Institute of Experimental Morphology and Anthropology with Museum

Acta morphologica et anthropologica, 11
Sofia • 2006

Cephalometric Characteristics of Facioscapulohumeral Muscular Dystrophy Patients

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Facioscapulohumeral muscular dystrophy is the third most common myopathy. It is inherited in autosomal - dominant way with prevalence of 1:20 000. Muscle involvement affects consecutively somatic muscles in a descending manner. The only anthropometric data available for FSHD patients show reduced calf, thigh and upper arm circumferences while fat percent is similar to the controls. According to our knowledge no cephalometric studies have been performed for this patients group. Using eighteen directly derived cephalometric features and eight cephalometric indexes we have fulfilled the first pilot cephalometric study on 13 FSHD patients. Our results showed a tendency for patients of both sexes to show smaller head and face dimensions compared to the controls.

Key words: facioscapulohumeral muscular dystrophy, anthropometric data, cephalometric features and indexes.

Introduction

Facioscapulohumeral muscular dystrophy (FSHD1A, MIM 158 900) is an autosomal dominant myopathy with progressive weakness and atrophy of facial and shoulder girdle muscles, with consecutive and gradual spread to abdominal and foot extensor muscles and with final involvement of pelvic girdle muscles. The disease shows inter- and intrafamilial variability in clinical expression [6, 9, 12].

The FSHD locus has been mapped to the long arm of 4th chromosome (4q35) [10, 11]. It was recently shown that FSHD is specifically related to the "A" type 4qter alleles [5].

Facial muscles are usually involved first with or without involvement of shoulder girdle muscles. Most severely and usually asymmetrically affected are m. orbicularis oculi, m. orbicularis oris, m. zygomaticus major [9]. Other muscles are never involved like m. temporalis, external ocular muscles, which gives clues in the differential diagnosis of Myotonic dystrophy and other myopathies [1].

M. orbicularis oculi involvement leads to incomplete disappearance of eyelashes upon forced eye closure. Finally part of sclera stays uncovered and inflammation ensues. M. orbicularis oris affection causes asymmetric location of mouth angles. M. zygomaticus major impact on facial appearance becomes visible on patients attempts for smiling. Finally most of facial muscles become involved in the dystrophic process so that the face looses its normal lines. An expressionless facial appearance with falsely depressive view ensues [8].

Anthropometric data showed significantly reduced calf, thigh and upper arm circumferences of FSHD patients, while fat per cent was similar to controls [2]. According to our knowledge no data for cephalometric discrepancies between FSHD patients and controls are still available.

Materials and Methods

A cepahalometric study was performend on 13 FSHD patients as follows: 6 males (mean age 42.83±6.07) and 7 females (mean age 59.74±4.93). We used an anthropometric program that includes 18 directly derived cephalometric features and 8 cephalometric indexes (Table 1). All the features are recorded in mm except the *head circumference* in cm. All the data were compared with those of a control study including 20 males (mean age 45.63±6.11) and 20 females (mean age 41.25±5.14). Separate features' measurements were accomplished by a classical methods of R. Martin and K. Saller [7] using an original cephalometric set. All the cephalometric features were categorized via conventional differentiating values (rubrications) [7].

Genetic studies for evaluation of alleles' dimensions were performed as described [4]. Allele typing was made according to the referent laboratory [3]. All the enzymes were purchased from MBI Fermentas except for BlnI - Amersham-Pharmacia.

Results

Descriptive statistics data of the directly derived cephalometric features of the patients and controls are presented in Table 2 and Table 3. Both sexes patients show a tendency

T a b l e 1. Cephalometric features and indexes included in the present study

Cephalometrical features		Cephalometrical indexes
• *Head length* (**gl-op**)	• *Nasal-subnasal length* (**n-sn**)	• *Head index* $I = [eu\text{-}eu / g\text{-}op]_x 100$
• *Head breadth* (**eu-eu**)	• *Nasal-pronasal length* (**n-prn**)	• *Morphological face index* $I = [n\text{-}gn / zy\text{-}zy]_x 100$
• *Minimal frontal diameter* (**ft-ft**)	• *Nose protrusion* (**sn-prn**)	• *Physiognomical upper face index* $I = [n\text{-}sto / zy\text{-}zy]_x 100$
• *Bizygomatical diameter* (**zy-zy**)	• *Philtrum length* (**sn-sto**)	• *Jugo-mandibular index* $I = [go\text{-}go / zy\text{-}zy]_x 100$
• *Bigonial diameter* (**go-go**)	•• *Interocular diameter* (**en-en**)	• *Transversaler kephalofacial index* $I = [zy\text{-}zy / eu\text{-}eu]_x 100$
• *Trichion-nasion distance* (**tr-n**)	• *Biocular diameter* (**ek-ek**)	• *Transversaler frontoparietal index* $I = [ft\text{-}ft / eu\text{-}eu]_x 100$
• *Physiognomical face height* (**tr-gn**)	• *Nose breadth* (**al-al**)	• *Jugo-frontal index* $I = [ft\text{-}ft / zy\text{-}zy]_x 100$
• *Morphological face height* (**n-gn**)	• *Lip length* (**ch-ch**)	• *Nose index* $I = [al\text{-}al / n\text{-}sn]_x 100$
• *Morphological upper face height* (**n-sto**)	• *Head circumference*	

Table 2. Main statistical values of the directly obtained cephalometric features for FSHD male patients and male controls

Features	Patients					Controls					
	$\bar{X}$	SD	V	min	max	$\bar{X}$	SD	V	min	max	t
g-op	193.17	9.66	68.57	117	200	194.64	1.80	3.25	192	198	−0.37
eu-eu	147.00	3.58	12.80	144	154	155.36	6.00	36.05	148	163	**−3.60***
ft-ft	123.83	9.60	92.17	107	135	126.09	5.77	33.29	118	136	−0.53
zy-zy	140.00	4.43	19.60	134	146	141.55	8.27	68.47	128	154	−0.50
go-go	111.67	9.50	90.27	98	126	116.82	7.33	53.76	102	128	−1.15
tr-n	66.00	6.90	47.60	57	73	70.55	9.67	93.47	54	82	−1.12
tr-gn	185.00	11.17	92.40	171	195	188.64	7.66	58.65	181	200	−0.71
n-gn	119.33	8.31	69.07	108	128	123.36	6.83	46.65	113	136	−1.02
n-sto	76.00	4.47	20.00	70	83	76.55	6.31	39.87	64	85	−0.21
n-sn	53.00	4.29	18.40	48	60	57.64	4.92	24.25	47	63	**−2.07***
n-prn	49.17	4.83	23.37	43	55	55.27	3.23	10.42	48	58	**−2.78***
sn-prn	25.00	1.10	1.20	23	26	19.73	2.41	5.82	18	24	**6.17***
sn-sto	21.50	1.38	1.90	20	23	18.18	2.52	6.36	15	22	**3.51***
en-en	32.33	2.25	5.07	30	35	35.91	2.43	5.89	32	40	**−3.05***
ek-ek	99.17	3.92	15.37	92	103	102.64	4.65	21.65	98	113	−1.63
al-al	37.00	3.41	11.60	34	43	38.64	1.29	1.65	36	40	−1.14
ch-ch	57.33	2.16	4.67	55	61	60.55	4.72	22.27	55	67	−1.92
Head circumference	55.92	1.53	2.34	54	58	57.82	0.87	0.76	56	59	**−2.80***

*** statistically significant values of t at $P<0.05$**

Table 3. Main statistical values of the directly obtained cephalometric features of FSHD female patients and female controls

Features	Patients					Controls					
	$\bar{X}$	SD	V	min	max	$\bar{X}$	SD	V	min	max	t
g-op	182.33	4.93	24.27	176	189	185.00	6.90	47.64	175	197	−0.98
eu-eu	147.33	3.98	15.87	140	151	150.50	5.90	34.82	143	164	−1.40
ft-ft	118.00	7.13	50.80	110	127	121.33	4.21	17.70	116	130	−1.13
zy-zy	137.67	5.89	34.67	130	147	132.25	5.51	30.39	124	139	1.98
go-go	104.83	5.49	30.17	95	109	110.17	6.22	38.70	102	124	−1.95
tr-n	56.17	5.49	30.17	48	65	63.67	6.31	39.88	56	73	**−2.72***
tr-gn	163.00	3.16	10.00	158	167	172.50	7.63	58.27	162	182	**−3.79***
n-gn	109.17	2.48	6.17	106	113	114.58	7.39	54.63	104	128	**−2.32***
n-sto	71.00	4.38	19.20	66	76	74.00	4.33	18.73	68	80	−1.45
n-sn	49.00	3.29	10.80	45	55	51.83	4.04	16.33	46	57	−1.66
n-prn	46.33	2.94	8.67	42	50	47.83	4.04	16.33	41	56	−0.93
sn-prn	21.33	0.82	0.67	20	22	20.75	2.86	8.20	17	27	0.66
sn-sto	20.33	2.73	7.47	16	24	19.58	3.48	12.08	15	26	0.52
en-en	33.00	1.90	3.60	30	35	35.58	1.68	2.81	32	38	**−2.98***
ek-ek	97.17	3.13	9.77	94	102	101.00	5.41	29.27	92	113	−1.95
al-al	33.50	3.73	13.90	29	39	37.00	2.49	6.18	33	41	**−2.25***
ch-ch	54.80	2.17	4.70	52	57	56.83	3.93	15.42	52	63	−1.45
Headcircumference	54.40	1.14	1.30	53	56	56.33	0.58	0.33	56	57	**−4.18***

*** statistically significant values of t at $P<0.05$**

for smaller mean values compared to the controls. Male FSHD patients show higher mean values for nose protrusion (sn-prn) and philtrum length (sn-sto) only. Female patients show higher values for the following cephalometric features: bizygomatical diameter (zy-zy), nose protrusion (sn-prn) and philtrum length (sn-sto). The difference between the mean values are bigger for female than male patients when compared to the controls. Women with FSHD and controls show statistically significant differences of the means for the following features: trichion-nasion distance (tr-n), physiognomical face height (tr-gn), morphological face height (n-gn), interocular diameter (en-en), nose breadth (al-al) and head circumference. Bizygomatical diameter (zy-zy), bigonial diameter (go-go) and binocular diameter (ek-ek) approximate the statistical significance but do not reach it. Statistically significant differences ($P<0.05$) between the means of male patients and controls are reached for: head breadth (eu-eu), nasal-subnasal length (n-sn), nasal-pronasal length (n-prn), nose protrusion (sn-prn), philtrum length (sn-sto), the interocular diameter (en-en) and head circumference.

According to the anthropology accepted discriminating values, the means of head breadth (eu-eu), bizygomatical diameter (zy-zy) and morphological upper face height (n-sto) belong to the category "middle" for male controls and male FSHD patients. For both groups bigonial diameter (go-go) and nose breadth (al-al) belong to the category "over middle", while morphological face height (n-gn) is categorized as "middle high". Beside the similarities described, male patients and controls show differences when categorizing mean values of certain features (Table 4).

The female FSHD patients show the same category compared to the controls only for the mean values of morphological upper face height (n-sto) – "middle high". All the other cephalometric features categories with settled discriminating values differ between the patients and controls (Table5).

The cephalometric feature peculiarities between the patients and controls are reflected in the values of cephalometric indexes (Table 6 and Table 7). Male FSHD patients compared to the controls show lower values for head index, jugo-frontal index,

Table 4. Differences in categorization of FSHD male patients and controls concerning four cephalometric features

Cephalometric feature	FSHD male patients category	Controls' category
*Head length (**g-op**)*	long	very long
*Nasal-subnasal length (**n-sn**)*	over middle	high
*Interocular diameter (**en-en**)*	narrow	middle
*Binocular diameter (**ek-ek**)*	bright	very bright

Table 5. Differences in categorization of FSHD female patients and controls concerning nine cephalometric features

Cephalometric feature	FSHD female patients category	Controls' category
*Head length (**g-op**)*	long	very long
*Head breadth (**eu-eu**)*	middle	bright
*Bizygomatical diameter (**zy-zy**)*	bright	middle
*Bigonial diameter (**go-go**)*	middle	over middle
*Morphological face height (**n-gn**)*	middle high	high
*Nasal-subnasal length (**n-sn**)*	under middle	over middle
*Nose breadth (**al-al**)*	middle	over middle
*Interocular diameter (**en-en**)*	narrow	middle
*Biocular diameter (**ek-ek**)*	bright	very bright

Table 6. Statistical values of the studied cephalometric indexes in male FSHD patients and male controls

Index	Patients (n=6)					Controls (n=20)					
	$\bar{X}$	$\sigma_{\bar{X}}$	SD	min	max	$\bar{X}$	$\sigma_{\bar{X}}$	SD	min	max	t
Head index	76,27	1,79	4,40	69,90	83,05	79,83	0,98	3,24	75,51	84,02	-1,741
Transversaler frontoparietal index	84,27	2,76	6,75	73,79	91,84	81,28	1,54	5,10	75,64	88,59	0,947
Jugo-frontal index	88,43	2,43	5,96	79,85	97,83	89,31	1,76	5,84	82,52	98,44	-0,293
Transversaler kephalofacial index	95,30	1,76	4,30	88,96	100,00	91,30	2,19	7,27	78,53	99,33	1,424
Jugo-mandibular index	79,81	2,81	6,87	69,01	88,06	82,62	1,34	4,46	75,00	89,84	-0,903
Morphological face index	85,23	2,09	5,11	78,83	91,79	87,43	2,16	7,15	81,12	98,44	-0,733
Phisiognomical upper face index	54,25	0,66	1,61	52,24	56,85	54,20	1,50	4,96	44,14	60,94	0,024
Nose index	68,75	2,40	5,88	57,63	72,92	67,51	2,03	6,73	61,29	85,11	0,394

**** statistically significant values of t at P<0.05***

Table 7. Statistical values of the studied cephalometric indexes in female FSHD patients and female controls

Index	Patients (n=7)					Controls (n=20)					
	$\bar{X}$	$\sigma_{\bar{X}}$	SD	min	max	$\bar{X}$	$\sigma_{\bar{X}}$	SD	min	max	t
Head index	80,86	1,28	3,15	77,25	84,27	81,45	1,26	4,35	75,76	88,65	-0,328
Transversaler frontoparietal index	80,11	1,87	4,59	74,32	85,23	80,74	1,23	4,27	73,78	86,67	-0,281
Jugo-frontal index	85,75	1,81	4,43	78,01	91,30	91,81	0,87	3,01	88,06	98,39	-3,020*
Transversaler kephalofacial index	93,48	1,80	4,41	86,67	98,66	87,99	1,40	4,86	80,77	93,24	2,405*
Jugo-mandibular index	76,17	1,27	3,11	70,90	78,99	83,44	1,68	5,82	75,00	92,54	-3,452*
Morphological face index	79,43	1,65	4,03	72,11	83,85	86,75	1,78	6,18	76,81	96,77	-3,016*
Phisiognomical upper face index	51,68	1,72	4,21	44,90	55,97	56,05	1,16	4,03	49,28	62,90	-2,106*
Nose index	68,63	3,73	9,14	60,42	80,00	71,64	1,58	5,46	61,11	78,72	-0,743

**** statistically significant values of t at P<0.05***

jugo-mandibular and morphological face index. A reverse correlation with predominant higher values in the patients that controls is observed for transversaler frontoparietal index, transversaler kephalofacial index and nose index. The differences between the means of patients cephalometric indexes and those of controls are not statistically significant. The comparison between the groups of FSHD female patients and controls show a tendency for lower index values for the patients. This trend is kept for all the indexes except for the transversaler kephalofacial index. Statistically significant mean values distinction between the FSHD female patients and controls are observed for jugo-frontal index, transversaler kephalofacial index, jugo-mandibular, morphological face index and physiognomical upper face index (P<0.05).

Table 8. Categorical distribution and differences between the FSHD female patients and controls

Cephalometric indexes	FSHD female patients category	Controls' category
Jugo-frontal index	bright	very bright
Transversaler kephalofacial index	over middle	middle
Jugo-mandibular index	middle	very narrow
Morphological face index	euryprosop	leptoprosop
Nose index	leptorrhin	mesorrhin
Physiognomical upper face index	euryen	mesen

According to the anthropologically accepted categories for cephalometric indexes, male patients' and controls' mean values of the head index belong to category "mesocephal", to category "eurymetop" for transversaler frontoparietal index, to category "very bright" for jugo-frontal index, to category "mesoprosop" for morphological face index, to category "leptorrhin" for nose index and to category "mesen" for phisiognomical upper face index. Both groups differ only for mean values of transversaler kephalofacial index and jugo-mandibular index Patients' transversaler kephalofacial index belongs to the category "over middle" while jugo-mandibular index to "middle". In controls values belong accordingly to categories "middle" and "narrow". In the studied group of female FSHD patients and controls mean values of one and the same category are found only for head index and transversaler frontoparietal index.Mean value for the head index belongs to the category "mesocephal", for transversaler frontoparietal index to the category "eurymetop". All the other studied cephalometric indexes show differences between the mean values of female patients and controls (Table 8).

All the patients are genetically verified with allele size dimensions below 38 kb. All the alleles are of type "A".

Discussion

Changes of the main head features (head length, head breadth, head circumference) follow a uniform tendency between the controls and patients regardless of sex. FSHD patients have significantly smaller head circumference compared to the controls ($P<0.05$). Head lengths and breadths of the patients are smaller than these of the controls. In addition mean head breadth value in male patients is statistically significantly lower that this of controls ($P<0.05$). The both sexes difference between the controls and patients is bigger for the head breadth than head length. It shows that the differences between the patients and controls are owned more to head breadth than its length.

The differences between the patients and controls in the sense of facial height and breadth follow again a common tendency. Male and female FSHD patients have smaller facial features values compared to the controls. Main breadth cephalometric dimensions like bizygomatical diameter and bigominal diameter show bigger inter group differences for females. Some of the other breadth dimensions show bigger values for male FSHD patients compared to the controls (interocular diameter, lip length), while others are bigger in the female patients (biocular diameter, nose breadth). Data analysis shows that values distinctions between the main height cephalometric features (facial height, physiognomical face height, morphological face height, physiognomical upper face height) are better expressed between the female FSHD patients and controls than males. In contrast differences between the height facial dimensions of the nasal and upper lip regions are more pronounced between the male patients and controls than females.

It is known that the separate head parts shape is better expressed by indexes than absolute values of the features. In that sense cephalometric characteristics presented by

indexes are probably more informative for the cephalometric status of the patients.

Head index represents the shape of the head watched from the top. According to our results male and female FSHD patients have lower mean values for the head index compared to the controls. It shows that our patients have significantly smaller breadth than length of their heads.

Data analysis for transversaler kephalofacial index and transversaler frontoparietal index show that male patients have wider forehead and bigger cheek-bone distance while female patients have narrower forehead and bigger cheek-bone distance, compared to the controls.

According to the data of morphological face index and physiognomical upper face index, patients of both sexes show shorter faces than the controls. It is expressed by smaller morphological face height and morphological upper face height compared to the facial breadth.

Mean values of jugo-frontal and jugo-mandibular indexes for both sexes are lower than those of controls. According to these data FSHD patients have seemingly underdeveloped forehead and mandibular breadth than bizygomatical diameter. Patients of both sexes have comparatively narrower lower than upper facial half.

Data analysis for nose index shows that male patients have relatively wider while female patients narrower noses, compared to the controls.

Conclusion

Comparative data analysis between the groups show a common tendency for patients of both sexes expressed by the smaller head and face dimensions compared to the controls. This trend is better expressed for females than males.

Compared to controls patients of both sexes are characterized by relatively smaller head breadth than length; narrower forehead and mandibula than facial breadth; shorter and wider face than head breadth. Male patients are characterized by relatively wider forehead, when compared to the head breadth and wider noses. In contrast female patients are marked by relatively narrower forehead when compared to the head breadth and narrower noses.

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