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The cephalometric assessment of the facial depth in skeletally class I individuals

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SUMMARY

Mean facial depth distance of a balanced face was introduced and the relationship with anterior facial height was investigated. The distance between the projections of Condylion (Co') and Nasion (N') points on Frankfort Horizontal plane was defined as facial depth distance and this distance was compared with anterior facial height to identify a proportion. The lateral cephalometric radiographs of 1061 individuals (577 female, 484 male) with skeletally class-I (0°≤ANB≤4°) relationship and vertically normal according to the Jaraback proportion (62%≤S-Go/N-Me≤65%) were selected for the study. The two gender groups were divided into four subgroups according to their periods of growth and development. Due to identify the term of ''normal'' in facial depth distance, the relation between the facial depth distance (Co'-N') and the anterior facial height (N-Me) was examined separately in each group. A proportion of 69,32±4,15% was found between the facial depth distance and the anterior facial height. Besides, gender did not affected this proportion and age depended relation was found insignificant. Using this proportion could facilitate the detection of the facially balanced individuals.

Key words: *Cephalometric, facial depth, skeletally class I*

ÖZET

İskeletsel sınıf I olgularda yüz derinliğinin sefalometrik olarak değerlendirilmesi

Bu çalışmada, dengeli bir yüzün sahip olması gereken ortalama yüz derinliği tespit edilerek, bu mesafe ile ön yüz yüksekliği arasındaki ilişki araştırılmıştır. Bu amaçla condylion noktası ile nasion noktasının Frankfort Horizontal düzlemindeki izdüşümleri arasındaki mesafe Yüz Derinlik Mesafesi (Co'-N') olarak tanımlanmış ve bu mesafe ile ön yüz yüksekliği karşılaştırılarak belirli bir oran saptanmaya çalışılmıştır. Tedavi olmuş ya da olmamış ayrımı yapılmadan, cinsiyet ve yaş farkı gözetmeksizin, İskeletsel Sınıf I ve Jarabak'a göre normal yüz oranına sahip, 1061 bireyin (577 kız, 484 erkek) sefalometrik filmleri seçilerek araştırma kapsamına alınmıştır. Çalışmamızda 2 ana grup (kız ve erkek) değerlendirilmiştir. Bu gruplar büyüme ve gelişim dönemleri dikkate alınarak 4 alt gruba ayrılmıştır. Ayrıca istatistiksel olarak kız ve erkeklerin birbirleriyle karşılaştırılabilmesi için genel grup oluşturulmuştur. Genel grup da kronolojik yaşa göre 4 alt grupta değerlendirilmiştir. Tüm veriler istatistiksel olarak değerlendirdiğinde, yüz derinlik mesafesinin ön yüz yüksekliğine oranının (Co'-N'/N-Me) 69,32±4,15% değerinde olduğu, bu oranın cinsiyetten etkilenmediği ve yaş dağılımı dikkate alındığında ise kliniksel olarak önemsiz seviyede etkilenebileceği tespit edilmiştir. Bundan dolayı, klinik uygulamalarda dengeli bir yüzün tanımlanmasında bu oranın kullanılmasını önermekteyiz.

Anahtar kelimeler: *Sefalometri, yüz derinliği, iskeletsel sınıf I*

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Introduction

Standard cranial x ray images are routinely in use for the definition of craniofacial morphology, the follow-up, evaluation and prediction of growth and development, in orthodontic, orthopedic and orthognathic surgical diagnose, treatment planning and in the treatment results evaluation. Researchers have developed many cephalometric analyse methods with such images systematically. In these enhanced cephalometric analysis techniques, various reference planes were used for diagnosing the cases. These reference planes show differences in both normal individuals and individuals with malocclusion(1-3). These images also address clinical assesments for the comparison of individuals of different age, gender, race and dental occlusion groups, the prediction of orthognathic surgery, the identification of the pathologies related to head and neck, the occlusal analysis, the determination of growth and development periods, the long-term follow-up of treatment and/or growth and development(1-7). Due to cephalometric definition difficulties and contradictions, to determine the maxillomandibular sagittal relationship correctly, different measurements with various reference planes have been suggested(1,2,4,6).

Wylie et al(4). evaluated five linear measurements between various anatomical point projections on Frankfort Horizontal (FH) plane to identify the tendencies to Class I, II and III. Downs(5) described the facial angle between FH and N-Pog plane and determined the position of the mandible on the saggital plane. Steiner(6) identified the S-L distance as "effective mandible length" to determine the condyle positioning according to cranium. Burstone et al(8). used S-N-7º plane and decleared that some points were not affected either by age or gender. Some re-

serachers evaluate the effect of age and gender on deteremination of the mandible length with geometric relationship between midface length and mandible length(7,9). Wits measurement was suggested to form a measurement independent from the skull base by taking the occlusal plane into consideration(10). Ferrazini(11) showed that the magnitude of maxillary prognathism did not changed by the inclinations of the maxillary plane and the variations of the facial height. The Downs' facial angle value designates the horizontal position of the maxilla and the skeletally Class-II or Class-III relationship with the mandible(12). Chang(13) suggested using AF-BF measurement to evaluate the relationship between anteroposterior positions of the jaws. Nanda and Merrill(14) decleared that the anteroposterior direction relation decreases with age. Judy et al(15). indicated that the linear correlation of age growing with ANB angle and AF-BF measurement is a clinically beneficial tool for the cephalometric evaluation on the anterioposterior sagittal malocclusions of the jaws. Lux et al(16). did not found a statistically significant difference between age and AF-BF distance.

Although there are many cephalometric measurement techniques used successfully in the evaluation of facial vertical dimension, none of them is adequate to determine the facial depth distance (FDD). The aim of this study was to define the FDD for a proportional facial morphometry and normal occlusion. Due to identify the term of ''normal'' in facial depth, the relation between the FDD (Co'-N') and anterior facial height (AFH) (N-Me) was examined in skeletally Class-I (0≤ANB≤4) and proportional faced individuals (62≤S-Go/N-Me≤65).

Material and Methods

Cephalometric images of treated or non-treated individuals from two different orthodontic treatment centers' achieves (Gulhane Military Medical Academy, Dental Science Center and Hacettepe University, Faculty of Dentistry) were analysed. The criterias used for the patient selection in this retrospective study were:

a) Skeletally Class I individuals according to Steiner analysis (0°≤ANB≤4°) (6)
b) Individuals with a normal facial proportion according to Jarabak proportions (62%≤S-Go/N-Me≤65%)

Totally, 1061 individuals (577 girls, 484 boys) have been confirmed as fitting to the study criterias by researchers. The lateral cephalometric images were evaluated in two main gender groups (girls and boys) and than divided in four subgroups according to chronological age with a care to growth and development differences for the balanced distribution among each group.. The age periods of the subgroups were;

1. at 9 years and under (9/9↓ years) (Girls n=99, Boys n=67)
2. between 10-14 years (10-14 years) (Girls n=242, Boys n=220)
3. between 15-19 years (15-19 years) (Girls n=173, Boys n=143)
4. at 20 years and over (20/20↑ years) (Girls n=63, Boys n=54)

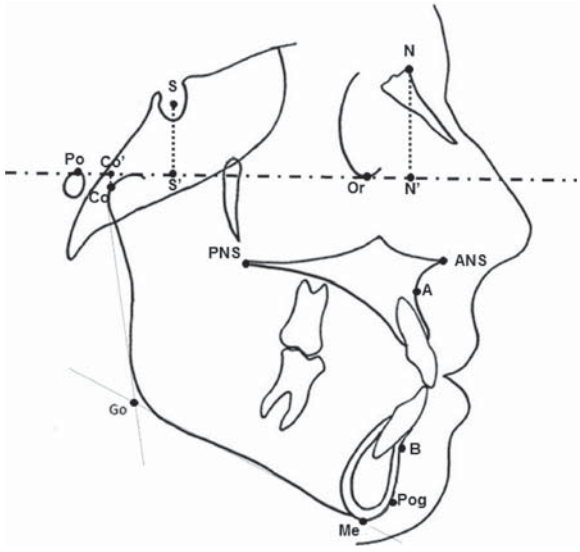
Standardization of the lateral cephalometrics:

Same technique was used to obtain the lateral cephalograms in the two different centers: All lateral cephalometric images were obtained while teeth were in centric occlusion and the FH plane was parallel to the ground. Patient head was stabilized with cephalostat rod and the patient's mid sagittal plane distance to x-ray beam source was standardized at 155 cm far and the distance to the image cassette was 12.5 cm far.

An acetate paper placed on the lateral cephalometric images and previously designated cephalometric points marked with 0.3 mm precise pens. In double images, drawings were made after centering. The cephalometric reference points, specific cephalometric points, angle measurements, distance measurements and planes used in the study were described and illustrated in Figure 1 and 2.

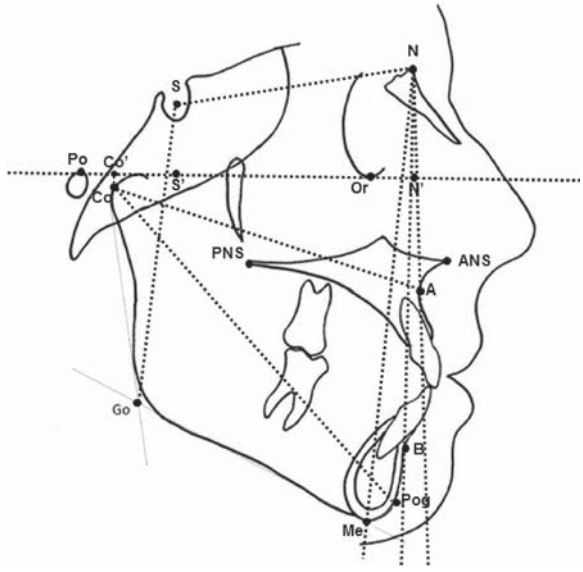
The SPSS 15.0 (SPSS Inc., Chicago, USA) software was used for the statistical evaluation of the measurements. Mean±standard deviation was used for the descriptive statistics. The differences between gender groups' measurement values were analyzed with independent samples t-test. One-way ANOVA test was used to determine the differentiation among age groups with Bonferroni correction as Post-Hoc test. α=0.05 value was determined as the error level and the difference of p values equal or lower than this value were accepted as statistically significant ($p \leq 0.05$).

The measurements of 450 patients have been repeated after 1 month and method error has been calculated with Dahlberg formula ($ME = \sqrt{\sum d^2/2n}$, where n is the sample amount and d is the difference between two measurements) and all measurements resulted below 0.47mm.



(1) Sella (S); (2) Nasion (N); (3) Anterior nasal spina (ANS); (4) Posterior nasal spina (PNS); (5) A point (A); (6) B point (B); (7) Menton (Me);(8) Gonion (Go); (9) Orbita (Or); (10) Condylion (Co); (11) Porion (Po); (12) Pogonion (Pog); (13) N': The projection point of N point on Frankfort Horizontal (FH) plane; (14) S': The projection point of S point on FH plane; (15) Co': The projection point of Co point on FH plane.

Figure 1. The cephalometric reference points and the specific created cephalometric points used in the study.



(1) SNA angle; (2) SNB angle; (3) ANB angle; (4) SN plane; (5) FH plane; (6) Co-A distance: The distance between Co and A points (Effective maxillary length); (7) Co-Pog distance: The distance between Co and Pog points (Effective mandibular length); (8) Co'-Or distance: The distance between the projection point of Co point on FH plane and Or point (Posterior part of facial depth); (9) N'-Or distance: The distance between the projection point of N point on FH plane and Or point (Anterior part of facial depth); (10) Co'- N' distance: The distance between the projection points of Co and N points on FH plane (Facial depth distance); (11) N-Me distance: The distance between N and Me points (Anterior facial height); (12) S-Go distance: The distance between S and Go points (Posterior facial height); (13) S-Go/N-Me ratio: The ratio of posterior facial height to anterior facial height (Jarabak proportion); (14) Co'-N'/N-Me ratio: The ratio of facial depth to anterior facial height; (15) S-Go/Co'-N' ratio: The ratio of posterior facial height to facial depth; (16) N'-Or/Co'-N' ratio: The ratio of anterior part of facial depth to facial depth; (17) Co'-Or/Co'-N' ratio: The ratio of posterior part of facial depth to facial depth.

Figure 2. The cephalometric angles, planes and distance measurements used in the study.

Results

The descriptive statistics of the groups and the data of the comparisons of intragroup differences (the differentiation between the age groups) were presented in Tables I-III. The comparison of measurements between the main gender groups were presented in Table IV. Statistical significancy was presented as "*" (p<0,05), "**" (p<0,01), "***" (p<0,001).

Discussion

FDD is a fundamental notion and the determination of the average facial depth is a necessity for the evaluation of the ideal function, phonation and aesthetics. The lack of the presense of such a data could be a deficiency in orthognatic surgery treatment planning. Though many researches on FDD were presented in the literature, none of them detailed a gold standard for FDD until now.

Subject population was selected from Skeletally Class-I individuals who were normal according to Steiner analysis and with normal facial proportion according Jarabak analysis, to eliminate any vertical dimension differences(6,17).

In the study, some points have been discussed for determining the facial depth plane like the CC point (the projection of Ptm on FH plane). CC point was a more stabile point than Condylion points and was suggested for determining the posterior border of facial depth(12). Especially the use of Co-A distance as the effective midfacial length which was presented in Harvold analysis has given us the hint for choosing Co point(7). Since Co point is hard to determine, it causes some difficulties as a reference point. This difficulty could be solved in two ways. First, the routine radigraphy quality obtained by the clinician could be improved; secondary, the metallic record rings on the ear rods could be removed.

In this study ANS, N, A, B and Pog points have been evaluated to determine the anterior border of facial depth. Since ANS point was affected by maxillary rotation; A point by both maxillary rotation and maxillary incisor root inclination; Pogonion point by mandible rotation, B point by both mandible rotation and mandible incisor root inclination and all these points were also affected by the treatment itself. So ANS, N, A, B and Pog points were not preferred to be the reference points in the current study(18). Although its moving forward and a bit upwards with growth and development, N point was selected as a

Table I. The descriptive statistics and the comparisons of intragroup differences of the General Group I, II, III and IV (age related comparison).

Parameters	Group I			Group II			Group III			Group IV			I-II	I-III	I-IV	II-III	II-IV	III-IV
	Mean±SD	min	max	Mean±SD	min	max	Mean±SD	min	max	Mean±SD	min	max	p	p	p	p	p	p
SNA	79,66± 2,59	72	86	78,78± 3,20	70	90	78,42± 3,34	70	88	78,03± 3,17	71	86	0,011*	0,001***	0,001***	0,405	0,103	0,341
SNB	76,79± 2,54	69	84	76,31± 3,25	67	87	76,11± 3,21	66	85	75,94± 2,94	71	85	0,325	0,101	0,107	0,805	0,655	0,959
ANB	2,87± 1,20	0	4	2,46± 1,25	0	4	2,31± 1,28	0	4	2,09± 1,34	0	4	0,02*	0,001***	0,001***	0,364	0,025*	0,376
Co-A	85,42± 6,16	72	115	87,42± 5,76	70	117	90,54± 6,78	75	115	91,22± 6,49	75	112	0,002**	0,001***	0,001***	0,001***	0,001***	0,743
Co-Pog	112,40± 7,75	95	145	115,84± 8,31	95	151	121,96± 9,00	101	154	124,18± 9,49	105	165	0,001***	0,001***	0,001***	0,001***	0,001***	0,079
Co'-Or	68,01± 4,85	52	83	68,74± 6,36	44	84	71,56± 6,99	46	92	72,49± 6,36	55	87	0,572	0,001***	0,001***	0,001***	0,001***	0,535
N'-Or	14,25± 2,94	9	23	15,06± 3,10	7	29	15,36± 3,45	8	29	15,38± 3,36	9	24	0,028*	0,022*	0,019*	0,576	0,764	1,000
Co'-N'	82,26± 5,80	64	102	83,81± 6,66	63	104	86,92± 7,83	57	111	87,87± 7,16	69	103	0,068	0,001***	0,001***	0,001***	0,001***	0,590
N-Me	115,24± 8,52	94	145	120,53± 8,46	96	154	127,81± 8,79	106	156	130,45± 10,17	104	159	0,001***	0,001***	0,001***	0,001***	0,001***	0,028*
S-Go	73,96± 5,41	59	95	76,98± 6,05	62	99	81,91± 6,05	65	103	83,96± 6,49	68	102	0,001***	0,001***	0,001***	0,001***	0,001***	0,006**
S-Go/N-Me	64,01± 1,13	62	65	63,72± 1,24	62	65	63,94± 1,17	62	65	64,15± 1,12	62	65	0,054	0,911	0,789	0,062	0,003**	0,366
Co'-N'/N-Me	71,50± 3,98	56	82	69,69± 5,45	52	99	68,09± 5,20	47	82	67,61± 6,00	49	82	0,01**	0,001***	0,001***	0,01**	0,001***	0,826
S-Go/Co'-N'	90,05± 5,25	77	109	92,20± 7,27	66	123	94,65± 7,63	72	138	95,95± 8,56	78	127	0,006**	0,001***	0,001***	0,001***	0,001***	0,349
N'-Or/Co'-N'	17,28± 3,02	10	27	18,00± 3,53	9	31	17,66± 3,49	8	30	17,49± 3,42	10	24	0,095	0,657	0,958	0,527	0,477	0,968
Co'-Or/Co'-N'	82,72± 3,02	72	89	82,00± 3,53	68	90	82,34± 3,49	69	92	82,51± 3,42	75	89	0,095	0,657	0,958	0,527	0,477	0,968

SD: Standard deviation; min: Minimum value; max: Maximum value. (* p< 0,05 ; ** p< 0,01; *** p< 0,001).

Table II. The descriptive statistics and the comparisons of intragroup differences of the Girls Group G-I, G-II, G-III and G-IV (age related comparison).

Parameters	Group G-I			Group G-II			Group G-III			Group G-IV			GI-GII	GI-GIII	GI-GIV	GII-GIII	GII-GIV	GIII-GIV
	Mean±SD	min	max	Mean±SD	min	max	Mean±SD	min	max	Mean±SD	min	max	p	p	p	p	p	p
SNA	80,28± 2,35	74	86	78,89± 3,19	70	87	78,94± 3,13	70	87	78,08± 2,98	73	84	0,06	0,14	0,01**	0,998	0,327	0,307
SNB	76,94± 2,15	72	82	76,42± 3,23	68	85	76,53± 3,12	68	85	76,02± 2,98	71	83	0,616	0,802	0,396	0,979	0,837	0,724
ANB	3,34± 0,93	1	4	2,48± 1,22	0	4	2,40± 1,23	0	4	2,06± 1,43	0	4	0,001***	0,001***	0,001***	0,897	0,125	0,319
Co-A	83,77± 4,96	72	96	86,39± 5,74	70	115	88,52± 5,71	75	112	90,84± 6,62	76	112	0,048*	0,001***	0,001***	0,01**	0,001***	0,058
Co-Pog	110,11± 6,62	95	124	114,44± 7,88	95	138	119,23± 7,06	101	138	122,29± 8,86	106	145	0,001***	0,001***	0,001***	0,001***	0,001***	0,059
Co'-Or	66,83± 4,16	56	78	67,95± 6,36	44	84	69,27± 5,86	46	85	72,96± 5,48	56	87	0,519	0,024*	0,001***	0,089	0,001***	0,01**
N'-Or	13,36±2,50	10	23	14,62± 2,82	7	24	14,62± 2,98	8	24	15,04± 3,32	9	24	0,048*	0,014*	0,012*	1,000	0,779	0,800
Co'-N'	80,19± 4,68	70	93	82,57± 6,48	63	99	83,89± 6,48	57	102	88,00± 6,01	73	103	0,032*	0,001***	0,001***	0,119	0,001***	0,001***
N-Me	111,42± 6,32	94	124	118,22± 8,21	96	143	125,04± 7,19	107	141	126,94± 8,95	104	148	0,001***	0,001***	0,001***	0,001***	0,001***	0,426
S-Go	71,84± 4,18	59	81	75,45± 5,29	62	93	79,97± 4,85	67	92	81,65± 5,63	68	97	0,001***	0,001***	0,001***	0,001***	0,001***	0,166
S-Go/N-Me	64,36± 0,93	62	65	63,68± 1,27	62	65	63,76± 1,22	62	65	64,08± 1,17	62	65	0,055	0,054	0,621	0,855	0,139	0,376
Co'-N'/N-Me	72,04± 3,31	65	81	70,00± 5,37	53	99	67,22± 5,49	47	82	69,51± 4,96	58	80	0,025*	0,001***	0,052	0,001***	0,930	0,048*
S-Go/Co'-N'	89,71± 4,47	77	100	91,71± 7,13	66	122	95,80± 8,42	79	138	93,00± 6,46	80	106	0,201	0,001***	0,084	0,001***	0,664	0,082
N'-Or/Co'-N'	16,64± 2,78	12	27	17,75± 3,40	9	31	17,42± 3,20	9	26	17,07± 3,44	10	24	0,070	0,353	0,898	0,710	0,540	0,911
Co'-Or/Co'-N'	83,36± 2,78	72	87	82,25± 3,40	68	90	82,58± 3,20	73	90	82,93± 3,44	75	89	0,070	0,353	0,898	0,710	0,540	0,911

SD: Standard deviation; min: Minimum value; max: Maximum value. (* p< 0,05 ; ** p< 0,01; *** p< 0,001)

Table III. The descriptive statistics and the comparisons of intragroup differences of the Boys Group B-I, B-II, B-III and B-IV (age related comparison).

Parameters	Group B-I			Group B-II			Group B-III			Group B-IV			BI-BII	BI-BIII	BI-BIV	BII-BIII	BII-BIV	BIII-BIV
	Mean±SD	min	max	Mean±SD	min	max	Mean±SD	min	max	Mean±SD	min	max	p	p	p	p	p	p
SNA	79,94± 2,88	72	86	78,26± 3,24	70	90	78,21± 3,30	70	87	77,59± 3,26	71	86	0,002 **	0,005 **	0,005 **	0,999	0,660	0,754
SNB	77,07± 2,85	69	84	75,87± 3,30	66	87	75,98± 2,97	70	85	75,65± 2,73	71	82	0,027*	0,038*	0,023*	0,989	0,979	0,945
ANB	2,76± 1,17	0	4	2,37± 1,31	0	4	2,22± 1,31	0	4	1,94± 1,32	0	4	0,127	0,033*	0,014*	0,712	0,256	0,674
Co-A	87,45± 5,73	75	102	88,67± 6,09	70	117	93,31± 7,68	75	115	93,41± 5,11	86	108	0,505	0,001***	0,001***	0,001***	0,001***	1,000
Co-Pog	115,06± 8,18	100	145	117,77± 8,79	95	151	126,23± 10,93	102	165	128,47± 6,52	114	141	0,137	0,001***	0,001***	0,001***	0,001***	0,590
Co'-Or	69,49± 5,29	52	83	70,01± 6,21	53	86	74,36± 7,52	55	92	74,12± 6,68	58	87	0,937	0,001***	0,004**	0,001***	0,003**	0,998
N'-Or	14,94± 3,20	9	22	15,81± 3,38	8	29	15,84± 3,84	8	29	15,97± 3,22	10	22	0,260	0,319	0,492	1,000	0,994	0,998
Co'-N'	84,43± 6,37	64	102	85,82± 6,79	70	107	90,20± 8,32	69	103	90,09± 6,89	72	102	0,490	0,001***	0,01**	0,001***	0,006**	1,000
N-Me	119,09± 9,10	103	145	123,86± 8,64	103	154	131,75± 10,34	106	159	135,65± 9,89	114	157	0,001***	0,001***	0,001***	0,001***	0,001***	0,133
S-Go	76,36± 5,65	66	95	79,14± 5,74	65	99	84,84± 6,84	69	103	87,53± 6,24	74	101	0,005**	0,001***	0,001***	0,001***	0,001***	0,103
S-Go/N-Me	63,88± 1,17	62	65	63,82± 1,19	62	65	64,17± 1,07	62	65	64,32± 1,01	62	65	0,977	0,362	0,258	0,055	0,074	0,893
Co'-N'/N-Me	71,04± 4,54	56	82	69,44± 5,26	52	85	68,57± 5,12	58	80	66,74± 6,88	49,66	82,46	0,119	0,011*	0,001***	0,431	0,026*	0,283
S-Go/Co'-N'	90,63± 5,70	77	109	92,53± 7,16	72	123	94,42± 7,09	78	110	97,66± 9,79	78,72	127,78	0,213	0,003**	0,001***	0,079	0,001***	0,094
N'-Or/Co'-N'	17,64± 3,20	10	25	18,41± 3,58	10	31	17,54± 3,77	8	28	17,75± 3,40	11,36	23,66	0,385	0,998	0,999	0,122	0,740	0,991
Co'-Or/Co'-N'	82,36± 3,20	74	89	81,59± 3,58	68	89	82,46± 3,77	71	92	82,25± 3,40	76,34	88,64	0,375	0,998	0,998	0,128	0,740	0,991

SD: Standard deviation; min: Minimum value; max: Maximum value. (* p< 0,05 ; ** p< 0,01; *** p< 0,001)

Table IV. The comparisons of measurements between Girls and Boys groups in General Groups (gender related comparison).

Parameters	Group I			Group II			Group III			Group IV		
	Group GI	Group BI	GI-BI	Group GII	Group BII	GII-BII	Group GIII	Group BIII	GIII-BIII	Group GIV	Group BIV	GIV-BIV
	Mean±SD	Mean±SD	p	Mean±SD	Mean±SD	p	Mean±SD	Mean±SD	p	Mean±SD	Mean±SD	p
SNA	80,28±2,35	79,94±2,88	0.480	78,89±3,19	78,26±3,24	0,141	78,94±3,13	78,21±3,30	0,142	78,08±2,98	77,59±3,26	0,798
SNB	76,94±2,15	77,07±2,85	0,237	76,42±3,23	75,87±3,30	0,235	76,53±3,12	75,98±2,97	0,532	76,02±2,98	75,65±2,73	0,969
ANB	3,34±0,93	2,76±1,17	0,319	2,48±1,22	2,37±1,31	0,379	2,40±1,23	2,22±1,31	0,259	2,06±1,43	1,94±1,32	0,535
Co-A	83,77±4,96	87,45±5,73	0,001***	86,39±5,74	88,67±6,09	0,003**	88,52±5,71	93,31±7,68	0,001***	90,84±6,62	93,41±5,11	0,012*
Co-Pog	110,11±6,62	115,06±8,18	0,001***	114,44±7,88	117,77±8,79	0,009**	119,23±7,06	126,23±10,93	0,001***	122,29±8,86	128,47±6,52	0,001***
Co'-Or	66,83±4,16	69,49±5,29	0,001***	67,95±6,36	70,01±6,21	0,013*	69,27±5,86	74,36±7,52	0,001***	72,96±5,48	74,12±6,68	0,115
N'-Or	13,36±2,50	14,94±3,20	0,014*	14,62±2,82	15,81±3,38	0,01**	14,62±2,98	15,84±3,84	0,001***	15,04±3,32	15,97±3,22	0,117
Co'-N'	80,19±4,68	84,43±6,37	0,001***	82,57±6,48	85,82±6,79	0,001***	83,89±6,48	90,20±8,32	0,001***	88,00±6,01	90,09±6,89	0,032*
N-Me	111,42±6,32	119,09±9,10	0,001***	118,22±8,21	123,86±8,64	0,001***	125,04±7,19	131,75±10,34	0,001***	126,94±8,95	135,65±9,89	0,001***
S-Go	71,84±4,18	76,36±5,65	0,001***	75,45±5,29	79,14±5,74	0,001***	79,97±4,85	84,84±6,84	0,001***	81,65±5,63	87,53±6,24	0,001***
S-Go/N-Me	64,36±0,93	63,88±1,17	0,219	63,68±1,27	63,82±1,19	0,530	63,76±1,22	64,17±1,07	0,057	64,08±1,17	64,32±1,01	0,364
Co'-N'/N-Me	72,04±3,31	71,04±4,54	0,217	70,00±5,37	69,44±5,26	0,687	67,22±5,49	68,57±5,12	0,09	69,51±4,96	66,74±6,88	0,078
S-Go/Co'-N'	89,71±4,47	90,63±5,70	0,240	91,71±7,13	92,53±7,16	0,590	95,80±8,42	94,42±7,09	0,053	93,00±6,46	97,66±9,79	0,04*
N'-Or/Co'-N'	16,64±2,78	17,64±3,20	0,211	17,75±3,40	18,41±3,58	0,112	17,42±3,20	17,54±3,77	0,125	17,07±3,44	17,75±3,40	0,434
Co'-Or/Co'-N'	83,36±2,78	82,36±3,20	0,209	82,25±3,40	81,59±3,58	0,115	82,58±3,20	82,46±3,77	0,127	82,93±3,44	82,25±3,40	0,424

SD: Standard deviation.

reference point, due to its easy determination for the anterior and median point of the face(18).

FH plane is a reliable plane and could be easily detected with the developed technologies that providing better quality output for the cephalometric images(2,3). So, we measured the distance between the projections of the determined points on FH plane.

The "Harvold Triangle" is between effective midface length (Co-A), effective mandible length (Co-Gn) and lower anterior facial height (ANS-Me distance). In our study, the relationship of FDD (Co'-N') with AFH (N-Me) in skeletally Class-I and normal face cases has been evaluated to define the average value for facial depth. Additionaly, the part of the facial depth (Co'-N') distance remains in front of orbital point was evaluated as the anterior part of facial depth (N'-Or'), while the part remains behind the orbital point was evaluated as the posterior part of facial depth (Co'-Or')(7).

In the evaluation of the differences between Girls and Boys groups; the FDD (Co'-N') measurement values were found significantly higher in Boys group at all age subgroups when compared with the Girls group. We believe that this observation was the result of boys' bigger cranial structure when compared to girls. These higher values obtained in boys' groups showed similarities with the studies of Wylie et al(4). and Burstone et al(8).

When intragroup differences were evaluated according to age subgroups, the FDD showed an increase with age in all groups and these increases were statistically significant among almost in all age groups. This increase could be due to the upward and backward growth of the condyle and the forward growth of the Nasion. These findings were in accordance with the previous similar studies(7-9,18-20).

For AFH (N-Me) values, a statistically significant difference was obsereved in boys when compared to girls. Nanda(21) observed similar difference in the sex comparison.

In all groups, significant increase was observed with age; except age 15-19 and 20/20↑ groups. This increase could be due to the forward and downward growth of nasomaxillary complex and mandible. Also, Nanda(21), Hunter(22), Pike(23), Baughan et al.(24), Baume et al.(25), Moore et al.(26), Van der Beek et al.(27), West and McNamara(28), Dibbets and Nolte(29) observed an increase in AFH with age.

In the evaluation of the ratio of FDD to AFH (Co'-N'/N-Me); no statistical significance was observed between Girls and Boys groups. So depending on this data, we could decleare that gender did not affect the ratio of FDD to AFH.

Significant decreases were found by age relation in intragroup comparison. The growth in the vertical direction was greater, when compared to the growth in the sagittal direction(25,27). As the increase in AFH was affected by the vertical growth and was greater than the FDD in sagittal growth, this decrease had been reflected to our results. However, in some sequenced age subgroups no significant difference was found in the Co'-N'/N-Me ratio. We believed that this result was caused by the similar magnitudes of the changes in both FDD and AFH measurements during the mentioned periods of growth.

In the evaluation of the anterior part of FDD (N'-Or/Co'-N') and posterior part of FDD (Co'-Or/Co'-N'); the values did not affected by gender and age. This could be the result of the similar amount of the change in N'-Or, Co'-Or distances and FDD (Co'-N') by growth. According to the results of the study we could state that age and gender did not affect FDD.

The evaluation of posterior facial height (PFH) (S-Go);

Statistically significant differences were observed in PFH in all Boys subgroups when compared to their equivalent Girls subgroups. In the comparison of the all age subgroups of Girls, Boys and General groups, significant increases were found between the PFH measurments (except between age 15-19 and 20/20↑ groups in Girls and Boys groups). We concluded that, this increase was releated with the upword growth of the condyle and the enhancement of the ramus height(20-29).

In the evaluation of the ratio of FDD to PFH (S-Go/Co'-N'); only at age 20/20↑ subgroups the ratio was found different in Girls and Boys' equivalent subgroups. The reason of this difference could be due to the completion of the growth in the vertical direction before ages 20/20↑ in girls, while the growth in the vertical direction still continues in boys after age 20.(21). So, it could be concluded that, gender was not effective on FDD to PFH ratio.

In the comparison of intragroups of General and Boys groups, statistically significant increases were observed with growth (except between age 15-19 and 20/20↑ groups in General, between the sequenced subgroups age 9/9↓ and 10-14, age 10-14 and 15-19,

and age 15-19 and 20/20↑ in Boys). In the light of these data, we could consider that, this increase was the result of the increase of PFH in vertical growth was greater than the increase of FDD in sagittal growth during the growth period. The differences between the other boys and girls subgroups were statistically insignificant.

Age and gender did not effect the the ratio of FDD to AFH (S-Go/N-Me). The subjects' selection was performed according to Jarabak proportions (62%≤S-Go/N-Me≤65%) and assumed them as having "normal facial proportion". So, the reason for this result could be the study subjects having "normal facial proportion".

Effective mid-facial lenght (Co-A) and effective mandibular lenght (Co-Pog) values were greater in boys than girls. In conjunction with aging, significant increases were observed between in both boys' and girls' subgroups. These increases could be due to the effect of condyller growth magnitude during the growth period and were in accordance with the previous studies(13,14,16,19,20).

In the present study, the average FDD and AFH necessary for a balanced face has been investigated. Besides, the relationship of mean FDD with the posterior face height and the internal distribution of facial depth have been studied and reported in detail.

After statistical evaluations, the mean value for FDD (Co'-N') was found as 85,64±8,12mm. and the ratio of this distance with AFH (Co'-N'/N-Me) was determined as %69,32±4,15.

It was concluded that the use of this rate would provide great benefit in clinic applications, especially in the pre-orthognatic surgery plannings to define a balanced face.

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