Regional homogeneity in patients with obsessive-compulsive disorder and depression: a resting state functional magnetic resonance imaging study

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Abstract

Objection: To explore the brain functional impairment in patients of obsessive-compulsive disorder (OCD) with and without depressive symptoms, and then analyze the correlation between the degree of impairment and the severity of symptoms.

Method: In this study, 14 patients with OCD who met the ICD-10 diagnostic criteria for "obsessive-compulsive disorder" were included; the OCD with depression (OCDd) group consisted of 15 patients; and 17 healthy controls (HC) matched for age and education were included. The Yale-Brown OCD Scale (Y-BOCS) and the 24-item Hamilton Assessment of Depression Scale (HAMD) were administered to the OCD group and the OCDd group. Resting-state functional brain magnetic resonance imaging was performed in three groups of participants.

Result: The OCDd group had lower scores on the HAMD, Y-BOCS, and obsessive-compulsive thinking subscales than the OCD group ($P<0.05$). Scores on the OCDd subscale were negatively correlated with HAMD scores ($R = -0.568$, $P = 0.027$). The OCDd group had higher ReHo values in the lingual gyrus than the OCD group. The OCDd group had higher ReHo values in the lingual gyrus than the HC group, while the OCDd group had higher ReHo values than the HC group. These differences were statistically significant ($P<0.05$). After correction for multiple comparisons, there was no significant difference between the OCDd and HC groups ($P>0.05$). In the OCD group, the ReHo value of the tongue was negatively correlated with the Y-BOCs total score and the compulsive behavior subscale score ($R = -0.609, -0.552, P = 0.016, 0.033$).

Conclusion: Abnormal ReHo values in the lingual gyrus and right medial superior frontal gyrus were found in patients with OCD. No effect of OCD symptoms on the local coherence of brain function was observed, which may indicate that OCD symptoms are not responsible for the changes in local coherence of the brain, but are caused by depressive symptoms. In the OCD group, ReHo values of the lingual gyrus were negatively correlated with scores on the Y-BOCs total and obsessive-compulsive subscales, suggesting that abnormal local coherence of the lingual gyrus may be related to the severity of OCD.

1. Introduction

Obsessive-compulsive disorder (OCD) is a common psychiatric disorder whose main clinical manifestations are obsessive-compulsive disorder and obsessive-compulsive disorder. The disease is characterized by early onset, long duration, difficulty in treatment and easy recurrence, causing great suffering to patients and seriously affecting their social functioning(Yuan et al., 2020). Between 1% and 3% of the world's population has OCD, with a lifetime prevalence of 2% to 3%(Tibi et al., 2017). Patients with OCD take an average of seven years to reach a diagnosis(Thompson et al., 2020), which results in a low rate of early identification of OCD, and the condition is often chronic and difficult to heal naturally without systematic treatment, with patients always accompanied by suicidal thoughts and suicidal behavior(Breet, Kidd, McGregor, Stein, & Lochner, 2019; Tibi et al., 2017). Therefore, OCD patients are prone to comorbid depression(Jones, Mair, Riemann, Mugno, & McNally, 2018). Depression is a common
disease that seriously affects social function and quality of life. In 2008, the World Health Organization announce that the disease burden caused by depression ranked third among all diseases, and it is expected to rise to the first place in 2030 (Malhi & Mann, 2018). There are now 350 million people worldwide who suffer from depression. Studies show that patients with comorbid obsessive-compulsive depression have a worse prognosis and are more difficult to treat (Rozenman et al., 2019).

The etiology of OCD and depression is extremely complex, involving social, psychological, and biological factors. Currently, some studies suggest that the pathogenesis of OCD and depression is related to cortico- striato-thalamo-cortical (CSTC) abnormalities (Park, Kim, Kim, Lee, & Kwon, 2020). Genetic studies have shown that CSTC is an important neurological circuit that regulates 5-hydroxytryptamine, dopamine and glutamate in patients with OCD. It has been shown to be associated with psychomotor retardation in depression (Pauls, Abramovitch, Rauch, & Geller, 2014). Abnormal secretion of 5-hydroxytryptamine and dopamine was also found to be associated with the pathogenesis of depression. Chattun (Chattun et al., 2020) proposed that suicide risk in depressed patients is associated with the dorsolateral prefrontal cortex, caudate nucleus and thalamus in the CSTC circuit, which is responsible for executive functions and working memory. Studies have also shown that OCD and depression share the same susceptibility genes, such as the serotonin transporter gene (Miozzo, Eaton, Joseph Bienvenu, Samuels, & Nestadt, 2020; Sinopoli et al., 2020). At present, serotonin reuptake inhibitors are recommended as first-line treatment for depression and obsessive-compulsive disorder, and the treatment schemes of depression and obsessive-compulsive disorder are highly similar. These studies suggest that depression and obsessive-compulsive disorder have common pathophysiological changes and common neurobiological basis to some extent.

In recent years, the research on the pathogenesis of obsessive-compulsive disorder has made new progress. Resting-state functional magnetic resonance imaging (rs-fMRI) (Khosla, Jamison, Ngo, Kuceyeski, & Sabuncu, 2019) can reflect the pathophysiological changes of brain functional activities by measuring the spontaneous fluctuation of blood oxygen level dependent (BOLD) signals in the brain. ReHo is one of the main research methods of rs-fMRI, which can measure the temporal similarity between a single voxel and its adjacent voxels, and this value can reflect the regional synchronization of spontaneous brain activity (Xia et al., 2020). At present, studies have found that patients with OCD and depression have abnormal ReHo value of brain function. Yang (Yang et al., 2019) contrast OCD patients with their healthy siblings and healthy controls found that they all show increased ReHo values in right dorsolateral prefrontal cortex (DLPFC), and the ReHo value in the left middle frontal gyrus of OCD patients is higher than that of their healthy siblings and healthy controls. At the same time, studies have shown that in depressed patients, ReHo values in the left posterior central gyrus, left superior temporal gyrus and left orbitofrontal cortex were significantly lower than those in healthy controls (Song, Shen, Mu, Mao, & Wang, 2020).

We planned to explore the effects of OCD symptoms and depression symptoms on the functional brain network of OCD patients by performing resting-state brain function MRI ReHo analysis in OCDd and OCD patients. Also, the existence of synergistic or antagonistic effects between obsessive-compulsive
symptoms and depression was analyzed. The correlation between the severity of different obsessive-compulsive symptom dimensions and the ReHo results was compared to provide ideas for the diagnosis and treatment of OCD as well as to improve the prognosis. Previous reports have more often selected subjects from the perspective of a single disorder, and less often considered the comorbidity of OCD and depression. Therefore, the present study is important for finding the neuropathogenesis of OCD and depression.

2. Materials And Methods

2.1 Subjects

15 OCDd patients, 14 OCD patients and 17 healthy controls matched in age and education are selected from the First Affiliated Hospital of Nanchang University. The age of all participants is 10-18 years old.

OCD group inclusion criteria: (1) Meet the diagnostic criteria of "obsessive-compulsive disorder" in ICD-10, and the course of disease is less than 3 months. (2) Y-BOCS total score ≥ 16; (3) No family history of mental illness. (4) Subjects have not taken any psychiatric drugs in the past 3 months. (5) Right-handed. (6) Han Nationality. (7) Informed consent signed by patients and their guardians.

OCDd group inclusion criteria: HAMD scores are more than 7 and less than 20. And meet the inclusion and exclusion criteria of (1), (2), (3), (4), (5), (6) and (7) above.

HC group inclusion criteria: Age and education were matched with the patient group. And meet the inclusion criteria in (3), (4), (5), (6) and (7) above.

Exclusion criteria for the three groups of participants: (1) Serious physical diseases, has a history of suicide by self-injury; (2) Suffer from other mental disorders, such as bipolar disorder, schizophrenia, mental retardation, alcohol dependence and so on; (3) HAMD score ≥ 20 points.

2.2 Data acquisition

All MRI data were acquired on a Siemens skyra3.0T Tim MRI scanner at the First Affiliated Hospital of Nanchang University. The scans included conventional structural MRI data and resting-state functional MRI data. During the scans, participants were told to lie quietly on the examination bed with their eyes closed to avoid systematic thinking. Earplugs and foam padding were used to reduce scanner noise and to minimize head movement.

Resting-state whole-brain BOLD data were collected by the (GRE-EPI) sequence. Repetition time (TR) = 2000 ms, echo time (TE) = 30 ms, rotation angle = 90°, field of view (FOV) = 200 mm × 200 mm, layer thickness = 4 mm, matrix = 64 × 64, voxel size = 33.0 × 3.0 × 4.0 mm3, interval = 1.2 mm, scan time 8 min 6 sec, 240 time phases were acquired.
High-resolution 3D T1-weighted images were acquired by 3D T1SPGR sequence. \( tr=1900 \text{ms}, \ TE=2.26 \text{ms}, \) turn angle=9°, FOV=250×250mm, matrix=256×256, voxel size=1.0×1.0×1.0mm, layer thickness=1mm, layer spacing=0.5mm, total 176 layers.

### 2.3. Data processing

First, conventional MRI images of all participants were examined, and those with cerebral parenchymal lesions were excluded. Then, the MRIcro software package was used to check the fMRI data, and the incomplete image range, artifacts and large head movement data were removed. Finally, SPM8 and DPARSFV23 software packages running on MALTAB2012a platform are used to preprocess all the resting state data: Data format conversion: DICOM data is converted into NIFTI format. Remove the data of the first 10 time points: it takes a certain amount of time for participants to adapt to the scanning environment and the magnetic field to reach steady state, thus reduce the possible influence. Time layer correction: Eliminate the time phase difference caused by the scanning interval, and correct the data collected at different time points to the same time. Head movement correction: Although the head of the subjects was fixed with sponge foam, because the scanning time was longer, the subjects would inevitably interfere with the BOLD signal because of breathing and swallowing movements. The participants' function data were aligned with the data at the first time point in space and removed subjects who moved >2mm or >2 degrees in the direction of x, y and z. Spatial standardization: T1WI thin anatomical images of the participants were registered on the average BOLD image, and software tools based on DARTEL algorithm were used to divide the registered structural images into gray matter, white matter and cerebrospinal fluid. The segmented structural image data were registered to the brain template space of the Montreal Neurological Institute (MNI) to obtain the registration matrix of the structural image, and then the registration parameters of the structural image were written into the functional image to obtain the functional image data of the MNI space. Finally, the functional image data were resampled to make the voxel size 3mm×3mm×3mm. Smoothing: Gaussian smoothing is applied to smooth the spatially standardized image. Remove linear drift: to remove the chemotactic effect with linear drift technology. Remove covariables: remove covariables such as white matter, cerebrospinal fluid, whole brain voxel time series and head movement parameters. Filter: reduce physiological high frequency noise and low frequency drift.

### 2.4. Statistical analysis

SPSS24.0 software and DPABI software based on MATLAB were used for data analysis. Y-BOCS and HAMD scores were compared by independent sample T test, and age and years of education were analyzed using one-way ANOVA. Measurement data were expressed as mean±standard deviation (x±s) (all data were normal distribution). The counting data were analyzed by chi-square test. Inspection level \( \alpha= 0.05, P< 0.05 \), the difference was statistically significant. The data after magnetic resonance preprocessing were analyzed by DPABI software, and then compared by independent sample t-test. Gaussian random field multiple correction was used to define the regions with single voxel \( P< 0.001 \) and brain region mass \( P< 0.05 \) as the regions with statistically significant differences. At the same time, the
Montreal Neurological Institute (MNI) of the most significant difference point (peak point) in the area with statistical difference is located, and it is named as the brain area with statistical difference. The brain regions were represented based on the use of predefined automated anatomical labeling (AAL). Pearson correlation analysis was performed between the ReHo values of these brain regions and Y-BOCS and HAMD scores.

3. Results

3.1 General and clinical data characteristics

Detailed clinical and demographic data of the participants are shown in Table 1. There were no significant differences between the three groups in terms of gender, age and years of education (P > 0.05). The OCDd group had lower scores on the HAMD, Y-BOCS and obsessive thinking subscales than the OCD group (P < 0.05). There was no significant difference in the Y-BOCS compulsive behavior scores between the OCDd and OCD groups.

<table>
<thead>
<tr>
<th></th>
<th>OCDd N=15</th>
<th>OCD N=14</th>
<th>HC N=17</th>
<th>F/χ²/t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>gender n %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5 33.3</td>
<td>9 64.3</td>
<td>11 64.7</td>
<td>3.962</td>
<td>0.138</td>
</tr>
<tr>
<td>Female</td>
<td>10 66.7</td>
<td>5 35.7</td>
<td>6 35.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age(years)</td>
<td>15.60±2.47</td>
<td>15.64±2.53</td>
<td>15.88±1.83</td>
<td>0.072</td>
<td>0.930</td>
</tr>
<tr>
<td>Years of education (years)</td>
<td>9.60±2.47</td>
<td>9.64±2.53</td>
<td>9.88±1.83</td>
<td>0.072</td>
<td>0.930</td>
</tr>
<tr>
<td>Y-BOCS obsessive score</td>
<td>12.87±2.07</td>
<td>10.71±3.29</td>
<td>-</td>
<td>2.125</td>
<td>0.043</td>
</tr>
<tr>
<td>Y-BOCS compulsive score</td>
<td>9.67±3.71</td>
<td>9.07±3.25</td>
<td>-</td>
<td>0.458</td>
<td>0.651</td>
</tr>
<tr>
<td>Y-BOCS total score</td>
<td>22.53±3.44</td>
<td>19.79±2.72</td>
<td>-</td>
<td>2.373</td>
<td>0.025</td>
</tr>
<tr>
<td>HAMD total score</td>
<td>14.07±3.04</td>
<td>4.86±1.61</td>
<td>-</td>
<td>9.836</td>
<td>0.027</td>
</tr>
</tbody>
</table>

Note: 1: χ²; 2: F; 3: t.

3.2. fMRI analyses

ReHo values in the lingual gyrus were higher in the OCDd group than in the OCD and HC groups, and ReHo values in the right superior frontal gyrus were lower in the OCDd group than in the HC group; these differences were statistically significant (P < 0.05). Without correction for multiple comparisons, the ReHo
values of the right inferior temporal gyrus, right superior temporal gyrus, left middle temporal gyrus, left middle frontal gyrus, and right precuneus were higher in the OCD group than in the HC group; the values of the left caudate nucleus and right superior limbic gyrus were lower in the OCD group than in the HC group. There was no significant difference between the OCD and HC groups after correction for multiple comparisons by GRF ($P > 0.05$) (Table 2, Figures 1 and 2).

Table 2 Brain regions with different ReHo values in the three groups

<table>
<thead>
<tr>
<th>Regions</th>
<th>Voxels</th>
<th>MNI coordinate</th>
<th>Peak T-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>OCD vs. OCD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lingual gyrus</td>
<td>59</td>
<td>-24</td>
<td>-87</td>
</tr>
<tr>
<td>OCD vs. HC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lingual gyrus</td>
<td>59</td>
<td>30</td>
<td>-87</td>
</tr>
<tr>
<td>OCD vs. HC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right medial superior frontal gyrus</td>
<td>71</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>OCD vs. HC Results without multiple comparison correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right inferior temporal gyrus</td>
<td>11</td>
<td>48</td>
<td>-15</td>
</tr>
<tr>
<td>Right superior temporal gyrus</td>
<td>10</td>
<td>45</td>
<td>-33</td>
</tr>
<tr>
<td>Left middle temporal gyrus</td>
<td>6</td>
<td>-39</td>
<td>-63</td>
</tr>
<tr>
<td>Left middle frontal gyrus</td>
<td>25</td>
<td>-36</td>
<td>15</td>
</tr>
<tr>
<td>Right precuneus</td>
<td>9</td>
<td>18</td>
<td>-60</td>
</tr>
<tr>
<td>OCD vs. HC Results without multiple comparison correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left caudate nucleus</td>
<td>17</td>
<td>-9</td>
<td>15</td>
</tr>
<tr>
<td>Superior right marginal gyrus</td>
<td>12</td>
<td>60</td>
<td>-33</td>
</tr>
</tbody>
</table>

Note: MNI is the human brain coordinates of the Montreal Institute of Neurology. GRF correction, voxel $P$ value < 0.001, cluster $P$ value < 0.05.

3.3. Correlation analyses

There was no linear correlation between the total score of Y-BOCS, the scores of each subscale of Y-BOCS and the ReHo value in OCD group ($P > 0.05$). The ReHo value of lingual gyrus in OCDd group was negatively correlated with the total score of Y-BOCS and the score of compulsive subscale ($r = -0.609$, -
0.552, \( P = 0.016, 0.033, \text{Figure 3, Figure 4} \). The score of OCDd group’s obsessive subscale was negatively correlated with HAMD score \( (r = -0.568, \ P = 0.027, \text{Figure 5} \).

4. Discussion

Although OCD and depression are considered two separate disorders, however, Moore suggested that OCD is strongly correlated with depression and negative mood (Moore & Howell, 2017). In this study, the lingual gyrus ReHo values were found to be higher in the OCDd group than in the OCD and HC groups. The lingual gyrus is a part of the occipital lobe of the brain, which is divided into: dorsal, medial and basal. Many studies support this finding: the occipital lobe and the lingual gyrus have been reported to be involved in the regulation of visual recognition and to play a role in the consolidation of episodic memory (Kukolja, Göreci, Onur Ö, Riedl, & Fink, 2016). A meta-analysis of studies on emotional activation showed that emotions induced by visual stimuli can activate the occipital cortex (Phan, Wager, Taylor, & Liberonz, 2002). Several studies have pointed to visual memory and problem solving as potential endophenotypes in OCD patients. Visual memory and problem solving impairments were found in both the OCD group and their healthy siblings (Yuan et al., 2020). Also, depression can limit visual capture and facilitate the perception of negative information (De Zorzi et al., 2020), which leads to changes in the distribution of attention in the visual field, which in turn affects the visual recognition function in depressed patients. The aforementioned studies suggest that depression and OCD symptoms may affect patients’ visual memory by influencing the function of the tongue gyrus. It has been found that the functional connectivity of the executive control and emotion processing networks was significantly reduced in patients with OCD compared with HC, and the functional connectivity of the right cerebellar and inferior parietal executive networks was positively correlated with symptom severity; the reduced connectivity of the emotion processing network in the left cerebellar lobule and lingual gyrus was negatively correlated with the course of the illness. It has been suggested that OCD may interfere with executive control and emotion processing by affecting the functional connectivity between the lingual gyrus and the cerebellum (Deng et al., 2019).

Internally directed cognition involved bilateral activation of the lingual gyrus and inferior parietal lobe areas as well as wide-spread deactivation of visual networks. Jeyoung Jung proposed that among patients with depression, the volume of lingual gyrus of patients with good treatment effect is larger than that of patients with poor treatment effect and healthy people. The volume of lingual gray matter in patients with depression is related to antidepressant treatment responsiveness and cognitive function. The larger the volume of lingual gray matter, it may indicate that the antidepressant effect begins to appear earlier, and the patients have better performance in neuropsychological tests. Some scholars have found that compared with Alzheimer’s disease patients without depressive symptoms, the resting functional connection value between the dorsal anterior cingulate cortex, the right occipital lobe and the right lingual gyrus of Alzheimer’s disease patients with depressive symptoms is lower than that of Alzheimer’s disease patients, indicating that the depressive symptoms may be caused by the reduced connection function between the lingual gyrus and other brain regions. In addition, some scholars have found that loneliness in the elderly is related to bilateral lingual gyrus. Loneliness is a common clinical
symptom of depression, and the hyperfunction of lingual gyrus in OCDd group may be related to it. Therefore, the further study of the functional connection between lingual gyrus and other brain regions may contribute to the understanding of the mechanism of loneliness. The score of OCDd group’s forced thinking subscale is negatively correlated with HAMD score, which may mean that patients divert their attention during long-term repeated thinking, so they have less negative thoughts. The ReHo value of lingual gyrus in OCDd group was negatively correlated with the total score of Y-BOCS and its forced action subscale score, but not with the forced thinking subscale score, which may suggest that the severity of forced action is affected by visual recognition and visual memory, thus affecting the function of lingual gyrus. There was no significant correlation between the scale score and ReHo value in OCD group ($P > 0.05$), which may suggest that obsessive-compulsive symptoms are not the cause of local consistency changes in the brain, but the cause of depressive symptoms; This finding can help to further explore the neurobiological mechanism of OCD.

Internally directed cognition involves bilateral activation of the lingual gyrus and inferior parietal regions, as well as extensive deactivation of the visual network (Ceh et al., 2021). JeyoungJung suggested that in depressed patients, the volume of the lingual gyrus was larger in patients with good treatment than in patients with poor treatment and healthy individuals (Jung et al., 2014). The lingual gray matter volume in depressed patients is associated with responsiveness to antidepressant treatment and cognitive function. Larger tongue gray matter volume may indicate earlier onset of antidepressant effects and better patient performance on neuropsychological tests. It has been found that Alzheimer's disease patients with depressive symptoms have lower values of resting functional connectivity between the dorsal anterior cingulate cortex, the right occipital lobe, and the right lingual gyrus than Alzheimer's disease patients, suggesting that depressive symptoms may be caused by reduced connectivity between the lingual gyrus and other brain regions (Liu et al., 2017). In addition, it has been found that loneliness in the elderly is associated with the bilateral lingual gyrus (Lan et al., 2015). Loneliness is a common clinical symptom of depression, and hyperfunction of the lingual gyrus in the OCDd group may be related to it. Therefore, further study of the functional connections between the lingual gyrus and other brain regions may help to understand the mechanisms of loneliness. scores on the obsessive-compulsive thinking subscale in the OCDd group were negatively correlated with HAMD scores, which may imply that patients diverted their attention during prolonged repetitive thinking, so they had fewer negative thoughts. ReHo values of the lingual gyrus in the OCDd group were negatively correlated with total Y-BOCS scores and their scores on the obsessive-compulsive action subscale. negatively correlated with the compulsive thinking subscale score, but not with the compulsive thinking subscale score, which may indicate that the severity of compulsive actions is influenced by visual recognition and visual memory, thus affecting the function of the tongue gyrus. The scale scores of the OCD group did not correlate significantly with ReHo values ($P > 0.05$), which may suggest that obsessive-compulsive symptoms are not the cause of local consistency changes in the brain, but rather the cause of depressive symptoms; this finding helps to further explore the neurobiological mechanisms of OCD.

The superior frontal gyrus is part of the frontal lobe. the ReHo value of the right medial superior frontal gyrus was higher in the HC group than in the odd group, suggesting that the severity of depressive
symptoms in OCD patients may affect the functional expression of the right medial superior frontal gyrus. Currently, related studies support similar views. For example, the low-frequency amplitude of the left medial superior frontal gyrus in OCD patients is lower than normal, whereas the functional connections between the right thalamus, bilateral medial superior frontal gyrus and right putamen, and between the left caudate and right insula are enhanced (Wang et al., 2019). In contrast, patients with OCD show a reduction in specific functions and gray matter volume in the medial prefrontal cortex. It has been suggested that this is related to poor self-control in OCD patients (Norman et al., 2016). K. LuanPhan noted that the medial prefrontal cortex plays a role in emotion processing (Phan et al., 2002). DelCasale reported task-related activation in the left frontal gyrus and thalamus, as well as bilateral activation in the inferior parietal and insular cortex in OCD patients, and activity in the right caudate, right medial gyrus, and middle frontal gyrus in OCD patients is reduced (Del Casale et al., 2016). It has also been proposed that OCD patients have symptoms of pleasure deficit and found lower low-frequency amplitudes in the right superior temporal gyrus and higher low-frequency amplitudes in the medial prefrontal cortex in OCD patients with pleasure deficit than in OCD patients. Also, low-frequency amplitude in the right superior temporal gyrus was negatively correlated with the degree of social pleasure deficit in OCD patients, whereas low-frequency amplitude in the medial prefrontal was positively correlated with the degree of social pleasure deficit (Xia et al., 2019). Lack of pleasure is also a core symptom of depression, and functional differences in the right medial superior frontal gyrus may contribute to this symptom.

Currently, depression and OCD have also been reported to have decreased amplitude of low-frequency fluctuations in the medial prefrontal lobe. Depression also has decreased amplitude of low-frequency fluctuations in the left striatum and increased amplitude of low-frequency fluctuations in the right orbitofrontal cortex. After transcranial magnetic stimulation, depressed patients had increased low-frequency amplitudes in the left dorsolateral prefrontal and superior frontal gyrus. After treatment, there was no significant correlation between brain imaging changes and clinical outcome (Zheng et al., 2020). Also, depressed patients had reduced gray matter volumes in the superior frontal gyrus, right middle frontal gyrus, and superior temporal gyrus. In the geriatric depression group, gray matter volumes were reduced in the right middle frontal gyrus, superior temporal gyrus, right inferior temporal gyrus, and right precentral gyrus. Some scholars intervened with auditory evoked potentials in depressed patients and found that the amplitudes of auditory evoked potentials P200 and P300 were decreased and the latency of P300 was prolonged in depressed patients compared with HC; the activation of P200 sources in the right insula, right precentral gyrus, left precuneus gyrus, medial frontal gyrus, superior frontal gyrus and middle frontal gyrus was decreased in depressed patients. Also, activation of P300 agonists was decreased in several brain regions (insula, postcentral gyrus, superior temporal gyrus, inferior parietal lobule, transverse temporal gyrus, cingulate gyrus, precentral gyrus, middle frontal gyrus, superior frontal gyrus, medial frontal gyrus, and paracentral gyrus) in depressed patients. This suggests that the pathophysiological mechanisms of depression may be related to extensive dysfunction of the right cerebral hemisphere. Some scholars who assessed depressed patients with electroencephalography (EEG) found that frontal alpha asymmetry scores in medial prefrontal cortex and geniculate cingulate cortex were negatively correlated with depression sign scores and cognitive affective depression scores.
and that subjects with more severe depressive symptoms had lower frontal alpha asymmetry scores (Imperatori et al., 2019), and these physiological indicators of brain function could be used for further assessment in future contacts.

Previous studies have pointed out that the cortico-striato-thalamo-cortical (CSTC) circuit is the neural basis of OCD pathophysiology and that the functional connection between the right thalamus and the right dorsal cingulate cortex is related to glutamate levels in the right thalamus (Chen et al., 2019), and some scholars have used proton magnetic resonance spectroscopy to evaluate the metabolic changes of neuronal metabolites and neurotransmitters in the CSTC circuit in OCD patients. The results showed that glutamate levels decreased in the medial prefrontal and right thalamus and increased cholinergic compounds in the left thalamus in OCD patients (Zhu et al., 2015). Previous studies have shown that glutamate mediates the upregulation of resting-state activity in healthy individuals. It has been suggested that decreased glutamate levels may be associated with poor self-control and pleasure deficit symptoms. Further studies will help to shed light on the biochemical pathogenesis of OCD and depression.

In this study, we used ReHo analysis in resting brain functional MRI to study the differences in brain function between patients with first-onset untreated OCD and those with OCDd, and analyzed the correlation between ReHo values and symptom severity. It provides a scientific reference to further explore the neurobiological mechanisms of OCD and depression. However, this study is a cross-sectional study. Individuals' conditions change over time and changes in brain function after treatment could not be observed dynamically. In addition, the sample size of this study was small, and the ReHo analysis of the OCD group and HC was not significantly different after correction for multiple comparisons. The results of the study may be biased, so it is necessary to increase the sample size for further studies in the future. We performed ReHo analysis on subjects only. In the future, voxel-based morphological analysis, diffusion tensor imaging, brain regions of interest, and other methods of functional brain analysis can be used to further elaborate the neurological changes in patients with OCD.

**Declarations**

**Ethical Approval**

The study was conducted according to the Declaration of Helsinki and was reviewed and approved by the Medical Research Ethics Committee of the First Affiliated Hospital of Nanchang University (2020-31).

**Consent to participate**

All patients, their guardians and healthy participants signed informed consent before participating in the study.

**Consent for publication**

I, Xin Yuan, on behalf of all other authors of this article, give my consent for the publication of the manuscript, tables and figures (including supplementary material) to be published in Journal Brain
imaging and behaviour.

**Competing interests**

The authors have no relevant financial or non-financial interests to disclose.

**Author contributions**

XY and YZ: manuscript writing, study search, data collection, and data analysis. MH: study search, data collection, and data analysis. LX, BY, JZ, ZH, YW, PL and MH: selected the studies, extracted the data, and assessed the risk of bias. All authors contributed to the article and approved the submitted version.

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**Availability of data and materials**

The data can not be made openly available due to restrictions by national law and local ethical permissions. Data sharing is possible via formal material transfer agreements for which interested investigators should contact the authors.

**References**


**Figures**
Figure 1

Results of ReHo value T test in OCDd group and OCD group

Note: Compared with OCD group, red represents the brain area with increased ReHo value in OCD group. Blue represents the brain area with reduced ReHo value in OCDd group.
Figure 2

Results of ReHo value T test in OCDd group and HC group
Figure 3

Correlation between ReHo value of lingual gyrus and total score of Y-BOCS in OCDd group
Figure 4

Correlation between ReHo value of lingual gyrus and score of compulsive behavior subscale in OCDd group
Figure 5

Correlation between OCDd group obsessive thought subscale score and HAMD score