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Arnett Facial Soft-tissue Cephalometric Analysis Norms for Mongolian Children

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Objectives: This study aimed to determine norms cephalometric norms of Mongolian children and compare their development in boys and girls between 6 and 15 years of age. **Methods:** Lateral cephalograms were performed on 541 subjects (225 male and 316 females) having normal occlusion between the ages of 6 to 15 years. All radiographs were digitized on a computer using a cephalometric software program. A total of 6 angular, 38 linear measurements were measured by a radiologist for skeletal hard and soft tissue analysis. **Results:** Mx-occlusal plane angle, Md1 to Md occlusal plane angle, Nasolabial angle decreased with age. Mx1, Mx occlusal plane angle, and overbite were stable with age. In contrast, the other measurements typically increased with age. No statistically significant gender differences were observed. Some distinct ethnic differences were found between Caucasians and Mongolian children with Mongolian children having thinner and shorter lips compared to Caucasians. **Conclusions:** No significant differences were observed in any of the dentoskeletal factors representing hard tissue to hard tissue measurements. Results were similar to those found in Caucasian males and females.

Keywords: Arnett, Cephalometer, Cephalogram, Orthodontics, Mongolia

Introduction

Harmonious facial esthetics and useful functional occlusion have long been recognized as the two most important goals of orthodontic treatment. To accomplish these goals, knowledge of the normal craniofacial growth, and the effects of orthodontic treatment on the soft tissue profile, is crucial [1]. Some researchers have studied the thickness of the soft tissues to determine the relationship between the hard and soft tissues, and determine the effect of hard tissues on facial aesthetics [2-4]. Others have highlighted the requirement for the hard and soft tissues to be evaluated together, bringing perioral function, facial aesthetics, and stability together as essential factors in orthodontic treatment. Focusing on hard-tissue measurements alone is too simplistic. As Holdaway stated, Systems based on hard-tissue measurements or reference lines alone may produce disappointing results [5].

Craniofacial dimensions of bony structures and soft tissue depth over the skull contribute to the general appearance of the face. It is documented that races, ethnic groups, age, sex, etc. influence common facial traits [6]. These traits of various peoples have important implications for craniofacial surgeons and other medical professionals whose work involves analysis and correction of morphological disfigurements and anomalies of the head and face.

Facial features have been commonly studied in full-face and profile views. A variety of methods have been used to evaluate these facial changes together with anthropometry [7,8], photogrammetry [9-14], computer imaging [15-17], cephalometry [18-22] and scan [23]. Profiles have been evaluated by using both cephalometric or photometrical linear and angular measurements [24-34], or combinations of metric, angular, and proportional measurements. Radiographic cephalometry is one of the most important tools of clinical and research orthodontics, and normal cephalometric values have provided helpful guidelines in orthodontic diagnosis and treatment planning.

In orthodontics, different authors have reported soft-tissue parameters in cephalometric analyses [5,40,41]. Various soft tissue facial analyses based on photogrammetry have also been described [2,4,28]. Arnett and Bergman described an analysis of the soft tissue facial profile on cephalometric records in the natural head position. Their studies of the symmetry, both vertical and horizontal, the contour of the smile line, the facial middle lines, and the facial shape were important. In their linear measurements, they analyzed the position of the upper and lower lips to the Sn-Pg line (previously used by Burstone [46], the length of the upper (Sn-Ls) and lower (Li-Me) lips, the upper incisor exposure at rest (1 - 5 mm), and the inter labial gap. The authors defended the equality in the facial thirds Tri-G/G-Sn/Sn-Me (55 - 65 mm) [36].

There are no standardized published cephalometric values of normal Mongolian children, vital for diagnosis and planning of orthodontic treatment for Mongolian children with dentofacial deformity. Our study aims to determine these norms for Arnett's soft tissue cephalometric analysis [2,3] from cephalograms of Mongolian children and to identify the 9-year change in the cephalogram due to growth and development in boys and girls between 6 and 15 years of age. Additionally, we aim to compare these norms to Caucasian children.

Materials and Methods

Subjects

The Craniofacial Collaborative Research Project, a collaborative effort of the Tokyo Medical and Dental University and the Mongolian National University of Medical Sciences, conducted a longitudinal population-based survey of craniofacial growth of Mongolian children between 2013 and 2015. A total of 1842 students, attending the 33rd and 67th municipal schools of Ulaanbaatar participated. They were screened using a medical examination, questionnaire, profile photograph, and mandibula and maxilla impressions. Based on the inclusion criteria, 541 children were enrolled to have measurements in this study and, their lateral cephalogram was performed between July 2018 and March 2019.

Children were included in our study if they were 6 to 15 years of age, had normal growth and development, no facial asymmetry, no malocclusion or occlusal deformation, Angle's Class I occlusion with well-aligned maxillary and mandibular dental arches, overjet and overbite scale within 2 - 4 mm, cephalograms of normal contrast, no previous history of orthodontic or prosthodontic treatments and no history of maxillofacial or plastic surgery.

We compared our results with the previously published data on Caucasian children, the cephalogram of 40 subjects (20 males and 20 females), selected from the longitudinal growth data at the Burlington Growth Centre in Toronto, Canada [41].

Cephalograms

Lateral cephalograms of the subjects were taken using a digital cephalometric machine (Veraviewpocs, Morita, Japan). The subjects were placed in the headholder and asked to look straight ahead to establish the natural head position before adjusting the built-in nasal positioner with a millimeter scale. With teeth in centric occlusion and lips in a relaxed position, the cephalogram was taken at a focus/object distance of 150 cm and an object receptor distance of 20 cm.

All radiographs were digitized on a computer by one radiologist with 20 years of experience doing cephalometry to eliminate inter-examiner variability. Using cephalometric software (Winceph 11.0; Rise, Sendai, Japan), six angular and 38 linear measurements were obtained for skeletal hard and soft tissue analysis using 32 landmark points and two reference planes shown in Figures 1. Dentists with more than 20 years of experience with cephalometry and image manipulation have validated the landmarks and determined their reproducibility to be 95% using the ellipse method.

Landmarks

The landmarks were identified on each cephalogram. All the required cephalometric landmarks were identified and marked using a cursor/mouse manually. The landmarks and measurements were taken according to the soft tissue cephalometric analysis, and the true vertical line (TVL) was established.

TVL was drawn through the subnasal parallel to the chain representing the true vertical and perpendicular to the natural head position.

Measurements

For the projections to TVL, the horizontal distance between the various landmarks and the TVL were measured. Structures to the right of TVL were given a positive sign, and those to the level of TVL were given a negative sign. Five group measurements were selected to evaluate the differences in the soft tissue profile and are as follows: dentoskeletal factors, soft tissue structures, facial length, TVL projections and as well as facial harmony values which consist from intramandibular harmony, interjaw relationship, orbital rim to jaws and total face harmony (Figure 2-6).

Statistical analysis

The effects of age and gender on our cephalometric measurements of Mongolian children were determined using independent t-tests. Participants were stratified into two age groups, those between and those between 6 - 10 years of age and those between 11 - 15 years. Because each measurement was used twice in statistical analyses (once comparing age and again comparing gender), we controlled for type I statistical error using the Bonferroni correction, with $p \leq 0.025$ being statistically significant. We compared the cephalometric measurements of Mongolian and Caucasian children of the same gender and age using independent t-tests with $p \leq 0.05$ being significant. All statistical analyses were performed using STATA 14 software (StataCorp.2015, USA).

Ethical statement

Ethical approval for this study was obtained from the Research Ethics Committee of the Mongolian National University of Medical Sciences on June 08, 2018. Before data collection, the parents or guardians of all children provided written, informed consent.

Results

Five dentoskeletal measurements are summarized in Table 1. There were significant gender differences in most of the facial length measurements.

Table 1. Soft-tissue cephalometric analysis of Mongolian children categorized by age

	6-10 years			11-15 years		
	Males (n = 129) Mean ± SD	Females (n = 156) Mean ± SD	P-value	Males (n = 96) Mean ± SD	Females (n = 160) Mean ± SD	P-value
Dentoskeletal factors						
Mx occlusal plane (°)	105.8 ± 3.4	105.9 ± 3.4	0.623	104.0 ± 3.3	104.0 ± 3.3	0.511
Mx1 to Mx occlusal plane (°)	55.1 ± 4.0	54.7 ± 4.3	0.634	55.3 ± 4.4	55.0 ± 4.2	0.254
Md1 to Md nocclusal plane (°)	68.3 ± 5.0	68.5 ± 5.7	0.635	65.5 ± 5.7	65.8 ± 5.5	0.704
Overjet (mm)	2.3 ± 1.2	2.5 ± 1.4	0.768	2.8 ± 1.2	3.2 ± 1.4	0.996
Overbite (mm)	1.3 ± 1.2	1.8 ± 1.3	0.999	1.8 ± 1.2	2.3 ± 1.3	0.998
Soft tissue structure						
Upper lip thickness (mm)	10.9 ±	10.8 ± 1.8	-	12.6 ± 2.0	12.3 ± 1.8	0.152
Lower lip thickness (mm)	10.1 ± 1.5	10.0 ± 1.8	0.237	11.0 ± 1.8	10.7 ± 1.9	0.137
Pogonion-Pogonion' (mm)	11.6 ± 1.9	11.5 ± 2.1	0.348	129 ± 2.0	12.8 ± 2.0	0.235
Menton-Menton' (mm)	7.3 ± 1.6	7.4 ± 1.4	0.833	8.4 ± 1.9	8.3 ± 1.6	0.304
Nasolabial angle (°)	102.8 ± 8.2	101.7 ± 9.3	0.152	99.8 ± 8.8	98.6 ± 9.9	0.137
Upper lip angle (°)	17.3 ± 4.6	17.0 ± 5.9	0.254	15.7 ± 5.6	15.5 ± 6.1	0.351
Facial length						
Nasion'-Menton' (mm)	116.9 ± 7.5	117.0 ± 8.6	0.526	128.2 ± 9.6	124.8 ± 9.3	0.000
Upper lip length (mm)	21.6 ± 1.9	17 ± 5.9	0.002	23.4 ± 2.4	22.2 ± 2.6	0.000
Interlabial gap (mm)	1.6 ± 1.1	1.6 ± 1.0	0.357	1.3 ± 0.4	1.4 ± 0.4	0.920
Lower lip length (mm)	41.1 ± 3.8	40.2 ± 4.1	0.023	45.3 ± 4.7	43.5 ± 4.0	0.000
Lower 1/3 of face (mm)	64.5 ± 4.4	62.6 ± 4.9	0.000	70.2 ± 5.6	67.1 ± 4.8	0.000
Mx1 exposure (mm)	1.9 ± 1.9	2.2 ± 1.6	0.905	2.0 ± 1.5	2.6 ± 1.6	0.999
Maxillary height (mm)	23.7 ± 2.3	23.5 ± 2.3	0.317	25.6 ± 2.0	24.8 ± 2.5	0.000
Mandibular height (mm)	42.5 ± 3.4	41.5 ± 3.8	0.007	46.4 ± 4.1	45.3 ± 3.2	0.003
Projections to TVL						
Glabella (mm)	1.0 ± 3.1	1.0 ± 4.2	0.512	-0.4 ± 4.2	-0.4 ± 4.7	0.467
Orbital rims (mm)	-18.0 ± 2.9	-16.7 ± 4.8	0.994	-20.3 ± 9.2	-18.6 ± 8.9	0.951
Cheek bone (mm)	-15.2 ± 6.7	-14.2 ± 6.5	0.893	-14.8 ± 3.6	-11.6 ± 8.2	0.999
Subpupil (mm)	-11.4 ± 3.7	-10.3 ± 4.2	0.986	-8.9 ± 3.0	-12.1 ± 2.4	1.000
Alar base (mm)	-6.5 ± 2.0	-6.7 ± 2.0	0.202	-8.9 ± 3.0	-8.32 ± 2.5	0.971
Nasal projection (mm)	10.5 ± 2.0	10.8 ± 1.9	0.910	13.2 ± 1.9	12.9 ± 1.9	0.146
A point' (mm)	0.1 ± 0.5	0.1 ± 0.7	0.247	0.2 ± 0.5	0.2 ± 0.6	0.428
Upper lip anterior (mm)	4.6 ± 1.9	4.4 ± 2.1	0.195	4.8 ± 1.9	5.1 ± 2.1	0.403
Mx1 (mm)	-9.7 ± 2.4	-9.8 ± 2.3	0.311	-9.7 ± 2.7	-9.2 ± 2.4	0.956
Md1 (mm)	-11.6 ± 3.4	-12.0 ± 3.3	0.182	-12.0 ± 4.4	-12.0 ± 3.0	0.527
Lower lip anterior (mm)	1.1 ± 1.6	1.1 ± 3.3	0.418	1.7 ± 2.3	1.5 ± 2.5	0.548
B point' (mm)	-7.0 ± 4.1	-6.5 ± 3.0	0.890	-8.0 ± 4.3	-6.7 ± 4.3	0.994
Pog' (mm)	-7.9 ± 5.8	-7.0 ± 6.0	0.927	-8.6 ± 5.6	-7.2 ± 5.3	0.987

The Nasion-Mention measurement in 11 - 15 years old group showed that the facial length for boys was greater than girls, 128.2 ± 9.6 and 124.8 ± 9.3 mm, respectively ($p < 0.000$). As for upper lip length, the measurement showed that the length of boys in either of the age groups was 1.2 - 4.6 mm longer than the girls of the same age. The lower lip lengths recorded for 6 - 10 years old Mongolian boys and girls in this study were 41.1 ± 3.8 mm and 40.2 ± 4.1 mm ($p < 0.023$), respectively; while the corresponding range of values in 11 - 15 years old group were 45.3 ± 4.7 and 43.5 ± 4.0 mm ($p < 0.000$), respectively. Further, there was a significant difference in mandibular height between boys and girls groups. The mean mandibular height of both age groups of boys was 42.5 ± 3.4 and 46.4 ± 4.1 mm, respectively, which was greater than girls of the same age. However, no significant differences seen in these factors between boys and girls for either age groups ($p > 0.05$). In contrast, no significant differences were observed in soft tissue structures between Mongolian boys and girls of the same age by Arnett`s method.

Table 2. Comparison of harmony values between Mongolian children by age

	6-10 years			11-15 years		
	Males (n = 129)	Females (n = 156)	P-value	Males (n = 96)	Females (n = 160)	P-value
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Intramandibular relations						
Md1-Pog' (mm)	2.7 ± 2.6	-	-	4.0 ± 3.7	-	-
LLA-Pog' (mm)	7.1 ± 4.1	7.0 ± 4.2	0.429	6.6 ± 3.8	6.7 ± 4.1	0.548
B point'-Pog' (mm)	-1.9 ± 2.6	-1.0 ± 2.1	0.999	-1.2 ± 2.1	-0.6 ± 2.2	0.994
NTP to Pog' (mm)	54.5 ± 6.0	54.9 ± 5.6	0.731	60.0 ± 6.9	59.7 ± 2.2	0.385
Interjaw relations						
Subnasale'-Pog' (mm)	8.7 ± 3.8	7.7 ± 3.6	0.011	8.3 + 4.4	8.1 ± 4.6	0.293
A point'-B point' (mm)	6.9 ± 2.4	6.7 ± 2.5	0.247	7.1 ± 3.5	7.2 ± 3.9	0.563
ULA –LLA (mm)	3.8 ± 1.5	4.1 ± 2.2	0.911	3.8 ± 1.9	3.7 ± 3.4	0.403
Orbit to jaws						
OR'- A point' (mm)	16.0 ± 4.0	-	-	18.5 ± 4.9	18.8 ± 4.3	0.746
OR'-Pogonion' (mm)	9.1 ± 5.1	8.7 ± 4.6	0.242	11.8 ± 5.6	10.8 ± 5.6	0.061
Full facial balance						
Facial angle (mm)	169.6 ± 6.8	171.0 ± 5.6	0.973	171.9 ± 4.7	171.9 ± 4.9	0.541
G'-A point' (mm)	-0.8 ± 2.3	-0.5 ± 2.5	0.792	0.8 ± 2.8	0.2 ± 3.2	0.034
G'-Pogonion' (mm)	-10.7 ± 6.4	-9.6 ± 5.6	0.928	-7.2 ± 6.7	-6.5 ± 6.1	0.854

Comparison analysis of the mean value of facial harmony analysis by Arnett`s method and age differences were summarized in Table 2. The OR'-Pogonion' and G'-A point' were greater in boys than girls in both age groups ($p < 0.000$). Moreover, boys in the 6 - 10 years old group had significantly thicker soft-tissue thickness than girls in the same age group (8.7 ± 3.8 vs. 7.7 ± 3.6, $p = 0.011$). The harmony values revealed no significant statistical differences in intramandibular relations at both gender groups at either age group.

Facial angle measurements increased in boys 6 - 11 years of age then decreased, whereas in, the girls' group, such measurements increased in 10 - 12 years of age and then decreased.

In our study, OJ, OB upper lip thickness, lower lip thickness, Pogonion-Pogonion, Menton-Menton, Nasion-Menton, upper lip length, lower of 1/3 face, maxillary height, lower lip length, nasal projection, mandibular height in Mongolian children increased with age. In contrast, Mx occlusal plane, Md1 to Md occlusal plane, nasolabial angle, glabella, cheekbone, Mx1 to Mx occlusal plane decreased with age.

Table 3 shows the comparison of measurements between Mongolian and Caucasian children [41] over four age groups from ages 6 to 14. Since there were four age groups in the study of Caucasians, we stratified our data into the same age groups in Table 3.

The soft tissue structures, the lower lip length in all age groups were similar in both populations. However, the lower lip thickness in 6-year-old and 9-year-old Mongolian girls was less compared with the same age group of Caucasian girls.

Significant gender differences were observed in the facial angle values of Mongolian and Caucasian children. The facial angle for the Mongolian girls was 3.4 - 8.6° higher compared with Caucasian girls of the same age, while no significant differences were identified between male populations.

Table 3. Soft-tissue cephalometric analysis comparing Mongolian children with Caucasian children of the same age and gender

	6 years			9 years			12 years			14 years		
	Mongolian (n = 29)	Caucasian (n = 20)	P-value	Mongolian (n = 34)	Caucasian (n = 20)	P-value	Mongolian (n = 35)	Caucasian (n = 20)	P-value	Mongolian (n = 30)	Caucasian (n = 20)	P-value
Girls	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD		Mean ± SD	Mean ±SD		Mean ± SD	Mean ± SD	
Facial angle (°)	172.3 ± 2.8	168 ± 4	0.013	171.4 ± 4.5	168 ± 4	0.033	173.3 ± 8.3	165 ± 4	0.039	174.6 ± 2.1	166 ± 3	0.018
Nasal projection (mm)	8.1 ± 1.2	10 ± 1.5	0.012	11.4 ± 1.6	11 ± 1.5	0.490	12.7 ± 2	13 ± 1.5	0.699	13.7 ± 1.2	14 ± 1.5	0.739
Lower 1/3 of face (mm)	58.7 ± 3.3	58 ± 4	0.640	64.4 ± 2.8	62 ± 4	0.019	66.7 ± 5.1	65 ± 5	0.423	67.9 ± 0.6	66 ± 4	0.033
NTP to Pog' (mm)	52.4 ± 1.9	47 ± 5	0.001	55.5 ± 5.1	51 ± 5	0.015	59.7 ± 7.3	54 ± 5	0.086	61.9 ± 5.3	54 ± 5	0.123
Nasolabial angle (°)	101.9 ± 5.5	107 ± 9	0.074	95.5 ± 16	105 ± 9	0.079	100.2 ± 4.4	107 ± 7	0.007	96.2 ± 5.4	105 ± 8	0.104
Upper lip length (mm)	19.4 ± 1.7	18 ± 2	0.102	21.3 ± 1.6	19 ± 2	0.001	22.2 ± 0.7	20 ± 2	0.000	22.6 ± 0.7	21 ± 2	0.276
Upper lip thickness (mm)	9.3 ± 0.8	11 ± 1	0.004	11.4 ± 1.2	11 ± 1	0.318	12.8 ± 2.4	12 ± 1	0.411	12.8 ± 0.8	12 ± 1	0.197
Upper lip angle (°)	14.1 ± 2.1	4.5 ± 1	0.000	15.6 ± 3	4 ± 1	0.000	18.8 ± 6.2	4.5 ± 1	0.001	16 ± 8.7	4 ± 1	0.138
Mx1 exposure (mm)	2.2 ± 1.1	2.3 ± 2	0.854	3.4 ± 1.1	2 ± 2	0.022	3.5 ± 0.9	2.5 ± 2	0.023	1.7 ± 0.1	3 ± 1	0.003
Interlabial gap (mm)	1.3 ± 0.3	3 ± 1	0.000	1.6 ± 0.7	3 ± 1	0.000	1.3 ± 0.3	3 ± 1	0.000	1.5 ± 0.2	2 ± 1	0.038
Lower lip length (mm)	37.3 ± 1.4	37 ± 2	0.606	41.4 ± 2	40 ± 2	0.338	43 ± 3	43 ± 3	0.971	44.1 ± 1.3	44 ± 2	0.936
Lower lip thickness (mm)	9 ± 1	10 ± 1	0.060	10.2 ± 1.2	11 ± 1	0.058	10.6 ± 1.7	11 ± 1	0.563	10.9 ± 0.9	11 ± 1	0.904
Boys	(n = 25)	(n = 20)	P-value	(n = 24)	(n = 20)	P-value	(n = 28)	(n = 20)	P-value	(n = 15)	(n = 20)	P-value
Facial angle (°)	167.7 ± 5.2	169 ± 4	0.593	170.1 ± 3.7	169 ± 3	0.502	168.7 ± 2.3	167 ± 3	0.248	168.8 ± 7.1	167 ± 3	0.465
Nasal projection (mm)	8.4 ± 0.7	10 ± 1.5	0.005	11.6 ± 1.3	11 ± 1.5	0.361	13 ± 1.6	12 ± 1.5	0.294	14 ± 2.7	13 ± 1.5	0.284
Lower 1/3 of face (mm)	60.7 ± 3.2	62 ± 4	0.427	65.6 ± 1.2	65 ± 3	0.297	70 ± 2.6	67 ± 4	0.101	72.5 ± 3.3	71 ± 6	0.207
NTP to Pog' (mm)	50.2 ± 3.5	49 ± 7	0.500	56.3 ± 7.5	52 ± 5	0.217	60.5 ± 9.2	54 ± 7	0.251	62 ± 3.5	57 ± 6	0.003
Nasolabial angle (°)	104.2 ± 4.2	107 ± 4	0.211	100.6 ± 8.1	106 ± 7	0.164	100.3 ± 8.8	108 ± 7	0.177	99.3 ± 9	110 ± 7	0.007
Upper lip length (mm)	20.2 ± 2.3	19 ± 1	0.294	22.2 ± 1.3	20 ± 1	0.009	23.5 ± 1.4	21 ± 2	0.042	24.2 ± 2.2	22 ± 2	0.002
Upper lip thickness (mm)	9.4 ± 0.8	11 ± 1	0.010	11.2 ± 1	11 ± 1	0.685	12.5 ± 0.7	13 ± 1	0.240	13.2 ± 1	13 ± 1	0.668
Upper lip angle (°)	18.8 ± 3.8	4.5 ± 1	0.001	15.8 ± 6.6	5 ± 1	0.010	17.6 ± 2.2	4.5 ± 1	0.001	14.8 ± 3.4	4.5 ± 1	0.000
Mx1 exposure (mm)	1.7 ± 0.9	2.5 ± 2	0.208	1.9 ± 1.1	2.5 ± 2	0.224	1.4 ± 0.8	2.5 ± 2	0.073	2.3 ± 1.8	2.5 ± 2	0.787
Interlabial gap (mm)	1.2 ± 0.2	4 ± 2	0.000	1.6 ± 0.8	3 ± 2	0.006	1.1 ± 0.2	3 ± 1	0.001	1.2 ± 0.2	3 ± 1	0.000
Lower lip length (mm)	39.4 ± 2.6	39 ± 2	0.775	41.9 ± 2.7	42 ± 2	0.931	44.7 ± 2	44 ± 4	0.675	46 ± 3.1	47 ± 4	0.366
Lower lip thickness (mm)	9.2 ± 1.2	10 ± 1	0.193	10.6 ± 1.9	11 ± 1	0.585	10.8 ± 1.7	11 ± 1	0.825	11.4 ± 1.7	12 ± 1	0.323

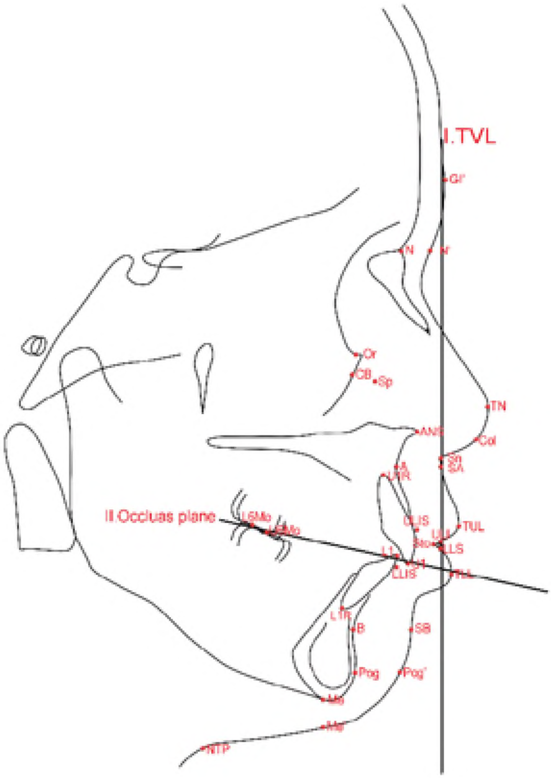


Figure 1. Hard and soft tissue landmarks and reference lines
I. True vertical line TVL
II. Occlusal plane (U1-Mo6)

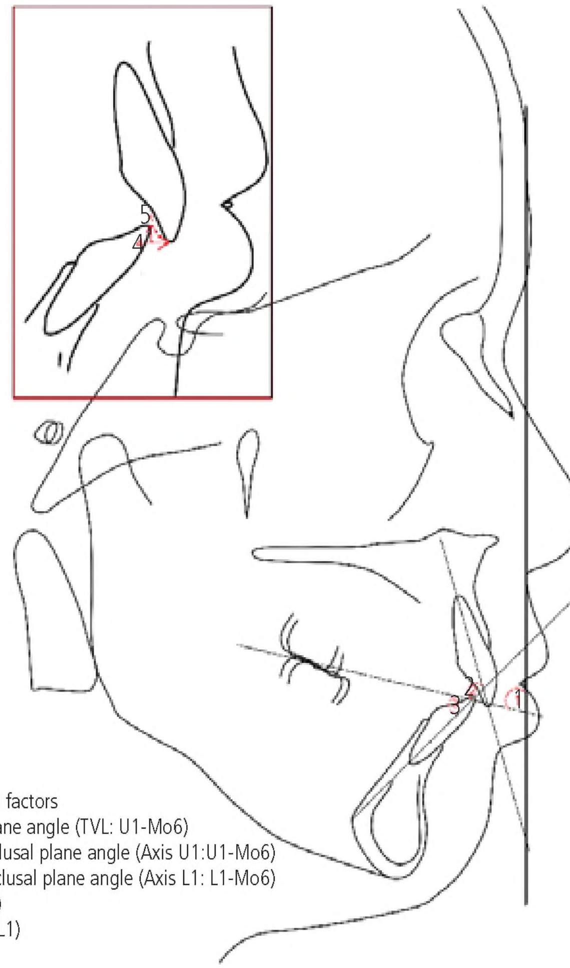


Figure 2. Dentoskeletal factors
1. Mx occlusal plane angle (TVL: U1-Mo6)
2. Mx1 to Mx occlusal plane angle (Axis U1:U1-Mo6)
3. Md1 to Md occlusal plane angle (Axis L1: L1-Mo6)
4. Overjet (U1-L1)
5. Overbite (U1 : L1)

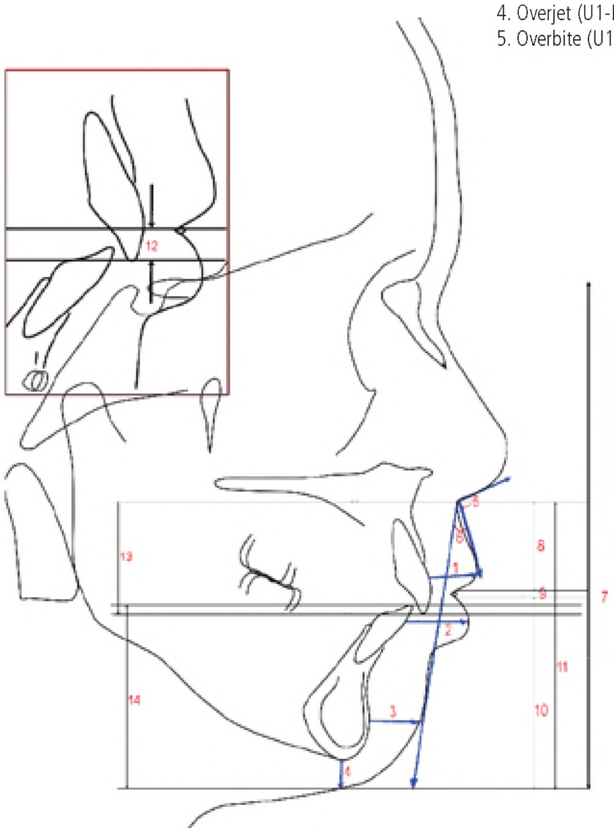
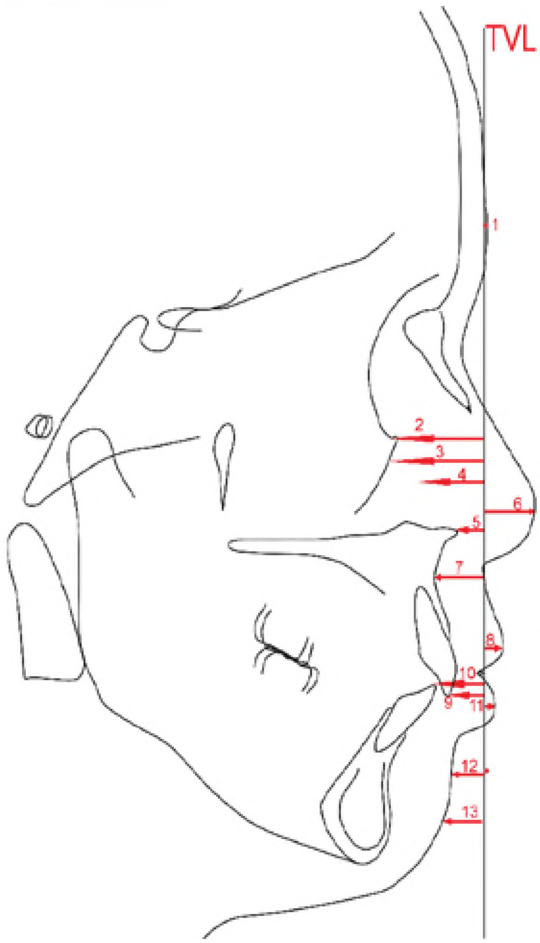


Figure 3-4.
Soft-tissue structures
1. Upper lip thickness (ULA-ULIS)
2. Lower lip thickness (LLA-LLIS)
3. Pogonion-Pogonion' (Pog-Pog')
4. Menton-Menton' (Me-Me')
5. Nasolabial angle (Col:Sn:Pog')
6. Upper lip angle (ULA:Sn:Pog')

Facial lengths
7. Nasion'-Mentio' (N'-Me')
8. Upper lip length (Sn-ULI)
9. Interlabial gap (ULI-LLI)
10. Lower lip length (LLI-Me')
11. Lower 1/3 of face (Sn-Me')
12. Mx1 exposure (ULI-U1)
13. Maxillary height (Sn-U1)
14. Mandibular height (L1-Me')



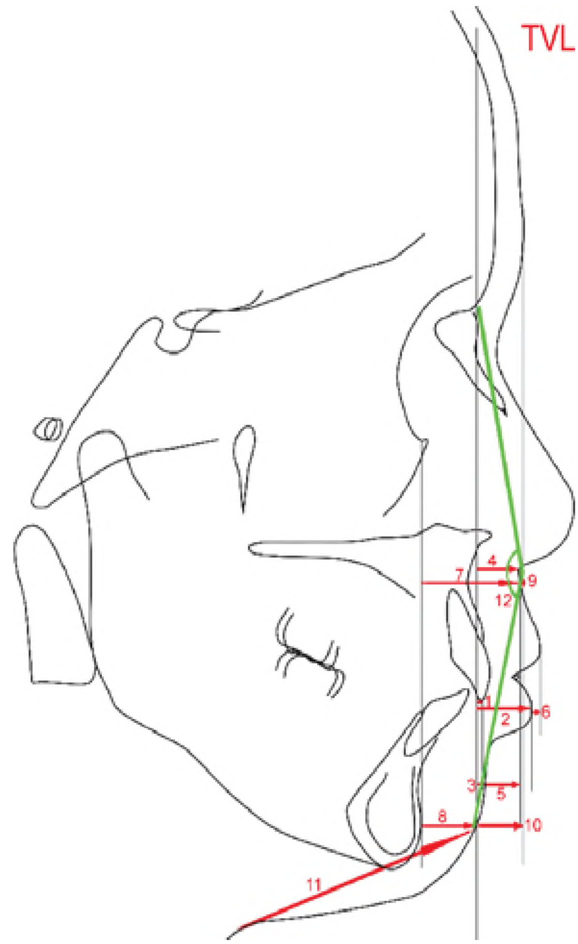


Figure 5. Projections to TVL
1. Glabella (Gl')
2. Orbital rims (Or)
3. Cheek bone (Cb)
4. Subpupil (Sp)
5. Alar base (ANS)
6. Nasal projection (TN)
7. A point' (SA)
8. Upper lip anterior (ULA)
9. Upper incisor 1 (U1)
10. Lower incisor (L1)
11. Lower lip anterior (LLA)
12. B point' (SB)
13. Pogonion' (Pog')

Figure 6. Harmony values
1. Md1-Pog'
2. LLA-Pog'
3. SB-Pog'
4. Sn-Pog'
5. SA-SB
6. ULA-LLA
7. Or-SA
8. Or-Pog'
9. Gl'-SA
10. Gl'-Pog'
11. Throat length (NTP-Pog')
12. Facial angle (N':Sn:Pog)

Discussion

Malocclusion of the teeth often leads to serious oral health complications. Therefore, appropriate diagnosis and treatment are essential. Even though facial esthetics is one of the methods for improving the misalignment, it does not rely solely on hard tissues because it can be misleading as the sole consideration. Usually, the dimensions of the soft tissue which cover the teeth and bones vary as a result of the lip length, postural tone as well as the thickness of the tissue. It has been reported that all parts of the soft-tissue profile do not directly follow the changes in the underlying skeletal profile [35]. Moreover, Burstone revealed that clinical evaluation of the facial soft tissue is essential to establish the orthodontic diagnosis and plan treatment [36].

Craniofacial morphology and thickness of soft tissues are genetic and racial, thus varying among different population groups. Therefore, the same facial esthetics should not be applied to all ethnic groups. For example, Uysal et al. [37], Scavone et al. [38] and Gunaid et al. [38] reported that the use of Caucasian cephalometric norms is not appropriate for Turkish, Japanese-Brazillian as well as Yemeni population, respectively. Thus, these authors independently established the soft tissue cephalometric norms and standard deviations for the populations mentioned above [40]. On the other hand, almost two decades ago, William Arnett introduced soft tissue cephalometric analysis, which combines clinical facial analysis and soft tissue cephalometrics. Because it is widely used and has key features such as natural head position, true vertical reference line and separate values for male and female patients, we used the parameters established in Arnett's analysis to determine the norms for the Mongolian children.

The cephalometric parameters were divided into five groups: dentoskeletal factors, softtissue structures, facial lengths, projections to the TVL and harmony values. Statistical analysis revealed characteristic gender differences in some measurements related to soft tissue dimensions and soft tissue to hard tissue dimensions, whereas no significant differences were observed in any of the dentoskeletal factors representing hard tissue to hard tissue measurements. These results were similar to those found in Caucasian males and females by Arnett et al. [41].

Of the five dentoskeletal factors, only Mx occlusal plane to TVL significantly differed between Mongolian and Caucasians for both genders. The inclination of the maxillary occlusal plane to TVL was significantly greater in both Mongolian boys and girls. This means that their occlusal planes are rotated more clockwise, causing the chin to be more retruded in the Mongolian than in Caucasians. This finding is in complete agreement with those reported by Hwang HS. et al. [42], Anamika A. et al. [43], and Tripti T. et al. [44], Kazuya Watanabe et al. [45].

Of the 13 TVL projections, nine significantly varied between Caucasian and Mongolian girls, and seven were significantly different between Caucasian and Mongolian boys. Caucasians showed greater absolute TVL projections for both genders. This indicates that Caucasian faces are more deeply chiseled compared with Mongolian faces. Because the Mongolian have more retruded chins, the distance from Pog' to the TVL significantly varied between the Mongolian and Caucasians by 6.5 mm in girls and 3.8 mm in boys.

Our study has a few limitations. Our sample size was small and limited to children from the urban area of Ulaanbaatar. So our results may not be fully representative of Mongolian children. Therefore, a study with a larger sample size from across the country is needed. Our choice of independent t-tests rather than analysis of variance limited our ability to draw some potentially interesting conclusions. Although using independent t-tests identified differences in our measurements as a result of age, it precluded our ability to identify any cephalometric measurements that may change more in one gender than the other with growth. Such was not the focus of our study.

Conclusions

Comparison analysis of some measurement results with age groups shows that Mx Occlusal plane angle, Md1 to Md nocclusal plane angle, Nasolabial angle decreased with age, Mx1, Mx nocclusal plane angle and overbite was stable with age, whereas the other measurements tended to increase with age. No gender differences were identified.

Some distinct ethnic differences were found between Caucasians and Mongolian children. The facial angle of Mongolian children was more than North American children, whereas nasolabial angle in Mongolian children was less than North American children. This shows that Mongolian children have a more pronounced convexity facial profile than Caucasians. In contrast, the nasal projection was more prominent in Caucasian children than in Mongolians. Other features, including upper and lower lip thickness and upper and lower lip length, were thicker and longer in Caucasian children.

Conflict of Interest

The authors declared no conflict of interest.

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