolescents: Clinical and Functional Options]. Irkutsk, RIEL, 2008. 180 p.

12. Polyakov V.M Specifics of the circadian rhythm of asymmetry in children and adolescents with essential hypertension. *Byulleten' VSNTs SO RAMN = Bulletin of ESRC of SD of RAMS*. 2013; 1 (89): 201–205.

13. Kolesnikova L.I., Dolgikh V.V., Polyakov V.M. Psychophysiological relationship with hypertension in ontogeny. *Byulleten' VSNTs SO RAMN = Bulletin of ESRC of SD of RAMS*. 2009; 5 (139): 79–85.

14. Avtandilov A.G., Aleksandrov A.A., Balykova L.A. et al. Diagnosis, treatment and prevention of hypertension in children and adolescents. *Kardiovaskulyarnaya terapiya i profilaktika = Cardiovascular therapy and prevention*. 2019; 8 (4): Appendix 4.

15. Annett M. Handedness as a continuous variable with dextral shift: sex, generation, and family handedness in subgroups of left- and right-handers. *Behav. Genet*. 1994; 24: 51–63.

16. Bragina N.N., Dobrokhotova T. A. *Funktsional'nye asimmetrii cheloveka. 2-e izd*. [Functional Asymmetry of Person]. Moscow, Meditsina, 1988. 240 p.

17. Khomskaya E.D., Privalova N.N., Enikolopova E.V., Efimova I.V., Budyka E.V., Stepanova O.B., Gorina I.S. *Metody otsenki mezhpolusharnoi asimmetrii i mezhpolusharnogo vzaimodeistviya* [Methods for Assessing Hemispheric Asymmetry and Interhemispheric Interaction]. Moscow, MGU, 1995. 78 p.

18. Sidorenko E. V. *Metody statisticheskoi obrabotki v psikhologii* [Statistical Methods in Psychology]. St. Petersburg, Rech', 2007. p. 203–204.

19. Il'in V.P. Methodical features of the application of statistical methods in nonparametric analysis of biomedical data. *Byulleten' VSNTs SO RAMN = Bulletin of ESRC of SD of RAMS*. 2011; 5 (81): 160–164.

20. Nasledov A.D. *Matematicheskie metody psikhologicheskogo issledovaniya. Analiz i interpretatsiya dannykh. 4-e izd*. [Mathematical Methods of Psychological Research. Analysis and Interpretation of Data.]. St. Petersburg, Rech', 2012. 392 p.

21. Efimova M.R., Petrova E.V., Rumyantseva V.I. *Obshchaya teoriya statistiki: Uchebnik. 2-e izd*. [General Theory of Statistics: A Textbook. 2nd ed.]. Moscow, INFRA-M, 2005. p. 27–50.

22. Leventhal T., Graber J.A., Brooks-Gunn J. Adolescent transitions into young adulthood: Antecedents, correlates and consequences of adolescent employment. *J. Res. Adolesc*. 2001; 11: 297–323.

23. Bi Kh. *Razvitie rebenka. 9-e izd*. [Child Development. 9th edition]. St. Petersburg, Piter, 2004. p. 716–723.

24. Annett M. The right-shift theory of a genetic balanced polymorphism for cerebral dominance and cognitive processing. *Curr. Psychol. Cognition*. 1995; 14 (5): 427–480.

25. Annett M. Cerebral asymmetry in twins: predictions of the right shift theory. *Neuropsychologia*. 2003; 41 (4): 469–479.

26. Swanson R.A., Kinsbourne M., Horn F. Cognitive deficit and left-handedness. A cautionary note. In: Neuropsychology of lefthandedness. J. Herron (ed.). New York: Oxford University Press. 1980. P. 281–292.

27. Karimullina E.G., Zvereva N.V. *Pertseptivnaya asimmetriya u zdorovykh i "problemnykh" detei. Dokl. Vtoroi mezhdunar. konf., posvyashchennoi 100-letiyu so dnya rozhdeniya A.R. Luriya* [Perceptual Asymmetry in Healthy and «Problem»Children. Reports of Second Intern. Conference dedicated to the 100th anniversary of A.R. Luriya]. Moscow, Smysl, 2003. p. 251–255.

28. Udachina E.G. Functional asymmetry of the cerebral hemispheres and the regulation of emotional state. *Psikhologicheskii zhurnal = Psychological journal*. 2001; 22 (2): 57–65.

Table 1 Distribution of lateral features in hand tests of patients with AH and in control group

Parameter	Patients with AH, %	Control group, %	Trustworthiness of difference (Fischer criterion)
Domination of right lateral features*	46,4 (n=46)	60,8 (n=60)	p = 0,031
Symmetric distribution of lateral features**	49,4 (n=48)	35,6 (n=35)	p = 0,036
Domination of left lateral features***	4,2 (n=4)	3,8 (n=3)	p = 0,109
Total	100	100	-

* (5 – 4 points); **(3 – 2 points); ***(1 – 0 points)

Table 2. Asymmetry in auditory system in patients with AH and in control group

Parameter	Patients with AH, %	Control group, %	Trustworthiness of difference (Fischer criterion)
Dominant right ear	39.8 (n=39)	63.9 (n=63)	p< 0.001
Dominant left ear	42.8 (n=42)	26.8 (n=26)	p = 0.007
Symmetry	17.4 (n=17)	9.3 (n=9)	P= 0.046
Total	100	100	-

Table 3 Asymmetry in vision in patients with AH and in control group

Parameter	Patients with AH, %	Control group, %	Trustworthiness of difference (Fischer criterion)
Dominant right eye	66.3 (n=65)	73.0 (n=72)	p = 0.086
Dominant left eye	25.5 (n=25)	19.8 (n=19)	p = 0.087
Symmetry	8.2 (n=8)	7.2 (n=7)	p = 0.108
Total	100	100	-

Table 4 Dynamics of hemispheric asymmetry indicators in ontogeny in patients with AH and in control group*

Indicators (points)	**First group (10-12 years old)**								
	Boys			**Girls**			**Boys+girls**		
Asymmetry type	AH	CG	Trustworthines of difference	AH	CG	Trustworthines of difference	AH	CG	Trustworthines of difference
Hand	3,4	3,8	p <0,1	3,1	3,1	p >0,1	3,3	3,4	p >0,1
Sensorimotor	4,8	5,2	p <0,1	4,7	4,6	p >0,1	4,7	4,9	p >0,1

Second group (13 -15 years old)									
Hand	3,4	4,1	p < 0,05	3,1	3,8	p <0,01	3,2	3,9	p <0,01
Sensorimotor	5,0	6,5	p <0,001	5,2	5,6	p <0,1	5,1	6,1	p <0,001
Third group (16-17 years old)									
Hand	3,0	4,4	p <0,001	3,3	3,8	p <0,05	3,1	4,1	p <0,001
Sensorimotor	5,0	6,8	p <0,001	5,3	6,2	p <0,05	5,2	6,5	p <0,001

* Trustworthiness value was determined based on Mann-Whitney criterion

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