Obsessive-compulsive dimension localized using low-resolution brain electromagnetic tomography (LORETA)

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Abstract

Electroencephalographic mapping techniques have been used to show differences between normal subjects and those diagnosed with various mental disorders. To date, there is no other research using the techniques of low-resolution brain electromagnetic tomography (LORETA) with the obsessive-compulsive disorder (OCD) population. The current investigation compares current source density measures of persons with OCD symptoms to an age-matched control group. The main finding is excess current source density in the Beta frequencies in the cingulate gyrus. This Beta activity is primarily located in the middle cingulate gyrus as well as adjacent frontal parieto-occipital regions. Lower frequency Beta is prominent more anteriorly in the cingulate gyrus whereas higher frequency Beta is seen more posteriorly. These preliminary findings indicate the utility of LORETA as a clinical and diagnostic tool.

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Electroencephalographic mapping techniques have been used to show differences between normal subjects and those diagnosed with various mental disorders. Studies have been conducted previously on depression [10], attention-deficit disorder [2] and other more disorders such as schizophrenia [8]. Quantitative electroencephalographic (QEEG) mapping techniques have traditionally been used [2] whereas others have also incorporated low-resolution electromagnetic tomography (LORETA) [8,10]. Combined, these studies have illustrated the usefulness of such mapping techniques in the diagnosis and treatment of these disorders. QEEG and LORETA techniques are useful in treating disorders through increased accuracy in diagnoses, medication response prediction and potentially through EEG-based biofeedback [5]. Previous QEEG research on obsessive-compulsive disorder (OCD) has indicated an excess of Alpha and Beta activity in the central channels when analyzed using QEEG techniques [11]. However, to date, there is no current research using the techniques of LORETA with the OCD population. The current investigation compares current source density measures of persons with OCD symptoms to an age-matched control group.

The data for this study was selected from an archived database of 108 adult clients who had presented for evaluation of various complaints. All clients had completed a Symptom Checklist—Revised (SCL-90-R) and had an electroencephalograph (EEG) recording scalp electrical potentials as part of the assessment. To be included in the clinical group the subject must have scored a t-value of 67 (95 percentile) or higher on the obsessive-compulsive dimension of the SCL-90-R, with all other dimensions having a t-value below 63 (90 percentile). There are no specific studies that could be found to address the correlation of obsessive-compulsive dimension to obsessive-compulsive disorder. However, the individuals included in the clinical population scored at the 67 t-value are in the 95% of the normative sample for those symptoms included in the obsessive-compulsive dimension, which were the same as those required for the obsessive compulsive disorder diagnosis by the DSM-IV-TR [1]. There were eight subjects from the sample of 108 that fit these criteria. The
sagittal view left of picture is front of the brain. The slice passing thought the voxel with maximal t

Non-significant statistics are coded as zero. At the top of each image are printed the placement. Electrode impedances were reduced to below according to the International 10-20 System of electrode standard deviations.

ages of 17 and 29 years old. The mean age was 23.1 and 4.04 four females and four males. All subjects were between the inclusion did not allow for sex match. The control group consisted of three females and five males and the clinical group included four females and four males. All subjects were between the ages of 17 and 29 years old. The mean age was 23.1 and 4.04 standard deviations.

Brain electrical activity had been digitally recorded on a LEXICOR NeuroSearch-24 system from 19 scalp electrodes, according to the International 10-20 System of electrode placement. Electrode impedances were reduced to below 5 kΩ. EEG was recorded continuously in the awakened state with eyes closed and open and during active task conditions. For this study, the eyes closed data was imported into the EuseKa! software [3] for precise artifact rejection and for computing the cross-spectral analysis for each subject in nine bands. These bands were Delta (2–3.5 Hz), Theta (4–7.5 Hz), Alpha1 (8–10 Hz), Alpha2 (10–12 Hz), Beta1 (12–16 Hz), Beta2 (16–20 Hz), Beta3 (20–24 Hz), Beta4 (24–28 Hz) and Beta5 (28–32 Hz). Each group’s cross-spectra was computed and the two groups compared using a t-sum procedure which is a multiple comparison procedure based on a combination of t-sums and LORETA difference maps for the nine frequencies were displayed using the LORETA Key software [9].

There is a main finding of excess current source density in the Beta frequencies in the cingulate gyrus. The Beta frequencies are primarily located in the middle cingulate gyrus as well as adjacent frontal parieto-occipital regions. However, when this Beta is examined in narrower defined frequency bands, each localizes in a slightly different location. Lower frequency Beta is prominent more anteriorly in the cingulate gyrus whereas higher frequency beta is seen more posteriorly (see Fig. 1). This study is aimed at finding the location of current source density differences between two groups that differed on the obsessive-compulsive dimension of the SCL-90-R. Other dimensions are not considered except that they have a t-value of less than 63 (90 percentile). For this study, OCD is defined and measured by the SCL-90-R as “symptoms that are often identified with the standard clinical syndrome of the same name.” This measure focuses on thoughts, impulses and actions that are experienced as unremitting and irresistible and that are of an ego-alien or unwanted nature [6].

The finding is that individuals who subscribe to symptomatology of OCD have excess Beta activity in the cingulate gyrus when compared to a non-OCD control group. This is consistent with the [11] QEEG finding of excess central Beta, but is not corroborative of their finding of excess central Alpha. A probable explanation is that clinical symptoms may be present within the groups used in this study, which may not be measured by the SCL-90-R. As measured by this scale, the control group is a normal group and the OCD group had no other dimensions of clinical significance.

Surgical treatment of refractory cases of OCD have sometimes involved small anterior cingulotomies [7]. In this study the primary results were in the middle cingulate gyrus. Based on the high signal-to-noise ratio of the EEG recordings, we do not believe that LORETA introduced large (>2 cm) localization errors for this data. Indeed, significant differences in Beta1 cover the anterior cingulate and the areas usually involved in anterior cingulotomy. Our findings suggest that in addition to these regions, overactivation of the middle cingulate gyrus also plays an important role in OCD symptoms. In general, the higher the Beta frequency range the more posterior the portion of the middle cingulate involved. Further studies should explore other scales measuring OCD symptoms to evaluate the specificity of these findings using the SCL-90-R. Despite the limitations, this preliminary study demonstrates the utility of LORETA as a clinical tool.

References


