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Consideration of effect of the amount of mandibular setback on the submental region in the planning of orthodontic–orthognathic treatment

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Abstract

Aesthetic outcome has gained in importance in the treatment of patients with orthognathic problems. Historically, Class III malocclusions have historically been treated by isolated mandibular setback and maxillary advancement, whereas bimaxillary procedures have recently become the more common option. Functional outcome and stability have been discussed previously. The aim of this observational study was to evaluate the effect of mandibular setback (BSSO) on the cervical region. We studied 38 Class III patients (20 women and 18 men, mean (SD) age 25 (0.8) years) who we identified from our clinical records and who were treated between 1 January 2002 and 30 December2012 with mandibular setback procedures and followed up for 6 months. To study the effect of the amount of mandibular setback on the aesthetic outcome we have distinguished between patients with less than 5 mm setback and those with 5 mm or more. In patients whose mandibular setback was less than 5 mm there was no significant change in cervical length. However, it decreased significantly in patients in whom the movement was 5 mm or more. Postoperatively the lip–chin–throat angle ($p = 0.02$), the length of the lower lip ($p = 0.002$), and the length of the upper lip ($p = 0.003$) from the aesthetic line also differed significantly between the 2 groups. Our observations strongly suggest that all these relations should be considered when treatment is being planned to avoid an unpleasant aesthetic impact on the chin region.

Keywords: Orthodontic and orthognathic treatment; Submental region; Mandibular setback

Introduction

When deformities of the jaw are being treated there are 3 main issues that must be dealt with: aesthetics, function, and long-term stability. Combined orthodontic and orthognathic surgical treatment can be used to optimise these issues in skeletal Class III malocclusion. Maxillary advancement, mandibular setback, and bimaxillary osteotomy are 3 options from which we should select the best procedure. The extent of complications should also be considered. These considerations should be borne in mind from the beginning when treatment is being planned.

Mandibular setback as the sole option for treatment is now used in less than 10% of Class III patients, whereas maxillary advancement is used in 45–50%, and two-jaw surgery has become the preferred method in the remaining 40–45%

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of cases.[1] Although this is supposed to optimise the aesthetic and functional outcome with better long-term stability, two-jaw surgery may increase the morbidity and has to be justified in relation to the stated goals.[2] Two-jaw surgery also allows adaptation of the amount of movement to the deformity presented, the desired result, and the surgical limitations. The amount of movement may also influence the functional and aesthetic outcome as well as the long-term stability. Generally treatment can be planned based on the extent and position of the deformity as seen in SNA and SNB. Some investigators have evaluated the lateral radiographs to measure the change in pharyngeal airway space after mandibular setback, and usually report a reduction. [2–8]

Demtriades et al.[9] reported a higher rate of mild to moderate obstructive sleep apnoea syndrome in patients with mandibular setback of 5 mm or more compared with those in whom it is less than 5 mm.

The aesthetic outcome should be considered during the planning of treatment. Many analyses of hard and soft tissue have been developed over the years to predict the amount the soft tissues change after the skeletal movement.[10] These studies have reported various results and further investigations are needed. There have been a considerable number of studies that have dealt with changes in soft tissues after mandibular setback.[11,12] However, few have specifically focused on the changes in the region of the chin and neck.[13]

We designed the present study to evaluate the effect of the degree of mandibular setback on the aesthetic outcome. Like Demetriades et al.[9] we used the cutoff of 5 mm in judging the degree of mandibular setback. The aesthetic outcome was assessed by the neck-chin contour, cervical length, and the aesthetics of the upper and lower lips. We hypothesised that there would be no significant changes in the aesthetic outcome between the two groups.

Patients and methods

We designed a cohort study based on medical records in our clinic. We identified 38 patients who presented to our clinic between 1 January 2002 and 30 December 2012 for orthodontic and orthognathic surgical treatment, and fulfilled the following criteria: they had skeletal Class III anomaly (Wits <0); skeletal growth was complete at the time of the intervention; mandibular setback (BSSO) was the surgical treatment chosen; and they had had no previous operations that involved the middle or lower face, or additional procedures such as genioplasty or rhinoplasty.

Patient's records, consisting of standard lateral cephalograms, were available for 34 patients. Lateral cephalometric radiographs were taken at the beginning of the orthodontic treatment and at least 6 months postoperatively to ensure that postoperative swelling did not mask the actual soft tissue changes. Patients were asked to have their teeth in occlusion and their lips in an unstrained and relaxed position to avoid muscular compensation. The following measurements were made (Fig. 1):

SNA angle, SNB angle, Wits appraisal, nasolabial angle (CotgSnLs); amount of mandibular setback, N-B; horizontal distance from the nasion perpendicular to B point; cervical length (Gn′-H); distance of the points soft tissue gnathion (Gn′) and neckpoint (H); facial contour (Gl′Sn-Pog′); angle between the upper and lower facial planes (EpPerp-Sn);lower lip-chin-throat-angle (LiPog′-Gn′H); the angle between a tangent to the lower lip and the chin and the throat line formed by the reference lines Li-Gn′ and Me′-H; the soft tissue balance (Ls-Ns Pog′); the distance from the upper lip to the aesthetic line and the lower lip to the aesthetic line (Li-NsPog′); the nasal prominence (SS – Ns); the distance from the tip of the nose to the sulcus of the upper lip; the basic thickness of the upper lip (A′-SS); the distance between about 3 mm below the A point on the lying point of the upper alveolar process and the nasolabial sulcus; the length of the upper lip (UpLL); the distance from subnasal (Sn) to stomion (Sto) that indicates the length of the upper lip; the length of the lower lip (LoLL); and the distance from the stomion (sto) to the gnathion (Gn′) that indicates the length of the lower lip.

To study the effect of the amount of mandibular setback on the aesthetic outcome, we distinguished between patients with less than 5 mm mandibular setback ($n = 16$) and those with 5 mm mandibular setback or more ($n = 18$).

Statistical analysis

Because of the limited sample size, we have restricted our statistical evaluation to a *t* test for independent samples. To assess the significance of differences between the 2 groups (less than 5 mm compared with 5 mm or more), we used the test that assumed non-homogeneity of variance. This adjusts degrees of freedom for the *t* distribution (Table 1). To assess the significance of differences between the two groups by sex, we used Fisher's exact test (Table 2). The reliability of measurements and the errors of the method were calculated by randomly selecting 15 cephalograms before and after operation. The same investigator analysed the cephalograms after 2 weeks. The SD of the error of each measurement was calculated according to Dahlberg's formula [14] ($SE = \sqrt{\Sigma d^2/2n}$), where d is the difference between the first and the second measurement and n is the number of double measurements (Table 1). SAS software (V 9.0) under Windows 7.0 was used for computations, and probabilities of less than 0.05 were accepted as significant.

Results

The sample comprised 38 Class III patients (18 men and 20 women, mean (range) age 25 (16–51) years who required orthodontic and orthognathic treatment (Table 2). We had cephalograms both before and after operation for only

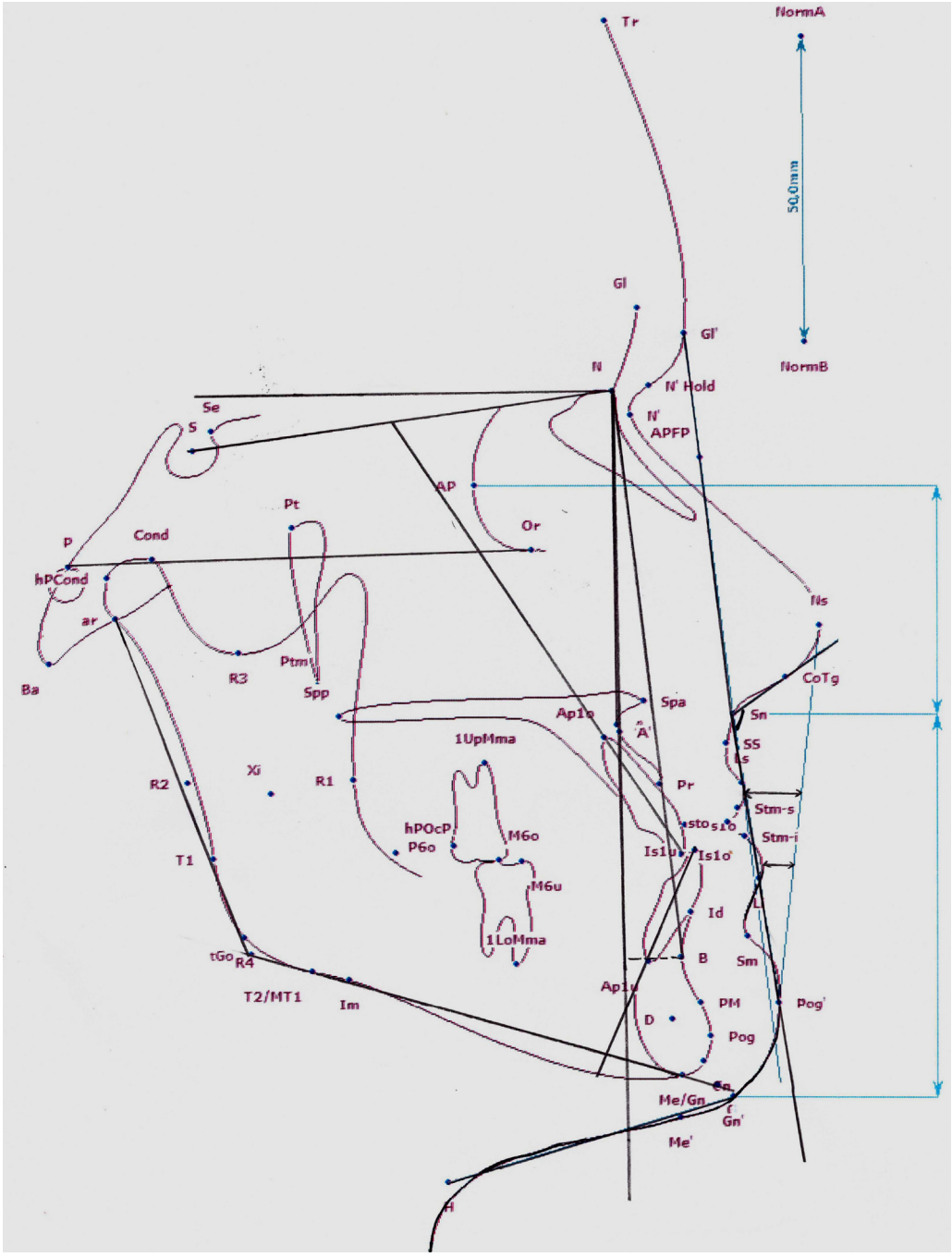

Fig. 1. Graphic mean tracing of hard and soft tissue (Gonion angle, Mandible inclination, Upper 1 inclination, Lower lip to E-line, Nasolabial angle, Soft tissue facial angle, Nose prominence, Upper lip thickness, Upper lip length, Lower lip length, Cervical length, Lip chin throat angle, Facial contour, Upper lip to E-line).

34 patients. The mean (SD) amount of mandibular setback was 5.4 (3.1) mm. The mandibular position was changed by a maximum of 12.7 mm and a minimum of 3.8 mm.

Table 1 shows the means (SD) and Dahlberg errors before and after operation. The error of the method (Dahlberg error) [14] was less than 1.00 (Table 1). Soft tissue balance differed significantly relative to differences at point B between the 2 groups ($p = 0.002$). The mean distance of the upper lip was changed by 1.3 (2.4) mm in the group with less than 5 mm setback and 3.4 (1.2) mm in the group with 5 mm setback or more.

The distance from the lower lip to the aesthetic line changed significantly depending on the amount of mandibular setback ($p = 0.007$). The patients in the <5 mm group had a mean difference of −0.2 (3.6) mm, and in the 5 mm or more group had a mean difference of −1.5 (3.2) mm (Table 2). The cervical length differed significantly ($p = 0.003$) between the two groups (Table 2).

Table 1
Mean (SD) values of selected cephalometric variables before and after operation with Dahlberg's SD of error for each varia.

Variable	Preoperatively	Postoperatively	Accidental error
SNA (°)	81 (4.2)	81 (4.1)	0.8
SNB (°)	83.9 (4.7)	80.5 (4.2)	0.8
Wits appraisal (mm)	−10 (4.1)	−4.1 (3.5)	0.8
Gonion angle (°)	128.5 (6.3)	128.2 (6.9)	1.0
Inclination of mandible (°)	34.6 (6.8)	34.8 (6.4)	0.9
Inclination of upper 1 (°)	105.6 (7.6)	104.9 (5.8)	0.8
Lower lip to E-line (mm)	−8.3 (3.3)	−5.7 (3.7)	0.5
Nasolabial angle	−2.5 (3.3)	−3.4 (3)	0.9
Soft tissue facial angle	110 (12.5)	100.6 (12.2)	0.8
Thickness of upper lip (mm)	18.2 (3.5)	16.5 (3.3)	0.5
Pg′ (mm)	13 (3)	13 (4)	0.7
Length of upper lip (mm)	21.9 (4.3)	23.7 (4.4)	0.4
Length of lower lip (mm)	46.5 (7.5)	48.1 (6.1)	0.6
Cervical length (mm)	50.6 (10)	47.9 (10)	0.7
Lip-chin-throat angle	50.6 (10)	47.9 (10)	0.8
Upper lip to E-line (mm)	−8.3 (3.3)	−5.7 (3.7)	0.7

The mean change of the lip-chin-throat angle was 7 (2.1)° in the <5 mm group and 10.2 (4.5)° in the other group. These changes were significantly associated with the baseline measurement and the horizontal skeletal change ($p = 0.002$). The change in facial contour differed significantly between the two groups ($p = 0.04$) (Table 2).

Changes in gonion angle are shown in Table 2. There was no significant difference in the changes at point B and the gonion angle between the two groups ($p = 0.73$).

The mean change in the soft tissue facial angle in the <5 mm group was −2 (3)° and 3.1 (2.5)° in the other group. We found no significant mean change of the soft tissue facial angle between the two groups ($p = 0.29$) (Table 2).

The mean surgical change of the thickness of the upper lip was anterior movement of 0.7 (4.3) mm in the <5 mm group and 0.9 (2.7) mm in the other group. This was not significantly changed in relation to the amount of mandibular setback ($p = 0.66$). The length of the lower lip did not change significantly in relation to the amount of setback ($p = 0.07$) (Table 2).

The difference in the length of the upper lip did not change significantly according to the amount of mandibular movement ($p = 0.72$) (Table 2).

Discussion

The modern treatment of an orthognathic deformity requires complex planning by the orthodontist and the orthognathic surgeon and should be initiated during the first presentation. The aesthetic outcome is increasingly important, and the possible change in the soft tissue caused by change in the hard tissue should be considered during planning. Achieving optimal facial aesthetics has interested many research workers from different disciplines.[15] It influences the social and psychological development of the patient, and can play an important part in their relationships. [16,17] Many factors such as nose, lips, chin, and cervical length have a fundamental influence on the aesthetic outcome. Ho et al., [18] showed that the chin is a key aesthetic unit, which contributes to the

Table 2
Mean (SD) differences in soft tissue cephalometric index in relation to the degree of setback (*t* test for non-homogeneous variances): comparison of groups within sexes.

Variable	Setback < 5 mm ($n = 16$)	Setback 5 mm or more ($n = 18$)	Statistic	*P* value
Male/female	9/7	9/9	−0.4	0.73
Age (years)	28 (7)	27 (8)	0.2	0.82
Angle of gonion	−0.2 (3.4)	−0.6 (4.8)	0.3	0.78
Inclination of mandible (°)	−0.6 (2.6)	0.6 (2.2)	−2	0.06
Inclination of upper 1 (°)	1.6 (6.8)	−2.8 (7.9)	1.8	0.09
Lower lip to E-line (mm)	−0.1 (3.4)	−4.3 (1.4)	3.3	0.002
Nasolabial angle	−0.4 (9.6)	2 (5.6)	−0.9	0.38
Soft tissue facial angle	−2 (3)	−3 (2.5)	1.1	0.28
Nasal prominence	0 (2.9)	−0.6 (1.5)	0.7	0.48
Thickness of upper lip (mm)	0.7 (4.3)	0.7 (2.7)	0.5	0.66
Length of upper lip (mm)	1.1 (2.8)	0.7 (2.7)	0.4	0.72
Length of lower lip (mm)	−2 (5.3)	0.8 (3.3)	−1.9	0.07
Cervical length (mm)	−4.2 (2)	−7.1 (3.1)	3.2	0.003
Lip-chin-throat angle	7 (2.1)	10.2 (10)	−2.6	0.02
Upper lip to E-line (mm)	1.3 (2.4)	3.4 (1.2)	−3.4	0.002

balance and harmony of the lower third of the face. However, the lip–chin–throat angle has not often been considered in previous publications. [19]

The main purpose of this study was to discover the effect of mandibular setback on the lip–chin–throat angle and the cervical length. Various types of bias could affect observational studies, and the degree of bias cannot be assessed. Randomisation, which protects against the most important types of bias, could not be used because the amount of mandibular setback could not be randomised with respect to the patients. To make the measurements as objective as possible, which may be influenced by errors, we calculated the SD of the error according to Dahlberg's formula. Because of the sample size we were not able to account for confounding variables in our meta-analysis. However, our research is based on an important group of patients compared with other studies.[2]

Cervical length is important because of the possibility of creating a double jaw, which is aesthetically unpleasant. The only operation that we used was BSSO. There were significant changes in the lip–chin–throat angle in the group with mandibular setback of 5 mm or more. The mean change of the lip–chin–throat angle was 7.0 (2.1)° in the <5 mm group, and 10.2 (4.5)° in the other group. There were significant differences between the amount of mandibular setback and cervical length (Table 2).

Modern treatment of Class III deformity consists of advancement of the maxilla together with mandibular setback. The amount of repositioning of any jaw can influence the functional, aesthetic, and long-term stability of the achieved result. Lim et al. pointed out that the impact of soft tissue changes after mandibular setback was greater in the lower lip and chin than in the upper lip and corner of the mouth. [17] The generation of a double jaw should be considered in the amount of movement of the jaws, and not only according to the cephalographic values.

Until 2005 the correction of the skeletal discrepancy of Class III in our hospital had focussed primarily on mandibular setback as far as possible, and advancement of the maxilla to compensate. The main concept of treatment planning was based on cephalographic results. We increasingly adapted the amount of movement of the jaw to the anatomical findings and the deformity present on the one hand, but aimed for an optimal aesthetic and functional outcome on the other. In other words we adapted the amount of movement of the jaw individually, and not only according to the findings on the cephalograms.

As suggested by Arnett et al., [15] we should consider a combination of clinical, facial, and soft tissue cephalometrics as effective guidance to treat not only the occlusion but also the face in 3 dimensions to improve the aesthetic outcome. Our results have clearly shown the adverse effects of mandibular setback on submental aesthetics. As stated by Demetriades et al., [9], a mandibular setback of more than 5 mm also has an adverse effect on the functional outcome, and should be considered when treatment is being planned. Many recent studies have suggested bimaxillary surgery as the best option in Class III deformity, but for different reasons (Kunjur, et al. The effects on the upper airway following bimaxillary and bilateral sagittal split osteotomies to correct malocclusion. Paper presented at the British Association of Oral and Maxillofacial Surgeons meeting, 2013). [19–21] One reason is the significant increase in the width of the airway postoperatively, which is beneficial to the patient, whereas the opposite could be detrimental. We think that if this fact is ignored when treatment is being planned it will result in an undesired effect in the submental region, which may require additional operations such as liposuction. [18] If the amount of maxillary advancement is increased during double-jaw surgery, it will reduce the need for extensive mandibular setback. Reduced mandibular setback can influence the aesthetic and the functional outcome, as has been shown in this and other studies, by respecting anatomical feasibility. In addition, bimaxillary osteotomy has been shown to have better long-term stability. [21]

References

1. Guglielmi M, Schneider KM, Iannetti G, Feng C, Martinez AY. Orthognathic surgery for correction of patients with mandibular excess: don't forget to assess the gonial angle. *J Oral Maxillofac Surg* 2013;**71**:1063–72.
2. Jakobsone G, Stenvik A, Espeland L. Soft tissue response after Class III bimaxillary surgery. *Angle Orthod* 2013;**83**:533–9.
3. Mucedero M, Coviello A, Baccetti T, Franchi L, Cozza P. Stability factors after double-jaw surgery in Class III malocclusion. A systematic review. *Angle Orthod* 2008;**78**:1141–52.
4. Marşan G, Cura N, Emekli U. Soft and hard tissue changes after bimaxillary surgery in Turkish female Class III patients. *J Craniomaxillofac Surg* 2009;**37**:8–17.
5. Hochban W, Schürmann R, Brandenburg U, Conradt R. Mandibular setback for surgical correction of mandibular hyperplasia – does it provoke sleep-related breathing disorders? *Int J Oral Maxillofac Surg* 1996;**25**:33–8.
6. Saitoh K. Long-term changes in pharyngeal airway morphology after mandibular setback surgery. *Am J Orthod Dentofacial Orthop* 2004;**125**:556–61.
7. Tselnik M, Pogrel MA. Assessment of the pharyngeal airway space after mandibular setback surgery. *J Oral Maxillofac Surg* 2000;**58**: 282–7.
8. Eggensperger NM, Lieger O, Thüer U, Iizuka T. Soft tissue profile changes following mandibular advancement and setback surgery an average of 12 years postoperatively. *J Oral Maxillofac Surg* 2007;**65**:2301–10.
9. Demetriades N, Chang DJ, Laskarides C, Papageorge M. Effects of mandibular retropositioning, with or without maxillary advancement, on the oro-naso-pharyngeal airway and development of sleep-related breathing disorders. *J Oral Maxillofac Surg* 2010;**68**: 2431–6.
10. Abeltins A, Jakobsone G, Urtane I, Bigestans A. The stability of bilateral sagittal ramus osteotomy and vertical ramus osteotomy after bimaxillary correction of Class III malocclusion. *J Craniomaxillofac Surg* 2011;**39**:583–7.
11. Malkoç S, Demir A, Uysal T, Canbuldu N. Angular photogrammetric analysis of the soft tissue facial profile of Turkish adults. *Eur J Orthod* 2009;**31**:174–9.
12. Fernández-Riveiro P, Smyth-Chamosa E, Suárez-Quintanilla D, Suarez-Cunqueiro M. Angular photogrammetric analysis of the soft tissue facial profile. *Eur J Orthod* 2003;**25**:393–9.

13. Moreno A, Bell WH, You ZH. Esthetic contour analysis of the submental cervical region: a study based on ideal subjects and surgical patients. *J Oral Maxillofac Surg* 1994;**52**:704–14.
14. Dahlberg G. *Statistical methods for medical and biological students*. London: Allen & Unwin; 1940. p. 122–32.
15. Arnett GW, Gunson MJ. Facial planning for orthodontists and oral surgeons. *Am J Orthod Dentofacial Orthop* 2004;**126**:290–5.
16. Gerzanic L, Jagsch R, Watzke IM. Psychologic implications of orthognathic surgery in patients with skeletal Class II or Class III malocclusion. *Int J Adult Orthodon Orthognath Surg* 2002;**17**:75–81.
17. Lim YK, Chu EH, Lee DY, Yang IH, Baek SH. Three-dimensional evaluation of soft tissue change gradients after mandibular setback surgery in skeletal Class III malocclusion. *Angle Orthod* 2010;**80**:896–903.
18. Ho CT, Huang CS, Lo LJ. Improvement of chin profile after mandibular setback and reduction genioplasty for correction of prognathism and long chin. *Aesthetic Plast Surg* 2012;**36**:1198–206.
19. Mobarak KA, Krogstad O, Espeland L, Lyberg T. Factors influencing the predictability of soft tissue profile changes following mandibular setback surgery. *Angle Orthod* 2001;**71**:216–27.
20. Proffit WR, Phillips C, Turvey TA. Stability after surgical- orthodontic correction of skeletal Class III malocclusion. III. Combined maxillary and mandibular procedures. *Int J Adult Orthodon Orthognath Surg* 1991;**6**:211–25.
21. Costa F, Robiony M, Sembronio S, Polini F, Politi M. Stability of skeletal Class III malocclusion after combined maxillary and mandibular procedures. *Int J Adult Orthodon Orthognath Surg* 2001;**16**:179–92.