Int. J. Morphol.,
44(1):179-187, 2026.

The Influence of Short Upper Posterior Dental Height on Dental, Skeletal, and Soft Tissue Profile in Different Vertical Facial Patterns in Skeletal Class I Patients

Influencia de la Altura Dental Posterior Superior Corta en el Perfil Dental, Esquelético y de Tejidos Blandos en Diferentes Patrones Faciales Verticales en Pacientes con Clase I Esquelética

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TECHARUDEEWAN, S. & CHAROEMRATROTE, C. The influence of short upper posterior dental height on dental, skeletal, and soft tissue profile in different vertical facial patterns in skeletal class I patients. *Int. J. Morphol., 44(1)*:179-187, 2026.

SUMMARY: The objective of this study was to investigate the influence of short upper posterior dental height (S-UPD) on dental, skeletal, and soft tissue profile in different vertical facial patterns in skeletal Class I patients. Lateral cephalometric radiographs of 136 skeletal Class I patients were grouped according to UPD: normal UPD (N-UPD) (n=64) and S-UPD (n=72). The S-UPD group was categorized according to the divergent pattern (Frankfort-mandibular plane angle [FMA]): normodivergent (Normo) (20o≤ FMA≤ 28o) (n=32), hypodivergent (Hypo) (FMA<20o) (n=20), and hyperdivergent (Hyper) (FMA>28o) (n=20). The skeletal, dental, and soft tissue characteristics were compared among the groups and analyzed for correlations. The results indicated that SNA was not significantly different among the groups, but SNB was significantly less in Hyper/S-UPD. Anterior facial height (N-Me and ANS-Me) in S-UPD was shorter than N-UPD. Posterior facial height (S-Go and Ar-Go) was the least in Hyper/S-UPD. Dentoalveolar height in the S-UPD group was significantly shorter than N-UPD except for UADH in Hyper/S-UPD. A significant difference was found in the angulation and position of the lower incisors. The soft tissue parameters showed that the upper and lower lips were more protrusive to the E-line in Hyper/S-UPD. Lower facial height and upper and lower lip lengths were greater in Hyper/S-UPD among the S-UPD. Throat length was greatest in Hypo/S-UPD, and the lip-chin-throat angle was greatest in Hyper/S-UPD. Moreover, the correlation results were consistent with the findings. Decreased UPDH was found to be related to decreased UADH, LADH, and LPDH except for UADH in Hyper/S-UPD. The decreased dentoalveolar height parameters, which led to a decreased overall facial height in both skeletal and soft tissue aspects, primarily affected the lower facial height. However, divergence of the face was affected by the posterior facial height.

KEY WORDS: Upper posterior dental height; Dentoalveolar height; Facial height; Dental compensation; Divergence.

INTRODUCTION

In orthodontics, posterior dental height was found to correlate with facial characteristics, particularly in vertical facial proportions. Research showed that vertical dimensions of the face are influenced by the height of the posterior dentoalveolar structures, both upper and lower. These structures play a significant role in the facial vertical growth pattern and the overall harmony of facial esthetics and functions (Arat & Rübendüz, 2005). Dentoalveolar structures play a compensatory role, which is a system that maintains an occlusal relationship and normal overbite based on the changes in the maxillomandibular relationships to cover up skeletal irregularities (Solow, 1980; Ardani *et al*., 2021).

Posterior dental height is positively correlated with vertical facial measurements. Many studies reported that hyperdivergent subjects showed greater dentoalveolar height compared to normodivergent subjects, while hypodivergent subjects displayed decreased dentoalveolar heights. This occurs due to the dentoalveolar compensatory mechanism where teeth erupt in response to skeletal discrepancies to maintain occlusal function (Opdebeeck & Bell, 1978; Kuitert *et al*., 2006; Islam *et al*., 2016; Ardani *et al*., 2021). Additionally, the vertical growth of posterior teeth can influence mandibular rotation. For example, excessive eruption of posterior teeth leads to downward and backward

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Received: 2025-09-22 Accepted: 2026-01-22

rotation of the mandible that contributes to a longer lower face height. Conversely, insufficient posterior eruption can result in a shorter face height and a greater horizontal growth pattern (Bjork, 1969).

These findings are crucial in orthodontic diagnosis, treatment planning, and stability after orthodontic treatment when addressing vertical growth discrepancies in patients. Posterior dental height, particularly the extrusion of posterior teeth, can significantly impact facial vertical proportions and skeletal patterns. In cases like malocclusion with deep bites, extrusion of molars can open the mandibular plane that increases lower facial height, which affects facial esthetics and skeletal balance. This can improve vertical facial proportions but may worsen sagittal discrepancies such as more Class II profiles by rotating the mandible downwards and backwards (Chua *et al*., 1993; Jariyavithayakul & Charoemratrote, 2019).

Understanding the relationship between dentoalveolar height and vertical skeletal patterns can help orthodontists modify the position of the teeth to correct the skeletal discrepancy in the vertical dimension, thus preventing excessive compensations. Therefore, the aim of this research was to study the relationship of short posterior dental height on dental, skeletal, and soft tissue profile compared with normal posterior dental height. The null hypothesis is that no significant differences can be detected in the dental, skeletal, and soft tissue parameters of patients with short and normal posterior dental height.

MATERIAL AND METHOD

This retrospective study was conducted following the approval obtained from the Human Ethics Committee of the Faculty of Dentistry, Prince of Songkla University (protocol number EC6708-037). This study was conducted in Thai patients with skeletal Class I relationship with normal upper posterior dental height (N-UPD) and short upper posterior dental height (S-UPD). The patients sought orthodontic treatment between 2014 and 2024 at the orthodontic clinic, Faculty of Dentistry, Prince of Songkla University, Songkhla, Thailand. The inclusion criteria were (1) non-growing patients aged between 18 and 35 years, (2) full permanent dentition except for third molars, (3) available standard lateral cephalometric radiographs with clear anatomical structures, and (4) radiographs taken in maximum intercuspation without the presence of any appliances. Patients with a history of (1) orthodontic treatment, (2) orthognathic surgery, (3) facial trauma, or (4) plastic surgery were excluded from the study.

Since a similar study did not exist, a pilot study was conducted in 45 lateral cephalograms provided by the Faculty of Dentistry. Radiographs were categorized according to the divergent pattern (Frankfort-mandibular plane angle [FMA]): normodivergent (Normo) ($20^o \leq$ FMA$\leq 28^o$) (n=32), hypodivergent (Hypo) (FMA$<20^o$) (n=20), and hyperdivergent (Hyper) (FMA$>28^o$) (n=20). The most significant difference found in the pilot study was the lower anterior face height (LAFH) of <0.001. The means and standard deviations from this parameter were used to calculate the sample size. The sample size was calculated using G*Power program version 3.1 (Franz Faul; Christian-Albrechts-Universitat, Kiel, Germany) based on a significance level of alpha = 0.05 and power = 80 %. The effect size of the pilot study was 0.58 for the sample size calculation. Therefore, the total sample size of this study was 51. At least 17 subjects were required per group. However, in this study we decided to include normal upper posterior dental height (N-UPD) to compare any parameters to the S-UPD groups. Also, S-UPD was categorized into three groups according to the mandibular plane angle into Normo/S-UPD, Hyper/S-UPD, and Hypo/S-UPD.

The lateral cephalometric evaluations followed the standardized procedures that closely ensured the precision and consistency of the data obtained. Lateral cephalometric radiographs were from the same X-ray machine (Orthopantomograph® OP300, Instrumentarium Dental, Tuusula, Finland) at 90 kV and 12.5 mA using a 15 s exposure time and a magnification of 10.45 %. All radiographs were obtained in the natural head position. The teeth were in maximum intercuspation while the lips were kept in a relaxed position. Cephalometric tracing was digitized and analyzed using Dolphin Imaging® version 11.9 (Dolphin Imaging, Chatsworth, CA, USA). The measurements from the cephalograms were converted to actual distances. (Fig. 1).

All lateral cephalometric analyses and measurements were performed by a single examiner. Thirty randomly selected subjects were remeasured after two weeks to determine measurement error and reliability. Comparisons between the first and second measurements were done using the independent t-test and intraclass correlation coefficient (ICC). Measurement error was determined using Dahlberg's formula. Kolmogorov-Smirnov and Shapiro-Wilk normality tests were performed, and non-parametric tests were chosen. Kruskal-Wallis test was performed for a statistical comparison of the skeletal, dental, and soft tissue measurements among the groups. The Bonferroni test was used to pairwise compare between the groups. A p-value less than 0.05 was considered statistically significant. Pearson's correlation coefficient was used to find the correlation between dentoalveolar height and skeletal and soft tissue parameters.

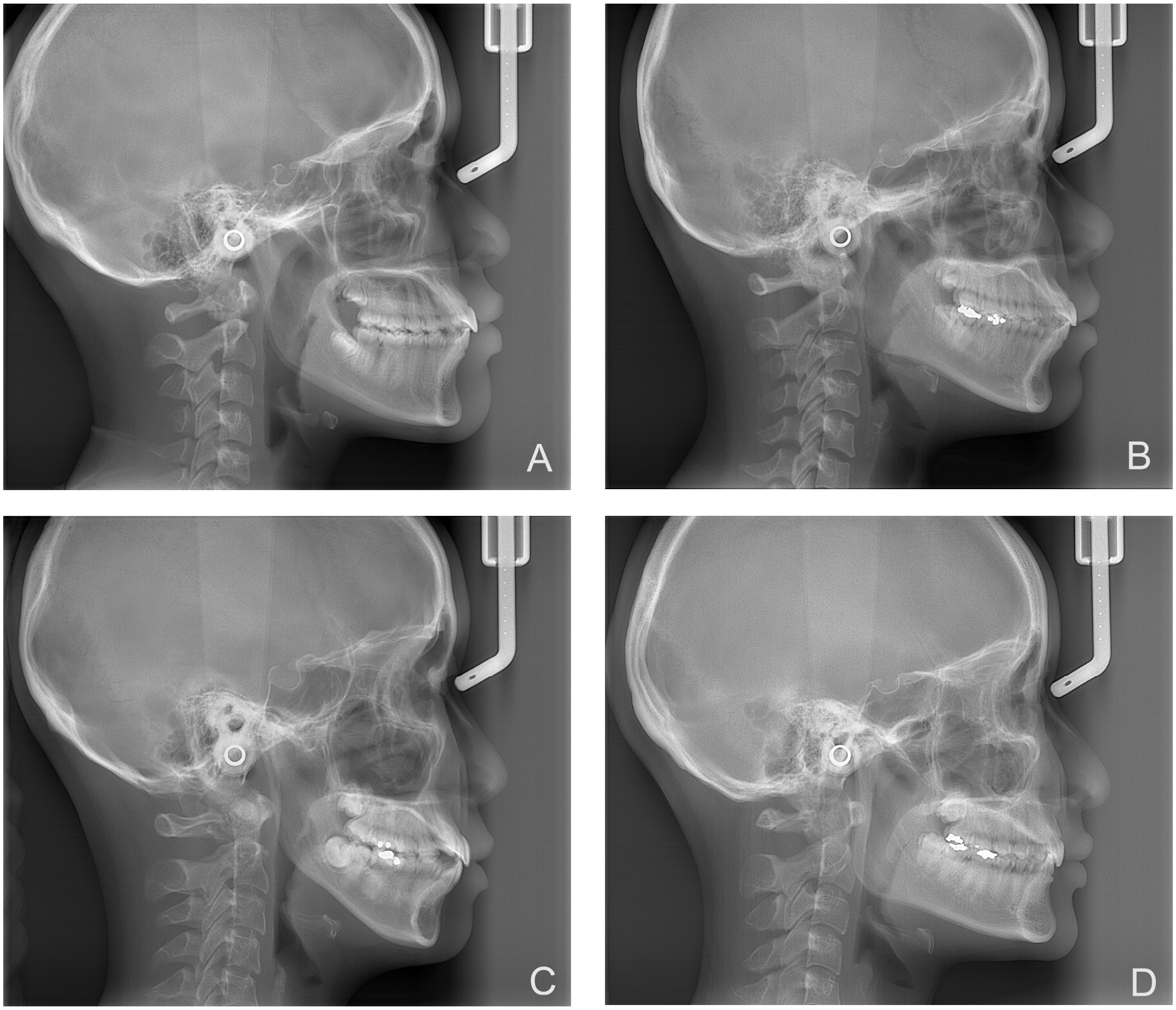

Fig. 1. Examples of lateral cephalometric radiographs show A, normal upper posterior dental height (N-UPD); B, normodivergent/short upper posterior dental height (Normo/S-UPD); C, hyperdivergent/short upper posterior dental height (Hyper/S-UPD); D, and hypodivergent/short upper posterior dental height (Hypo/S-UPD)

RESULTS

The average ICC of all variables was 0.94, which indicated excellent reliability. The results of Dahlberg's formula for linear and angular measurements were 0.74 and 1.67, respectively. There were more females than males in all groups. The maxillae in the anteroposterior position of all groups were in the normal position and were not found to be statistically different. The mandibles in the anteroposterior position of all groups were also in the normal position; however, the SNB angle was significantly greater in the Hypo/S-UPD compared with the Hyper/S-UPD and N-UPD groups. Therefore, the position of point B in the Hypo/S-UPD was more anterior than in the other two groups. The ANB angle in all groups was in the normal range of skeletal Class I relationship. The Frankfort-mandibular plane angle (FMA) varied among the groups as it was used to categorize the subjects into three distinct groups: Normo-, Hyper-, and Hypodivergent. Similarly, the posterior dental height was categorized into S-UPD and N-UPD (Table I).

Table II shows skeletal measurements in the vertical dimension. Anterior facial height measurements found that N-Me was lower in all S-UPD. We found no significant difference in N-ANS among the groups. However, differences were found in the total anterior facial height that came from lower anterior facial height (ANS-Me), which was less in S-UPD compared with N-UPD and also significantly less in Hypo/S-UPD compared with Hyper/S-UPD. A significantly less S-Go and Ar-Go were observed in Hyper/S-UPD compared with the others, and Ar-Go was also found to be significantly different in Hyper/S-UPD.

Table I. Demographic data of normal upper posterior dental height (N-UPD), normodivergent/short upper posterior dental height (Normo/S-UPD), hyperdivergent/short upper posterior dental height (Hyper/S-UPD), and hypodivergent/short upper posterior dental height (Hypo/S-UPD) (N=136).

Variables	N-UPD (n=64)	Normo/S-UPD (n=32)	Hyper/S-UPD (n=20)	Hypo/S-UPD (n=20)	*p*-value
Male/Female	21/43	11/21	5/15	8/12	N/A
Age	28.00±6.57	26.22 ±5.91	24.40 ± 5.97	25.90±6.96	0.084
SNA (deg)	83.50± 2.76	84.70 ±3.43	83.58 ± 2.89	85.16 ± 3.63	0.144
SNB (deg)	80.48± 3.05	81.92 ±3.16	80.10 ± 2.64	82.78 ± 3.53	$0.022^{c,f}$
ANB (deg)	3.00± 1.11	2.91 ±1.41	3.43 ± 1.44	2.40 ± 1.26	0.074
FMA (deg)	24.93± 2.79	23.55 ±3.47	31.63 ± 2.26	17.45 ± 1.88	$<0.001^{b,c,d,e,f}$
UPDH (mm)	19.70± 1.34	15.84 ± 0.83	16.13 ± 0.65	16.03±0.97	$<0.001^{a,b,c}$

Values are presented as mean±standard deviation. Differences between groups were tested by Kruskal-Wallis test, and pairwise comparison was tested by the Bonferroni test.
Superscripts: *a*, N-UPD compared to Normo/S-UPD; *b*, N-UPD compared to Hyper/S-UPD; *c*, N-UPD compared to Hypo/S-UPD; *d*, Normo/S-UPD compared to Hyper/S-UPD; *e*, Normo/S-UPD compared to Hypo/S-UPD; *f*, Hyper/S-UPD compared to Hypo/S-UPD **p*<0.05.

Table II. Skeletal measurements of normal upper posterior dental height (N-UPD), normodivergent/short upper posterior dental height (Normo/S-UPD), hyperdivergent/short upper posterior dental height (Hyper/S-UPD), and hypodivergent/short upper posterior dental height (Hypo/S-UPD) (N=136).

	Groups				
Variables	N-UPD (n=64)	Normo/S-UPD (n=32)	Hyper/S-UPD (n=20)	Hypo/S-UPD (n=20)	*p*-value
N-Me (mm)	114.22±5.59	110.19±4.88	109.85±7.53	107.50±4.08	$<0.001^{a,b,c}$
N-ANS (mm)	51.03±3.48	51.47±2.58	49.35±3.54	50.65±2.78	0.171
ANS-Me (mm)	64.50±4.12	59.75±3.70	62.15±5.38	57.95±3.07	$<0.001^{a,b,c,f}$
S-Go (mm)	76.91±5.53	74.53±5.35	68.15±5.99	78.20±3.55	$<0.001^{b,d,f}$
Ar-Go (mm)	46.95±4.13	44.19±3.45	39.70±4.77	47.20±4.03	$<0.001^{a,b,d,e,f}$
OP-FH	10.14±2.78	10.59±3.05	13.93±2.28	7.65±3.16	$<0.001^{b,c,d,e,f}$

Values are presented as mean±standard deviation. Differences between groups were tested by Kruskal-Wallis test, and pairwise comparison was tested by the Bonferroni test.
Superscripts: *a*, N-UPD compared to Normo/S-UPD; *b*, N-UPD compared to Hyper/S-UPD; *c*, N-UPD compared to Hypo/S-UPD; *d*, Normo/S-UPD compared to Hyper/S-UPD; *e*, Normo/S-UPD compared to Hypo/S-UPD; *f*, Hyper/S-UPD compared to Hypo/S-UPD **p*<0.05.

Table III shows the dental parameters. Dental parameters such as Ui-NA (deg), Ui-NA (mm), Li-NB (deg), Ui-Li (deg), Ui-PP (deg), OJ (mm), and incisal show at rest (mm) showed no significant differences among the groups. However, significant differences were found in the position of the lower incisor (Li-NB [mm]) which was significantly greatest in hyper/S-UPD among S-UPD. Li-NB (deg) was not found to be statistically significantly different; however, it was found to have the highest value in Hyper/S-UPD. Li-MP (deg) was found to be significantly greatest in Hypo/S-UPD.

The dental height parameters of the maxilla showed that the UPD was short in the S-UPD group. Also, the upper anterior dental heights were short in Normo/S-UPD and Hypo/S-UPD except for Hyper/S-UPD, which was comparable to the N-UPD. In the mandible, both LADH and LPDH in all S-UPD were significantly shorter than N-UPD. Overjet was not found to be significantly different among the groups. However, overbite was found to be significantly different in Hyper/S-UPD compared with Hypo/S-UPD and Normo/S-UPD while incisal show at rest was not significantly different between the groups.

Table IV shows the soft tissue measurements. UL-EP (mm) in the Hyper/S-UPD was significantly the most anterior position among S-UPD but not different from N-UPD. LL-EP (mm) in Hyper/S-UP was in the most anterior position among all groups. NLA (deg), FCA (deg), and UFH (mm) were not significantly different among all groups. LFH (mm) in the S-UPD group was less than N-UPD except for Hyper/S-UPD, which was comparable to N-UPD; furthermore, LFH in the Hypo/S-UPD group was significantly less than Hyper/S-UPD. Also, LLL (mm) and ULL (mm) were found to be less in S-UPD than N-UPD except for Hyper/S-UPD. The interlabial gap was not found to be significantly different. Throat length (TL) (mm) was found to be significantly greater in Hypo/S-UPD compared with the other groups. The lip-chin-throat angle (LCTA [deg]) was significantly greatest in Hyper/S-UPD.

Table III. Dental measurements of normal upper posterior dental height (N-UPD), normodivergent/short upper posterior dental height (Normo/S-UPD), hyperdivergent/short upper posterior dental height (Hyper/S-UPD), and hypodivergent/short upper posterior dental height (Hypo/S-UPD) (N=136).

Variables	Groups				*p*-value Kruskal-Wallis
	N-UPD (n=64)	Normo/S-UPD (n=32)	Hyper/S-UPD (n=20)	Hypo/S-UPD (n=20)	
Ui-NA (deg)	27.21±5.97	26.94±8.27	26.68±4.28	29.45±4.08	0.373
Ui-NA (mm)	6.22±2.36	5.39±3.08	5.83±1.36	5.63±1.65	0.540
Li-NB (deg)	31.05±6.36	28.52±5.26	32.75±5.89	29.65±6.04	0.058
Li-NB (mm)	6.95±2.31	5.50±2.17	7.58±2.60	5.38±1.88	$<0.001^{a,c,d,f}$
Ui-Li (deg)	118.80±10.19	121.691±1.76	116.93±8.83	118.10±7.98	0.598
Ui-PP (deg)	118.88±6.72	119.88±7.10	117.55±6.64	121.68±4.54	0.128
Li-MP (deg)	98.50±6.50	96.09±6.82	95.18±5.53	102.10±6.59	$0.004^{c,e,f}$
UADH (mm)	28.22±2.34	26.00±2.05	27.28±2.52	25.08±1.75	$<0.001^{a,c,f}$
UPDH (mm)	19.70±1.34	15.84±0.83	16.13±0.65	16.03±0.97	$<0.001^{a,b,c}$
LADH (mm)	40.13±2.77	37.75±2.69	38.85±3.15	37.20±2.44	$<0.001^{a,b,c}$
LPDH (mm)	31.59±4.48	30.25±2.87	29.80±3.21	30.45±2.09	$0.002^{a,b,c}$
Overjet (mm)	3.55±1.32	4.13±1.52	3.38±1.46	3.93±1.34	0.069
Overbite (mm)	2.14±1.02	2.34±1.17	1.73±0.92	2.63±1.15	$0.043^{d,f}$
Incisal show at rest (mm)	3.07±1.47	2.78±1.71	3.43±1.30	2.65±1.69	0.421

Values are presented as mean±standard deviation. Differences between groups were tested by Kruskal-Wallis test, and pairwise comparison was tested by the Bonferroni test.

Superscripts: *a*, N-UPD compared to Normo/S-UPD; *b*, N-UPD compared to Hyper/S-UPD; *c*, N-UPD compared to Hypo/S-UPD; *d*, Normo/S-UPD compared to Hyper/S-UPD; *e*, Normo/S-UPD compared to Hypo/S-UPD; *f*, Hyper/S-UPD compared to Hypo/S-UPD *$p<0.05$

Table IV. Soft tissue measurements of normal upper posterior dental height (N-UPD), normodivergent/short upper posterior dental height (Normo/S-UPD), hyperdivergent/short upper posterior dental height (Hyper/S-UPD), and hypodivergent/short upper posterior dental height (Hypo/S-UPD) (N=136).

Variables	Groups				*p*-value Kruskal-Wallis
	N-UPD (n=64)	Normo/S-UPD (n=32)	Hyper/S-UPD (n=20)	Hypo/S-UPD (n=20)	
UL-EP (mm)	0.09±1.99	0.48±1.67	1.33±1.21	0.10±1.71	$0.032^{b,f}$
LL-EP (mm)	1.64±2.34	1.38±2.05	3.19±1.18	1.20±1.86	$0.001^{b,d,f}$
NLA (deg)	89.16±9.61	88.75±7.92	89.03±5.55	89.331±0.75	0.975
FCA (deg)	8.66±4.34	8.83±4.90	9.20±3.71	8.38±5.54	0.891
UFH (mm)	44.90±4.60	44.83±2.86	43.53±2.81	44.40±2.75	0.432
LFH (mm)	66.07±4.43	62.18±4.05	64.88±5.24	60.65±2.75	$<0.001^{a,c,f}$
ULL (mm)	22.00±1.96	20.45±1.91	21.10±1.65	20.05±2.08	$<0.001^{a,c}$
LLL (mm)	43.42±3.27	40.97±2.76	42.33±3.42	39.98±1.90	$<0.001^{a,c,f}$
Interlabial gap (mm)	0.65±1.32	0.76±1.40	1.45±2.05	0.63±1.10	0.359
TL (mm)	54.23±6.19	51.98±6.15	51.15±5.69	57.76±6.02	$0.005^{c,e,f}$
LCTA (deg)	113.38±7.93	114.08±6.61	117.23±6.77	111.90±9.16	$0.019^{b,d,f}$

Values are presented as mean±standard deviation. Differences between groups were tested by Kruskal-Wallis test, and pairwise comparison was tested by the Bonferroni test.

Superscripts: *a*, N-UPD compared to Normo/S-UPD; *b*, N-UPD compared to Hyper/S-UPD; *c*, N-UPD compared to Hypo/S-UPD; *d*, Normo/S-UPD compared to Hyper/S-UPD; *e*, Normo/S-UPD compared to Hypo/S-UPD; *f*, Hyper/S-UPD compared to Hypo/S-UPD *$p<0.05$

Based on the Pearson's correlation coefficient, all dentoalveolar height parameters showed a positive correlation with UPDH, as well as skeletal parameters in the vertical dimensions (N-Me and ANS-Me). Facial divergence was not significantly correlated with dentoalveolar height except for UADH. However, a statistically significant negative correlation was observed with posterior facial height where posterior facial height tends to decrease as facial divergence increases. Soft tissue parameters in the vertical dimension, including LFH, ULL, and LLL, showed a statistically significant positive correlation with all dentoalveolar height parameters. However, UFH did not exhibit the same pattern of correlation (Table V).

Table V. Correlations between dentoalveolar height and the skeletal and soft tissue parameters.

	Skeletal and soft tissue parameters												
	UPDH (mm)	FMA (deg)	N-Me (mm)	N-ANS (mm)	ANS-Me (mm)	S-Go (mm)	Ar-Go (mm)	UL-EP (mm)	LL-EP (mm)	UFH (mm)	LFH (mm)	ULL (mm)	LLL (mm)
UPDH (mm)	1	0.032	0.488**	0.088	0.576**	0.358**	0.451**	-0.103	0.004	0.125	0.445**	0.399**	0.411**
UADH (mm)	0.507**	0.331**	0.664**	0.032	0.845**	0.273**	0.248**	0.183*	0.442**	0.109	0.721**	0.640**	0.562**
LPDH (mm)	0.466**	0.210*	0.755**	0.289**	0.825**	0.440**	0.450**	0.279**	0.439**	0.334**	0.778**	0.553**	0.662**
LADH (mm)	0.400**	-0.069	0.743**	0.385**	0.732**	0.651**	0.552**	0.077	0.279**	0.332**	0.662**	0.491**	0.607**
FMA (deg)	0.032	1	0.162	-0.123	0.323**	-0.523**	-0.494**	0.163	0.287**	-0.036	0.335**	0.230**	0.269**

*$p<0.05$, **$p<0.01$

DISCUSSION

Only skeletal Class I patients were included in the study due to different appearances found in a pilot study among different sagittal skeletal types. The aim was to observe the appearances caused by posterior dental height, which was used to categorize patients into short and normal upper posterior dental height. From the pilot study, we observed differences in facial characteristics among the various types of divergent patterns. Therefore, we further subdivided the subjects with S-UPD into different divergent types based on the FMA.

Although the subjects in this study were only skeletal Class I patients, we found differences in the mandibular anteroposterior position from SNB. Insufficient posterior tooth eruption can lead to forward rotation of the mandible (Bjork, 1969). Therefore, we predicted a greater anterior position of point B in the short upper posterior dental height group. In this study, we found SNB was more anterior in short upper posterior dental height subjects, especially in Hypo/S-UPD, which exhibited the highest SNB angle among S-UPD subjects. Except in Hyper/S-UPD, the SNB was least and not significantly different from N-UPD. Similar to previous studies, it was found that as vertical development increased, the sagittal dimension decreased (Chung & Wong, 2002; Eröz Dilaver *et al.*, 2022).

From vertical skeletal measurements, posterior facial height is comprised of total posterior facial height (S-Go) and lower posterior facial height (Ar-Go). For anterior facial height, N-me (mm) or total anterior facial height in all divergent S-UPD was found to be lower than N-UPD. This indicated that the determinant of the divergent pattern in S-UPD is the posterior facial height. Previous studies indicated that sagittal facial growth involves both vertical (downward) and horizontal (forward) components. When vertical growth at the facial sutures and the alveolar processes around the molars exceeds the vertical growth at the condyles, the mandible rotates backward (clockwise), which leads to an increase in anterior facial height. On the other hand, if vertical growth at the condyle surpasses the combined vertical growth at the facial sutures and molar regions, the mandible rotates forward (counterclockwise) (Schudy, 1964; Isaacson *et al.*, 1971). In the case of S-UPD, vertical growth decreased in the molar regions. Therefore, rotation of the mandible is not solely influenced by the height of the posterior teeth. The divergent pattern of the face is also affected by the posterior facial growth from the condyles. A study reported that changes in the anteroposterior position of the mandible were found to be closely associated with the growth of posterior facial height, which is measured from sella to gonion and articulare to gonion (Sinclair & Little, 1985).

Additionally, total anterior facial height is comprised of the upper anterior facial height (N-ANS) and the lower anterior facial height (ANS-Me). In this study, we found that the anterior facial height is shorter in S-UPD, N-Me, and ANS-Me but N-ANS was not significantly different from N-UPD. Therefore, the posterior dental height affects only the lower anterior facial height. The vertical dimensions of the midface and maxilla were not affected.

Among the S-UPD groups, no statistically significant differences were found between the position and inclination of the upper incisors. However, upper incisor inclination was found to be the highest in Hypo/S-UPD, which may be due to impaction from the lower front teeth. The study revealed that lower incisor position relative to the NB line (Li-NB [mm]) was highest in the Hyper/S-UPD, which is likely due to the most posterior positioning of point B compared to other groups. Measurement of inclination indicated that Li-NB (deg) was the highest in the Hyper/S-UPD group due to posterior rotation of the mandible, which caused the inclination to slope forward as Bjork stated. However, lower incisor angulation relative to the mandibular base was greatest in Hypo/S-UPD due to the difference in the angle of the mandibular plane. This was consistent with previous findings that reported the Li-MP (deg) increased as vertical growth decreased (Eröz Dilaver *et al*., 2022).

The dentoalveolar height in the S-UPD was lower compared to the N-UPD, which was consistent with previous studies (Kuitert *et al*., 2006; Ardani *et al*., 2021) except for the UADH. The UADH in the Hyper/S-UPD was the only dentoalveolar height value comparable to N-UPD. This implied that when S-UPD occurs, a short UADH could be exhibited as well. However, only Hyper/S-UPD showed normal UADH. This may be due to dental compensation aimed at achieving a normal overbite. Another interesting finding is the dental height in the mandible in S-UPD was also short compared to N-UPD. Also, Hyper/S-UPD in the LPDH and LADH was also short. When the mandible has posterior rotation, the lower anterior teeth need to erupt more, causing longer LADH but this was not found in this study. This aligned with previous studies that found UADH was highest in the hyperdivergent group. This observation explains that to achieve a normal overbite, vertical growth is compensated primarily from upper anterior teeth eruption (Islam *et al*., 2016). Notably, our study showed that overbite in the Hyper/S-UPD was lower than in Normo/S-UPD, while the overbite was highest in the Hypo/S-UPD (Solow, 1980).

In terms of soft tissue, the anteroposterior position of the upper and lower lips in the Hyper/S-UPD was more prominent than in the other groups. Based on the findings of this study, this was likely due to the more posterior positioning of point B in this group, which influences the position of the soft tissue pogonion, which is a key determinant of the E-line. Furthermore, the study found no significant differences in the position of point A and the upper incisors between the groups. So the difference of the anteroposterior position of the upper lip came also from the E-line. In the vertical dimension, UFH was not affected by the posterior dental height. ULL in the S-UPD was lower than in the N-UPD, except in the Hyper/S-UPD, where greater vertical dental compensation was observed compared to the other groups, which corresponded with the UADH values.

LFH and LLL showed a similar trend with both values being lower in the S-UPD compared to N-UPD, except in Hyper/S-UPD, where the values were comparable to N-UPD. This is consistent with the findings of Al-Sayagh *et al*. (2011) who studied soft tissue profiles across different vertical growth patterns and found that the hypodivergent pattern group exhibited less facial height and LLL compared to the other groups.

TL was significantly greatest in Hypo/S-UPD. This result was similar to a study that reported that TL was significantly greater in hypodivergent patterns compared to hyperdivergent patterns in individuals with Class I skeletal relationships (Kadam *et al*., 2021). The LCTA was greatest in Hyper/S-UPD, which was due to the most anterior position of the lower lip in this group and from the posterior rotation of the mandible.

We found positive correlations between UPDH and other dentoalveolar height parameters (UADH, LADH, LPDH) from Pearson's correlation. These results were consistent with previous results from the Kruskal-Wallis test, which indicated that individuals in the S-UPD group tended to have decreased dentoalveolar height in other regions. This pattern was also reflected in the vertical facial length, in both the skeletal (N-Me and ANS-Me) and soft tissue parameters (LFH). This also confirmed that the upper facial height, for both skeletal and soft tissue, was not affected by a short UPDH.

Posterior dental height can be altered by orthodontic treatment. The orthodontic correction in patients with short facial height would be posterior teeth extrusion, whereby LAFH can be brought into the normal range, which results in improved vertical facial profile. However, care is needed when choosing to perform posterior teeth extrusion to increase vertical facial height. This procedure can affect the anteroposterior dimension by causing mandibular posterior rotation that can lead to a more convex facial profile and a more retrusive chin position. Based on the findings of this study, particular care is needed in hyperdivergent individuals, as they already exhibit the most retrusive chin position and have vertical facial height comparable to the normal group.

The limitations of this study include its retrospective nature and the use of lateral cephalometric radiographs, which may restrict the scope of analysis and introduce potential biases inherent in retrospective studies. This study was conducted on individuals aged 18-35 because this age range is considered to represent the completion of growth. Consequently, the findings of this study may not be applicable to individuals in other age groups. Additionally, the study only focused on comparisons within the skeletal Class I relationship, which limited its applicability to skeletal Class II or Class III cases.

CONCLUSION

When a short UPDH is observed, the dentoalveolar height measurements (UADH, LADH, LPDH) decrease as well, except for UADH in Hyper/S-UPD, which is comparable to N-UPD. The decrease in the dentoalveolar height parameters influence the overall facial height in both skeletal and soft tissue aspects by primarily affecting the lower facial height, which leads to decreased lower facial height in all divergences. However, divergence of the face is affected by the posterior facial height as measured by S-Go and Ar-Go, which are extremely short in hyperdivergent patterns.

ACKNOWLEDGEMENTS

This work was supported by the Graduate School of Faculty of Dentistry, Prince of Songkla University. We would like to thank Glenn K. Shingledecker for providing help with the language and proofreading the article.

TECHARUDEEWAN, S. & CHAROEMRATROTE, C. Influencia de la altura dental posterior superior corta en el perfil dental, esquelético y de tejidos blandos en diferentes patrones faciales verticales en pacientes con clase I esquelética. *Int. J. Morphol., 44(1)*:179-187, 2026.

RESUMEN: El objetivo de este estudio fue investigar la influencia de la altura dental posterior superior corta (S-UPD) en el perfil dental, esquelético y de tejidos blandos en diferentes patrones faciales verticales en pacientes con clase I esquelética. Las radiografías cefalométricas laterales de 136 pacientes con clase I esquelética se agruparon según la UPD: UPD normal (N-UPD) (n = 64) y S-UPD (n = 72). El grupo S-UPD se categorizó según el patrón divergente (ángulo del plano mandibular de Frankfort [FMA]): normodivergente (Normo) (20o ≤ FMA ≤ 28o) (n = 32), hipodivergente (Hipo) (FMA <20o) (n = 20) e hiperdivergente (Hiper) (FMA >28o) (n = 20). Se compararon las características esqueléticas, dentales y de los tejidos blandos entre los grupos y se analizaron las correlaciones. Los resultados indicaron que el SNA no fue significativamente diferente entre los grupos, pero el SNB fue significativamente menor en Hyper/S-UPD. La altura facial anterior (N-Me y ANS-Me) en S-UPD fue más corta que en N-UPD. La altura facial posterior (S-Go y Ar-Go) fue la menor en Hyper/S-UPD. La altura dentoalveolar en el grupo S-UPD fue significativamente más corta que en el grupo N-UPD, excepto por la UADH en el grupo Hyper/S-UPD. Se encontró una diferencia significativa en la angulación y la posición de los incisivos inferiores. Los parámetros de los tejidos blandos mostraron que los labios superior e inferior eran más protrusivos con respecto a la línea E en el grupo Hyper/S-UPD. La altura facial inferior y las longitudes de los labios superior e inferior fueron mayores en el grupo Hyper/S-UPD entre los grupos S-UPD. La longitud de la garganta fue mayor en el grupo Hypo/S-UPD, y el ángulo labio-mentón-garganta fue mayor en el grupo Hyper/S-UPD. Además, los resultados de la correlación fueron consistentes con los hallazgos. Se encontró que la disminución de la UPDH estaba relacionada con la disminución de la UADH, la LADH y la LPDH, excepto por la UADH en el grupo Hyper/S-UPD. La disminución de los parámetros de la altura dentoalveolar, que condujo a una disminución de la altura facial general, tanto en los aspectos esqueléticos como de los tejidos blandos, afectó principalmente a la altura facial inferior. Sin embargo, la divergencia de la cara se vio afectada por la altura facial posterior.

PALABRAS CLAVE: Altura dental posterior superior; Altura dentoalveolar; Altura facial; Compensación dental; Divergencia.

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