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Lateral Cephalometric Linear Measurement Standards of Mongolian Children with Normal Occlusion from 6-7 Years of Age

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Objectives: The aim of this study was to analyze craniofacial linear dimensions in subjects with normal occlusions to establish age and gender-specific lateral cephalometric linear measurement norms for Mongolian children. **Methods:** 161 six year old children and 122 seven year old children were recruited for this study. Digital cephalograms of 75 six year old children (34 male and 41female), 49 seven year old children (22 male and 27 female) were selected to establish lateral cephalometric linear measurement norms. Anatomic landmarks were identified directly on the digital images. The means and standard deviations of linear measurements were calculated using 18 variables. Student's t-test was employed to test for gender differences in each age. **Results:** Anterior cranial base length and midfacial length were significantly larger in six year old male subjects. Mo-Ms and A-Ptm were significantly larger in seven year old male subjects. **Conclusion:** Our results showed that linear craniofacial dimension of the hard tissue was gender-dependent. Therefore, gender-specific differences of craniofacial distances should be taken into account during diagnosis and treatment planning. The results from this study can be used as reference values for 6-7 years old children of Mongolia.

Keywords: Cephalometry, Children, Mongolia, Orthodontics

Introduction

Craniofacial growth and development are important issues to clinicians, as the amount and direction of growth alter orthodontic therapy and treatment protocols [1]. Descriptions of craniofacial relationship in individuals with normal and abnormal morphology is one of the most important and addressed topics in orthodontics [2]. As recent studies show, malocclusion rates among Mongolian children are increasing yearly [3-6]. Diagnosis and treatment of malocclusion depends on knowledge about

the form and growth of the human face [7]. The diagnosis of craniofacial deformities is derived by comparing the patient's cephalometric values with statistically defined population norms.

Downs has compared the dentofacial patterns of various races, including African, Japanese, Chinese, Australian, Native American, and Caucasian, and has found differences in their facial profiles [8-9]. Likewise, detailed studies on Japanese facial structures has revealed a facial convexity distinct from other Asians [9]. These findings show that the confounding variables brought about by age, gender, and race must be recognized for meaningful diagnosis. Therefore, each population needs lateral cephalometric measurement norms as a reference tool for research, diagnosis, and treatment planning of craniofacial deformities. It is illogical to use lateral cephalometric norms of one racial group for a different population.

In modern orthodontics, computer-based cephalometry has produced a generation of craniofacial normative databases for most racial groups. In previous lateral cephalometric measurement studies among the Mongolian population, the lateral cephalometric angular measurement method was mostly used in adults according to gender and age [10-12]. Cephalometric angular measurements remain largely constant during craniofacial growth and development, whereas most cephalometric linear measurements change with advancing age. Cephalometric linear measurements such as hard palatal length (Ans-Pns), maxilla and mandible relationship (Wits appraisel), mandibular length (Go-Pog), lower face height (Ans-Me), and posterior face height (Cd-Go) have clinical importance for diagnosis and treatment decisions. However, a comprehensive Mongolian cephalometric reference database for children is still lacking. Thus, the purpose of this study was to establish lateral cephalometric linear measurement norms for Mongolian children from 6-7 years of age with normal occlusion.

Materials and Methods

1. Ethical statement

Ethical approval for this study was acquired from the Research Ethics Committee of the Mongolian National University of Medical Sciences on June 19, 2015. Before data collection, parents of all children signed a written, informed consent.

2. Subjects

A total of 283 children, aged 6-7 years, from the 33th and 67th General Education School in Ulaanbaatar, Mongolia were recruited for this study. We collected medical records, which included information about previous dental casts, oral examination charts, extra and intraoral photographs, cephalogram x-rays, orthopantomogram x-rays, dental casts, and 3D images.

Primary inclusion criteria included normal occlusal relationship and no orthodontic treatment before and throughout the observation period. The occlusal relationship was defined as normal when the following criteria were fulfilled: class I canine relationship and mesial step or a flush terminal plane deciduous molar relationship in the deciduous and mixed dentition, all teeth present according to age, good facial symmetry, no significant medical history, no history of trauma, no midline deviation, positive overjet less than 3.5mm, and positive overbite less than 2/3 overlap of the maxillary to the mandibular incisors. Using all collected data, we selected 75 six year old children (34 male, 41 female), 49 seven year old children (22 male, 27 female) with normal occlusion.

3. Cephalometric analysis

The lateral cephalograms were taken in a habitual intercuspal position (centric occlusion) by determining the natural head position clinically and placing cephalostat ear rods in the ears. All lateral cephalograms were traced electronically on digital images by an experienced investigator. Using the cephalometric landmarks and reference lines (Figure 1, 2), 18 variables of linear measurements were taken from each subject. Linear measurements on lateral cephalograms were calculated electronically using the Winceph version 11.0 (Rise Corp, Japan) software.

4. Statistical analysis

Descriptive statistics of craniofacial measurements, including means and standard deviations, were calculated for two stages of craniofacial development (age 6 years and 7 years). Student's t-test was employed to test for gender differences in both ages (STATA, version 11.0, College Station, TX, USA).

Table 1. Summary of demographic characteristics

	Age		Gender	
	6	7	Male	Female
Number	75	49	56	68
Percent	60.4 %	39.5%	45%	55%

Table 2. Cephalometric linear measurements of six year old subjects

	6 years old			
Linear measurements	Male (Mean ±SD)	Female (Mean ±SD)	CI[95%]	p-value *
Na-S	66.1±2.2	64.5±2.25	65.3	0.003
Na-ANS	48.01±2.8	46.3±3.2	46.3	0.02
ANS-Me	62.2±2.5	61.0±3.2	60.8	0.07
ANS-PNS	46.4±2.4	45.3±1.8	45.9	0.06
Wits appraisel	1.8±2.4	1.8±2.1	1.8	0.2
S-Ptm	18.2±2.2	19.5±2.7	17.2	0.4
A-Ptm	44.4±2.1	43.8±2.4	43.5	0.2
Ptm-Ms	10±2.4	9.9±2.2	9.4	0.9
A-Ms	34.4±2.3	33.8±2.4	33.5	0.27
Is-Is'	27.6±1.7	27.3±1.7	27	0.4
Mo-Ms	15.6±2.1	14.8±1.5	14.8	0.06
Is-Mo	36.2±2.6	35.5±2.1	35.2	0.1
Gn-Cd	98.7±4.6	97.6±4.03	97.1	0.2
Pog-Go	64.2±4.2	63.4±3.9	62.8	0.4
Cd-Go	47.1±3.8	46.2±3.8	45.7	0.3
Li-Li'	36.3±1.9	35.1±1.9	35.2	0.006
Mo-Mi	27.5±2.1	26.7±	26.7	0.08
Li-Mo	33.1±2.1	32.3±1.6	32.2	0.07

* T-test

Results

Demographic characteristics of participants are shown in Table 1. A total of 124 patients, 56 males (45%) and 68 females (55%), were enrolled in this study. 75 patients were six years old (60%), and 49 patients were seven years old (40%).

All cephalometric linear measurements for six and seven year old subjects with normal occlusion are shown by gender in Table 2 and Table 3, respectively. The cephalometric landmarks and reference lines used in this study are illustrated in Figure 1 and Figure 2, respectively.

1. Craniofacial base measurements

The anterior craniofacial base length (S-N,) was increased in both genders in both age groups. Age differences were not statistically significant when comparing all males to all females, but gender differences were statistically significant when comparing all six year olds to all seven year olds ($p \geq 0.05$).

2. Horizontal plane measurements

In general, male craniofacial horizontal plane dimensions were slightly larger than the female dimensions. The males had longer hard palatal length (Ans-Pns), mandible length (Go-Pog), and posterior facial height (Cd-Go), compared with the female

Table 3. Cephalometric linear measurements of seven year old subjects

	7 years old			
	Male	Female		
Linear measurements	(Mean ±SD)	(Mean ±SD)	CI[95%]	p-value *
Na-S	67.3±2.5	65.7±2.5	66.2	0.03
N-ANS	49.2±2.1	48.1±2.8	47.9	0.16
ANS-Me	63.8±3.7	61.9±3.3	61.7	0.05
ANS-PNS	46.6±2.5	46.1±1.7	46.3	0.15
Wits appraisel	1.9±2.5	1.8±2.2	1.8	0.19
S-Ptm	18.5±2.4	18.4±2.9	17.7	0.9
A-Ptm	45.6±2.2	44.3±1.5	44.3	0.01
Ptm-Ms	11.9±2.5	11.2±1.6	10.9	0.2
A-Ms	33.6±2.4	33±1.6	32.7	0.28
Is-Is'	27.5±2.2	27.2±1.8	26.8	0.6
Mo-Ms	16.3±1.9	14.8±1.6	15	0.007
Is-Mo	36.4±2.5	36.2±2.4	35.6	0.7
Gn-Cd	103.1±4.4	101.1±4.8	100.7	0.14
Pog-Go	66.3±3.8	66.6±4.2	65.3	0.7
Cd-Go	47.8±3.8	47.2±4.9	46.2	0.6
Li-Li'	38.1±2.2	36.3±2.2	36.5	0.005
Mo-Mi	28.6±1.7	28.7±2.4	28.06	0.8
Li-Mo	33.1±2.7	33.4±2.02	32.6	0.6

*T-test

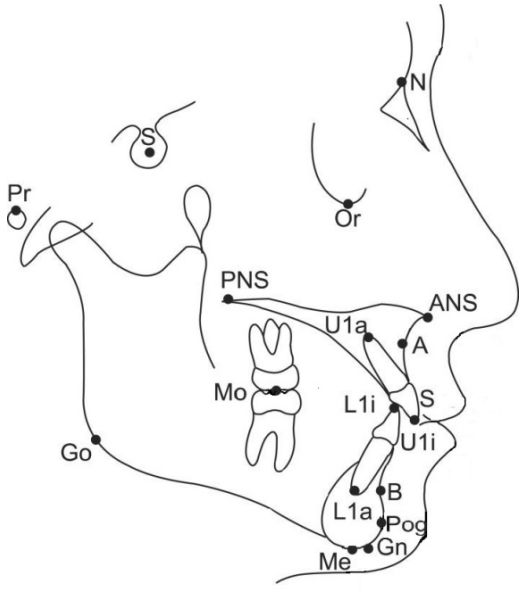

Figure 1. Cephalometric landmarks

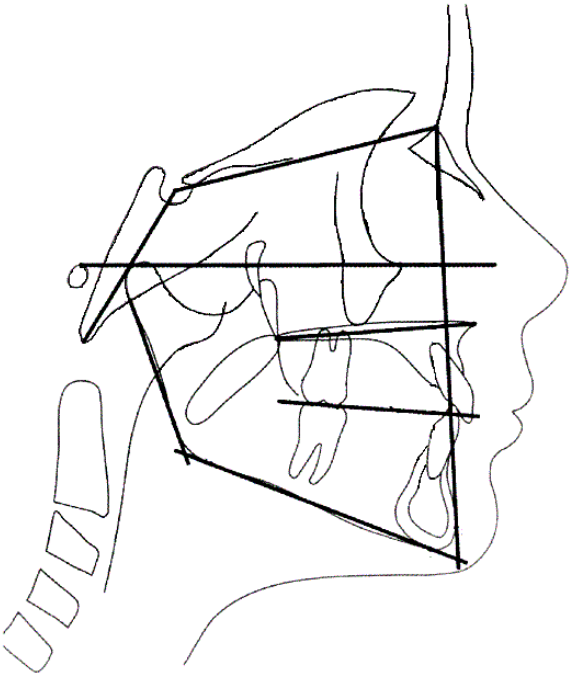

Figure 2. Cephalometric reference lines

group. These three variables did not show statistically significant differences between age and gender, but the midface length (A-Ptm) was significantly larger in seven year old male subjects ($p \geq 0.05$).

3. Dental measurements

The Li-Li^{i}variable was significantly larger in six year old male subjects compared with seven year old male subjects. The Mo-Ms variable was significantly larger in seven year old male subjects compared with six year old male subjects ($p \geq 0.05$). There was no significant difference in female subjects of both ages.

Discussion

Among adults, the lateral cephalometric angular measurement method has been used according to gender and age. However, a comprehensive data on lateral cephalometric linear and angular measurements for Mongolian children is still lacking. The reference values from this study will be the first of its kind and will be useful in orthodontics for diagnosis and treatment planning among Mongolian children.

Subjects in this study were Mongolian children, aged 6 and 7 years old, with normal occlusion and well-balanced faces living in the city of Ulaanbaatar. The inclusion criteria for this study was very strict. Lateral cephalograms were collected from subjects. Because cephalometric analysis involves methodological errors in identifying cephalometric landmarks, especially when a series of digital images are being analyzed, we had one experienced investigator solely trace all the digital images.

In our study, we observed that craniofacial dimensions grew with age, and male linear dimension values were all slightly larger than that of females. This indicates that it is essential to have cephalometric linear measurements reference values according to age and gender.

Recent studies have shown that cephalometric linear measurements increased with age, while angular measurements appeared more constant [13]. In the presence of a normal occlusion, the craniofacial complex grows continuously in a downward and anterior direction along the Downs facial axis, and this process is not gender-specific [14-15].

In a Japanese study, all lateral linear measurements value increased with age and were different by gender [16]. In our study, the anterior cranial base (Na-S) and mandibular length (Cd-Gn) values were greater than the Japanese values.

Normal occlusal relationships, especially in the anterior region, seem to be important in establishing and maintaining proportion between different craniofacial structure such as cranial base, midface, mandible, and dentition. Thus, establishing normal occlusal relationships (especially in the incisal area) at an early developmental stage is of upmost importance [17-18].

This study is limited in that it only covers six and seven years old Mongolian children, and thus, future investigation on lateral cephalometric standards for more age groups is necessary.

Conflict of Interest

The authors state no conflict of interest.

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