HEMISPHERIC SPECIALIZATION IN PARTIAL EPILEPSY

ROLE OF DICHOTIC LISTENING CV TASK AND CENTRAL AUDIOLOGICAL EVALUATION IN THE NEUROPSYCHOLOGICAL ASSESSMENT

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SUMMARY — We studied 49 patients with partial epilepsy divided into lesional cases (i.e. with lesions on CT scan) and non-lesional cases (i.e. without CT scan lesions), in relation to the Wechsler Intelligence Scale subtests (Coding, Digit span), dichotic listening CV task and Central Auditory Test (SSI, PSI). The aim of this paper was to study the hemispheric prevalence in dichotic listening task with regard to cognitive perforamance, as well as the presence or absence of central auditory dysfunction. Lesional cases presented a hemisphere prevalence in dichotic listening task with regard to cognitive performance, as well as the non-lesional cases tend to report the stimuli in the same side of EEC focus. Significant differences were found among the lesional and non lesional cases in relation to the digit span score and Coding subtest in right lesional cases versus right non-lesional cases. Both lesional and non-lesional group showed signs of central auditory dysfunction. We suggest that the dichotic listening and SSI and PSI test can be useful for a best comprehension of asymmetric neuropsychological performance in partial epilepsy.

Especializarão hemisférica na epilepsia parcial: papel da prova de estimulação dicótica CV e da avaliação audiológica central na apreciação do desempenho neuropsicológico

RESUMO — Foram avaliados 49 pacientes com epilepsia parcial, divididos em dois grupos que incluiam casos lesionais (com lesão estrutural à TCC e casos não lesionais (sem lesão à TCC). Os pacientes foram submetidos à prova de estimulação dicótica consoante-vogal (c-v), a teste autidivo central (Jerger - SSI e PSI) e à escala de Inteligência Wechsler. O objetivo do estudo foi analisar a preferência hemisférica em provas de estimulação dicótica em relação ao desempenho cognitivo bem como a presencia ou ausência de disfunção auditiva central. Os casos com epilepsia parcial lesionai apresentaram preferência hemisférica à prova de estimulação no lado oposto à lesão cerebral, enquanto os casos não lesionais apresentaram preferência hemisféria no mesmo lado do foco elentrencefalográfico. Com relação ao desempenho nos subtestes do Wechsler, observamos que os casos lesionais com foco no hemisfério direito apresentaram menor desempenho nos subtestes relacionados a atenção/concentração e memória imediata (subtestes: Código e Dígitos). Tanto os casos lesionais como os não lesionais apresentaram sinais de disfunção auditiva central. Os autores sugerem que os testes de estimulação dicótica aliados à bateria cognitiva e à avaliação auditiva central podem ser considerados instrumentos úteis no estudo da assimetria funcional hemisférica em pacientes com epilepsia parcial.

The relation between cognition and epilepsy is complex and has aroused many controversy, mainly related to cause-effect association. The mechanism in which the neuronal discharges influence the cognitive process in partial epilepsy is unknown, but some hypotheses have been suggested including biochemical differences in temporal lobe cholinergic system 2, neuroendocrine dysfunctionu, kindling effect in temporal

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limbic areas 3 and antiepileptic drugs effects 27. The transitory cognitive impairment, previously described in generalized epilepsy with spike-wave 3 Hz, has recently been reported in interictal period of partial epilepsy 4. Most studies analyzing the cognitive abnormalities during interictal period of partial epilepsy have showed inhibitory influence of the localized discharge over the cognitive performance 18,19. However, few papers studying cognitive performance in epileptic patients related their findings to the differences in hemispheric specialization for verbal and non-verbal stimuli processing 20,21. Since 1961, after the introduction of dichotic listening tests 16, many reports have been made showing an important role of dichotic listening to determination of hemisphere preference to process verbal and non-verbal stimuli in normal right handed patients 9,23. Although the pioneer papers were done with epileptic patients candidates to neurosurgery intervention^ the hemispheric preference in dichotic test in epileptic patients had not been related to epilepsy features, as epilepsy duration, seizures frequency, age onset of seizures 5,25. Mclntyre et al.22 studying epileptic patients with the so-called «temporal lobe epilepsy» found a relation between hemispheric preference and paroxystic activity in EEC with a shift of hemisphere preference to the side opposite to EEG focus («lesion effect»), similarly the Shullof and Goodglass28 and Johnson et al.!5 findings in brain lesion patients. Mazzucchi and Parma 20 observed the «lesion effect» only in partial epileptic patients with brain lesion, since the non-lesional patient showed hemispheric preference in dichotic listening test in the same side of EEG focus, «paradoxical effect»[42]. Muszkat24 found similar findings and the hemispheric preference in dichotic CV task was not related to the epilepsy duration, seizures frequency and age onset of seizures.

The purpose of this paper is to study the lateralization in dichotic CV task concerning cognitive performance, mainly memory and attention, as well as the presence or absence of central auditory dysfunction signs.

PATIENTS AND METHODS

Forty nine right-handed epileptic out-patients seen at Epilepsy Section of Neurology and Neurosurgery Department from Escola Paulista de Medicina were evaluated, 29 male and 20 female, whose mean age was 35 years. All cases had partial epilepsy according I.L.A.E.7, showing in the interictal EEG paroxystic activity localized in just one cerebral hemisphere, without diffusion to the opposite side. The. epileptic seizures were classified according I.L.A.E.6. The casuistic includes children and teens with age ranging from 6 to 18 years (21 cases) and adults with age ranging from 18 to 60 years (28 cases). According to CT scan and EEG recordings all cases were grouped in the following way: (1) Right EEG lesionai cases (R-L.es.), includes the cases with right hemisphere lesion and right hemisphere paroxystic activity in the interictal EEG; (2) Left EEG lesionai cases (L-Les.), includes the cases with left hemisphere lesions and left hemisphere paroxystic activity in the interictal EEG; (3) Bight EEG non-lesional cases (R-NLes.), includes the cases with right hemisphere paroxystic activity in the interictal EEG without lesions in CT scan; (4) Left EEG nwn-lesicHiai eases (L-NLes.), includes the cases with left hemisphere paroxystic activity without CT scan abnormalities.

All patients underwent a clinical and audiologic otorhinolaryngologic examination including tonal and speech audiometry and admitance to avoid cases with peripheral hearing loss. The patients with normal audition were submitted to the following tests:

(1) Lateral Dominance and Handedness — as determined by self report, Lateral Dominance task in the Neurolog cal Developmental Examination and direct observations of patient activities.

(2) Jerger's Central Auditory tests — Synthetic Sentences Identification 13 with contralateral competing message (SSI-CCM) and Pediatric Speech Intelligibility 14 with contralateral competing message (PSI-CCM). From the 49 patients, 47 perform the test and 2 cases did not attend at the session test.

(3) Cognitive evaluation using the Weehsler battery test — WISC and WAIS for IQ determination and analysis of the subtests including verbal subtests (Similarities, Comprehension, Arithmetic, Information, Digit span) and performance subtests (Picture Completion, Object Assembly, Block Design, Picture Arrangement, Coding). From 49 eplileptic cases, 38 perform the test and 11 did not attend at the session test.

(4) Dichotic listening CV task — From the 49 patients, 35 performed the dichotic verbal task and 14 did not attend at the session test. The dichotic listening task was an adaptation

to the Poruguese language for he Consonant-Vowel Task (CV) 29 made by Muszkat 24. The procedure consists of exposition of 80 pairs of CV non-sense syllables (BA, DA, GA, CA, PA, TA) presented simultaneously to both ear. The test was presented to the subjects from AKAY CS 705 recorder via 2 channels AMPLAID audiometer connected to TDH-39 earphones. The dichotic CV test was administered using 40 pairs of CV non-sense syllables (BA, DA, GA, CA, PA, TA) as stimuli with simultaneous onset of pairs. The test material was presented at 60 dB to both ears. The presentation of the CV syllables includes all possible non-identical pairing of dichotic stimuli with an interstimulus intervtal of 6 seconds. Half way through the test, the 2 channels were reversed with respect to the ears via the audiometer. The patients say the syllable moret clearly detected. Bar preference score (E.P.S.) for dichotic listening were estimated using the method of Johnson et al.15. The number of left (L) ear correct responses was subtracted from the number of right (R) ear correct responses and the difference was divided by the total number of right ear plus left ear correct responses (E.P.S. = R ear - L ear/R ear f L ear). The positive E.P.S. reflects a right ear preference or a left hemispheric preference, while a negative E.P.S. reflects a left ear preference or a right hemispheric preference. Neutral preference was considered when E.P.S.=0±0.05.

The control group was formed by 26 right-handed persons with normal intelligence (IQ > 70) in which 23 performed a dichotic listening CV task and 16 the Jerger's central auditory tests (SSI and PSI). The mean age of the control group was 36 years. All subjects had no history of seizures or any other neurological disorders.

The results in Dichotic Listening CV task, SSI and PSI were analyzed in relation to age, epilepsy duration, neurologic clinical examination, antiepileptic drugs, seizures and epilepsy type, seizures frequency, IQ, attention/concentration-Coding subtest (WISC and WAIS) and immediate memory-Digit span (WISC and WAIS).

For statistical analysis we employed nonparametric tests.

RESULTS

1. Description data: The characteristics of epileptic group are showed in Table 1. Most cases (61.2%) showed epilepsy onset before 10 years and epilepsy duration more than 5 years in 66.3% of cases. The mean age at onset of their seizures was 11.2 years (SD±11.7) Idiopathic partial epilepsy was found in 26 cases (53%) and symptomatic partial epilepsy in 23 cases (47%). In regard to the CT scan and EEG classification we found: 7 R-Les., 11 L-Les., 15 R-NLes., 16 L-NLes. cases. Most patients showed association of 2 types of seizures (63.2%; 31/49). The etiology in the symptomatic group is showed in Table 1. A predominance of undetermined causes (34.7%) followed by neurocystieercosis (30.4%) was found. The EEG paroxystic activity showed preference for anterior temporal areas (83.6%) and the CT scan revealed extensive lesions involving temporo-parietal areas in 18 lesional cases. As for seizures frequency, most patients (75.5%) presented less than one seizure a month. It was found that 57.1% were receiving monotherapy, in which phenobarbital monotherapy prevailed (64.2%). The Wechsler Intelligence Scale was administered to all patients and the IQ mean score obtained was 89.87 (SD±18.18).

2. Significant correlation data:

(A1) Dichotic listening CV task was done in 35 cases. Right hemisphere preference (negative E.P.S.) was found in 12 cases and left hemisphere preference (positive E.P.S.) in 18 cases; 5 cases presented a neutral preference. All cases from the control group showed a left hemisphere preference. Great frequency of right hemispheric preference was found in epileptic group (Table 2). The epileptic patients showed a significant association among the side of lesion and EEG paroxystic activity. The lesional cases presented hemispheric preference in dichotic listening CV task related to the opposite side of the brain lesion («lesion-effect») while the non lesional cases tend to report the CV stimuli in the same side of EEG focus. Table 3 shows the absolute value of E.P.S. (ear preference score) obtained in the epileptic and control group. It was found only a greater E.P.S. score in the R-Les. cases (E.P.S.=0.68) than in R-NLes. cases (E.P.S.=0.26).

(A2) Dichotic listening and cognitive assessment (Tables 4 and 5) — Significant differences were found (Tabela 4a) among the lesional and non-lesional patients in relation to the Wechsler digit span score (immediate memory) with a great impairment in memory function in the lesional group (R-Les. and L-Les.). Nevertheless, only the lesional cases with abso-

Classification	Nº of Cases (N)	Age (SD) years	Age onset (SD) years	Sex (F/M)	Duration of epilepsy (SD)	Etiology	Antiepileptic Monotherapy	Drug Politherapy
Right Lesional	7	31.4 (19.1)	11.1 (19.5)	3/4	20.2 (15)	3 undet, 1 NC 1 St, 1 Por	3	4
Right Non-Lesional	15	20.8 (14)	9.2 (7.5)	6/9	11.6 (12.2)	1 NC, 1 anoxia 13 undet	11	4
Left Lesional	11	27.8 (14.1)	14 (16.0)	5/6	13 (12.4)	5 NC, 1 undet 2 Traum, 2 Por, 1 HHE	3	8
Left Non-Lesional	16	23.5 (14.8)	11 (6.9)	7/9	12.3 (11.1)	16 undet	11	5

Table 1 — Characteristic of epileptic group.
F, female; M, male; undet, undetermined; NC, neurocysticercosis; St, stroke; Por, porencephalus; Traum, traumatic; HHE, hemiparesis hemicounvulsions epileptic syndrome.

Group	Hemispheric prevalence (Dichotic listening) Right	Left	Total	% Right
Epileptic	12	18	30*	40%
Control	0	26	26	0%

Table 2 — Hemisphere prevalence (Dichotic listening) in epileptic and control group.
** It was excluded: 5 epileptic cases with neutral prevalence (E.P.S. = 0).*
*Chi-square = 10.96 *, $p < 0.01 = 6.63$.*

Group	Hemisphere prevalence right	left	neutral	Absolute value E.P.S. (mean)	Significant* correlation
R-Les.	0	6	0	0.68 (A)	A x B* $p < 0.05$
R-NLes.	6	0	3	0.25 (B)	
L-Les.	6	0	1	0.28 (C)	
L-NLes.	0	12	1	0.40 (D)	
Total	12	18	5		

Table 3 — Hemispheric prevalence in dichotic listening CV task in lesional and non-lesional cases.
E.P.S., ear preference score; R-Les., right lesional; L-Les., left lesional; R-NLes., right non-lesional; L-NLes, left non-lesional.
** Kruskal-Wallis test; no other significant correlations.*

Group	N	Immediate memory (Digit span-mean)	Significant correlation	
Lesional (R-Les + L-Les)	12	5 (A)	A x B	$p<0.05$*
Non-Lesional (R-NLes + L-NLes)	23	7.3 (B)		

Table 4a — Immediate memory (Digit span) and epileptic group.
R-Les, right lesional; L-Les., left lesional; R-NLes, right non-lesional; L-NLes., left non-lesional.
** Mann-Whitney test.*

E.P.S. Group	Digit span (mean)	Significant correlation	
Lesional			
0:————0:5 (A)	6.5		
0:5:———— (B)	3.5		
Non-lesional		B x C	$p<0.05$*
0:————0.5 (C)	7.36		
0.5:———— (D)	7.25		

Table 4b — Immediate memory (Digit span) and Ear Preference Score (E.P.S.) in epileptic group.
E.P.S., ear preference score.
** Kruskal-Wallis test; no other significant correlation.*

Group	N	Coding score (mean)	Significant correlation
R-Les.	6	4.83 (A)	A x B $p<0.05$*
R-NLes.	7	10.25 (B)	
L-Les.	12	5.43 (C)	
L-NLes.	13	8.69 (D)	

Table 5 — Attention/Concentration (Coding score) in epileptic group.
R-Les, right lesional; R-NLes, right non-lesional; L-Les, left lesional; L-NLes, left non-lesional.
** Kruskal-Wallis tests; no other significant correlations.*

lute value of E.P.S. above 0.5 (Table 4b) showed lower performance in Digit span subtest than non-lesional cases with E.P.S. less than 0.5. Only the right lesional (R-Les.) cases showed a lower score in attention/concentration (Wechsler Coding subtest) than right non-lesional (R-NLes.) cases (Table 5). No differences were observed between the absolute E.P.S. value and total IQ score.

(B) Jerger's central auditory tests — The Jerger's SSI-ICM and PIS-ICM tests were done in 47 epileptic patients and in 26 persons of the control group. In control group no abnormality was detected, while 38% of epileptic cases showe4 signs of central auditory dysfunction (Table 6). It was observed that 47% (8/17) of lesional cases showed a lateralization in Jerger's Central auditory tests, in which 87.5% (7/8) cbrrespond to ipsilateral lesion hemisphere side, whereas in non-lesional cases only 26% (8/30) showed lateralization in Jerger's tests (Table 7). However, it was not possible to make statistical analysis between lesion and EEG discharges side with lateralization of Jerger's central auditory tests (SSI-CCM, PSI-CCM), due to the few number of cases. No significant correlation was detected among the central auditory lateralization in Jerger's tests (SSI-CCM), PSI-CCM) and IQ score, immediate memory (Digit span) and attention/concentration (Coding subtest) performance.

Group	Normal	Abnormal	Total	% Abnormal
Control	26	0	26	0%
Epileptic	29	18	47	38%

Table 6 — Jerger's Central auditory tests (SSI-CCM and PSI-CCM) in epileptic and control group.
SSI-CCM, synthetic sentences identification with contralateral competing message; PSI-CCM, pediatric speech identification with contralateral competitive message.
Chi-square test $p<0.01$.

Group	Lateralization side			
	Right	Left	None	Bilateral
Lesional (n==17)				
R-Les.	2	0	3	1
L-Les.	1	5	5	0
Total	3	5	8	1
Non-Lesional (n==30)				
R-NLes.	4	2	10	0
L-NLes.	1	1	11	1
Total	5	3	21	1

*Table 7 — SSI-CCM and PSI-CCM lateralization in epileptic group *.*
R-Les., right lesional; R-NLes, right non-lesional; L-Les., left lesional; L-NLes., left non-lesional.
** Data not analysed statistically.*

COMMENTS

Our data show that epileptic patients, both lesional and non-lesional group (Table 2), differ from control group with regard to hemispheric preference in dichotic listening CV task[21.24]. Such findings suggest that partial epilepsy may affect the normal left hemispheric preference to process language stimuli in right-handed patients^. There is a close similarity between our findings and Mazzuchi and Parma[20] results, where the hemispheric preference was related to the presence or absence of brain monohemispheric lesion. Another interesting finding was the greater absolute value of Ear Preference Score (E.P.S.=0.68) in the right lesional patients than right non-lesional cases (E.P.S.=0.25), Table 3. There are three possible explanations for such findings: (a) In dichotic listening CV task of non-lesional epileptic patients with right EEG discharges, the right non-dominant hemisphere preference to be expressed have to supplant the left normal hemisphere preference to process verbal "stimuli; (b) The great E.P.S. (E.P.S.=0.68) observed in right lesional cases (R-Les.) can reflect contralateral auditory extinction 30 observed in patients with right hemisphere lesions, since the right hemisphere is considered the responsible for selective modulation of attention; indeed, in our cases the right lesional cases showed a lower performance in coding subtest (Table 5), which is mainly related to attention and concentration; (c) The great absolute value of E.P.S. in rigth-lesional cases (Table 3) can also be related to an impairment of immediate memory mechanisms, once the lesional group had a lower memory score than the non-lesional group (Table 4a).

Many reports describing a relation between EEG focus and the memory impairment were published, mainly about the verbal memory deficits in left EEG focus and non-verbal deficits in right EEG focus 18.19. However, we did not find papers relating the memory deficits linked to hemispheric specialization detected by double sensory stimulation tasks, except in comissurotomized patients[24]. Our findings can suggest that not only the perception of different stimuli (verbal or non-verbal) can be influenced by EEG focus side, but also the spatial distribution of stimuli in the extrapersonal space.

Finally, in regard to central auditory dysfunction detected in the Jerger's tests, the epileptic group showed more frequent central auditory dysfunction signs than the non-epileptic control group (Table 6). In lesional cases, where central auditory dysfunction was detected, the lesion effect can be due to structural involvement of primary auditory sensorial areas. Nevertheless, the shift of hemisphere preference (lesion effect) was observed in all lesional cases, even in those without any signs of central auditory dysfunction. We also found that non-lesional patients presenting central auditory dysfunction did not modified the lateralization in dichotic listening CV task. Such findings may suggest that the hemispheric lateralization observed in epileptic patients can be related to anatomic structures not restricted to the primary auditory sensorial areas and can involve more diffuse neuronal circuits for attention selective process.

In sum, we can suggest an interesting role for dichotic listening CV task and Jerger's Central auditory tests on neuropsychological assessment. They can also be useful to understand better how the neuronal discharge can affect the functional hemispheric brain asymmetries in partial epilepsy.

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