

CHAPTER III

MATERIALS AND METHODS

MATERIALS

Before conducting this study, a pilot study was conducted in 10 samples of each group: a control or normal occlusion group and the class III malocclusion group, to obtain a reasonable estimated sample size (Zar, 1996). TRUE EPISTAT program (Epistat Services, Texas, USA, 1991) was used to calculate the findings. The 95% confidence interval and 80% power of the test were used for significant results. Then, a minimal required number of class III malocclusion sample were compared to 70 cases of normal occlusion sample should be 69 samples. The sample size for this study was 70 cases for each group.

The study was performed on the pretreatment orthodontic data from the clinical records, study models and lateral cephalograms of all subjects.

The criteria for sample inclusion were as follows,

- 1) All permanent dentition, regardless of the third molars
- 2) No supernumerary tooth or missing teeth
- 3) No proximal caries
- 4) No previous orthodontic treatment
- 5) No congenital deformity or trauma found in the craniofacial structures
- 6) Thais, at least 16 and 15 years of age for males and females respectively.

In this study, the sample comprised of the study models and the centric occluded lateral cephalograms of 140 Thai adults: 67 males and 73 females (Table 3.1).

The subjects were equally divided into two groups according to their occlusions: a control or normal occlusion group and the class III malocclusion group. The average ages for the male and female subjects in both groups in this study were presented in Table 3.2.

Table 3.1 The distribution of subjects by type of occlusion and gender

Type of occlusion	Gender		Total
	Male	Female	
Normal occlusion	35	35	70
Class III malocclusion	32	38	70
Total	67	73	140

The normal occlusion group was the study models and the lateral cephalograms of 70 (35 males and 35 females) Northern Thai adults ranging in age from 16.3 to 25.7 years in male sample and from 15.8 to 28.8 years in female sample from the collection of the Orthodontic Department of the Faculty of Dentistry, Chiang Mai University. Each subject should have a good or an excellent occlusion, normal overjet and overbite and good or pleasing soft tissue profile (Chatkupt *et al.*, 1987).

The class III malocclusion group consisted of pretreatment study models and lateral cephalograms of 70 (32 males and 38 females) Thai adults ranging in age from 16.0 to 27.3 years in male sample and from 15.0 to 28.0 years in female sample obtained from the Orthodontic Department of the Faculty of Dentistry, Chiang Mai University and several private orthodontic clinics in Chiang Mai Province.

The selection of the class III malocclusion sample was based on the following criteria:

1. *Dental relationship*: Class III incisor and molar relationships, at the time of initial presentation, that are evaluated from study models and lateral cephalograms.
2. *Skeletal relationship*: Skeletal class III pattern (ANB angle is less than 0 degree), at the time of initial presentation, that is evaluated from lateral cephalograms.

Since the class III malocclusion group comprised several vertical skeletal patterns, therefore the SN-GoGn angle was employed to classify the class III malocclusion group into class III Normal Overbite, class III Openbite and class III Deepbite subgroups. The mean and standard deviation of the SN-GoGn angle for the

normal occlusion of Northern Thai adults were determined 29.2 ± 4.4 degrees. Thus skeletal normal overbite would have the range of the SN-GoGn angle between minus and plus one standard deviation from mean of normal occlusion: 24.8 – 33.6 degrees. Skeletal openbite would have the SN-GoGn value over 33.6 degrees and SN-GoGn value for skeletal deepbite was less than 24.8 degrees. These criteria were provided for combined genders because of small sample size in each subgroup.

Table 3.2 Age distribution of the normal occlusion and class III malocclusion groups

Group	Number of subjects	Age (years)		Mean age (years)	SD
		Min	Max		
Normal occlusion					
Male	35	16.30	25.70	20.97	1.83
Female	35	15.80	28.80	19.17	2.48
Class III malocclusion					
Male	32	16.00	27.30	19.22	2.49
Female	38	15.00	28.00	19.03	2.92

METHODS

The investigation methods of this study were consisted of 2 parts as the following

Part 1: Model Analysis

Part 2: Cephalometric Analysis

Part 1: Model Analysis

Electronic digital caliper (KEIBA) with fine tips measuring within 0.01 mm. was used for digital measuring the linear measurements of dental arch form: intercanine width, interpremolar width and intermolar width of both class III malocclusion and normal occlusion groups. Then, a transparent ruled grid was used to place over the maxillary and mandibular study models and using the electronic digital caliper (KEIBA) to

measure canine depth and molar depth. The following 10 linear measurements and 4 proportional measurements were identified in Figure 3.1. The metric analyses of arch form in this investigation were adopted from Rakosi *et al.* (1993), Kahl-Nieke and Schwarze (1996) and Nojima *et al.* (2001).

1.1 Arch form linear measurements (mm.) (Figure 3.1)

1) CWu, upper intercanine width:

The distance between cusp tips or estimated cusp tips in cases of wear facets of upper canines.

2) CWL, lower intercanine width:

The distance between cusp tips or estimated cusp tips in cases of wear facets of lower canines.

3) PWu, upper interpremolar width:

The distance between the midpoint of central groove of upper first premolars.

4) PWL, lower interpremolar width:

The distance between the midpoint of central groove of lower first premolar.

5) MWu, upper intermolar width:

The distance between the centric fossa of upper first molars.

6) MWL, lower intermolar width:

The distance between the distobuccal cusp tips of lower first molar.

7) CDu, upper canine depth:

The shortest distance from a line connecting the upper canine cusp tips to the midpoint of the incisal edges of the upper central incisors.

8) CDL, lower canine depth:

The shortest distance from a line connecting the lower canine cusp tips to the midpoint of the incisal edges of the lower central incisors.

9) MDu, upper molar depth:

The shortest distance from a line connecting the centric fossa of upper first molars to the midpoint of the incisal edges of the upper central incisors.

10) MDL, lower molar depth:

The shortest distance from a line connecting the distobuccal cusp tip of lower first molars to the midpoint of the incisal edges of the lower central incisors.

1.2 Arch form proportional measurements

1) CWu/CDu, upper canine W/D ratio:

The ratio of the upper intercanine width and the upper canine depth.

2) CWL/CDL, lower canine W/D ratio:

The ratio of the lower intercanine width and the lower canine depth.

3) MWu/MDu, upper molar W/D ratio:

The ratio of the upper intermolar width and the upper molar depth.

4) MWL/MDL, lower molar W/D ratio:

The ratio of the lower intermolar width and the lower molar depth.

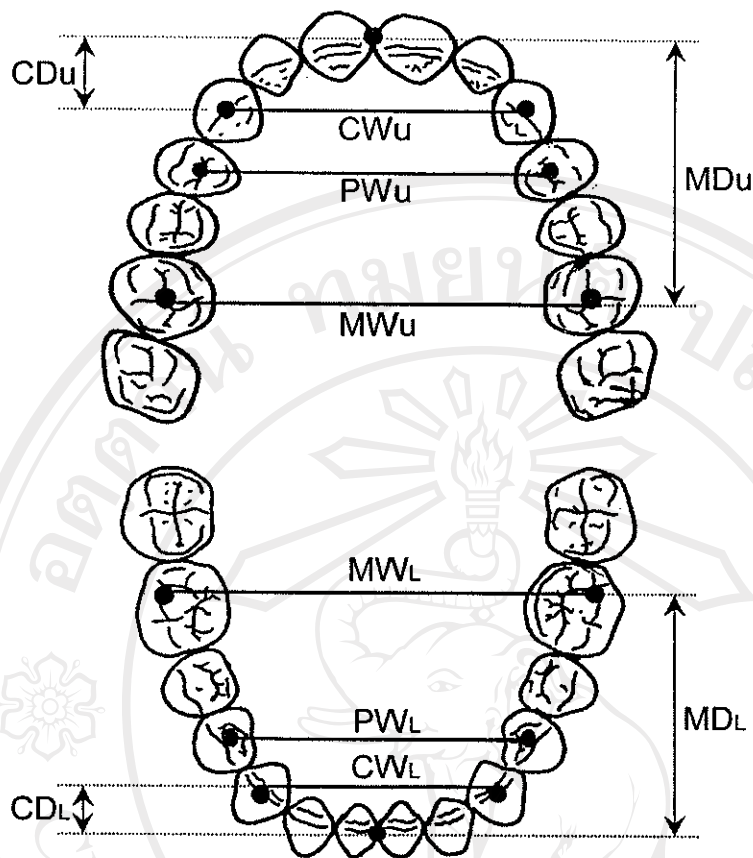


Figure 3.1 Arch form linear measurements

Part 2: Cephalometric Analysis

All the lateral cephalometric tracings were performed on 8 inches by 10 inches acetate paper over an illuminated viewbox in the dark room with a 0.3 millimeter 2B pencil by a single investigator. When bilateral images were not coincident, the midline between both images will be traced. Electronic digital caliper (KEIBA) with fine tips measuring within 0.01 mm. was used for digital measuring the linear measurements and using the standard cephalometric protractor (ORMCO) which could measure differences as small as 0.5 degree was done the angular measurements.

Lateral cephalograms were traced, orientated with the horizontal plane at seven degrees to the Sella-Nasion line (Burstone *et al.*, 1978). The 20 cephalometric landmarks of hard and soft tissues, the 13 planes/lines, 20 angular measurements,

31 linear measurements and 5 proportional measurements were identified in Figure 3.2 to Figure 3.9. All cephalometric variables were selected from the studies of Jacobson *et al.* (1974), Guyer *et al.* (1986), Jarvinen (1988), and Toms (1989). The cephalometric analyses in this investigation were adopted from Steiner analysis (Steiner, 1960), Jarabak and Fizzell analysis (Jarabak and Fizzell, 1972), Jacobson analysis (Jacobson, 1975), Hasund (Bergen) analysis (Jotikasthira, 1989) and Holdaway's soft tissue cephalometric analysis (Holdaway, 1983).

According to different sources of all lateral cephalograms, so the correction of radiographic enlargement to natural size was conducted by calculating the image magnification from the reference objects that locating at the nasal positioner and the cephalostat. This applied to linear dimensions only, because magnification resulting from radiographic projection is proportional and hardly affects angular values (Dibbets and Nolte, 2002).

2.1 Descriptions of cephalometric landmarks, lines and planes used in this study

2.1.1 Skeletal, dental and facial soft tissue landmarks (Figure 3.2)

2.1.1.1 Skeletal and dental landmarks:

1) A, 'A' point or subspinale:

The deepest point on the maxilla between the anterior nasal spine and alveolar process.

2) ANS, anterior nasal spine:

The tip of the projection on the maxilla for support of the nose.

3) Ar, articulare:

The posterior outline of the condylar neck visible below the cranium. It may also be selected at crossing of the dorsal outline, the neck of condylar process, with the NBa plane.

4) B, 'B' point or supramentale:

The deepest point on recess of the alveolus outline on the mandible.

5) Ba, basion:

The point at the center of the anterior border of foramen magnum at the base of the occipital bone.

6) Gn, gnathion:

the antero-inferior margin of symphysis

7) Go, gonion:

The point where the bisector of the angle between the posterior and lower mandibular border tangents meets the mandibular angle.

8) Me, menton:

The lowest point on the symphysis

9) N, nasion:

The junction of frontal, maxillary and nasal bones.

10) PNS, posterior nasal spine:

The midpoint of the base of the palatine bones at the posterior margin of the hard palate.

11) Pg, pogonion:

The most prominent point at the anterior curvature of the chin.

12) S, sella:

The arbitrary point selected by inspection of the sella tursica.

2.1.1.2 Facial soft tissue landmarks:

13) N', soft tissue nasion:

The most concave point in the tissue overlying the area of the frontonasal suture.

14) Prn, pronasale, the tip of nose:

The most prominent point of the soft tissue outline of the nose.

15) Cm, columella:

The most anterior soft tissue point on the columella of the nose.

16) Sn, subnasale:

The point at which the columella merges with the upper lip in the midsagittal plane.

17) Ls, labrale superius:

The most prominent point on the soft tissue outline of the upper lip.

18) Li, labrale inferius:

The most prominent point on the soft tissue outline of the lower lip.

19) Sm, supramentale:

The point of greatest concavity in the midline of the lower lip between labrale inferius and soft tissue pogonion.

20) Pg', soft tissue pogonion:

The most anterior point on the soft tissue chin.

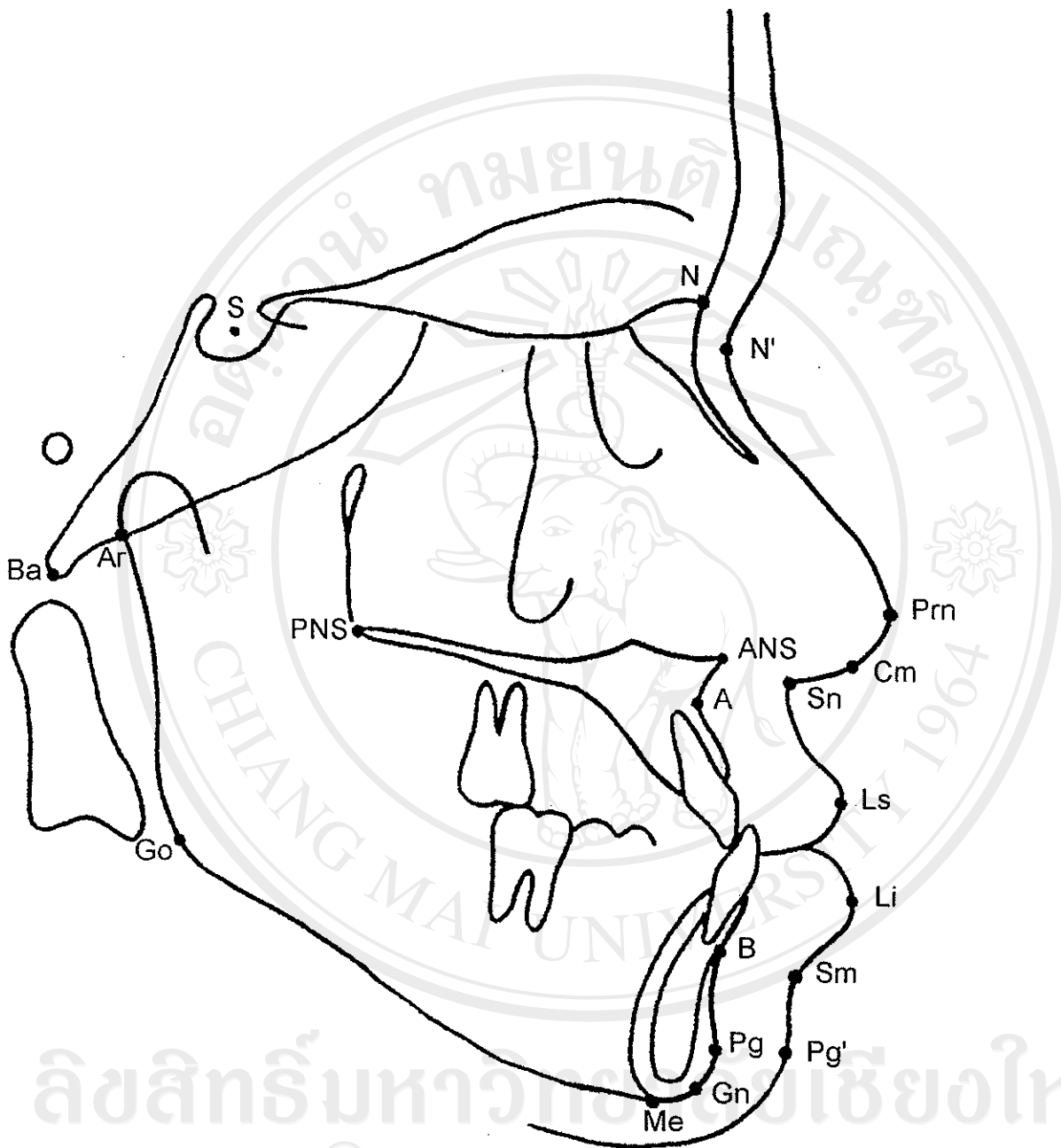


Figure 3.2 Skeletal, dental and facial soft tissue landmarks

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2.1.2 Lines and Planes (Figure 3.3)

1) ANS-PNS, palatal plane (PP):

The line between ANS and PNS.

2) APog:

The line between 'A' point and Pogonion.

3) ArGo:

The line between Articulare and Gonion.

4) E-line, esthetic line:

The line between tip of nose and soft tissue chin.

5) H-line, Holdaway line:

The line between soft tissue chin to labrale superius

6) FOP, functional occlusal plane:

The line drawn by eye between the tips of the cusps of all fully mandibular first molar and premolar teeth.

7) GoGn, Steiner's mandibular plane:

The line between Gonion and Gnathion.

8) NA line:

The line between Nasion and point A.

9) NB line:

The line between Nasion and point B.

10) SAR:

The line between Sella and Articulare.

11) SBa:

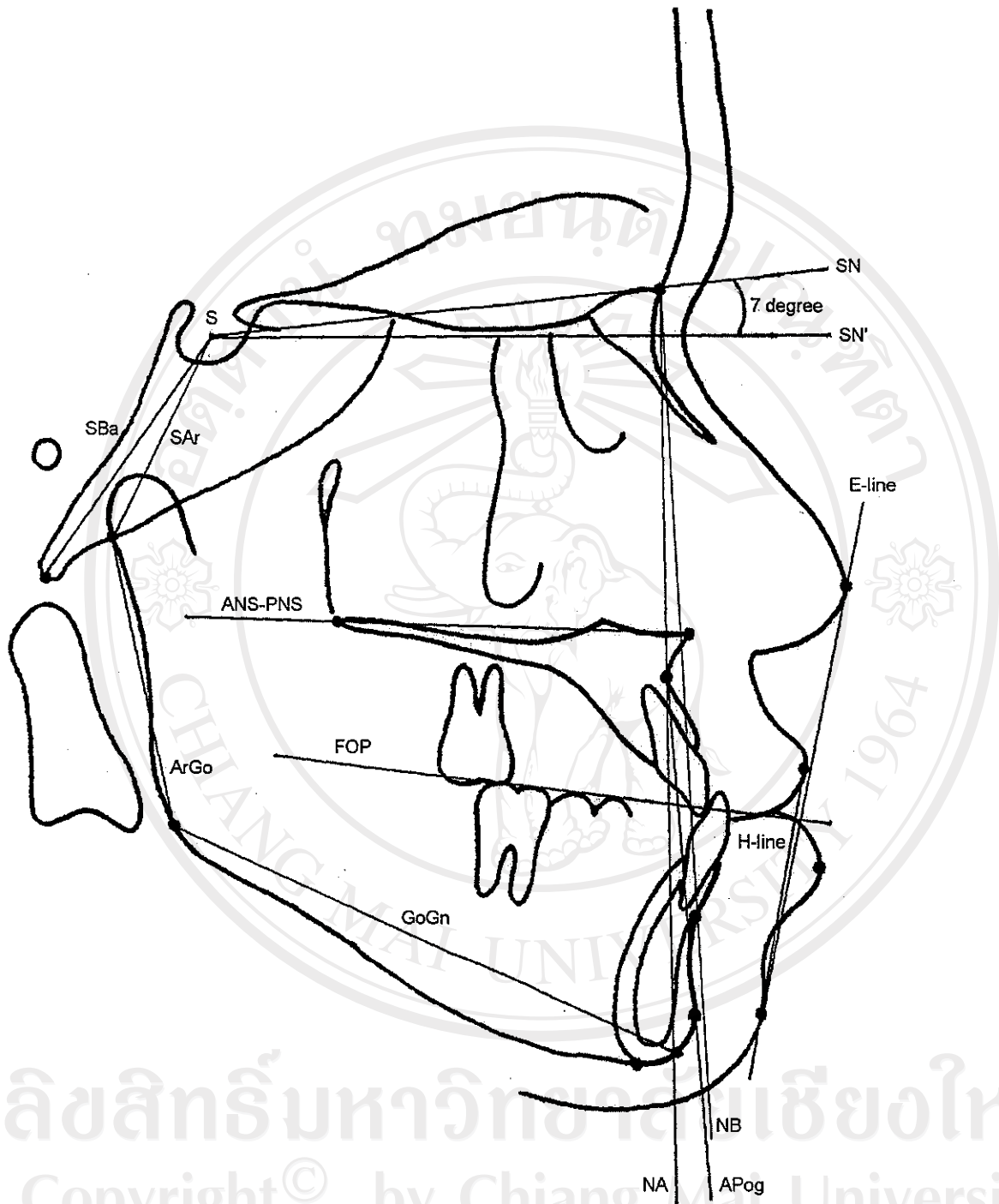
The line between Sella and Basion.

12) SN, Sella-Nasion plane:

The line between Sella and Nasion.

13) SN', Sella-Nasion prime plane:

The sagittal axis constructed through Nasion at an angle of 7 degrees to the SN (Burstone *et al.*, 1978).



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Figure 3.3 Lines and planes

2.2 Angular Measurements (degree)

2.2.1 Skeletal variables (Figure 3.4)

1) SNA:

The angle between SN plane and NA line, to evaluate anteroposterior position of maxilla to the cranium.

2) SNB:

The angle between SN plane and NB line, to evaluate anteroposterior position of mandible to the cranium.

3) ANB:

The angle between NA line and NB line, to evaluate the anteroposterior relationship between and mandible.

4) NSBa:

The angle between SN plane and SBa line, to evaluate configuration of cranial base.

5) SArGo:

The angle between SAr line and ArGo line to evaluate the anteroposterior relation of the mandible to the posterior cranial base.

6) ArGoGn:

The angle between ArGo line and GoGn line (Gonial angle), to evaluate morphology of mandible.

7) NSGn:

The angle between SN plane and SGn line shows growth direction of mandible, represent to Y-axis angle.

8) SN-GoGn:

The angle between SN plane and GoGn line, to evaluate the vertical relationship between anterior cranial base and mandible.

9) SN-PP:

The angle between SN plane and palatal plane, to evaluate the vertical relationship between anterior cranial base and maxilla.

10) SN-OP:

The angle between SN plane and functional occlusal plane, to evaluate the vertical relationship between anterior cranial base and occlusal plane.

11) PP-GoGn:

The angle between palatal plane and GoGn line, to evaluate the vertical relationship between maxilla and mandible.

2.2.2 Dental variables (Figure 3.5)

12) U1-NA:

The angle between long axis of maxillary incisor and NA line, to evaluate inclination of maxillary incisor in relation to NA line.

13) U1-SN:

The angle between long axis of maxillary incisor and SN plane, to evaluate inclination of maxillary incisor in relation to anterior cranial base.

14) L1-NB:

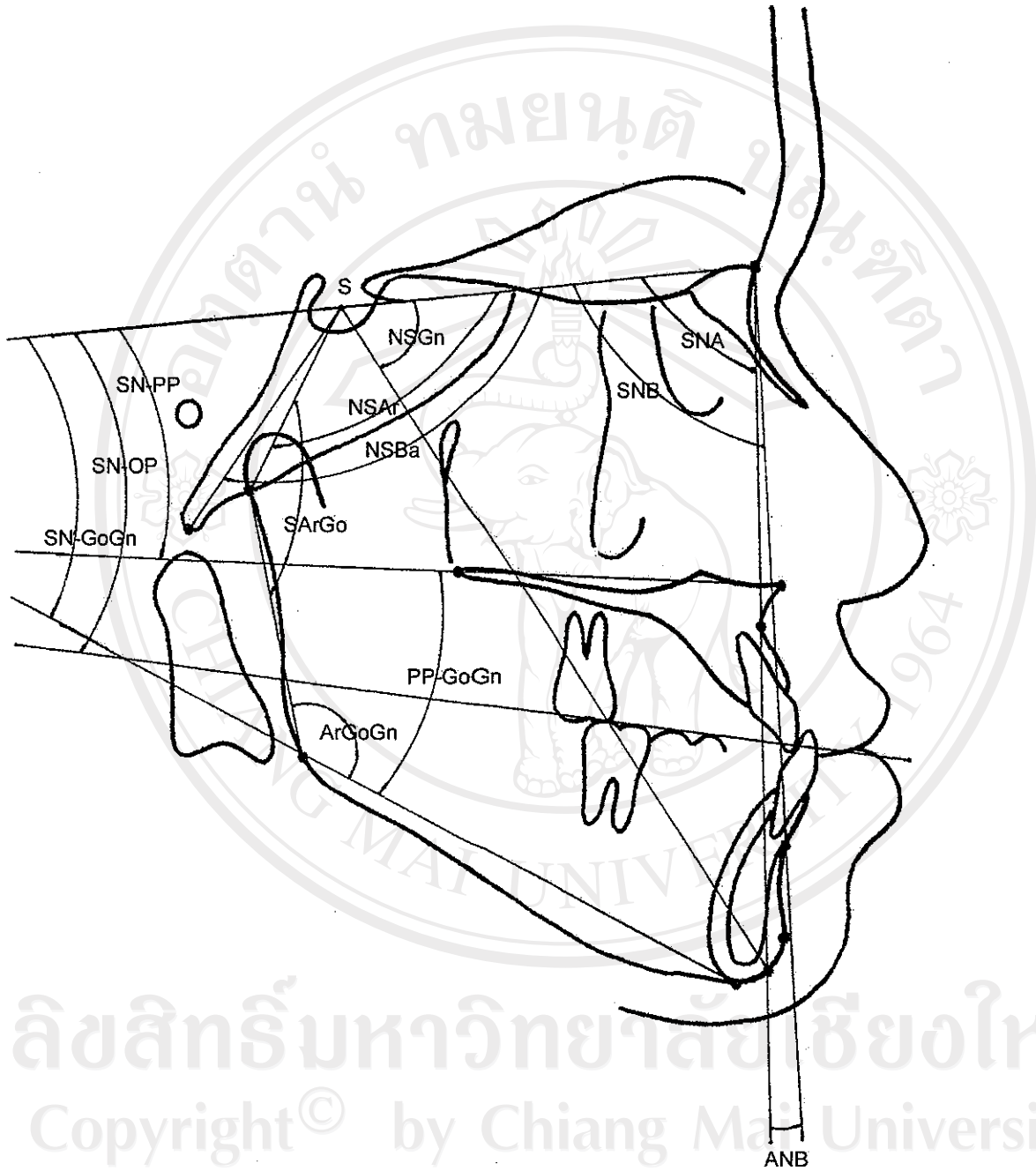
The angle between long axis of mandibular incisor and NB line, to evaluate inclination of mandibular incisor in relation to NB line.

15) L1-GoGn:

The angle between long axis of mandibular incisor and GoGn line, to evaluate inclination of mandibular incisor in relation to GoGn line.

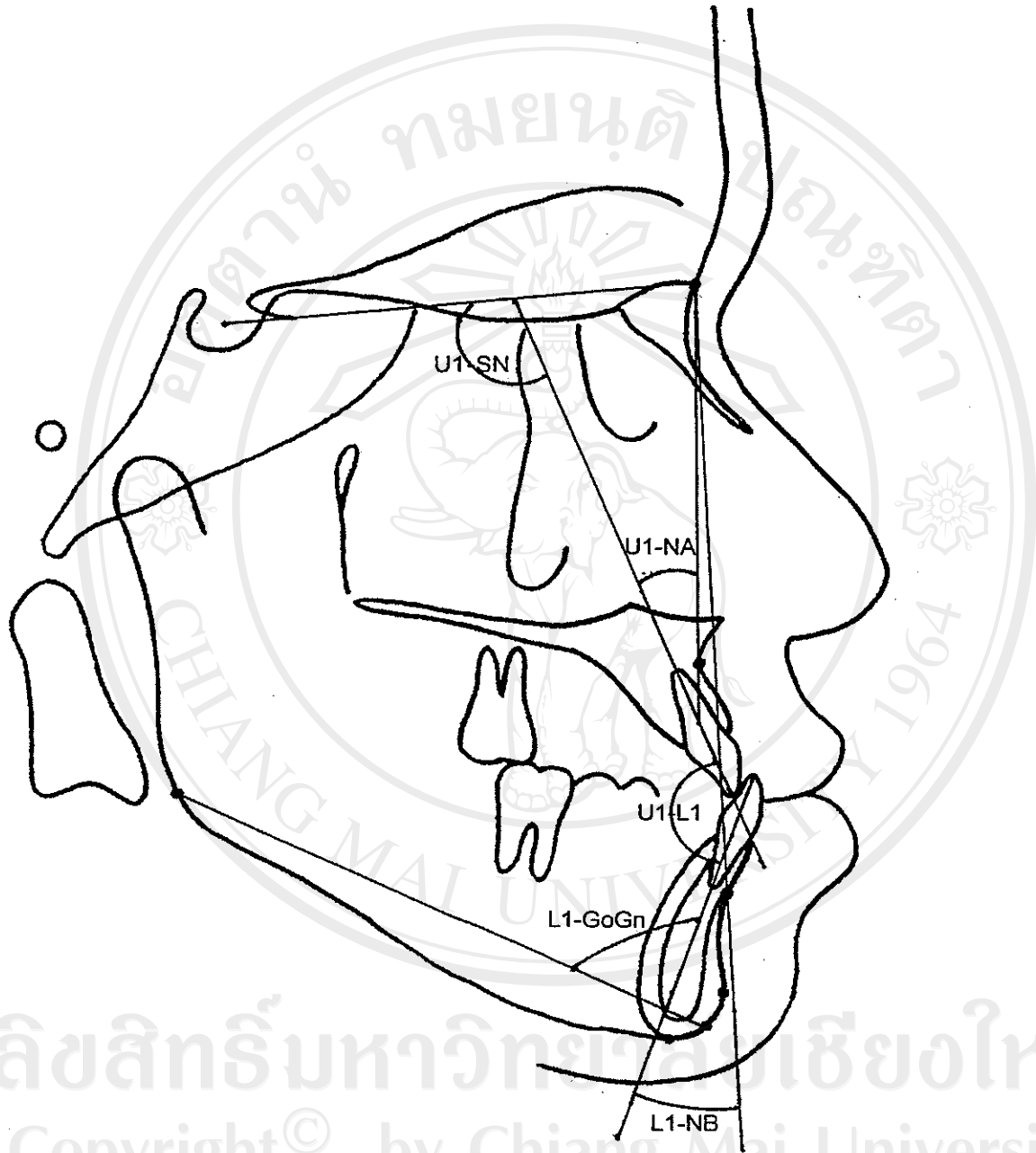
16) U1-L1:

The angle between long axis of maxillary incisor and long axis of mandibular incisor represents the interincisal angle.



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Figure 3.4 Skeletal angular measurements



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Figure 3.5 Dental angular measurements

2.2.3 Facial soft tissue variables (Figure 3.6)

17) $N'-Pg'$ to SN' , soft tissue facial angle:

The angle between soft tissue facial line ($N'-Pg'$) to SN'

18) $Cm-Sn-Ls$, nasolabial angle:

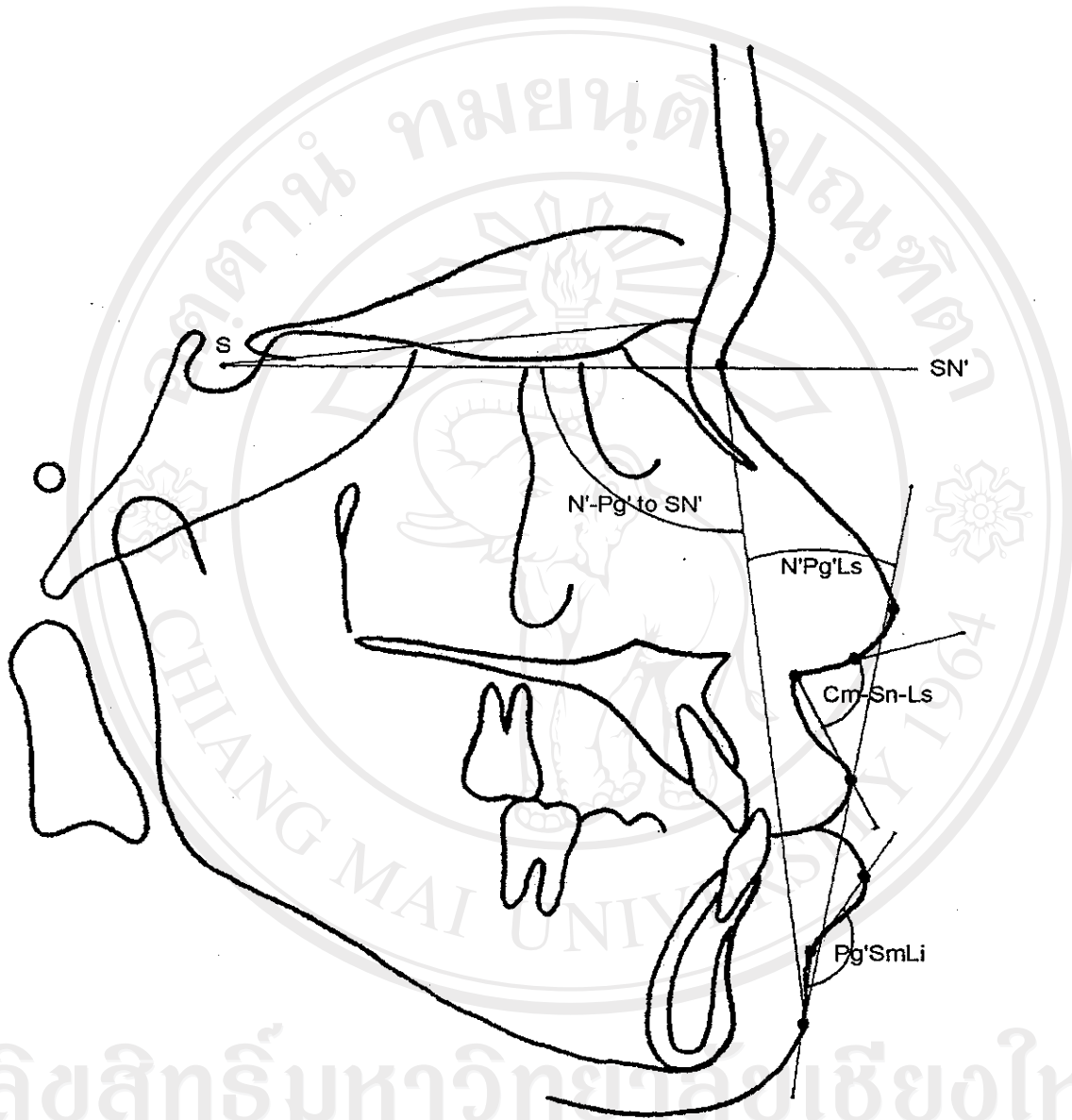
The angle that formed by intersection of line originating in subnasale, tangent to lower margin of nose (columella), and line traced between subnasale and labrale superius.

19) $Pg'-Sm-Li$, mentolabial angle:

The angle that formed by intersection of line originating in supramentale, tangent to the soft tissue pogonion, and line traced between supramentale and labrale inferius.

20) $N'-Pg'/Pg'-Ls$, H angle:

The angle between soft tissue nasion to soft tissue pogonion line and soft tissue pogonion to labrale superius line.



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Figure 3.6 Facial soft tissue angular measurements

2.3 Linear Measurements (mm.)

2.3.1 Skeletal variables (Figure 3.7)

1) SN:

anterior cranial base length.

2) SBa:

posterior cranial base length.

3) ANS-PNS:

maxillary length.

4) Ar-Go:

ramus height.

5) Ar-Me:

effective mandibular length.

6) Go-Gn:

mandibular length.

7) Wits appraisal (AO-BO):

The distance between the perpendicular lines drawn from point A and point B onto the functional occlusal plane, to identify anteroposterior jaw disharmony.

8) Symphyseal width (SW):

The distance on the symphysis from Pogonion parallel to SN'.

9) Symphyseal height (SH):

The distance from point B to Menton perpendicular to SN'.

2.3.2 Dental variables (Figure 3.8)

10) Overjet:

The distance from labial surface of mandibular incisor to labial surface of maxillary incisor at the level of maxillary incisal edge, measured parallel to functional occlusal plane.

11) Overbite:

The distance from incisal edge of maxillary incisor to incisal edge of mandibular incisor, measured perpendicular to functional occlusal plane.

12) L1-APg:

The distance from incisal edge of mandibular incisor perpendicular to APg line.

13) UADH, upper anterior dentoalveolar height:

The perpendicular length of a line dropped from the incisal edge of the maxillary central incisor to the palatal plane.

14) UPDH, upper posterior dentoalveolar height:

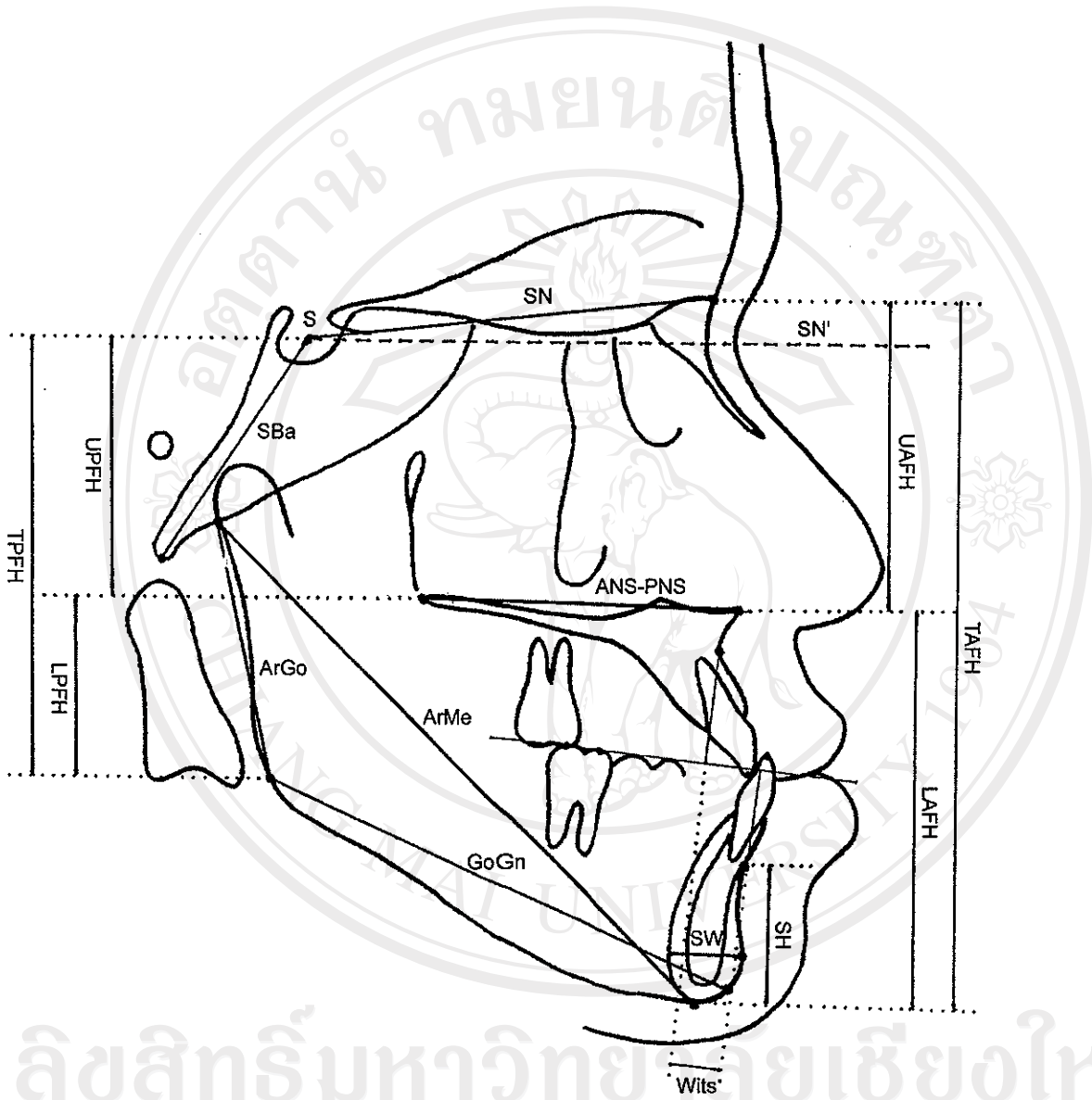
The perpendicular length of a line dropped from the mesiobuccal cusp tip of the maxillary first molar to the palatal plane.

15) LADH, lower anterior dentoalveolar height:

The perpendicular length of a line dropped from the incisal edge of the mandibular central incisor to the mandibular plane.

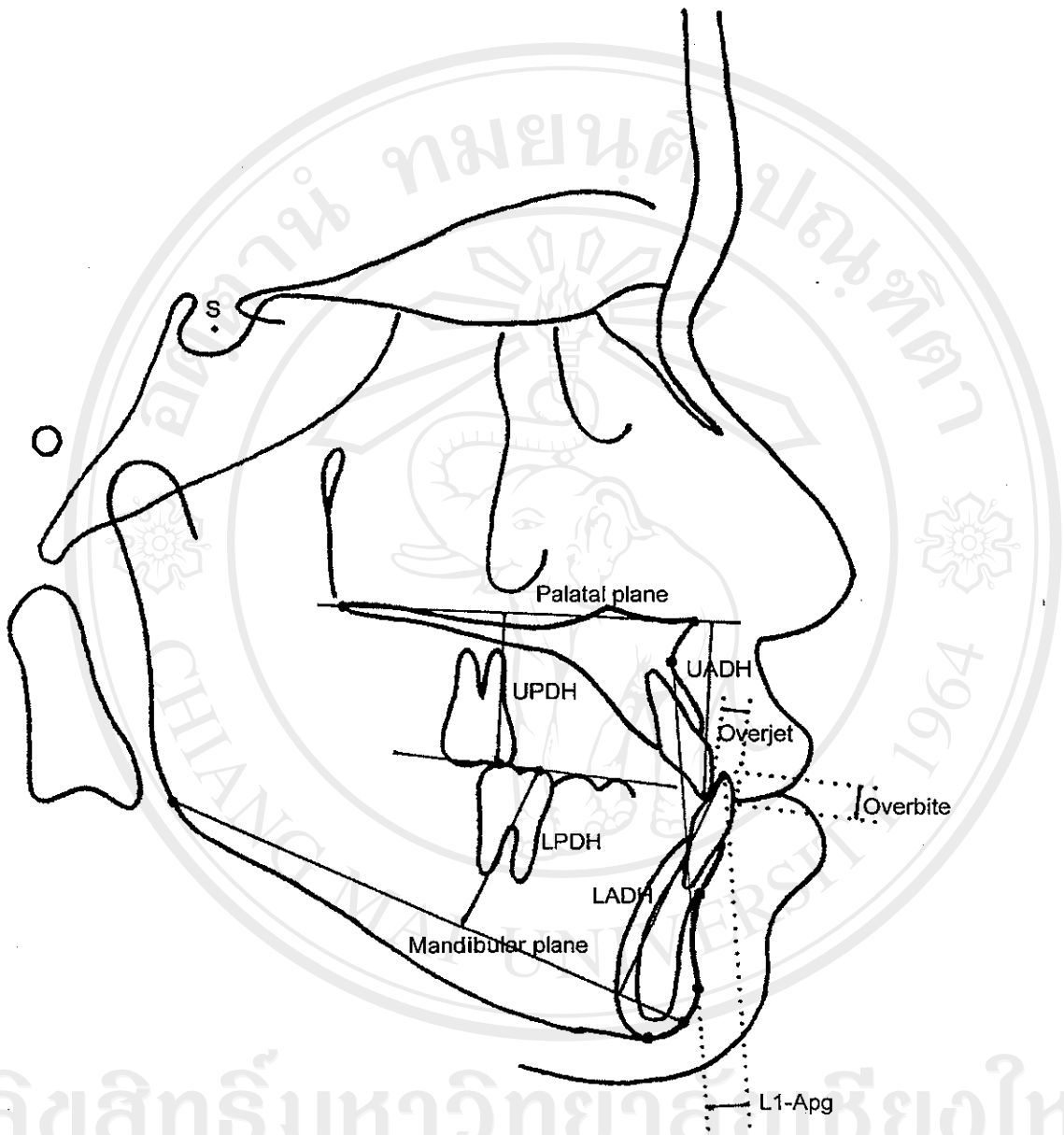
16) LPDH, lower posterior dentoalveolar height:

The perpendicular length of a line dropped from the mesiobuccal cusp tip of the mandibular first molar to the mandibular plane.



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Figure 3.7 Skeletal linear measurements



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Figure 3.8 Dental linear measurements

2.3.3 Facial soft tissue variables (Figure 3.9)

17) Nose prominence:

The distance between the tip of nose and a perpendicular line drawn to SN' from subnasale.

18) Superior sulcus depth:

The distance between the subnasale (Sn) and a perpendicular line drawn from the labrale superius to SN' line.

19) Inferior sulcus depth:

The distance between the supramentale (Sm) and a perpendicular line drawn from the labrale superius to soft tissue pogonion (H-line).

20) Subnasale to H-line:

The distance between the subnasale and soft tissue pogonion to labrale superius line.

21) Upper lip thickness:

The distance between labrale superius point and a parallel line to SN' from the labial surface of upper incisor.

22) Lower lip thickness:

The distance between labrale inferius point and a parallel line to SN' from the labial surface of lower incisor.

23) Soft tissue chin thickness:

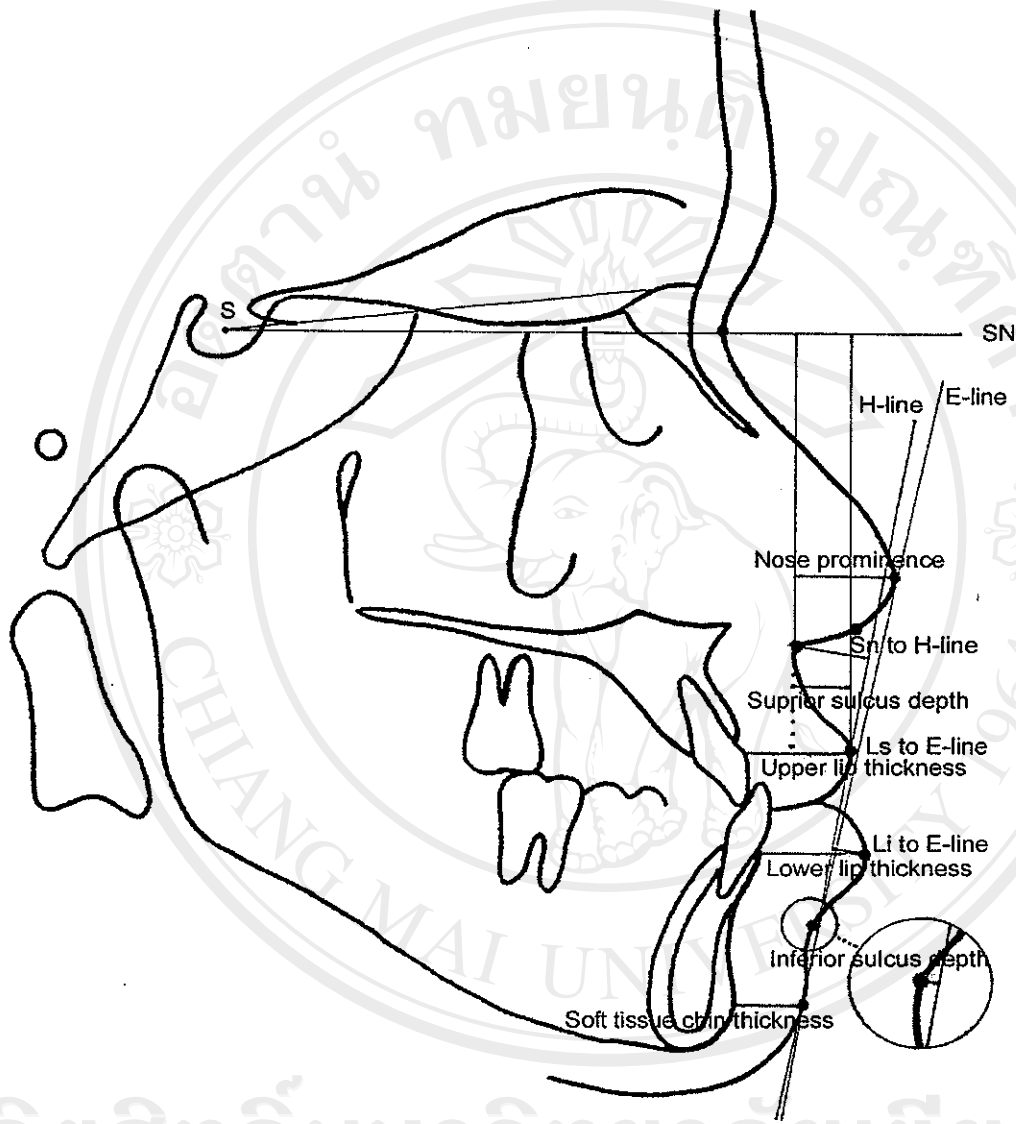
The distance between soft tissue pogonion (Pg') and a parallel line to SN' from the symphysis.

24) Ls to E-line:

The distance from labrale superius to Esthetic line.

25) Li to E-line:

The distance from labrale inferius to Esthetic line.



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Figure 3.9 Facial soft tissue linear measurements

2.4 Skeletal proportional measurements

1) UAFH / LAFH ratio:

The ratio of upper anterior facial height to lower anterior facial height
(N-ANS / ANS-Me, measured perpendicular to SN').

2) UPFH / LPFH ratio:

The ratio of upper posterior facial height to lower posterior facial height
(S-PNS / PNS-Go, measured perpendicular to SN').

3) TPFH / TAFH ratio (Jarabak quotient):

The ratio of total posterior facial height to total anterior facial height
(S-Go / N-Me, measured perpendicular to SN').

Statistical analyses

The SPSS for Windows Release 10.0.1 program (SPSS Inc., Chicago, USA, 1989-1999) and the STATA for Windows Release 6.0 program (Stata Corp., Texas, USA, 1984-1999) were used to calculate the following analyses:

1. Descriptive analyses provided the means and standard deviations for each craniofacial measurement to describe the characteristics of the sample groups.

2. Two way analyses of variance (two-way ANOVA) were performed to assess the differences for each craniofacial measurement between class III malocclusion group and normal occlusion group by gender.

Any significant interaction was found between type of occlusion and gender, one way analyses of variance (one-way ANOVA) were performed to assess the differences for each craniofacial measurement among the groups categorized by type of occlusion and gender.

3. One way analyses of variance (one-way ANOVA) were performed to assess the differences for each craniofacial measurement among the skeletal normal overbite, openbite and deepbite in class III malocclusion group.

4. Multiple comparisons for means (Scheffe test) were employed after one-way ANOVA, to identify which pair of groups were significantly differences.

5. Simple logistic regression analyses, Bivariate logistic regression analyses and Forward stepwise multiple logistic regression analyses were performed to investigate the associations between type of occlusion and craniofacial measurements.

The 95% confidence interval was used for significant results.

The probability of significance was donated as * for $P < 0.05$, as ** for $P < 0.01$ and as *** for $P < 0.001$.

Reliabilities of the measurements

20% of the samples, 28 study models and 28 lateral cephalograms, were randomly selected to perform intrainvestigator calibrations (in the same investigator). These study models were measured and the lateral cephalograms were traced and measured by the investigator. The second investigations were conducted after the first investigations for two weeks as suggested by Houston (1983). Both investigations showed very high correlations with Pearson's product-moment correlation coefficients of 0.993 to 0.999 ($P < 0.001$) (Table A.1 and A.2, Appendix A). This indicated that the craniofacial measurements of the investigator were satisfied with a very high reproducibility.



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