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Soft tissue stability in segmental distraction of the anterior mandibular alveolar process. A 2-year follow-up

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Abstract. This study evaluated soft tissue changes in adult patients treated with distraction osteogenesis (DOG) of the anterior mandibular alveolar process and related it to different parameters. 33 patients (27 females; 6 males) were analysed retrospectively before surgery at T1 (17.0 days), after surgery at T2 (mean 6.5 days), at T3 (mean 24.4 days), and at T4 (mean 2.0 years). Lateral cephalograms were traced by hand, digitized, superimposed, and evaluated. Statistical analysis was carried out using Kolmogorov–Smirnov test, paired *t* test, Pearson's correlation coefficient, and linear backward regression analysis. 2 years postoperatively (T4), the net effect of the soft tissue at point B′ was 100% of the advancement at point B whilst the lower lip (labrale inferior) followed the advancement of incision inferior to 46%. Increased preoperative age was correlated ($p < 0.05$) with more horizontal backward movement (T4–T3) for labrale superior and pogonion′. Higher NL/ML′ angles were significantly correlated ($p < 0.05$) with smaller horizontal soft tissue change at point B′. Gender and the amount of skeletal and dental advancement were not correlated with postoperative soft tissue changes (T4–T3). DOG of the anterior mandibular alveolar process is a valuable alternative for mandibular advancement regarding soft tissue change and predictability.

Keywords: distraction osteogenesis; soft tissue stability; soft tissue to hard tissue ratio; soft tissue change; cephalometry; mandibular advancement.

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The early 21st century saw a paradigm shift in the treatment goal for orthodontic patients. The emphasis on skeletal and dental relationships is changing towards greater consideration of the facial soft tissues[16]. The combination of orthodontic treatment with maxillofacial surgery aims for optimal function and the best aesthetic results. Commonly, when orthognathic surgery is planned, the skeletal tissues are used to determine the amount of change necessary to provide an appropriate soft tissue profile change. The clinician needs precise information to increase the ability to predict the surgical effect of skeletal displacement on the patient's overlying soft tissue profile.

The changes in shape and position of the overlying soft tissues in retrognathic patients has been evaluated mainly for bilateral sagittal split osteotomy (BSSO) with mandibular advancement[2,5,8,13,15,18] and less frequently for mandibular distraction osteogenesis (DOG)[1,12]. Until now, the evaluation of the soft tissue profile and its change in DOG of the lower anterior

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mandibular alveolar segment has not been carried out, whereas skeletal relapse has been examined recently[9]. DOG of the lower anterior mandibular alveolar segment was introduced by Triaca et al.[19,20]. They noted that DOG of the anterior mandibular alveolar process can be applied in the following specific cases: skeletal Class II patients with crowding to reduce the required sagittal distance to be achieved by an advancement BSSO; skeletal Class III patients to create space for the decompensation of the lower incisor inclination; skeletal Class I with dental Class II patients to create space of one premolar width and overjet normalization; and skeletal and dental Class I patients with crowding to avoid extraction and the often resulting unfavourable profile.

The aim of the present study was to evaluate the soft tissue changes in adult patients treated with DOG of the anterior mandibular alveolar process and to relate them to different parameters.

Materials and methods

The sample consisted of 33 Caucasian patients (27 females; 6 males); aged 16.5–56.0 years (mean 30.3 years, SD 10.7). They were treated orthodontically by one orthodontist (MA) and underwent DOG of the mandibular anterior alveolar process to correct a skeletal Class II and large overjet, with or without incisor crowding, from 1998 to 2004[9]. The female patients had a mean age of 30.8 years (16.8–56.0 years, SD 10.9 years) and the male patients 28.3 years (16.5–43.7 years, SD 10.5 years). The surgical procedure was performed by one experienced maxillofacial surgeon (AT); the technique has been published previously[19,20]. Patients receiving other surgical procedures simultaneously on the mandible and maxilla, such as genioplasty, BSSO, and Le Fort were excluded. Syndromic or medically compromised patients were excluded.

Ethical approval was obtained from the ethics committee of the Kanton Zürich, Switzerland, number 593. All subjects signed written, informed consent.

Four cephalograms were taken: the first, on average, 17.0 days before surgery (T1); the second (T2) between 0 and 12 days (mean 6.5 days) after the osteotomy and before any distraction was carried out; the third (T3) between 13 and 92 days (mean 24.4 days); and the fourth (T4) between 0.9 and 3.7 years (mean 2.0 years) after distraction of the mandibular anterior alveolar process. The distraction was completed at T3 and the orthodontic treatment at T4. All patients were debonded before T4 and the retention of the lower incisors was achieved with a bonded canine-to-canine retainer.

Cephalometric analysis

The soft tissue changes were evaluated on profile cephalograms taken with the teeth in the intercuspal position, and including a linear enlargement of 1.2%. The cephalograms were taken with the subject standing upright with a natural head position and with relaxed lips. The same X-ray machine and the same settings were used to obtain all cephalograms.

The lateral cephalograms of each patient were scanned and evaluated with the program Viewbox 3.1® (dHal software, Kifissia, Greece). The conventional cephalometric analysis for T1, T2, T3, and T4 was carried out by one author (CUJ) and included the reference points and lines shown in Fig. 1. Horizontal (*x* values) and vertical (*y* values) linear measurements were obtained by superimposing the tracings of the different stages (T2, T3, and T4) on the first radiograph (T1), and the reference lines were transferred to each consecutive tracing. During superimposition, particular attention was given to fitting the tracings of the cribriform plate and the anterior wall of the sella turcica which undergo minimal remodelling[3]. A template of the outline of the mandible of the preoperative cephalogram (T1) was made to minimize errors for superimposing on subsequent radiographs.

Conventional cephalometric variables as well as the coordinates of the reference points were calculated by the computer program. The coordinate system had its origin at point S (sella), and its *x* axis formed an angle of 7° with the reference line NSL (Fig. 1). Overjet and overbite were calculated from the coordinates of the points Is (incision superior) and Ii (incision inferior).

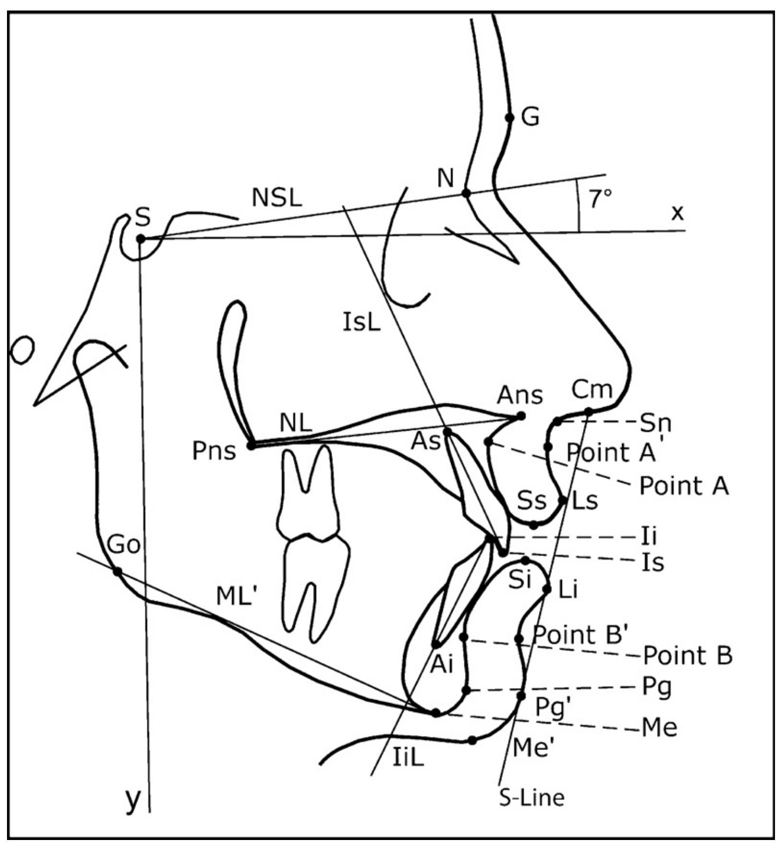

Fig. 1. Reference points and lines used in the cephalometric analysis. The coordinate system had its origin at point S (sella), and its *x* axis formed an angle of 7° with the reference line NSL. G, glabella; S, sella; NSL, nasion-sella-line; N, nasion; *x*, horizontal reference plane; NL, nasal line; Cm, columella; Sn, subnasale; ILs, upper incisal line; Ans, anterior nasal spine; Pns, posterior nasal spine; As, apex superior; point A; point A′, soft tissue point A; Ls, labrale superior; Ss, stomion superior; Ii, incision inferior; Is, incision superior; Si, stomion inferior; Li, labrale inferior; Go, gonion; ML′, mandibular line prime; Ai, apex inferior; point B; point B′, soft tissue point B; Pg, pogonion; Pg′, soft tissue pogonion; Me, menton; Me′, soft tissue menton; S-line; and *y*, vertical reference plane.

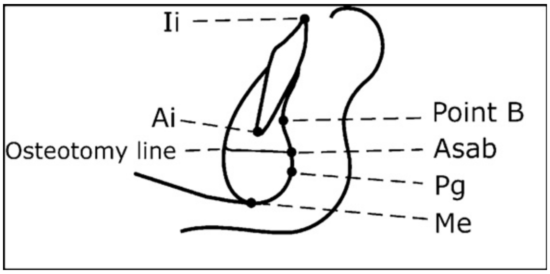

Fig. 2. Reference points used in the cephalometric analysis of the lower apical base in DOG patients. Ii, incision inferior; point B; Ai, apex inferior; Asab, apical surgical anterior base; Pg, pogonion; and Me, menton. Asab is the most anterior and inferior point of the lower anterior segment resulted by the surgical osteotomy. Asab was introduced to evaluate the movement (rotation versus translation) of the lower anterior segment base in comparison to the lower incisors (Ii); for the ratio see the text.

The lateral cephalograms of T2 were only used to locate the cephalometric point, called the alveolar surgical anterior base (Asab) before postoperative distraction of the alveolar process was carried out. Asab is the most anterior and inferior point of the lower anterior segment resulting from the surgical osteotomy (Fig. 2). This cephalometric point was introduced to evaluate the movement (rotation versus translation) of the lower anterior segment base in comparison with the lower incisors as ratio (Ii [*x* value, T3–T2]/Asab [*x* value, T3–T2]).

Error of the method

To determine the error of the method, 21 randomly selected cephalograms were retraced and re-analysed after a 2-week interval. Horizontal (*x* values) and vertical (*y* values) linear measurements were reobtained by superimposing the tracings of the different stages (T2–T4) on the first radiograph (T1). The error of the method (si) was calculated with the formula:

$$si = \sqrt{\frac{\sum d^2}{2n}}$$

where *d* is the difference between the repeated measurements and *n* is the number of duplicate determinations[4].

The random errors are presented in Table 1. The measurement of the nasiolabial angle (Cm–Sn–Ls) and menton (*x* value) were excluded owing to the increased random error. No systematic errors were found when the values were evaluated with a paired *t* test.

Statistical analysis

Statistical analyses were conducted using SPSS software (version 13.0, SPSS Inc., Chicago, IL, USA). Normal distribution was confirmed with the Kolmogorov–Smirnov test. The effect of treatment (i.e. the differences between the variables and co-ordinates at T3 and T1, T4 and T1, T4 and T3) was tested with a paired *t* test. The relationships between soft tissue and skeletal variables, age, and gender were analysed with the Pearson's product moment correlation coefficient and linear backward regression analysis.

Table 1. Random errors (si) of the cephalometric analysis.

Variable	si	Variable	si	Reference point	si (mm) *x*	si (mm) *y*
SNA (°)	1.14	Overjet (mm)	0.36	Incision sup.	0.48	0.21
SNB (°)	0.82	Overbite (mm)	0.53	Incision inf.	0.58	0.55
ANB (°)	0.48	Cm–Sn–Ls (°)	3.32	Point B	0.28	0.45
NSL/NL (°)	0.86	G–Sn–Pg′ (°)	1.14	Asab	0.35	0.25
NSL/ML′ (°)	1.01	Ls/Cm–Pg′ (mm)	0.67	Pogonion	0.37	1.19
NL/ML′ (°)	0.84	Li/Cm–Pg′ (mm)	0.49	Menton	0.89	0.45
IsL/NSL (°)	1.52			Labrale sup.	0.78	1.30
IsL/NL (°)	1.31			Stomion sup.	1.68	0.99
IiL/ML′ (°)	1.39			Labrale inf.	1.07	1.01
IsL/IiL (°)	1.63			Stomion inf.	1.15	0.85
				Point B′	1.20	1.10
				Pogonion′	1.19	1.15
				Menton′	3.07	1.21

Results

Horizontal and vertical changes

Table 2 shows the selected variables at T1 and T4. The mean changes, standard deviations, and ranges for the selected cephalometric parameters (horizontal and vertical direction) before surgery and during the subsequent observation periods are given in Tables 3 and 4.

Negative values imply a backward, and positive values a forward, movement of the point in the horizontal plane. Negative values imply an upward, and positive values a downward, movement of the point in the vertical plane.

Soft to hard tissue ratios

The net effect (T4–T1) in labrale inferior was 46% of the advancement in Ii. The corresponding values for point B′ to point B was 100% and for labrale superior to Ii −2%.

Correlations and backward linear regression

In the period T4–T3, an increase in the patient's age was significantly correlated with a downward movement of the vertical, or *y* values, of stomion inferior ($p = 0.023$; $R = 0.395$), point B′ ($p = 0.012$; $R = 0.431$), pogonion′ ($p = 0.011$; $R = 0.439$), and menton′ ($p = 0.014$; $R = 0.422$). Increased patient age was significantly correlated with a backward movement of the horizontal, or *x* values, of labrale superior ($p = 0.035$; $R = -0.368$) and pogonion′ ($p = 0.006$; $R = -0.466$) in the period (T4–T3).

The amount of advancement (T3–T1, *x* values) at point B and Ii was not significantly correlated with the amount of change (T4–T3, *x* and *y* values) measured at soft tissue points. A higher ratio (Ii [*x* value, T3–T2]/Asab [*x* value, T3–T2]), i.e. a more rotational than translational distraction of the alveolar process, was significantly correlated ($p = 0.012$; $R = 0.433$) with a forward movement of labrale superior in the period (T4–T3). A preoperative larger NL/ML′ angle (T1) was significantly correlated ($p = 0.036$; $R = 0.366$) with a smaller horizontal change at point B′ (T4–T3, *x* value). No significant correlations were found between the change at T4–T3 of all soft tissue points and gender.

Correlations were significant between horizontal (*x* value) hard to soft tissue movements for point B and point B′ (T3–T1: $p = 0.000$; $R = 0.648$; T4–T3: $p = 0.003$; $R = 0.503$), for Ii and labrale inferior (T3–T1: $p = 0.000$; $R = 0.720$;

Table 2. Cephalometric variables at T1 (before surgery) and T4 (2 years after surgery).

T1	Mean	SD	Range	T4	Mean	SD	Range
SNA (°)	80.5	3.7	73.1–88.0		80.2	4.0	72.8–92.1
SNB (°)	76.2	4.1	68.8–85.4		77.2	4.4	69.9–90.1
ANB (°)	4.3	2.0	0.3–8.0		3.0	2.2	−1.4 to 6.6
NSL/NL (°)	7.6	4.2	−1.9 to 15.0		7.9	4.1	0–14.6
NSL/ML′ (°)	33.7	7.3	16.3–53.7		34.8	7.3	13.9–53.2
NL/ML′ (°)	26.0	6.4	13.9–44.8		26.9	6.3	12.4–45.4
IsL/NSL (°)	106.8	8.7	81.7–120.5		105.3	8.0	92.1–125.0
IsL/NL (°)	114.4	8.4	91.0–126.7		113.2	7.3	100.8–126.4
IiL/ML′ (°)	91.1	7.3	77.2–104.6		95.4	8.2	78.3–111.3
IsL/IiL (°)	128.5	12.4	106.9–157.3		124.5	10.6	100.1–145.6
Overjet (mm)	7.4	2.4	4.1–14.3		2.4	0.8	0.9–4.1
Overbite (mm)	4.0	2.0	0.7–7.5		1.7	1.6	−0.7 to 5.4
Facial convexity (°)	14.9	6.5	4.2–32.0		12.2	6.0	−2.5 to 25.5
Upper lip to S-line (mm)	−2.8	2.5	−8.8 to 2.4		−4.8	2.9	−10.4 to 1.5
Lower lip to S-line (mm)	−2.2	3.6	−11.2 to 3.2		−2.6	3.3	−8.3 to 5.1

Facial convexity, G–Sn–Pg′; upper lip to S-line, Ls/Cm–Pg′; lower lip to S-line, Li/Cm–Pg′.

T4–T3: $p = 0.000$; $R = 0.647$), for Ii and labrale superior (T3–T1: $p = 0.001$; $R = 0.539$; T4–T3: $p = 0.005$; $R = 0.482$).

Results for the backward linear regression analysis are shown in Tables 5 and 6.

Discussion

This research is a continuation of the authors' previous study[9] on the skeletal relapse rate in patients undergoing DOG of the anterior mandibular alveolar process. Additional surgical procedures on the mandible (e.g. genioplasty, BSSO) and maxilla were excluded to ensure a uniform patient sample. This allows the examination of DOG of the anterior mandibular alveolar process to be studied without the influence of other confounding surgical procedures. All patients were skeletally mature (mean age 30.3 years, SD 10.7) which excludes the effect of growth as a confounding factor.

Lateral cephalograms can only reproduce a two-dimensional preoperative and postoperative situation. There has been a recent trend to quantify soft tissue profile changes using three-dimensional evaluation (i.e. optical laser surface scanners[14], stereophotogrammetry with cameras[6], or

Table 3. Changes (mm or degree) in the variables and coordinates of the mandible and lower incisors as the immediate (T3–T1) and final (T4–T1) result of DOG surgery.

	Variable or coordinate	Short term change (T3–T1)†				Long term change (T4–T1)‡			
		Mean	p	SD	Range	Mean	p	SD	Range
Horizontal									
x value (mm)	Incision sup.	1.3	***	1.6	−1.3 to 5.4	0.1	ns	2.1	−3.6 to 6.5
	Incision inf.	6.4	***	2.5	−0.5 to 13.1	4.8	***	2.9	−0.9 to 10.4
	Point B	4.2	***	2.4	−0.21 to 11.6	3.4	***	2.3	0.1–11.8
	Asab	2.9	***	2.3	−1.1 to 6.7	1.6	***	2.2	−2.1 to 7.1
	Pogonion	0.0	ns	1.1	−3.7 to 1.8	0.6	*	1.5	−3.2 to 4.5
	Labrale sup.	1.0	***	1.5	−1.3 to 5.3	−0.1	ns	1.8	−3.7 to 5.6
	Labrale inf.	4.3	***	2.8	−1.6 to 11.2	2.2	***	2.6	−3.8 to 8.0
	Point B′	5.9	***	2.6	−0.5 to 11.4	3.4	***	2.3	0.7–10.0
	Pogonion′	4.9	***	1.9	1.5–8.6	3.0	***	2.0	−0.3 to 7.4
Vertical									
y value (mm)	Labrale sup.	1.2	**	2.4	−4.2 to 6.2	−0.1	ns	1.8	−2.8 to 4.1
	Stomion sup.	−0.7	*	1.8	−4.5 to 2.5	0.3	ns	1.2	−2.2 to 3.0
	Labrale inf.	0.9	ns	3.2	−5.9 to 9.6	0.9	ns	3.0	−4.2 to 9.4
	Stomion inf.	0.9	ns	3.1	−4.1 to 10.2	1.1	*	2.4	−4.2 to 8.3
	Point B′	3.8	***	4.0	−5.0 to 10.5	3.8	***	3.4	−2.4 to 16.1
	Pogonion′	1.0	ns	3.5	−6.9 to 9.1	2.3	**	4.4	−6.4 to 17.7
	Menton′	1.3	**	2.3	−3.9 to 7.1	1.9	***	2.8	−2.3 to 12.9
Angular (°) and linear measurements (mm)									
	Facial convexity	−3.1	***	3.0	−7.8 to 3.7	−2.7	***	3.0	−11.5 to 4.6
	Ls to S-line	−1.3	***	1.7	−7.0 to 2.4	−2.0	***	2.0	−5.9 to 1.1
	Li to S-line	0.6	ns	2.3	−4.3 to 6.6	−0.4	ns	2.1	−5.6 to 5.7
	Ii/Asab	1.87		15.4	−66.2 to 42.3				

T1, before surgery; T3, 24.4 days after surgery; T4, 2.0 years after surgery. Facial convexity, G–Sn–Pg′; upper lip to S-line, Ls/Cm–Pg′; lower lip to S-line, Li/Cm–Pg′.

† T3–T2 for Asab, Ii (*x* value, T3–T2)/Asab (*x* value, T3–T2) instead mean value the median was taken for this ratio and no paired *t*-test was possible because measured on a single occasion.

‡ T4–T2 for Asab.

* $p \le 0.05$.

** $p \le 0.01$.

*** $p \le 0.001$.

Table 4. Changes (mm, degree or ratio) in the variables and coordinates of the mandible and lower incisors as the relapse (T4–T3) of DOG surgery.

	Variable or coordinate	T4–T3			
		Mean	*p*	SD	Range
Horizontal					
x value (mm)	Incision sup.	−1.2	***	1.6	4.7–1.2
	Incision inf.	−1.6	***	2.1	−6.2 to 2.6
	Point B	−0.8	***	1.2	−3.2 to 1.7
	Asab	−1.2	***	1.5	−4.2 to 1.6
	Pogonion	0.7	***	1.0	−1.2 to 3.7
	Labrale sup.	−1.1	***	1.6	−4.4 to 2.7
	Labrale inf.	−2.0	***	1.8	−7.0 to 1.7
	Point B′	−2.4	***	1.7	−6.0 to 1.2
	Pogonion′	−1.9	***	2.0	−6.3 to 3.1
Vertical					
y value (mm)	Labrale sup.	−1.3	**	2.4	−7.8 to 2.4
	Stomion sup.	1.0	**	1.8	−1.8 to 5.2
	Labrale inf.	0.0	ns	3.6	−8.7 to 7.0
	Stomion inf.	0.1	ns	3.5	−9.3 to 6.2
	Point B′	0.0	ns	3.7	−8.5 to 8.0
	Pogonion′	1.3	*	3.2	−4.1 to 8.6
	Menton′	0.5	ns	2.8	−6.2 to 8.0
Angular (°) and linear measurements (mm)					
	Facial convexity	0.4	ns	2.2	−5.6 to 3.6
	Ls to S-line	−0.7	*	1.8	−4.0 to 2.5
	Li to S-line	−1.0	*	2.1	−4.8 to 3.5

T3, 24.4 days after surgery; T4, 2.0 years after surgery.
* $p \leq 0.05$.
** $p \leq 0.01$.
*** $p \leq 0.001$.

computed tomography assisted imaging[17]).

To the authors' knowledge, soft tissue ratios and changes in DOG of the anterior mandibular alveolar segment have not previously been investigated. In the present study, point B′ followed point B to 100% and lower lip (labrale inferior) the advancement of Ii to 46%. There are no data on adult patients after DOG available in the literature for comparison. Research on soft tissue compared with skeletal changes after DOG for mandibular elongation is only available for children with hypoplastic mandibles evaluated on lateral cephalograms[12] or photographs combined with postero-anterior cephalograms[1]. MELUGIN et al.[12] found that point B′ followed point B and pogonion′ to pogonion to 90% at post-consolidation in 27 paediatric patients. The magnitude of the advancement, and the age, and sex of the patients had no effect on these ratios.

Joss et al.[7] systematically reviewed the effect of BSSO with rigid internal fixation (RIF) or wire fixation (WF) for mandibular advancement on soft tissue ratios. Short- and long-term ratios for lower lip to lower incisor in RIF or WF can be described as 50%. No difference between short- and long-term ratios for point B′ to point B and pogonion′ to pogonion could be observed. It could be characterised as a 1 to 1 ratio. The exception was that pogonion′ to pogonion with RIF tended to be higher than a 1 to 1 ratio in long-term results. The upper lip mainly showed retrusion but high variability. There is almost no difference in the ratios for the lower lip and point B′ when comparing the present data to the data found in this review on BSSO for mandibular advancement in RIF and WF.

The influence of gender on soft tissue change has only limited validity because there was a predominance of female patients (27 versus 6 males) in this study. This is often found because more females seek orthodontic treatment combined with maxillofacial surgery[10,11]. Another possibility is that the total number of patients included was too small to determine any difference. Nevertheless, no significant correlations were found between gender and the change T4–T3 in all described soft tissue points.

The amount of skeletal and dental advancement (T3–T1, *x* values) at point B and Ii seems to have no influence on the amount of soft tissue change (T4–T3) measured at all described soft tissue points. These two findings are in accordance with the results of Joss et al.[8] in their long-term study on hard and soft tissue changes in patients with BSSO for mandibular advancement and RIF.

RIF, in the form of miniplates in the present study, adds more volume on the labial surface of the chin bone, which has an impact on the soft tissue profile and limits the exact location of cephalometric landmarks. Miniplates were present at T2 and T3 but surgically removed before T4 in all but one patient. The removal of the miniplates could have led to a slight increase in soft tissue change (T4–T3) of point B′.

The interface of the surgical section of the anterior aspect of the symphysis was also more susceptible to resorption and bony remodelling[9]. In addition to the new soft tissue position of the lower face, an important short-term effect of maxillofacial surgery and confounding variable is postoperative swelling (oedema from retraction, irritation and inflammation). Thus, the immediate short-term soft tissue profile changes measured on lateral cephalogram are always in addition to the surgery, swelling, and thickness of the orthodontic brackets[7].

2 years postoperatively, correlations were found between the patient's age and changes (T4–T3, *x* and *y* values) of different soft tissue points. Significant positive correlations were seen for vertical soft tissue change (*y* values) of stomion inferior, point B′, pogonion′, and menton′. That means that increased preoperative age showed more downward movement,

Table 5. Backward linear regression. Dependent variable: point B′ (*x* value) T4–T3.

Model	B	95% confidence interval for B		Significance	R	R^2
		Lower bound	Upper bound			
(Constant)	3.873	−2.704	10.450	.238		
Age	−.057	−.105	−.008	.024		
IiL/ML′ at T1	−.044	−.115	.028	.224	0.649	0.421
(Ii [*x* value; T3–T2]/Asab [*x* value; T3–T2])	−.015	−.053	.022	.401		
Point B (*x* value) T4–T3	.787	.314	1.261	.002		

Table 6. Backward linear regression. Dependent variable: labrale inf. (x value) T4–T3.

Model	B	95% confidence interval for B		Significance	R	R^2
		Lower bound	Upper bound			
(Constant)	−1.483	−4.267	1.301	.285		
Age	−.021	−.068	.026	.369		
NL/ML′ at T1	.047	−.033	.126	.238	0.719	0.517
Incision inf. (x value) T4–T3	.491	.242	.741	.000		
Incision sup. (x value) T4–T3	.261	−.069	.592	.117		

and younger age more upward movement in these points. Significant negative correlations were found for horizontal change (x values) for labrale superior and pogonion′. In other words, the older the patient, the more horizontal backward movement was seen for labrale superior and pogonion′. It is possible that soft tissue strength was reduced by further ageing.

The same patient population examined earlier for skeletal relapse did not show any significant correlations between age and amount of relapse (T4–T3) measured at Ii or point B[9]. Interesting research questions, such as associations between soft tissue change and gender, preoperative age, low and high angle patients, and the amount of advancement have not yet been addressed in other studies for DOG or BSSO on mandibular advancement[7] with one exception. Joss & Thuer[8] could not find any correlations between soft tissue changes and preoperative age, gender, and the amount of advancement in their long-term study on BSSO for mandibular advancement. It is possible that larger patient samples are able to show a difference between genders.

In selected cases, DOG of the anterior alveolar process is a valuable alternative to BSSO for mandibular advancement regarding soft tissue change and predictability.

Competing interests

None declared.

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Ethical approval

Yes. Ethical approval was admitted by the Ethic Committee of the Kanton Zürich, Switzerland, number 593.

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