Lateral Cephalometric Analysis in Thai Patients without Clinical Features of Obstructive Sleep Apnea Syndrome

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ABSTRACT

Objective: To obtain referent normative values of lateral cephalometric parameters of the upper airway in Thai people without clinical features of obstructive sleep apnea syndrome (OSAS).

Methods: A total of 105 healthy subjects (80 males and 25 females) were recruited. Inclusion criteria were healthy people age ≥ 18 years with body mass index (BMI) of < 30 kg/m^2, normal visual harmony of facial profile, no history of snoring or witnessed apnea, and no excessive daytime sleepiness (Epworth Sleepiness Scale ≤ 8). All subjects must have a regular sleep pattern with total sleep duration of 7-9 hours and must have no complaint of difficulty sleeping. Exclusion criteria were pregnant women, patients with previous orthodontic treatment, corrective jaw surgery, upper airway surgery, neoplasm, irradiation in head and neck, and patients who had underlying illnesses using medication or substance which affected the sleep-wake cycle. All subjects had lateral cephalometric radiographs taken with a standardized technique. Every data was measured twice on separate occasions.

Results: The reliability of repeated measurements was excellent shown by intraclass correlation coefficients ranging from 0.95 to 0.99. The baseline data were presented in mean ± SD. SNA, SNB, PAS, MPH and PNS-P in males were 84.3 ± 4.0, 81.5 ± 4.1, 14.2 ± 3.4, 16.1 ± 5.3, and 34.8 ± 6.1, respectively. SNA, SNB, PAS, MPH and PNS-P in females were 84.4 ± 3.1, 80.7 ± 3.2, 11.1 ± 3.3, 10.8 ± 4.9, and 32.3 ± 3.1, respectively. The parameters that were different between both genders included N-ANS, GN-GO, H-PP, MPH, PAS, and TL. ($p < 0.05$)

Conclusion: To date, this study has possibly represented the largest local database of lateral cephalometric measurements focusing on Thai people without clinical features of OSAS. It may be another useful reference for future research and clinical practice.

Keywords: Lateral cephalometry, snoring, obstructive sleep apnea, Thai

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Obstructive sleep apnea syndrome (OSAS) is a disorder characterized by repetitive events of upper airway narrowing that causes fragmented sleep with or without significant oxygen desaturation. Common symptoms of OSAS include habitual snoring, choking, witnessed apnea, restless sleep, and excessive daytime sleepiness (EDS). If left untreated, it may increase the risks of motor vehicle accidents, hypertension, cardiovascular consequences, and etc.[1,2]

Over the years, lateral cephalometry has become one of the standard diagnostic tools in patients with OSAS, particularly with regard to the assessment of craniofacial and upper airway structures. Its advantages over other investigations for OSAS such as magnetic resonance imaging (MRI), computed tomography (CT), and drug-induced sleep endoscopy, are particularly on its low cost and simplicity.[3] One of the dominant indications for performing lateral cephalometry has been treatment with oral appliances especially regarding the assessment of potential predictive parameters for treatment success and dental side effects.[4] It has also been indicated in the preoperative evaluation of the craniofacial skeletal anatomy before maxillomandibular advancement surgery.[5] However, its usefulness with regard to the prediction of the success of the upper airway surgery such as uvulopalatopharyngoplasty (UPPP) still has no convincing evidence to date.[6,7]

Although, there have been several reports regarding the relationship of OSAS and some anatomical abnormalities on lateral cephalometry, most of them were done in

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the Western countries.[8-10] For those studies done in Thai people with normative data reported, they were mainly focused on dentofacial structures or occlusion[11,12] which are different aspects from the clinical practice in OSAS particularly on the soft tissue and airway parameters.[13,14] Furthermore, variations of the craniofacial and upper airway structures can be commonly found among different ethnic groups and between both genders.[15,16] Thus, this study aimed to analyze the cephalometric findings of the Thai population to obtain the normative data that may be applied for individuals with and without clinical features of OSAS. This is another large set of data that may be a useful reference for future research and clinical practice in Thailand.

MATERIALS AND METHODS

This study was approved by Siriraj Institutional Review Board (SIRB) with the approval number of 174/2552 (EC3) and conducted at Siriraj Hospital between April 20, 2009 and April 19, 2010. All participants were recruited with consent forms.

Subjects

A total of 105 healthy subjects (80 males and 25 females) from the dental clinic at Siriraj Hospital were recruited. All subjects were screened with a set of self-administered questionnaires and Epworth sleepiness scales (ESS) developed by a sleep specialist.[17] The inclusion criteria were healthy people age ≥ 18 years who had a body mass index (BMI) of < 30 kg/m^2 and normal visual harmony of facial skeletal profile evaluated by an otolaryngologist. All subjects must have no history of snoring, witnessed apnea, insomnia, or complaints of excessive daytime sleepiness confirmed by the ESS scores ≤ 8 and must have a regular sleep pattern with an average total sleep duration of 7-9 hours per night without any history of frequent waking up after sleep onset (≤ 2 times per night). The exclusion criteria were pregnant women, previous orthodontic treatment, corrective jaw or upper airway surgery, neoplasm, and irradiation in their head and neck regions. Any subjects who had serious underlying illnesses such as unstable cardiopulmonary diseases, chronic renal failure, psychosis, malignancy, or who used substances affecting the sleep-wake cycle regularly such as alcohol, hypnotics, or stimulants were also excluded from the study.

Epworth sleepiness scales (ESS)

The ESS is a set of self-administered questionnaires which aims to assess the degree of sleepiness during eight common situations where subjects are asked to rate their chance of dozing in recent times on a scale of 0 to 3 in each situation. The total score can range from 0 to 24 in which a lower score means less sleepiness. It is probably one of the most popular instruments in sleep medicine research due to its property of shortness and simplicity. In this study, we used the validated Thai version of ESS which has been recently published.[17]

Imaging techniques

All lateral cephalometric radiographs in this study were done with a standard imaging technique.[18] During examination, every subject stayed in a standing posture with a natural head position stabilized by bilateral ear rods and sagittal plane parallel to the film. All subjects were asked to keep their teeth and jaws in centric relation, light occlusion, and relaxed lips while radiographs were taken at the end of expiration without swallowing. Only one machine of X-ray (Asahi III Ecm) and one type of film (the Fuji cassette type C 20.125.2 cm) were used. The distance from the anode to mid-sagittal plane of the patient was 150 cms, while the distance from the mid-sagittal plane to the film was 18 cms. All cassettes were processed under standardized conditions. The magnification factors of these radiographs from the X-ray machine were corrected with the formula of M = (X' – X) / X for the film plates. In this formula, X and X' represented the diameter of radio opaque ear rod from the machine and the diameter measured from the magnified ear rod on the radiograph, respectively.

Landmarks and measurement

The reference points and angles used in analysis are shown in Fig 1-3. The description of the nomenclatures used in this study are shown in Table 1.[16,19] All parameters were measured twice by the same investigator at 2 weeks apart.

Statistical analysis

The results of cephalometric analysis were presented in mean ± SD for both male and female subjects. All variables were measured twice were and then compared with each other by intra-class correlation coefficients (ICC) to detect any systematic error in measurements. The calculation program used in this study was the Statistical Package for Social Science (SPSS) version 11.5.

RESULTS

There were 105 subjects (80 males, 25 females) recruited in this study. The demographic data of subjects are shown in Table 2. The reliability of repeated measurements was excellent with ICC ranging from 0.97 to 0.99

Fig 1. Landmarks of lateral cephalometric skeletal angular parameters.
A = Subspinale, **B** = Supramentale, **S** = Sella, **N** = Nasion, **BA** = Basion

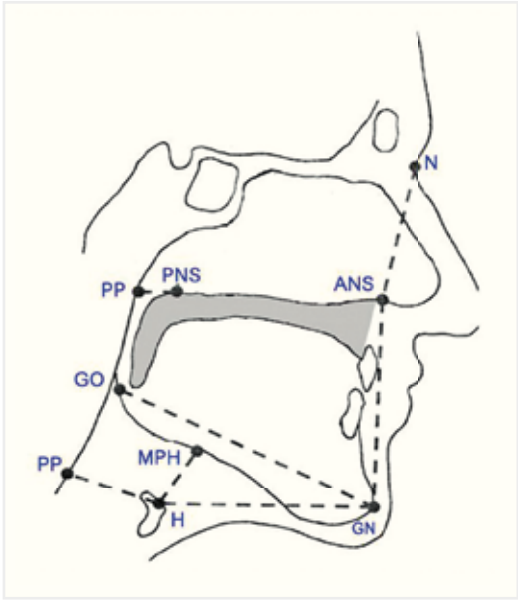

Fig 2. Landmarks of lateral cephalometric skeletal linear parameters.
N = Nasion, **ANS** = Anterior nasal spine, **PNS** = Posterior nasal spine, **H** = the most anterior and superior point of the hyoid bone, **GO** = Gonion, **GN** = Gnathion, **PP** = Posterior pharyngeal wall, **MP** = Mandibular plane

in males and 0.95 to 0.99 in females. The parameters with highest reproducibility were SNA in males and angle HP/SP in females. The parameter with lowest reproducibility was ANB in both genders. The means of all cephalometric parameters of both genders are shown in Table 3. The parameters that were different between male and female subjects included N-ANS, GN-GO (mandibular length), H-PP, MPH, PAS, and TL.

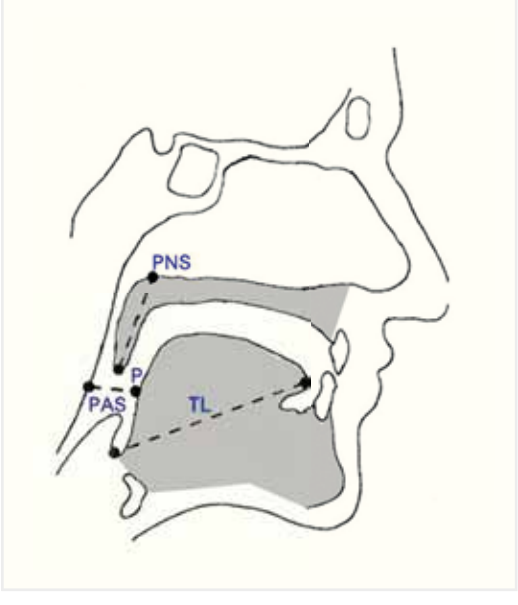

Fig 3. Landmarks of lateral cephalometric soft tissue linear parameters.
PNS = Posterior nasal spine; **P** = Tip of soft palate (maybe uvula), **PAS**; posterior airway space, **TL**; Tongue length

DISCUSSION

This study aimed to analyze the cephalometric parameters in a large group of normal Thai people with a different focus from other studies that were done mainly in patients with OSAS[13,14,20] or who were planned orthodontic treatment. The subjects in this study were healthy people who had no clinical features of OSAS such as loud snoring, choking, restless sleep, observed apnea, and EDS. Although, the gold standard diagnosis of OSAS is based on polysomnography (PSG) and clinical presentation alone may not be sufficient to exclude the possibility of OSAS, the use of PSG was impractical for studying in a large group of patients since it has very high costs, long waiting lists, and intensive labor requirements. Furthermore, many people who have PSG taken may have difficulty sleeping or the first-night effects and the results of investigation may vary from night to night.[21,22] Therefore, this study selected all subjects based on a self-reported sleep questionnaire, ESS, and clinical examination done by an otolaryngologist specialized in sleep medicine to reduce the possibility of having OSAS as much as possible. This means that every subject was screened for risk factors of OSAS such as advanced age, obesity, obvious craniofacial disorders, nasal obstruction, upper airway neoplasm, and neuromuscular disorders. In addition, they were also screened for co-morbid sleep disorders presenting with EDS such as insomnia, chronic sleep deprivation, circadian rhythm disorders, or medication and substance side effects by a set of sleep questionnaires to prevent confounding factors in this study. These selection criteria were more rigid than those of the control groups in several studies in the literature.[9,13,15,16,23-25]

The majority of subjects in this study were males which is relevant to the prevalence of OSAS in general populations.[26,27] Although, the mean ages of subjects in both genders were different from each other and both were younger than the common age groups of patients with OSAS, the cephalometric variables particularly on skeletal parameters are still reliable and applicable since the size and shape of skulls are stable with very few changes after 18 years old if there are no interfering factors mentioned in the exclusion criteria of our study. Nevertheless, the soft tissue parameters may be less reliable since they can be changed by factors such as a significant increase or decrease in bodyweight.[15,28]

Our study showed that there were statistical differences between males and females in the means of important cephalometric parameters including the N-ANS, GN-GO, H-PP, PAS, MPH, and TL. The differences of these findings particularly on PAS and MPH were comparable to several studies in the literature.[14-16] When compared with control subjects of studies among different races, we found that there were remarkable differences in cephalometric analysis of our subjects and other ethnicities. (Table 4) The normal people of this study in both sexes have greater SNA and SNB than Caucasians and Hispanics, but less than those of Africans.[15] These findings were similar to other reports that East Asians are more prominent in both upper and lower jaws than people from Western countries,[29,30] but less prominent than Africans.[11] However, Thai people especially males in this study have SNA close to Japanese, but less than Singaporeans who are in the same geographic region, but the majority are Southern Chinese.[16,23] When we compared soft tissue parameters with other ethnic groups, we found that Thai

TABLE 1. Definition of cephalometric parameters in this study.

Abbreviations	Definitions
SNA	Angle formed by sella-nasion-subspinale
SNB	Angle formed by sella-nasion-supramentale
ANB	Angle formed by subspinale -nasion-supramentale
N-S-BA	Angle formed by nasion-sella-basion
HP/SP	Angle between hard palate and soft palate
N-ANS	Distance between nasion and anterior nasal spine
ANS-GN	Distance between anterior nasal spine and gnathion
GN-GO	Distance between gnathion and gonion
PNS-PP	The shortest distance between posterior nasal spine and posterior pharyngeal wall
H-PP	The shortest distance from hyoid bone to posterior pharyngeal wall
H-GN	Distance from hyoid bone to gnathion
MPH	Distance from the mandibular plane to the hyoid bone
PAS	The shortest distance between the base of the tongue and the posterior pharyngeal wall, the narrowest sagittal airway space
PNS-P	Length of soft palate, the distance between posterior nasal spine and tip of uvula
TL	Distance between tip of tongue and valleculae, the intersection of epiglottis and base of tongue

people particularly males in this study have a soft palate length (PNS-P) and PAS comparable to Caucasians and Hispanics, but greater than Singaporeans.[16] However, the mean of MPH of both genders in this study was lower than most of other ethnicities except for Japanese males.[15,16,23] This may imply that Thai people have a relatively higher tongue base position than most other races.

When compared with cephalometric data currently available in Thailand (Table 5), the means of SNA and SNB in our subjects were very close to the normative data in the study of Suchato et al.[11] However, the subjects in this study were less prominent in both upper and lower jaws than the control subjects in the study of Junpen et al and the primary snorers in the study of Jamsirirojrat et al. In regard to the soft tissue parameters, the mean of soft palate length (PNS-P) of our subjects was shorter and the mean of MPH was greater than the studies of Junpen et al[13] and Jamsirirojrat et al.[13] However, the mean of PAS in males and females of this study were close to the control subjects of Junpen et al[13] and the primary snorers of Jamsirirojrat et al[14], respectively. Although, there have been variations in cephalometric parameters even among studies in Thai people, this study has possibly included the largest group of population who had no clinical features of OSAS in Thailand reported up to date. Furthermore, our results particularly on skeletal parameters including SNA and SNB were quite similar to those of normative data in a hundred people who had ideal occlusion and harmonious dentofacial profiles reported by Suchato et al, a group of orthodontists.[11] All of these findings would suggest that there are varieties of cephalometric values among different groups of population and that physicians managing patients with OSAS should have a set of normative values which can be properly applied to their local population. Adopting referent data from other studies especially those accomplished in white people may not yield accurate and sufficient useful information.

The limitations of this study are that some of the subjects may still have some degree of OSA, despite having no symptoms and very low risks, since we did not perform any sleep tests to confirm the diagnosis. There were a smaller number of female subjects, compared with male subjects. However, we believe that the majority of our participants should represent general Thai people who have never sought medical treatment for problems with OSAS. In addition, the screening methods for control groups in most studies in the literature were also based on clinical features, since it was more practical. Therefore, we believe that the results from this study may be at least acceptable to be another useful reference for future research and practice in several Thai patients who have problems with OSAS. Nonetheless, whenever possible, we would suggest those who are interested in lateral cephalometry and sleep disorders to do a larger research on subjects who are better

TABLE 2. Demographic data of each group.

	Male	Female	*p*-value
Age (yr)	27.6 ± 13.0	22.8 ± 4.5	< 0.01
Weight (Kg)	65.5 ± 8.8	51.2 ± 8.5	< 0.01
Height (cm)	171.0 ± 6.1	158.4 ± 5.4	< 0.01
BMI (kg/m^2)	22.4 ± 2.7	20.4 ± 3.3	< 0.01
ESS	6.0 ± 8.8	5.9 ± 2.0	0.76

Values are presented in mean ± S.D.

BMI= Body mass index, AHI = apnea-hypopnea index, ESS= Epworth Sleepiness Scale

TABLE 3. Cephalometric data on healthy male and female subjects.

Parameter	Males	Females	*p*-value
SNA (degree)	84.3 ± 4.0	84.4 ± 3.1	0.92
SNB (degree)	81.5 ± 4.1	80.7 ± 3.2	0.41
NSBA (degree)	130.8 ± 5.3	132.2 ± 6.0	0.26
ANB (degree)	3.2 ± 1.8	3.9 ± 2.0	0.07
HP/SP (degree)	124.8 ± 7.0	126.1 ± 7.6	0.42
N-ANS (mm)	58.6 ± 3.8	55.7 ± 3.6	0.02*
ANS-GN (mm)	73.5 ± 4.6	71.3 ± 6.0	0.60
GN-GO (mm)	84.8 ± 4.7	80.4 ± 4.3	< 0.01*
PNS-PP (mm)	26.6 ± 3.5	26.9 ± 3.2	0.68
H-PP (mm)	35.6 ± 4.4	29.0 ± 2.9	< 0.01*
H-GN (mm)	50.9 ± 6.5	50.0 ± 7.2	0.59
MPH (mm)	16.1 ± 5.3	10.8 ± 4.9	< 0.01*
PAS (mm)	14.2 ± 3.4	11.1 ± 3.3	< 0.01*
PNS-P (mm)	34.8 ± 6.1	32.3 ± 3.1	0.05
TL (mm)	81.0 ± 5.4	76.7 ± 4.7	< 0.01*

Values are presented in mean ± S.D.

** The mean difference is significant at the level of < 0.05. (2-tailed)*

TABLE 4. Cephalometric data on normal population among different ethnic groups.

Measurement	Caucasians N = 15	Hispanics N = 9	African American N = 18	Singaporean N = 41	Japanese N = 30	Thai people (This study) N = 105
Male						
SNA (degree)	81.8 ± 3.5	81.5 ± 4.7	87.6 ± 7.2	87.0 ± 5.2	84.6 ± 5.5	84.3 ± 4.0
SNB (degree)	78.1 ± 4.9	80.6 ± 8.0	84.4 ± 7.1	82.3 ± 6.4	82.7 ± 5.0	81.5 ± 4.1
PAS (mm)	13.9 ± 4.1	14.6 ± 4.2	16.3 ± 6.5	12.2 ± 3.6	10.6 ± 3.0	14.2 ± 3.4
MPH (mm)	25.5 ± 6.6	20.1 ± 7.5	23.8 ± 6.9	15.8 ± 5.9	9.2 ± 5.9	16.1 ± 5.3
PNS-P (mm)	34.6 ± 3.7	34.9 ± 3.3	30.1 ± 6.5	31.2 ± 5.8	37.2 ± 4.7	34.8 ± 6.1
Female						
SNA (degree)	82.7 ± 3.9	83.2 ± 2.3	85.6 ± 5.0	88.5 ± 3.4	-	84.4 ± 3.1
SNB (degree)	77.8 ± 5.3	80.7 ± 3.2	81.2 ± 5.0	82.5 ± 2.9	-	80.7 ± 3.2
PAS (mm)	10.5 ± 3.2	13.7 ± 4.6	14.0 ± 4.6	9.7 ± 2.9	-	11.1 ± 3.3
MPH (mm)	19.2 ± 5.4	17.0 ± 7.4	19.2 ± 7.1	12.4 ± 3.0	-	10.8 ± 4.9
PNS-P (mm)	31.9 ± 4.1	32.4 ± 8.0	32.9 ± 6.6	28.6 ± 3.5	-	32.3 ± 3.1

TABLE 5. Cephalometric data among different studies in Thai people.

Measurement	Jamsirirojrat C. (Primary snorers) N = 33	Junpen V. (non-snorers) N = 28	Suchato W (Normal) N = 100	This study (Non- OSAS) N = 105
Male				
SNA (degree)	87.7 ± 2.9	87.4 ± 3.8	84.5 ± 3.7	84.3 ± 4.0
SNB (degree)	83.4 ± 3.6	87.4 ± 3.7	81.9 ± 3.8	81.5 ± 4.1
ANB (degree)	-	-	2.7 ± 1.9	3.2 ± 1.8
NSBA (degree)	-	119.6 ± 5.5	-	130.8 ± 5.3
PAS (mm)	11.6 ± 3.1	14.6 ± 3.5	-	14.2 ± 3.4
MPH (mm)	14.4 ± 6.1	11.8 ± 2.9	-	16.1 ± 5.3
PNS-P (mm)	41.9 ± 4.1	39.3 ± 4.6	-	34.8 ± 6.1
GN-GO (mm)	-	82.7 ± 4.5	-	84.8 ± 4.7
Female				
SNA (degree)	86.4 ± 4.1	-	83.9 ± 3.4	84.4 ± 3.1
SNB (degree)	81.6 ± 4.1	-	80.8 ± 3.3	80.7 ± 3.2
ANB (degree)	-	-	3.1 ± 1.7	3.9 ± 2.0
PAS (mm)	10.9 ± 2.6	-	-	11.1 ± 3.3
MPH (mm)	7.2 ± 4.3	-	-	10.8 ± 4.9
PNS-P (mm)	38.2 ± 3.0	-	-	32.3 ± 3.1

matched with OSAS patients particularly on age group, sex, and BMI. Furthermore, it is preferable to have sleep tests included in the methodology, so that the results of the studies will be the most reliable information.

CONCLUSION

To date, this study possibly represents the largest local database of lateral cephalometric measurements of the upper airway focusing on Thai people without clinical features of OSAS. It may be another useful reference for clinical practice and future research.

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