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ISCHEMIC CEREBROVASCULAR DISEASE IN CHILDHOOD

Cognitive assessment of 15 patients

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ABSTRACT - The aim of this study was to evaluate and to compare the cognitive function of children with ischemic cerebrovascular disease (ICVD). Fifteen children, 7 girls and 8 boys, aged 7.9 to 16.1 years, were evaluated by Piaget's clinical method. The control group was composed by fifteen children whose ages, sex and socioeconomic conditions were similar to those of the ICVD group. The cognitive function evaluation of the ICVD group showed that most of the children (10/15) were under their age group. The SPECT was performed on 14 children with ICVD and the results showed that 8/9 children with hypoperfusion presented a poor cognitive estimation and 3/5 children with normal perfusion demonstrated an adequate performance. We conclude that ICVD in childhood may compromise cognition; therefore, it needs a follow up of acquisitions during all the stages of development.

KEY WORDS: cerebrovascular disease, stroke, childhood, cognitive function, SPECT .

Doença cerebrovascular isquêmica na infância: avaliação cognitiva de 15 pacientes

RESUMO - O objetivo deste estudo foi avaliar e comparar as funções cognitivas de crianças acometidas por doença cerebrovascular isquêmica (DCV-I). Quinze crianças com idade entre 7,9 e 16, 1 anos foram avaliadas pelo método clínico de Piaget, sendo 8 do sexo masculino. Outras 15 crianças, com idade, sexo e nível sócio-econômico similares aos do grupo propósito compuseram o grupo controle. A avaliação das funções cognitivas mostrou que a maioria das crianças (10/15) do grupo DCV-I apresentou defasagem para a faixa etária. Catorze crianças do Grupo DCV-I realizaram o SPECT. Comparando-se o resultado deste exame com a avaliação cognitiva, verificou-se que a maioria das crianças com hipoperfusão (8/9) apresentou déficit na avaliação cognitiva e 3/5 com perfusão normal tiveram desempenho adequado. Concluímos que a DCV-I na infância pode comprometer a cognição da criança, indicando a necessidade do acompanhamento evolutivo das aquisições em todas as etapas do desenvolvimento.

PALAVRAS-CHAVE: doença cerebrovascular, ictus, infância, funções cognitivas, SPECT.

Cerebrovascular disease (CVD) in childhood is considered rare. Its incidence was reported to be 1.2 to 2.5 per 100000/year in children under 15 years of age[1-3]. The technological, laboratory and imaging advances have been allowing increase precise diagnoses and it has been motivating a growing interest in researchers to increase their knowledge on CVD. If this is true for clinical and neurological aspects, it does not happen regarding to further investigation of cognitive function, with rare publications about this aspect[3-8].

The majority of the studies that had investigated the cognitive aspect of children with CVD had used isolated psychologic tests and none of them had added the evaluation of cognitive functional proposed by Piaget, which is considered an important diagnoses in clinical psychology. One of the first works, in this line of research was developed by Inhelder in 1963[9], when she investigated the logical reasoning in mental impairment patients. Ajuriaguerra and Tissot[10] reported the vality of the method to evaluate the cognitive functions. In the same way, Lefèvre[11], in 1992, suggested that this test should make part of neurological evaluation at the investigation of operative thought. Using the operative tests, applied according to Piaget's

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clinical method, it is possible to identify the child's logical reasoning and, consequently, the stage of development are he/she situated[12], sensori-motor stage (from birth up to 2 years of age); pre-operational stage (from 2 up to 6-7 years of age); concrete operational stage (from 6-7 up to 11-12 years of age) and formal operational stage (from 11-12 up to 15-16 years of age).

The purpose of this study is to evaluate and to compare the performance of children with CVD of ischemic type (ICVD) in six operative tests.

METHOD

The ICVD group consisted of 15 patients (7 females and 8 males, aged from 7.9 to 16.1 years), treated at Faculdade de Ciências Médicas (FCM) of the Universidade Estadual de Campinas (UNICAMP), during the period from June 2000 to May 2002. Children evaluation was performed through: a) neurological examination; b) electroencephalogram (EEG); c) computadorized tomography of the skull (CT); d) single photon emission computed tomography (SPECT). The first evaluation was performed at the acute phase of the disease and afterwards during the evolution in the

Table 1. Ischemic cerebrovascular disease: clinical characteristics in 15 children.

Subject	Gender	Onset age	Age at installation	Damaged hemisphere	CT - changes in acute stage	Vascular territory	Neurological evolution
1	F	9 y 3m	7 y 8m 8 y 5m	B	L: Insula Capsule (L > R) R: Capsule Insula Frontal (R < L)	PB PB / MCA	Hp R (brachial)*
2	M	10 y 9m	4 y 11m 5 y	B	R: Superior parietal L: Brain stem	MCA PCA	Hp L (crural)*
3	M	9 y 6m	6 y 11m	R	Brain stem	PCA	Hp L
4	M	11 y 6m	3 y 1m	R	Capsule	PB	Hp L
5	M	14 y 6m	5 y 4m	L	Temporal Parietal Frontal Capsule	MCA / PB	Hp L, Lgg dis
6	M	8 y 1m	4 y 10m	L	Frontal Parietal Temporal Insula Basal nucleus	MCA / PB	Hp R
7	F	12 y 8m	10 y	L	Basal nucleus (corona radiata)	PB	Hp R
8	M	8 y 3m	4 y 7m-I 4 y 8m-I 4 y 8m-H	L	Brain stem Cerebellum	BA	Hp R, Lgg dis
9	M	13 y	3 y 11m	B	Occipital Parietal Frontal R ** Occipital L	MCA / PB	Hp L, visual inv
10	F	13 y 1m	10 y 7m	R	Basal nucleus	PB	Normal
11	F	8 y	5 y 2m 5 y 4m	B	B: Parietal R Occipital Parietal L**	MCA / PB PCA	Hp L, visual, renal cardiac inv
12	M	7 y 9m	7 y	R	Frontal Temporal**	MCA / PB	Hp L, visual inv
13	F	12 y 4m	7 y 7 y 6m 8 y	B	Temporal Parietal L** Occipital Parietal R**	MCA / PB	Hp R
14	F	9 y 9m	1 y 1m	L	Basal nucleus	PB	Normal
15	F	16 y 1m	6 y 6m	R	Temporal Parietal**	MCA/PB	Hp L

F , Female; M, male; Y, year; m, month; I, ischemic; H, hemorrhagic; L, left; R, right; B, bilateral; **, cortex-subcortex; MCA, middle cerebral artery; PB, perforating branches; PCA, posterior cerebral artery; BA, basilar artery; Hp, hemiparesis; *, predominant; Lgg, language; dis, disorder; inv, involvement.

Table 2. Characteristics of the ICVD Group.

Case	Gender	Age at cognitive evaluation*	Onset age of ICVD*	Time of the onset until cognitive assessment*
1	F	9.3	7.8	1.7
7	F	12.8	10.0	2.8
10	F	13.1	10.7	2.6
11	F	8.0	5.2	2.10
13	F	12.4	7.0	5.4
14	F	9.9	1.1	8.8
15	F	16.1	6.6	9.7
Mean		11.6 (sd = 2.77)	6.8 (sd = 3.18)	4.6 (sd = 3.30)
Median		12. 4	7.0	2.6
2	M	10.9	4.11	5.10
3	M	9.6	6.11	2.7
4	M	11.6	3.1	7.7
5	M	14.6	5.4	9.2
6	M	8.1	4.10	3.3
8	M	8.3	4.7	3.8
9	M	13.0	3.11	9.1
12	M	7.9	7.0	0.9
Mean		10.4 (sd = 2.47)	5.0 (sd = 1.26)	5.1 (sd = 3.15)
Median		10.1	4.7	4.3
ICVD Group-mean		10.9 (sd 2.59)	5.9 (sd = 2.44)	4.9 (sd = 3.11)

ICVC, ischemic cerebrovascular disease; F, female; M, male; sd, standard deviation; * years,months

Children and Adolescent CVD Ambulatory Research Unit. The researcher design was approved by Ethical Committee on research of FCM/UNICAMP.

The control group consisted of 15 children with similar characteristics of the ICVD group (age, sex and socioeconomic conditions). They were all enrolled in public schools and according to their teachers they had no learning difficulties.

The cognitive function of the ICVD group and control group were evaluated by Piaget's clinical method, which consisted of six operative tests conservation of number; conservation of the quantity of water, conservation of the quantity of plasticine, two tasks involving arrangement of objects in class; seriation of objects). The criteria used for scoring the tests were: correct response - one point; responses indicating typical transition - 0.5; incorrect response - none. Hence, the maximum score that could be achieved was 6 points (the PROEPRE Protocol - Laboratório de Psicologia Genética - Faculdade de Educação/UNICAMP).

The SAS System for Windows (version 8.02)® and the SPSS for Windows (version 10.0.5)® were used to analyze the statistics and to chose the test (Fisher, Mann-Whitney, Kruskal Wallis or Wilcoxon) and in order to evaluate the results it was performed an analysis according to the type of variable that was being analyzed (categorical or continuous).The significance level adopted was $p<0.05$.

RESULTS

Fifteen patients were evaluated. Their school grades were from first to 8th grade (primary school), most of them were public school (11/14). The mean age at the time of the ICVD was 5.9 years (range 1.1 to 10.7 years). In the boys the mean age of the ICVD was 5.0 (range 3.1 to 7.0 years), while the girl's mean age was 6.8 (range 1.1 to 10.7 years).

The mean age of cognitive function assessment of the ICVD group was 10.9 years (range to 7.9 to 16.1 years). In the boys the mean age was 10.4 (ranged 7.9 to 14.6 years), while in the girls the mean age was 11.6 (range 8.0 to 16.1) The mean age between acute vascular lesion onset and cognitive function evaluation was 4.9 years (range 9 months to 9.7 years), summarized in Tables 1 and 2.

The period between the onset until cognitive assessment was similar for both gender, with the mean of 5.1 for boys (range 9 months to 9.2 years) and 4.6 for girls (range 1.7 years to 9.7) ($p=0.6943$).

The left hemisphere was affected in five patients, while the right hemisphere was affected in five patients and bilateral lesions were found in five other patients. In 9/15 patients, the lesion simultaneously affected the cortical and subcortical areas and in the remaining patients it only had affected

Table 3. Performance of ICVD and Control Group in operative tests.

ICVD	Gender	Age*	Score	Control	Sex	Age*	Score
1	F	9.3	4	1-c	F	9.3	4.0
2	M	10.9	6	2-c	M	10.7	6
3	M	9.6	0.5	3-c	M	9.3	3.5
4	M	11.6	5	4-c	M	11.6	6
5	M	14.6	6	5-c	M	14.10	6
6	M	8.1	0	6-c	M	8.1	5
7	F	12.8	4	7-c	F	12.4	6
8	M	8.3	0	8-c	M	8.3	5
9	M	13.0	0	9-c	M	12.7	6
10	F	13.1	5	10-c	F	12.9	6
11	F	8.0	0	11-c	F	7.8	6
12	M	7.9	3.5	12-c	M	7.4	3.5
13	F	12.4	0	13-c	F	11.7	6
14	F	9.9	6	14-c	F	9.9	6
15	F	16.1	3.5	15-c	F	15.3	6
		Score	43.5			Score	81
ICVD Group (mean)			2.9	Control Group (mean)			5.4

Wilcoxon Test (p = 0.002); ICVD, ischemic cerebrovascular disease; M, male; F, female; *years, months.

the subcortical areas. The middle cerebral artery (MCA) and its perforating branches (PB) were the most affected. Five of 15 patients had recurrence ICVD and three of them were females (Table 1).

Thirteen children presented hemiparesis, and five of them had also presented disturbance of motor speech (subjects 5 and 8), visual involvement (subjects 9 and 12) and visual, renal and cardiac involvement was seen in one patient (subject 11).

Information about the cognitive functions of both ICVD group and control group is summarized in Table 3. The ICVD group showed a performance significantly below (p=0.002) compared to the control group (Fig 1). No significant difference was observed in patients who had recurrence and those who had been affected only once.

Finally, the cognitive results were compared with the SPECT, obtained in 14/15 children of the ICVD group: 8/9 patients with hypoperfusion showed a performance below normal for age group, while 3/5 with normal perfusion, presented an adequate performance (Table 4).

DISCUSSION

There are no published studies at the literature which had assessed the cognitive evolution of children with CVD by Piaget's clinical method. In this way, are results are important because they can add data about the evolutive cognitive aspect of children with ICVD.

Nicolaides & Appleton[13] mention that at CVD there is no preference in terms of which gender is affected, a fact that is also verified in our study. These same authors and also Moura-Ribeiro et al.[14] had conclude that children with inferior age of 2 years old were more often affected by CVD. In our research, the mean age was 5.9 years old. Therefore, it should be considered that in this search the casuistic is small and it does not include the patients from CVD Research Out-Patient. The majority of the patients (9/15) had simultaneous attacks of subcortical and cortical areas involving MCA and PB, a fact that was also mentioned by the literature. Schryner et al.[3] described two recurrences in 35 patients and at this present study it was seen 5 recurrences in 15 patients. Perhaps this fact should be related to the features of the outpatients, which is referred unit in this area of the country.

Regarding to the cognitive assessment, the expectiveness is that all the children between 7-8 years of age (maximum 9 of age) had reached success at

Table 4. Performance of ICVD and results from the SPECT.

Case	Gender	Age at cognitive evaluation*	Score	SPECT
2	M	10.9	6.0 - A	Normal
3	M	9.6	0.5 - D	Normal
4	M	11.6	5.0 - D	Hypoperfusion R: basal nucleus, thalamus
5	M	14.6	6.0 - A	Hypoperfusion L: temporal, parietal, basal nucleus, thalamus
6	M	8.1	0 - D	Absence of perfusion L: temporal lobe, posterior frontal lobe, posterior parietal, basal nucleus
7	F	12.8	4.0 - D	Hypoperfusion L: basal nucleus
8	M	8.3	0 - D	Hypoperfusion L: cerebellar hemispheres, mesial, temporal, basal nucleus
9	M	13.0	0 - D	Absence of perfusion R: hemisphere (temporal, parietal, occipital); Hypoperfusion L: cerebellum, primary visual area.
10	F	13.1	5.0 - D	Normal
11	F	8.0	0 - D	Hypoperfusion B: frontal, parietal, occipital / Hypoperfusion L: primary visual area, thalamus, anterior temporal
12	M	7.9	3.5 - A	Normal
13	F	12.4	0 - D	Hypoperfusion L: temporal, parietal / Hypoperfusion R: parietal, occipital
14	F	9.9	6.0 - A	Normal
15	F	16.1	3.5 - D	Absence of perfusion R: parietal, frontal, temporal

M, male; F, female; A, Adequate; D, Deficit; L, left; R, right; *, years,months.

the six operative tasks[12]. Under this perspective, 11 children from ICVD group should have received maximum score (6 points). Although, only three children had achieved this score (Table 3). It is important to point out that 6/12 children (subjects 4,7,9,10,13 and 15) that not achieved the expected 6 points at the score, were the ones with ages above 9 years old (from 11.6 to 16.1 years of age), a fact that indicates a clear discrepancy at the cognitive development. The remaining children with a score below 6 (subjects 1, 3, 6, 8, 11 and 12) were between 7.9 and 9.6 years of age. The cultural and environmental factors can contribute to the delay on acquisition of the operative thought[12]. So, the children from this age period could be in a transitory phase and could only have success in some of the tests. At this present study only subjects 1 and 12 were in this phase and also 5/10 children (subjects 1, 2, 5, 12 and 14) from ICVD group had satisfactory performance. Accounting for the discrepancy hypothesis at the performance of ICVD it was considered the onset age, the site and lesion length.

Regarding to the onset age, ICVD had affected the children in different stages of their development (from 1.1 to 10.7 years of age), difficulting the performance analysis of the subjects at operative tests. The children with satisfactory performance (subjects 1, 2, 5, 12 and 14) had cerebrovascular lesion between 1.1 to 7.8 years of age and the others who had dissatisfactory performance (subjects 3, 4, 6, 7, 8, 9, 10, 11, 13 and 15) were between 3.1 and 10.7 years of age. So, the onset age of ICVD did not influence the children's performance.

Regarding to hemispheric localization of ICVD, it was verified that five subjects had bilateral lesion, while five had lesion on the right hemisphere and the others, on the left hemisphere. Knowing beforehand that the left hemisphere is related to the speach arrangement and with superior mental ways linked to it, it was hypothezed that the children with lesion on the left hemisphere should have a less performance. Therefore, considering the children who had dissatisfactory performance (subjects 3, 4, 6, 7, 8, 9, 10, 11, 13 and 15) it was seen that four of these subjects had the right hemisphere affected (subjects 3, 4, 10 and 15), three of them had the left hemisphere affected (subjects 6, 7, and 8) and the other three children had bilateral lesions.

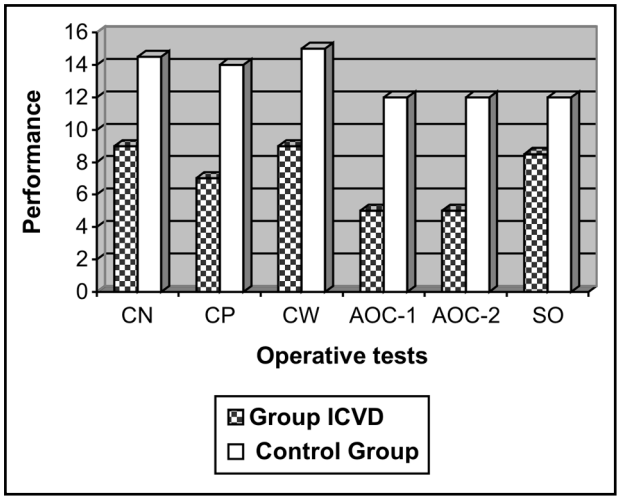

Fig 1. Performance of ICVD and control groups in operative testes (CN, conservation of number; CP, conservation of a quality of plasticine; CW, conservation of a quantify of water; AOC, arrangement objects in class; SO, seriation of objects).

So, the hemisphere localization of ICVD had not influenced the performance of the patients.

In the same way as age and the hemisphere localization, the lesions on subcortical areas or cortical and subcortical areas together were not determinant on the performance of the evaluated subjects, because among the 10 subjects who had presented dissatisfactory performance, 5 had subcortical lesion (subjects 3, 4, 7, 8 and 10) and in 5 patients the lesion was cortical and subcortical (subjects 6, 9, 11, 13 and 15). The cognitive discrepancy of the studied group is significantly inferior (p= 0.002) to the control group, confirming the hypothesis previously seen[15,16]. At the control group 10/15 subjects had reached the maximum score and the remaining children (5/15) that did not reach success in all the 6 tests (subjects 1c, 3c, 6c, 8c and 12c) were between 7.4 and 9.3 years of age and they also were in transitory phase, showing an adequated performance for the age period. So, all the 15 children from this group had presented a satisfactory performance (Fig 1).

Regarding to the findings on the SPECT, it was verified a high correlation between the perfusion and the result of the cognitive evaluation: 8 children with hypoperfusion had a performance inferior to the expected one while 3 with normal perfusion had an adequated performance. These results suggest that new studies should be done and also they restrengthen the importance of neuroimage resources at the clinical and functional investigation for the understanding of the cerebral pathophysiology.

It was concluded that children with ICVD assessed evolutionally by Piaget's clinical method had presented a performance significantly inferior when compared to the control group, a rare verification in children with ICVD.

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