

Soft tissue profile changes after vertical ramus osteotomy

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SUMMARY Patients with mandibular prognathism have, for a number of years, been treated by orthognathic surgery and post-surgical changes in the facial profile have been widely reported. However, little is known about the influence of gender and age on the soft tissues. The aim of this study was to investigate changes in the soft tissue profile following orthognathic surgery and to evaluate gender and age differences in the ratios of soft-to-hard tissue change.

Forty-two Caucasian adults (18 males and 24 females) aged from 17 to 46 years with mandibular prognathism who underwent vertical ramus osteotomy were included. Lateral cephalograms were taken 2–8 months pre- (T1) and 12–19 months post- (T2) surgically. Five skeletal, two dental, and seven soft tissue parameters were hand traced. Paired and unpaired Student's *t*-tests, Pearson's correlation coefficients, and multiple regression analyses were used to evaluate the data.

Due to the setback of the mandible, soft and hard tissues changed in a 1:1 ratio at the mentolabial fold and chin in females and 1:1,1 in males. Significant differences of soft-to-hard tissue ratios were found at points Pg ($P < 0.05$) and Gn ($P < 0.01$). Age effects on the ratios were not significant. Other effects of the mandibular setback on the soft tissue profile were a significant increase in facial convexity, a deepening of the mentolabial fold, an increase in lower lip thickness, and a decrease in upper lip thickness, which increased the nasolabial angle.

These findings indicate that use of gender-specific ratios in treatment planning might improve the accuracy of predicting treatment results.

Introduction

A common feature of mandibular prognathism is a concave facial profile characterized by an upper lip behind the aesthetic line, a small nasolabial angle, a protrusive and full lower lip, and a poorly defined mentolabial fold (Kajikawa, 1979; Lew *et al.*, 1990). Patients with severe mandibular prognathism resulting in a Class III malocclusion have for a number of years been treated with a combined orthodontic and surgical approach (Willmot, 1981; Bystedt and Westermarck, 1996). Surgical correction of Class III dentofacial deformities may be accomplished by mandibular setback, maxillary advancement, or a bimaxillary procedure (Bailey *et al.*, 1996; Bystedt and Westermarck, 1996). The treatments of choice are based on extent of the deformity, degree of desirable jaw movement, and anticipated soft tissue changes following surgical intervention (Gjörup and Athanasiou, 1991).

Treatment planning for patients with mandibular prognathism should not only correct the malocclusion involving the stomatognathic function but also consider facial harmony. Aesthetic problems associated with malocclusion often cause social handicap and psychological disorders. It is therefore important for the clinician to be able to analyse and predict soft tissue changes (Heldt *et al.*, 1982; Garvill *et al.*, 1992; Nurminen *et al.*, 1999).

Information on changes in the facial profile and in the hard to soft tissue ratio following surgical correction

of mandibular prognathism has been previously reported (Lines and Steinhauser, 1974; Kajikawa, 1979; Willmot, 1981; Fanibunda, 1989; Lew *et al.*, 1990; Ingervall *et al.*, 1995; Chunmaneechote and Friede, 1999; Gaggl *et al.*, 1999; Hu *et al.*, 1999; Mobarak *et al.*, 2001). However, the predictability of soft tissue changes is still not a precise science and little is known about how gender and age influence treatment outcome. Knowledge of these variables is important in pre-surgical prediction.

The purposes of the present study were to:

1. evaluate soft tissue profile changes after vertical ramus osteotomy (VRO);
2. investigate the relationship between soft tissue and skeletal movements;
3. determine whether gender and age differences influence the predictability of soft tissue behaviour.

Subjects and methods

Approval for the study was obtained from Skane County Council according to the Personal Data Act. A power analysis was undertaken to determine the sample size. This calculation showed that 15 patients in each group were needed to detect a mean difference of 1 mm with a power of 83 per cent, based on an alpha significance level of 0.05 and a beta of 0.1.

Subjects

The sample consisted of 42 Caucasian adult patients (24 females and 18 males) with mandibular prognathism resulting in a Class III malocclusion. Subjects with craniofacial anomalies or syndromes, edentulous persons, and individuals who had undergone genioplasty or conjunctive maxillary osteotomy procedures were excluded. Fifty-four patients with mandibular prognathism who had undergone VRO at the Department of Maxillofacial Surgery and Jaw Orthopaedics, Malmö University Hospital during the period 1992–2005 were identified. Twelve were excluded due to missing pre- or post-surgical cephalograms (Figure 1). The other 42 were all non-growing patients, and pre- and post-surgical lateral cephalograms of adequate quality were available, thus permitting accurate cephalometric tracing. The patients' ages at time of surgery ranged from 17 to 46 years [median 25 years, standard deviation (SD) 8.7].

Treatment

Orthodontic treatment. Before surgical correction, levelling of the curve of Spee, expansion of the dental arches, correction of incisor axis inclinations, and alignment of displaced teeth, with and without extractions of premolars, were performed to obtain a stable occlusion post-operatively. Post-surgical orthodontic management was limited to completing adjustment of the occlusion.

Surgical treatment. All patients had undergone a bilateral VRO performed by two different surgeons. The jaws were placed in the planned position and stabilized with 0.3 mm intermaxillary stainless steel wires for 4–6 weeks. Post-operative orthodontic treatment started within 2–4 weeks after termination of intermaxillary fixation and lasted for 4–6 months.

Cephalometric method

Cephalograms were taken with the patients in a standing upright position and holding their heads in a natural position. They were asked to keep their teeth in centric occlusion and their lips relaxed. The radiographs were reproduced with a linear enlargement of 9 per cent. The cephalograms were taken 2 to 8 months (median 3.5 months) before surgery (T1) and 12 to 19 months (median 14.6 months) after surgery (T2). The same examiner (JN) performed the cephalometric analysis. All radiographs were hand traced on acetate paper. An x - y cranial base co-ordinate system was constructed on each radiograph through sella with the x -axis drawn at a 7 degree inclination to the sella-nasion line and the y -axis passing through sella perpendicular to the x -axis. The tracing of the T2 radiograph was superimposed on the T1 radiograph, and the reference lines were transferred to the tracing on each consecutive cephalogram. Distances were measured by dropping a perpendicular from the reference line to the point in question. Soft tissue measurements were selected using a modification of the soft tissue analysis of Legan and Burstone (1980; Figure 2) to evaluate changes between T1 and T2. The entire cephalometric analysis comprised five skeletal and two dental measurements together with seven soft tissue parameters. Changes in soft tissue reference points were compared with translations of three hard tissue references in the sagittal plane. The percentage of relative positional change was calculated with the formula:

$$\frac{ST(T2 - T1 \text{ mean of soft tissue changes})}{HT(T2 - T1 \text{ mean of skeletal changes})} \times 100,$$

where T2 – T1 mean of soft tissue changes (ST) refers to Ls, Li, Pg', Si, Sn, Gn', and T2 – T1 mean of skeletal changes (HT) refers to Pg, B, Ii, and Gn.

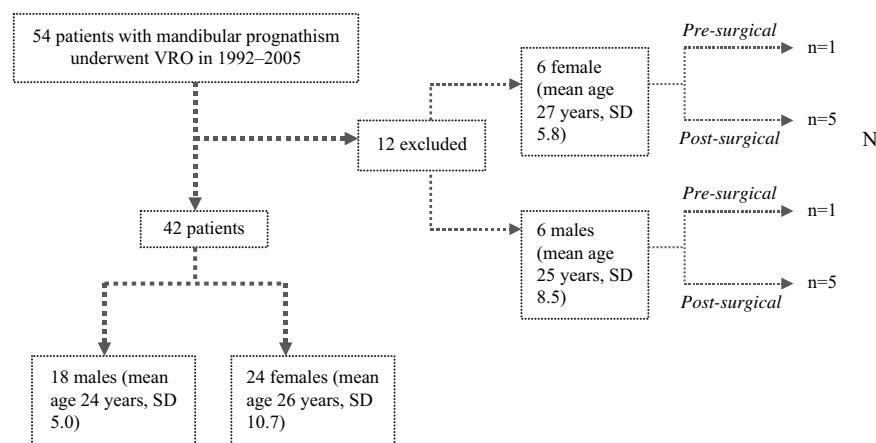


Figure 1 Schematic illustration of age and gender distribution and flow of patients who underwent vertical ramus osteotomy (VRO).

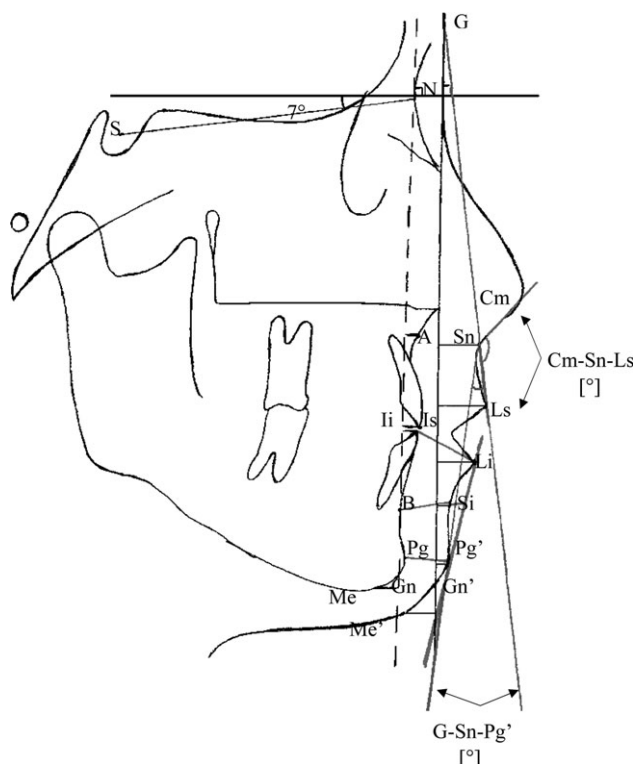


Figure 2 Cephalometric landmarks and definitions used in the study. Solid line: soft tissue; dashed line: hard tissue; SNA, angle between points S–N–ss; SNB, angle between points S–N–Sm; ANB, angle between points Ss–N–Sm; SNPg, angle between points S–N–Pg; G, glabella: the most anterior point on the forehead in the region of the supraorbital ridges; S, sella: the centre of sella turcica; N, nasion: the most anterior point of the frontonasal suture; x-axis, the horizontal plane at a 7 degree slope to sella-nasion (SN) plane; y-axis, the plane that passes through sella, perpendicular to the x-axis; Cm, columella point: the midpoint of the columella of the nose; Sn, subnasale: the point at which the columella (nasal septum) merges with the upper lip in the midsagittal plane. A, point A: the innermost point on the contour of the maxilla between anterior nasal spine and the incisor; Ls, labrale superius: the most anterior point of the upper lip; Is, incision superior incisal: the midpoint of the incisal edge of the most prominent maxillary central incisor; Li, incision inferior: the midpoint of the incisal edge of the most prominent mandibular central incisor; Li, labrale inferius: the most anterior point of the lower lip; Si, mentolabial sulcus: the point of greatest concavity in the midline between the lower lip (Li) and chin (Pg'); B, point B: the innermost point on the contour of the mandible between the incisor and the bony chin; Pg, pogonion: the most anterior point on the osseous contour of the chin; Pg', soft tissue pogonion: the most anterior point of the soft tissue chin; Gn, Gnathion: the most inferior point of the mandible in the midline; Gn', soft tissue gnathion: the most antero-inferior point of the soft tissue chin; Me, menton: the most inferior midline point on the mandibular symphysis; Me', soft tissue menton: the lowest point on the contour of the soft tissue chin; Cm–Sn–Ls, nasolabial angle: the angle made by points Cm–Sn–Ls; G–Sn–Pg', facial convexity: the angle made by points G–Sn–Pg'; Si depth, mentolabial fold depth: the distance from point Si to a line connecting Li and Pg'; Li–Li, B–Si, and P–Pg', soft tissue thickness: the distance from point Li to Li, from B to Si, and from P to Pg', respectively.

Method error and statistical analysis

The same investigator (JN) retraced 12 randomly selected radiographs on two separate occasions with an interval of 1 month. The method of Dahlberg (1949–1950) was used to determine error between duplicate determinations, and the

coefficient of reliability was calculated. No systematic errors were found when the analysis was evaluated with a paired *t*-test. Accidental error was generally small; all error values were less than 1.0 mm or 1.0 degree. Paired and unpaired Student's *t*-tests were used to compare values between the T1 and T2 cephalometric variables within and between the male and female groups. Pearson's correlation coefficient was used to examine relationships between soft and hard tissue changes and multiple regression analyses to examine whether age and gender influenced soft-to-hard tissue ratios.

Results

Changes in skeletal and dental horizontal measurements

In this study, the sample distribution resembled a normal distribution according to the descriptive data. The skeletal variables (SNA, point A) and dental landmark (Is) that were related only to the maxilla did not change between T1 and T2. All other hard tissue landmarks were relocated in a posterior direction (Table 1). ANB was corrected and changed from a mean -2.8 to $+1.7$ degrees, mostly through a decrease in SNB (mean 4.3 degrees). Mandibular setback before and after surgery changed from 76 to 80 mm (horizontal changes in B, Li, and Pg).

Changes in soft tissue horizontal measurements

Upper lip. Posterior repositioning of the upper lip landmarks, Sn and Ls, was observed 1 year after mandibular setback. The results revealed a tendency to flattening. The most pronounced backward movement was at Ls (mean 2.0 mm, SD 3.0; $P < 0.001$). Sn underwent a significant net posterior movement (mean 1.0 mm, SD 1.0; $P < 0.001$). A significant increase in the nasolabial angle (mean -3.2° , SD 6.6; $P < 0.01$) was also observed. Upper lip thickness significantly decreased, which was noted in the Sn–A measurement (mean 1.0 mm, SD 1.0; $P < 0.001$; Table 2).

Lower lip and chin. All soft tissue landmarks were significantly relocated in a posterior direction as an effect of mandibular setback. A mean increase (Si to Li–Pg') of -1.0 mm (SD 1.0; $P < 0.001$) in the mentolabial fold depth was also observed at T2. A slight net decrease in soft tissue thickness at the mentolabial fold region (B–Si) mean 1.0 mm (SD 1.0; $P < 0.001$) was registered and a slight mean increase of -2.0 mm (SD 2.0; $P < 0.001$) in lower lip thickness (Li–Li) was observed. Similarly, soft tissue thickness at the chin (Pg–Pg') remained mostly unchanged (mean 1.0 mm, SD 1.0; $P < 0.01$). Due to surgery, facial convexity (G–Sn–Pg') increased significantly (mean -7.8° , SD 3.5; $P < 0.001$; Table 2).

Changes in soft tissues related to hard tissue landmarks

The ratios of some changes in the soft tissues in relation to movement of the underlying hard tissues were calculated

(Table 3). Net hard tissue changes were generally higher than net soft tissue changes, e.g. slightly less change in Pg' than in Pg. Mean repositioning of Pg followed by Pg' was 100 per cent. Changes in the Li:Pg ratio indicated a mean posterior repositioning of 67 per cent. To record changes in upper lip position (Li) that may occur with posterior positioning of the mandible, the Ls:Pg movement ratio was investigated. The results indicated a 22 per cent mean change in upper lip position. A higher horizontal displacement of Ii followed by Li was maintained (mean 86 per cent). Correlation between the magnitude of skeletal movement and the amount of soft tissue change appeared to be good, and, except for the Sn:B ratio, differences in all variables listed in Table 3 were significant ($P < 0.001$).

Effect of gender on soft and hard tissue response

Differences between the genders in the magnitude of setback at the different hard and soft tissue variables were not significant except for Gn', where differences were significant ($P < 0.05$).

Effect of gender on ratios of soft-to-hard tissue change

The ratios of soft and hard tissue changes (S/H) before and after surgery were calculated for each gender (Table 4). Differences between genders in S/H were tested for significance. Soft tissue movement was generally greater in females than in males, but the difference was significant only for Pg'/Pg ($P < 0.05$) and Gn'/Gn ($P < 0.01$).

Effect of gender and age on the ratios of soft-to-hard tissue change

Multivariately, differences for the ratios listed in Table 5 were not significant when age and gender were kept constant with two exceptions; when age was constant, Pg'/Pg was 2.50 mm greater ($P < 0.05$) and Gn'/Gn was 2.80 mm greater ($P < 0.01$) for females than for males.

Discussion

In this investigation, mandibular setback surgery increased the nasolabial angle and decreased upper lip thickness, which is in agreement with reports of other authors (Lew *et al.*, 1990; Gjörup and Athanasiou, 1991; Hu *et al.*, 1999; Chunmaneechote and Friede, 1999; Mobarak *et al.*, 2001). One explanation for these changes is that the upper lip, because of the abnormal incisal relationship before surgery, is kept in a pseudoposition as a form of adaptation and compensation (Gjörup and Athanasiou, 1991). When a normal incisor relationship is achieved, the soft tissue overlying the incisors will improve lip competence and posture. Facial convexity (G–Sn–Pg') was also significantly increased ($-7.8 \pm 3.5^\circ$; $P < 0.001$) due to the surgery. A similar change in facial convexity was reported by Hu *et al.* (1999) and Mobarak *et al.* (2001).

Previous cephalometric studies (Kajikawa, 1979; Willmot, 1981; Fanibunda, 1989; Hu *et al.*, 1999; Mobarak *et al.*, 2001) found that the mentolabial fold became more concave after VRO, which is in line with the results of the

Table 1 Skeletal and dental variables measured on pre- (T1) and post-surgical (T2) cephalograms and changes in these variables (T1–T2) among 42 mandibular setback patients.

Variable	T1		T2		T1–T2	
	Mean	Standard deviation (SD)	Mean	SD	Mean ^a	SD
Skeletal (mm) ^b						
A	73.0	6.0	73.0	6.0	0.0	0.0
B	76.0	9.0	68.0	9.0	8.0***	2.0
Pg	79.0	10.0	70.0	10.0	9.0***	3.0
Gn	76.0	10.0	67.0	10.0	9.0***	3.0
Me	67.0	11.0	58.0	11.0	9.0***	4.0
Dental (mm) ^b						
Is	76.0	8.0	7.9	8.0	0.0	0.0
Ii	80.0	8.0	7.3	8.0	7.0***	3.0
Angular ($^\circ$) ^b						
SNA	81.4	4.0	81.4	4.0	0.0	0.0
SNB	84.4	4.2	80.0	4.0	4.3***	1.6
ANB	-2.8	2.1	1.7	2.1	-4.2***	1.6
SNPg	85.2	4.4	81.3	3.8	3.9***	1.7

^aP values refer to the mean differences T1–T2.

^bHorizontal changes: positive value, posterior movement; negative value, anterior movement. Dimensional changes: positive value, an increase; negative value, a decrease.

*** $P < 0.001$.

Table 2 Soft tissue variables measured on pre- (T1) and post-surgical (T2) cephalograms and changes in these variables (T1–T2) among 42 mandibular setback patients.

Variable	T1		T2		T1–T2	
	Mean	Standard deviation (SD)	Mean	SD	Mean ^a	SD
Soft tissue (mm) ^b						
Sn	91.0	7.0	90.0	7.0	1.0***	1.0
Pg'	91.0	11.0	82.0	11.0	9.0***	4.0
Gn'	85.0	11.0	76.0	12.0	9.0***	3.0
Me'	70.0	12.0	60.0	13.0	1.0***	4.0
Ls	92.0	8.0	90.0	9.0	2.0***	3.0
Li	94.0	9.0	88.0	9.0	6.0***	3.0
Si	89.0	9.0	81.0	10.0	8.0***	3.0
Soft tissue thickness (mm) ^b						
Ii–Li	16.0	2.0	18.0	2.0	–2.0***	2.0
B–Si	13.0	2.0	13.0	2.0	1.0***	1.0
Pg–Pg'	13.0	2.0	12.0	3.0	1.0**	1.0
Si to Li–Pg'	5.0	6.0	7.0	7.0	–1.0***	1.0
Sn–A	18.0	3.0	17.0	3.0	1.0***	1.0
Angular (°) ^b						
G–Sn–Pg'	3.0	5.6	10.8	4.4	–7.8***	3.5
Cm–Sn–Ls	98.4	27.8	101.6	28.1	–3.2**	6.6

^aP values refer to the mean differences T1–T2.

^bHorizontal changes: positive value, posterior movement; negative value, anterior movement. Dimensional changes: positive value, an increase; negative value, a decrease.

P < 0.01; *P < 0.001.

Table 3 Ratio of soft-to-hard tissue change (S/H) in the horizontal plane in 42 patients.

Variables (S/H)	Soft tissue (mm)	Hard tissue (mm)	S/H	r ^a
Ls/Pg	2.0	9.0	0.22	0.56***
Li/Ii	6.0	7.0	0.86	0.70***
Li/Pg	6.0	9.0	0.67	0.71***
Pg'/Pg	9.0	9.0	1.00	0.76***
Si/B	8.0	8.0	1.00	0.84***
Si/Pg	8.0	9.0	0.89	0.72***
Sn/B	1.0	8.0	0.13	0.08
Gn/Gn'	9.0	9.0	1.00	0.99***

^aPearson's correlation coefficient for soft and hard tissue changes.

***P < 0.001.

present study. This increase in mentolabial fold depth is probably related to the decrease in soft tissue thickness in that area. A normalization of perioral muscle function could be another explanation.

In addition, significant retropositioning of the lower lip was found, but the upper part of the lower lip did not generally follow the setback of the hard tissue as closely as the mentolabial fold or the soft tissue of the chin followed the hard tissue. The net effect on point Li in this study was 86 per cent of that of the mandibular incisor. In other studies, the net effect for the lower lip was reported to vary between 66 and 105 per cent (Lines and Steinhauser, 1974; Kajikawa,

1979; Gjörup and Athanasiou, 1991; Ingervall *et al.*, 1995; Hu *et al.*, 1999; Mobarak *et al.*, 2001). This difference could be related to the pre-operative soft tissue thickness of the measured points. Mobarak *et al.* (2001) investigated soft tissue thickness and pre-operative morphology and found that the greater the pre-operative soft tissue thickness of the lower lip the greater the expected change.

The correlation coefficients between the net effects on the hard and soft tissues agree well with those in other investigations (Willmot, 1981; Fanibunda, 1989; Gjörup and Athanasiou, 1991; Ingervall *et al.*, 1995; Gaggli *et al.*, 1999), as in the present study, coefficients close to 0.9 were found for the soft tissue chin and the underlying hard tissue. Correlations of this magnitude allow useful predictions to be made. However, the ratio between soft and hard tissue changes varies. In the present research and in the other studies, the soft tissue chin varied between 80 and 107 per cent and the mentolabial fold between 90 and 112 per cent (Table 4). Most studies, however, have reported percentage values relatively close to 100. As a rule of thumb, a 1:1 ratio between soft and hard tissue changes can be assumed for the net antero-posterior effect at the mentolabial fold and chin. For the lower lip, on the other hand, correlation coefficients are generally somewhat smaller. In the present study, the net change of lower lip (Li) to skeletal pogonion (Pg) was 67 per cent, which is comparable with that found by Lines and Steinhauser (1974), Mommaerts and Marxer (1987), and Quast *et al.*

Table 4 Ratio of soft-to-hard tissue change (S/H) in the horizontal plane in 18 males and 24 females.

Variables (soft/hard)	Males				Females				P value ^b
	Soft tissue (mm)	Hard tissue (mm)	S/H	<i>r</i> ^a	Soft tissue (mm)	Hard tissue (mm)	S/H	<i>r</i> ^a	
Ls/Pg	2.0	9.0	0.22	0.55*	2.0	9.0	0.22	0.58***	NS
Li/Ii	6.0	7.0	0.86	0.70***	6.0	7.0	0.86	0.72***	NS
Li/Pg	6.0	9.0	0.66	0.69***	6.0	9.0	0.66	0.73***	NS
Pg'/Pg	8.0	9.0	0.88	0.76***	9.0	9.0	1.00	0.84***	<0.05
Si/B	8.0	8.0	1.00	0.91***	9.0	8.0	1.13	0.81***	NS
Si/Pg	8.0	9.0	0.88	0.84***	9.0	9.0	1.00	0.65***	NS
Sn/B	1.0	8.0	0.13	0.06	1.0	8.0	0.13	0.12	NS
Gn'/Gn	8.0	9.0	0.89	0.75***	8.0	10.0	0.80	0.66***	<0.05

^aPearson's correlation coefficient for soft and hard tissue change.

^bSignificance of difference in S/H ratios between males and females.

* $P < 0.05$; *** $P < 0.001$.

Table 5 Ratio of soft-to-hard tissue change (S/H) when gender and age are kept constant in a group of 42 males and females.

	Dependent variables (soft tissue/hard tissue)							
	Ls/B	Li/Ii	Li/Pg	Pg'/Pg	Si/B	Si/Pg	Sn/B	Gn'/Gn
Age (B) ^a	0.00	0.10	0.00	0.10	-0.10	-0.10	0.10	-0.10
Gender (B) ^a	0.60	-0.70	0.40	2.50*	0.80	0.80	-0.60	2.80**
<i>R</i> ^{2b}	0.02	0.03	0.01	0.06	0.03	0.03	0.06	0.17
<i>F</i> ^c	0.30	0.59	0.15	2.46	1.73	1.67	1.15	5.23
P value	0.75	0.56	0.87	0.01**	0.19	0.20	0.36	0.01**

^aB, regression coefficient.

^b*R*², squared multiple correlation coefficient.

^c*F* value, mean square regression/mean square residual; df1/df2 = 2/39.

* $P < 0.05$; ** $P < 0.01$.

(1983). Thus, the outcome of the setback is less predictable for the lower lip. Excessive accompanying movement of soft tissue pogonion relative to skeletal pogonion found in the present study is possibly related to relaxation of the soft tissue chin and a new configuration with a more convex form.

Few studies have reported gender and age effects on soft and hard tissue changes. In the present study, absolute measurements (Table 3) and ratios (Table 4) are reported together to eliminate the effect of size differences between males and females. The findings demonstrate only a significant difference between absolute measurements for males and females in soft tissue gnathion ($P < 0.05$). This finding is contrary to that of Hu *et al.* (1999) who found soft tissue pogonion to be significantly greater in females than in males and soft tissue thickness at Li-Ii and Pg-Pg' to be lower in females and higher in males. In their study, the mentolabial fold became significantly flatter in the female sample. The differences in the present study and that of Hu *et al.* (1999) may be related to intergroup differences between the subjects. Previous studies (Wei, 1969; Ngan

et al., 1997) have found gender differences in skeletal and soft tissue measurements in white and Chinese Class III subjects. The ratios of soft-to-hard tissue change were somewhat greater in females than in males (statistically significant for the chin, $P < 0.05$, and gnathion, $P < 0.01$), which is in agreement with the conclusions of Mobarak *et al.* (2001). In the Chinese sample investigated by Hu *et al.* (1999), ratios were greater for females than males. Those authors related these differences to the greater thickness of the soft tissues in males compared with females. In the present study, multivariate regression analyses were used to investigate how age and gender simultaneously affect the ratios. No significant age or gender differences was found in the ratios except for Pg'/Pg, where the ratio for females was 2.5 mm ($P < 0.05$) greater than for males, and in Gn'/Gn, where the ratio for females was 2.8 mm ($P < 0.01$) greater than for males with age kept constant. This suggests that clinicians should use gender-based data to improve prediction accuracy.

However, the prediction of soft tissue changes is not a precise science. Cephalometric norms differ from one

population to another, and facial attractiveness is influenced by racial, ethnic, and social background and by the patient's expectations. Facial attractiveness has no standards, and what the public perceives to be the most beautiful face would not match the average person's face (Perrett *et al.*, 1994). Furthermore, soft tissue responses to orthognathic correction are influenced by several factors. The final position of the soft tissue is directed not only by the degree of prognathism but also by the three-dimensional interrelationship of the hard and soft tissues that existed before surgery. Hence, to predict final appearance and treatment success, such as the degree of overbite or overjet, the presence or absence of a lip seal, and the degree of stretching or contraction of muscles, subcutaneous tissues, and skin before surgery should be taken into account.

Conclusion

Mandibular setback surgery resulted in an increase in facial convexity, a deepening of the mentolabial fold, an increase in lower lip thickness, a decrease in upper lip thickness, and an increase in the nasolabial angle. Soft and hard tissue changed in a 1:1 ratio at the mentolabial fold and the chin for females and 1:1,1 for males. The ratios were greater in females than males. Age effects on the ratios were not significant.

According to the above findings, clinicians should consider gender when predicting the post-surgical position of the soft tissues in the region of the chin in patients with mandibular prognathism.

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