

The Appropriate Anteroposterior Position of Maxillary Incisor in Thai Adults

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Abstract

The aim of this study was to determine the appropriate sagittal maxillary position in Thai adults for orthognathic surgery. The study included males and females with completed orthodontic treatment, normal profile, dental and skeletal Class I. Two linear and four angular parameters of lateral cephalometry were measured to obtain maxillary position and upper incisor to Nasion perpendicular (UI-Nperp) distance. The digital cephalometric analyses were performed using Dolphin Imaging Software. Seventy-five patients met the inclusion criteria with a mean age of 23.79 ± 4.74 years. The means of UI-Nperp were 7.3 ± 4.6 mm for males and 8.4 ± 3.6 mm for females. No significant difference was observed in the UI-Nperp distance between the extraction and non-extraction groups. In conclusion, the UI-Nperp distance could be a useful tool for determining proper sagittal maxillary position when performing Le Fort I osteotomy in orthognathic surgery.

Keyword: Orthognathic surgery, Sagittal maxillary position, Upper incisor

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Introduction

In general, orthognathic surgeons and orthodontists collect data from history taking, clinical examinations, radiographic images, and model analyses for orthognathic surgical planning.¹ The proper maxillary position in sagittal, vertical, and transverse dimensions is essential for facial profile esthetics in double jaw surgery.² Goals for vertical and transverse maxillary position depend on facial evaluations and the surgeon experiences, but the proper anteroposterior maxillary position can be determined from cephalometric analysis and a clinical examination.

There were several cephalometric analyses for determining the appropriate sagittal position of the maxilla. Steiner³ described the use of the angle derived from connecting the cephalometric landmarks of SNA to determine the sagittal position of the maxilla compared with population norms. Ricketts⁴ studied measurement of Maxillary depth which does not change with age. McNamara⁵ proposed the use of the natural head position and an external reference line (nasion-perpendicular) to measure the sagittal maxillary position. Wolford² recommended the use of a desired

anteroposterior position of the upper incisor as a guide for the proper maxillary position. However, there were some limitations for norms of one ethnic group that cannot be applied to others.⁶⁻¹²

Many cephalometric Thai norms were reported. Suchato and Chaiwat¹³ studied 100 untreated orthodontic Thai patients with Class I molar relationships in Bangkok. This study showed the mean value of SNA and UI-NA. Sorathes¹⁴ studied the craniofacial norms for Thais from 100 untreated orthodontic Thai patients with good occlusion. This article showed that the means of male and female SNA were different from Caucasians. Ruksujarit *et al*¹⁵ conducted a study in 173 Thai children with an esthetically acceptable facial profile in Khon Kaen province. This study showed the means of SNA, Maxillary depth, McNamara's nasion perpendicular, and UI-NA that represented the sagittal position of the maxilla. Chaiworawitkul¹⁶ studied 70 Thai Northern adults with a natural optimal occlusion, a normal facial profile and normal soft tissue function in 2008. They reported the means of SNA and UI-NA which were significantly different from the British.

From previous studies,¹³⁻¹⁶ the use of landmarks in maxilla related to the cranial base or the Frankfort horizontal plane have been published in many articles but the use of the upper incisor position as the landmark for determining the proper maxillary position has not been previously reported in Thailand. The purpose of this study was to determine the appropriate sagittal position of maxilla in Thai adults for orthognathic surgery.

Materials and Methods

This retrospective analytical study recruited patients who underwent orthodontic treatment at the Department of Orthodontics, Faculty of Dentistry, Chulalongkorn University, Thailand from January 2010 to January 2020. Participants included Thai adults above 18 years old, skeletal Class I, skeletal normal bite, Class I canine relationship with 2-4 mm overjet and overbite, less than 2 mm of crowding,

competent lips, normal function of lips and tongue, and good quality of lateral cephalometric radiograph after completing orthodontic treatment. The patients who had a history of facial trauma, a history of craniofacial deformity or systemic disease that affected growth and development and a previous history of cosmetic surgery of the face were excluded.

The selected post-treatment (after debonding) lateral cephalometric radiographs were reoriented in the natural head position (The eye was pointed directly forward focusing on a point on the wall at eye level) and traced with Dolphin Imaging Software version 11.95 (Dolphin Imaging and Management Solutions, Chatsworth, CA). All measurements were made by one investigator. The internal reliability of the method was analysed using the intraclass correlation coefficient (ICC) by comparing cephalometric measurements taken at least two weeks apart.

Six cephalometric measurements chosen to represent the maxillary position are described below: (Fig. 1).

1. SNA: the angle formed by the sella-nasion (SN) line and a line from the nasion to point A (NA line).
2. Maxillary depth: the angle formed by the Frankfort horizontal plane and the NA line.
3. McNamara's nasion perpendicular (A-Nperp): The nasion perpendicular was a vertical line drawn inferiorly from the nasion perpendicular to the Frankfort horizontal plane. The measurement taken was the linear distance from point A to the nasion perpendicular.
4. Upper central incisor position to the nasion perpendicular (UI-Nperp): The measurement taken was the linear distance from the tip of the upper incisor to the nasion perpendicular.
5. Upper incisor to N-A line (UI-NA): the angle formed between the long axis of the maxillary incisor and the N-A line.
6. Upper incisor angulation to the palatal plane (UI-PP): the angle formed between the palatal plane and the long axis of the maxillary incisor.

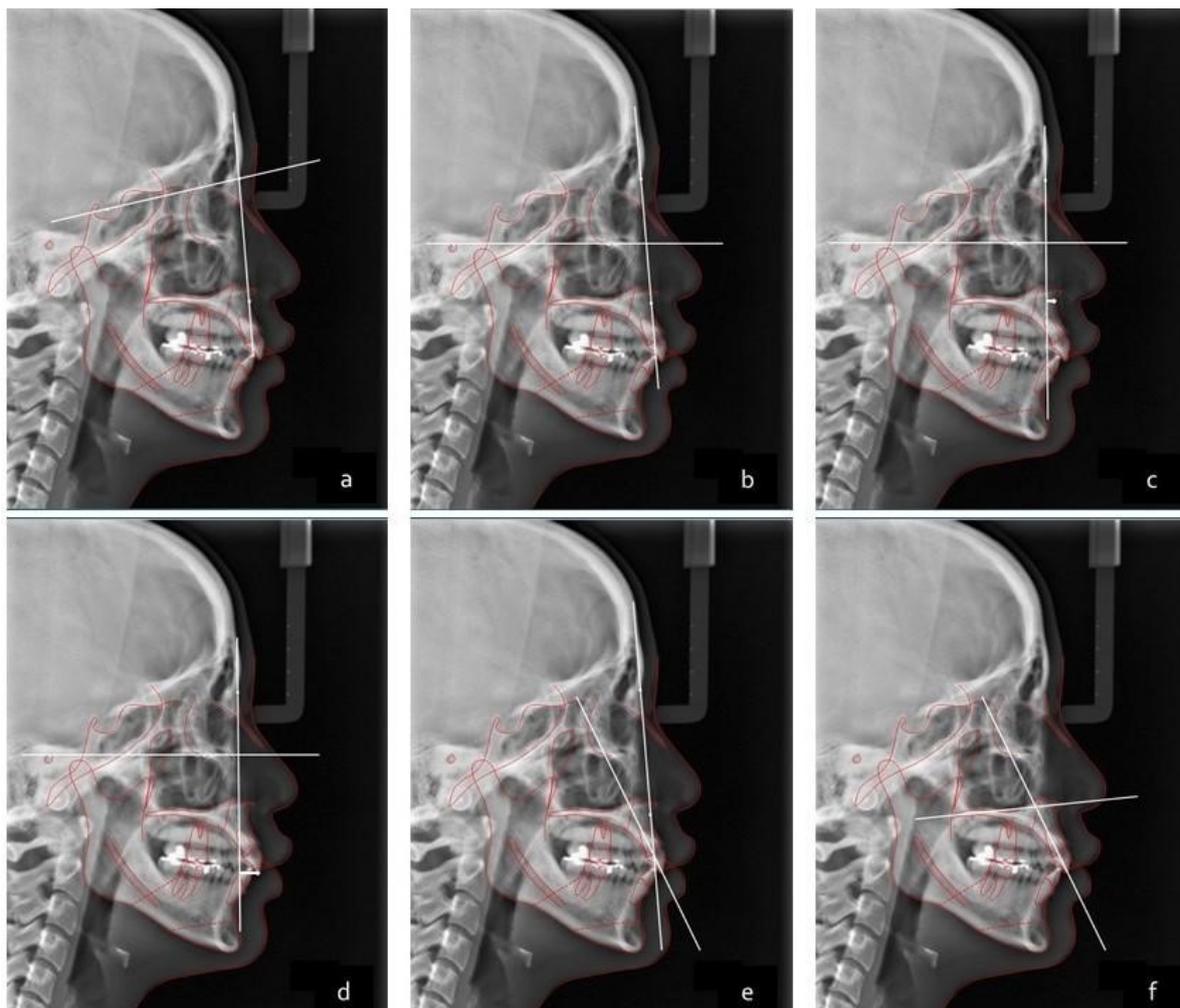


Figure 1 Six cephalometric measurements: (a) SNA, (b) Maxillary depth, (c) McNamara's nasion perpendicular (A-Nperp), (d) Upper central incisor position to nasion perpendicular (UI-Nperp), (e) Upper incisor to N-A line (UI-NA), (f) Upper incisor angulation to palatal plane (UI-PP)

The demographic data and data from the measurements were collected and recorded in digital format. For continuous variables, means and standard deviations were presented. The statistical analyses were performed using SPSS version 22.0 (SPSS, Inc., Chicago IL). A normal distribution was tested by the Shapiro-Wilk test.

Results

Seventy-five patients were recruited from the Department of Orthodontics, Faculty of Dentistry, Chulalongkorn University. Demographic data of the participants are described in Table 1.

The independent *t*-tests were used to compare the data between Thai male and female groups and between extraction and non-extraction groups.

The study was approved by the Human Research Ethics Committee of the Faculty of Dentistry, Chulalongkorn University (HREC-DCU 2019-077).

Linear and angular measurements were reported in millimeters (mm) and degrees ($^{\circ}$), respectively. Results of all parameters were presented in Tables 2, 3, and 4.

Table 1 Demographic data

Age (y)	Average	23.79 ± 4.74
	Minimum	18.15
	Maximum	44.97
Sex	Male	27 (36 %)
	Female	48 (64 %)
Extraction or Non-extraction group	Extraction	42 (56 %)
	Non-extraction	33 (44%)

Table 2 Cephalometric parameters values in Thai

Parameter	Overall	
	Mean	SD
SNA (°)	84.4	2.4
Maxillary depth (°)	93.3	2.6
A-Nperp (mm)	3.2	2.6
UI-Nperp (mm)	8.2	4.0
UI-NA (°)	23.6	7.5
UI-PP (°)	114.9	7.4

Table 3 Cephalometric parameters values in Thai males and females

Parameter	Male	Female	P-value
SNA (°)	84.7 ± 2.5	84.3 ± 2.4	0.53
Maxillary depth (°)	92.7 ± 3.0	93.5 ± 2.3	0.20
A-Nperp (mm)	2.6 ± 3.0	3.3 ± 2.3	0.25
UI-Nperp (mm)	7.3 ± 4.6	8.4 ± 3.6	0.29
UI-NA (°)	25.1 ± 8.6	22.5 ± 6.6	0.15
UI-PP (°)	116.4 ± 8.2	113.7 ± 6.8	0.13

Table 4 UI-Nperp distance in extraction and non-extraction groups

UI-Nperp	Extraction	Non-extraction	P-value
Overall	8.1 ± 4.1	7.9 ± 4.0	0.89
Male	7.4 ± 4.6	7.2 ± 4.7	0.89
Female	8.4 ± 3.7	8.3 ± 3.7	0.90

Discussion

Evaluation of the sagittal maxillary position has evolved over time. One of the earliest techniques was developed by Steiner,³ who described the use of the angle

derived from connecting the cephalometric landmarks of SNA to determine the sagittal position of the maxilla compared with population norms. The SNA is subject to

variation in the length and position of the skull base, which is commonly abnormal in patients with dentofacial deformities.¹⁷ This limitation led to the development of analyses using linear rather than angular measurements. Ricketts⁴ studied the cephalometric analysis to determine the facial profile particularly Maxillary depth. This value shows the anteroposterior position of the maxilla at point A related to the cranium that does not change with age. McNamara⁵ suggested using the natural head position and an external reference line (nasion-perpendicular, Nperp) to measure the sagittal maxillary position (Nperp to point A). These cephalometric analysis, however, were also unreliable in patients with dentofacial deformities and did not correlate well with facial esthetics.

Several authors have previously suggested the incisor position in relation to the facial profile as a driver for facial harmony. Schlosser *et al*¹⁸ demonstrated a direct relationship between the maxillary incisor and the upper lip positions and facial esthetics in a survey study using digitally altered photographs. Adams *et al*¹⁹ found that the maxillary incisors were positioned between the ‘‘forehead facial axis’’ (defined similarly to the FA point of the analysis described by Andrews), and the glabella in 91 % of the adult white males sampled. Webb *et al*²⁰ also reported that a maxillary incisor position between the forehead midpoint and the glabella was associated

with an esthetically pleasing profile. McNamara analysis⁵ determined the anteroposterior position of the upper incisor relative to point A. This measurement should be 4 to 6 mm. Wolford² proposed that a short vertical line drawn 4 mm anterior to the nasion perpendicular was used as the desired antero-posterior position of the maxillary incisor. These studies were mainly based on a Caucasian population. However, the cephalometric standards used for one ethnic group might not be applicable for other ethnic groups.

Cephalometric Thai norms were reported in many articles but the use of UI-Nperp have not been previously reported in Thailand. The results of this study showed that the UI-Nperp were 7.3 ± 4.6 mm for males and 8.4 ± 3.6 mm for females. According to Chaiworawitkul *et al*,¹⁶ the nasion in a Thai male was located more anterior than in a female. Therefore, the more forward position of the nasion could influence the UI-Nperp distance to be lower in males.

Factors related to the UI-Nperp distance were the sagittal maxillary position, the upper incisor axis and the extraction plan of orthodontic treatment. The sagittal maxillary position in the study was represented by the values of SNA, Maxillary depth and A-Nperp. The parameters of the present study were consistent with previous Thai research.¹³⁻¹⁶ (Table 5)

Table 5 Comparison of the lateral cephalometric values for Thai

Parameter		SNA (mm)	Maxillary Depth (°)	A-Nperp (mm)
The present study	Male	84.7 ± 2.5	92.7 ± 3.0	2.6 ± 3.0
	Female	84.3 ± 2.4	93.5 ± 2.3	3.3 ± 2.3
Suchato <i>et al</i> ¹³	Male	84.5 ± 3.7		
	Female	83.9 ± 3.4		
Sorathesn ¹⁴	Male	83.0 ± 11.2		
	Female	85.0 ± 3.7		
Ruksujarit <i>et al</i> ¹⁵	Male	82.4 ± 3.0	90.1 ± 2.7	0.1 ± 2.9
	Female	84.9 ± 3.0	91.8 ± 2.8	1.9 ± 2.9
Chaiworawitkul <i>et al</i> ¹⁶	Male	83.8 ± 3.3		
	Female	83.5 ± 3.5		

A change in the upper incisor inclination may also affect the distance from the tip of the incisor to the nasion perpendicular. The results of the UI-NA and UI-PP in our study were also consistent with those in previous Thai cephalometric values.^{13,15,16} These findings supported the reliability of using the UI-Nperp to represent the appropriate sagittal maxillary position in the Thai population.

According to the extraction guideline of Proffit *et al*,²¹ the upper incisors may move approximately 3 mm backwards when orthodontic treatment with extraction is planned. Therefore, it can be hypothesized that the extraction treatment plan may affect the distance from the upper incisor to the nasion perpendicular. However, the present study revealed that the difference between the

extraction and the non-extraction groups was not significant. The reason for this insignificant difference might be that the extraction group had more protruded upper incisors initially and they were moved back during retraction or had severe arch-length discrepancy before treatment. Moreover, there were also many factors affecting the orthodontic tooth movement during the orthodontic phase.

Interestingly, the results of our study were similar to Sutthiprapaporn *et al*²² (Table 6) that reported the esthetic lateral cephalometric values of Thai adults after orthodontic treatment. Therefore, it may be implied that the participants in the present study had acceptable skeletal cephalometric values that could lead to an esthetic facial profile.

Table 6 Comparison of the lateral cephalometric values between the study and Sutthiprapaporn *et al*²²

Parameter	The present study		Sutthiprapaporn <i>et al</i> ²²	
	Male	Female	Male	Female
SNA (°)	84.7 ± 2.5	84.3 ± 2.4	84.6 ± 3.8	84.6 ± 3.3
Maxillary Depth (°)	92.7 ± 3.0	93.5 ± 2.3	91.9 ± 3.1	91.3 ± 3.1
A-Nperp (mm)	2.6 ± 3.0	3.3 ± 2.3	2.1 ± 3.4	1.2 ± 3.0
UI-NA (°)	25.1 ± 8.6	22.5 ± 6.6	21.6 ± 6.8	21.3 ± 7.7
UI-PP (°)	116.4 ± 8.2	113.7 ± 6.8	114.2 ± 7.1	113.6 ± 7.6

There were some limitations of the present study. Firstly, our study established the cephalometric values from skeletal Class I patients which might not be appropriate to use as a guideline for orthognathic surgical planning in patients with large dentofacial deformities such as clefts. Secondly, cephalometric parameters from our study were analysed from participants with normal occlusion and normal skeletons that did not indicate a pleasing or attractive profile. Thirdly, the variability of the A-Nperp and UI-Nperp values were dependent on the Frankfort horizontal plane angulation. However, the Frankfort horizontal plane required the localization of the anatomic porion and orbitale in which it was sometimes difficult to find the precise location. Therefore, precise landmark identification needs proper training and practice. Another limitation was that the nasion perpendicular is usually, but not always, a reliable

line for the orientation of the maxillary position. One exception is the Class III malocclusion in which a short anterior cranial base exists.^{23,24} Therefore, construction of an erroneous nasion perpendicular causes an appearance in that the maxilla is excessively anteriorly positioned.

Conclusion

The UI-Nperp could be a useful goal for determining the sagittal maxillary position when performing Le Fort I osteotomies. However, it must be considered together with clinical examinations to achieve an ideal outcome. Future studies should compare the analysis of skeletal Class II and Class III malocclusions in Thai adults.

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References

1. Fonseca RJ. Oral and maxillofacial surgery: 3-Volume Set. Elsevier Health Sciences; 2017.
2. Wolford LM, Dugan DJ, Hilliard FW. Surgical treatment objective. A systematic approach to the prediction tracing: CV Mosby; 1985.
3. Steiner CC. The use of cephalometrics as an aid to planning and assessing orthodontic treatment: Report of a case. *Am J Orthod* 1960;46(10): 721-35.
4. Ricketts RM. Cephalometric analysis and synthesis. *Angle Orthod* 1961;31(3):141-56.
5. McNamara JA Jr. A method of cephalometric evaluation. *Am J Orthod* 1984;86(6):449-469.
6. Kowalski CJ, Nasjleti CE, Walker GF. Differential diagnosis of adult male black and white populations. *Angle Orthod* 1974;44(4):346-350.
7. Richardson ER. Racial differences in dimensional traits of the human face. *Angle Orthod* 1980;50(4):301-311.
8. Gonzalez MB, Caruso JM, Sugiyama RM, Schlenker WL. Establishing cephalometric norms for a Mexican population using Ricketts, Steiner, Tweed and Arnett analyses. *APOS-Trends Orthod* 2013;3(6):171-177
9. Miura F, Inoue N, Suzuki K. Cephalometric standards for Japanese according to the Steiner analysis. *Am J Orthod* 1965;51:288-295.
10. Wu J, Hägg U, Rabie AB. Chinese norms of McNamara's cephalometric analysis. *Angle Orthod* 2007;77(1):12-20.
11. Gu Y, McNamara JA Jr, Sigler LM, Baccetti T. Comparison of craniofacial characteristics of typical Chinese and Caucasian young adults. *Eur J Orthod* 2011;33(2):205-11.
12. Atit MB, Deshmukh SV, Rahalkar J, Subramanian V, Naik C, Darda M. Mean values of Steiner, Tweed, Ricketts and McNamara analysis in Maratha ethnic population: A cephalometric study. *APOS-Trends Orthod* 2013;3(5):137-151
13. Suchato W, Chaiwat J. Cephalometric evaluation of the dentofacial complex of Thai adults. *J Dent Assoc Thai* 1984;34(5):233-243.
14. Sorathesn K. Craniofacial norm for Thai in combined orthodontic surgical procedure. *J Dent Assoc Thai* 1988;38(5):190-201.
15. Ruksujarit T, Ratanayatikul C, Godfrey K, Deesamur S. Lateral cephalometric norms for 12-14-year Thai girls and boys in Khon Kaen who have acceptable facial profiles. *KKU Research Journal* 2004;4:44-55.
16. Chaiworawitkul M. Cephalometric norms of Northern Thais. *J Thai Assoc Orthod* 2008;7:1-7.
17. Patel F. Book review: Handbook of orthognathic treatment: a team approach. *Br Dent J* 2014;216(12):661-.
18. Schlosser JB, Preston CB, Lampasso J. The effects of computer-aided anteroposterior maxillary incisor movement on ratings of facial attractiveness. *Am J Orthod Dentofacial Orthop* 2005;127(1):17-24.
19. Adams M, Andrews W, Tremont T, Martin C, Razmus T, Gunel E, et al. Anteroposterior relationship of the maxillary central incisors to the forehead in adult white males. *Orthodontics (Chic)* 2013;14(1): e2-9.
20. Webb MA, Cordray FE, Rossouw PE. Upper-Incisor Position as a Determinant of the Ideal Soft-Tissue Profile. *J Clin Orthod* 2016; 50(11):651-62.
21. Proffit WR, White RP, Sarver DM. Contemporary treatment of dentofacial deformity: Mosby St. Louis; 2003.
22. Sutthiprapaporn P, Manosudprasit A, Pisek A, Manosudprasit M, Pisek P, Phaoseree N, et al. Establishing esthetic lateral cephalometric values for Thai adults after orthodontic treatment. *Khon Kaen Univ Dent J* 2020;23(2):31-40.
23. Chang HP, Chou TM, Hsieh SH, Tseng YC. Cranial-Base Morphology in Children with Class III Malocclusion. *Kaohsiung J Med Sci* 2005; 21(4):159-65.
24. Proff P, Will F, Bokan I, Fanghänel J, Gedrange T. Cranial base features in skeletal Class III patients. *Angle Orthod* 2008; 78(3):433-9.