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Dermatoglyphic features – potential predictors in patients with schizophrenia

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A valuable approach to the neurodevelopmental etiology of mental disorders is the assessment of dermatoglyphic patterns in patients with schizophrenia. This study aimed to determine the predictor dermatoglyphic features of independent contribution to the membership status "schizophrenia patient – control subject". The study included 141 patients with schizophrenia and 120 mentally healthy subjects of Bulgarian origin. Fingerprints were obtained using an ink method and were read in accordance with the methods given by Cummins, Midlo. The data were analyzed with SPSS 28.0 using logistic regression. Differences between the patients and control groups were statistically significant for five dermatoglyphic features in males and two in females that made significant contribution to the prediction of the patient-control status in the regression model. The logistics model defines a set of dermatoglyphic features that distinguishes patients with schizophrenia from healthy controls and contributes to the validation of dermatoglyphics as biological markers in schizophrenia development.

Key words: dermatoglyphics, schizophrenia, logistic regression, neurodevelopment, predictor models

Introduction

Over the last years a tendency of using biological markers in mental disorders has been observed, focusing on early prenatal brain damage and caused by the influence of a certain static agent [12, 20]. An important approach to the neurodevelopmental etiology of mental disorders is the assessment of dermatoglyphic patterns in patients with schizophrenia [7, 8, 19].

Dermatoglyphics are individual characteristics with several features, such as stability, personality, regeneration capacity and hereditary determination. Their biological and clinical value is associated with the common ectodermal origin of the brain and dermal patterns and the strictly defined periods of embryonic formation of

papillary ridges (III – IV month of gestation) [21, 23]. In this sense ridge patterns might become reliable biomarkers for neurodevelopmental disorders, which is assumed in the neurodevelopmental hypothesis of mental disorders.

The aim of this study was to determine the predictor dermatoglyphic features of independent contribution to the membership status "schizophrenia patient – control subject".

Material and methods

Subjects

The study included 141 patients with schizophrenia (76 males, 65 females), consecutively admitted to the Clinic of Psychiatry in Plovdiv and the District Psychiatry Dispensary in Plovdiv with mean age 32.09 years (SD = 9.73). All patients satisfied DSM-IV criteria for diagnosis of schizophrenia on the basis of case records review, a semi-structured interview based on a checklist of items from DSM-IV (performed by psychiatrists of the Department of Psychiatry and Medical Psychology at the Clinic of Psychiatry, Medical University – Plovdiv, Bulgaria) and information obtained from relatives to enhance the validity of the diagnosis. Potential subjects were excluded if they had any signs of mental retardation, a history of drug or alcohol abuse, an identifiable neurological disorder (seizure disorder, head injury, multiple sclerosis, etc.) or a general medical condition with direct effects on the central nervous system [2].

Exclusion criteria: a history of drug or alcohol abuse; an identifiable neurological disorder (seizure disorder, head injury, multiple sclerosis etc.); intellectual disability or a somatic disorder with neurological components; pathological conditions, associated with variation of dermatoglyphic patterns, e.g., psoriasis, congenital abnormalities, etc.

The normal comparison group comprised 120 mentally healthy subjects (54 males, 66 females) with a mean age of 39.65 years (SD =10.68), volunteers with socioeconomic background comparable to that of the patients. Normality was defined as the absence of a major axis I or axis II disorder according to DSM-IV based on a semi-structured interview performed by the authors with the collaboration of psychiatrists of the Department of Psychiatry and Medical Psychology at the Clinic of Psychiatry, Medical University – Plovdiv, Bulgaria [2]. The mean age of the control group was greater than that of the patient group to minimize the cumulative risk of developing future major psychiatric disorder. Normal controls satisfied exclusion criteria similar to those applied to patients. In addition, to distinguish better the control from the patient group potential controls were excluded if they had a first-degree relative with a history of a psychotic disorder, major affective disorder or suicide.

All patients and control subjects were of Bulgarian origin to avoid the potential confounding effects of racial and ethnic variations.

The study was approved by the local Ethics Committee at the St. George University Hospital. All subjects gave written informed consent to participate.

Experimental procedure

A set of dermatoglyphic patterns with low racial instability and high diagnostic value was examined [10]. Fingerprints and palmprints were obtained using an ink method and were read with light (6D) magnification in accordance with the methods

given by Cummins, Midlo [5]. Fingerprinting was carried out in a passive manner, using a rotary cone sample divider method. For greater reliability the scoring of the palmprints was done separately by two persons according to the rules in Memorandum on dermatoglyphic nomenclature [18].

Data analysis

Thirty – five dermatoglyphic patterns were analyzed, including ridge counts of the fingers of the right and left hands, total finger ridge count for the right and left hands, arches, ulnar and radial loops, whorls for the right and left hands, a-b, b-c, c-d and total ridge counts for the right and left hands, white lines on the right and left palms.

The data were analyzed with SPSS 28.0 using logistic regression. All statistical analyses were performed separately for males and females in view of the available evidence for significant gender differences in ectodermal derivatives [1]. The level of statistical significance was set at $P < 0.05$. Dermatoglyphic patterns were included in a logistic regression procedure using a forward stepwise selection algorithm. Through the stepwise (Forward Stepwise Selection) logistic approach, the characteristic with the most significant contribution in predicting the status of "schizophrenic patients - control subject" was first determined. When determining the contribution of each of the characteristics, its interrelationship with the analyzed previous characteristics was considered. In the presence of significant intercorrelation between certain traits, they were excluded to create the best final logistic regression model. In order to determine the reliability of the obtained regression models, the indicators Cox & Snell R Square and Nagelkerke R Square, as well as the Hosmer and Lemeshow test were applied. As a rule, the Cox & Snell R Square indicator shows in what percentage the variation of the dependent variable (in the present study, the belonging of individuals to a certain group) can be explained by the logistic model. Higher values of this indicator also reflect greater reliability of the regression model.

The Nagelkerke R Square modification ranges from 0 to 1 and is a more reliable indicator than the Cox & Snell R Square. As a rule, it is always higher than the Cox & Snell index. The Nagelkerke index determines in percentage the correlation between the predictors and the prediction. An alternative to the presented indicators is the Hosmer and Lemeshow test. The essence of this model is the division of the studied objects into 10 groups and the comparison of the actual number of objects belonging to each of these groups with the predicted number of objects belonging to the groups obtained by the regression model. The probability level P was calculated based on chi-square with 8 degrees of freedom to test the reliability of a logistic model. If the Hosmer and Lemeshow test statistic shows a score greater than 0.05, it is impossible to reject the null hypothesis that there is no difference between the observed and model-predicted values. This means that the model estimates match the actual observed data to an acceptable level. Well-overlapping models indicate a lack of significance in the Hosmer and Lemeshow test. This desired result of no statistical significance indicates that the predicted pattern is not significantly different from the observed pattern.

Results

The logistic regression model successfully distinguished between the two groups as 81.0% of the cases were correctly classified in males and 81.7% in females (**Table 1**).

Table 1. Classification table – percent schizophrenic patients correctly classified by the one-step logistic model in males and females.

	Predicted group affiliation		Correctly classified
Observed	**Controls**	**Schizophrenia**	**%**
Males			
Controls	29	12	**70.7%**
Schizophrenia	8	56	**87.5%**
Totally			**81.0%**
Females			
Controls	46	10	**82.1%**
Schizophrenia	9	39	**81.3%**
Totally			**81.7%**

Forward stepwise logistic regression analysis was applied in order to establish the predictor dermatoglyphic variables, which contributed independently to the prediction of the status "schizophrenia patients - control subjects" (**Table 2**). Totally 76.2% of the male and 60.6% of the female subjects were correctly classified by the analysis in predicted group affiliation.

Table 2. Classification table – percent schizophrenic patients correctly classified by the Forward Stepwise Selection model in males and females.

	Predicted group affiliation		Correctly classified
Observed	**Controls**	**Schizophrenia**	**%**
Males			
Controls	26	15	**63.4%**
Schizophrenia	10	54	**84.4%**
Totally			**76.2%**
Females			
Controls	42	14	**75.0%**
Schizophrenia	27	21	**43.8%**
Totally			**60.6%**

Cox & Snell and Nagelkerke indicators were taken into account in order to determine the reliability of the regression model (**Table 3**).

Table 3. Cox & Snell and Nagelkerke indicators summarizing the one-step logistic regression model for the predilection of the "schizophrenia – controls" status in males and females.

Model Summary

	Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Males	1	81.269	0.431	0.584
Females	1	87.701	0.416	0.555

Hosmer and Lemeshow's test, with greater sensitivity in determining the reliability of the logistic model, showed a lack of statistical significance, which determined the regression analysis as sufficiently reliable to determine the group affiliation of males and females to the status of "patients with schizophrenia - controls" (**Table 4**).

Table 4. Hosmer and Lemeshow test of reliability of the one-step regression model in patients with schizophrenia and controls in males and females.

Hosmer and Lemeshow Test

	Step	χ^2	df	Sig.
Males	1	8.264	8	0.408
Females	1	3.045	8	0.931

The variables – dermatoglyphic features with statistically significant independent contribution to the prediction of the status "schizophrenia patients – control subjects" in males were disassociated white lines of the left hand, ulnar loops of the left hand and loops of the right hand, total a-b ridge count and the ridge count of L2 (**Table 5**).

Table 5. Logistic regression analysis (Forward Stepwise Selection) with independent variables dermatoglyphic features and dependent variable the status "schizophrenic patient – control subject" in males.

Step - entering the model variable	**B**	**Wald**	**P**	**χ^2**	**Sig.**	**Correctly Classified %**
Entering the model						
Constant	5.673	8.618	0.003			
1. Disassociated white lines on the left hand	-1.830	8.086	0.004	9.904	0.002	**61.0%**
2. Ulnar loops on the left hand	-0.759	9.143	0.002	15.824	0.000	**66.7%**
3. Loops on the right hand	0.787	8.542	0.003	20.914	0.000	**71.4%**
4. Total a-b ridge count	-0.058	6.649	0.010	26.417	0.000	**76.2%**
5. Ridge count of L2	0.090	4.135	0.042	30.843	0.000	**76.2%**

In females the dermatoglyphic features with statistically significant independent contribution to the prediction of the status "schizophrenia patients – control subjects" were: ulnar loops on the left hand and severe corrugations of white lines on the right hand (**Table 6**).

Table 6. Logistic regression analysis (Forward Stepwise Selection) with independent variables dermatoglyphic features and dependent variable the status "schizophrenic patient – control subject" in females.

Step – entering the model variable	B	Wald	P	χ^2	Sig.	Correctly classified %
Entering the model						
Constant	0.120	0.042	0.837			
1. Ulnar loops on the left hand	-0.301	3.772	0.052	14.268	0.003	**60.6%**
2. Severe corrugations of white lines on the right hand	2.503	8.398	0.015	10.310	0.006	**61.5%**

Discussion

The results of the present study in schizophrenia allow the identification of a set of dermatoglyphic features that could reveal early dysontogenic events associated with the subsequent development of the disease. Differences between the patients and control groups were statistically significant for five dermatoglyphic features in males and two in females (out of a total of 35 dermatoglyphic patterns examined) that made significant contribution to the prediction of the patient-control status in the regression model. These were disassociated white lines on the left hand, ulnar loops on the left hand, loops on the right hand, total a-b ridge count and ridge count of L2 in males, and ulnar loops on the left hand and severe corrugations of white lines on the right hand in females. The results that we obtained confirm similar studies of dermatoglyphic features and could be explained as follows [19]. On the one hand the change in the frequency of specific dermatoglyphic patterns or the deviation from the mean values of quantitative dermatoglyphic characteristics of individuals reveal disturbances in normal morphogenesis, even though they do not represent anomalies by themselves [17]. The individuality of papillary images, their unchanged structure after birth and the common ectodermal origin with the nervous system draw attention to genetic and epigenetic events occurring during the embryonic period, which can be considered biological markers of dysontogenesis affecting the development of dermatoglyphics [9]. This defines the period 6.5 to 16-18 gestational weeks as the most critical period in the development of dermatoglyphics and the nervous system and determines the research of causal relationships of dysontogenetic events in this period. Certain dermatoglyphic patterns in patients with schizophrenia could serve as chronomarkers for determining the duration of action of exogenous factors damaging ectodermal derivatives. In this sense, the processes of formation and differentiation of papillary images are of great

importance and depend on the size and shape of the dermal pads and some gender differences [4, 11, 14, 22].

Another significant point that could explain the obtained results is the pronounced sexual dimorphism in most of the dermatoglyphic traits. In general, male patients have more statistically significant features in ridge patterns than female patients. Regarding the disease, earlier onset of schizophrenia symptoms has been found in men, followed by a more severe course of the disease, while in women there is more favorable outcome of the disease, presented by milder course and better response to therapy [3, 6]. Given the multifactorial etiology in the development of schizophrenia, it is clear that males are more vulnerable and more sensitive to endogenous and exogenous influences than females, which explains the greater abnormal dermatoglyphic findings in males with schizophrenia [15, 16, 22]. This is probably due to the protective effect of neurohumoral regulatory mechanisms in females, as well as individual anatomical characteristics and differences between the genders. For example, the later onset of schizophrenia in females compared to males is probably due to the protective effect of estrogen. Gender differences successfully define the male sex as more susceptible to abnormalities in the development of ectodermal derivatives. This is well illustrated by the predictor patterns in male and female patients. In this sense, the stepwise logistic regression model identified a larger set of traits that successfully distinguished patients from controls better in males than in females [13, 22, 24].

Conclusions

As a whole, established by us the logistic regression model defines a set of dermatoglyphic features (five in males and two in females from the examined patterns) that distinguishes sufficiently well patients with schizophrenia from mentally healthy individuals and thereby contributes to the validation of dermatoglyphics as biological markers in the development of schizophrenia.

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