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Change in the Inclination of the Occlusal Plane during Craniofacial Growth and Development

N. Vukušić[1], M. Lapter[2] and Ž. Muretić[2]

[1] Private orthodontic practice, Zagreb, Croatia
[2] Department of Orthodontics, School of Dental Medicine, University of Zagreb, Zagreb, Croatia

A B S T R A C T

The aim of this study was to examine the change in the occlusal plane inclination that takes place during craniofacial growth relative to various facio-cranial reference lines, as well as to find possible differences in means between sexes, to determine if there were correlations among variables, and to find out which of the parameters were the most reliable in determining the occlusal plane inclination. The investigation was carried out on 192 lateral radiographs of subjects divided into five age groups. The radiographs were traced and six angular roentgencephalometric variables were analysed by using different reference lines: cranial base (OLNS), Frankfort horizontal (OLFH), maxillary base (OLPL), mandibular base (OLML), anterior face height (OLNM) and posterior face height (OLSGO). It could be concluded that the change in occlusal plane inclination shows anterior rotation (left profile) during growth. The most significant change of the occlusal plane inclination was found using variables OLPL, OLFH and OLNS. There were no significant differences according to sex. Small but significant correlations were found between all investigated variables, except OLML.

Introduction

Dynamic changes in the craniofacial growth and development affect many changes in occlusal relationships. Therefore, understanding the static and dynamic details of occlusion is crucial for achieving a harmonic function of the masticatory system. The shape and inclination of the occlusal plane is an individual characteristic and is connected with the function of the stomatognathic system[1,2].

Many factors influence the morphology and function of the occlusal plane: growth, head and neck muscles, rotation

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of the mandible during growth, tooth eruption, nutritional habits etc.[3–5]. Occlusal plane characteristics have been changing during phylogenetic evolution. 150 million years ago, in the late Jurasic period, the temporomandibular joint was located at a lower level relative to the occlusal plane[6]. Subsequently, with the uprighting of the head, the occlusal plane assumed an inferior position relative to the joint[4]. The occlusal plane undergoes constant change during growth, so what would be considered normal in childhood, would not be considered normal for an adolescent or adult. The occlusal plane adapts to the variations of vertebral, dental and chronological age, in accordance with biological rhythms[7,8]. It is not possible to predict correctly the direction and intensity of growth of the relevant craniofacial structures, even when evident signs of the specific growth type are present, because they are not sufficient for a definite prediction of the occlusal relationships to be made[9].

Subjects and Methods

The investigation was carried out on 192 lateral cephalometric radiographs (92 male and 100 female subjects) presenting with a nearly normal occlusal pattern (Class I molar relationships, physiologic overbite and overjet). The sample was divided into five age groups that ranged from 10 years old to 18 years and above. Each group was represented by a closely percentage of cephalograms of subjects of both sexes (Table 1).

The study was performed using six angular roentgencephalometric variables relatiave to the Occlusal Plane or Line (OL), which was defined as the plane connecting the incisal tip of the maxillary central incisor to the distobuccal cusp of the maxillary first molar[10]. Mandibular plane used in this study is defined with roentgencephalometric points menthon-

TABLE 1
STRUCTURE OF THE SAMPLE

Age	Male	Female	Total
10–11	20	18	38
12–13	18	22	40
14–15	17	21	38
16–17	19	19	38
18–18+	18	20	38
Total	92	100	192

gonion. The following variables were measured:

- Variable 1 – OLNS: the angle between the occlusal plane and cranial base;
- Variable 2 – OLFH: the angle between the occlusal plane an the Frankfort horizontal plane;
- Variable 3 – OLPL: the angle between the occlusal and maxillary planes;
- Variable 4 – OLML: the angle between the occlusal and mandibular planes;
- Variable 5 – OLNM: the angle between the occlusal plane and the plane used to determine anterior face height;
- Variable 6 – OLSGO: the angle between the occlusal plane and the plane used to determine posterior face height.

These variables are shown in Figure 1.

The radiographs were taken by the standardized cephalometric technique and all films were traced on transparent paper using a 0.3 mm technical pen. The left profile was analysed and all angles measured by means of a protractor having a precision of 0.5 degrees. Measurements were performed twice on two separate occasions and mean values calculated.

Means, standard deviations and the significance of differences between means according to sex using Student's *t* test were performed for each variable. Since the differences between sexes were not

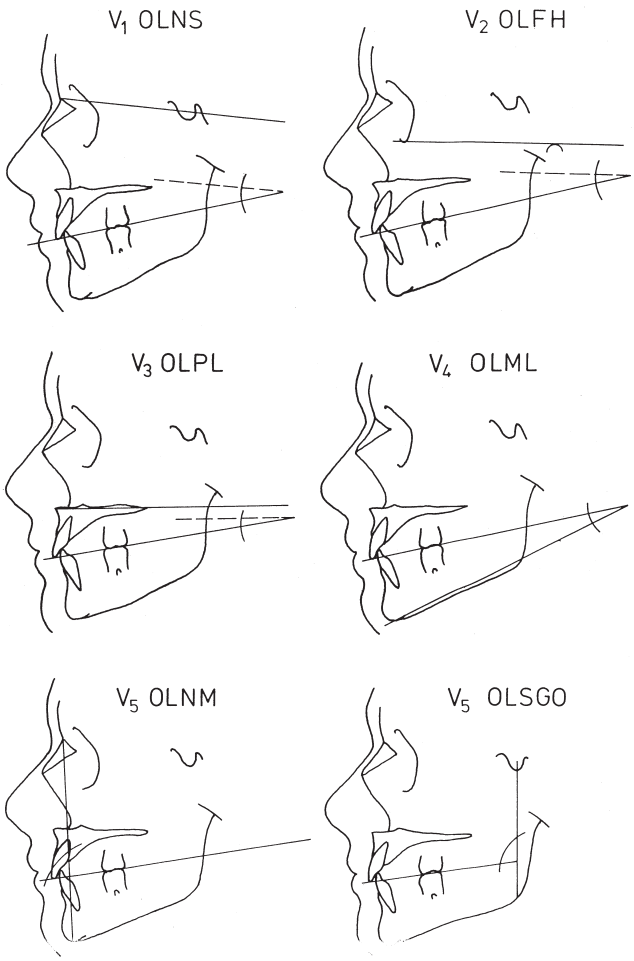

Fig. 1. Roentgencephalometric variables.

statistically significant, these data were pooled and correlation analyses performed for the whole sample. Mean values obtained in this study serve to provide new norms for investigated variables in the Croatian population.

Results

Results of the data analysis: means (x) and standard deviations (sd) for all investigated variables are shown in Table 2. By analysing the means in different age groups, marked changes in occlusal plane inclination were registred during various growth phases. Table 3 shows the significance of differences between means from the youngest to the oldest age group. Significant differences were found between the mean values of all investigated variables, except in the variable representing the angle between the occlusal and man-

dibular planes (OLML). Table 4 shows the correlation analysis between all investigated variables. Small but significant correlations were found between all investigated variables, again with the exception of OLML.

Discussion

The mean values of the variable OLNS decreased during growth from 19.75 degrees to 16.44 degrees (16.75%), which represented an anterior rotation of the occlusal plane inclination. Chang[11] also found decrease in values of the same variable from observations of 12-year old subjects (16.54 degrees) to adults (14.12 degrees) in a Chinese population. Iseri and Solow[12] in their longitudinal study of 9–25 years old female subjects found a decrease of 6 degrees. Öztürk[13] registered a decrease of 1.8 degrees even in the short period between 10 and 11 years of age.

The angle between the occlusal plane and Frankfort horizontal plane was also shown to decrease during growth, with the change in occlusal plane inclination showing a similar anterior rotation during growth when using FH as a reference line. The values decreased markedly after 14 and 15 years of age with entry into the postadolescent age. Chang et al.[11] also found a decrease in the same variable, while Humerfelt [14] and Björk[15], on a sample of twelve year old subjects, reported mean values of 14.33 degrees and 14.39 degrees, respectively, which is simmilar to our own findings (15.51degrees). The average values of the variable OLPL were shown to change significantly during growth, from 11.39 degrees in the youngest to 8.02 degrees in the oldest age groups, which reflects a 29.58% change. Decrease was more evident after 14 and 15 years of age. Kuno et al.[16] in adult Japanese, recorded 8.6 degrees for this angle which is very similar to our findings. Chang[11] likewise found a decrease in the mean of this variable in a Chinese population.

In summary, when viewed in left profile, occlusal plane inclination undergoes a anterior rotation when maxillary plane is used as a reference line – which is consistent with the direction of the previously discussed variables.

TABLE 3
THE SIGNIFICANCE OF DIFFERENCES BETWEEN INVESTIGATED VARIABLES

Variable	t-values	Significance
OLNS	3.34	0.001
OLFH	3.91	0.000
OLPL	4.08	0.000
OLML	–0.64	n.s
OLNM	2.85	0.006
OLSGO	4.53	0.000

TABLE 2
DESCRIPTIVE STATISTICS OF INVESTIGATED VARIABLES

Age	10–11		12–13		14–15		16–17		18–18+		All	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
OLNS	19.75	4.51	19.43	3.75	18.27	4.52	17.28	4.40	16.44	4.08	18.25	4.39
OLFH	15.11	4.71	15.51	4.92	14.31	4.25	12.63	4.45	10.81	4.88	13.70	4.92
OLPL	11.39	3.79	10.00	3.60	10.43	4.05	8.31	3.88	8.02	3.39	9.63	3.92
OLML	14.98	3.24	15.52	3.46	16.21	3.40	16.68	3.40	15.48	3.60	15.77	3.52
OLNM	95.34	2.90	93.65	3.17	94.35	2.47	94.03	2.22	93.28	3.50	94.12	2.91
OLSGO	98.86	4.34	98.20	5.10	96.90	3.57	95.60	3.42	94.43	4.17	96.82	4.45

Variable OLML, the angle between the occlusal and the mandibular planes, did not increase. This prompts the conclusion that the relationship between the occlusal and mandibular planes remains consistent throughout growth, with the direction and intensity of the occlusal plane inclination following that of the inclination of the mandibular basal. The same findings have been reported by others[17,14].

Variable OLNM was introduced for the specific purpose of the present investigation. The mean value for the whole sample was found to be 94.12 degrees, a decrease of 2.16 % from the youngest to the oldest age group.

Variable OLSGO also decreased during growth, with the mean difference between the youngest and the oldest age group being 4.69%, which is statistically significant.

Correlation analysis revealed significant correlations between all investigated variables, with the exception of OLML, which showed only a small correlation with variables OLNM (r = –0.42) and OLSGO (r = –0.28). Oktay[18] found small correlations between OLNS and OLNM (r = –0.14).

Seifert et. al. found similar correlations between variables OLNS and OLFH, OLNS and OLML, OLPL-OLML as were found in our study[19].

Correlations found in this study are partly of a topografic origin in that all investigated parameters had the occlusal line in common. As a results of correlation analysis it could be concluded that the occlusal line inclination could be reliably predicted using Frankfort horizontal plane, the cranial base and the maxillary base plane as reference lines.

Conclusions

The conclusions of this study can be summarised as follows. Significant changes in inclination of the occlusal plane in anterior rotation take place during growth; there were no significant differences between the mean values of all investigated variables according to sex; the most significant change of inclination of the occlusal plane was found using variables OLPL (29.5%), OLFH (28.4%) and OLNS (16.7%); small but significant correlations were found between all investigated variables, except OLML, which showed just small correlation with variables OLSGO and OLNM. As a result of correlation analysis it could be concluded that all reference lines, with the exception of the mandibular plane, could be used for determination of occlusal plane inclination. This study provides new norms for the static and dynamic estimates of occlusal plane inclination in a sample of Croatioan population.

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M. Lapter

Department of Orthodontics, School of Dental Medicine, University of Zagreb, Gundulićeva 5, 10000 Zagreb, Croatia

PROMJENA INKLINACIJE OKLUZIJSKE LINIJE TIJEKOM RASTA KRANIOFACIJALNOG SISTEMA

S A Ž E T A K

Svrha istraživanja bila je utvrditi promjenu inklinacije okluzijske linije tijekom kraniofacijalnog rasta, ima li razlika u nagibu okluzijske linije između muških i ženskih ispitanika, ima li značajnih korelacija između primijenjenih varijabli, te koji je od primijenjenih parametara najpouzdaniji pri procjeni nagiba oluzijske linije. Istraživanje je provedeno na uzorku od 192 rentgenograma ispitanika podijeljenih u pet dobnih skupina. Izvršena je procjena 6 angularnih rentgenkefalometrijskih varijabli. Precrtavanjem rentgenograma na providni papir mjerile su se varijable koje čini okluzijska linija s kranijalnom bazom (OLNS), s Frankfurtskom horizontalom (OLFH), s bazom gornje čeljusti (OLPL), s bazom donje čeljusti (OLML), s prednjom visinom lica (OLNM) i sa stražnjom visinom lica (OLGO). Može se zaključiti da se porastom dobi mijenja nagib okluzijske linije u smislu anteriorne rotacije (gledajući lijevi profil) tijekom rasta. Najintenzivnije promjene nagiba okluzijske linije uočene su primjenom varijabli OLPL, OLFH i OLNS. Nisu uočene statistički značajne razlike prema spolu. Male ali značajne korelacije nađene su između svih ispitivanih varijabli, osim OLML.