Age Features of Etiological Factors of Cerebral Stroke in Children

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Abstract— The etiological factors of acute disorders of cerebral circulation (ACVI) in children and adolescents of the type of cerebral stroke (CS) are extremely diverse in comparison with adults, and therefore the systematization of the causes of stroke in childhood is very difficult. In 20% of cases, the cause of the verified (according to X-ray computed or magnetic resonance imaging) CS in children remains unclear.

Keywords— Stroke, Arterial and Venous Aneurysms, Arteriovenous Malformations.

I. INTRODUCTION
The aim of the study is to reveal the age-related characteristics of etiological factors of CS in children and adolescents.

II. METHODOLOGY
The analysis of the causes of CS was carried out in 66 children. 10 (15.38%) children with CS under the age of 1 year were observed; 6 (9.23%) - early childhood; 15 (23.07%) - preschoolers; 17 (26.15%) children of primary school age and 18 (27.69%) adolescents. The average frequency of CS within one year of each age period did not differ significantly. This indicator was 10 cases in the first year of life, 2 ± 0.57 - in early childhood, 2 ± 0.51 - in preschool, 2 ± 0.66 - in primary school and 3 ± 0.68% of cases in adolescents in year. CS prevailed in boys in 40 (60.61%) cases. In girls, CS was recorded in 26 (39.39%) observations. In 34 (51.51%) children, CS proceeded according to the hemorrhagic type and in 32 (48.49%) cases, CS was verified...
as ischemic. The predominance of hemorrhagic CS in the period of newborn and early childhood in a ratio of 3: 1, in preschool age - 2: 1, in older age groups this ratio was equal to 1: 1. Repeated CS for the hemorrhagic variant were registered in 4 (6.06%) children. Right hemispheric CS were in 26 (39.39%), left hemispheric - in 24 (36.36%), bilateral (all hemorrhagic) - in 2 (3.03%) children. Brain-cerebellar CS was verified in 5 (7.57%) patients. Subarachnoid hemorrhages developed in 7 (10.60%) children, intraventricular hemorrhages - in 2 (3.03%) children. The lethal outcome was in 8 (12.12%) cases and only in hemorrhagic cysts, without significant differences in age groups.

All etiological factors of CS were combined into 2 groups of I and II orders. The etiological factors of the first order included cerebral and extracerebral causes - organic pathology of the central nervous system and somatic sphere. The leading cerebral factors were congenital anomalies of cerebral vessels (aneurysms of arteries, veins, arteriovenous malformations), cranial and extracranial arteritis, neuroinfectious and neuro-oncological causes. Among the extracerebral etiological factors were identified: cardiac (congenital heart defects and large vessels, diagnostic studies and surgical interventions for congenital defects * Ivanovo State Medical Academy of the Ministry of Health of the Russian Federation of the heart); hematological (hemorrhagic diathesis, thrombocytopenia, anaplastic anemia); renal (acute glomerulonephritis); endocrine (congenital dysfunction of the adrenal cortex). The etiological factors of the second order included residual states with an inferiority of cerebrovascular, somatic reactivity, failure of neuro- and CSF dynamics. In this group of causative factors, a special place was taken by residual phenomena of perinatal pathology (hypoxic-ischemic encephalopathy, immaturity of the central nervous system of premature infants, operative delivery), mild traumatic brain injury, transient arterial hypertension, bronchial asthma, physical overstrain (including straining and cry). Proportional etiological coefficients (PEC) were calculated. PEC1 is equal to the ratio of the absolute number of identified etiological factors and the total number of children with CS, PEC2 is the ratio of the absolute number of cerebral and extracerebral factors, and PEC3 is the ratio of first order etiological factors and second order etiological factors.

### III. RESULT

Analysis of the causes of CS in 66 examined children showed that in 14 (21.21%) of them extracerebral factors were determined, in 31 (46.93%) - cerebral factors, i.e. in 45 (68.14%) subjects, first order etiological factors were verified. Etiological factors of the second order were detected in a slightly larger number (48; 72.72%) children. It should be assumed that more than 50% of children with strokes had constellations of factors of both groups, since factors of the second order were to a greater extent the pathogenetic mechanisms of stroke development. For example, the occurrence of QI due to rupture of an abnormally developed intracerebral vessel (saccular aneurysm) against the background of intense physical activity, during which systemic arterial pressure and hemodynamic perfusion in the cerebral arteries increase. On the other hand, in 6 patients the immediate cause of stroke was not established (in both hemorrhagic and ischemic variants), for example, in spontaneous subarachnoid hemorrhages. However, 2 of them had a history of meningitis (serous and purulent) transferred (in the neonatal period in one and at an early age in another). Among the extracerebral factors, the largest proportion (7 children; 10.6%) were cardiac causes (congenital heart defects, predominantly of the "blue" type, diagnostic studies and surgical interventions in this regard with the use of a heart-lung machine). In 5 (7.57%) children, hematological factors were identified, such as hemorrhagic diathesis, idiopathic thrombocytopenia, anaplastic anemia, and disseminated intravascular coagulation. In 1 (3.03%) case, renal (acute glomerulonephritis) and endocrine (congenital dysfunction of the adrenal cortex) factors were determined, accompanied by arterial hypertension.

Cardiac extracerebral factors were of primary importance in the development of CI in preschool children, hematological factors - in children of the first year of life. Renal and endocrine factors were recorded in preschool and early childhood. The leading cerebral factors were congenital anomalies of cerebral vessels (aneurysms of arteries, veins, arteriovenous malformations, angiometatosis) in 19 (28.78%) children. Congenital anomalies of the brain structure (Arnold-Chiari syndrome, retrocerebellar arachnoid cyst) were verified in 3 (3.54%) children. In 3 (3.54%) cases, viral hemorrhagic encephalitis was detected. Nonspecific infectious-allergic cerebral (primary and secondary) arteritis and aorto-arteritis were the causes of CS in 5 (7.57%) children. Angioireticuloma of the brain tissue - in 1 child.

The analysis of age-related characteristics of cerebral factors revealed the following: arteriovenous and arterial aneurysms and arteritis were neuroimaged more often in children of school and preschool age and were not causes of CS in the first year of life and in early childhood. However, venous aneurysms, venous angiomatosis, neuroinfections and brain abnormalities were manifested by ACAV and (or) accompanying it mainly in the first year of life and in early childhood.

Among the etiological factors of the second order, anamnestic data on the unhappiness of the perinatal period were revealed in 17 (25.75%) individuals, i.e. every fourth child. If we take into account the fact that congenital defects in the development of cerebral vessels and the brain are of dysontogenetic origin, then the proportion of perinatal factors in the development of CS will at least double. The most common factor was hypoxic-ischemic encephalopathy - 8 (12.12%) cases and prematurity - 5 (7.57%) cases. Surgical delivery (by cesarean section) and hydrocephalus were 4 (6.06%) and 7 (10.65%) cases. The absolute number of perinatal factors prevailed significantly in the first year of
life, less often in preschool age. Even less often, these anamnestic data were found in children with CS in other age groups. There were 2 cases of "late child" and 1 case of multiple pregnancy. Arterial hypertension was registered in 11 (16.66%) individuals with a predominance of school-age children in comparison with younger age groups. The same distribution was noted for physical overvoltage (6 cases).

The analysis of PEC1 suggests that the absolute number of etiological factors of CS prevails in newborns (PEC1 = 1.9 arbitrary units), and as the age of children increases, there is a general tendency to decrease them, i.e. with all the variety of reasons for CS in a number of children, mainly older children, it was not possible to establish an etiological diagnosis even when using highly informative paraclinical research methods, such as cerebral angiography. Therefore, PEC1 for senior schoolchildren was 0.9 conventional units. PEC2, showing the ratio of cerebral etiological factors to extracerebral in group comparison, had a tendency to maximum growth in preschoolers (PEC2 = 12.0 conventional units) and, to a lesser extent, among senior pupils (PEC2 = 4.0 conventional units). The exception was the PEC2 indicators in young children (0.33) and preschoolers (1.16). The ratio of 1st order etiological factors and 2nd order etiological factors (PEC3) was approximately the same in young children and primary schoolchildren (1.33 and 1.30 conventional units, respectively), the first year of life and preschoolers (0.9 and 1.0 conventional units). In adolescents, this indicator was 0.45 conventional units due to the predominance of second-order etiological factors.

IV. CONCLUSION

With increasing age of children, there was a decrease in the absolute number of causes leading to the development of CS, and the number of strokes with an unknown etiological factor increased. The critical age periods in terms of the importance of cerebral factors were adolescence and, to a greater extent, younger school age, extracerebral factors were early childhood and preschool age.

Of greater importance in the development of CS in children were etiological factors of the second order, more often in infancy, preschool and high school. In newborns, the leading factors were perinatal factors (hypoxic-ischemic encephalopathy, prematurity, hydrocephalus), and in adolescence - arterial hypertension, physical overstrain, in preschool age, mild traumatic brain injuries were more often than in other age groups.

REFERENCES