Article

Difference in Laterality of the Dorsal Striatum in Schizoaffective Disorder

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Abstract

Background: Recent research has demonstrated that the dorsal striatum is directly associated with the integration of cognitive, sensory-motor, and motivational/emotional data. Disruptions in the corticostriatal circuit have been implicated in the pathophysiology of psychosis. The dorsal striatum was reported to show lateralized pathology in psychotic disorders. In this study, we aimed to analyze the laterality of the dorsal striatum with texture analysis of T2-weighted magnetic resonance imaging (MRI) images from schizoaffective disorder (SAD) patients.

Methods: Twenty SAD patients, met the inclusion criteria and had available cranial MRI data were assigned as the patient group. Twenty healthy individuals were determined as the control group. Texture analysis values were obtained from striatum region of interests (ROI) generated from T2-weighted MRI images. Data are presented as mean and standard deviation. The suitability of the data for normal distribution was analyzed with the Kolmogorov-Smirnov test. Analysis of variance (ANOVA) test (Post Hoc TUKEY) was employed to compare the group data based on test findings.

Results: There was no significant difference between the groups in terms of gender and age. There were differences in the values of texture analysis parameters of both caudate and putamen nuclei in comparison to controls. We identified differences in the left dorsal striatum nuclei in SAD. The differences in the putamen were more and more pronounced than in the caudate.

Conclusions: Texture analyses suggest that the left dorsal striatum nuclei may be different in SAD patients. Further studies are needed to determine the pathophysiology of SAD and how it may affect disease treatment.

Keywords

schizoaffective disorder; caudate nucleus; putamen; computer-assisted image processing; magnetic resonance imaging

Introduction

Schizoaffective disorder (SAD) is a chronic, potentially disabling, psychotic disorder. It is commonly encountered in clinical settings and is diagnosed in individuals with a mixture of mood and psychotic symptoms [1]. Major mood episode symptoms include delusions, hallucinations, or disorganized speech [2]. SAD is among the highly misdiagnosed psychiatric disorders in that the exact pathophysiology is unknown [3]. It has been suggested that abnormalities in dopamine, norepinephrine and serotonin could play a role in its pathophysiology [4]. Cognitive studies can reflect the biological discrimination profile of SAD compared to healthy individuals, along with the presence of distinguishable neurobiological abnormalities that support both conceptual and categorical distinctions [5]. In particular, white matter abnormalities in the left temporal gyrus,

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right lentiform nucleus, and right precuneus were associated with SAD, while decreased hippocampal volume and significant deformations in the medial and lateral thalamic regions were also reported [6–8].

Striatum's role in regulating movement has long been recognized; however, the frontal corticobasal ganglia networks were described recently along with a role of the dorsal striatum in executive functions. The dorsal striatum was reported to be directly associated with action selection, initiation and decision-making via the integration of cognitive, sensory-motor, and motivational/emotional data, particularly in corticostriatal circuits such as the striatum [9–13]. Disruptions in the corticostriatal circuit have been implicated in the pathophysiology of psychosis with decreased dopamine in the prefrontal cortex and excess dopamine in the striatum [14,15]. A previous functional magnetic resonance imaging (fMRI) study provided cross-sectional evidence that reduced striatal signal is associated with psychotic symptoms [16].

A useful method for examining the neurobiology of psychotic disorders is the assessment of cerebral lateralization. The brain is both structurally and functionally lateralized. Domains of functional and cerebral lateralization abnormalities have been described in psychotic disorders [17–19]. Patients with SAD were shown to exhibit anomalous cerebral lateralization, as indicated by the localization of the M20 somatosensory evoked field source generator in both hemispheres [20]. Mataboge *et al*. [21] reported that patients diagnosed with schizophrenia and/or SAD were more likely to be non-right-handed than their non-affected first-degree relatives as well as two healthy control groups.

Two-dimensional digital images used in routine clinical applications include small rectangular blocks called pixels. Pixels represent spatial points on the image and the value of the pixels represents the intensity of gray at that point on the image. Several mathematical methods have been employed to determine the variations in spatial gray levels on the image that are called "texture properties" or constituent derivatives, which measure the heterogeneity in texture analysis. The position and intensity of image pixels can be analyzed with texture analysis methods [22–29]. Based on the available literature described above and preliminary (unpublished) data generated by us, we hypothesized that the dorsal striatum may show lateralization in SAD. To address this hypothesis, we aimed to analyze the dorsal striatum laterality with texture analysis from T2-weighted (W) magnetic resonance imaging (MRI) images of SAD patients and compare the findings with healthy controls.

Materials and Methods

Participants and Study Design

The current cross-sectional retrospective study included data from consecutive patients who were admitted to the outpatient or inpatient clinics in a Psychiatry Training and Research Hospital between January 2018 and July 2022 and met the SAD criteria from the Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5) [1]. Participants were selected among patients who were diagnosed with schizoaffective disorder by an expert psychiatrist and differential diagnosis with other psychotic disorders were made. Patients using antipsychotics and mood stabilizers were included in the study to ensure that the treatment was similar.

A local Ethics Committee approved the study (IRB: 07/07/2022–2022.07.177). MRI images of 20 cases were identified from the Hospital Information System (HIS). These patients were diagnosed with SAD, underwent cranial examination and met the criteria for participation in the study. The MRI data were evaluated by a specialist radiologist, and if found suitable, were included in the study.

The inclusion criteria for patients: To be between the ages of 18 and 65 years, to have no other psychiatric diagnosis or mental retardation, to have no diagnosis of neurological or physiological diseases, or history of alcohol or substance use in the last 6 months based on the HIS data and patient statements.

The exclusion criteria for patients: To be under the age of 18 and above the age of 65. To have any comorbid psychiatric, neurological or physiological diseases or mental retardation. To have history of alcohol or substance use in the last 6 months and to be illiterate.

The control group included healthy individuals who were matched for gender and age with the patient group, who did not have any psychiatric, neurological or physiological diagnosis, who did not have mental retardation and who underwent brain MRI examination for other reasons.

Data Acquisition and Analysis of Images

All participants underwent the MRI examination with the same equipment. A 1.5 T Brivo MR355 scanner (General Electric Medical System, Milwaukee, WI, USA) was used for MRI. T2-weighted Fast Spin Echo MRI images (T2 propeller, TR/TE: 5636/111 ms, acquisition matrix 256 × 256, image resolution 0.47 × 0.47 × 5 mm) were obtained.

Table 1. Distribution of the analyzed caudate nuclei signal intensity parameters in the groups.

Caudate	Control Right (20)		Control Left (20)		Schizoaffective Right (20)		Schizoaffective Left (20)		F	*p*
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation		
Pixel Count of ROI	448.00	115.78	512.25	112.28	517.00	128.92	533.60	101.84	2.134	0.103
Mean	480.87	75.91	483.89	81.58	552.94	116.06	566.08	118.65	4.031	0.010
Standard Deviation	63.07	19.44	78.63	27.17	71.99	23.75	83.70	44.59	1.735	0.167
Median	477.05	76.67	475.83	80.58	551.43	113.84	558.03	118.34	4.170	0.009
Mean Absolute Deviation	45.57	11.33	55.37	15.29	51.95	14.30	58.50	26.84	1.907	0.135
Median Absolute Deviation	34.53	8.08	40.65	9.20	38.65	12.59	39.85	12.55	1.273	0.290
Minimum	336.95	74.03	311.15	66.78	382.55	95.76	371.55	94.10	3.054	0.033
Maximum	765.70	185.81	886.90	245.14	889.70	292.57	989.70	318.08	2.389	0.075
Variance	4336.68	2729.00	6884.26	5133.47	5718.11	3826.05	8894.41	9223.37	2.004	0.121
Range	428.75	182.17	575.75	223.91	507.15	238.43	618.15	286.35	2.474	0.068
Interquartile Range	69.54	16.56	82.20	19.19	78.79	25.53	82.69	29.09	1.389	0.253
Most Frequent Value	467.30	88.00	466.65	85.53	551.65	113.02	555.65	125.89	4.592	0.005
Size %L	13.15	4.92	11.83	4.92	13.68	4.94	11.57	4.43	0.895	0.448
Size %M	73.96	8.02	76.32	7.61	73.97	8.42	76.44	6.32	0.669	0.574
Size %U	12.89	3.75	11.85	3.16	12.36	3.71	12.00	3.05	0.368	0.776
Kurtosis	6.84	5.49	7.87	5.25	7.09	5.77	7.55	4.33	0.156	0.925
Skewness	0.87	1.28	1.24	1.19	0.80	1.36	0.92	1.21	0.476	0.700
Smoothness	0.00032	0.00020	0.00021	0.00010	0.00026	0.00018	0.00027	0.00024	1.339	0.268
Root-Mean-Square Level	485.43	75.35	490.91	81.80	557.80	117.45	573.54	120.32	4.033	0.010
Root-Sum-of-Squares Level	10,152.28	1670.78	11,043.24	2186.09	12,464.44	2675.82	13,123.03	2758.38	6.489	0.001
1st Percentile	357.49	73.29	342.13	66.11	410.04	99.13	409.22	99.03	3.356	0.023
3rd Percentile	379.93	74.70	368.02	74.13	432.60	101.29	436.74	98.42	3.235	0.027
5th Percentile	391.35	74.38	381.24	75.44	444.91	101.12	452.42	100.13	3.363	0.023
10th Percentile	409.96	76.46	401.51	78.73	467.68	101.20	480.02	104.47	3.817	0.013
25th Percentile	442.60	77.42	436.06	79.49	510.08	103.44	518.16	110.22	4.283	0.008
75th Percentile	512.14	78.50	518.26	84.66	588.86	123.80	600.85	126.30	3.847	0.013
90th Percentile	549.34	77.25	565.56	88.76	629.57	132.99	655.12	142.70	3.939	0.011
95th Percentile	582.73	86.93	619.52	118.95	662.97	142.15	715.42	196.09	3.255	0.026
97th Percentile	619.66	104.18	667.30	147.57	693.64	159.57	758.00	232.42	2.375	0.077
99th Percentile	688.52	151.35	762.33	182.36	790.07	241.50	839.72	261.83	1.743	0.165
Entropy	4.49	0.45	4.79	0.36	4.53	0.33	4.58	0.32	2.613	0.057
Uniformity	0.22999	0.08097	0.19959	0.08190	0.23388	0.10473	0.21405	0.08493	0.630	0.598
Mean Local Entropy	3.29	0.34	3.50	0.27	3.26	0.26	3.30	0.23	3.201	0.028
Mean Local Range	156.92	28.34	167.10	29.73	169.04	39.78	176.78	46.01	0.993	0.401
Mean Local Standard Deviation	62.44	11.27	65.78	11.74	67.69	16.61	69.97	18.03	0.938	0.426
Katz Fractal Dimension	1.19	0.11	1.29	0.04	1.22	0.09	1.30	0.07	7.958	0.000

Analysis of variance (ANOVA) test. ROI, region of interests.

Table 2. Significance parameters for the Table 1.

Caudate		Control Right		Control Left		Schizoaffective Right
Tukey	Control Left	Schizoaffective Right	Schizoaffective Left	Schizoaffective Right	Schizoaffective Left	Schizoaffective Left
Pixel Count of ROI	0.298	0.239	0.096	0.999	0.936	0.968
Mean	1.000	0.112	***0.042***	0.137	0.053	0.976
Standard Deviation	0.371	0.788	0.146	0.899	0.952	0.614
Median	1.000	0.091	0.056	0.084	0.051	0.997
Mean Absolute Deviation	0.316	0.676	0.112	0.931	0.946	0.657
Median Absolute Deviation	0.284	0.623	0.407	0.936	0.995	0.985
Minimum	0.764	0.318	0.560	***0.042***	0.111	0.976
Maximum	0.476	0.455	***0.045***	1.000	0.613	0.634
Variance	0.552	0.890	0.093	0.930	0.725	0.358
Range	0.207	0.719	0.062	0.794	0.941	0.449
Interquartile Range	0.315	0.588	0.282	0.966	1.000	0.951
Most Frequent Value	1.000	0.060	***0.044***	0.057	***0.042***	0.999
Size %L	0.823	0.986	0.726	0.622	0.998	0.512
Size %M	0.762	1.000	0.734	0.764	1.000	0.737
Size %U	0.770	0.960	0.842	0.965	0.999	0.987
Kurtosis	0.924	0.999	0.973	0.965	0.997	0.993
Skewness	0.791	0.998	0.999	0.689	0.852	0.991
Smoothness	0.196	0.719	0.752	0.777	0.746	1.000
Root-Mean-Square Level	0.998	0.114	***0.035***	0.163	0.054	0.960
Root-Sum-of-Squares Level	0.634	***0.014***	***0.001***	0.236	***0.034***	0.815
1st Percentile	0.942	0.221	0.233	0.067	0.072	1.000
3rd Percentile	0.974	0.240	0.183	0.103	0.073	0.999
5th Percentile	0.984	0.233	0.139	0.114	0.062	0.993
10th Percentile	0.991	0.196	0.080	0.108	***0.039***	0.973
25th Percentile	0.996	0.113	0.061	0.069	***0.035***	0.993
75th Percentile	0.998	0.108	***0.046***	0.158	0.072	0.984
90th Percentile	0.969	0.125	***0.022***	0.292	0.070	0.893
95th Percentile	0.844	0.286	***0.021***	0.767	0.150	0.647
97th Percentile	0.805	0.505	0.052	0.959	0.324	0.619
99th Percentile	0.696	0.442	0.123	0.977	0.664	0.883
Entropy	0.058	0.986	0.869	0.126	0.281	0.974
Uniformity	0.700	0.999	0.941	0.614	0.955	0.894
Mean Local Entropy	0.074	0.991	0.997	0.036	0.115	0.960
Mean Local Range	0.816	0.724	0.325	0.998	0.838	0.909
Mean Local Standard Deviation	0.890	0.673	0.374	0.976	0.804	0.961
Katz Fractal Dimension	***0.002***	0.674	***0.001***	***0.046***	0.993	***0.023***

ROI, region of interests. NOTE: Indicators with $p < 0.05$ are bolded and italicized.

Table 3. Distribution of the analyzed putamen signal intensity parameters in the groups.

Putamen	Control Right (20)		Control Left (20)		Schizoaffective Right (20)		Schizoaffective Left (20)		F	*p*
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation		
Pixel Count of ROI	984.50	140.88	968.15	204.11	1105.15	223.09	1083.25	253.13	2.170	0.098
Mean	404.99	73.84	419.11	73.26	469.30	97.14	507.37	100.00	5.855	0.001
Standard Deviation	42.13	10.06	44.62	10.14	40.85	9.53	50.35	20.16	2.023	0.118
Median	405.53	74.48	418.58	73.09	469.38	96.91	507.20	99.18	5.855	0.001
Mean Absolute Deviation	33.58	7.98	35.38	7.94	32.79	7.82	41.13	17.90	2.230	0.091
Median Absolute Deviation	28.33	6.86	29.58	6.81	28.03	6.70	36.55	17.96	2.793	0.046
Minimum	267.10	43.63	283.75	54.35	337.85	79.09	358.65	75.90	8.942	0.000
Maximum	531.30	89.83	566.00	114.01	580.05	112.80	648.05	141.22	3.569	0.018
Variance	1871.02	843.77	2088.74	944.16	1754.79	803.91	2920.97	2635.52	2.412	0.073
Range	264.20	61.63	282.25	80.34	242.20	54.95	289.40	89.50	1.669	0.181
Interquartile Range	56.88	13.49	59.25	13.35	56.08	14.09	73.10	36.31	2.704	0.051
Most Frequent Value	403.50	74.72	412.65	74.21	460.95	93.20	510.50	115.25	5.887	0.001
Size %L	15.69	1.07	15.59	1.33	15.81	1.31	16.33	1.35	1.347	0.266
Size %M	68.63	1.95	68.93	2.80	67.91	2.43	67.11	2.49	2.216	0.093
Size %U	15.68	1.24	15.48	1.84	16.28	1.64	16.56	1.46	2.079	0.110
Kurtosis	3.12	0.38	3.43	1.47	2.94	0.43	2.84	0.44	1.987	0.123
Skewness	–0.07631	0.25064	0.07224	0.41482	–0.12664	0.19397	–0.10086	0.21475	1.996	0.122
Smoothness	0.00068	0.00040	0.00058	0.00028	0.00071	0.00035	0.00055	0.00033	0.992	0.401
Root-Mean-Square Level	407.23	74.20	421.54	73.57	471.12	97.37	510.02	101.15	5.801	0.001
Root-Sum-of-Squares Level	12,780.45	2634.43	13,051.87	2688.43	15,474.65	3176.09	16,600.26	3727.99	7.278	0.000
1st Percentile	302.95	56.86	315.43	58.18	370.04	82.90	392.58	76.71	7.616	0.000
3rd Percentile	324.33	62.10	336.06	62.42	391.19	86.83	414.14	78.70	6.931	0.000
5th Percentile	335.57	62.51	346.92	65.40	401.36	87.72	425.15	79.47	6.646	0.000
10th Percentile	351.19	64.22	363.06	66.63	416.92	89.07	442.12	82.58	6.438	0.001
25th Percentile	376.93	69.50	389.34	69.40	442.04	92.85	471.08	88.22	6.029	0.001
75th Percentile	433.80	78.29	448.59	76.96	498.11	102.13	544.18	113.27	5.711	0.001
90th Percentile	458.18	83.44	475.68	81.69	522.00	107.38	571.75	120.70	5.222	0.002
95th Percentile	473.02	87.16	491.62	85.41	535.40	108.33	588.06	126.09	4.933	0.003
97th Percentile	482.55	89.54	503.07	88.95	543.92	109.66	597.44	129.10	4.605	0.005
99th Percentile	500.73	92.83	527.06	99.61	557.47	109.70	618.09	134.92	4.178	0.009
Entropy	4.22	0.34	4.00	0.43	4.12	0.37	3.87	0.40	3.177	0.029
Uniformity	0.25744	0.04343	0.21648	0.06707	0.28970	0.06241	0.25346	0.04984	5.629	0.002
Mean Local Entropy	2.96	0.29	2.79	0.40	2.85	0.34	2.63	0.35	3.108	0.031
Mean Local Range	101.63	23.38	105.00	24.57	102.85	25.49	109.59	24.50	0.408	0.747
Mean Local Standard Deviation	41.49	9.61	42.95	10.28	42.80	11.49	45.30	10.39	0.460	0.711
Katz Fractal Dimension	1.29	0.05	1.23	0.03	1.29	0.06	1.22	0.01	20.357	0.000

Analysis of variance (ANOVA) test. ROI, region of interests.

The images were uploaded to a Windows 10 (Microsoft Corporation, Seattle, WA, USA) computer in DICOM format to obtain the final study data. The analysis algorithm was applied to all selected images with an in-house software developed in MATLAB (version R2021b; MathWorks, Natick, MA, USA).

The nuclear caudate and putamen regions were selected individually in the axial images that represented the anatomy. The region of interests (ROI) that was determined by a senior radiologist (M.B.) and we ensured that the borders, based on the ROI were not exceeded [30,31]. Texture analysis values were described by previous studies in literature [13,22,24,32].

Statistical Analysis

Data are presented as mean and standard deviation. Statistical analyses were conducted with the IBM SPSS for Windows version 26 (IBM Statistics, IBM Corporation, Armonk, NY, USA). The suitability of the data for normal distribution was analyzed with the Kolmogorov-Smirnov test. Student *t* test was used for age. For normal distributions of the data used, analysis of variance (ANOVA) test (Post Hoc TUKEY) was employed to compare the group data based on test findings. $p < 0.05$ values were considered statistically significant.

Results

Out of the 20 patients and 20 controls recruited to the study, 4 participants were female in each group. There was no significant difference in gender between the groups. The mean age was 43.70 $\pm$ 10.52 years in the patient group and 39.65 $\pm$ 12.35 years in the control group (t = –1.579, $p = 0.118$). As can be seen in Tables 1,2,3,4, differences in the values of the texture analysis parameters of both caudate and putamen nuclei were identified in the patient group compared to the controls. Mean, minimum and maximum intensity values, and most frequent values were significantly higher in both nuclei (caudate and putamen) in patients with SAD than in controls ($p < 0.05$). This was also the case for most of the other histogram parameters evaluated. Particularly in schizoaffective cases and their left side nuclei, high signals with significant parameters indicate that the dorsal striatum is likely affected in SAD and the left side is more affected ($p < 0.05$).

Root mean square level, root sum of squares level, 10th percentile, 25th percentile, 75th percentile, 90th percentile, 95th percentile and Katz fractal dimension values for the caudate nucleus were also different between groups ($p < 0.05$). In addition to these values for the putamen nucleus, the 1st percentile, 3rd percentile, 5th percentile, 97th percentile, 99th percentile, entropy, uniformity, and average local entropy values were also different between groups ($p < 0.05$).

The differences become especially evident in the histogram findings. In the schizoaffective group, the differences in the putamen nucleus were more and more pronounced than in the caudate nucleus. The fact that there was no difference in the pixel numbers of the evaluated areas suggested the presence of textural changes rather than a dimensional change. Fractal analysis results strengthened this textural difference, again evident in the putamen.

Discussion

Differences in the functioning of the two cerebral hemispheres have been recognized for more than a century. In recent years, lateralized dysfunction has been implicated psychiatric disorders such as schizophrenia and bipolar disorder. Thus, schizophrenia may be associated with left-hemisphere dysfunction and bipolar disorder with right-hemisphere dysfunction. Lateralized pathology and dysfunction are some of the most commonly reported localized biological findings in schizophrenia [19].

Although significant lateralization cannot be demonstrated in most psychiatric studies, the dorsal striatum has been reported to show lateralization [13,33,34]. Mettler emphasized a role of the basal ganglia in perception and its implications for schizophrenia [35]. Other studies that have combined neurochemical, neuropathological, and neuropsychological data have highlighted the importance of the striatum and pallidum in the etiology of psychotic symptoms [36,37]. Early *et al*. [38] suggested a lateralized hypofunction of dopaminergic neurons of the striatum, leading to hyperactivity of the striatum on the left side in schizophrenia patients. fMRI studies have pointed out reduced striatal signals with the development of psychotic symptoms [16].

In the present study, the left dorsal striatum was found to harbor differences in patients with SAD. T2W MRI images indicated that the dimensions (pixel counts) and signal intensities of the left nucleus were increased in the SAD group when compared to the contralateral and control groups. Putaminal changes were more significant compared to the changes in the caudate nucleus with the right putamen specifically affected in SAD. Increased size of the nuclei and increased signal intensity in T2W images indicated the occurrence of structural changes.

Table 4. Significance parameters for the Table 3.

Putamen		Control Right		Control Left		Schizoaffective Right
Tukey	Control Left	Schizoaffective Right	Schizoaffective Left	Schizoaffective Right	Schizoaffective Left	Schizoaffective Left
Pixel Count of ROI	0.995	0.271	0.448	0.173	0.311	0.987
Mean	0.956	0.098	***0.002***	0.270	***0.010***	0.513
Standard Deviation	0.933	0.990	0.211	0.804	0.523	0.114
Median	0.964	0.101	***0.002***	***0.258***	***0.010***	0.517
Mean Absolute Deviation	0.958	0.996	0.157	0.885	0.379	0.098
Median Absolute Deviation	0.983	1.000	0.081	0.968	0.177	0.066
Minimum	0.849	***0.005***	***<0.001***	***0.049***	***0.003***	0.743
Maximum	0.780	0.547	***0.011***	0.981	0.122	0.256
Variance	0.969	0.995	0.135	0.898	0.313	0.080
Range	0.862	0.776	0.695	0.312	0.990	0.180
Interquartile Range	0.986	0.999	0.092	0.967	0.189	0.070
Most Frequent Value	0.989	0.198	***0.002***	0.341	***0.006***	0.319
Size %L	0.995	0.989	0.385	0.944	0.261	0.576
Size %M	0.980	0.781	0.208	0.548	0.095	0.734
Size %U	0.978	0.618	0.293	0.374	0.139	0.944
Kurtosis	0.633	0.900	0.704	0.243	0.114	0.980
Skewness	0.350	0.942	0.993	0.125	0.220	0.992
Smoothness	0.796	0.997	0.594	0.678	0.987	0.468
Root-Mean-Square Level	0.955	0.105	***0.002***	0.285	***0.011***	0.500
Root-Sum-of-Squares Level	0.992	***0.036***	***0.001***	0.071	***0.003***	0.658
1st Percentile	0.942	***0.016***	***0.001***	0.071	***0.004***	0.736
3rd Percentile	0.957	***0.026***	***0.001***	0.090	***0.006***	0.755
5th Percentile	0.963	***0.033***	***0.002***	0.105	***0.007***	0.744
10th Percentile	0.961	***0.039***	***0.002***	0.124	***0.008***	0.724
25th Percentile	0.962	0.060	***0.002***	0.174	***0.010***	0.667
75th Percentile	0.959	0.143	***0.002***	0.348	***0.010***	0.413
90th Percentile	0.945	0.188	***0.003***	0.461	***0.016***	0.397
95th Percentile	0.941	0.231	***0.004***	0.539	***0.021***	0.376
97th Percentile	0.927	0.264	***0.005***	0.614	***0.030***	0.384
99th Percentile	0.875	0.371	***0.007***	0.820	0.053	0.313
Entropy	0.272	0.849	***0.024***	0.745	0.695	0.162
Uniformity	0.109	0.278	0.996	***0.001***	0.172	0.187
Mean Local Entropy	0.454	0.747	***0.019***	0.964	0.434	0.201
Mean Local Range	0.972	0.999	0.735	0.992	0.934	0.821
Mean Local Standard Deviation	0.971	0.979	0.659	1.000	0.893	0.874
Katz Fractal Dimension	***<0.001***	1.000	***<0.001***	***<0.001***	0.714	***<0.001***

ROI, region of interests. NOTE: Indicators with $p < 0.05$ are bolded and italicized.

Several studies in the literature have reported data that are consistent with our findings [20,39,40]. Heckers *et al*. [39] and Jernigan *et al*. [40] reported left laterality of the striatum in psychosis. A postmortem study conducted by Heckers *et al*. [39] indicated that the volume of the basal ganglia was significantly increased in psychosis with no significant differences in cortical or white matter volumes. However, the data reported by Mataboge *et al*. [21] did not suggest any increased left-handedness in the patients with schizophrenia and SAD in an Afrikaner Founder population. More research is needed to show exactly the type of changes that occur in SAD and how they occur. Histogram parameters and fractal analysis (Katz) value from texture analysis methods have not been used in previous studies and therefore constitute a promising field of study. With this method, changes in the relevant tissues and their effects on the etiopathology of a disease can be clarified.

The study has some limitations. First, retrospective design made it necessary to work with findings from past cases. So we could not exclude the medication effects by selecting patients who did not receive treatment or who are on standard medication. Another limitation is the inclusion of a relatively low number of cases. The last one is, the majority of the participants were male. The fact that the numbers of both genders were similar may make it stronger to generalize the results to both genders.

Conclusions

Texture analyses carried out in the current study suggest that the left dorsal striatum nuclei may be different in patients with SAD. Further studies are needed to determine the pathophysiology of SAD and how it may affect disease treatment. In particular, functional imaging can provide more information to understand the pathology of the disease. It will be beneficial to also analyze the laterality of the dorsal striatum in schizoaffective disorder under functional behavioral task states. It is highly recommended that other parts of the brain be analyzed as well.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

MB and SB designed the research study, HÖK, ÖG and MNN performed the research and TÖ and MB analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The entire study was conducted in accordance with the 2013 revised version of the 1964 Declaration of Helsinki. Istanbul S.B.U. Kanuni Sultan Süleyman Training and Research Hospital Local Ethics Committee approval dated 07/07/2022 and numbered 2022.07.177 was obtained and the patients were exempted from informed consent.

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Conflict of Interest

The authors declare no conflict of interest.

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