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Fluctuating Asymmetry of Dermatoglyphic Features in Patients with Turner Syndrome

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Dermatoglyphic study of patients with Turner Syndrome and such with gonadal dysgenesis syndrome (GDS) are investigated. Fluctuating asymmetry of finger patterns type, finger ridge counts and palmar ridge counts is determined. Subject of the investigation are 31 patients with *45X0*, 10 with *45X0/46XX* and 7 with partial monosomic X. The data in patients are compared with those in 131 healthy women. Highest is the fluctuating asymmetry in the patients with *45X0* followed by *45X0/46XX*. In the patients with partial monosomic X the fluctuation asymmetry is near to those of controls. Highest fluctuating asymmetry is established for ridge counts on III and V pair digits and the palmar *a-b* ridge counts in *45X0*, and in patients with *45X0/46XX* – for ridge counts on I homologous digit and palm *c-d* ridge counts. The data gives reason to assume that anomalies connected with sexual chromosomes number have a considerable effect on dermatoglyphic fluctuating asymmetry.

Key words: dermatoglyphic features, fluctuating asymmetry, patients with Turner Syndrome and gonadal dysgenesis syndrome.

Introduction

The investigation of individuals with genome and chromosome mutations attacking sexual chromosomes is an interesting and actual problem reflecting on many contemporary medical and anthropological studies [6,7,8]. The rise of such mutations is a result of an abnormal miosis and mitosis and of an irregular distribution of the sexual chromosomes in the newly born sexual and somatic cells respectively. The presence of such mutations in the genotype determines the expression of a phenotype that is described as specific combinations of features and symptoms forming a clear expressed clinical status. The unique of these combinations serves as a ground for them to be determined as separate specific syndromes. The fact unifying these syndromes is that the violation of sexual chromosomes' balance or the gene localization in them express phenotypic itself in different diversion's degree from the normal sexual development of the individuals.

The *aim* of the present work is to assess the fluctuating asymmetry level of three dermatoglyphic features (patterns' type on homologous digits, finger ridge count on homologous digits and palmar *a-b, b-c, c-d* and *a-d* ridge count) in individuals with sexual chromosome mutations. Summarizing the fluctuating asymmetry is determined as an expression of accidental differences in the chromosome's size of structures that

theoretically could be the same. It is well known that the fluctuating asymmetry level of the bilateral morphological structures serves as a homeostasis indicator in the individual's development [2, 3, 4, 5, 9]. Basically this understanding comprises the idea that the genetic factors or the environmental ones that disturbed the normal individuals' development exert a negative influence on the bilateral structures control, as well. So, the disturbances' degree in the perfect bilateral symmetry gives possibilities of the precise in the mechanisms that controls the individuals' homeostasis to be accessed.

Material and Methods

Object of the present study are individuals with sexual chromosomes' aneuploidy from the type *total monosomic X (45XO) – Shershevski – Turner syndrome* and *45XO/46XX mosaic form in the gonadal dysgenesis syndrome*, as well as individuals with *partial monosomic X – gonadal dysgenesis syndrome (GDS)*. The investigation encloses 31 patients with *total monosomic X (45XO)*. 10 patients with *45XO/46XX mosaic form in the gonadal dysgenesis syndrome* and 7 ones with *partial monosomic X.*

The analysis of dermatoglyphic features is made by the method of C u m m i n s, M i d l o [1] and the fluctuating asymmetry level for finger and palm ridge counts – by the coefficient of indetermination ($1-r^2$). As it is well-known, the square of the product-moment correlation coefficient (r^2) of the two variables is a measure of their common variance, and the coefficient of indetermination ($1-r^2$) is an estimate of their unshared variance and thus of fluctuating asymmetry [4]. In the practical example this unshared variance concerning the finger and palm ridge counts on left and right hand in the individuals with gonadal dysgenesis determines the fluctuating asymmetry level of the investigated features.

The fluctuating asymmetry level of finger patterns is determined by the indetermination degree of the papillary patterns on the homologous digits.

The data about fluctuating asymmetry level for the three-dermatoglyphic features in the patients subgroups are compared with analogous data for a control group of healthy persons (131 females).

Results

The comparative analysis of the data obtained about patients with *gonadal dysgenesis* and healthy persons show significant differences for the investigated dermatoglyphic features. The analysis of finger ridge counts' distribution outline a tendency toward a remarkable higher finger ridge counts in the patients with *gonadal dysgenesis* compared to the healthy persons (Table 1, Fig. 1). The comparison of the finger ridge count values on left and right hand in the individuals with *gonadal dysgenesis* show a common tendency expressed by a presence of higher ridge counts in the patients with *total monosomic X (45XO)* and the ones with *45XO/46XX mosaic form* compared to the patients with *partial monosomic X*. The descendent formulae about finger ridge counts for the investigated groups are presented below:

	Left hand	Right hand
Total monosomic X (45XO)	I>IV>III>II>V	I>IV>II>V>III
45XO/46XX mosaic form	I=IV>V>II>III	I>IV>II>III>V
Partial monosomic X	I>IV>V>II>III	I>IV>V>II>III
Healthy persons	I>IV>V>III>II	I>IV>V>II>III

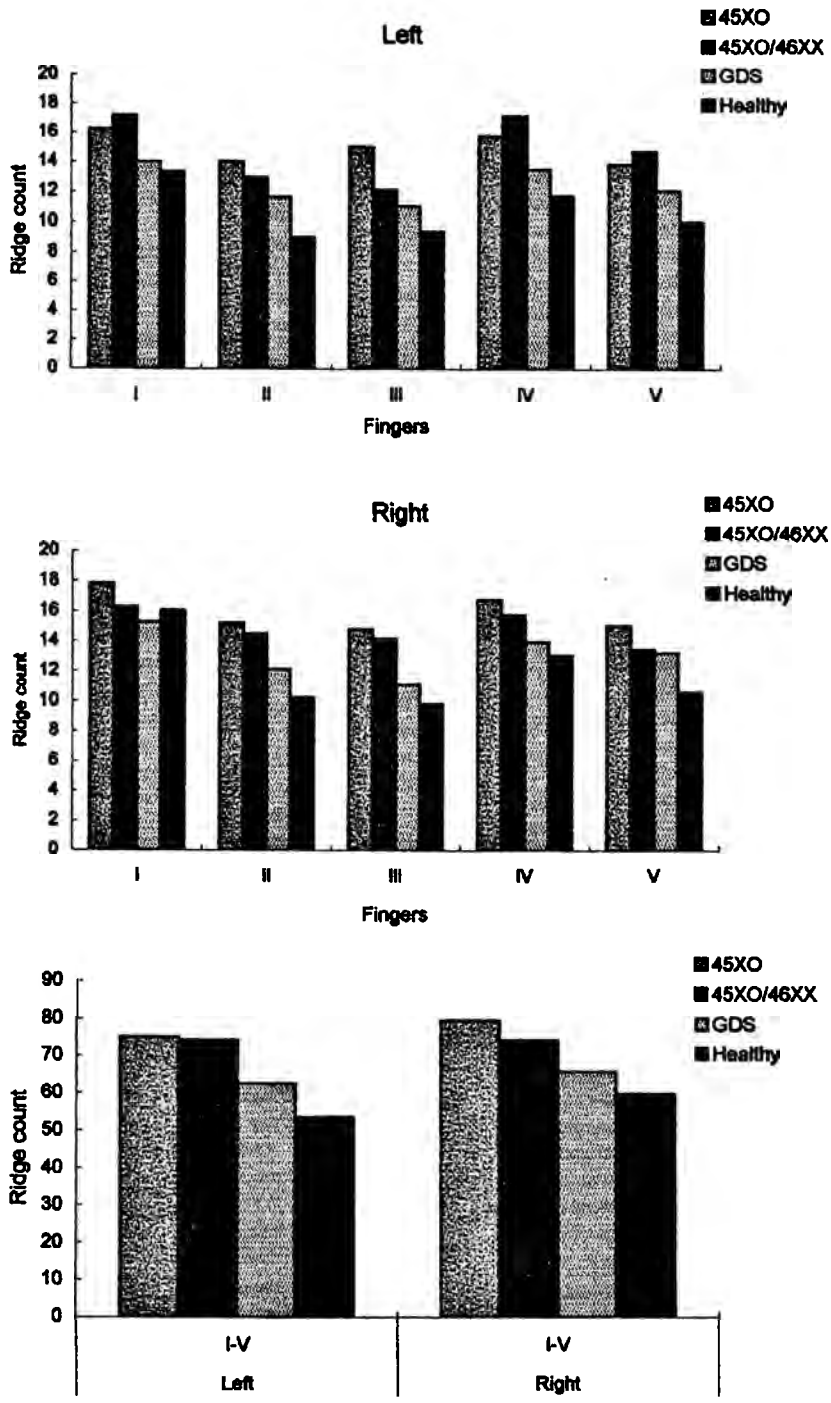

Fig. 1. Distribution of finger ridge counts

Table 1. Distribution of finger and palm ridge counts

FEATURES		Patients				
		45XO		45XO/46XX		G
		X	SD	X	SD	X
Finger ridge counts:						
I	left	16.26	7.62	17.20	7.61	14.00
II	left	14.03	6.40	13.00	9.60	11.71
III	left	15.06	4.54	12.20	6.88	11.14
IV	left	15.87	5.71	17.20	4.82	13.57
V	left	13.90	4.50	14.80	5.33	12.14
I-V	left	75.13	22.71	74.40	30.83	62.57
I	right	17.84	6.70	16.30	6.99	15.28
II	right	15.23	5.94	14.50	7.01	12.14
III	right	14.84	6.03	14.20	5.57	11.14
IV	right	16.81	4.57	15.80	5.57	14.00
V	right	15.06	4.34	13.50	6.15	13.28
I-V	right	79.77	19.80	74.30	27.61	65.86
Palmar ridge count:						
a-b	left	37.50	7.14	41.27	6.66	31.00
b-c	left	24.58	6.77	24.73	5.71	25.75
c-d	left	28.77	9.83	39.64	4.32	29.88
a-d	left	92.81	21.21	95.64	11.10	86.62
a-b	right	37.08	6.80	37.73	7.95	31.38
b-c	right	24.23	5.78	24.54	5.85	24.62
c-d	right	30.50	6.36	30.64	3.26	31.50
a-d	right	91.81	14.16	92.91	13.62	87.50

DS		Controls	
	SD	X	SD
	6.73	13.34	5.41
	6.18	9.05	5.88
	5.01	9.44	5.73
	5.86	11.81	6.31
	5.34	10.08	4.51
	26.65	53.49	21.62
	7.16	16.06	5.86
	5.64	10.31	5.89
	5.49	9.89	5.53
	3.65	13.12	5.53
	5.59	10.63	5.30
	25.73	59.91	22.21
	7.29	33.76	5.95
	6.20	22.11	5.08
	4.85	31.08	6.05
	8.60	86.88	12.47
	5.32	34.64	5.88
	6.37	22.08	5.22
	4.21	32.01	5.64
	7.60	88.65	12.68

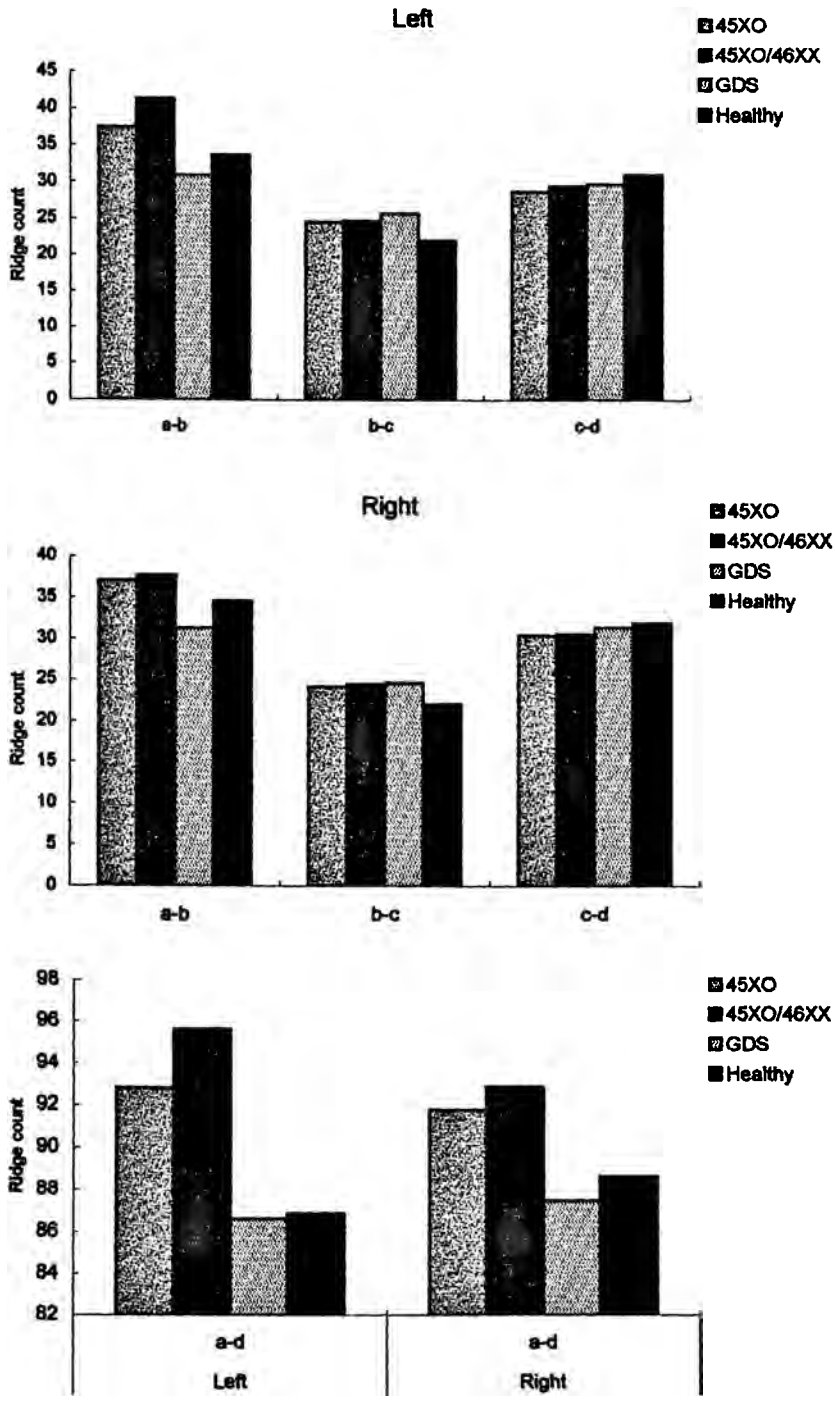

Fig. 2. Distribution of palmar ridge counts

Table 2. Correlation coefficients (r) about finger and palm ridge counts

FEATURES	Correlations			
	45XO	45XO/46XX	GDS	Controls
Finger ridge counts				
I	0.8365	0.9317	0.9890	0.6963
II	0.6866	0.7887	0.8329	0.7294
III	0.5704	0.8192	0.8830	0.6455
IV	0.6774	0.8732	0.8808	0.7651
V	0.4534	0.8712	0.8869	0.7969
I-V	0.8780	0.9500	0.9817	0.8968
Palmar ridge counts				
a-b	0.4161	0.8545	0.6303	0.5877
b-c	0.6342	0.6479	0.8288	0.6632
c-d	0.7074	0.2916	0.5840	0.6992
a-d	0.6085	0.6661	0.6045	0.7405

The total finger ridge counts (I–V fingers) for both hands have highest values for the patients with *total monosomic X (45XO)* and they decrease consecutively for the patients with *45XO/46XX mosaic form,* the patients with *partial monosomic X* and the healthy persons.

The distribution of palm ridge counts on left and right hand for the patients with *gonadal dysgenesis* and the healthy persons shows the same tendency (Table 1, Fig. 2). Highest are the values about palmar *a-b* ridge counts in all investigated groups. The individuals with *gonadal dysgenesis* have higher values about *a-b* and *b-c* palmar ridge counts and lower ones of *c-d* palmar ridge counts compared to the healthy individuals. The values about *a-b* palmar ridge count range within wider limits than the values about *b-c* and *c-d* palmar ridge count in all investigated subgroups. The comparison of palmar ridge count values in the patients with the three forms *gonadal dysgenesis* trend towards a higher *a-b* and lower *b-c* and *c-d* palmar ridge counts in the patients with *total monosomic X (45XX)* and the patients with *45XO/46XX mosaic form* compared to the patients with *partial monosomic X.* The values of the total *a-d* ridge counts are considerably higher in the patients with *45XO/46XX mosaic form* and in those with *total monosomic X (45XO)* compared to the ones with *partial monosomic X* and the healthy persons.

The comparative analysis of correlation coefficient values shows a prevailing lower correlation between ridges counts on homologous digits in left and right for the patients with *total monosomic X (45XO)* compared to the healthy persons (Table 2, Fig. 3). For the established difference in correlation coefficients about finger ridge counts in the patients with *total monosomic X (45XO)* and the healthy individuals, highest and statistical significant ($P<0,05$) is only the difference for the V homologous digits. The values of correlation coefficient in the patients with *45XO/46XX mosaic form* and the ones with *partial monosomic X* are allied or a little bit higher to those in the healthy women.

The data analysis of palmar ridge counts shows predominantly lower correlation between *a-b, b-c* and *c-d* palmar ridge counts in left and *a-b, b-c* and *c-d* palmar ridge counts right for the patients with *gonadal dysgenesis* compared to the healthy persons (Table 2, Fig. 3). The tendency described is more strongly expressed in the patients with *total monosomic X (45XO)* and *45XO/46XX mosaic form* than in the ones with *partial monosomic X.* Only the correlation coefficient values for the *c-d* palmar ridge counts in

the patients with *45XO/46XX mosaic form* and the healthy persons achieve statistical significant difference.

The described correlation dependences about finger and palmar ridge counts have a direct reverberation upon fluctuating asymmetry level for both dermatoglyphic features. The coefficient of indetermination about ridge counts on the homologous I-V digits, respectively, the fluctuating asymmetry level for finger ridge counts has predominantly higher values for the patients with *total monosomic X (45XO)* compared to the other investigated subgroups (Table 3, Fig. 4). The highest difference in the values of fluctuating asymmetry is established for the V homologous digits between the patients with *total monosomic X (45XO)* and the healthy persons. Among the patients with *gonadal dysgenesis* highest is the level of fluctuating asymmetry in the patients with *total monosomic X (45XO)* followed by the patients with *45XO/46XX mosaic form* and the ones with *partial monosomic X*. The direction in which fluctuating asymmetry level changes for all the investigated subgroups is as follows:

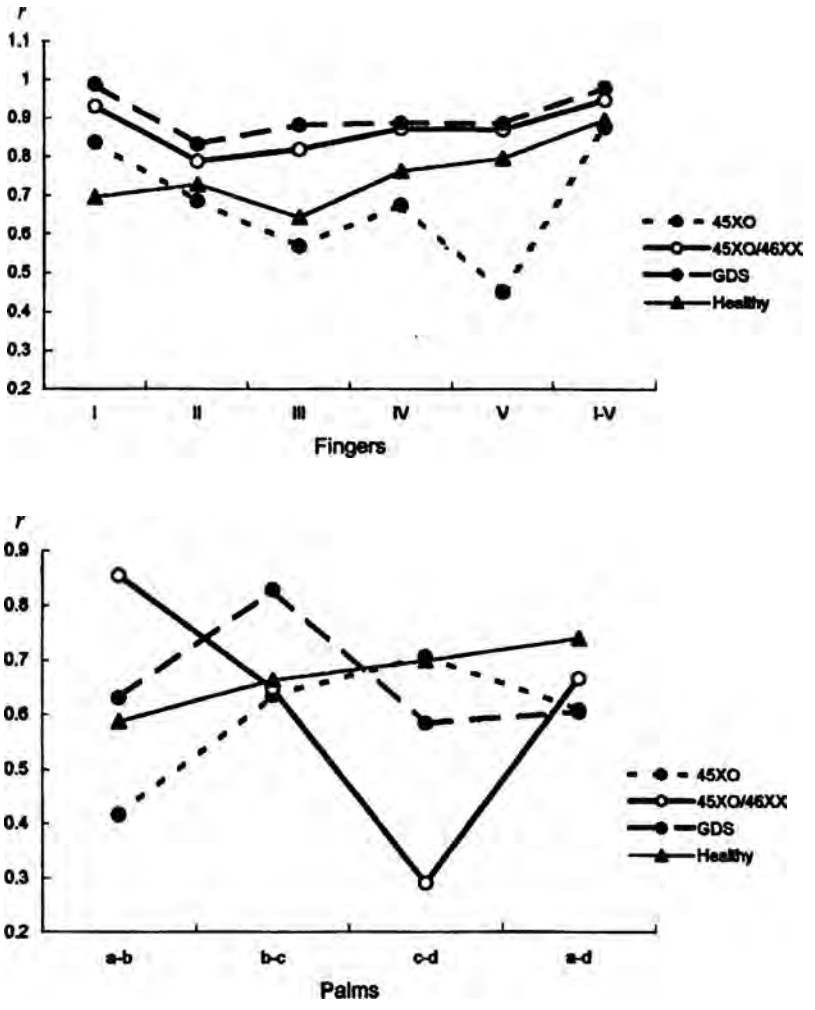

Fig. 3. Correlation coefficient (r) of finger and palmar ridge counts

Table 3. Fluctuating asymmetry ($1-r^2$) of finger and palmar ridge coun

FEATURES	Coefficient of indetermination ($1-r^2$)								
	45XO	Controls	Differences	45XO/46XX	Controls	Differences	GDS	Controls	Differences
Finger ridge counts									
I	0.3002	0.5152	-0.2149	0.1319	0.5152	-0.3833	0.0219	0.5152	-0.4933
II	0.5286	0.4680	0.0606	0.3779	0.4680	-0.0900	0.3063	0.4680	-0.1617
III	0.6746	0.5833	0.0913	0.3289	0.5833	-0.2544	0.2202	0.5833	-0.3630
IV	0.5412	0.4146	0.1269	0.2374	0.4146	-0.1771	0.2241	0.4146	-0.2031
V	0.7944	0.3650	0.4294	0.2411	0.3650	-0.1240	0.2134	0.3650	-0.1516
I-V	0.2291	0.1958	0.0333	0.0974	0.1958	-0.0983	0.0362	0.1958	-0.1596
Palmar ridge counts									
a-b	0.8269	0.6546	0.1723	0.2698	0.6546	-0.3848	0.6028	0.6546	-0.0519
b-c	0.5978	0.5602	0.0376	0.5802	0.5602	0.0200	0.3130	0.5602	-0.2471
c-d	0.4996	0.5111	-0.0115	0.9156	0.5111	0.4045	0.6590	0.5111	0.1478
a-d	0.6297	0.4517	0.1780	0.4845	0.4517	0.0328	0.6346	0.4517	0.1829

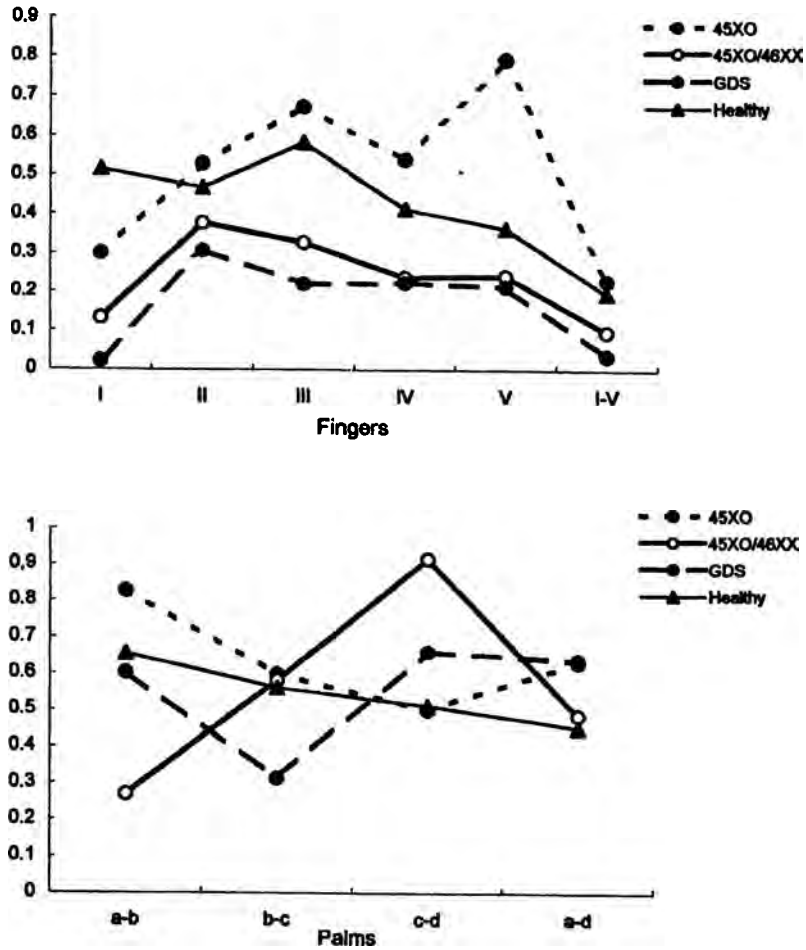

Fig. 4. Fluctuating asymmetry measure ($1-r^2$) of finger and palmar ridge counts

- *Total monosomic X (45XO)* – V>III>IV>II>I;
- *45XO/46XX mosaic form*– II>III>V>IV>I;
- *Partial monosomic X* – II>IV>III>V>I;
- *Healthy persons* – III>I>II>IV>V.

Regarding the palmar ridge counts, the patients with *gonadal dysgenesis* have predominantly higher values of fluctuating asymmetry compared to the healthy persons (Table 3, Fig. 4). Along with that the patients with *total monosomic X (45XO)* and the ones with *45XO/46XX mosaic form* have higher fluctuating asymmetry level for the feature mentioned above compared to the patients with *partial monosomic X*. The direction in which the fluctuating asymmetry level changes about every subgroup separately is presented below:

- *Total monosomic X (45XO)* – (*a-b*) > (*b-c*) > (*c-d*);
- *45XO/46XX mosaic structure* – (*c-d*) > (*b-c*) > (*a-b*);
- *Partial monosomic X* – (*c-d*) > (*a-b*) > (*b-c*);
- *Healthy persons* – (*a-b*) > (*b-c*) > (*c-d*).

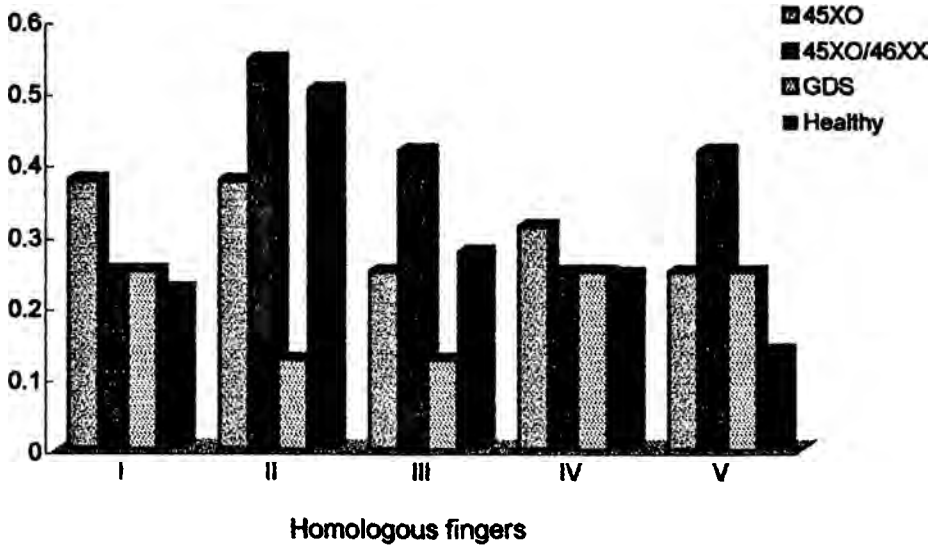

Fig. 5. Fluctuating asymmetry of patterns on homologous fingers

The analysis of the investigation shows that predominantly higher is the coincidence of finger patterns' type on the homologous digits in the healthy persons compared to the patients with *gonadal dysgenesis* (Table 4). Contrariwise, the no coincidence degree of finger patterns type and the fluctuating asymmetry level respectively is higher for the patients with *gonadal dysgenesis* compared to the healthy persons (Table 5, Fig. 5). The patients with *total monosomic X (45XO)* and *45XO/46XX mosaic forms* have higher fluctuating asymmetry level than the patients with *partial monosomic X*. The descendent formulae of fluctuating asymmetry level for the finger patterns type are as follows:

- *Total monosomic X (45XO)* – I=II>IV>III=V;
- *45XO/46XX mosaic structure* – II>III=V>I=IV;
- *Partial monosomic X* – I=IV=V>II=III;
- *Healthy persons* – II>III>IV>I>V.

Discussion

The summarized results of the investigation show a predominantly higher level of fluctuating asymmetry in the patients with *gonadal dysgenesis* compared to the healthy persons. As it is well known, the individuals with mutations that affect sexual chromosomes have a disturbed balance of the genes, which determine the development of sexual features. The phenotype abnormalities degree the in the sexual development of these individuals could be determined basically from the number of the damaged gene material. In the patients with *total monosomic X (45XO),* such by which one of the sexual chromosomes X is completely absent, the gene balance determining the sexual features development is obviously disturbed in greatest degree. In the patients with *45XO/46XX mosaic form* who have two branches of somatic cells, the presence of a cell branch whose genotype consists of normal composition sexual chromosomes alleviate, to a great degree the violations in the balance of those genes that determine sexual features, and thereby the manifestation of phenotype abnormalities. Compared to the patients

Table 4. Coincidence of finger patterns of homologous fingers

Homologous fingers	Patients						Controls	
	45XO		45XO/46XX		GDS			
	X	SD	X	SD	X	SD	X	SD
I	0.6250	0.492	0.7500	0.452	0.7500	0.463	0.7752	0.419
II	0.6250	0.492	0.4545	0.522	0.8750	0.354	0.4961	0.502
III	0.7500	0.440	0.5833	0.515	0.8750	0.354	0.7909	0.450
IV	0.6875	0.471	0.7500	0.452	0.7500	0.463	0.7519	0.434
V	0.7500	0.440	0.5833	0.515	0.7500	0	0.8605	0.348

Table 5. Discordance of finger patterns of homologous fingers

Homologous fingers	Investigated groups								
	45XO	Controls [C]	Differences [45/XO – C]	45XO/46XX	Controls [C]	Differences [45XO/46XX – C]	GDS	Controls [C]	Differences [46XX – C]
I	0.3750	0.2248	0.1502	0.2500	0.2248	0.0252	0.2500	0.2248	0.0252
II	0.3750	0.5039	-0.1259	0.5455	0.5039	0.0416	0.1250	0.5039	-0.3789
III	0.2500	0.2791	-0.0291	0.4167	0.2791	0.1376	0.1250	0.2791	-0.1541
IV	0.3125	0.2481	0.0644	0.2500	0.2481	0.0019	0.2500	0.2481	0.0019
V	0.2500	0.1395	0.1105	0.4167	0.1395	0.2772	0.2500	0.1395	0.1105

with aneuploidy of sexual chromosomes, the misbalance of genes located in sexual chromosomes is most slightly expressed in the ones with *partial monosomic X*. From the three forms *gonadal dysgenesis* analysed in a comparative aspect, the patients with *total monosomic X (45XO)* have highest level of fluctuating asymmetry, followed by the patients with *45XO/46XX mosaic form*. The fluctuating asymmetry level of the investigated features for the patients with *partial monosomic X* have lowest values near to the normal ones.

Conclusion

The phenotype abnormalities in the patients with *gonadal dysgenesis* are an indicator about the negative influence of the mutations affecting sexual chromosomes on the individuals' homeostasis; independently in what degree they could be displayed. In this sense, the fluctuating asymmetry level in the investigated individuals indirectly could be accepted as indicator for the capability of their organisms to alleviate the negative influence of sexual connected mutations that attack their normal physical development. In conformity with the number of the gene material that have been attached, logically could be expected the homeostasis' violations to be expressed in a greatest degree by the patients with *total monosomic X (45X0)*, and in lowest degree by the ones with *partial monosomic X*. The results obtained about fluctuating asymmetry level entirely substantiate the logical conclusion laid above.

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