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Research Article

Magnetic Resonance Imaging Characteristics of Brain Structure and Neuroendocrine Changes in Patients with First-Episode Schizophrenia

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This research was aimed to investigate the magnetic resonance imaging (MRI) features of brain structure and neuroendocrine levels in patients with first-episode schizophrenia. 25 hospitalized patients with first-episode schizophrenia were selected as the observation group, while 25 healthy people were selected as the control group. All the objects underwent MRI examination, and the images as well as gray matter density of the original image data were analyzed under voxel-based morphometry (VBM). The cortisol and prolactin in the observation group were detected, and the levels were compared. The Pearson correlation analysis was adopted to analyze the correlation between cortisol and prolactin levels and the total score of the Positive and Negative Syndrome Scale (PANSS). The results showed that the gray matter volume of the precentral gyrus, superior frontal gyrus, middle frontal gyrus, inferior frontal gyrus, postcentral gyrus, inferior parietal lobule, superior parietal lobule, and anterior cingulate cortex of the observation group decreased, while the volume of cerebellar gray matter increased. The levels of cortisol and prolactin in the observation group ($387.54 \pm 117.69\,\mu$g/L and $804.16 \pm 267.13\,\mu$IU/mL, respectively) were significantly higher than those in the control group ($138.46 \pm 62.47\,\mu$g/L and $397.54 \pm 203.82\,\mu$IU/mL, respectively), and the differences were statistically significant ($P < 0.05$). The results of the Pearson correlation test showed that the higher the cortisol level, the more severe the schizophrenia ($r = 0.421$ and $P = 0.013$), while the prolactin level was not directly related to the severity of schizophrenia ($r = 0.019$ and $P = 0.568$). In conclusion, the MRI features based on the VBM technology can accurately assess the changes of gray matter; the levels of cortisol and prolactin in patients with first-episode schizophrenia were significantly higher than those in healthy people; and the higher the cortisol level, the more severe the schizophrenia symptoms. This study provided a certain research basis for MRI features of brain structure and neuroendocrine changes in patients with first-episode schizophrenia.

1. Introduction

Schizophrenia is a group of severe mental illnesses of unknown etiology, mostly slow or subacute in young adults. It usually presents clinically as a syndrome with various symptoms, involving sensory, perceptual, thinking, emotional, and behavioral disturbances, as well as uncoordinated mental activities [1]. Patients with schizophrenia have clear consciousness and normal intelligence in daily life, but some patients will have cognitive impairment as the disease progresses. The course of the disease is generally protracted, repeated, aggravated, or worsened. Some patients will eventually experience mental decline and mental disability, but some patients can maintain or basically recover after

treatment [2]. Schizophrenia is a clinical syndrome consisting of a group of symptoms. It is a multifactorial disease. The possible causes of current research include family inheritance, personality disorders (introversion, withdrawal, and stubbornness), and frequent life (psychological) blows [3]. First-episode schizophrenia is defined as having been evaluated for treatment for the first episode of psychosis associated with schizophrenia spectrum disorder. Patients have a transitional process from mental health to mental illness. Patients first develop some symptoms such as depression, anxiety, obsessive-compulsive behaviors and obsessions, and insomnia and then progress to some mild psychotic symptoms, such as self-talk, transient hallucinations, and personality changes [4, 5]. If there is no intervention at this time, it will progress further, resulting in obvious psychotic symptoms, until the final official diagnosis of schizophrenia. Treatment of patients with first-episode schizophrenia must follow the principles of comprehensive therapeutic management, including pharmacotherapy, psychotherapy, and social therapy, and plans for future maintenance therapy to prevent recurrence [6].

Magnetic resonance imaging (MRI) technology is based on the principle of nuclear magnetic resonance imaging. It has the advantages of noninvasive and precise positioning. It is one of the important technologies in medical imaging. Brain function research has always been a very challenging topic, and this research direction has a significant role in promoting the field of neurology and clinical diagnosis [7]. According to a study [8], the gray matter volume of schizophrenia patients was reduced compared with normal healthy people by MRI features. At the same time, some scholars pointed out [9] that there is a certain relationship between the reduction of gray matter volume and the psychiatric symptoms and the severity of cognitive impairment in patients with schizophrenia. Several studies have found [10] that changes in gray matter volume have high diagnostic value in clinically distinguishing schizophrenia, bipolar disorder, and normal healthy populations. Voxel-based morphometry (VBM) is a technique for analyzing brain magnetic resonance images at the voxel level. It is a method to calculate the voxel size and specific structure concentration of local structures (such as brain gray and white matter) automatically and objectively by applying the voxels of spatially normalized images to evaluate the differences in brain anatomy from an overall perspective [11, 12]. At present, it is widely used in the quantitative analysis of the morphological structure of the whole brain under normal brain aging and pathological conditions.

There is also an important research direction in the etiology of schizophrenia, that is, neuroendocrine. Neuroendocrine abnormalities can cause changes in hormone levels, leading to mental and behavioral abnormalities in patients [13], among which cortisol and prolactin are strongly correlated with mental abnormalities. Cortisol is a kind of epinephrine produced by the human body in response to stress. The abnormal activity of the hypothalamic-pituitary-adrenal axis will lead to excessive secretion of cortisol, and the increase of its level is related to abnormal cognitive, emotional, and memory functions. Performance is correlated [14, 15]. Prolactin is a protein hormone produced by lactating cells in the anterior pituitary gland and is an important neuroendocrine factor. Pathological changes in the hypothalamic-pituitary-gonadal axis will change the level of prolactin. In addition, the release of prolactin is modulated and inhibited by the dopamine system, so it can be used as an observation standard for evaluating dopamine activity [16, 17], which shows that patients with schizophrenia may have abnormal dopamine function.

In this research, the voxel-based morphological analysis method was used to analyze the gray matter structure of the gray matter of first-episode schizophrenia and to detect the levels of cortisol and prolactin in plasma. The objective was to investigate the magnetic resonance imaging features of brain structure in patients with first-episode schizophrenia and to explore the pathological significance of neuroendocrine levels in schizophrenia, so as to provide a theoretical reference for the pathology of schizophrenia.

2. Materials and Methods

2.1. Research Objects. A total of 25 patients with first-episode schizophrenia admitted to the hospital from May 2019 to December 2021 were selected and set as the observation group. There were 15 males and 10 females, with an age range of 18–35 years and an average age of 23.4 ± 1.5 years. 25 healthy people who underwent physical examination in the hospital during the same period were selected as the control group, including 13 males and 12 females, with an age range of 19–34 years and an average age of 22.3 ± 1.7 years. Both the control group and the observation group received MRI examination, and the levels of cortisol and prolactin of patients in the observation group were detected. The research objects agreed to sign informed consent forms with the consent of their family members. This research had been approved by the ethics committee of hospital.

2.1.1. Inclusion Criteria. Inclusion criteria include patients whose diagnosis meeting the diagnostic criteria for schizophrenia in "Chinese Classification and Diagnostic Criteria for Mental Disorders" [18]; patients with first onset and no drug or psychological treatment; patients with no history of drug use; patients with no history of alcohol abuse within 3 months; and patients with complete clinical data.

2.1.2. Exclusion Criteria. Exclusion criteria include patients with organic mental disorders, mood disorders, and mental disorders caused by psychoactive substances; patients with serious physical diseases; those with a history of epilepsy or febrile convulsion; those who had attempted suicide; those with poor compliance and who were unable to cooperate with the experiment, or who had no guardian; pregnant or lactating women; and patients with contraindications to magnetic resonance scanning.

2.2. MRI Examination and Image Processing. 3.0T MRI system with 8-channel standard head coil was used. Before the examination, the objects were confirmed to have no

metal or magnetic substances, and the cranial MRI examination was performed in the supine position. The head was fixed to prevent artifacts, and conventional weighted T1 and T2 scans were given to monitor the morphological appearance of the brain and obtain brain anatomical images. Scanning parameters were set as follows: time of repetition (TR)/time of echo (TE) = 8.2/3.2 ms, matrix was 256×256, and layer thickness was 1 mm. After scanning, the scanned image was transmitted to the image processing system for subsequent processing.

FSL-VBM analyzed its gray matter structural changes and processes Tl 3D high-resolution images. In the first step, the average symmetrical template of the brain was established, and the initial MRI image was converted into an image with a size of about $1 \times 1 \times 1\ mm^3$, and the T1 template was constructed by spatial smoothing. In the second step, the gray matter template was established, the initial MRI image was registered to the T1 template, and the gray matter was extracted and segmented. In addition, Gaussian smoothed space and averaged superposition were performed. The third step was to create a mirror image for all study objects. The fourth step was to segment the mirror images and initial MRI images of all objects to the generated template, standardize the gray matter template established by the initial gray matter image, apply the standardized parameters to the initial image, and obtain the final standardized brain image. It should segment the normalized image and smooth the gray matter image.

2.3. Detection of Neuroendocrine Levels. The patients were tested for cortisol and prolactin. At 8:00 in the morning, the venous blood was drawn when the patients were in a fasting state, left standing for half an hour, and centrifuged at 3,000 r/min to extract serum. Chemiluminescence immunoassay was used for the determination. The reagents and measuring instrument were ELISA kits and electrochemiluminescence immune-analyzer, respectively. The calibration curve and the radioactivity values of the specimens were printed with a γ-scintillation counter. The normal reference value at 8:00 in the morning ranged 140–630 nmol/L.

Prolactin was detected using the chemiluminescence method and counted using a γ-counter. The reference interval was 4.79–23.3 ng/mL. When the prolactin level was higher than the upper limit, it was determined that the prolactin was abnormally elevated. When the prolactin level was lower than the upper limit, the level was relatively low.

2.4. Psychiatric Symptom Assessment. Severity of symptoms was assessed using Positive and Negative Syndrome Scale (PANSS), which was adapted from a combination of the Brief Psychiatric Scale and the Psychopathological Rating Scale. It was mainly suitable for adults. The psychiatrist who had been trained in the use of the scale conducted psychiatric examination of the patients and evaluated the relevant information provided by the comprehensive clinical examination and the insiders. The time frame for the assessment was specified as all the information in the week preceding the assessment, and the entire assessment took approximately 30–50 minutes.

The PANSS consisted of a 7-item positive symptom scale, a 7-item negative symptom scale, and a 16-item general psychopathology subscale. The positive symptom scale was composed of delusion, conceptual confusion, hallucinatory behavior, excitement, exaggeration, suspicion or victimization, and hostility. The negative symptom scale included affective retardation, emotional withdrawal, affective communication disturbance, passiveness or apathy, abstract thinking, lack of spontaneity and fluency in conversation, and stereotyped thinking. The general psychopathology subscale was made up of worry about physical health, anxiety, guilt ideas, nervousness, posturing, depression, slow movement, uncooperativeness, abnormal thinking, orientation disorder, attention disorder, lack of self-knowledge, volitional disorder, impulse control disorder, preoccupation, and active social avoidance. Each item was rated using a 7-point scoring method (none, very mild, mild, moderate, slightly severe, severe, and extremely severe). The scores of the positive symptom scale, negative symptom scale, and general psychopathology subscale ranged from 7 to 49, 7 to 49, and 16 to 112, respectively. The total score was the sum of scores of the three subscales, ranging 30–210. The PANSS score was closely related to the clinical features of schizophrenia. The higher the PANSS score is, the more severe the positive, negative, and general psychiatric symptoms of patients are.

2.5. Statistical Analysis. SPSS 24.0 software was used for statistical analysis of the obtained data. Measurement data were expressed as the mean +standard deviation ($\overline{x} \pm s$), and count data were inferred by χ^2 test. The measurement data conformed to the normal distribution, and the t test was used. The correlation analysis between the indicators was performed by the Pearson test. The r value represents the correlation coefficient between variables in the sample, indicating the size of the correlation; the P value was the test value, which was to test whether the two variables have the same correlation as the sample in the population from which the sample came. The larger the absolute value of the correlation coefficient r, the stronger the correlation: the closer the correlation coefficient r was to 1 or −1, the stronger the correlation, and the closer the correlation coefficient was to 0, the weaker the correlation. The correlation strength of variables was judged by the following value ranges: correlation coefficient 0.8–1.0 meant very strong correlation, 0.6–0.8 meant strong correlation, 0.4–0.6 meant moderate correlation, 0.2–0.4 meant weak correlation, and 0.0–0.2 meant very weak correlation or no correlation related. The FMRIB software library was used to analyze the gray matter density of the mirror image and the original image data based on VBM, and the international statistical parameter map was used to represent it. $P < 0.05$ was considered statistically significant.

Table 1: Comparison on general clinic data.

Indicators	Control group	Observation group	P value
Age (years old)	22.3 ± 1.7	23.4 ± 1.5	0.653
Gender (male/female)	13/12	15/10	0.762
Course of disease (years)	—	1.36 ± 0.15	—
PANSS score (points)			
Positive symptom score	—	20.72 ± 4.32	—
Negative symptom score	—	19.46 ± 6.84	—
General psychopathology score	—	43.26 ± 7.35	—
PANSS total score	—	83.46 ± 12.63	—

3. Results

3.1. Comparison on General Clinic Data. Table 1 shows that there was no statistical significance in general clinical data such as age, gender ratio, and course of disease in the two groups of objects ($P > 0.05$), which were comparable.

3.2. Brain Structure Detection Results Based on VBM. As shown in Table 2 and Figure 1, the voxel-based morphometric results found that the differences between the observation group and the control group were more obvious. The patients in the observation group had obvious gray matter volume reduction in the frontal lobe and cingulate cortex, mainly including precentral gyrus, superior frontal gyrus, middle frontal gyrus, inferior frontal gyrus, postcentral gyrus, inferior parietal lobule, superior parietal lobule, and anterior cingulate cortex ($P < 0.05$, corrected by TFCE). As shown in Table 3 and Figure 2, the voxel-based morphometric results showed that compared with the control group, patients in the observation group had increased gray matter volume in some regions ($P < 0.05$, corrected by TFCE), mainly located in the cerebellum.

3.3. Comparison of Cortisol and Prolactin Levels. As shown in Figure 3, the plasma cortisol level of the observation group was $387.54 \pm 117.69\,\mu$g/L, which was significantly higher than that of the control group (138.46 ± 62.47); the prolactin level of the observation group was $804.16 \pm 267.13\,\mu$IU/mL, which was significantly higher than that of the control group (397.54 ± 203.82), and the difference was statistically significant ($P < 0.05$).

3.4. Pearson Correlation Analysis. As shown in Table 4, the Pearson correlation analysis between the plasma cortisol level of the observation group and the PANSS total score was $r = 0.421$ and $P = 0.013$, indicating that the higher the cortisol level, the more severe the patient's schizophrenia. The Pearson correlation analysis between the prolactin level and the PANSS total score in the observation group was $r = 0.019$ and $P = 0.568$, and the significance test failed, indicating that there was no statistical correlation between the two.

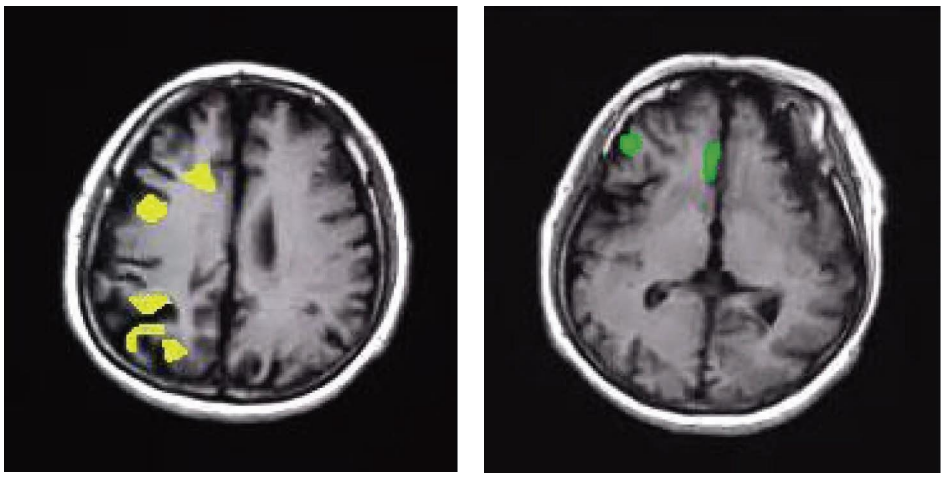
4. Discussion

Schizophrenia is a rare psychiatric disorder whose etiology is still being explored, along with the potential for chronic disability. This disease is probably caused by a large number of cerebral nerve cell lesions, showing a progressive development trend, and it is also accompanied by a variety of cognitive dysfunctions. Human brain activity is realized through a complex network system. The study by Guo et al. [19] showed that functional connectivity disorder caused by abnormal gray matter structure in various brain regions was one of the important factors for the onset of schizophrenia and various clinical symptoms. The basic condition of executive function is normal gray matter structure, but some studies related to magnetic resonance imaging have shown [20] that patients with schizophrenia may have extensive gray matter structure changes. MRI can be used to study the structure of living tissue, which is an effective method to study the structure of the gray matter, and has a wide range of applications in analyzing the changes in the structure of the gray matter in patients with schizophrenia.

The article by Koelkebeck et al. [21] pointed out that the gray matter structural abnormalities appear in almost all brain regions of patients with schizophrenia, but may not change independently, but appear mutually and have a certain correlation. The VBM results of this research showed that compared with the control group, the patients in the observation group had a decrease in the gray matter volume, and the main areas included precentral gyrus, superior frontal gyrus, middle frontal gyrus, inferior frontal gyrus, postcentral gyrus, inferior parietal lobule, superior parietal lobule, and anterior cingulate cortex, while the cerebellum gray matter volume increased. Such results are basically consistent with the results of Alemán-Gómez et al. [22]. The frontal lobe accounts for about one-third of the human brain, and the prefrontal lobe is the main area for the realization of high-level cognitive tasks, and it is also closely related to human cognitive function, emotional regulation, and self-regulation. Several studies have shown that patients with schizophrenia have reduced frontal gray matter volume. Quinn et al. [23] noted that a clinically meaningful history of alcohol or marijuana use did not significantly exacerbate the gray matter deficits associated with schizophrenia. The article by Tseng et al. [24] suggested that patients with first-episode schizophrenia had abnormal frontal gray matter in the early stage of the disease. From this, it can be understood that both patients with first-episode and chronic schizophrenia may have abnormal frontal gray matter structure. Many studies suggest that inferior parietal lobule plays a role in human social cognition and working memory. The precuneus is also of great significance to the process of human neuropsychological development and has a strong correlation with human insight and self-conscious processing. Some patients with schizophrenia will

Table 2: Results of VBM.

Regions	Right/left	Number of voxels	Coordinate X	Coordinate Y	Coordinate Z	1-*P* value
Precentral gyrus	Right	735	28	−8	45	0.9996
	Left	1036	−49	8	14	0.9996
Superior frontal gyrus	Right	2168	23	47	15	0.9996
	Left	1013	−23	31	35	0.9996
Middle frontal gyrus	Right	2396	32	49	10	0.9996
	Left	2302	−30	38	24	0.9996
Inferior frontal gyrus	Right	241	34	6	32	0.9996
	Left	456	−42	8	16	0.9996
Postcentral gyrus	Right	501	35	−26	48	0.9996
	Left	622	−58	−7	28	0.9996
Inferior parietal lobule	Left	842	−47	−49	34	0.9992
Superior parietal lobule	Right	347	48	−38	61	0.9996
	Left	149	−45	−48	34	0.9996
Anterior cingulate cortex	Right	505	10	47	14	0.9996
	Left	552	−10	26	29	0.9981



(a) (b)

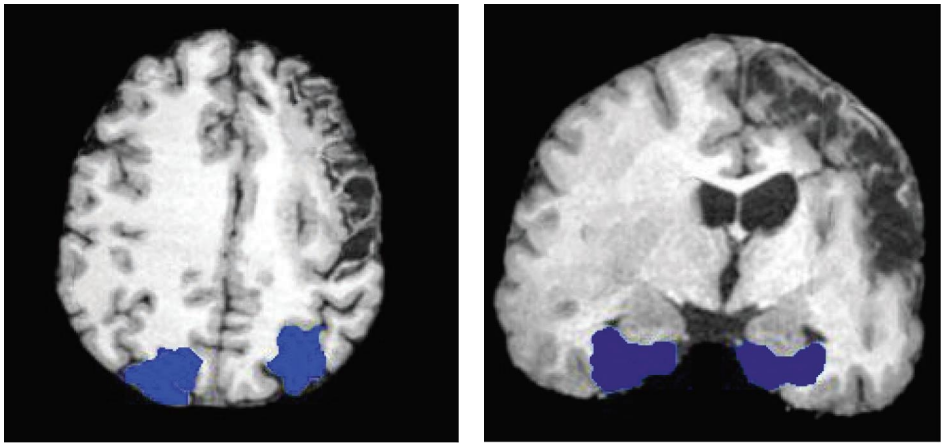
Figure 1: The results of VBM showed that the gray matter volume of the observation group was reduced compared to the control group. (a, b) MRI T1W1 images of the patients in the observation group. The yellow area in (a) represented precentral gyrus, superior frontal gyrus, middle frontal gyrus, postcentral gyrus, and superior parietal lobule. The green area in (b) represented inferior frontal gyrus and anterior cingulate cortex.

Table 3: The results of VBM show that the gray matter volume increased in the observation group compared with the control group.

Regions	Right/left	Number of voxels	Coordinate X	Coordinate Y	Coordinate Z	1-*P* value
Cerebellum	Right	1746	24	−73	−47	0.9996
	Left	1653	−26	−79	−39	0.9991

experience cognitive impairment and reduced insight, mainly affected by the structural changes of the parietal gray matter, which mostly occur in the superior parietal lobule and the inferior parietal lobule. Nestor et al. [25] suggested that the cortex of the superior parietal lobule in patients with schizophrenia was thinned. Schoretsanitis et al. [26] considered that first-episode schizophrenia patients had inferior parietal lobule gray matter density reduction. These all indicate that there may be abnormalities in the parietal gray matter structure in patients with schizophrenia.

The cerebellum is an important control organ that can coordinate activities in the human body and is closely related to human emotion regulation, attention management, social communication, language processing, and word memory. The findings of Cui et al. [27] showed an increase in small gray matter in patients with first-episode schizophrenia, which is consistent with the findings of this research. Patients with schizophrenia may exhibit abnormal changes in the structure of the small gray matter, manifested by increased gray matter volume. In addition, the results of this



(a) (b)

Figure 2: The results of VBM showed the increased gray matter volume in the observation group compared with the control group. (a) The MRI axial image, and (b) the MRI coronal image. The blue areas in the figure represented areas of the increased gray matter volume.

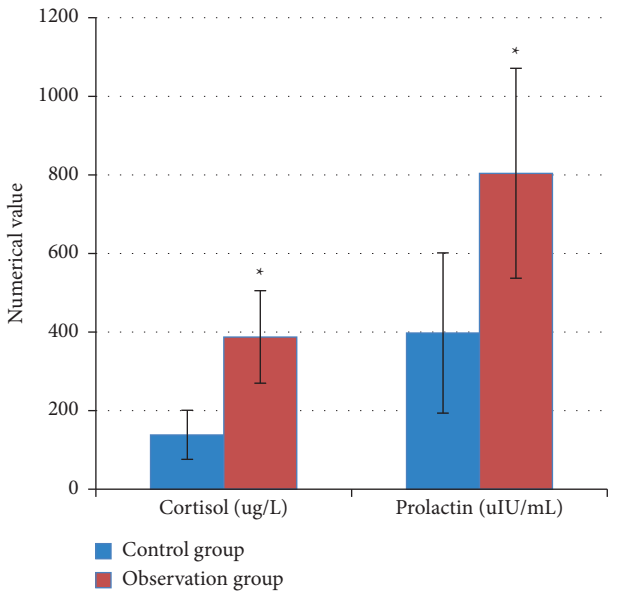


Figure 3: Comparison of cortisol and prolactin levels. * Compared with control group, $P < 0.05$.

Table 4: Cortisol analysis of cortisol and prolactin levels and PANSS total score.

Indicators in observation group	R	P
Cortisol level	0.421	0.013
Prolactin level	0.019	0.568

research showed that the plasma cortisol level of the observation group was (387.54 ± 117.69) μg/L, which was significantly higher than that of the control group (138.46 ± 62.47) μg/L, and the prolactin level was (804.16 ± 267.13) μIU/mL, which was significantly higher than that of the control group (397.54 ± 203.82) μIU/mL, showing statistically significant differences ($P < 0.05$). The results of the Pearson correlation test showed that the cortisol level of the observation group was significantly correlated with the PANSS total score ($r = 0.421$ and $P = 0.013$), indicating that the higher the cortisol level, the more severe the degree of schizophrenia in the patient. However, there was no significant correlation between the prolactin level and PANSS total score ($r = 0.019$ and $P = 0.568$), indicating that the prolactin level of patients had no definite relationship with the degree of symptoms of schizophrenia. This result is consistent with the conclusion of the article by Jen et al. [28] that the level of prolactin in schizophrenia patients is not significantly different from that in healthy people. Therefore, it is still unknown whether prolactin at high levels can cause the onset of schizophrenia in patients.

5. Conclusion

This research analyzed the brain magnetic resonance images of first-episode schizophrenia patients based on VBM and compared neuroendocrine levels with healthy controls. The results showed that the gray matter volume in the precentral gyrus, superior frontal gyrus, middle frontal gyrus, inferior frontal gyrus, postcentral gyrus, inferior parietal lobule, superior parietal lobule, and anterior cingulate cortex decreased, while the gray matter volume in the cerebellum increased. The levels of cortisol and prolactin in patients with first-episode schizophrenia were significantly higher than those in healthy people, and the level of cortisol was directly proportional to the severity of the patients' psychiatric symptoms, while the level of prolactin was not directly related to the severity of symptoms. The disadvantage of this research was that only the default setting parameters in the software were used in the voxel-based morphometric processing, and it was necessary to change the parameters to analyze the brain magnetic resonance images in more detail and comprehensively in the future. In conclusion, MRI-based voxel morphometry can accurately and reliably assess brain structure, and the levels of cortisol and prolactin in patients with first-episode schizophrenia

were significantly higher than those in healthy people. The higher the cortisol level, the more severe the schizophrenia symptoms. This research provided a reference for the pathological study of first-episode schizophrenia.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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