Alzheimer’s disease, i.e. AD is a common neurological degenerative disease in elderly patients. With recent increase of aging population, incidence of AD increases, which causes a large impact on patients’ daily life. In clinical practice, assessment of AD mainly depends on observation of the symptoms as well as determination of NFDS. However, influenced by subjective judgment, it cannot assess the condition in a more comprehensive and objective manner. EEG and serum index detection have the ideal characteristics of repeatability and objectivity and are increasingly used for AD condition assessment. In the following research, quantitative EEG detection results of AD patients and its correlation with serum index were analyzed.

1. Materials and methods

1.1 Subjects

50 AD patients diagnosed in our hospital from May 2012 to August 2014 were enrolled in the observation group, all of whom met the diagnostic criteria, first diagnosed with AD and had not received drug treatment. Healthy people who received physical examination in our hospital during the same period were enrolled in the control group. Then quantitative EEG detection was conducted and serum was collected to detect contents of inflammatory factors and neuron injury related molecules.

1.2 Methods
1.2.1 EEG detection methods

EEG detection was conducted in a quiet, dim and electric shielding examination room. Patients were in a quiet and eye-closed state. Electrodes were placed according to international 10-20 system to collect 16 unipolar lead sampling, FP1, FP2, F3 and F4 being frontal lobe, F7, F8, T3, T4, T5 and T6 being temporal lobe, parietal lobe and occipital lobe of the observation group were higher than those of the control group; (2)inflammatory factors: serum TNF-α, IL-1β, IL-6, MMP2, MMP9 and ET contents of the observation group were higher than those of the control group and were positively correlated with (δ+θ)/(α+β) ratios; (3) neuron injury related molecules: serum Hcy, Aβ1-42, Tau, Glu, Aap and Gly contents of the observation group were higher than those of the control group and were positively correlated with (δ+θ)/(α+β) ratios.

1.3.2 Objective

To study the quantitative EEG detection results of patients with Alzheimer's disease and its correlation with serum index.

Methods: 50 patients with Alzheimer's disease diagnosed in our hospital from May 2012 to August 2014 were enrolled in the observation group; healthy people who received physical examination in our hospital during the same period were enrolled in the control group. Then quantitative EEG detection was conducted and serum was collected to detect contents of inflammatory factors and neuron injury related molecules.

Results: (1)quantitative EEG: (δ+θ)/(α+β) ratios of whole brain, frontal lobe, temporal lobe, parietal lobe and occipital lobe of the observation group were higher than those of the control group; (2)inflammatory factors: serum TNF-α, IL-1β, IL-6, MMP2, MMP9 and ET contents of the observation group were higher than those of the control group and were positively correlated with (δ+θ)/(α+β) ratios; (3) neuron injury related molecules: serum Hcy, Aβ1-42, Tau, Glu, Aap and Gly contents of the observation group were higher than those of the control group and were positively correlated with (δ+θ)/(α+β) ratios.

Conclusion: (δ+θ)/(α+β) ratios of quantitative EEG detection of patients with Alzheimer's disease abnormally increase and have good correlation with abnormality of serum inflammatory factors and neuron injury related molecules; it's an ideal method to evaluate the severity degree of Alzheimer's disease.
0.8-4.0Hz, θ wave of 4.0-7.8Hz, β wave of 7.8-12.8Hz, β wave of 12.8-20.0Hz; absolute power values and (+θ)/(+β) ratios were calculated.

1.2.2 Serum detection methods

RP-HPLC fluorescence method was used to detect Glu, Asp and Gly contents; ELISA was used to detect TNF-α, IL-1β, IL-6, MMP2, MMP9, ET, Hcy, Aβ1-42 and Tau contents.

1.2.3 Statistical methods

Data were input and analyzed by SPSS18.0 software, measurement data for t test and correlation analysis for linear regression. Differences were considered to be statistically significant at a level of \( P < 0.05 \).

2. Results

2.1 Quantitative EEG detection results

Quantitative EEG is the objective and noninvasive method to detect neural function. At first, both groups received quantitative EEG detection. Absolute power values of wave, β wave, wave and θ wave of whole brain, frontal lobe, temporal lobe, parietal lobe and occipital lobe were analyzed. (+θ)/(+β) ratios were calculated to reflect relative power. After t test, it was found that (+θ)/(+β) ratios of whole brain, frontal lobe, temporal lobe, parietal lobe and occipital lobe of the observation group were higher than those of the control group. Differences had statistical significance (\( P < 0.05 \)).

### Table 1
Comparison of both groups' quantitative EEG (+θ)/(+β) ratios

<table>
<thead>
<tr>
<th></th>
<th>whole brain</th>
<th>frontal lobe</th>
<th>temporal lobe</th>
<th>parietal lobe</th>
<th>occipital lobe</th>
</tr>
</thead>
<tbody>
<tr>
<td>The observation group</td>
<td>2.13±0.34</td>
<td>2.58±0.38</td>
<td>1.94±0.25</td>
<td>2.29±0.29</td>
<td>2.08±0.32</td>
</tr>
<tr>
<td>The control group</td>
<td>0.89±0.10</td>
<td>1.21±0.18</td>
<td>0.77±0.09</td>
<td>1.04±0.15</td>
<td>0.81±0.09</td>
</tr>
<tr>
<td>( T )</td>
<td>13.484</td>
<td>11.104</td>
<td>15.029</td>
<td>10.592</td>
<td>14.204</td>
</tr>
<tr>
<td>( P )</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

2.2 Serum inflammatory factors

Inflammation is an important pathological link which causes neurological impairment in AD patients. And serum inflammatory factor contents can reflect inflammation degree. Therefore, ELISA was used to detect both groups' serum inflammatory factor contents. After t test, it was found that serum TNF-α, IL-1β, IL-6, MMP2, MMP9 and ET contents of the observation group were higher than those of the control group. Differences had statistical significance (\( P < 0.05 \)).

### Table 2
Comparison of both groups' serum inflammatory factor contents

<table>
<thead>
<tr>
<th></th>
<th>TNF-α (ng/L)</th>
<th>IL-1β (ng/L)</th>
<th>IL-6 (ng/L)</th>
<th>MMP2 (ng/L)</th>
<th>MMP9 (ng/L)</th>
<th>ET (ng/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The observation group</td>
<td>123.48±16.85</td>
<td>148.95±19.50</td>
<td>139.18±18.62</td>
<td>226.86±30.49</td>
<td>341.95±45.69</td>
<td>245.23±45.62</td>
</tr>
<tr>
<td>The control group</td>
<td>51.34±6.92</td>
<td>84.59±10.29</td>
<td>67.71±9.48</td>
<td>105.68±14.85</td>
<td>165.69±23.15</td>
<td>104.54±14.59</td>
</tr>
<tr>
<td>( P )</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

2.3 Serum neuron injury related molecules

Inflammatory hyperthyroidism and inflammatory factor injury can damage neurons and cause unusually high levels of serum neuron injury related molecules. Nerve-related protein and excitatory amino acid are important serum indexes that reflect extent of neuronal damage. Therefore, both groups' serum neuron injury related molecule contents were detected. After t test, it was found that serum Hcy, Aβ1-42, Tau, Glu, Aap and Gly contents of the observation group were higher than those of the control group. Differences had statistical significance (\( P < 0.05 \)).

### Table 3
Comparison of both groups' serum neuron injury related molecule contents

<table>
<thead>
<tr>
<th></th>
<th>Hcy (μmol/L)</th>
<th>Aβ1-42 (ng/L)</th>
<th>Tau (ng/L)</th>
<th>Glu (mg/mL)</th>
<th>Asp (mg/mL)</th>
<th>Gly (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The observation group</td>
<td>18.53±2.26</td>
<td>75.29±9.26</td>
<td>32.18±5.17</td>
<td>141.24±19.18</td>
<td>123.12±17.45</td>
<td>98.32±10.61</td>
</tr>
<tr>
<td>The control group</td>
<td>7.19±0.98</td>
<td>27.84±3.18</td>
<td>11.47±2.08</td>
<td>63.31±8.42</td>
<td>49.52±7.19</td>
<td>31.38±5.12</td>
</tr>
<tr>
<td>( P )</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>
3. Discussions

Characteristics of AD are overall disorders of cognitive function, mobility impairments of activities of daily living and abnormalities of mental state and acts, which will cause negative effect on patients’ life quality. In clinical practice, establishment of treatment options depend on accurate assessment of the disease. Clinical symptom observation and neuropsychological scale are common ways to judge AD. However, psychological scales are influenced by subjective judgment. At the same time, AD patients have severe cognitive function disorder and are unable to complete assessments of a variety of scales without good cooperation. Common methods cannot accurately and objectively assess AD patients’ conditions. Quantitative EEG is the auxiliary examination method for nerve functional assessment in recent years. It can directly display the activity of neurons of the brain. It quantifies raw EEG data through mathematical method and computer technology, transforms the relationship between EEG amplitude and time into digital information of EEG power and frequency, with advantages of noninvasive and objective[1-2]. Studies have shown that routine EEG of AD patients displays weakening wave and β wave activity and strengthening wave and θ wave activity. And it has good correlation with cognitive function impairment[3]. Absolute EEG powers are largely different among different individuals. But relative EEG powers reflect nerve function by calculating the percentage of a certain frequency power to the total power, which can effectively eliminate the influence of individual factors on EEG power[4]. The research used (α+θ)/(α+β) ratios to reflect relative EEG power. Analysis of characters of EEG of AD patients and healthy people showed that (α+θ)/(α+β) ratios of the observation group were higher than those of the control group, which indicated that EEG indexes of AD patients were abnormal.

In the occurrence and development process of AD, Aβ deposition and tangles of nerve fiber are the important pathological features while inflammatory hyperthyroidism and large generation of inflammatory factors are the important reasons of neuronal damage and Aβ deposition[5]. Serum inflammatory factors come from activated inflammatory cells and excessively damaged endothelial cells, etc. They can change blood-brain barrier and enter the cerebrospinal fluid, thus resulting in neuronal damage. TNF-α and IL-1β are currently known inflammatory factors with the most wide features, which can directly act on neurons and cause cell damage. Excessively generated TNF-α and IL-1β in serum and cerebrospinal fluid are important pathological factors that cause AD occurrence [6-7]. IL-6 is an endogenous chemokine secreted by activated mononuclear macrophage, which can recruit multiple inflammatory cells in local neurons and promote secretion of inflammatory factors [8]. MMPs family is a type of protease super family with zinc domain. MMP2 and MMP9 are largely expressed and in the zymogen form in amyloid plaques of AD patients. When affected by cathepsin, elastase and superoxide anion, they are activated, cause degradation of extracellular matrix and myelin basic protein, and ultimately result in central nerve cell blood-brain barrier damage and neurological impairment[9]. ET is a kind of inflammatory factors that are closely related to vascular endothelial function, which can strongly contract vascular and influence endothelial function. Excessive generation of ET will cause neural microcirculation damage and oxidative stress[10]. The research analyzed both groups’ serum inflammatory factor contents and found that serum TNF-α, IL-1β, IL-6, MMP2, MMP9 and ET contents of the observation group were higher than those of the control group and positively correlated with (α+θ)/(α+β) ratios, which indicated that AD patients’ serum inflammatory factor contents abnormally increased and had good correlation with EEG detection results.

As has been noted, inflammation is an important pathological link which causes neurological impairment in AD patients. High local amount of inflammatory factors can directly act on neurons and cause cell damage. Recent studies have shown that a variety of serum indexes can accurately assess the extent of neuronal damage. Hyperhomocysteinemia is an important feature of AD. Excessive accumulation of homocysteinemia, i.e. Hcy in serum can increase β-amyloid deposition, form senile plaques and cause amyloid and necrosis of neurons. At the same time, Hcy can activate oxidative stress and N-methyl D-aspartate receptors to produce neurotoxicity [11]. Aβ is the peptide fragments of amyloid precursor protein through enzymatic hydrolysis. It is the initial factor of neurons amyloidosis. Aβ 1-40 and Aβ 1-42 are two subtypes of Aβ. The latter one has stronger neurotoxicity and can more easily accumulate and form amyloid deposition[12]. Tau is a kind of phosphorylated proteins in neurons with effects of connecting microtubules and stabiling neurons. When neurons suffer from inflammatory injury, cells burst and Tau proteins in the cytoplasm are largely released into blood [13]. Excitatory amino acids are important signal molecules in the implementation of neural function, but excessive accumulation of excitatory amino acids in the synaptic structure will lead to continuously increased neuronal excitability and large internal flow of Na⁺ and Ca²⁺, and cause osmotic stress of neurons [14-15]. Glu, Asp and Gly are three main excitatory amino acids. The research analyzed both groups’ serum neuron injury related molecule contents and found that serum Hcy, Aβ 1-42, Tau, Glu, Aap and Gly contents of the observation group were higher than those of the control group and were positively correlated with (α+θ)/(α+β) ratios, which indicated that AD patients’ serum neuron injury related molecule contents abnormally increased and had good correlation with EEG detection results.
In conclusion, \((\frac{\alpha + \beta}{\alpha + \theta})\) ratios of quantitative EEG detection of patients with Alzheimer’s disease abnormally increase and have good correlation with abnormality of serum inflammatory factors and neuron injury related molecules; it’s an ideal method to evaluate the severity degree of Alzheimer’s disease.

References


