ORIGINAL ARTICLE

Soft Tissue Esthetic Changes Following a Modified Twin Block Appliance Therapy: A Prospective Study

Mohamadreza Shahamfar[1], Mohamad Hossein A Atashi[2], Niloofar Azima[3]

Abstract

Aim: Achieving a satisfactory facial esthetics is of utmost importance in the practice of orthodontics. Cl II div 1 patients often suffer from numerous adverse facial characteristics which may impair their social well-being. The objective of the current study was to evaluate the esthetic changes in such patients by using a modified twin block appliance.

Materials and methods: Seventy adolescent patients with mandibular deficiency consecutively underwent treatment with a modified twin block appliance for a mean period of 13 months. Soft tissue analyzes of Burstone and Mcnamara were applied to evaluate the changes before and after the treatment. The esthetic changes before and after the therapy were compared using parametric paired *t* tests analysis. *p* values less than 0.05 were considered significant.

Results: Facial convexity, lip incompetence, upper lip protrusion, and columellar inclination significantly decreased ($p < 0.05$) while Merrifield's *Z*-angle nasolabial angle, lower lip length, and mentolabial angle significantly increased ($p < 0.05$). Vertical facial height ratio, lower lip protrusion, upper lip length as well as nasal projection and inclination, did not change significantly ($p > 0.05$)

Conclusion: Our findings indicated that a modified form of the twin block appliance can be substantially effective in the improvement of several aspects of patients' facial balance with minimum untoward effects.

Clinical significance: Adolescents suffering from mandibular deficiency can gain substantial facial balance with the twin block appliance. The whole face attractiveness, however, is another subject and should not be conflicted with the facial balance.

Keywords: Esthetics, Facial profile, Soft tissue, Twin block.

International Journal of Clinical Pediatric Dentistry (2020): 10.5005/jp-journals-10005-1759

Introduction

Facial esthetic improvement is a key objective in the practice of orthodontics. The contemporary paradigm of soft tissue enhancement underlines the importance of this issue.[1] The Cl II division 1 malocclusion is one of the most frequent orthodontic conditions encountered by the patients comprising 20–30% of all orthodontic patients.[2] The condition may pose such adverse facial characteristics that may result in negative psychological consequences and reduced self-esteem of the patients.[3] These characteristics include retrusive chin, increased facial convexity angle, lip incompetence and decreased mentolabial angle.[4]

It is generally agreed that functional appliances can be used to successfully treat Cl II malocclusion in growing and cooperative patients.[5] However, despite the plethora of reports investigating the dentoskeletal effects of various orthopedic appliances,[6,7] the soft tissue change remains scarcely investigated.[8,9] Furthermore, there has been no agreement between the results of previous studies on profile changes and the response of soft tissue to functional appliances is far from being fully understood.[10] The previous studies on soft tissue have been mostly based on either cephalometric,[9] laser scanning[11,] or finite element scaling analysis.[12] Photographs of the patients, on the other hand, have been used as part of the routine standard for pre- and posttreatment documentation and are most perceivable for the patients. So the photographs can be Fairley used for judgment of soft tissue changes provided they are registered in a standard method using natural head position concept.[13]

Twin block appliance is a popular functional appliance that efficiently reduces overjet in Cl II patients.[14] It provides more freedom of mandibular movement and increases patient compliance.[15] The current study aimed to analyze the soft tissue facial profile changes in patients with skeletal Cl II mandibular deficiency before and after functional therapy using a modified twin block appliance and based on the silhouettes derived from the NHP photographs.

[1]Department of Orthodontics, Islamic Azad University, Tabriz Branch, Tabriz, Iran

[2]Department of Orthodontics, Tabriz University of Medical Sciences, School of Dentistry, Tabriz, Iran

[3]Department of Pediatric Dentistry, Tabriz University of Medical Sciences, School of Dentistry, Tabriz, Iran

Corresponding Author: Mohamadreza Shahamfar, Department of Orthodontics, Islamic Azad University, Tabriz Branch, Tabriz, Iran, Phone: +989143017330, e-mail: mohamadreza_shr@yahoo.com

How to cite this article: Shahamfar M, Atashi MHA, Azima N. Soft Tissue Esthetic Changes Following a Modified Twin Block Appliance Therapy: A Prospective Study. Int J Clin Pediatr Dent 2020;13(3):255–260.

Source of support: Tabriz University of Medical Sciences

Conflict of interest: None

Materials and Methods

The current study was conducted in the department of orthodontics, Tabriz University of Medical Sciences. Before the study, informed patients' consent was obtained from the patients and/or the parents and the protocol of the study was approved by the respective university research ethics committee. The study was in accordance with the Helsinki declaration of human rights. The sample size consisted of 70 patients (37 girls and 33 boys, mean age

10.2 years ± 10 months and 11.4 years ±12 months, respectively) who were consecutively recruited into the study. The mean active treatment time for the patients was 13.6 ± 4 months.
The inclusion criteria for the patients were:

- Skeletal Cl II relationship with ANB at or greater than 5°.
- Mandibular retrognathia with normal maxillary growth (SNA at 80–82 and SNB less than 76.
- Full cusp Cl II molar and canine relationship.
- Overjet at or greater than 6 mm.
- Normal facial growth pattern.

Furthermore, patients with lower incisor protrusion, developmental syndromes, or congenitally missing teeth were excluded from the study. Patients were instructed to wear the appliance full time except for meals and a paper sheet was given to monitor the compliance. The design of the appliance is shown in Figure 1. Some modifications were applied to the original Clark's twin block (TB) design. An acrylic cap in the incisor segment covered about 2 mm of the lower incisor edges. The initial working bite was registered at 4 mm advancement with an incremental increase of 3–4 mm depending on patients' overjet and compliance adding acrylic to the posterior slopes of lower bite plate. The amount of vertical opening was 2–4 mm beyond freeway space and the treatment continued until all patients reached normal Cl I molar relationship and overjet at the end of active treatment. Modified Hawley retainers as described by Clark were prescribed for patients to achieve satisfactory posterior intercuspation.[16]

The pre- and posttreatment lateral photographs were obtained (Nikon Kuplix-8700, Tokyo, Japan) with the patients' head in the natural head position, by a single operator. The photographs were then scanned (Canon MF230, Tokyo, Japan) and transferred to a computer. Adobe Photoshop software (Adobe Systems Inc., California, USA) was used to produce silhouettes for evaluation of the soft tissue changes (Fig. 2). The pre- and post-treatment silhouettes were then coded to blind the evaluator. A single expert orthodontist analyzed the silhouettes. The silhouettes were manually traced and analyzed by a previously calibrated examiner, on a blind basis. Nineteen commonly used soft tissue variables were measured 1 week before (T1) and a week after the treatment completed (T2). Figure 3 illustrates the landmarks used in the study. The soft tissue analyzes applied to the silhouettes were mainly based on the works of Burstone and Mcnamara.[17,18] Definitions of the soft tissue measurements are described in Table 1 and the linear and angular analyzes applied to the patients are described in Figures 4 and 5, respectively.

All measurements were tabulated for statistical analysis using SPSS16 software (SPSS Inc., Chicago, Illinois, USA) for windows and the Statistical significance was set at $p < 0.05$.

To determine the reliability of the silhouettes' analyzes, 12 silhouettes were randomly selected and underwent re-tracing and analysis with a 1-month interval. A paired *t* test was used to determine the difference and no significant difference was achieved ($p > 0.05$).

Mean and standard deviation of variables were obtained before and after treatment. Normal distribution of the data was verified using Kolmogorov–Smirnov analysis and the data were found normally distributed. Parametric analysis of paired *t* test was used to compare the mean values before and after treatment.

Results

The mean and standard deviation of soft tissue linear and angular measurements before and after treatment are described in Table 2. The results demonstrated a 2° reduction in the convexity angle while Merrifield's *Z*-angle demonstrated an almost 8° increase. Furthermore, the soft tissue pog moved forward by a mean value of 3.18 mm. All these changes were found statistically significant ($p > 0.05$).

With regard to the relationship between the base of the nose and the upper lip, the results indicated a statistically significant increase in the nasolabial angle and a significant reduction in the upper lip protrusion ($p < 0.05$). Columellar inclination, on the other hand, showed a statistically significant reduction ($p < 0.05$).

As for the vertical dimension of the lips, the lower lip length significantly increased ($p < 0.05$) coincidentally with a statistically significant reduction in the interlabial gap ($p < 0.05$). Mentolabial angle, on the other hand, showed a significant increase after TB treatment as a result of the forward movement of soft tissue pog, contributing to the lower third facial balance.

Upper lip length and lower lip protrusion, however, did not show any significant change as did midface protrusion and the vertical height ratio ($p > 0.05$). Linear and angular measurements related to the soft tissue of the nose, including nasal projection and inclination of the nose also, did not show any significant change either ($p > 0.05$).

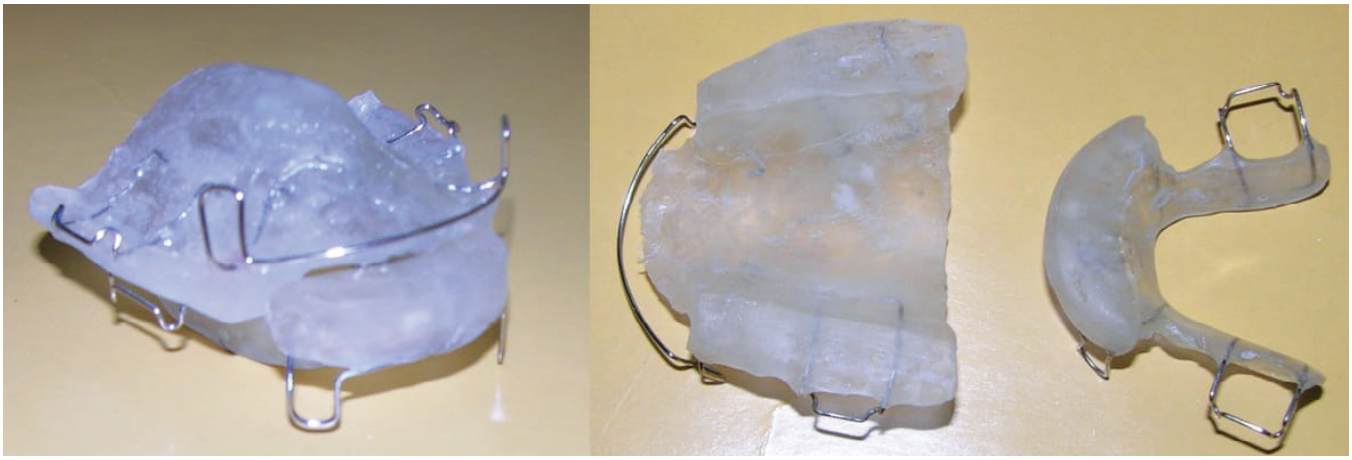
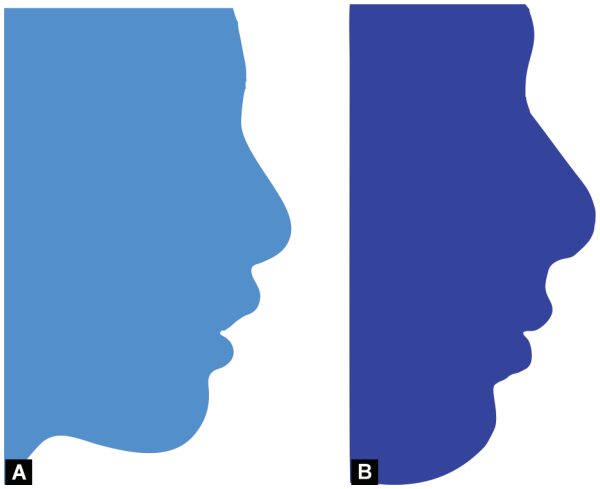


Fig. 1: Design of the appliance

Discussion

It is generally believed that orthodontic treatment is successful only when facial esthetics is improved. It is because that facial appearance has a crucial role in the social well-being of individuals and perception of one's personal attributions. Several methods have been used to assess the esthetics of the facial profile.[9,11,12] Some of these, include laser scanning of the face, or the use of cephalograms.[9,11] In our study, we utilized patients' silhouettes derived from photographs to evaluate the soft tissue profiles. Photographs compared to lat. Cephalograms have several advantages. Photographs are frequently the first line for both



Figs 2A and B: Silhouette of a patient. (A) Pretreatment; (B) Posttreatment

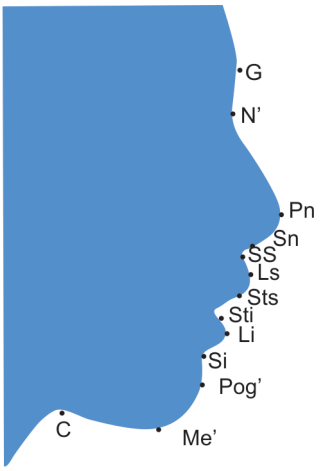


Fig. 3: Landmarks used in the study.
G, Glabella; N′, soft tissue nasion; Pn, Pronasale; Sn, subnasale; Ss, sulcus superior; Ls, labrale superior; Sts, stomion superior; Sti, stomion inferior; Li, labrale inferior; Si, sulcus inferior; pog', Soft tissue pog; Me', Soft tissue menton; C, cervical point

Table 1: Definition of soft tissue linear and angular measurements used in the study

S. no.	*Soft tissue measurements*	*Definition*	*Description*
1	Facial convexity angle	G-Sn-Pg′ (angle)	The angle formed by a line connecting glabella to subnasale and subnasale to soft tissue pog
2	Nasolabial angle	Cm-Sn-Ls (angle)	The angle formed between columella, subnasale and labrale superior
3	Lower cace-Throat angle	Sn-Gn′-C (angle)	The angle formed by intersection of lines passing through sunbnasal to soft tissue gnathion and from that point to cervical point
4	Lower face protrusion	G-Pg′ (II TH)	Horizontal distance from a line passing from glabella to soft tissue pog
5	Vertical height ratio	G-Sn/Sn-Me (P TH)	The ratio of upper to lower face
6	Z-Merrifield angle	Pog′-Ls or Li/TH	The angle formed by intersection of true horizontal and a line connecting pog′ and the most protrusive lip point (may be upper or lower)
7	Midface protrusion	G-Sn (II TH)	Horizontal distance from a vertical line passing through glabella to subnasale
8	Upper lip length	Sn-Sts (P TH)	Vertical distance between and upper lip stomion and subnasale
9	Lower lip length	Sti-Me′ (P TH)	Vertical distance between lower lip stomion and soft tissue menton
10	Superior labial sulcus depth	ss-SnV (II TH)	Horizontal distance between sulcus superior and subnasale-vertical line
11	Upper lip protrusion	Ls-Snpog′ (II TH)	Horizontal distance between the most anterior point of upper lip to sn-pog′ line
12	Lower lip protrusion	Li-Snpog′ (II TH)	Horizontal distance between the most anterior point of lower lip to sn-pog′ line
13	Inferior labial sulcus depth	Si-SnV (II TH)	Horizontal distance between sulcus inferior and subnasale vertical line
14	Soft tissue pogonion	Pg′-SnV (II TH)	Horizontal distance between soft tissue pog and subnasale vertical line
15	Inter labial gap	Sts-Sti (P TH)	Vertical distance between upper lip stomion and lower lip stomion
16	Mentolabial angle	Li-ILS-Pog′	The angle formed between labrale inferiuri, inferior labial sulcus and soft tissue pog
17	Nasal projection (nose)	Pn-Sn (II TH)	Horizontal distance between subnasale to the tip of the nose
18	Columellar Inclination	Sn-Cm/TH	The angle between true horizontal and a line passing through columella and subnasale
19	Inclination of nose	N′-Pn/TV	The angle between true vertical line and a line passing through pronasale to soft tissue nasion

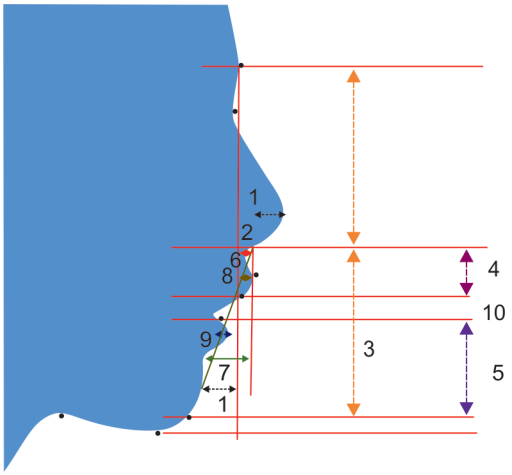


Fig. 4: Linear measurements used in the study.
1, lower face protrusion; 2, midface protrusion; 3, vertical height ratio, 4, upper lip length; 5, lower lip length; 6, superior labial sulcus depth; 7, inferior labial sulcus depth; 8, upper lip protrusion; 9, lower lip protrusion; 10, interlabial gap; 11, Nasal projection

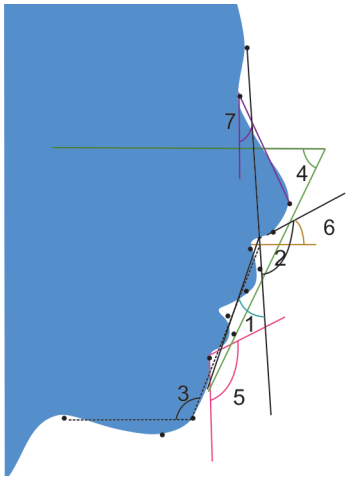


Fig. 5: Angular measurements used in the study.
1, facial convexity angle; 2, Nasolabial angle; 3, lower face-throat angle; 4, Merrifield's Z-angle; 5, Mentolabial angle; 6, columellar inclination; 7 = inclination of nose

Table 2: Soft tissue profile changes before and after treatment

	Before treatment T1		*After treatment T2*		
Soft tissue measurements	*Mean*	*SD*	*Mean*	*SD*	*p value*
Facial convexity angle	23.56	4.46	21.56	4.28	0/001*
Midface protrusion	7.68	4.02	9.24	4.18	0/104
Lower face protrusion	−14.16	7.69	−10.22	5.20	0/001*
Vertical height ratio	1.0288	0.07	1.0116	0.091	0/24
Lower face-throat angle	118.88	6.43	119.38	4.99	0/747
Z-Merrifield angle	61.56	9.44	69.48	11.64	0/001*
Nasolabial angle	94.26	17.92	103.22	18.32	0/001*
Upper lip length	28.52	8.44	29.54	5.74	0/218
Lower lip length	52.26	11.88	57.62	12.80	0/001*
Supper labial sulcus depth	−1.6	1.85	−3.04	1.84	0/001*
Upper lip protrusion	2.76	3.64	−0.56	2.98	0/001*
Lower lip protrusion	−8.16	4.61	−7.4	3.74	0/276
Inferior labial sulcus depth	−22.82	4.64	−19.46	3.77	0/001*
Soft tissue pogonion	−19.06	13.28	−15.88	11.10	0/001*
Inter labial gap	8.44	6.87	1.62	6.26	0/001*
Mentolabial angle	108.56	22.66	118.48	21.32	0/001*
Nasal projection (nose)	19.41	2.21	21.20	6.4	0/188
Columellar inclination	17.79	6.8	15.79	6.19	0/029*
Inclination of nose	29.04	3.09	29.5	2.05	0/362

*Significant

clinicians and patients for the judgment of esthetic changes. Furthermore, they are low cost and have no risk of X-ray exposure. All the photographs were taken with patients head in the NHP position since the NHP reflects the real appearance of the patients as they are in everyday life with acceptable reproducibility.[19] The reason that silhouettes were used, was to eliminate the drawbacks of the previous methods, have the advantages of them, and at the same time, eliminate all the extrinsic and intrinsic confounding factors, e.g., hairstyle, makeup and skin characteristics in the evaluation of the facial balance.[20] However, it should be noted that the silhouettes do not necessarily reflect the attractiveness of the whole face since the same profile outline shape could produce a different attractiveness in the different faces under the influence of extrinsic variables.[21] So when evaluating a profile, the facial balance should not be conflicted with facial attractiveness, since the latter, is highly dependent on extrinsic factors not necessarily identical to gold standards of orthodontics.

Twin block appliance is one of the most popular functional appliances used in the orthodontic practice. It provides more compliance of the patients, is less voluminous, and permits talking

as well.[22,23] A modified form of the appliance with an acrylic cap on the lower incisors was utilized to minimize lower incisor protrusion. This was done to minimize the contribution of incisor protrusion in the overjet correction. This modification might have contributed to the relatively stable inclination of the lower lip. This was in contrast to several previous studies that reported lower lip protrusion with twin block appliance.[8,10,12] This was important since some previous reports suggested extraction in the second phase of treatment (fixed orthodontic therapy) to correct the protrusion, which in our study was not found obligatory.[24]

We found no vertical facial dimension change. This is a favorable effect since any vertical lengthening can dilute the effect of the forward movement and is considered an untoward side effect. This is in contrast with some previous findings which reported vertical facial height increase.[8,25,26] Our results showed that strict control of the bite blocks can be effective in the control of the vertical dimension. However, this should be interpreted with caution because soft tissue facial height might be affected by the varying compliance of patients, varying thickness of the soft tissue, and the method of evaluation as well.

In our study, we found several significant positive improvements in the silhouette. Reduction in the convexity angle, the subsequent increase in the *Z* angle and the advancement of soft tissue pog, all contributed to the esthetic improvement of the silhouettes and were similar to the results of several previous investigations.[8,11,27] The upper lip protrusion and the superior labial sulcus depth, significantly decreased while no change was observed in the upper lip's length. As for the lower lip, a significant increase in its length was observed. These findings support the results of several previous investigations.[10–12] The possible reason for the lower lip length increase might be the tension reduction in the lower lip followed by mandibular advancement which in turn leads to a reduction in the interlabial gap and eventually improves lip competence. Also, a significant reduction of the inferior labial sulcus depth was found in our study which is comparable with the results of Singh et al., who in their finite element study found a flattening of mentolabial groove following TB treatment.[12] This is important since, in Cl II div 1 malocclusion, the lower lips are distorted behind the upper incisors resulting in a deep mentolabial sulcus and acute mentolabial angle. In our study, we found a significant increase in the mentolabial angle following TB therapy. Two reasons have been suggested for this phenomenon:[28] first the reduction of overjet and the second the change in the tonicity and posture of perioral muscles. However, this finding is not unanimous in the literature and contrasts with a previous report.[11] The difference, however, might be related to the varying designs of the appliances too. We suggest that the modified acrylic cap on the lower incisors has contributed to the stable inclination of lower lips and in this way contributed to the mentolabial balance improvement.

In our study, we found a backward movement of the superior labial sulcus. This might have been related to the impeditive effect of TB therapy over the maxillary dentition region. This is further augmented by a significant reduction in the upper lip protrusion. These findings support the results of a previous report on hard and soft tissue indicating a retrusive force over the maxillary dentition region.[11] This might be considered a side effect to the TB therapy.[11,28]

A drawback to the current study was that no untreated groups were compared, so the findings should be interpreted with caution.

Conclusion

The principal finding of our study was that TB treatment resulted in several significant positive improvements in the facial esthetics of the patients with minimum untoward effects. These positive changes included the forward movement of soft tissue pog, improved mentolabial fold, improved lip competence, and reduction of facial convexity. However, facial balance is a different concept than facial attractiveness and they should not be held identical.

References

1. Sarver DM. Special considerations in diagnosis and treatment planning. In: Graber LW, Vanarsdall R, Vig KW, et al. Orthodontics current principles and techniques. St.louis: Mosby; 2017. pp. 245–246.
2. Proffit WR. Malocclusion and dentofacial deformity in contemporary society. In: Proffit WR, Fields HW, Sarver DM, et al. Contemporary Orthodontics. 5th edn., St Louis: Mosby; 2013. p. 8.
3. Tung AW, Kiyak HA. Psychological influences on the timing of orthodontic treatment. Am J Orthod Dentofacial Orthop 1998;113(1):29–39. DOI: 10.1016/S0889-5406(98)70274-4.
4. Rego MV, Martinez EF, Coelho RM, et al. Perception of changes in soft-tissue profile after Herbst appliance treatment of class II division 1 malocclusion. Am J Orthod Dentofacial Orthop 2017;151(3):559–564. DOI: 10.1016/j.ajodo.2016.08.028.
5. McNamara JA, McClatchey LM, Graber LW. Optimizing orthodontics and dentofacial orthopedics: Treatment timing and mixed dentition therapy. In: Graber LW, Vanarsdall R, Vig KW, et al. Orthodontics current principles and techniques. St.louis: Mosby; 2017. p. 404.
6. Mills CM, McCulloch KJ. Treatment effects of the twin block appliance: a cephalometric study. Am J Orthod Dentofacial Orthop 1998;114(1):15–24. DOI: 10.1016/S0889-5406(98)70232-X.
7. O'Brien K, Wright J, Conboy F, et al. Effectiveness of treatment for class II malocclusion with the Herbst or twin-block appliances: a randomized, controlled trial. Am J Orthod Dentofacial Orthop 2003;124(2):128–137. DOI: 10.1016/S0889-5406(03)00345-7.
8. Quintão C, Helena I, Brunharo VP, et al. Soft tissue facial profile changes following functional appliance therapy. Eur J Orthod 2006;28(1):35–41. DOI: 10.1093/ejo/cji067.
9. Baysal A, Uysal T. Soft tissue effects of twin block and Herbst appliances in patients with class II division 1 mandibular retrognathia. Eur J Orthod 2013;35(1):71–81. DOI: 10.1093/ejo/cjq187.
10. Flores-Mir C, Major PW. Cephalometric facial soft tissue changes with the twin block appliance in class II division 1 malocclusion patients. A systematic review. Angle Orthod 2006;76(5):876–881.
11. Lee RT, Kyi CS, Mack GJ. A controlled clinical trial of the effects of the twin block and dynamax appliances on the hard and soft tissues. Eur J Orthod 2007;29(3):272–282. DOI: 10.1093/ejo/cjm004.
12. Singh GD, Clark WJ. Soft tissue changes in patients with class II division 1 malocclusions treated using twin block appliances: finite-element scaling analysis. Eur J Orthod 2003;25(3):225–230. DOI: 10.1093/ejo/25.3.225.
13. Moorrees FA. Natural head position: the key to cephalometry. In Jacobson A, Jacobson RL. Radiographic cephalometry from basics to 3D imaging. Hanover: Quintessence Books; 2006. pp. 153–160.
14. Sattarzadeh AP, Lee RT. Assessed facial normality after twin block therapy. Eur J Orthod 2010;32(4):363–370. DOI: 10.1093/ejo/cjp141.
15. Clark WJ. The twin block technique. A functional orthopedic appliance system. Am J Orthod Dentofacial Orthop 1988;93(1):1–18. DOI: 10.1016/0889-5406(88)90188-6.
16. Clark WJ. Twin block functional therapy: applications in dentofacial orthopedics. 3rd edn., New Delhi: Jaypee brothers; 2015.
17. McNamara Jr JA. A method of cephalometric evaluation. Am J Orthod 1984;86(6):449–469. DOI: 10.1016/S0002-9416(84)90352-X.
18. Legan HL, Burstone CJ. Soft tissue cephalometric analysis for orthognathic surgery. J Oral Surg 1980;38(10):744–751.

19. Cooke MS. Five-year reproducibility of natural head posture: A longitudinal study. Am J Orthod Dentofacial Orthop 1990;97(6): 489–494. DOI: 10.1016/S0889-5406(05)80029-0.
20. Shelly AD, Southard TE, Southard KA, et al. Evaluation of profile esthetic change with mandibular advancement surgery. Am J Orthod Dentofacial Orthop 2000;117(6):630–637. DOI: 10.1016/S0889-5406(00)70171-5.
21. Spyropoulos MN, Halazonetis DJ. Significance of the soft tissue profile on facial esthetics. Am J Orthod Dentofacial Orthop 2001;119(5): 464–471. DOI: 10.1067/mod.2001.113656.
22. Brennan JA, Littlewood SJ. Twin block re-activation. J Orthod 2006;33(1):3–6. DOI: 10.1179/146531205225021330.
23. Varlik SK, Gültan A, Tümer N. Comparison of the effects of twin block and activator treatment on the soft tissue profile. Eur J Orthod 2008;30(2):128–134. DOI: 10.1093/ejo/cjm121.
24. Tulloch JF, Phillips C, Proffit WR. Benefit of early class II treatment: progress report of a two-phase randomized clinical trial. Am J Orthod Dentofacial Orthop 1998;113(1):62–72. DOI: 10.1016/S0889-5406(98)70277-X, quiz 73-4.
25. Sharma AA, Lee RT. Prospective clinical trial comparing the effects of conventional twin-block and mini-block appliances: part 2. Soft tissue changes. Am J Orthod Dentofacial Orthop 2005;127(4):473–482. DOI: 10.1016/j.ajodo.2004.03.027.
26. Lee RT, Barnes E, DiBiase A, et al. An extended period of functional appliance therapy: A controlled clinical trial comparing the twin block and dynamax appliances. Eur J Orthod 2014;36(5):512–521. DOI: 10.1093/ejo/cjs076.
27. McDonagh S, Moss JP, Goodwin P, et al. A prospective optical surface scanning and cephalometric assessment of the effect of functional appliances on the soft tissues. Eur J Orthod 2001;23(2):115–126. DOI: 10.1093/ejo/23.2.115.
28. Lange DW, Kalra V, Broadbent Jr BH, et al. Changes in soft tissue profile following treatment with the bionator. Angle Orthod 1995;65(6): 423–430.