บทวิทยาการ
Original Article

Correlations between Soft and Hard Tissue Measurements in Thai Female Subjects with a Convex Profile
ความสัมพันธ์ระหว่างการวัดเนื้อเยื่ออ่อนและแข็งในกลุ่มผู้หญิงไทยที่มีรูปหน้าอูม

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Abstract

Introduction: The aim of this study was to investigate the characteristics of the soft tissue profile and relationships between soft and hard tissue measurements in Thai female subjects with a convex facial profile. **Materials and Methods:** Pretreatment lateral cephalograms of 130 Thai female subjects with a convex profile aged 18 - 44 years old were examined and compared to 30 female subjects with a normal profile. All cephalograms were traced and digitized by one investigator to assess soft and hard tissue cephalometric parameters using Dentofacial planner plus version 2.02 software. The associations between soft and hard tissue were analyzed using Pearson correlation coefficients. **Results:** Most subjects with a convex profile had an anterior Sn position (70.8%), followed by a normal position and posterior position. Normal and posterior Pg' positions were most equally common in the subjects with convex profile. The two most frequent convex

Received: 03/08/2561 Revised: 27/12/2562 Accepted: 14/02/2563

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profile combinations were an anterior Sn position with normal Pg' position (40.8%), and normal Sn with posterior Pg' (21.5%). Hard tissue measurements in convex profile patients were correspondent with soft tissue measurements, except measured with Co - A and Co - Gn based on A - Nperp (point A to Nasion perpendicular) and Pg - Nperp (Pogonion to Nasion perpendicular). **Conclusions:** The soft tissue profile of Thai female subjects with a convex profile corresponds well with hard tissue measurements. The Thai female subjects with convex facial profile mostly present with anterior Sn positions in combination of normal Pg' positions.

Keywords: convex profile, lateral cephalometric analysis, facial soft tissue measurement, dentoskeletal measurement

Introduction

A convex profile is a common characteristic of most individuals with Class II malocclusion, and is not a single clinical entity but the outcome of numerous combinations of skeletal and dental components.[1] The various characteristics of class II malocclusion can be related to maxillary skeletal protrusion, maxillary dentoalveolar protrusion, mandibular dentoalveolar retrusion or mandibular skeletal retrusion.[1,2]

In addition to clinical examination of the facial soft tissues, cephalometric analysis is one of the most useful diagnostic tools for evaluating soft tissue characteristics and investigating the underlying skeletal and dentoalveolar structures. Understanding the correlations between the structures of the hard and soft facial tissues can provide useful baseline data in orthodontic diagnosis and treatment planning, especially when applying the soft tissue paradigm to achieve maximum soft tissue facial esthetics.[3 - 6]

Many methods were used to assess the facial soft tissue profile from lateral cephalometric radiographs[7 - 14]; however, all of these analyses have been conducted on individuals with a normal facial profile, including a cephalometric analysis of Thai adults.[15 - 16] Unfortunately, the associations between the skeletal parameters and facial profile measurements of Thai subjects with a convex facial profile have not yet been reported.

The purpose of this study was to classify the craniofacial morphology and explore the relationship between the soft tissue profile and underlying hard tissue in adult female Thai subjects with a convex facial profile.

Material and methods

130 pretreatment lateral cephalograms of female non - growing subjects (≥ 18 years old) evaluated in this study were taken from the files of the Orthodontic Clinic, Faculty of Dentistry, Prince of Songkla University, and were taken between 1993 and 2014. Two groups of radiographs were based on Sorathesn K's study.[15] The study was conducted in subjects with balanced facial profile and was indicated the norm for female subjects with facial contour angle (FCA) of 4 - 14 degrees. The first group was a normal facial profile classified by FCA as mentioned before. The second group was a convex facial profile classified by FCA >14 degrees.

The soft and hard tissue landmarks[7 - 14,17] used in this study were illustrated in Figure 1 and the reference planes were illustrated in Figure 2. The positions of the landmarks on the tracings were digitized using a transparent pad and commercial cephalometric program (Dentofacial planner plus version 2.02; Company, City, Country) to measure the dentoskeletal and soft tissue variables. The angular and linear measurements are illustrated in Figures 3 - 6.

Each linear and angular measurement on twenty randomly selected samples from each group was repeated twice at least four weeks apart by

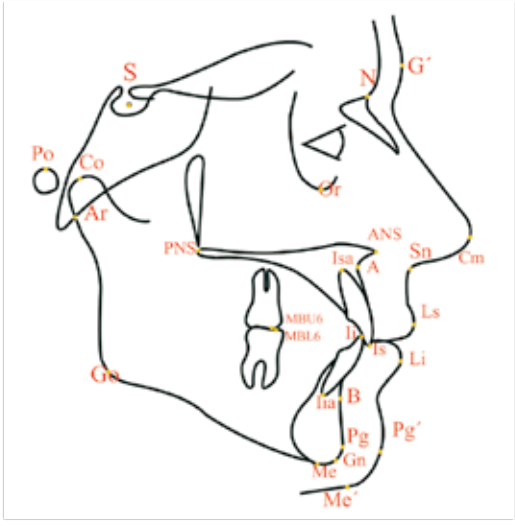

Figure 1: Illustration of the soft and hard tissue landmarks on the lateral cephalogram tracing.

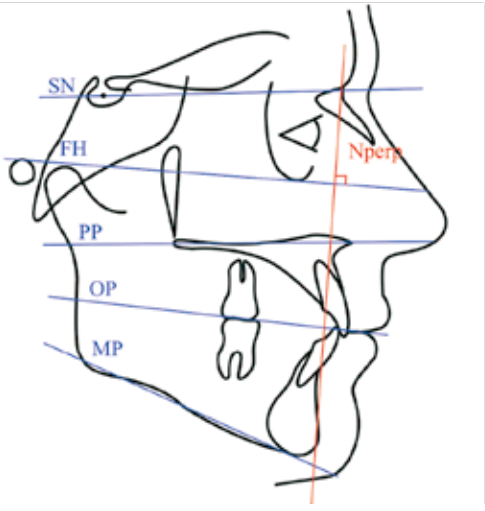

Figure 2: Illustration of the SN, FH, PP, OP, MP and Nperp reference planes on the lateral cephalogram tracing.

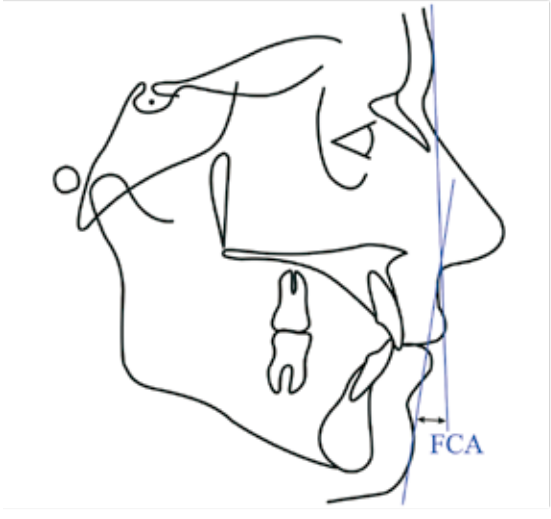

Figure 3: Illustration of the facial contour angle.

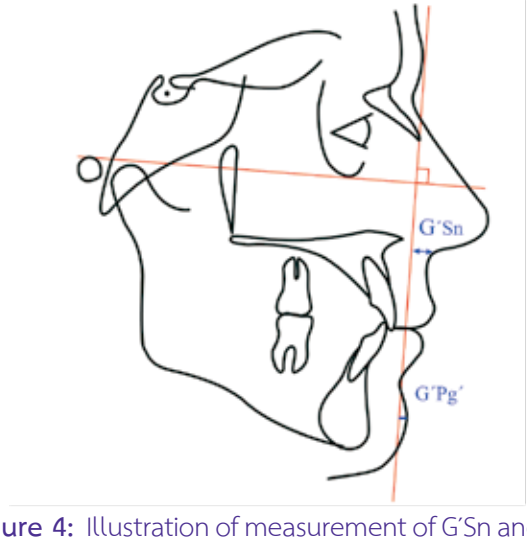

Figure 4: Illustration of measurement of G´Sn and G´Pg.´

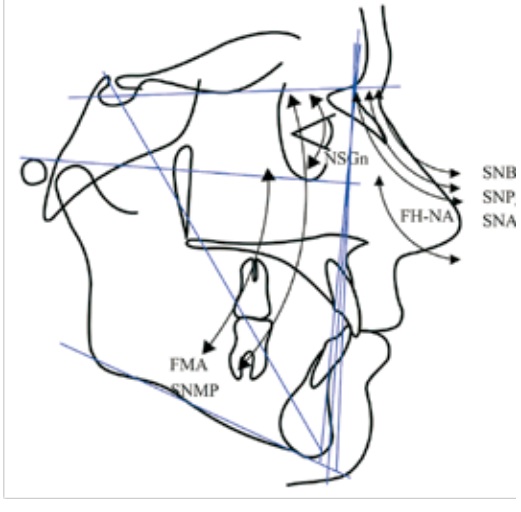

Figure 5: Illustration of the angular measurements.

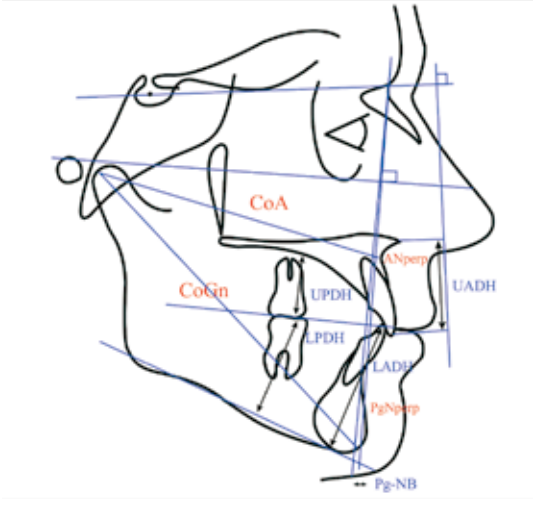

Figure 6: Illustration of the linear measurements.

one investigator. Dahlberg's formula18 were used to determine the intraobserver reliability.

Classification of convex profiles

The normal facial profile group was used as reference to classify the convex facial profile group. The lateral cephalometric radiographs of thirty females with a normal facial profile were used to determine the normal position of the subnasale (Sn) and soft tissue pogonion (Pg′). A vertical line was drawn from the most prominent point in the midsagittal plane of the forehead (G′) to measure the G′-Sn and G′-Pg′ distances; these measurements were used as references to divide the subjects with a convex profile (FCA > 14 degrees) into three subgroups for each jaw as follows:

Sn position

Anterior Sn: G′-Sn is greater than the mean +1 SD of the normal facial profile group.

Normal Sn: G′-Sn is within the mean +1 SD of the normal facial profile group.

Posterior Sn: G′-Sn is less than the mean -1 SD of the normal facial profile group.

Pg' position

Anterior Pg′: G′-Pg′ is greater than the mean +1 SD of the normal facial profile group.

Normal Pg': G′-Pg′ is within the mean +1 SD of the normal facial profile group.

Posterior Pg′: G′-Pg′ is less than the mean -1 SD of the normal facial profile group.

Statistical analysis

The means and standard deviation values and percentage of FCA, G'-Sn and G'-Pg' of convex profile patients were calculated. Pearson correlation coefficients were used to test the relationship between the soft tissue profile and the underlying hard tissue measurements in convex profile patients.

Results

The mean ages of the subjects were 21.19 ± 1.87 and 23.4±5.4 years in the normal facial profile and the convex facial profile groups, respectively. The intra - observer reproducibility for the angular and linear measurements ranged from 0.66 to 0.97 degrees and 0.56 to 1.12 mm, respectively.

The lateral cephalograms of the 30 female subjects with a normal facial profile and 130 female subjects with a convex facial profile were assessed to determine the normal range for the G'-Sn and G'-Pg' in Thai females (Table I).

Table I: Means and standard deviations (S.D.) of soft tissue measurements in Thai female subjects of a normal facial profile and convex facial profile.

	Normal facial profile group (*n* = 30)		Convex facial profile group (*n* = 130)	
Measurement	Mean ± S.D.	Range	Mean ± S.D.	Range
FCA (degrees)	9.58 ±1.60	6 to 13	17.96 ± 3.00	14.2 to 26.7
G'-Sn (mm)	7.27 ±1.77	4 to 11	10.97±3.56	2.7 to 18.6
G'-Pg' (mm)	3.53 ±2.76	-1 to 9	1.19 ± 6.45	17.4 to 16.5

Based on the mean ± standard deviation values for the G'-Sn and G'-Pg' in the subjects with a normal facial profile, the 130 female subjects with a convex profile were classified into subgroups, as shown in Table II. Most subjects with a convex profile had an anterior Sn position (70.8%), followed by a normal position and posterior position. Normal and posterior Pg' positions were almost equally common in the subjects with a convex profile, and a small number of subjects with a convex profile had an anterior Pg' position (Table II).

Based on the combinations of the positions of the subnasale and soft tissue pogonion, all six groups of the convex profile were observed in the 130 Thai female subjects with a convex facial profile, as shown in Table II. The most frequent convex profile combination was anterior Sn- normal Pg' (40.8%) followed by normal Sn- posterior Pg' (21.5%). Anterior Sn- posterior Pg' and anterior Sn- anterior Pg' were observed at almost the same frequency (15.4 and 14.6% respectively), with normal Sn- normal Pg' the least frequent combination (1.5%).

Table II: Characteristics of the Sn and Pg subgroups of Thai female subjects with a convex facial profile

Subgroup	Definition	*n*	Percentage of subjects
Sn			
Sn1 (anterior)	G'-Sn > 9 mm	92/130	70.8%
Sn2 (normal)	G'-Sn = 5 - 9 mm	30/130	23.1%
Sn3 (posterior)	G'-Sn < 5 mm	8/130	6.1%
Pg'			
Pg'1 (anterior)	G'-Pg' > 7 mm	19/130	14.6%
Pg'2 (normal)	G'-Pg' = 1 - 7 mm	55/130	42.3%
Pg'3 (posterior)	G'-Pg' < 1 mm	56/130	43.15
Sn / Pg' combination			
Sn1-Pg'2		53/130	40.8
Sn2-Pg'3		28/130	21.5
Sn1-Pg'3		20/130	15.4
Sn1-Pg'1		19/130	14.6
Sn3-Pg'3		8/130	6.2
Sn2-Pg'2		2/130	1.5

Correlations between soft and hard tissue measurements in Thai female subjects with a convex facial profile (Table III)

The correlations between the soft tissue measurements (G'-Sn and G'-Pg') and the underlying hard tissue measurements in the 130 Thai female subjects with a convex facial profile were assessed using Pearson's correlation coefficient. With respect to maxillary measurements, G'-Sn correlated most highly with A - Nperp (r = 0.823; P < 0.01), followed by maxillary depth (r = 0.748; P < 0.05) and SNA (r = 0.483; P < 0.05); however, G'-Sn did not correlate significantly with Co-A (r = 0.110). In terms of mandibular measurements, G'-Pg' correlated most highly with Pg-Nperp (r = 0.929), followed by SNPg and SNB (r = 0.556 and 0.603, respectively); however, G'-Pg' did not correlate significantly with Co-Gn (r = 0.275; P > 0.05) or Pg-NB (r = 0.170; P > 0.05).

Table III: Correlations between soft and hard tissue measurements in Thai female subjects with a convex facial profile

Variables		Coefficient (r)
Soft tissue	Hard tissue	
G'-Sn	A-Nperp	0.823 **
	Maxillary depth (NA-FH)	0.748 *
	SNA	0.483 *
	Co-A	0.110
G'-Pg'	Pg-Nperp	0.929 *
	SNB	0.603 *
	SNPg	0.556 *
	Co-Gn	0.275
	Pg-NB	0.170

** Significance level, P valve <0.01

* Significance level, P valve <0.05

Discussion

As most of the sagittal and vertical linear measurements reported in previous studies[19 - 20] were significantly larger in males than females, and only a small number of radiographs were available for male subjects (n = 20) so that only female subjects (n = 130) were investigated in this study. It is possible that females are more likely to seek treatment when the convex profile presented.

Intraobserver errors occurred for both the angular and linear measurements, for the soft and hard tissue measurements; however, these errors were insignificant on clinical assessment. Additionally, all of the intraobserver errors in this study are comparable to those of other studies.[21 - 22]

Normal facial profile in Thai female subjects

The inclusion criteria for this study were based on the soft tissue profile rather than occlusion, according to the soft tissue paradigm.[3 - 6] The FCA was used to group the subjects into those with a convex facial profile and normal facial profile, based on the FCA of Thai subjects with a normal facial profile.[15]

The FCA values obtained for Thai female subjects with a normal facial profile in this study were smaller than the corresponding values for Caucasian subjects with a normal facial profile (12 ± 4 degrees),[17] but are similar to the values reported by Sorathesn in Thais with a normal facial profile (9 ± 4 degrees)[15]. This demonstrates that the difference between the Sn and Pg' is smaller in Thai females with a normal facial profile than Caucasian females with a normal facial profile; indicating that the Caucasian female normal profile is more convex than the Thai female normal profile.

The mean and standard deviation values for G'- Sn and G'-Pg' in normal facial profile subjects were 7.27 ± 1.77 mm and 3.53 ± 2.76 mm, respectively (Table I). These normal values were used to divide the subjects with a convex facial profile subjects to subgroups.

Legan and Burstone[17] determined the values for G'-Sn (6 ± 3 mm) and G'-Pg' (0 ± 4 mm) in Caucasian adult subjects with a normal facial profile; larger values for G'-Sn and G'-Pg' were obtained in this study, indicating that normal Caucacian subjects have a larger degree of retrusion of the Sn and Pg' than that of Thai female subjects with a normal facial profile.

Convex facial profile in Thai female subjects

When considering only the position of the Sn, most Thai female subjects with a convex facial profile (70.8%) had the anterior Sn position. In contrast, comparable percentages of subjects had the Pg' positions normal Pg' (42.3%) and posterior Pg' (43.1%). This indicates that most Thai females with a convex profile tend to have a protrusive Sn and either a normal or retrusive Pg'. However when the Sn and Pg' positions were combined, anterior Sn-normal Pg' (40.8%) was more common than anterior Sn–posterior Pg' (15.4%). When focusing on the Pg', most subjects in the normal Pg' subgroup (42.3%) had the anterior Sn-normal Pg' combination (40.8%), indicating that a normal Pg' frequently presents with a protrusive Sn in Thai female subjects with a convex facial profile. The posterior Pg' position (43.1%) was occurred most frequently with normal Sn (21.5%) followed by anterior Sn (15.4%), indicating that a retrusive Pg' most frequently presents with a normal Sn followed by a protrusive Sn in Thai female subjects with a convex facial profile. This could imply that when one of the soft tissue landmarks (Sn or Pg') deviates toward a more convex profile, the other one is most likely to be normal. An only a small percentage of combination deviations of both landmarks are found.

Correlations between soft and hard tissue measurements

The hard and soft tissue measurements which correlated most highly in Thai female subjects with a convex facial profile were the A-Nperp and Pg - Nperp measurements of the maxilla and mandible, respectively. A large G'-Sn indicates that a protrusive Sn is related to a larger A-Nperp, which indicates maxillary protrusion. Similarly to the G'-Sn, the G'-Pg' measurement also associated with the anteroposterior position of the chin as the Pg - Nperp measurement. Moreover, the position of Sn is related to A point in the maxilla, any treatment with an effect to more the A point posteriorly would be possible to reduce the prominent of Sn and subsequently to enhance soft tissue esthetic. Since the Frankfort plane during taking the cephalograms was set to parallel to the horizontal plane, so that both soft and hard tissue reference planes (Nperp and vertical lines from G') are parallel and can be assumed as the same line.

There were moderate correlations between soft and the hard tissue measurements that used the SN plane as a reference. Angular measurements using the SN reference plane may be affected by the inclination of the SN as well as the anteroposterior position of the nasion[23], which may explain why the correlations between these angles and the soft tissue measurements were lower than that of the aforementioned linear measurements.

Clinical implication

Since this study was conducted in female adults and found that most subjects with convex profile had an anterior Sn position. To improve the patient convexity, Sn reduction in Sn1 (anterior) group by moving point A posteriorly either by orthodontics or surgery would be recommended.

Conclusions

Based on this soft tissue analysis of a group of Thai females with a convex facial profile, in the upper jaw a protrusive Sn presents most frequently (70.8%), while, in the lower jaw a normal or retrusive Pg' present at similar frequencies (42.3 and 43.1 % respectively). However, the most frequent combination was a protusive Sn with a normal Pg' (40.8%). A high correlation exists between the hard and soft tissue measurements of the A-Nperp and Pg-Nperp for the maxilla and mandible, respectively, in Thai females with a convex facial profile.

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