The craniofacial morphology of individuals with hypodontia

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This work describes the variations in craniofacial morphology in individuals with congenitally missing permanent teeth with relation to facial prognathism, jaw development and inclination of the incisor teeth. Both sexes displayed significantly less upper jaw prognathism in individuals with hypodontia compared to the controls, and a less maxillary length as well. This finding was independent of whether the congenitally missing teeth were situated in the upper or the lower jaw. The upper incisors displayed greater anterior inclination in the individuals with hypodontia of both sexes.

Key-words: Hypodontia; cephalometry; maxillofacial development

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The facial morphology and growth changes in individuals without congenital disorders are thoroughly evaluated in a number of excellent works (*Brodie*, 1941; *Björk*, 1947; *Lande*, 1952; *van der Linden*, 1959; *Hasund*, 1966; *Solow*, 1966; *Humerfelt*, 1970). The morphology of various serious congenital defects has also been studied by numerous authors (*Graber*, 1954; *Derichsweiler*, 1959; *Ross & Coupé*, 1965; *Kisling*, 1966; *Shibasaki & Ross*, 1969; *Lande*, 1970; *Fredlund*, 1970; *Dahl*, 1970).

Variations in craniofacial morphology in individuals with minor congenital anomalies have been of limited interest. Studies have mainly been concentrated on the frequency and distribution of congenitally missing teeth (*Dolder*, 1936; *Grahnén*, 1956; *Ringquist & Thilander*, 1969; *Haavikko*, 1971; *Wisth, Thunold & Böe*, 1974). The influence on the tooth size has also been a field of interest (*Garn, Lewis & Kerewsky*, 1964, *Hanihara, Masuda & Tanaka*, 1965; *Keene*, 1964; *Garn & Lewis*, 1970; *Baum & Cohen*, 1971; *Wisth et al.* 1974). Some authors have also studied the relationship between hypodontia and somatic development and immaturity at birth (*Garn, Lewis & Bonné*, 1961; *Keene*, 1966; *Bailit, Thomson & Niswander*, 1968). Generally, they all agree that there is a positive correlation between delayed development and hypodontia. *Foster & van Roey* (1970) found that »partial anodontia» affects the form of the remaining teeth in such a characteristic manner, especially in the primary dentition, that it can be regarded as a diagnostic feature.

According to *Horowitz* (1966) most hypodontia cases are associated with an Angle Cl. I occlusion, but may also be found in Angle Cl. II cases. *Heyers* (1962) observed that hypodontia could be related to a reduced anterior-posterior development of the maxillary complex, indepen-

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dent of whether the temporary molars were missing. His conclusions were, however, based on the study of two cases only.

This work was undertaken to study the craniofacial morphology in individuals with hypodontia by cephalometric methods, and to find out whether hypodontia influences the craniofacial pattern.

MATERIAL AND METHODS

The material comprised 31 girls and 24 boys with hypodontia of one or more teeth. The frequency and distribution of the hypodontia have been described previously (*Wisth et al.*, 1974). All the children displaying this anomaly in the nine year age group in a Norwegian municipality (total 813 children) were included in the material. They all attended the Orthodontic Department, University of Bergen, for a routine orthodontic check, which also included a lateral cephalometric x-ray. When examined, each child was given a registration number. Where hypodontia was found, the adjacent number of the same sex was included in the control group.

The lines and angles measured are familiar ones, and presented in Fig. 1.

The measurement error was calculated from double registration of all the variables in both groups and was generally in agreement with those of other workers (*Hasund*, 1966; *Fredlund*, 1970; *Lande*, 1970; *Wisth*, 1973).

The mean of the double recordings was used in the statistical evaluation, which included testing of the means (Student's two sample t-test) and of the variability of the variables (Variance ratio test). If the variances were significant at the 5 per cent level, the corresponding t-value was calculated according to an alternative formula (*Hald*, 1952).

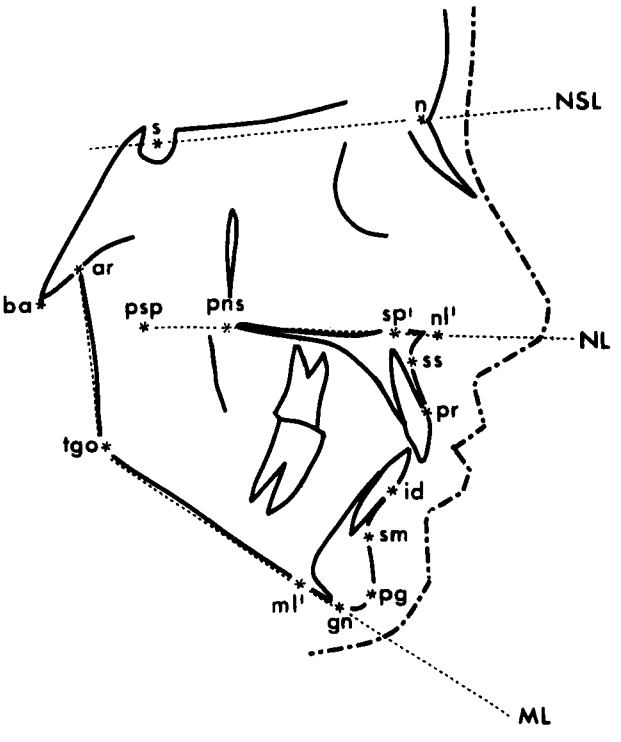

Fig. 1. Reference points and lines.

RESULTS

Prognathism and face height

In both sexes the prognathism of the upper jaw (s-n-ss) was significantly less in the hypodontia groups (Tables I and II) and so was the face convexity (n-ss-pg) as well. In boys with hypodontia the facial convexity (n-ss-pg) showed significantly greater variability, as did the sagittal basal jaw relationship (ss-n-sm).

Wiggle diagrams based on Björk's norms (*Björk*, 1963) (Figs. 2 and 3) show that in both sexes there was a greater retrognathic tendency in the hypodontia groups, except for the cranial base angle (n-s-ba) and maxillary inclination (NL-NSL) which displayed a slightly prognathic tendency in both sexes. In boys, the mandibular inclination (ML-NSL) was also on the prognathic side.

Table I. *Comparison of the female hypodontia and the female control group*

Measurements		Hypodontia group (n = 31)		Control group (n = 31)			
	Variable	$\bar{x}$	S.D.$_k$	$\bar{x}$	S.D.$_k$	t	F
	n-s-ba	131.06	4.22	130.61	4.59	0.40	1.19
	s-n-ss	79.53	3.67	81.24	2.92	—2.05*	1.59
Angular	s-n-sm	76.82	3.12	77.53	2.59	—0.97	1.45
facial	ss-n-sm	3.33	2.48	3.83	2.29	—0.79	1.17
measure-	s-n-pg	77.84	3.28	78.36	2.60	—0.69	1.59
ments	n-ss-pg	175.74	6.03	172.76	5.59	2.02*	1.17
	NL-NSL	7.42	2.32	7.86	2.03	—0.79	1.32
	ML-NSL	34.74	5.18	34.13	4.78	0.48	1.18
	n-sp'	47.32	2.80	45.91	2.62	2.05*	1.14
Linear	sp'-gn	56.58	3.57	56.53	3.38	0.05	1.12
facial	n-gn	103.93	5.64	102.55	4.21	1.09	1.80
measure-	s-psp	38.20	1.83	38.32	3.40	—0.17	1.85*
ments	psp-tgo	27.91	3.26	27.81	4.01	0.11	1.51
	s-tgo	65.83	3.52	64.73	4.63	1.05	1.73
	ar-tgo-gn	130.63	6.05	129.32	7.80	0.74	1.66
Angular	pr-nl'	12.50	1.85	11.81	2.07	1.39	1.26
and	ss-pns	43.68	2.53	46.00	7.03	—3.96**	1.52
linear	id-ml'	25.54	3.35	24.79	1.91	1.08	3.06**
jaw	pg-tgo	66.34	4.07	66.84	2.97	—0.55	1.88*
and	tgo-ar	40.22	3.17	38.32	3.97	2.27*	1.15
teeth	$\underline{1}$-n-ss	24.11	6.46	19.68	5.70	2.87**	1.28
measure-	$\underline{\underline{1}}$-n-sm	25.00	6.05	22.62	5.08	1.67	1.42
ments	$\underline{1}$-$\overline{1}$	128.31	9.25	134.00	7.99	—2.59**	1.34
	$\underline{1}$-$\overline{1}$(hor.)	2.87	1.29	3.35	1.74	—1.27	1.83
	$\underline{1}$-$\overline{1}$(vert.)	3.58	1.21	3.81	1.41	—0.57	1.46

* = significant at the 5 % level
** = significant at the 1 % level
F = values from variance ratio test.

Table II. *Comparison of the male hypodontia and the male control group*

Measurements		Hypodontia group (n = 24)		Control group (n = 24)			
	Variable	$\bar{x}$	s(x)	$\bar{x}$	s(x)	t	F
Angular facial measure-ments	n-s-ba	130.23	4.15	129.41	4.48	0.68	1.36
	s-n-ss	79.73	3.54	81.93	3.61	—2.30*	1.04
	s-n-sm	76.98	3.27	78.09	3.64	—1.20	1.24
	ss-n-sm	2.96	2.32	3.84	1.27	—1.63	3.36**
	s-n-pg	77.91	3.31	78.80	3.97	—0.91	1.44
	n-ss-pg	175.96	6.05	172.69	3.41	2.31*	3.15**
	NL-NSL	6.19	3.12	6.14	3.12	0.05	1.00
	ML-NSL	33.38	5.45	31.77	4.82	1.17	1.28
Linear facial measure-ments	n-sp'	47.57	2.69	47.02	2.66	0.78	1.02
	sp'-gn	58.72	3.58	57.52	3.82	1.22	1.14
	n-gn	106.32	5.07	104.97	5.48	0.96	1.17
	s-psp	40.00	3.35	39.42	7.65	0.73	1.60
	psp-tgo	28.70	4.46	28.90	3.17	—0.20	1.97
	s-tgo	68.69	4.47	68.40	4.03	0.24	1.23
Angular and linear jaw and teeth measure-ments	ar-tgo-gn	126.50	6.56	128.50	4.26	—1.25	2.36*
	pr-nl'	13.15	2.35	12.34	2.47	1.25	1.11
	ss-pns	44.06	2.84	46.93	2.39	—4.09**	1.41
	id-ml'	26.09	2.09	24.80	2.15	2.27*	1.05
	pg-tgo	69.73	4.07	67.37	3.83	2.24*	1.13
	tgo-ar	39.78	3.73	40.60	3.52	—0.85	1.13
	$\underline{1}$-n-ss	25.68	6.66	21.95	6.37	2.14*	1.09
	$\underline{\underline{1}}$-n-sm	24.35	7.03	23.02	5.63	0.72	1.56
	$\underline{1}$-$\overline{1}$	127.93	10.97	131.43	9.26	—1.29	1.40
	$\underline{1}$-$\overline{1}$(hor.)	3.49	2.05	3.79	1.31	—0.60	2.45*
	$\underline{1}$-$\overline{1}$(vert.)	3.66	1.64	4.21	1.50	—1.29	1.20

* = significant at the 5 % level
** = significant at the 1 % level
F = values from variance ratio test.

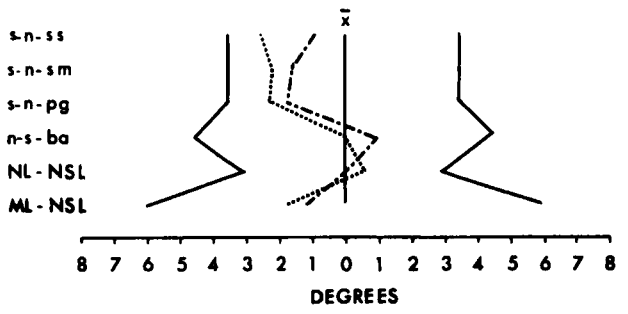

Fig. 2. Wiggle diagram comparing the female hypodontia group ..... and the female control group ----- to Björk's standards. Right prognathic, left retrognathic.

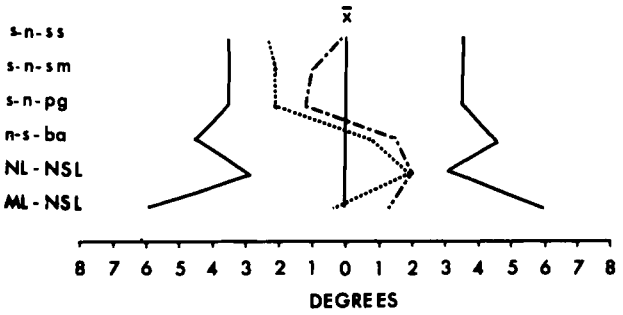

Fig. 3. Wiggle diagram comparing the male hypodontia group ..... and the male control group .-.-. to Björk's standards. Right prognathic, left retrognathic.

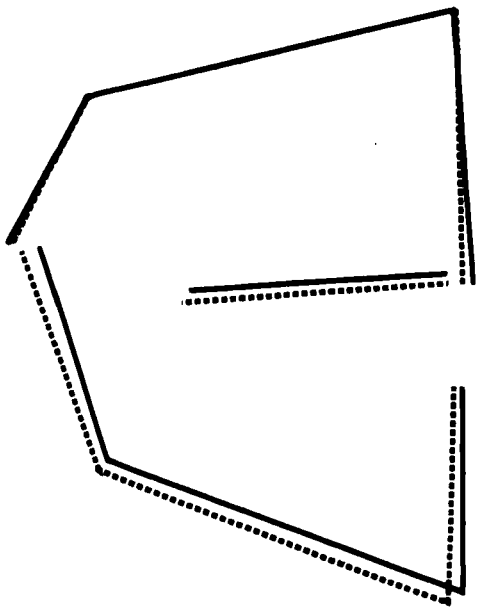

Fig. 4. Facial polygon comparing the female hypodontia group ..... and the female control group ——

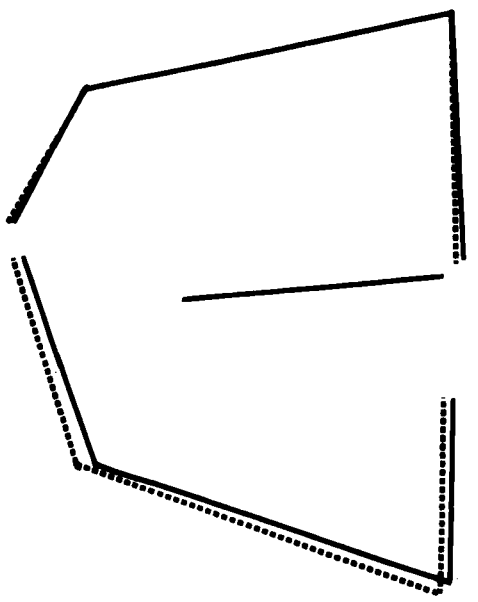

Fig. 5. Facial polygon comparing the male hypodontia group ..... and the male control group ——

The facial polynoms (Figs. 4 and 5) show the differences in prognathism, and also display that the differences compared to the control group were approximately similar in both sexes.

In girls the upper anterior (n-sp') face height was significantly greater in the hypodontia group (Table I). The control group showed greater upper posterior face height (s-psp) variability. No significant differences were observed in boys.

Jaws and teeth

Both sexes displayed a shorter maxillary base (ss-pns) in hypodontia individuals (Tables I and II). In girls the ramus height (tgo-ar) was greater in the hypodontia group, while in boys the anterior mandibular height (id-ml') and the mandibular length (pg-tgo) were greater. These two variables showed significantly higher variability in girls with hypodontia than in the controls.

Table III. *Comparison of individuals with hypodontia only in the upper jaw and the total controlgroup*

Measurements		Individuals with hypodontia in the upper jaw Both sexes (n = 19)		Control group Both sexes (n = 55)			
	Variable	$\bar{x}$	s (x)	$\bar{x}$	s (x)	t	F
	n-s-ba	130.15	4.68	130.04	4.71	0.04	1.01
Angular	s-n-ss	79.26	3.77	81.57	3.25	—2.58*	1.16
facial	s-n-sm	77.18	3.44	77.80	3.12	—0.73	1.10
measure-	ss-n-sm	2.47	2.48	3.84	1.86	—2.42*	1.33
ments	s-n-pg	78.00	3.40	78.57	3.30	—0.65	1.03
	n-ss-pg	176.92	5.82	172.73	4.64	3.21**	1.75
	NL-NSL	6.47	3.14	7.04	2.72	—0.75	1.15
	ML-NSL	33.76	5.18	33.01	4.90	0.58	1.06
	n-sp'	47.86	2.86	46.44	2.68	2.00	1.07
Linear	sp'-gn	58.62	3.56	57.00	3.59	1.71	1.01
facial	n-gn	106.52	5.13	103.70	4.97	2.13*	1.03
measure-	s-psp	40.41	2.75	38.04	2.87	3.16**	1.04
ments	psp-tgo	28.34	3.00	28.37	3.65	—0.01	1.22
	s-tgo	68.81	3.93	66.47	4.68	1.96	1.19
	ar-tgo-gn	127.84	7.24	128.93	6.33	—0.63	1.14
Angular	pr-nl'	13.13	2.43	12.06	2.27	1.76	1.07
and	ss-pns	43.95	2.88	46.45	2.75	—4.06**	1.05
linear	id-ml'	25.64	2.25	24.80	2.01	1.55	1.12
jaw	pg-tgo	68.64	4.58	67.09	3.38	1.59	1.36
and	tgo-ar	40.61	3.46	39.40	3.61	1.28	1.04
teeth	$\underline{1}$-n-ss	25.86	6.45	20.75	6.09	3.14**	1.06
measure-	$\overline{1}$-n-sm	24.03	7.37	22.81	5.31	0.78	1.39
ments	$\underline{1}$-$\overline{1}$	128.32	8.86	132.78	8.64	—1.95	1.03
	$\underline{1}$-$\overline{1}$(hor.)	3.07	2.11	3.56	1.56	—1.09	1.35
	$\underline{1}$-$\overline{1}$(vert.)	3.38	1.75	3.99	1.45	—1.52	1.18

* = significant at the 5 % level
** = significant at the 1 % level
F = values from variance ratio test.

The inclination of the upper incisors (1-n-ss) was greater in the hypodontia group of both sexes, and in girls the interincisal angle (1-1) was less.

Hypodontia in the upper and lower jaw respectively

In order to evaluate whether the results were different when congenitally missing teeth were found in one jaw, the material was arranged according to only upper or lower jaw hypodontia without any sex differentiation. Hypodontia only in the upper jaw compared with the total control group resulted in significant differences in upper jaw prognathism (s-n-ss), sagittal jaw relationship (ss-n-sm) and facial convexity (n-ss-pg) (Table III). The upper posterior facial height (s-psp) was greater in the hypodontia group as was the total anterior face height (n-gn). The maxillary basis (ss-pns) was significantly shorter in the hypodontia group, and the upper incisors were more protruded (1-n-ss).

Table IV. *Comparison of individuals with hypodontia only in the lower jaw and the total control group*

Measurements		Individuals with hypodontia in the lower jaw Both sexes (n = 28)		Control group Both sexes (n = 55)			
	Variable	$\bar{x}$	s (x)	$\bar{x}$	s (x)	t	F
Angular facial measurements	n-s-ba	131.20	3.98	130.04	4.71	1.12	1.18
	s-n-ss	79.78	3.50	81.57	3.25	—2.33*	1.08
	s-n-sm	76.57	3.00	77.80	3.12	—1.73	1.04
	ss-n-sm	3.56	2.10	3.84	1.86	—0.61	1.13
	s-n-pg	77.57	3.25	78.57	3.30	—1.32	1.02
	n-ss-pg	174.95	5.62	172.73	4.64	1.94	1.21
	NL-NSL	7.18	2.70	7.04	2.72	0.22	1.02
	ML-NSL	34.88	4.93	33.01	4.90	1.66	1.01
Linear facial measurements	n-sp'	47.54	2.62	46.44	2.68	1.81	1.02
	sp'-gn	57.97	3.51	57.00	3.59	1.18	1.02
	n-gn	105.53	5.13	103.70	4.97	1.59	1.03
	s-psp	38.43	2.96	38.04	2.87	0.60	1.03
	psp-tgo	28.74	4.57	28.33	3.65	0.45	1.25
	s-tgo	66.78	4.19	66.47	4.68	0.29	1.12
Angular and linear jaw and teeth measurements	ar-tgo-gn	129.30	6.12	128.93	6.33	0.26	1.03
	pr-nl'	12.90	2.13	12.06	2.27	1.65	1.07
	ss-pns	44.05	2.71	46.45	2.25	—4.33**	1.20
	id-ml'	26.53	2.90	24.80	2.01	3.24**	1.44
	pg-tgo	67.89	4.23	67.09	3.38	0.95	1.25
	tgo-ar	39.87	3.43	39.40	3.61	0.57	1.05
	1-n-ss	24.30	6.71	20.75	6.09	2.46*	1.10
	1-n-sm	25.13	5.81	22.81	5.31	1.84	1.09
	1-1	127.80	10.56	132.78	8.64	—2.33*	1.22
	1-1(hor.)	3.21	1.60	3.56	1.56	—0.99	1.03
	1-1(vert.)	3.68	1.46	3.99	1.45	—0.95	1.01

* = significant at the 5 % level
** = significant at the 1 % level
F = values from variance ratio test.

Even when the congenitally missing teeth were located only in the lower jaw there was a significantly reduced upper jaw prognathism (s-n-ss), a shorter maxillary basis (ss-pns) and an increased inclination of the upper incisors ($\underline{1}$-n-ss) (Table IV). Furthermore, the hypodontia group displayed a significantly higher anterior mandibular corpus (id-ml'), and a smaller interincisal angle ($\underline{1}$-$\overline{1}$).

A comparison of the groups with only upper or lower jaw hypodontia did not show any significant differences.

DISCUSSION

The criterion for selection of the present material was the congenitally missing teeth. Thus, any similarities or dissimilarities compared to the control group can not be caused by the arbitrary grouping of the material from an anatomical morphological differentiation.

The differences found can either be caused by a random difference between the hypodontia and the control groups or it must somehow be related to a morphological variation in individuals with congenitally missing teeth. An occasional difference between the group is, however, unlikely as they are drawn from the same ethnic group with the same age distribution. The sex differences between the groups also seem very similar, a fact which strengthens the hypothesis that the differences depend on a real anatomical variation.

The most striking fact was the retrognathism of the upper jaw, and the shorter maxillary base which was found both when the groups were evaluated according to sex, and when hypodontia in the upper and lower jaws was evaluated separately.

A shorter maxillary length has also been reported previously (*Heyers*, 1962; *Mizushima, Asano & Suzuki*, 1962), while other authors have found both the maxilla and the mandible to be normal, except for the lack of alveolar process, even in cases of complete absence of teeth (*Sainsbury*, 1931; *Battersby*, 1936; *Schultz*, 1938). The differences may, however, depend on somewhat different registration methods. The retrognathic position of the maxilla as found in the present study was not observed by *Mizushima et al.* (1962). *Brodie, Sarnat & Kubacki* (1953) found normal width and depth relations as well as a normal growth pattern even in a case of anodontia, a finding which was confirmed by *Ochiai, Ohmori & Ono* (1961).

It is likely that the greater inclination of the upper incisors in cases with hypodontia is a result of the retrognathic tendency, as was demonstrated by *Hasund & Ulstein* (1970).

It has been stated that presence of teeth is a contributing factor in establishing a normal morphological face height. It has been shown, however, that even patients with anodontia develop a normal face height (*Brodie et al.*, 1953; *Ochiai et al.*, 1961; *Mizushima et al.*, 1962), and the mean trend in this study was a slightly increased face height in the hypodontia individuals. Thus, presence or abscence of teeth do not seem to have a direct bearing on general facial growth. Others have observed that hypodontia individuals are characterized by immaturity at birth and delayed somatic development (*Garn et al.*, 1961; *Bailit & Sung*, 1968). It seems, however, that these differences are normalized during growth.

The only linear measurement which differed significantly in the present study was the maxillary base length. It is likely, therefore, that the different craniofacial growth in individuals with hypodontia

somehow mostly influenced the antero-posterior development of the maxilla, resulting in a maxillary retrognathism, even if the maxillary inclination was of such a magnitude that a prognathism slightly greater than the norm would be expected. The mechanism seemed to be independent of sex and whether the missing teeth were located in the upper or in the lower jaw.

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