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Preoperative IQ predicts seizure outcomes after anterior temporal lobectomy

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ABSTRACT

Purpose: IQ tests are frequently used in the preoperative neuropsychological assessment of candidates for anterior temporal lobectomy (ATL). We reviewed IQ test results and surgery outcomes to evaluate the roles of IQ tests in the preoperative work-up.
Methods: A total of 205 adult patients who had undergone ATL and whose seizure outcomes were followed for 2 years after surgery were included. The short form WAIS-R was used to estimate intelligence. Multiple linear regression and logistic regression analyses were used to examine the variables for IQ and seizure outcomes.
Results: Education, duration of epilepsy and gender were factors that accounted for 24.6% of the variance in the full-scale IQ (FSIQ) scores. The verbal IQ and performance IQ discrepancies at various magnitudes could not lateralize the seizure foci. Freedom of seizure was noted in 128 (62.4%) of the patients. Seizure outcomes, however, correlated with the preoperative FSIQ. After adjustment for variables that affect seizure outcomes, the FSIQ was an independent predictor of postoperative seizure outcomes (OR 1.04, 95% CI 1.01–1.06, $p = 0.003$). Of patients who had FSIQ lower than 70, 50% became free from seizures by 2 years after surgery.
Conclusions: In our study, IQ tests were unable to lateralize seizure foci but may serve as an independent predictor of postoperative seizure outcomes. Since a longer duration of epilepsy had deleterious effects on intelligence, earlier surgical intervention might better preserve neuropsychological function and, consequently, allow better seizure control after ATL. Nonetheless, patients with lower IQ scores could still benefit from ATL.

1. Introduction

Comprehensive neuropsychological assessments of candidates for epilepsy surgery are routinely administered at most centers that specialize in treating epilepsy.[1] These tests can facilitate the evaluation of the integrity of cognition before surgery, the identification of cognitive sequelae resulting from resection surgery, the refinement of surgical parameters, and appreciation of the overall impact of cognitive change following epilepsy surgery.[2] Patients with chronic temporal lobe epilepsy (TLE) have widespread cognitive morbidity. For patients with TLE, intelligence assessment is a frequently tested preoperative parameter, although greater attention is given to the material-specific memory deficits. Comparison of the results from various cognitive measures between patients with TLE and normal subjects demonstrated negative impacts of epilepsy on memory, naming, motor dexterity and intelligence.[3,4] The application of neuropsychological tests in lateralizing seizure focus has been of great interest for researchers. Verbal–performance IQ (V–P IQ) discrepancies related to the side of the hemispheric lesion have been reported in a large sample of neurological patients tested with different versions of IQ tests.[5,6] A logical hypothesis suggests that the V–P IQ discrepancies may be able to lateralize the epileptogenic foci. A large number of patients tested following the surgical removal of the affected temporal lobe have shown either performance IQs about 6 points higher than verbal IQs (in patients undergoing left anterior temporal lobectomy (ATL)), or verbal IQs 2.5 points higher than performance IQs (in patients undergoing right ATL).[6] The results, however, were not the same for lateralizing the epileptogenic side using V–P IQ discrepancies before surgery. Although a few studies have demonstrated some degree of lateralizing value for IQ tests under certain conditions,[7,8]

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most studies that attempted to evaluate the role of IQ tests in the lateralization of epileptogenic foci before surgery failed to demonstrate promising results.[1,9] Another application of preoperative IQ performance has been the prediction of seizure outcome after ATL. The results were consistent among previous studies of adult patients: the seizure outcomes of patients with lower preoperative intelligence performance were not as good as those of patients with IQs above average.[10–12] The most frequently used IQ tests, Wechsler Adult Intelligence Scale-revised (WAIS-R) or WAIS-III, require much time and effort to administer and score. The assessment of global intelligence by various short forms has been proven to be reasonable with respect to time and as effective as the full form.[1,9] We retrospectively evaluated the roles of IQ tests using a short form of the WAIS-R for our patients who underwent ATL. The impact of epilepsy on intelligence, lateralization values with respect to the side of TLE and prediction of postoperative outcomes were examined in this study.

2. Methods

2.1. Subjects

A total of 205 Chinese-speaking patients who had undergone ATL for intractable seizures at the Taipei Veterans General Hospital between 1987 and 2002 were enrolled in this study. All subjects were older than 16 years of age, and their preoperative IQ scores and postoperative seizure outcome data were available. Our preoperative evaluation included long-term video-electroencephalography (video-EEG) telemetry with sphenoidal electrodes, brain magnetic resonance imaging (MRI), magnetic resonance spectroscopy (MRS since 1995), magnetoencephalography (since 2000), interictal and postictal single-photon emission computed tomography (SPECT), fluoro-D-glucose positron emission tomography (PET), psychiatric consultation, neuropsychological assessment, and intracarotid amobarbital procedures (IAPs). The study results were discussed at the multidisciplinary seizure conference and, in each case, the side of the temporal lobectomy was determined by concordance of the above measurements. According to the video-EEG recording interictal spikes were categorized as unifocal (spikes only in the temporal region ipsilateral to the side of resection or no spikes) or non-unifocal (spikes in extratemporal regions or contralateral temporal spikes with an occurrence of more than 10% of the total amount of spikes). The interictal EEG was sampled for a 2-min duration every 30 min during the video-EEG recording. In order to examine the lateralization values based on preoperative IQ, only patients with left hemisphere speech dominance as determined by IAP were included. The seizure outcomes were categorized by Engel's classification.[13] In this study, freedom from seizures refers to complete freedom from disabling seizures with or without auras (Engel's IA and IB) for 2 years after ATL.

2.2. IQ tests

IQ tests were performed by the neuropsychologists. Three versions of IQ tests including WAIS-R, a short form of the WAIS-R (Digit span, Arithmetic, Similarities, Block design, Objects assembly and Digit symbol),[14] and WAIS-III, have been used in our epilepsy center over the past 20 years. The correlation between the short form and full form WAIS-R was examined in a subgroup of 30 patients. Correlations between the short form and full form WAIS-R in estimating the VIQ, PIQ and FSIQ (Spearman $r = 0.76, 0.81, 0.80$ for VIQ, PIQ and FSIQ) were significant and robust. The majority of our cases were assessed by the short form of the WAIS-R. In the present study, we enrolled only those patients for whom short form of WAIS-R was used.

2.3. Statistical analyses

Student's t, chi-square, and Mann–Whitney U tests were used to examine the differences in demographic characteristics between left and right TLE. Simple linear regression analysis was used to evaluate possible clinical variables, including age, gender, onset, duration of epilepsy, side of TLE, and pathology of lesions other than gliosis that could affect IQ. Variables that significantly correlated with IQ in the simple regression analysis were then submitted to multiple linear regression analyses. The model included only variables for which $p < 0.05$. When examining the lateralization value of IQ scores, the scores of the VIQ minus PIQ were categorized as greater than 10 (suggesting right TLE), intermediate, or less than −10 (suggesting left TLE). The lateralization results were then compared with the side of the ATL. To evaluate the relationship between postoperative seizure outcome and IQ, logistic regression analysis was used. Seizure outcomes were compared in patients whose FSIQ values were higher than 87 and lower than 87. The IQ cut-off was determined by the median FSIQ (87.0) of the 205 patients in this study. Adjusted variables in the multiple logistic regression models included age at onset, age at surgery, resection type (ATL with or without hippocampectomy), histopathological diagnosis (gliosis or other lesion), and structural abnormality upon MRI (yes or no). A p-value less than 0.05 was considered to be statistically significant. All statistical analyses were performed using SPSS version 15.0 for Windows.

3. Results

The demographic characteristics for both left and right TLE patients are shown in Table 1. The mean group age at the time of testing was higher for left TLE patients than right TLE patients ($p = 0.031$).

3.1. Factors related to intelligence

The duration of epilepsy and years of education were related to the IQ scores, according to the linear regression analysis. Patient age at testing and gender were also statistically significant in predicting FSIQ and VIQ (Table 2). The age at onset and duration of epilepsy showed high-grade co-linearity in this study. We then decided to exclude the age at onset from the multiple regression analysis because the duration of epilepsy demonstrated a stronger correlation with the dependent variable of IQ. Patients with unifocal interictal spikes or no interictal spikes demonstrated a better FSIQ and PIQ.

In the multiple regression models, education, duration of epilepsy, and gender accounted for 24.6% and 25.3% of the variance in the FSIQ and VIQ scores respectively. Education and duration of epilepsy accounted for 16.7% of the variance in the PIQ scores.

3.2. Lateralization based on IQ scores

The group IQ showed no difference with respect to the side of TLE (Table 1). The group difference in V–P IQ discrepancies was not statistically significant (Mann–Whitney U, $p = 0.311$).

V–P IQ discrepancies greater than 10 points were noted in 56 of the 205 patients (27.3%), and those less than −10 were present in 16 of the 205 patients (7.8%). Correct lateralization for V–P IQ discrepancies greater than 10 was 37.5% for left TLE and 57.1% for right TLE patients. Different magnitudes of V–P IQ discrepancies did not produce better lateralization values (Table 3). When patients with pathology diagnoses of gliosis or secondary TLE due to a tumor or some other structural lesions were analyzed separately, correct lateralization occurred in a similar fraction to