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Original Research Article

Utility of Western Aphasia Battery for Lateralizing Language Deficits in Persons with Medically Intractable Temporal and Extratemporal Epilepsy

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ABSTRACT

Persons with epilepsy (PWE) are prone to cognitive linguistic deficits. Presurgical evaluations in these patients include language assessments along with other cognitive domain assessments for lateralizing epileptogenesis. Western Aphasia Battery (WAB) has been documented as a test for assessment of language functions in PWE. However, it is uncertain whether this test can be used as a presurgical tool for cognitive assessment for lateralizing epileptogenesis. Hence the current study was undertaken towards identifying the utility of WAB as a language tool during presurgical evaluation of PWE. A total of 64 Malayalam speaking right handed persons with clinically diagnosed refractory right and left hemispheric temporal and extratemporal epilepsy were included along with 64 healthy controls. All subjects underwent language evaluations using the Malayalam version of WAB and aphasic quotients were used as outcome measure. It was noted that the participants only differed in the verbal fluency subsection of WAB. The mean aphasia quotients were not statistically significant across patients and controls or across patient groups. It was noted that WAB was not a useful tool to study linguistic disturbances that could cue towards hemispheric lateralization of epilepsy when used as part of cognitive assessment in presurgical evaluations. The study put forth the need to develop specific cognitive linguistic test batteries for PWE that can potentially pick up the depressed linguistic functions affected by epilepsy and then could favorably cue towards possible lateralization of epilepsy.

Keywords: *Epilepsy, Western aphasia battery, language lateralization*

INTRODUCTION

Persons with epilepsy (PWE) are at increased risk for language deficits. [1-3] This risk increases when epilepsy is medically intractable/ refractory. Medically intractable epilepsy patients are those who have uncontrolled seizures or devastating side effects affecting the quality of life despite tolerating appropriate and adequate dosages of one or more antiepileptic drugs. [4] Epilepsy affect various cognitive functions such as language, memory, attention, executive functions etc [5] and very often these difficulties are associated with multiple seizure related and treatment related variables such as age of onset of seizures, duration, frequency and type of

seizures, antiepileptics used by patients etc. [6-10]

For patients with medically refractory epilepsies, surgical resection of the epileptogenic foci is implicated for seizure control in a subset of patients. Hence, accurate localization of this zone from where seizure originates and its resection or disconnection for abolition of seizures is necessary in the surgical management of these patients. To identify the ideal candidates for surgery, a presurgical evaluation wherein clinical, cognitive, electroencephalography, magnetic resonance imaging and few other invasive and noninvasive evaluations are deemed necessary on a case by case basis. Among these, language-based assessments play an integral role among other cognitive domain examinations like memory, executive functions, visuospatial skills etc. There were reports in favor of depressed verbal memory and language skills attributed to left hemispheric epilepsies and nonverbal memory impairments to right hemispheric epilepsies. [11] Thus the cues derived from these cognitive assessments are also useful in lateralizing and localizing seizure focus. There was a reported 82% agreement by neuropsychologists in European epilepsy centers to undertake language investigations in persons with epilepsy as a tool for lateralizing epileptogenesis. [12]

The language deviancies observed in PWE include poor naming skills, poor verbal fluency measures, deficits in spontaneous speech and even repetition difficulties. [13-19] Various linguistic tests like Boston Naming test (BNT), verbal fluency tests, token tests, Boston Diagnostics Aphasia Examination (BDAE), Western Aphasia Battery (WAB) were often reported in the literature, for investigating language skills in PWE. [12,19-21]

Compared to western literature, Indian studies that have attempted to tackle linguistic functions in epilepsy are limited. To the best of our knowledge, there is only a single study reported from India that assessed the neuropsychological functions in PWE. [19] The focus of the study was to find out if there were differences in the distribution of cognitive functions such as memory, executive functions and language skills of prospectively recruited temporal and extratemporal lobe epilepsy patients. WAB was used to evaluate language functions in temporal and extratemporal epilepsy patients. Authors reported 47% prevalence for language impairments in the refractory epilepsy patients they included. It was reported that among all the subcomponents in WAB only the repetition score showed statistically significant difference between frontal lobe epilepsy (FLE) and temporal lobe epilepsy (TLE).

WAB subsections assess for spontaneous speech, auditory verbal comprehension, repetition and naming. Studies that focused on language deviancies in PWE have reported deficits in many of the above linguistic functions. [18,22,24] Hence, we speculated a difference in the performance of temporal and extratemporal epilepsy patients affecting the dominant and nondominant hemisphere to have varying performances in WAB. Specifically, we expected, left hemispheric epilepsies with temporal lobe involvements, to be at a higher risk for language and semantic memory deficits evident in WAB compared to right hemispheric epilepsies. Thus, the current study was planned to compare the language profile of persons with medically intractable temporal and extra temporal epilepsies using WAB, to specifically look at whether WAB has good lateralizing values towards picking up the linguistic changes caused by right or left sided temporal and extra temporal epilepsies.

Aim

The aim of the current study was to identify whether the Malayalam adaptation of WAB, WAB-Malayalam (Malayalam is a Dravidian language spoken in the state of Kerala, India), could be used as a presurgical language assessment tool in persons with temporal and extratemporal refractory epilepsy.

METHODOLOGY

A total of 64 persons in the age of 18-45 years with refractory epilepsy and Malayalam as first language were included prospectively after fulfilling the following criteria:

(1) right hand dominance as assessed on Edinburgh Handedness Inventory (EHI) [25]

(2) a minimum of 12 years of formal education

(3) Adequate performance on the lateralizing test batteries of Rey Auditory Verbal Learning Test (RAVLT) [26] in Malayalam and Wechsler Memory Scale (WMS) - paired associative learning in Malayalam [26] for neuropsychological explicit memory functions as detailed previously by Jeyaraj et al. [27]

After meeting these criteria there were a total of 24 males and 40 females who were included as participants for the study. Out of the total 64 patients, there were 16 patients each with right and left temporal lobe epilepsy and 16 patients each with right and left extratemporal lobe epilepsy. A total of 64 healthy normal controls (NC) with Malayalam as first language were also included. The inclusionary criteria for the NC were

(1) Right hand dominance (based on EHI)

(2) Minimum of 12 years of education

(3) Normal cognitive functions as evidenced from Addenbrookes Cognitive Examination Malayalam (ACE – Malayalam) [28] test.

Similar to patient groups, NC had 24 male and 40 female subjects. The study was approved by the ethics committee of institute.

After getting the informed consent, the participants were administered the fluency, comprehension, repetition and naming subcomponents of Malayalam adaptation of WAB. [29] The responses were noted in the WAB scoring sheet and aphasia quotients were estimated. Aphasia quotients were derived as a comprehensive score considering the fluency of spontaneous speech, comprehension, repetition and naming subcomponents in WAB. The derived aphasia quotients were used for comparison across the patient groups.

RESULTS

The data collected included the demographic variables and scores from WAB. The statistical analysis was performed using IBM SPSS statistics for Windows version 21 (Armonk, NY, USA). Demographic details such as age, education and handedness of both groups were following normality (p>.05) and hence were compared using independent t test which showed that the two groups did not differ in those variables. Demographic details of normal controls and persons with epilepsy were summarized in Table 1.

Table 1 ***Group demographic information with respective p values***

	NC (N=64)	PWE (N=64)	*p* value
	Mean (SD)	Mean (SD)	
Age (years)	25.9 (6.66)	26 (6.85)	.938
Education (years)	14.56 (1.78)	14.10 (1.57)	.130
Handedness (EHI* score)	96.34 (8.12)	97.76 (6.44)	.274
ACE-Malayalam score	94.59+/-3.12		
RAVLT delayed recall scores		Right side: 12.6+/-3.47; Left side: 11.4+/-5.1	
RAVLT recognition scores		Right side: 13.8+/-1.5; Left side: 13.4 +/-1.1	
WMS-R paired associative learning scores		Right side: 12.6+/-3.47; Left side: 11.4+/-5.1	

Note. NC = Normal controls; PWE = Persons with epilepsy; EHI = Edinburgh Handedness Inventory; ACE-M = Addenbrooke's Cognitive Examination – Malayalam; RAVLT = Rey Auditory Verbal Learning Test, WMS-R= Wechsler Memory scale- revised; N= Number of participants

Shapiro – Wilk test of normality was carried out on the outcome measure of Aphasia Quotient (AQ) and it was noted that the data followed non normal distribution (p< 0.05). On WAB, the mean scores for subcomponents on fluency, comprehension and repetition were noted to be same. All the participants got the maximum score for each of the subcomponents except for verbal fluency

under naming component. The overall decrease in AQ was due to the variations in verbal fluency. However, none of the individuals had aphasia quotients less than 93.8, indicative of aphasia. The mean (standard deviation) aphasia quotient was 98.16 (.66) and 98 (0.52) for normal and PWE respectively. Table 2 represents the mean AQ scores and standard deviations for the participant groups.

Table 2 ***Mean aphasia quotient (AQ) scores and standard deviation for each group***

Groups	N	Mean	SD
Right Temporal Lobe Epilepsy (RTLE)	16	97.98	0.55
Left Temporal Lobe Epilepsy (LTLE)	16	97.96	0.49
Right extratemporal lobe epilepsy (RETLE)	16	98.03	0.57
Left extratemporal lobe epilepsy (LETLE)	16	98.01	0.49
Normal controls (NC)	64	98.15	0.66

Note. N – Number of participants

Mann Whitney U test was used to compare the aphasia quotients between NC with PWE which noted no significant difference between controls and patient groups, /z/ = 1.064, p= .287. Kruskal Wallis H test was then carried out across the four epilepsy patient groups as independent variables and aphasia quotient as dependent variable. It showed that there was no statistically significant difference between epilepsy groups with respect to their aphasia quotients, χ^2 (3) = .954. Thus, overall, there were no differences in the performance on WAB across the different epilepsy groups, or between PWE and NC as measured by aphasia quotient.

DISCUSSION

The current study aimed at understanding the ability of WAB in identifying language deficits so as to provide evidences to determine the lateralization and location of seizure onset for presurgical evaluations in patients with medically refractory epilepsies.

In contrast to the speculation of the current investigation to note varying linguistic profiles in WAB for different subgroups of epilepsy, we could not find any differences in the performance between right or left hemispheric epilepsy or with temporal or extratemporal epilepsy on their performance in WAB. Though WAB extensively assess comprehension, naming and fluency (implicated as affected in PWE, especially in left hemispheric epilepsies), it was noted that WAB subcomponent scores or aphasia quotients could not be used for identifying functional language deficits associated with seizure lateralization in localization related epilepsies when used as part of presurgical assessments.

To discuss these results, an in-depth understanding of studies that have reported linguistic deficits in epilepsy is warranted. Temporal lobe epilepsy (TLE) patients were reported to exhibit only circumscribed linguistic deficits than general linguistic disturbance. Specifically, LTLE patients have lateralization significance only in the task of retrieving names from memory while on tasks such as comprehension task, token test, repetition tasks etc. they did not give any evidence favoring lateralization of epilepsy. [30] This could be the reason for not finding any measurable differences in WAB scores for comprehension and repetition tasks.

Literature pertaining to confrontational naming skills in TLE had shown contradicting results, wherein, the performance was poor in persons with TLE compared to matched controls without no significant difference between LTLE and RTLE. [31-34] In the present study, no difference was noted in confrontation naming section of WAB neither between PWE and NC nor between the various subgroups of PWE.

An attempt to understand semantic and phonologic processing in TLE patients using case decision, category decision and rhyme decision had shown that at a behavioral level though reaction times were showing significant group differences between TLE and normal, accuracy was almost comparable between RTLE, LTLE and normal controls. [35] The authors suggested that there could be organizational differences in language representation and semantic deficits which may not be directly recorded at behavioral level due to factors

such as task on demand, or compensation by other brain areas.

Though anomic states were reported to be more in LTLE compared to RTLE, few studies noted that only the auditory naming task had lateralizing significance compared to visual naming tasks. [24,36] The visual based confrontation naming could not reliably differentiate LTLE and RTLE patients. Hence the object naming part in WAB may be highly redundant that this subcomponent also must have been less sensitive towards the assessment of word finding difficulties in epilepsy patients.

Current study though brought out differences between participants on the semantic fluency measure; this was insignificant across individuals studied. Semantic fluency tasks had reportedly failed to differentiate FLE from TLE irrespective of side of epileptogenesis. [31] A meta-analytic study on verbal fluency in focal epilepsy reported that phonemic fluency is impaired in FLE compared to TLE and more so in left FLE, with no measurable differences in semantic fluency between FLE and TLE. [37] Also, compared to left, right TLE patients were having remarkable impairments on both phonemic and semantic fluency. Hence the authors reported that semantic fluency measures as part of presurgical language assessment had poor lateralizing evidence for seizures. WAB measures only semantic fluency and hence this component of WAB could not bring in lateralizing evidences of seizures in extratemporal or temporal epilepsy patients in current study.

In addition to seizure related changes in verbal fluency, there are recent reports that even antiepileptic drugs (AED) can significantly alter the verbal fluency measures in PWE as these drugs could alter functional cognitive networks in the brain which may not be measurable at a behavioral level due to complex link between brain connectivity and cognition. AEDs like lamotrigine and levetiracetam (sodium channel blocking AED) could bring about measurable difference in verbal fluency even when variables like age, gender, age of onset of epilepsy and AED usage were controlled for. [38]

The research done in epilepsy showed that there exists a lack of consensus between studies on the language performance of patients with epilepsy due to various factors that includes patient related variables like age, gender, education, socioeconomic status, literacy, seizure related variables like seizure severity, frequency of seizures, age of onset of seizure, duration of seizures, type of seizures and treatment related variables like antiepileptic drugs, poly vs mono pharmacy etc. These findings signify the complexity in figuring out language deficits at the performance level in the routine assessments of language functions.

A 47% prevalence of language impairment was noted in persons with refractory epilepsy, when assessed using WAB in a previous study. [19] But the present results did not report any patient falling to aphasic category. This is in consonance to earlier reports of non-aphasic WAB scores obtained in patients with TLE. [21] The higher AQ in the current study could also have been contributed by the higher educational status of the patients recruited. The participants recruited had minimum 12 years of education, and hence were expected of having better cognitive reserve. [39]

The above literature details the possibilities for not finding a difference in the WAB sub component or total scores when administered in PWE. In addition to the above reasons, as WAB as a clinical test was designed primarily to assess aphasic impairments it may not adequately tap the subtle epileptic language deficits, [40] especially in people with better cognitive reserve. However in cases of naming decline following certain surgical resections for epilepsy management like in temporal lobectomy [41] or to understand effects of surgery in non-naming functions, WAB may be useful to adequately map and monitor the language status longitudinally.

The absence of any significant difference in any of the WAB components however does not necessarily mean that the linguistic skills in refractory focal epilepsies are not relevant to be incorporated in presurgical evaluations in epilepsy, rather it just shows the complexity of language organization in the brain which may get modified due to epileptic activity. Hence, to draw links between the language representation at a neural level and language at a performance level is far too complex and tailored tests tapping these deficits are strongly indicated.

As a comprehensive scale for assessing naming and non-naming functions, WAB structure and components have the potential to contribute to develop a comprehensive test for use in PWE. Few suggestions that may be considered while devising a test battery for evaluating language functions in epilepsy include assessing spontaneous speech measures in terms of syntactic complexities, to elaborate language comprehension section by including linguistic complexities as in Token tests and active-passive based questions. Repetition of non-words, inclusion of more uncommon stimuli for confrontation naming task, inclusion of oral definition tasks, phonemic fluency measures in addition to semantic fluency etc. This way a sensitive language battery may be devised to pick up the subtle linguistic deficits specific to each type of focal epilepsy. It would also be ideal to include a semantic or lexical decision task based on accuracy and reaction time measurements in the assessment protocol. Use of reaction time-based assessments may help assess the intricate changes in language networks, even when the language appears intact at a functional level.

CONCLUSION

The current study brought out that WAB is not a sensitive tool to be incorporated in presurgical language testing for persons with refractory epilepsy with better cognitive reserves for lateralizing seizure onset. However, this test is useful in profiling the language skills at least in a subset of PWE who may have significant language deficits or may be used longitudinally to address linguistic changes in a particular patient, pre and post-surgery. The study highlights the lack and profound need to develop a specific test battery that may be used for assessing the language skills in persons with epilepsy in Indian context.

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