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Dermatoglyphics as markers of prenatal disturbances in schizophrenia: a case-control study

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Aim: Several studies have reported the importance of dermatoglyphics as markers of a prenatal disturbance in patients with schizophrenia. Due to the fact that finger- and handprints are formed by the end of the second trimester, they may provide clues to disturbances in early development. The aim of this study was to determine specific dermatoglyphical frequencies in a sample of patients with schizophrenia and normal controls.

Materials and methods: Fingerprints and palm prints were obtained from 45 schizophrenic patients as well as 45 healthy controls. The dermatoglyphic patterns on the fingers (total finger ridge count [TFRC]) and palms (a-b, b-c, and c-d ridge counts; total a-b ridge count [TABRC]; total c-d ridge count [TCDRC]; and atd angle) were evaluated.

Results: There was a significant decrease in both the TABRC ($P < 0.01$ for males and $P < 0.001$ for females) and the TCDRC ($P < 0.05$ for males and $P < 0.001$ for females) in the schizophrenic group compared with the control group. There was no significant difference in the TFRC in the male schizophrenic group compared with the male control group; however, there was a significant decrease in the TFRC in the female schizophrenic group compared with both the female control ($P < 0.005$) and male schizophrenic groups ($P < 0.003$). We found a significant decrease in both the right and left hand a-b and c-d ridge counts in female schizophrenics compared with female controls ($P < 0.01$ and $P < 0.01$, respectively), whereas this decrease was not significant with respect to the atd angle. On the other hand, it was determined that the left hand atd angle, a-b ridge count, and c-d ridge count were significantly decreased in male schizophrenics compared with male controls ($P < 0.01$ for the atd angel, $P < 0.01$ for the a-b ridge count, and $P < 0.05$ for the c-d ridge count), while there were no significant differences in the right hand atd angle, a-b ridge count, or c-d ridge count in the male schizophrenics compared with the male controls.

Conclusion: The frequencies of specific dermatoglyphic patterns were statistically different between schizophrenics and healthy controls with respect to hand (left or right) and gender. Therefore, dermatoglyphic markers may be indicative of an early disturbance in brain development in schizophrenics and may help elucidate the gender differences which exist in schizophrenia.

Key words: Schizophrenia, dermatoglyphic, gender comparison, finger ridge count, a-b ridge count, c-d ridge count

Şizofreni'de prenatal bozukluğun göstergesi olarak dermatoglifikler: Bir vaka-kontrol çalışması

Amaç: Şizofreni'de erken prenatal bozukluğun göstergesi olarak çeşitli çalışmalar bildirilmiştir. Parmak ve el izlerinin ikinci trimestır'ın sonuna kadar şekillenmesi nedeniyle gelişimin erken bozukluklarında bazı ip uçları sağlarlar. Bu çalışma şizofreni'li hastalar ile normal kontroller arasında dermatoglifik sıklıkları incelemek için planlanmıştır.

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Yöntem ve gereç: Parmak ve el izleri, 45 şizofrenik hasta yanı sıra 45 sağlıklı kontrol'den alındı. Dermatoglifik analiz olarak; parmakta total parmak çizgi sayısı (TFRC) ve elde a-b, c-d çizgi sayısı, total a-b çizgi sayısı (TABRC), total c-d çizgi sayısı (TCDRC), atd açısı değerlendirildi.

Bulgular: Şizofreni grubu ile kontrol grubu karşılaştırıldığında, hem TABRC ($P < 0,01$ erkekler için, $P < 0,001$ kadınlar için) ve TCDRC ($P < 0,05$ erkekler için, $P < 0,001$ kadınlar için) anlamlı olarak azalmıştı. Şizofren erkekler kontrol erkeklerle karşılaştırıldığında TFRC de anlamlı farklılık yoktu, oysa şizofren kadınlarda, hem kontrol kadınlarla ($P < 0,005$) hem de şizofren erkeklerle ($P < 0,003$) karşılaştırıldığında anlamlı olarak düşmüştü. Biz, şizofren kadınlarda hem sağ hem de sol el a-b, c-d çizgi sayısında kontrol kadınlarla karşılaştırıldığında anlamlı azalma olduğunu bulduk ($P < 0,01$, sırasıyla $P < 0,01$, sırasıyla), oysa bu azalma atd açısında anlamlı değildi. Diğer bir yönden şizofren erkekler kontrol erkeklerle karşılaştırıldığında sol el atd açısı, a-b çizgi sayısı, c-d çizgi sayısı anlamlı olarak azalmış olarak saptandı ($P < 0,01$ atd açısı için, $P < 0,01$ a-b çizgi sayısı için, $P < 0,05$ c-d çizgi sayısı için), oysa sağ elde bu parametrelerde anlamlı farklılık yoktu.

Sonuç: Bulgular, dermatoglifik farklılıkların sağ - sol ele ve cinsiyete göre değiştiğini gösterdi. Bu yüzden dermatoglifik göstergeler, şizofreni'de beyin gelişiminde erken bozukluğun habercisi olabilir ve cinsiyet farklılığını açıklayabilir.

Anahtar sözcükler: Şizofreni, dermatoglifik, cinsiyet karşılaştırılması, parmak çizgi sayısı, a-b çizgi sayısı, c-d çizgi sayısı

Introduction

Dermatoglyphics is the study of the epidermal ridges of the skin covering the digits, palms of the hands, and soles of the feet. Epidermal ridges are formed between the 11th and 24th weeks of gestation; after this time, the epidermal ridges do not change (1). Dermatoglyphic patterns may also be viewed as "fossils" of late first and second trimester fetal development (2). Moreover, critical growth of the brain is also occurring during this period. Since the skin and the brain develop from the same ectoderm, dermatoglyphic variations are informative for early developmental brain disturbances (3). It has been suggested that an insult causing damage to one of these systems would damage the other, and there is now evidence regarding the dermatoglyphic profiles of the hands in schizophrenics.

Dermatoglyphics may be affected by both genetic and environmental factors. A relationship exists between embryonic stress and distortion of dermatoglyphic patterns (4). The etiology of schizophrenia is still poorly understood. The neurodevelopmental hypothesis of schizophrenia is a major research concept that is consistent with the presence of minor physical abnormalities and dermatoglyphic variations, which are indicators of developmental problems (5). The neurodevelopmental hypothesis states that the interaction of genetic and environmental factors influences the ways in which nerve cells are laid down, differentiated, and remodeled. These changes begin in utero, affected by events around birth, and become fully expressed in early adulthood. There is also some evidence that schizophrenia has sexually dimorphic features (6). In fact, it is thought that sexual hormones may function as etiologic agents during the fetal period for psychiatric disorders. Daily et al. (7) suggested that males tend to be at greater risk for a neurodevelopmental subtype of schizophrenia than females.

Cerebral and epidermal tissues share some aspects of development, such as similar ectodermal origin, rapid development during the second trimester of gestation, and susceptibility to neuronal growth factor. Many studies have resorted to dermatoglyphic variables as a useful marker of an adverse intrauterine experience. Specifically, simplification, ridge dissociation, abnormal features, and fluctuating asymmetry (FA [the difference between the right and left sides of a quantifiable morphologic trait]) of dermatoglyphics have been analyzed in the study of psychiatric disorders. In addition, there have been several studies that have reported greater dermatoglyphic FA for both a-b ridge counts and fingerprint patterns in individuals with schizophrenia compared with healthy controls (8,9). Although there have been many studies regarding dermatoglyphics in schizophrenia, there exists a relatively diverse and inconsistent range of dermatoglyphic alterations in the literature.

Many research groups have reported that there is a significantly reduced a-b ridge count in patients

with schizophrenia compared with controls (2,4,10); however, not all studies have confirmed this finding (11). Furthermore, some studies have concluded that the total finger ridge counts in patients with schizophrenia are decreased compared with normal controls (10), whereas other studies have demonstrated no significant differences between schizophrenic patients and controls (2,12).

The inconsistency in the literature may be due to differences in the sample characteristics, methodology, analytical techniques, or the ethnicity of the patients. Therefore, we examined the quantitative dermatoglyphic variables in a case-control study, because a dermatoglyphic deviation involving schizophrenia has not been studied to date in a Turkish population. The aim of this study was to analyze dermatoglyphic traits, such as the total finger ridge count (TFRC), the a-b ridge count, the total a-b ridge count (TABRC), the c-d ridge count, the total c-d ridge count (TCDRC), and the atd angle in schizophrenics and healthy controls. To our knowledge, only one study has analyzed the c-d ridge counts in schizophrenic patients (13). In this study, the gender differences that exist in schizophrenia were also investigated.

Materials and methods

This study was conducted at Elazığ Psychiatry Hospital. Patients with a history of drug abuse or dependence, serious medical conditions, severe head injury, or seizure disorders were excluded from the study. The diagnosis of chronic schizophrenia was performed according to DSM-IV criteria on the basis of independent structured clinical interviews and reviews of records by one qualified psychiatrist, and included the Brief Psychiatric Rating Scale (BPRS). The controls were healthy subjects, none of whom had a history of psychiatric disorders, severe head injury, or seizure disorders.

After rolling black ink on a simple glass, first the fingerprints and then the palm prints were recorded on high quality paper. The resultant patterns were studied with a magnifying glass. Recognized quantitative parameters were recorded.

The study was conducted on 26 males and 15 females who were diagnosed with schizophrenia, and 45 healthy controls (27 males and 18 females). The ink prints of both hands were obtained such that the palms and fingertips could be studied with a magnifying glass. The prints were examined according to an international standard method (14). The measurement of dermatoglyphic variables included the TFRC, TABRC, TCDRC, and atd angle.

The ridge counts on each digit were scored as the number of ridges crossing the segment that connects the triradius and the center of the finger pattern. If more than one ridge count was available for a finger, as in the case of whorls or double loops, only the largest ridge count was used for further analysis. The ridge count of arches was conventionally scored as 0. The TFRC was calculated as the sum of the ridge counts for 10 digits.

The a-b interdigital ridge count (ABRC) was defined as the number of ridges that cross a line drawn between triradii a and b. The ABRC is a measure of the second interdigital area of the hand. It is measured by counting the number of ridges between the triradius a at the base of the index finger, and the triradius b at the base of the middle finger. The TABRC is determined by adding both the left and right ridge counts.

The c-d interdigital ridge count (CDRC) was defined as the number of ridges that cross a line drawn between triradii c and d. The TCDRC is determined by adding both the left and right ridge counts.

The two atd angles were analyzed between the a, t, and d triradial points on the right and left hands. The atd angle was formed by drawing lines from the digital triradius a to the axial triradius t (at the base of the palm), and to the digital triradius d.

Statistical Analysis

All analyses were performed using the SPSS statistical software package. Data were expressed as the mean ± standard deviation. The means were analyzed using the independent samples t-test. $P < 0.05$ was considered as significant.

Results

The TABRC, atd angle, and TCDRC data were available for 41 patients and 45 controls; complete data for the TFRC were available for 45 patients and 45 controls. We excluded 4 cases from the TABRC, atd angle, and TCDRC analyses since the handprints were not sufficiently legible.

The results are summarized in Tables 1-3. In Table 1, a significant decrease was demonstrated in the atd angle of the left hand in male schizophrenics compared with male controls ($P < 0.01$). However, there was no significant difference in the atd angle between the female study groups. Additionally, there was a significant decrease in the a-b ridge count of the left hand of male and female schizophrenics compared with the controls ($P < 0.01$ for males and $P < 0.001$ for females). Moreover, there was a significant decrease in the a-b ridge count of the right hand of female schizophrenics compared with the female controls ($P < 0.01$). Similarly, the c-d ridge count of the left hand of male schizophrenics was significantly decreased compared with the left hand of male controls ($P < 0.05$). There was a significant decrease in the c-d ridge count of both the left and right hands of female schizophrenics compared with the control group ($P < 0.001$ for the right hand and $P < 0.01$ for the left hand). In addition, as shown in Table 2, the TABRC was significantly decreased in male schizophrenics compared with the male controls ($P < 0.01$). The TABRC was significantly decreased in female schizophrenics compared with female controls ($P < 0.001$). The TCDRC in male schizophrenics was significantly decreased compared with male controls ($P < 0.05$). The TCDRC in female schizophrenics was significantly decreased compared with female controls ($P < 0.001$).

As shown in Table 3, the TFRC of schizophrenic patients was significantly decreased compared with the control groups ($P < 0.02$). The TFRC of female schizophrenic patients was significantly decreased compared with the TFRC of the healthy female control group ($P < 0.005$). Moreover, there was a significant decrease in the TFRC of female schizophrenic compared with the TFRC of male schizophrenic patients ($P < 0.003$). There was not a significant difference between the TFRC of male schizophrenics and the TFRC of healthy male controls. Also, there was no significant difference between the TFRC of the female and male controls.

Table 1. The comparison of atd angle, a-b ridge count, and c-d ridge count between schizophrenia and control groups.

		Males		Females	
		Number	Mean ± SD	Number	Mean ± SD
ATD angle (right)	Schizophrenia	26	38.69 ± 4.44	15	41.38 ± 4.65
	Control	27	40.70 ± 2.81	18	42.44 ± 3.88
ATD angle(left)	Schizophrenia	26	37.84 ± 3.61**	15	39.27 ± 4.01
	Control	27	41.11 ± 3.91	18	41.67 ± 3.93
AB ridge count (right)	Schizophrenia	26	37.76 ± 6.57	15	36.46 ± 5.81**
	Control	27	40.44 ± 5.62	18	42.33 ± 4.06
AB ridge count (left)	Schizophrenia	26	37.67 ± 5.38**	15	36.07 ± 3.88***
	Control	27	42.43 ± 4.95	18	42.47 ± 4.10
CD ridge count (right)	Schizophrenia	26	35.80 ± 7.55	15	31.23 ± 4.88***
	Control	27	38.81 ± 5.78	18	39.35 ± 4.14
CD ridge count (left)	Schizophrenia	26	32.92 ± 8.34*	15	28.64 ± 7.55**
	Control	27	37.72 ± 6.64	18	36.17 ± 4.03

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

Table 2. The comparison of TABRC and TCDRC between schizophrenia and control groups.

		Males		Females	
		Number	Mean ± SD	Number	Mean ± SD
TABRC	Schizophrenia	26	75.75 ± 9.82**	15	72.50 ± 8.34***
	Control	27	82.96 ± 8.69	18	84.63 ± 6.73
TCDRC	Schizophrenia	26	69.36 ± 13.97*	15	58.31 ± 9.92***
	Control	27	76.43 ± 11.32	18	74.79 ± 7.56

* P < 0.05; ** P < 0.01; *** P < 0.001

Table 3. The comparison of total finger ridge count between schizophrenia and healthy control groups.

Groups	TFRC
I- control males	136.39 ± 31.95
II- control females	127 ± 17.33
III-schizophrenia males	128.21 ± 26.14
IV-schizophrenia females	101.67 ± 27.67
V- control groups	133.23 ± 27.85
VI- schizophrenia groups	119.16 ± 29.26
P values	
I-II	n.s.
III-IV	P < 0.003
II-IV	P < 0.005
I-III	n.s.
V-VI	P < 0.024

Discussion

We evaluated the dermatoglyphic differences between schizophrenic and healthy control groups in terms of gender and the difference between right and left hands. Since the difference in gender is an important issue for the neurodevelopment hypothesis in schizophrenia, it may contribute to the elucidation of the etiology of schizophrenia. Additionally, the c-d ridge count was analyzed in this study. We observed that the c-d ridge count was analyzed in only a few studies involving schizophrenia.

The results of the present study demonstrated that the atd angle, a-b ridge count, and c-d ridge count were significantly decreased in the left hands of male schizophrenic patients compared with healthy male controls. Conversely, the a-b ridge and c-d ridge counts were significantly decreased both in the right and left hands in female schizophrenic patients compared with healthy female controls. Moreover, although there was not a significant difference in the TFRC of male schizophrenics compared with healthy controls, the TFRC of female schizophrenics was significantly decreased compared with both male schizophrenic patients and healthy female controls. In addition, there was not a significant difference in the TFRC between male and female controls. The difference in the left hand in male schizophrenics may indicate lateralization disturbances in schizophrenia, but we did not do lateralization or handedness examinations. It has been suggested that atypical patterns of lateralization exist in schizophrenics (15). Furthermore, in one of the previous studies, there is a right TFRC dominance in bipolar and control subjects, in contrast to findings in schizophrenic subjects (16).

In a study by Jantz et al. (17) evaluating the palmar interdigital ridge-counts (c-d, b-c, and a-b), the c-d and b-c ridge counts showed higher right side values, while the a-b count showed a higher left side value. Gender differences in asymmetry were significant, with females exhibiting larger left values than males for all 3 counts. The FA was highest for the c-d count, followed by the a-b count. Another study showed that the finger ridge count, as well as the palmar ridge

count, was markedly lower in bipolar affective disorder (BPAD) and schizophrenia as compared with controls (13). Additionally, it was shown that only the c-d ridge count was statistically different between the BPAD and schizophrenia patient groups (13). In our study, there was a significant decrease in the c-d ridge count in the left hand of male schizophrenics and the left and right hands of female schizophrenics, as well as the a-b ridge count. Thus, the differences between schizophrenic subgroups and controls might be related to the variation in the c-d ridge count. Further studies are needed to clarify this issue.

Significantly lower ridge counts have been described in schizophrenia, especially lower a-b ridge counts, because in schizophrenia, a more severe and/or an earlier developmental insult involving the ridges in the interdigital area II may be among the earliest to begin to form, and they develop over a longer time period than do digital dermal ridges (4). Although most studies have found that patients with schizophrenia have reduced a-b ridge counts, no significant difference was observed in the TFRCs between groups (2). Some studies of the a-b ridge count have reported this dermatoglyphic trait to be the most sensitive to environmental influence (9,18,19). In a twin study, it was suggested that the a-b count in males was more influenced by environmental factors than the other counts (3). Bramon et al. (20) observed that only patients who suffered from obstetric complications showed an abnormally reduced ABRC, while patients without obstetric events and unaffected relatives did not differ from controls. They suggested that subtle a-b ridge count reductions described in schizophrenia could be related to early environmental insults, such as obstetric complications. On the other hand, Fañanas (4) suggested that family studies have demonstrated higher correlation values for the total finger count than for the a-b ridge count. Since there was no significant difference in the TFRC of schizophrenic male patients compared with normal controls in our study, we suggest that male schizophrenics seem to be more influenced by environmental factors than female schizophrenics. Furthermore, there was a significant decrease in the TFRC in female schizophrenics compared with both the female controls and male schizophrenics, as well as the a-b and c-d ridge counts. For females, the 3 interdigital counts (a-b, b-c, and c-d) appear to have a strong genetic component influencing their phenotypic expression (21). Dogramaci et al. (22) showed that the frequency of loops on the fifth finger of the left hand and the mean c-d ridge count was significantly higher in female beta-thalassemia major patients than carriers and controls. Beta-thalassemia major is a genetic disease. It may be considered that females may be more influenced by genetic factors than environmental factors.

Cerebral and epidermal growth is influenced by testosterone in both genders during dermatoglyphic development (5). It has been suggested that testosterone inhibits the growth of certain areas of the left hemisphere and facilitates the growth of the same areas in the right hemisphere (21). Also, it has been concluded that the ratio of the 2nd digit to the 4th digit may be a possible marker for autism, which would implicate prenatal testosterone in its etiology (23). Most previous studies have evaluated alterations in the TABRC and TFRC without a difference in gender. Some previous studies have reported their derived asymmetry compared to controls. Our results were in consistent with the findings reported by previous studies of lower TABRC with lower TFRC in schizophrenic patients as compared with healthy controls. Rosa et al. (24) reported that negative schizotypy was associated with more FA (the absolute difference of the a-b ridge count between the right and left hands) and that the association with FA was more significant in boys. Saha et al. (12) found no difference for directional asymmetry or for FA. They explained that inconsistencies in the literature may be related to the different formulas used to assess dermatoglyphic FA. Hence, we did not do asymmetry analysis in this study. However, the findings in our study might be limited in certain aspects. We did not analyze the presence of lateralization in the present study. It was suggested in our study that a gender difference in dermatoglyphic variation may be important for the etiology of schizophrenia. It is known that differences exist between the 2 genders, with females consistently developing the disease slightly later than males (25). The gender difference may be explained on the basis of the membrane phospholipid hypothesis. Phospholipids are crucial to

synaptic remodeling, and their reduction is resisted more in females than in males. Thus, females would be expected to be more resistant to the neuronal consequences of a phospholipid abnormality. Horrobin (24) proposed that the neurodevelopmental concept of schizophrenia can be explained biochemically in relation to the phospholipid hypothesis.

In conclusion, these results suggest that there may be an association between early developmental disturbances, occurring during prenatal life, and the later onset of schizophrenia. The presence of abnormalities in the palmar prints may constitute indelible evidence of a prenatal disturbance in the 4th or 5th month of pregnancy. The limitation of consistency in the literature may be due to the differences in sample characteristics, methodology, or analytical techniques. Gilligan et al. (26) also reported that there was a significant correlation between dermatoglyphic and geographic distances, confirming the biological validity of the social and ethnic criteria. Thus far, there have been no studies in schizophrenic patients in the Turkish population. This provides us with more incentive to work on these patterns. Additionally, this study suggests that males tend to be at a greater risk for the neurodevelopment of schizophrenia than females, as in agreement with other studies (6,7).

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