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# The EEG as a diagnostic tool in distinguishing between dementia with Lewy bodies and Alzheimer's disease

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HIGHLIGHTS

- The Grand Total EEG (GTE) score can differentiate dementia with Lewy bodies (DLB) from Alzheimer's disease (AD) with good sensitivity and specificity.
- EEG should play a more prominent role in daily clinical practice as a diagnostic tool in differentiating DLB from AD.
- Future revisions of the diagnostic criteria for DLB should consider including frontal intermittent rhythmic delta activity (FIRDA).

ABSTRACT

*Objective:* Current diagnostic criteria for dementia with Lewy bodies (DLB) regard electroencephalogram (EEG) abnormalities as a supportive feature. It has also been suggested that EEG abnormalities in DLB are more extensive than in Alzheimer's disease (AD). Still, the use of qualitative EEG analysis as a diagnostic tool to distinguish between DLB and AD remains rare in daily clinical practice because of conflicting studies and absence of a reliable scoring method. The Grand Total EEG (GTE) score has been used in one study to differentiate DLB from AD with good sensitivity and specificity (Roks et al., 2008).
*Methods:* EEGs from 29 patients with DLB and 54 with AD were visually rated according to the GTE score.
*Results:* Patients with DLB had significantly higher median scores than patients with AD: 9 vs. 4. Patients with DLB could be distinguished from those with AD at a GTE cut-off score of 6.5 with a sensitivity of 79% and a specificity of 76%. The association between GTE and DLB was independent of age, gender, Mini Mental State Examination and use of medication. Frontal intermittent rhythmic delta activity (FIRDA) was found in 17.2% of patients with DLB compared to 1.8% with AD. Except for the lower cut-off score our results are comparable to the previous study on the GTE score.
*Conclusion:* The GTE score has proven to be a reliable and simple scoring method applicable to daily clinical practice. Qualitative EEG analysis can help to differentiate DLB from AD with good sensitivity and specificity.
*Significance:* EEG should play a more prominent role in daily clinical practice as a diagnostic tool in differentiating DLB from AD. Future revisions of the diagnostic criteria for DLB should consider the other EEG abnormalities as mentioned in the GTE score, especially FIRDA.


## 1. Introduction

Dementia with Lewy bodies (DLB) is widely considered to be the second most common cause of degenerative dementia after Alzheimer's disease (AD). The core features are fluctuating cognition, recurrent visual hallucinations and parkinsonism. In 2005 consensus criteria for the diagnosis of DLB were revised to improve

*Abbreviations:* GTE, Grand Total EEG; DLB, dementia with Lewy bodies; AD, Alzheimer's disease; EEG, electroencephalogram; FIRDA, frontal intermittent rhythmic delta activity.

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diagnostic accuracy (McKeith et al., 2005). However the diagnosis of DLB is still mostly based on the clinical picture and not all of the core features may be present at initial presentation or even during the entire course of the disease making it challenging to discriminate DLB from other dementias, especially AD, the most frequent clinical misdiagnosis of DLB. There are limited ancillary investigations to aid in the diagnostic process. The only test with high diagnostic accuracy is reduced striatal dopamine transporter uptake on functional imaging with a sensitivity of 78% and a specificity of 90% and is considered a suggestive feature for the diagnosis of DLB (Walker et al., 1999, 2002; McKeith et al., 2007). However this diagnostic test is not widely accessible for clinical use and alternative methods to improve accuracy of the diagnosis of DLB are needed.

In most memory clinics the electroencephalogram (EEG) is not considered a standard tool in the diagnostic workup of patients with DLB. Although quantitative EEG analysis have shown promise (Walker et al., 2000; Kai et al., 2005; Bonanni et al., 2008), this is a time consuming tool and not readily accessible for daily clinical practice. In the evaluation of dementia visual EEG analysis is only considered in case of suspected Creutzfeldt–Jacob disease, metabolic encephalopathy or non-convulsive seizures, or to differentiate AD from depression (Jonkman, 1997). There are reports that suggest that EEG abnormalities are more severe in patients with DLB compared to patients with AD reflecting the more severe loss of acetylcholine (Perry et al., 1993; Briel et al., 1999; Franciotti et al., 2006). However studies comparing EEG of patients with DLB and AD are scarce and conflicting as some report no differences between these two groups (Barber et al., 2000; Londos et al., 2003). In part this could be due to the use of different EEG scoring methods.

The Grand Total EEG score (GTE) is a qualitative EEG analysis method and has proven its diagnostic value in a variety of AD studies (Jonkman, 1997; Strijers et al., 1997; Claus et al., 1999). Only one study has compared the GTE scores of patients with DLB and AD (Roks et al., 2008). This study reported a significantly higher GTE score in patients with DLB and a good sensitivity and specificity to differentiate DLB from AD. Until this date however, these results have never been validated. In the present study we test the reproducibility of the former study. In addition, the present study was conducted in a different setting i.e. general teaching hospital compared to a tertiary referral clinic in the former study. Our goal is to determine the usefulness of the GTE score in daily clinical practice as an additional tool in the diagnostic workup and in the differentiation between patients with DLB and AD.

## 2. Methods

### 2.1. Patients

29 patients with probable DLB according to the consensus diagnostic guidelines (McKeith et al., 2005) were selected from the database of the memory outpatient clinic of St. Elisabeth Ziekenhuis, a general teaching hospital in Tilburg in the Netherlands. Of the 29 DLB patients there were 8 with 3 core features and 18 with 2 core features. The remaining 3 DLB patients had 1 core feature of which 2 had 2 additional suggestive features, and 1 had 1 additional suggestive and 1 supportive feature. The patients with DLB were compared to 54 patients with probable AD according to the NINCDS-ADRDA criteria. For each patient with DLB 2 patients with AD were matched for age and gender. For 4 patients with DLB, only 1 patient with AD could be matched, resulting in 54 patients with AD.

All patients had undergone a standard battery of examinations consisting of medical history, physical and neurological examination, screening laboratory tests, psychometric tests, brain imaging (either CT or MRI) and EEG. Diagnoses were made according to the consensus criteria for the diagnosis of DLB and NINCDS-ADRDA criteria. Neuropathological confirmation was not available, but for all patients a strict follow-up of at least 1 year was maintained throughout which clinical diagnosis remained unchanged.

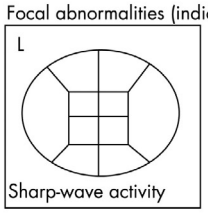
| | |
|---|---|
| Frequency of rhythmic background activity | 1 = 8–9 Hz<br>2 = 7–8 Hz<br>3 = 6–7 Hz<br>4 = 4–6 Hz<br>5 = none |
| Diffuse slow-wave activity | 0 = none<br>1 = intermittent theta<br>2 = intermittent theta + sporadic delta<br>3 = intermittent theta + intermittent delta<br>4 = continuous theta + delta<br>5 = continuous delta |
| Reactivity of rhythmic background activity | 0 = normal<br>1 = decreased with eye opening<br>2 = absent with eye opening<br>(3–5 = absence of reactivity after somatosensory and or auditory stimulus) |
| Paroxysmal activity | 0 = none<br>3 = paroxysmal slow-wave activity<br>5 = FIRDA |
| Focal abnormalities (indicate location in drawing) | 0 = none<br>1 = moderate unilateral<br>2 = moderate bilateral<br>3 = severe unilateral moderate contralateral<br>4 = severe bilateral<br>5 = multifocal |
|  <br>Sharp-wave activity | 0 = none<br>2 = sporadic sharp waves<br>3 = frequent sharp waves<br>4 = trifasic waves<br>5 = Creutzfeldt–Jakob complex or PLEDS |
| | GTE score = (sum) + 1 = … |

**Fig. 1.** The Grand Total EEG (GTE) score. FIRDA, frontal intermittent rhythmic activity; PLEDS, periodic lateralized epileptic discharges.