Dentoalveolar Morphology in Relation to Craniocervical Posture

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In a recent radiographic cephalometric study of head posture and craniofacial morphology[13] the position of the head in relation to the cervical column was found to display a comprehensive set of correlations with craniofacial morphology. Extension of the head in relation to the cervical column was found in connection with a large anterior and a small posterior facial height, small anteroposterior craniofacial dimensions, large inclination of the mandible to the anterior cranial base and to the nasal plane, facial retrognathism, a large cranial base angle, and a small nasopharyngeal space. Flexion of the head was seen in connection with a small anterior and a large posterior facial height, large anteroposterior craniofacial dimensions, a small inclination of the mandible, facial prognathism, a small cranial base angle, and a large nasopharyngeal space (Fig. 1).

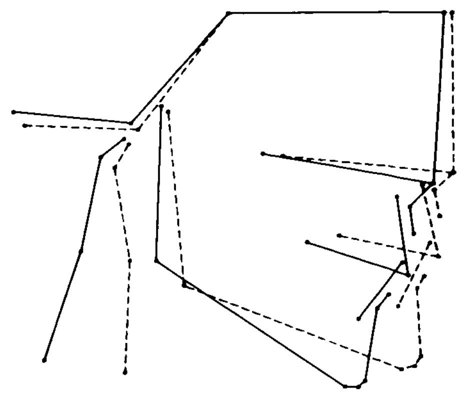

Fig. 1 Differences in average craniofacial morphology of 10 subjects with largest extension (——) and 10 subjects with most marked flexion (- - - -) of the head in relation to the cervical column (NSL/OPT) in the natural head position (mirror position). Mean facial diagrams superimposed on nasion-sella line with sella point coinciding. (From Solow and Tallgren.)[13]

In view of these findings, it was of interest to examine whether any relationship could be found between dentoalveolar morphology and head posture. In the literature, little information is available on this subject. Cleall, Alexander and McIntyre[7] in a cinefluorographic study of swallowing and head posture in a normal, a Class II, and a tongue-thrust group found no significant differences in head posture between the groups. However, Cleall[6] showed that when a tongue inhibiting appliance was inserted behind the incisors the head was extended in relation to the true vertical. Joint occurrence of extended head posture, open bite, and a unilateral crossbite ascribed to a lowered tongue position was observed by Ricketts[9] in subjects with extensive adenoid development.

The aim of the present study was to analyze the pattern of associations between dentoalveolar morphology and postural relationship of the head and the cervical column to each other and to the surroundings.

Material and Methods

The cephalometric analysis was performed on lateral head films obtained from 120 Danish male students aged 22-30 years. A detailed account of the radiographic procedure has been given elsewhere.[12] The subjects were positioned with the right side facing the

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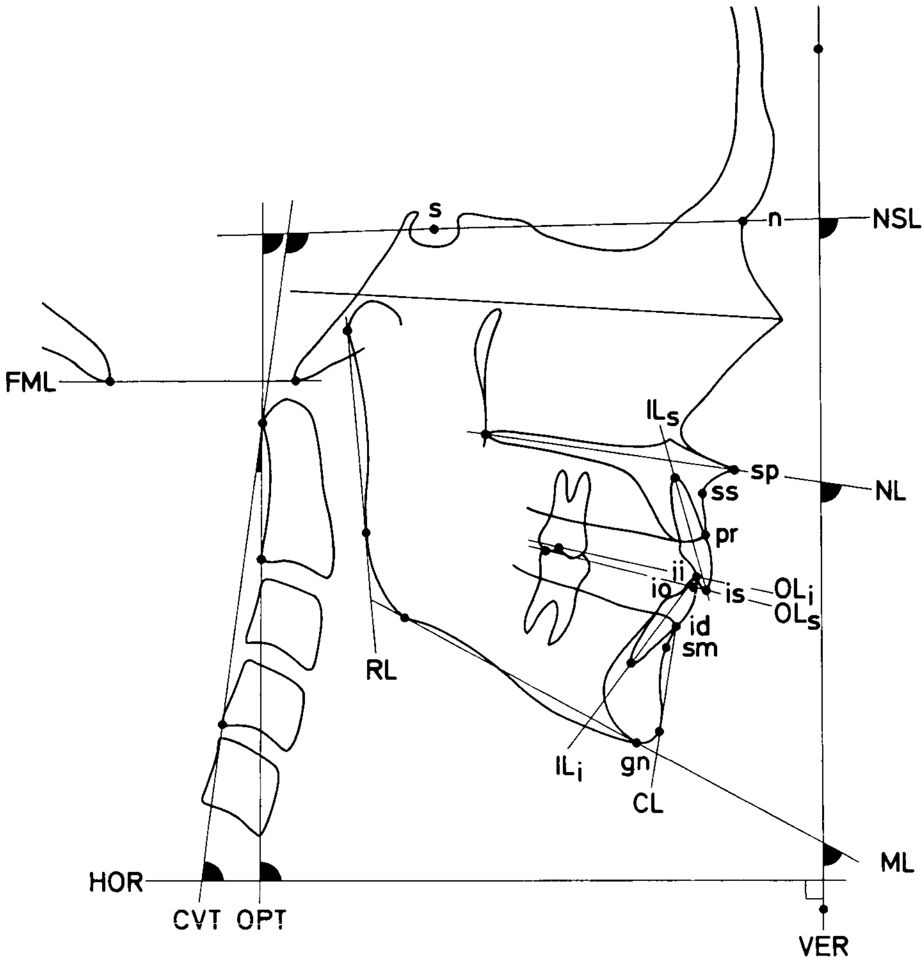

Fig. 2 Reference points and lines on the lateral cephalometric films. The definitions of some principal postural angles are indicated.

film, and two natural head positions were recorded, one determined by the subject's own feeling of a natural head balance (position 1, the self balance position), and the other by the subject fixing his eyes in a mirror in front of him (position 2, the mirror position). Both radiographic recordings were made with the subject standing in orthoposition, the intention position from standing to walking.[8]

Measurements

The reference points and lines used in the present study are shown in Figure 2. The reference points were marked with a pencil directly on the films and were recorded by a D-Mac Pencilfollower. A description of the recording procedure and the data processing has been given by Solow and Tallgren.[12,13] No corrections were made for the 5.6% radiographic enlargement.

The 17 dentoalveolar morphological variables studied are listed in Table I. These variables describe the anterior vertical dentoalveolar dimensions, the maxillary and mandibular alveolar

TABLE I
List of dentoalveolar morphological variables

Total lower anterior facial height	sp-gn
Upper dentoalveolar height	sp-is
Basal component	sp-ss
Alveolar component	ss-pr
Dental component	pr-is
Lower dentoalveolar height	ii-gn
Basal component	sm-gn
Alveolar component	id-sm
Dental component	ii-id
Max. alveolar prognathism	pr-n-ss
Mand. alveolar prognathism	CL/ML
Upper incisor inclination	IL_s/NL
Lower incisor inclination	IL_i/ML
Max. occl. plane inclination	OL_s/NL
Mand. occl. plane inclination	OL_i/ML
Overjet (Oj)	is-io
Overbite (Ob)	ii-io

For definitions of reference points and lines, see Fig. 2.

prognathism, the inclinations of the upper and lower incisors and of the occlusal planes, and the anterior occlusion. The 18 postural variables (Table III) describe the inclination of the craniofacial reference lines to the true vertical and to the cervical column, the inclination of the cervical reference lines to the true horizontal, and the curvature of the cervical column.

The method errors related to the radiographic procedure, the measuring technique and the reproducibility of the two head positions have previously been reported.[12] The method errors $s(i)$ for the present dentoalveolar variables are given in Table II. No systematic errors were found. The $s(i)$ values ranged from 0.312 to 1.453.

Results

The dentoalveolar variables studied are described statistically in Table II. The statistical description of the postural variables has been published elsewhere.[13] The correlations between the dentoalveolar morphological variables and the postural variables are given in Table III and are illustrated in Figure 3 by a comparison of the dentoalveolar morphology in subjects with marked extension and marked flexion of the head in relation to the cervical column. The 5% and 1% significance levels of the correlation coefficients were 0.179 and 0.234 for the present sample size of 120 subjects.

A brief account of the correlations will be given in the following. In accordance with a previously described procedure for analysis of craniofacial correlations,[10,13] main emphasis has been given to the nontopographical correlations, i.e., correlations between variables which have no reference points or reference lines in common.

The analysis showed that the correlation coefficients were similar in the two head positions investigated. No distinction is made, therefore, between the findings in the two head positions.

Dentoalveolar heights

In a previous study of head posture and craniofacial morphology[13] the lower anterior facial height (sp-gn) was found to be positively correlated with the craniocervical angulation, i.e., the position of the head in relation to the cervical column. The present analysis of the anterior dentoalveolar heights showed that the upper dentoalveolar height (sp-is) displayed marked positive correlations with the craniocervical angulation, whereas for the lower dentoalveolar height (ii-gn) only low positive correlations were seen.

Of the three components constituting the upper dentoalveolar height, the basal component (sp-ss) showed the most pronounced correlations with the craniocervical angulation; the dental component (pr-is) showed less marked correlations, and the alveolar component (ss-pr) displayed no significant correlations. Of the three components constituting the lower dentoal-

TABLE II

Statistical description of dentoalveolar variables. Sample size for statistical description = 120. Sample size for s(i) = 21. $s(i) = \sqrt{d^2/2n}$, where d represents the difference between double determinations of the same subject, and n the sample size. The variables are given in mm or degrees. *: p = 0.05, **: p ≤ 0.01.

Variable	No.	min.	max.	$\bar{x}$	s	Skewness $\sqrt{b1}$	Kurtosis b2	Method error s(i)
sp-gn	1	58.7	88.5	71.79	5.24	0.180	2.94	0.312
sp-is	2	22.2	39.1	30.17	2.83	-0.015	3.40	0.456
sp-ss	3	5.0	16.6	10.08	2.19	0.066	2.86	0.725
ss-pr	4	5.2	13.2	8.93	1.82	0.305	2.42	0.818
pr-is	5	11.3	15.9	13.74	0.92	-0.203	2.64	0.454
ii-gn	6	38.2	51.8	45.09	3.00	0.126	2.30*	0.334
sm-gn	7	22.2	33.4	27.69	2.46	0.085	2.44	0.564
id-sm	8	2.2	10.6	5.97	1.63	0.402*	3.17	0.603
ii-id	9	9.5	14.3	11.84	1.03	-0.039	2.75	0.587
pr-n-ss	10	-0.7	5.2	2.14	0.94	0.202	3.87*	0.312
CL/ML	11	57.2	83.2	71.24	5.40	0.017	2.77	0.600
IL_s/NL	12	87.4	123.5	110.51	7.22	-0.503*	3.44	1.231
IL_i/ML	13	71.4	116.6	95.39	8.76	-0.119	2.73	1.453
OL_s/NL	14	-2.6	18.3	6.38	3.63	0.182	3.71	0.659
OL_i/ML	15	7.8	30.8	19.54	4.60	0.244	3.07	1.282
Oj	16	1.1	11.0	3.66	1.48	1.781**	8.52**	0.321
Ob	17	-0.6	6.6	3.24	1.40	0.102	2.83	0.479

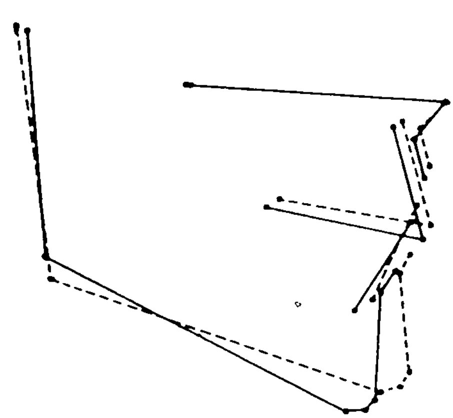

Fig. 3 Differences in dentoalveolar morphology of the same subjects as in Fig. 1. Mean diagrams superimposed on nasal line (NL) with spinal points (*sp*) coinciding. Notice the difference in vertical dentoalveolar development.

TABLE III

Correlations between postural variables and dentoalveolar morphological variables. Sample size = 120. *: $p \leq 0.05$, **: $p \leq 0.01$. The decimal points have been omitted.

[1]The correlation coefficients have been given for both head positions investigated: position 1, self balance, position 2, the mirror position.

Postural variables	No.	Head pos.[1]	Dentoalveolar morphological variables																
			sp-gn	sp-is	sp-ss	ss-pr	pr-is	ii-gn	sm-gn	id-sm	ii-id	pr-n-ss	CL/NL	IL_s/NL	IL_i/NL	OL_s/NL	OL_i/NL	Oj	Ob
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
NSL/VER	20	1	06	21*	17	14	-14	-06	-00	-06	-09	-13	10	-24**	09	28**	-08	03	05
		2	02	15	22*	-01	-08	-06	-07	06	-11	-04	13	-13	08	29**	-01	14	09
NL/VER	21	1	14	37**	29**	21*	-06	-03	02	-04	-08	-02	06	-30**	10	41**	-05	03	15
		2	10	31**	34**	06	01	-02	-05	08	-10	08	09	-18*	08	42**	02	15	20*
FML/VER	22	1	01	01	-01	03	-08	02	03	01	-01	02	-08	-05	01	07	01	-00	02
		2	-03	-05	01	-10	-02	02	-03	10	-02	10	-06	05	-01	06	06	08	04
NSL/OPT	23	1	32**	37**	40**	-01	16	16	05	18	05	-06	03	-06	-00	12	16	-08	-17
		2	31**	33**	39**	-03	16	16	02	21*	06	-04	05	-05	01	13	18*	-05	-19*
NSL/CVT	24	1	24**	35**	34**	03	15	09	05	09	-02	-02	12	-09	10	15	02	-10	-08
		2	23*	31**	35**	-01	16	09	01	15	-01	02	15	-05	10	15	08	-07	-11
NL/OPT	25	1	40**	52**	51**	05	25**	19*	07	20*	06	04	-01	-11	00	23*	19*	-08	-08
		2	38**	48**	50**	03	25**	19*	03	24**	08	05	01	-09	02	24**	22*	-04	-10
NL/CVT	26	1	32**	50**	45**	09	23**	12	07	11	-01	08	08	-13	11	26**	05	-10	01
		2	30**	45**	46**	05	24**	12	03	17	00	12	11	-09	11	26**	11	-06	-01
FML/OPT	27	1	23*	17	19*	-08	17	19*	07	20*	10	06	-12	08	-06	-04	19*	-09	-16
		2	21*	13	19*	-10	17	18*	04	22*	11	07	-10	09	-05	-03	21*	-06	-17
FML/CVT	28	1	16	14	14	-05	16	13	06	13	04	09	-05	06	02	-02	09	-10	-08
		2	14	10	13	-08	16	13	03	17	05	13	-03	09	02	-02	12	-07	-10
OPT/HOR	29	1	-26**	-19*	-24**	12	-28**	-21*	-05	-22*	-12	-05	06	-14	08	12	-22*	10	21*
		2	-30**	-22*	-22*	02	-23*	-21*	-08	-17	-15	01	06	-05	05	10	-20*	16	25**
CVT/HOR	30	1	-20*	-17	-20*	10	-30**	-15	-05	-15	-06	-10	-03	-14	-02	12	-11	13	14
		2	-24**	-20*	-18*	-00	-24**	-15	-08	-11	-09	-06	-04	-06	-04	10	-09	20*	20*
OPT/CVT	31	1	-21*	-08	-15	08	-05	-18	-02	-20*	-16	09	21*	-04	22*	05	-30**	-04	20*
		2	-21*	-10	-15	05	-04	-17	-02	-17	-17	15	20*	01	21*	03	-27**	-04	20*
ML/VER	32	1	-42**	-15	-13	03	-11	-45**	-18	-34**	-37**	01	21*	-17	38**	01	-67**	05	36**
		2	-49**	-22*	-12	-08	-06	-47**	-24**	-27**	-40**	08	23*	-08	39**	-01	-66**	14	40**
ML/OPT	33	1	-21*	01	08	-08	15	-29**	-15	-16	-28**	06	17	-05	34**	-11	-52**	-04	19*
		2	-23*	-03	08	-11	15	-30**	-18*	-12	-28**	08	19*	-04	36**	-10	-51**	-01	18
ML/CVT	34	1	-27**	-02	02	-05	12	-34**	-14	-22*	-32**	09	23*	-06	40**	-08	-60**	-05	25**
		2	-30**	-06	02	-08	13	-35**	-18*	-18*	-32**	13	26**	-03	42**	-08	-58**	-02	24**
RL/VER	35	1	-17	-09	-02	08	-20*	-21*	-10	-16	-11	07	-19*	-07	-18	02	05	-04	06
		2	-23*	-17	00	-05	-15	-21*	-17	-07	-12	16	-19*	05	-21*	-00	12	05	09
RL/OPT	36	1	10	10	23*	-05	09	01	-04	07	02	12	-26**	09	-26**	-11	28**	-15	-16
		2	09	06	23*	-07	10	01	-08	11	04	13	-23*	10	-25**	-10	31**	-11	-18
RL/CVT	37	1	01	07	17	-01	08	-07	-05	-02	-05	16	-17	07	-16	-09	15	-17	-07
		2	-00	02	17	-05	08	-07	-09	04	-04	21*	-15	11	-16	-09	20*	-14	-10

veolar height, only the alveolar component (id-sm) showed significant correlations with craniocervical angulation.

The upper and lower dentoalveolar variables which were correlated with the craniocervical angulation further showed negative correlations with the inclination of the cervical column (OPT/HOR, CVT/HOR).

Regarding the inclination of the mandibular line to the true vertical and the cervical column, marked negative nontopographical correlations were found with the dental and alveolar components of the lower dentoalveolar heights (ii-id and id-sm).

Alveolar prognathism and incisal inclination

The maxillary alveolar prognathism (pr-n-ss) and the mandibular alveolar prognathism (CL/ML) showed no significant correlations with the position of the head in relation to the cervical column. Likewise, no significant correlations were found between the inclinations of the upper and lower incisors (IL_s/NL and IL_i/ML) and the craniocervical angulation.

On the other hand, the lower incisor inclination (IL_i/ML) and the mandibular alveolar prognathism (CL/ML) showed negative nontopographical correlations with the inclination of the ramus line to the true vertical and the cervical column.

Occlusal plane inclinations

The inclination of the upper occlusal plane (OL_s/NL) showed some significant positive correlations with the position of the head in relation to the true vertical and the cervical column. The inclination of the lower occlusal plane (OL_i/ML) showed low positive correlations with the craniocervical angulation and negative correlations with the cervical inclination and curvature. Furthermore, positive nontopographical correlations were found between the inclination of the lower occlusal plane and the inclination of the ramus line to the cervical column.

Discussion

The effect of the dentoalveolar compensatory mechanism on the dimensions of the dental arches, the inclinations of the teeth, and the occlusal relationships has been well-documented.[1-5,10,11] When this mechanism is operating satisfactorily, deviations in sagittal, vertical, and transversal jaw relationships are compensated for by corresponding changes in dentobasal relationships so a normal occlusion of the dental arches is maintained. As pointed out by Solow,[10] positive or negative correlations are therefore found between jaw relationship and dentobasal variables whereas no correlations are found between jaw relationship and occlusion.

On the other hand, when the dentoalveolar compensation for variations in the jaw relationship has been less satisfactory, correlations will be found also between jaw relationship and occlusion, while the correlations between jaw relationship and the dentobasal variables will be less pronounced.

In a previous study,[13] marked positive associations were found between the vertical jaw relationship and the position of the head in relation to the cervical column, whereas only some low correlations were found between the sagittal jaw relationship and the craniocervical angulation. Consequently, head posture would be expected to display positive associations with the anterior dentoalveolar heights, with the occlusal plane inclinations and, in case of deficient dentoalveolar compensation, with the vertical overbite. On the other hand, no correlation would be expected between head posture and alveolar prognathism, incisor inclination, or overjet.

The present analysis of the relationship between dentoalveolar morphology and craniocervical posture showed a pattern of associations consistent with the above considerations (Fig. 3).

The dentoalveolar heights and the occlusal plane inclinations showed a set of positive correlations with the craniocervical angulation which indicated the dentoalveolar compensation for the differences in vertical jaw relationship related to head posture. Vertical overbite showed a tendency for negative associations with craniocervical angulation indicating a slight lack of efficiency of the compensatory mechanism in the present sample.

No associations were found between the craniocervical angulation and the indicators of sagittal dentoalveolar compensation, namely, alveolar prognathism, incisor inclination, and overjet. This is also in agreement with Cleall et al.[7] who found no difference in head posture between subjects with normal occlusion and Class II malocclusion.

Since, in the present study, the anterior dentoalveolar heights showed the highest correlations, these dimensions were analysed in some detail. The pattern of correlations displayed by the basal, alveolar, and dental components of the upper and lower dentoalveolar heights suggests that the reference point *ss* is generally relocated occlusally concomitantly with the increase in upper dentoalveolar height, whereas the reference point *sm* only to a lesser degree is relocated occlusally in response to increase in the lower dentoalveolar height.

Summary

The associations between dentoalveolar morphology and the posture of the head and the cervical column were studied in a sample of 120 Danish male students aged 22-30 years. Two head positions were recorded on lateral cephalometric radiographs, one determined by the subject's own feeling of a natural head balance (self balance position) and the other by the subject looking straight into a mirror (mirror position). Dentoalveolar morphology was described by 17 linear and angular variables and postural relationships by 18 angular variables.

The position of the head in relation to the cervical column showed positive correlations with the anterior upper and lower dentoalveolar heights and with the inclinations of the upper and lower occlusal planes. These correlations were considered to reflect the dentoalveolar compensatory adaptation to the variation in vertical jaw relationship, which in a previous study[13] had been found to be associated with craniocervical angulation. No associations were observed between craniocervical angulation and alveolar prognathism or incisor inclination. This was in accordance with the previous findings of a lack of associations between sagittal jaw relationship and craniocervical angulation.

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