Original Article

Correlation between occlusal abnormalities and parameters investigated by three-dimensional facial photography

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ABSTRACT

Objective: To clarify, by three-dimensional (3D) facial scans, if 4- to 6-year-old children with intraoral sagittal discrepancies and open-bite occlusion show differences in facial morphology when compared to children without anomalies.

Materials and Methods: Scans of 290 children presenting with occlusal abnormalities were compared to 1772 face scans of age-matched individuals photographed with a faceSCAN II® 3D data acquisition system. From these, three study groups were formed comprising 188 children with distal occlusion/increased overjet (Class II), 37 with mesial occlusion/inverse overjet (Class III), and 65 with open-bite occlusion. These groups were evaluated by age and gender for each group compared to the control individuals.

Results: The Class II group showed statistically significant reduced dimensions of head width, upper face width, and midface length. In addition, the mean values for mouth width and lip thickness were higher, and their upper lips were located more anteriorly than in the control group. The Class III group exhibited more markedly retruded upper lips. The facial profile of female 5-year-old Class III patients was significantly more concave. Patients in the open-bite group showed reduced upper lip length, with differences only being statistically significant in male 4-year-olds.

Conclusion: Dental Class II with increased overjet and dental Class III with decreased overjet influence soft tissue morphology and are represented on 3D facial scans. (*Angle Orthod.* 2013;83:782–789.)

KEY WORDS: 3D facial images; Morphometry; 4- to 6-year-olds

INTRODUCTION

The German Orthodontic Society stated in 2010 (Kahl-Nieke, 2010) that treatment planning in patients who still have their deciduous dentition at the time of therapy initiation can remain confined to history taking, extraoral and intraoral clinical examination, identification of functional problems, and a study cast. In spite of this, currently most orthodontic offices are known to also use lateral cephalometry on a routine basis,[1,2] even though radiation exposure carries a risk of promoting malignant diseases, especially in young patients.[3,4]

Photometry, anthropometry, and three-dimensional (3D) surface cephalometry, for example, are alternatives that do not involve ionizing radiation. However, these methods only visualize soft facial tissue.

This raises the questions of whether sagittal and vertical discrepancies of occlusion influence soft tissue morphology and if they are represented on 3D facial scans. These questions have not been resolved previously.[5]

A number of authors[6–10] did find an association between soft tissue and underlying bone/tooth structures, concluding that information about skeletal and dental abnormalities can be derived from soft tissue

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architecture. The fact, however, that these studies primarily refer to adults illustrates that pertinent data about younger patients remain to be collected. Past investigations have mainly included Class I patients or randomly selected volunteers. No studies based on larger cohorts of patients are currently available to shed light on potential correlations between sagittal/vertical occlusal deviations and soft tissue morphology.

The objective of the present study was to explore if children with intraoral sagittal and vertical discrepancies show differences in facial morphology compared to children without anomalies when assessed by 3D facial photography. Potential differences shall be identified in order to (i) complement diagnostic procedures, (ii) evaluate treatment efficacy, and (iii) judge the final outcome of therapy in sagittal and vertical malocclusions needing therapy.

MATERIALS AND METHODS

A total of 2524 children, ranging in age from 3 to 6 years, were examined in 201 nursery schools across the German state of Baden-Württemberg in 2007 and 2008 in order to raise reference values for 3D surface cephalometry.[11] Institutional approval for the study was obtained from the ethics committee at the University of Tübingen Medical School (project ID 345/2005). Children were selected from all socioeconomic groups and had to be 3 to 7 years old in terms of the minimum and maximum age requirements. Additional inclusion criteria were the following: absence of orthodontic treatment or pretreatment, White descent, and receipt of parental consent to participate. Children were excluded from the study if they presented with facial skeleton syndromes and any associated malformations or if they were not adequately willing or able to comply with instructions.[11]

All children were seen by a single orthodontic examiner who had received special training in performing relevant examinations on children in this age range prior to the study. A brief diagnostic report was compiled for each child. Metric parameters were captured with a ruler calibrated to a resolution of 0.5 mm. The brief diagnostic reports covered information about sagittal occlusal parameters, overjet and overbite, dental health, extracted teeth, and any other findings worth recording.

All children in this study (students of nursery schools in Baden-Württenberg, Germany) were photographed under standardized conditions using a faceSCAN II® 3D data acquisition system.[12] The children were casually looking forward as the images were taken, with their ears uncovered and the lips closed in a relaxed way, involving no tenseness of the perioral muscles. In the photograph, the bipupilar line ran parallel to the horizontal plane.[12] Subsequently, the data were transferred to a high-performance image processing system based on OnyxCeph3 software (a SQL-based client/server Windows application) to generate a 3D image detailing facial structures in a completely natural fashion.

Table 1. Age and Gender (f = feminine, m = masculine) Distribution of Children in the Control Group and in the Various Study Groups (Class II, Class III, Open Bite)

	Control Group		Class II		Class III		Open Bite	
Age, y	f	m	f	m	f	m	f	m
4	333	397	30	19	3	5	17	19
5	363	363	39	49	8	9	6	14
6	148	168	19	32	6	6	5	4

From the primary total of 2524 children, aged 3 to 6 years, a total of 234 images were not evaluated because of poor image quality. Additionally, for this study a total of 228 images of 3-year-olds were sorted out (study population: 4- to 6-year-olds). The remaining 2062 images of the 4- to 6-year-olds were subdivided into four groups, including (1) a Class II group (188 images) with distalized occlusion and increased positive overjet (deciduous canines distalized by $\geq$3 mm and labial surface of mandibular incisors located $\geq$3 mm from labial surface of maxillary incisors); (2) a Class III group (37 images) with mesialized occlusion and inverse overjet (primary canines mesialized by $\geq$3 mm; labial surface of mandibular incisors located less than or equal to -1 mm from labial surface of maxillary incisors: when anteroposterior occlusal findings in the posterior region of Class II/III group were not bilaterally equal, the side with the more pronounced occlusal deviation determined the degree of deviation from neutral occlusion in each case); (3) an open-bite group (65 images) with maxillary incisors failing to overlap mandibular antagonists by at least 1 mm; and (4) a control group (1772 images) consisting of the remaining subjects with neutral occlusion and almost-regular overjet and overbite (divergence from neutral occlusion of deciduous canines not more than 2.5 mm, overjet between 2.5 and -0.5 mm and overbite deeper than -1 mm). Out of the scans of 290 children presenting with occlusal abnormalities there were 10 children presenting an open bite in combination with either an increased overjet $\geq$3 mm with distalized occlusion ($\geq$3 mm) or an inverse overjet less than or equal to -1 mm with mesialized occlusion ($\geq$3 mm). Whether the open bite or the increased or inverse overjet was more pronounced determined the classification into the subdivisions. Each subdivision was additionally classified by age and gender (Table 1).

An OnyxCeph3-trained dentist marked 20 anatomical landmarks, as defined by Moller et al.,[11] on each scan (Figure 1). Based on these points, 13 distances

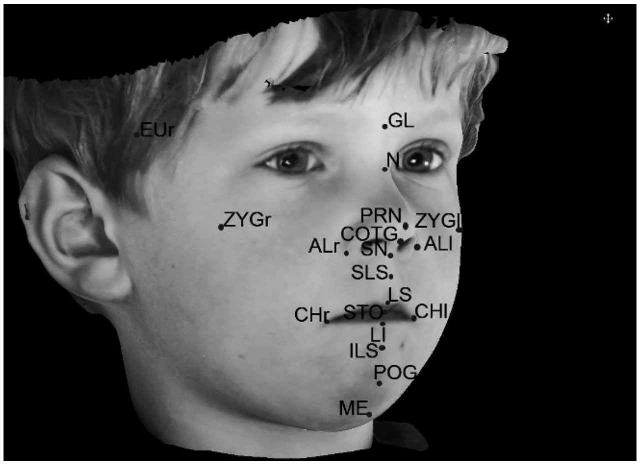

Figure 1. Three-dimensional scan of a child in the control group, with anatomical landmarks mapped out.

and seven angles were calculated and used as parameters to identify any statistically significant differences in facial morphology among the four groups (Table 2; Figure 2). The reproducibility of these points was investigated in a previous study.[12] According to this study some landmarks were poorly reproducible, with a standard deviation of more than 1 mm on each spatial plane. These landmarks were vertex (V), trichion (TR), and gonion (GO), which were thus not used in this study. All other landmarks except for three of them (eurion (EU); zygonion (ZYG); alare (AL) were found to be reproducible with $\leq$1 mm standard deviation for each plane of space.[12]

Data analysis was first performed with R (version 2.9.1) statistical programming language. The first study[11] on this population published previously employed the

Table 2. Cephalometric Parameters, Including 13 Distances and Seven Angles

Measurements	Definitions	Unit
Frontal measurements		
EUr-EUl	Head width	mm
ZYGr-ZYGl	Upper face width	mm
N-STO	Middle face length	mm
STO-ME	Mandibular height	mm
SN-ME	Lower face length	mm
N-SN	Nasal structure	mm
ALr-ALl	Lower nose width	mm
CHr-CHl	Mouth width	mm
SN-STO	Upper lip length	mm
LS-STO	Upper lip width	mm
LI- STO	Lower lip width	mm
LS-GLPOG	Distance upper lip to vertical profile line	mm
LI-GLPOG	Distance lower lip to vertical profile line	mm
Angles		
GL-SN-POG	Total face angle	°
N PRN-SN COTG	Nose tip angle	°
COTG-SN-LS	Nasolabial angle	°
LS-GL-POG	Upper lip angle	°
LI-GL-POG	Lower lip angle	°
SLS LS-LI ILS	Interlabial angle	°
LI-ILS-POG	Labiomental angle	°

Shapiro-Wilk test to verify the presence of a normal distribution. Even though the vast majority of groups were found to exhibit a normal distribution, all groups were nevertheless analyzed with the nonparametric Wilcoxon test, with $P \leq .05$ as level of significance to ensure commonality of the statistical approach (mainly for the small sample study groups). According to Primozic et al.[13] the mean and standard deviations are

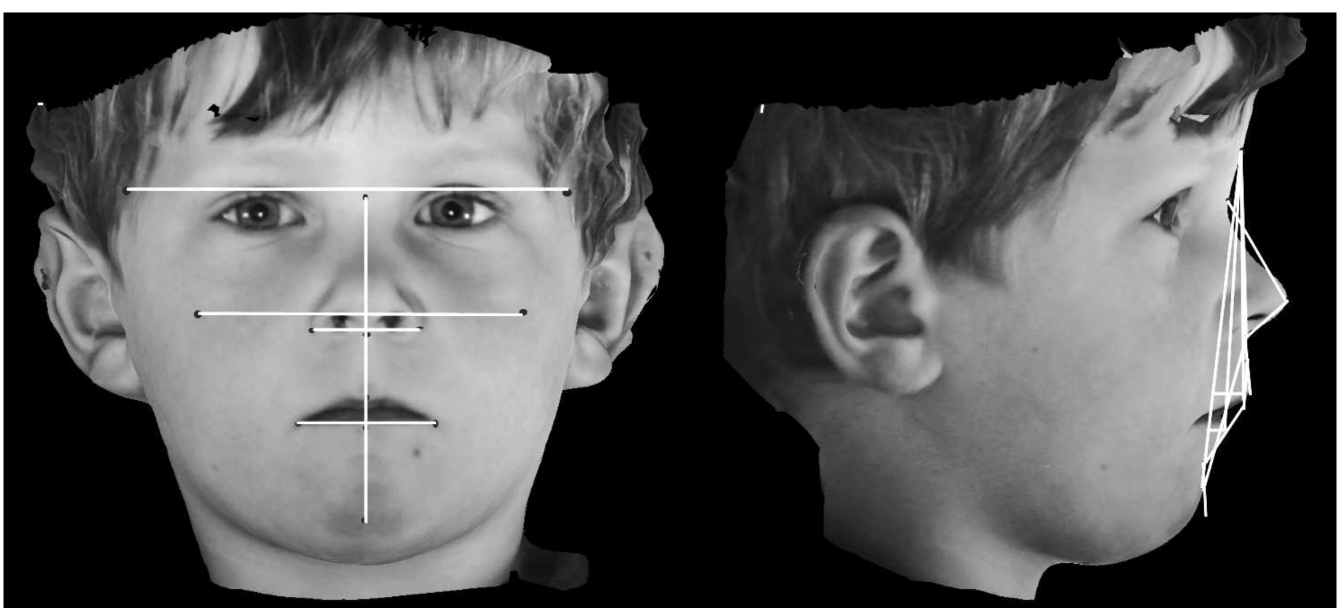

Figure 2. Measurements and angles.

Table 3. Representation of Significant Differences Between Mean Values (MV) Obtained in the Various Age and Gender Subsets Included in the Control Group vs the Same Age and Gender Subsets Within Each Study Group (Class II, Class III, Open Bite)[a]

	Control Group		Class II		Class III		Open Bite	
Age, y/Gender	MV	±SD	MV	±SD	MV	±SD	MV	±SD
Head								
EUr-Eula, head width								
4/f	118.4	13.1	108.4****	6.3			114.6	16.1
4/m	120.8	12.1	111.5****	4.5	109.0	6.1	109.2****	6.2
5/f	119.6	12.7	110.0****	5.4	110.9	8.5	110.9	4.9
5/m	122.6	12.7	113.8****	7.2	115.4	5.3	110.9****	4.0
6/f	118.7	13.0	111.6****	3.8	120.5	7.7	108.2	7.1
6/m	118.9	11.0	112.1****	4.8	111.0	3.4	109.3	5.6
Face								
ZYGr-ZYGl, upper face width								
4/f	88.8	8.5	82.1****	4.8	85.0	4.7	83.4	5.0
4/m	90.5	10.6	84.9	4.8	84.5	6.3	83.1****	4.0
5/f	89.7	8.6	85.1****	5.1	83.8	8.7	81.0	3.1
5/m	90.7	8.3	85.8****	5.3	85.8	8.8	88.1	11.4
6/f	90.4	8.6	86.0	5.5	87.3	5.9	83.9	7.7
6/m	91.9	8.5	86.4****	5.0	85.5	2.6	86.0	6.0
N-STO, middle face length								
4/f	52.8	3.7	50.6	2.9	52.3	0.9	51.8	3.3
4/m	54.4	3.7	52.9	3.1	51.7	2.1	51.2	3.2
5/f	54.5	4.0	54.3	3.2	53.0	5.7	51.0****	1.0
5/m	56.1	3.8	53.8****	3.3	54.7	2.0	54.7	3.8
6/f	55.9	3.7	53.9	3.1	55.7	4.3	51.2	4.2
6/m	57.4	4.3	56.1	3.3	54.1	4.5	55.6	2.8
STO-ME, mandibular height								
4/f	36.5	3.5	37.0	3.8	37.4	3.0	36.4	2.6
4/m	37.3	3.4	38.1	4.1	37.2	2.7	39.0	3.7
5/f	37.3	3.3	37.8	3.6	36.3	3.3	37.5	4.6
5/m	38.0	3.3	39.4	3.8	38.2	1.2	39.2	3.1
6/f	37.5	3.5	39.9	8.7	38.1	2.4	37.0	3.9
6/m	39.0	3.5	39.5	2.4	45.8	13.9	39.2	2.5
SN-ME, lower face length								
4/f	54.6	4.3	54.3	4.2	55.6	2.8	53.9	3.0
4/m	56.0	3.9	55.9	4.0	53.6	4.3	55.0	3.7
5/f	55.7	4.0	56.1	4.2	54.4	4.1	55.3	4.7
5/m	57.2	3.9	57.3	4.2	55.0	1.2	58.2	3.7
6/f	56.1	4.2	57.1	7.8	54.3	2.1	54.7	4.1
6/m	58.3	4.3	58.5	2.7	63.9	9.9	57.8	3.7
GL-SN-POG, total face angle								
4/f	162.3	5.3	163.0	5.0	175.2	1.5	164.7	4.8
4/m	161.5	5.1	162.0	5.1	169.3	3.9	165.3	5.8
5/f	161.8	5.2	162.1	4.6	172.3****	4.5	164.2	4.9
5/m	161.6	5.4	162.1	4.2	170.7	5.5	163.6	4.6
6/f	161.7	5.1	162.3	3.1	168.7	6.0	162.2	7.0
6/m	161.0	5.0	161.9	3.9	169.4	4.4	164.3	5.4
Nose								
N-SN, nasal structure								
4/f	35.3	3.2	33.7	2.8	34.0	3.6	34.1	2.8
4/m	36.2	3.5	35.3	2.9	35.3	1.4	34.6	2.7
5/f	36.7	3.7	36.2	2.8	34.2	3.4	33.4	1.4
5/m	37.5	3.6	35.8	2.9	37.6	1.1	36.3	3.2
6/f	38.1	3.6	36.9	2.6	39.6	3.4	33.7	3.8
6/m	38.8	4.1	37.5	2.8	34.9	3.4	36.9	2.9
N PRN-SN COTG, nose tip angle								
4/f	96.6	5.9	99.8	7.3	100.4	6.0	98.0	7.7
4/m	96.4	6.1	99.1	5.7	96.7	4.4	96.5	5.4
5/f	96.9	5.9	100.3	6.0	97.5	5.4	95.4	6.5
5/m	96.3	5.9	98.2	5.8	99.2	6.2	97.1	6.1
6/f	95.9	5.6	98.5	4.8	97.7	5.8	99.7	10.7
6/m	95.6	6.3	98.5	6.2	95.2	6.0	101.0	6.3

Table 3. Continued

	Control Group		Class II		Class III		Open Bite	
Age, y/Gender	MV	±SD	MV	±SD	MV	±SD	MV	±SD
COTG-SN-LS, nasolabial angle								
4/f	124.6	10.4	126.3	7.5	125.6	6.7	122.5	6.9
4/m	125.1	8.0	128.1	7.8	122.1	4.9	119.3	6.9
5/f	126.4	7.8	127.5	8.2	121.5	7.5	121.4	6.7
5/m	125.6	8.2	125.4	8.4	122.2	9.8	120.5	22.6
6/f	126.9	7.9	125.5	7.3	121.5	8.6	127.1	6.5
6/m	125.5	8.7	126.9	10.6	121.4	9.6	125.6	9.6
ALr-All, lower nose width								
4/f	29.7	2.1	28.9	2.3	32.3	0.9	30.1	1.6
4/m	30.5	2.1	31.6	1.7	30.5	4.2	30.0	2.0
5/f	30.2	2.2	30.3	2.1	31.2	1.6	30.1	2.3
5/m	30.9	2.3	31.2	2.3	32.3	2.6	30.7	2.3
6/f	30.7	2.3	30.8	1.9	31.9	2.2	28.8	1.6
6/m	31.3	2.4	31.4	2.4	31.5	2.4	31.1	3.0
Mouth								
CHr-CHl, mouth width								
4/f	36.0	3.8	36.3	3.5	37.8	5.7	35.9	3.3
4/m	36.6	3.7	39.0	3.2	38.6	4.0	36.7	4.3
5/f	37.0	3.9	38.1	4.0	37.2	3.1	38.2	5.4
5/m	37.4	3.8	39.3	3.1	40.5	6.3	37.7	3.3
6/f	37.7	3.9	39.3	3.3	39.7	3.0	37.5	1.8
6/m	38.2	4.1	39.6	3.6	38.6	3.6	38.2	5.1
SN-STO, upper lip length								
4/f	18.5	1.9	17.8	1.6	18.6	3.7	18.3	1.3
4/m	19.2	1.9	18.5	1.3	16.8	1.9	17.0****	1.5
5/f	18.8	1.8	19.0	1.6	19.0	3.4	18.2	1.4
5/m	19.6	1.8	18.7	1.9	17.3	1.9	19.4	1.5
6/f	18.9	1.7	17.9	1.2	16.6	1.1	18.2	0.8
6/m	19.7	2.0	19.5	1.8	19.5	2.3	19.2	1.3
LS-STO, upper lip width								
4/f	5.5	1.3	6.4	1.5	4.9	2.7	6.0	1.2
4/m	5.7	1.4	5.9	1.1	4.9	1.1	5.3	1.0
5/f	5.6	1.3	6.5	1.4	6.2	2.3	5.9	1.2
5/m	5.8	1.4	6.0	1.1	5.0	1.7	6.4	1.6
6/f	5.8	1.4	6.5	1.2	5.4	1.0	5.8	1.2
6/m	5.9	1.4	6.7	1.3	5.9	0.5	6.9	1.6
LI-STO, lower lip width								
4/f	5.1	1.2	5.8	1.5	5.5	0.3	5.8	1.2
4/m	5.4	1.4	6.3	1.4	5.8	1.9	5.7	1.2
5/f	5.3	1.3	5.9	1.5	5.7	1.0	5.9	1.1
5/m	5.5	1.4	6.3	1.7	5.0	1.5	5.6	1.4
6/f	5.3	1.5	6.0	1.4	4.6	0.6	5.1	0.9
6/m	5.5	1.3	6.0	1.3	6.1	0.8	6.9	0.6
LS-GLPOG, distance upper lip to profile line								
4/f	7.4	2.2	8.1	1.7	3.0	2.3	8.1	1.9
4/m	8.0	2.2	8.7	2.7	5.5	1.3	8.1	2.0
5/f	7.5	2.1	8.9	2.0	4.9	2.8	7.8	2.5
5/m	7.9	2.4	9.0	2.0	5.4	3.1	7.9	2.2
6/f	7.3	2.4	8.6	1.6	5.8	1.0	8.3	2.9
6/m	8.3	2.4	9.2	2.4	5.7	2.0	8.7	2.4
LI-GLPOG, distance lower lip to profile line								
4/f	4.2	1.8	4.0	1.7	2.3	1.2	5.4	2.1
4/m	4.7	1.8	5.0	2.0	4.8	1.7	5.4	2.1
5/f	4.2	1.8	4.6	2.1	4.3	1.3	4.8	2.4
5/m	4.7	2.0	4.7	2.1	4.0	1.9	4.5	2.0
6/f	3.9	1.9	3.7	1.7	3.1	1.1	5.0	2.0
6/m	4.8	2.2	4.6	2.0	4.2	1.7	5.6	1.4

Table 3. Continued

	Control Group		Class II		Class III		Open Bite	
Age, y/Gender	MV	±SD	MV	±SD	MV	±SD	MV	±SD
LS-GL-POG, upper lip angle								
4/f	7.2	2.1	7.7	1.7	2.6	1.9	7.7	1.8
4/m	7.5	2.1	7.8	2.4	5.2	1.4	7.6	2.0
5/f	7.1	2.0	8.1	1.8	4.6	2.2	7.3	2.3
5/m	7.2	2.2	8.0	1.7	4.6	2.5	6.9	1.8
6/f	6.7	2.2	7.7	1.6	5.1	0.8	7.9	2.3
6/m	7.4	2.1	7.9	1.9	5.2	2.0	7.6	1.9
LI-GL-POG, lower lip angle								
4/f	3.5	1.5	3.2	1.3	1.8	1.0	4.3	1.7
4/m	3.9	1.5	3.8	1.5	3.9	1.5	4.4	1.7
5/f	3.5	1.5	3.6	1.6	3.5	0.8	3.8	2.0
5/m	3.7	1.6	3.6	1.6	3.1	1.5	3.4	1.5
6/f	3.1	1.5	2.8	1.4	2.4	0.8	4.1	1.5
6/m	3.7	1.6	3.4	1.4	3.3	1.3	4.1	0.9
SLS LS- LI ILS, interlabial angle								
4/f	133.7	16.2	129.8	13.6	156.0	11.5	126.3	15.5
4/m	131.6	16.9	127.7	17.4	138.8	7.7	128.4	10.1
5/f	136.6	15.6	132.4	16.2	135.4	16.6	136.7	7.5
5/m	132.6	17.0	129.7	23.4	141.8	16.7	144.3	16.2
6/f	138.7	16.0	135.3	14.2	141.5	12.8	143.8	9.3
6/m	134.9	16.6	132.6	15.9	138.0	18.4	133.5	19.7
LI-ILS-POG, labiomental angle								
4/f	148.6	13.3	138.9	11.7	163.3	6.9	143.5	12.7
4/m	148.1	12.9	138.6	11.3	156.6	14.0	145.0	9.0
5/f	150.7	12.6	142.5	14.4	145.7	11.6	145.8	7.5
5/m	147.7	12.3	139.9	22.4	153.8	13.6	157.3	8.8
6/f	151.2	11.8	142.0	12.5	15.7	9.9	161.3	6.2
6/m	150.3	13.7	141.6	10.1	153.1	14.5	145.2	15.1

[a] SD indicates standard deviation; f, female; and m, male.

reported for descriptive purposes. Next, as a result of multiple testing, any statistical significance thus found was additionally subjected to Bonferroni correction at $P \leq .001$.

RESULTS

Table 3 summarizes all mean values obtained for the parameters investigated, broken down by age and gender and including first standard deviations. Significant differences between each study group (Class II, Class III, open bite) and the control group are marked with asterisks.

Head-Related Parameters

Head width (EUr-EUl) was significantly reduced in all male and female Class II patients compared to age-matched children in the control group. Differences were also obtained for the facial parameters, since upper face width (ZYGr-ZYGl) was significantly reduced in all Class II patients compared to the controls. The only exception to this was male 4-year-olds and female 6-year-olds, who were not significantly reduced. Middle face length (N-STO) was reduced in the Class II group, but this difference was only significant for male 5-year-olds.

Class II children revealed obvious differences in mouth-related parameters compared to their age-matched counterparts in the control group. However, these differences were not significant because of Bonferroni correction at $P = .001$: They showed markedly larger dimensions of mouth width (CHr-CHl) than their age-matched controls as well as increased values for the upper lip width (LS-STO). In addition, they generally exhibited more anterior upper lip positions, as expressed by an increased distance of upper lip to vertical profile line (LS-GLPOG).

By contrast, the Class III children revealed more posterior upper lip positions than the age-matched controls (LS-GLPOG): the distance between the upper lip and the vertical profile line was markedly but not significantly reduced. Furthermore, they exhibited obvious increases in total face angle (GL-SN-POG) and thus more concave profiles than their age-matched counterparts in the control group, but this difference was only significant for female 5-year-olds.

As was the case for the Class II patients, head width (EUr-EUl) and upper face width (ZYGr-ZYGl) were reduced in patients with open bite compared to age-matched children in the control group. The only significant differences for head width were obtained in male 4- and 5-year-olds and for upper face width in male 4-year-olds. In addition, patients with open bite revealed reduced middle face length (N-STO) compared to the controls, but this difference was only significant for female 5-year-olds. Another significant difference was found for the male 4-year-olds with open bite: they exhibited a significant reduced upper lip length (SN-STO) compared to the control group. Reduced dimensions of upper lip length were also obtained in all patients with open bite.

DISCUSSION

The results obtained in this study demonstrate that sagittal and vertical occlusal deviations can be related to soft tissue morphology in all groups when a statistical level of $P \leq .05$ is applied. The Bonferroni correction at $P \leq .001$ led to only a few significant differences. Nevertheless, clinically obvious differences were found among all groups (when only a statistical level of $P \leq .05$ was found).

Class II children showed significantly reduced dimensions of head width (EUr-EUl) and upper face width (ZYGr-ZYGl). Mouth-related parameters were markedly but not significantly different to those of age-matched children in the control group.

Class III children exhibited obvious increases in total face angle (GL-SN-POG) and thus more concave profiles than did their age-matched counterparts in the control group—this difference was significant for female 5-year-olds.

It must be stated that EU and ZYG showed standard deviations that were bigger than 1 mm in at least one spatial plane, leading to a reproducibility that was below that of all other landmarks. However, the standard deviation was still ≤2 mm on at least two spatial planes, which is still clinically acceptable, as stated in another study.[14] Dimaggio et al.[15] published an investigation based on two-dimensional photographs, some results of which can be compared to the findings of the present study. Their sample was exclusively comprised of 6-year-old children, who were classified both by gender and in accordance with the occlusal deviations presented by their dentition (Classes I, II, and III). It is not clear precisely which criteria were used to assign the children to the various occlusal classes in that study. The authors reported more prominent lip profiles in Class II than in Class I cases, which is consistent with our own finding of more protrusive upper lip profiles. They concluded that it was possible to identify the presence of Class II based on soft tissue features. The same authors observed smaller angles for the total face angle (GL-SN-POG) in Class II than in Class I patients, which is in contrast to a reverse observation reported by Ferrario et al.[16]

Our results did not reveal any significant differences in total face angle for Class II children. In accordance with the findings of Godt et al.,[7] however, we did notice higher values (to some extent significantly higher values) for this angle in the Class III patients than in the control group. The values those authors obtained with 95% confidence intervals (173.99° to 176.99°) were very similar to our mean values with standard deviations (168.7° to 175.2°).

In 2009, Staudt and Kiliaridis[17] investigated 29 men (mean age: 26.6 years) with Class III occlusion based on cephalograms and profile photographs. They also evaluated the total face angle (N-SN-POG), although they based this parameter on the nasion landmark N rather than the glabella, GL, as in the present study. They established a significant correlation between this angle and skeletal Class III relations, concluding that profile photographs provided an adequate basis for preliminary diagnosis of skeletal Class III without exposing patients to ionizing radiation and pointing out that more investigations into this matter should be performed, especially on younger patients. Kau et al.[18] conducted the only pertinent study. Using 3D imaging of Class III patients, they concluded that their soft tissue structures differed significantly from the ones found in controls. It should be noted, however, that their analysis was confined to only patients with Class III occlusion.

Most of the significant differences observed in the group with open-bite situations (Figure 5) were confined to the subset of male 4-year-olds. These children showed significantly reduced head and upper face width with significantly reduced upper lip length (SN-STO) compared to control children.

According to the results presented here, one must assume that the open-bite situations were more pronounced among the 4-year-olds, thereby increasing the differences in comparison with the controls. In fact, 4-year-olds have been reported in the literature to be affected by open-bite situations both more frequently and more severely than older children, which only goes to show that spontaneous improvement with age does occur.[19–21] The significantly reduced upper lip length (SN-STO) of the subset of male 4-year-olds might be caused by the presence of lip incompetency because of a shortened upper lip length in open-bite situations.[21] According to Dimaggio et al.,[15] the possible reason why the female 4-year-olds with open bite exhibited no significant differences to the age-matched control group is a sex-related difference for the position of SN in children showing occlusal abnormalities.

As suggested by Arat et al.,[22] imaging techniques give only restricted information about open-bite situations, which require a thorough workup, including both clinical and functional examinations.

This study warrants further studies investigating if 3D facial scans can be repeated during treatment of 4- to 6-year-olds, thus giving useful information on the impact of therapy on soft tissue appearance when correcting dental Class II with increased overjet or dental Class III with decreased overjet.

CONCLUSION

- Dental Class II with increased overjet and dental Class III with decreased overjet in 4- to 6-year-olds influence soft tissue morphology and are represented on 3D facial scans.

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