Original Article

Twin Block appliance with acrylic capping does not have a significant inhibitory effect on lower incisor proclination

Mark Cornelis van der Plas[a]; Krista Ingeborg Janssen[b]; Nikolaos Pandis[c]; Christos Livas[d]

ABSTRACT

Objective: To investigate the effect of acrylic capping, treatment duration, overjet, and lower incisor inclination on the posttreatment tooth position in patients treated with 2 Twin Block (TB) appliance versions.

Materials and Methods: Cephalograms of 56 patients with Class II malocclusion (21 boys, 35 girls; mean age before treatment [T1] = 12.5 years; standard deviation, 0.7) treated with a TB appliance with either acrylic capping or ball-ended clasps on lower incisors were retrospectively collected and traced. Lower incisor inclination (L1-GoGn, L1-GoMe, L1-MP) was measured at T1 and after TB appliance removal (T2). Regression analysis was performed to evaluate the effect on the lower incisor inclination of appliance type, overjet, lower incisor inclination at T1, and treatment duration after adjusting for baseline measurements.

Results: Appliance design was not a significant predictor for either incisor inclination measurement ($P < .05$). Pretreatment lower incisor inclination was the only factor significantly associated with final tooth inclination (L1-GoGn: $\beta = 0.57$, 95% confidence interval [CI] = 0.30, 0.84, $P < .001$; L1-GoMe: $\beta = 0.56$, 95% CI = 0.28, 0.84, $P < .001$; L1-MP: $\beta = 0.46$, 95% CI = 0.17, 0.75, $P = .003$). There was weak evidence that treatment duration excluding L1-MP (95% CI = –1.85, –0.02; $P = .045$) and overjet might be associated with inclination of lower incisors at T2.

Conclusions: TB appliance design with acrylic capping on lower incisors appears not to significantly control incisor proclination. Pretreatment lower incisor inclination may be significantly associated with tooth inclination after active TB treatment and should be considered in treatment planning. (*Angle Orthod.* 2017;87:513–518)

KEY WORDS: Twin Block; Lower incisor; Class II treatment

INTRODUCTION

Since its introduction by Clark,[1] the Twin Block (TB) functional appliance has gained increasingly wide popularity among clinicians worldwide for the treatment of Class II malocclusion. TB was voted as the preferred functional appliance by 75% of British orthodontists.[2] By engaging upper and lower acrylic plates with interlocking bite-blocks, TB induces a favorable forward mandibular displacement upon closure.[1] Significant proclination of lower incisors had been consistently reported by TB studies evaluated by a recent systematic review and meta-analysis.[3] This complication, generally acknowledged for functional appliances, is attributed to a protrusive effect on the lower incisors exerted by the lingual appliance components while the mandible attempts to rebound to normal resting posture.[4]

Given the fundamental role of interarch relationships of anterior teeth in treatment decision making, a number of studies have tested the efficiency of modified TB appliances in controlling the inclination of upper and/or lower incisors. Inclusion of Southend clasps in the lower anterior region significantly limited incisor proclination according to Trenouth and Des-

[a] Postgraduate student, Department of Orthodontics, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands.

[b] Staff member, Department of Orthodontics, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands.

[c] Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, School of Dental Medicine, University of Bern, Bern, Switzerland; and Private Practice, Corfu, Greece.

[d] Orthodontist, Dental Clinics Zwolle, Zwolle, The Netherlands.

Corresponding author: Dr Christos Livas, Dental Clinics Zwolle, Stationweg 5, 8011 CZ, Zwolle, The Netherlands
e-mail: christos.livas@dentalclinics.nl

Accepted: December 2016. Submitted: October 2016.
Published Online: January 27 2017

mond.[5] On the contrary, when a labial bow or torquing springs had been incorporated in the upper plate, no statistically significant differences in the angular position of incisors were observed between the two alternative designs.[6,7]

Acrylic capping was previously recommended to prevent labial tipping of the lower incisors in functional appliance treatment.[8] Such TB modification proved to minimize lower incisor proclination compared with untreated matched historical control subjects.[9] To our knowledge, no available studies compare the influence of TB acrylic extension on lower incisor proclination vs the conventional appliance design. Therefore, the primary aim of this investigation was to examine the effect of acrylic capping on incisor proclination in orthodontic patients immediately after TB treatment. Second, we aimed to identify factors that might influence post-TB inclination of lower incisors.

MATERIALS AND METHODS

Sample Collection

This retrospective study was carried out on 56 patients consecutively treated with TB functional appliances between August 2013 and June 2015 at the staff clinic of the Department of Orthodontics, University Medical Center Groningen. In this study, 29 participants (7 boys, 22 girls; mean age at the start of treatment, T1, 12.6; standard deviation, 0.8) were treated with TB appliance with acrylic capping on the lower incisors (TB-AC) and 27 (14 boys, 13 girls; mean age at T1, 12.4, standard deviation, 0.7) were treated with TB with ball-ended clasps in the lower anterior region (TB-NAC) (Table 1).

The inclusion criteria were as follows: white patients, Class II molar relationship of at least 1/2 premolar width at T1, nonextraction treatment plan, Class I canine and molar relationship at appliance removal (T2), and available T1 and T2 cephalograms of adequate quality for accurate landmark identification.

At an alpha level of 5% and power of 95%, it was calculated that 26 patients were required in each group to detect a significant difference of 5° in lower incisor inclination angles.

Appliance Design and Treatment Protocol

All appliances were fabricated by a single orthodontic laboratory with the following characteristics: Adams clasps on the first permanent molars and premolars or deciduous molars; midline screw in the upper plate activated where appropriate; upper and lower acrylic blocks constructed at 70° to the occlusal plane; upper labial bow extending from canine to canine made of 0.7 mm stainless steel; acrylic capping or ball-ended clasps on the lower incisors (0.7 mm stainless steel). Construction bite registration was obtained in edge-to-edge relation and with 2 mm interincisal space. Mandibular advancement did not exceed 70% of the total protrusive path.[10]

Table 1. Descriptive Statistics of the Study (TB-AC) and Control (TB-NAC) Groups

Group	n	Age at T1 (Years) Mean (SD)	T2-T1 (Months) Mean (SD)
TB-AC (boys)	7	13.0 (1.0)	10.6 (2.5)
TB-AC (girls)	22	12.4 (0.7)	
TB-NAC (boys)	14	12.7 (0.7)	10.2 (2.0)
TB-NAC (girls)	13	12.0 (0.6)	

All patients were treated by the same clinician with long experience in TB treatment (CL). Instructions were given for full-time appliance wear excluding meals and contact sport activities. Appointments during TB phase were scheduled at intervals of 8 weeks. T1 and T2 cephalograms were obtained using standard cephalometric X-ray equipment (Planmeca ProMax 3D Mid, Planmeca Oy, Helsinki, Finland).

Because both appliance types were routinely used in clinical practice, the Medical Ethics Review Board declared that the study was not clinical research with test subjects as described in the Medical Research Involving Human Subjects Act. Thus, formal ethics approval was not required.

Cephalometric Analysis

Digitization of all cephalograms was performed by means of cephalometric analysis software (Viewbox 3.0; dHAL Software, Kifissia, Greece) by the first author (MCvdP), who was blinded to the type of appliance. A number of skeletal and dental points were selected to determine lower incisor inclination and craniofacial pattern (Figure 1A). Inclination of the long axes of lower incisors was estimated in relation to 3 different reference mandibular planes commonly used in cephalometrics (Figure 1B): the line drawn from Me to Go,[11] the line drawn from Gn to Go,[12,13] and the tangent to the lower border of the mandible.[14–16] Thirty randomly selected tracings were repeated by the same investigator 2 weeks after the first series of tracings to calculate intraobserver agreement.

Statistical Analysis

Summary statistics (means, standard deviations) were calculated for all skeletal and dental variables. To determine intraobserver reliability, the intraclass correlation coefficient (ICC) was used. Independent *t*-tests were carried out to compare skeletal discrepancy (ANB angle) and incisor inclination values between

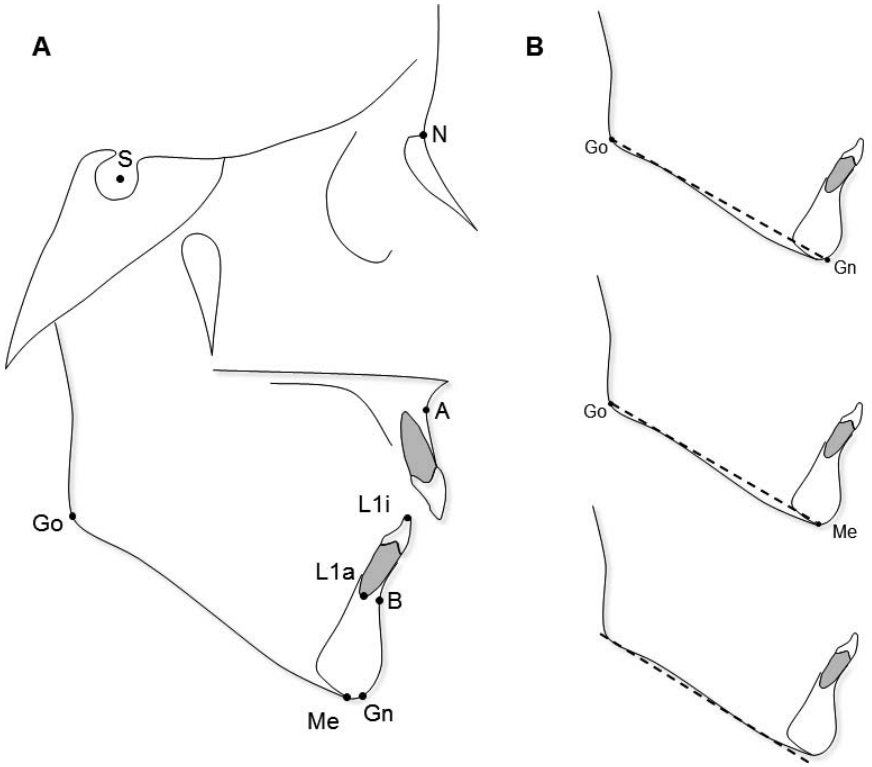

Figure 1. Cephalometric landmarks (A) and mandibular reference planes (B) used in the study. Lower incisor (L1) axis was constructed by a line connecting the incisal edge (L1i) and the root apex (L1a) of the most prominent lower incisor.

groups at T1 and T2. Regression analysis was conducted to evaluate the effect on the lower incisor inclination of appliance type, overjet, pretreatment lower incisor inclination, and treatment duration, after adjusting for baseline measurements. The significance level was set at .05. Statistical analysis was performed using specialized statistical software (STATA 14, Stata Corporation, College Station, Tex).

RESULTS

There was excellent intraobserver reliability, and ICC values ranged between 0.91 and 1.00.

Skeletal and dental measurements are summarized for both groups in Table 2. No statistically significant differences ($P > .05$) were observed between groups at T1 and T2 with respect to ANB and lower incisor inclination.

Regression analysis showed that appliance design (with or without acrylic capping) did not have a significant effect on lower incisor inclination regardless of definition used ($P < .05$) (Table 3).

Pretreatment lower incisor inclination was the only statistically significant predictor for final tooth inclination after TB treatment (L1-GoGn: $\beta = 0.57$, 95% CI = 0.30, 0.84, $P < .001$; L1-GoMe: $\beta = 0.56$, 95% CI = 0.28, 0.84, $P < .001$; L1-MP: $\beta = 0.46$, 95% CI = 0.17, 0.75, $P = .003$).

Treatment duration with the exception of mandibular plane related inclination ($\beta = –0.93$; 95% CI = –1.85, –0.02; $P = .045$) and overjet demonstrated weak evidence of association with lower incisor inclination (Table 3).

DISCUSSION

Proper positioning of lower incisors in the alveolar bone by use of orthodontics is essential to reach favorable anterior occlusal contacts. Increased incisor proclination and tooth movement out of the osseous envelope of the alveolar process may be associated with higher tendency for developing gingival recessions.[17] Moreover, reduced thickness of the free gingival margin, a narrow mandibular symphysis, inadequate plaque control, and aggressive brushing technique were identified as factors that may lead to gingival recession after orthodontic tipping and/or translation movement.[18] As a consequence, insufficient control of the labiolingual inclination of lower incisors in patients undergoing functional appliance therapy will profoundly affect the course of treatment.

Unlike previous findings,[9] TB design with acrylic capping of the lower anterior teeth in the present study could not restrain significantly incisor proclination during TB treatment phase. Treatment effect in the aforementioned study was estimated by subtracting

Table 2. Skeletal and Dental Measurements in the Study (TB-AC) and Control (TB-NAC) Groups Before and after Active Twin Block Treatment

	T1		T2	
Measurement	TB-AC	TB-NAC	TB-AC	TB-NAC
SNA (°)	82.69 (3.97)	81.99 (2.96)	82.35 (3.85)	80.90 (2.76)
SNB (°)	75.84 (4.09)	75.96 (3.03)	77.75 (3.85)	76.74 (2.84)
ANB (°)	6.85 (2.04)	6.02 (1.75)	4.60 (2.30)	4.16 (2.02)
Overjet (mm)	6.01 (1.90)	6.01 (2.22)	1.87 (1.16)	2.34 (1.19)
L1-MP (°)	97.52 (7.52)	95.11 (6.88)	100.31 (7.23)	97.14 (8.01)
L1-GoMe (°)	95.63 (7.10)	92.99 (6.62)	98.91 (7.23)	95.91 (6.81)
L1-GoGn (°)	98.44 (7.14)	96.07 (6.52)	101.75 (7.32)	98.90 (6.64)

the natural growth occurring in the control subjects from the treatment changes observed in the study group. Nonetheless, from a methodologic point of view, the selection of untreated control individuals from longitudinal growth study archives[19–22] may be treated with skepticism. Differences in dentofacial characteristics between populations and time periods[23] and absence of another TB alternative in the study of Sidlauskas[9] hinder hypothesis testing regarding the effect of acrylic extension over the incisal edges. Baysal and Uysal[24] attributed the lack of differences in lower incisor position between TB and untreated groups to the acrylic capping of the lower incisors. The authors referred to appliance design details in their own previous publication,[25] which surprisingly claimed to reproduce Clark's original description with interdental clasps rather than acrylic capping in the incisor region.[1]

Inclination of the lower incisors before TB insertion had a positive relationship to the posttreatment inclination angles, that is, the larger the incisor inclination before treatment, the larger the proclination after appliance removal. Given the cumulative effects of TB treatment,[3] leveling of the curve of Spee,[26] and arch expansion during the fixed appliance stage on the inclination of lower incisors, space gaining procedures may be required to reposition flared lower incisors in the dentoalveolar envelope and prevent or address soft tissue sequelae.

Our analysis provided weak evidence that pretreatment overjet and length of TB treatment may be significantly associated with increased post-TB inclination of lower incisors. Hypothetically, a larger protrusive movement of the mandible to address the existing sagittal discrepancy may exaggerate mesial force application on the lower incisors, and subsequently, tooth proclination. Furthermore, longer appliance wear may lead to more stable results and prevent the mandible from shifting to the pretreatment position.

This investigation presents certain limitations. First, as in all retrospective studies, patient information on exposure was retrieved from previously collected records, and therefore conclusions should be interpreted with caution. Randomized clinical trials implementing random assignment of individuals to alternative TB designs with proper allocation concealment may minimize selection bias reduction, control unobserved confounders, and improve internal validi-

Table 3. Coefficients, *P* Values, and 95% Confidence Intervals from the Regression Analysis for Lower Incisor Inclination; L1-GoGn (T1), L1-GoMe (T1), L1-MP (T1), Pretreatment Lower Incisor Inclination Values

		B Coefficient	*P* Value	95% Confidence Interval	
L1-GoGn					
Appliance type	With	Reference	-	-	-
	Without	–1.89	.27	–5.26	1.48
L1-GoGn (T1)	Per unit	0.57	>.001	0.30	0.84
Overjet (T1)	Per unit	0.85	.08	–0.12	1.81
Treatment duration	Per unit	–0.68	.09	–1.48	0.11
L1-GoMe (T2)					
Appliance type	With	Reference	-	-	-
	Without	–1.92	.27	–5.35	1.52
L1-GoMe (T1)	Per unit	0.56	>.001	0.28	0.84
Overjet (T1)	Per unit	0.87	.08	–0.11	1.86
Treatment duration	Per unit	–0.70	>.09	–1.51	0.11
L1-MP (T2)					
Appliance type	With	Reference	-	-	-
	Without	–2.60	.18	–6.46	1.25
L1-MP (T1)	Per unit	0.46	>.00	0.17	0.75
Overjet (T1)	Per unit	0.91	.10	–0.18	1.99
Treatment duration	Per unit	–0.93	.05	–1.85	–0.02

ty.[27] Second, the accuracy of assessing the lower border of the mandible on two-dimensional cephalometric images may be questioned. By averaging the lower border when two outlines were visible, observer bias might have been introduced. Additionally, identification of landmarks such as Go and lower incisor apex may be dubious.[28,29] Nevertheless, use of the specific mandibular planes has proven valid for measuring lower incisor inclination, and these measures are in excellent agreement with each other for growing orthodontic patients aged 12–16 years.[30] Finally, the actual appliance wear time per day, which may have influenced the active TB treatment duration and, potentially, the magnitude of treatment effects, remained unknown. However, a TB appliance is assumed to be worn daily longer than any other device.[2] Patient compliance in our study was clinically evaluated by the achieved correction of overjet and molar relationship, the appliance retention and appearance, and patient's speech while wearing the TB appliance. Patients who had failed to show substantial progress and eventually discontinued TB treatment were excluded. Electronic wear time documentation using incorporated microsensors would have aided quantification of patient adherence to prescribed wear time,[31] though flaws in identifying specific temperature profiles have been described elsewhere.[32]

When interpreting the results of TB studies that looked into incisor inclination changes, attention should be focused on methodologic issues like small sample size;[33] early treatment timing;[19] varying appliance wear protocols;[20,34] prolonged treatment, including retention phase;[19,25] and cephalometric evaluation after fixed appliances stage.[21,22] On the other hand, our study, the first one to report on the effect of acrylic capping on the lower incisor inclination in patients treated with two TB modifications, appears methodologically advantageous. Similarity of groups with respect to age, origin, and treatment duration; involvement of one clinician in treatment procedures; and sample-size calculation strengthen the validity of our conclusions. Large-scale randomized controlled clinical trials will shed more light on the contribution of TB appliance components on lower incisor inclination.

CONCLUSIONS

- The findings of this study suggest that the increase in lower incisor inclination may not be significantly restrained by adding acrylic extension in the anterior region of the lower plate of TB appliance.
- Pretreatment lower incisor inclination may be significantly associated with tooth inclination after active TB treatment and should be taken into account into treatment decision making.

REFERENCES

1. Clark WJ. The twin block technique. A functional orthopedic appliance system. *Am J Orthod Dentofacial Orthop*. 1988;93:1–18.
2. Chadwick SM, Banks P, Wright JL. The use of myofunctional appliances in the UK: a survey of British orthodontists. *Dent Update*. 1998;25:302–308.
3. Ehsani S, Nebbe B, Normando D, Lagravere MO, Flores-Mir C. Short-term treatment effects produced by the Twin-block appliance: a systematic review and meta-analysis. *Eur J Orthod*. 2015;37:170–176.
4. Proffit WR, Fields HJ Jr. Components approach to functional appliances. In: Proffit WR, HJ Fields Jr, Sarver DM, eds. *Contemporary Orthodontics*. 4th ed. St Louis, Mo: Mosby Year Book; 2007:73.
5. Trenouth MJ, Desmond S. A randomized clinical trial of two alternative designs of Twin-block appliance. *J Orthod*. 2012;39:17–24.
6. Harradine NW, Gale D. The effects of torque control spurs in twin-block appliances. *Clin Orthod Res*. 2000;3:202–209.
7. Parkin NA, McKeown HF, Sandler PJ. Comparison of 2 modifications of the twin-block appliance in matched Class II samples. *Am J Orthod Dentofacial Orthop*. 2001;119:572–577.
8. Mörndal O. The effect on the incisor teeth of activator treatment: a follow-up study. *Br J Orthod*. 1984;11:214–220.
9. Sidlauskas A. The effects of the Twin-block appliance treatment on the skeletal and dentolaveolar changes in Class II Division 1 malocclusion. *Medicina (Kaunas)*. 2005;41:392–400.
10. Clark W. Design and management of Twin Blocks: reflections after 30 years of clinical use. *J Orthod*. 2010;37:209–216.
11. Mills JR. The long-term results of proclination of lower incisors. *Br Dent J*. 1966;120:355–363.
12. Steiner CC. Cephalometrics for you and me. *Am J Orthod*. 1953;39:729–755.
13. Ricketts RM. A four step method to distinguish orthodontic changes from natural growth. *J Clin Orthod*. 1975;4:208–228.
14. Wylie WL. The assessment of antero-posterior dysplasia. *Angle Orthod*. 1947;17:97–109.
15. Downs WB. Variations in facial relationships: their significance in treatment and prognosis. *Am J Orthod*. 1948;34:812–840.
16. Tweed CH. The Frankfort mandibular plane angle in orthodontic diagnosis, classification, treatment planning and prognosis. *Am J Orthod Dentofacial Orthop*. 1953;73:321–327.
17. Joss-Vassalli I, Grebenstein C, Topouzelis N, Sculean A, Katsaros C. Orthodontic therapy and gingival recession: a systematic review. *Orthod Craniofac Res*. 2010;13:127–141.
18. Aziz T, Flores-Mir C. A systematic review of the association between appliance-induced labial movement of mandibular incisors and gingival recession. *Aust Orthod J*. 2011;27:33–39.
19. Mills CM, McCulloch KJ. Posttreatment changes after successful correction of Class II malocclusions with the twin block appliance. *Am J Orthod Dentofacial Orthop*. 2000;118:24–33.
20. Siara-Olds NJ, Pangrazio-Kulbersh V, Berger J, Bayirli B. Long-term dentoskeletal changes with the Bionator, Herbst,

Twin Block, and MARA functional appliances. *Angle Orthod*. 2010;80:18–29.
21. Ehsani S, Nebbe B, Normando D, Lagravere MO, Flores-Mir C. Dental and skeletal changes in mild to moderate Class II malocclusions treated by either a Twin-block or Xbow appliance followed by full fixed orthodontic treatment. *Angle Orthod*. 2015;85:997–1002.
22. Giuntini V, Vangelisti A, Masucci C, Defraia E, McNamara JA Jr, Franchi L. Treatment effects produced by the Twin-block appliance vs the Forsus Fatigue Resistant Device in growing Class II patients. *Angle Orthod*. 2015;85:784–789.
23. Dibbets JM, Nolte K. Regional size differences in four commonly used cephalometric atlases: the Ann Arbor, Cleveland (Bolton), London (UK), and Philadelphia atlases compared. *Orthod Craniofac Res*. 2002;5:51–58.
24. Baysal A, Uysal T. Dentoskeletal effects of Twin Block and Herbst appliances in patients with Class II division 1 mandibular retrognathy. *Eur J Orthod*. 2014;36:164–172.
25. Baysal A, Uysal T. Soft tissue effects of Twin Block and Herbst appliances in patients with Class II division 1 mandibular retrognathy. *Eur J Orthod*. 2013;35:71–81.
26. Pandis N, Polychronopoulou A, Sifakakis I, Makou M, Eliades T. Effects of levelling of the curve of Spee on the proclination of mandibular incisors and expansion of dental arches: a prospective clinical trial. *Aust Orthod J*. 2010;26:61–65.
27. Pandis N, Polychronopoulou A, Eliades T. Randomization in clinical trials in orthodontics: its significance in research design and methods to achieve it. *Eur J Orthod*. 2011;33:684–690.
28. Baumrind S, Frantz RC. The reliability of head film measurements: 1. Landmark identification. *Am J Orthod*. 1971;60:111–127.
29. Tng T, Chan TC, Hagg U, Cooke MS. Validity of cephalometric landmarks: an experimental study on human skulls. *Eur J Orthod*. 1994;16:110–120.
30. Jabbal A, Cobourne M, Donaldson N, Bister D. Assessing lower incisor inclination change: a comparison of four cephalometric methods. *Eur J Orthod*. 2016;38:184–189.
31. Schäfer K, Ludwig B, Meyer-Gutknecht H, Schott TC. Quantifying patient adherence during active orthodontic treatment with removable appliances using microelectronic wear-time documentation. *Eur J Orthod*. 2015;37:73–80.
32. Schramm C, Abaza A, Blumenstock G, Bechtold TE, Rickmann A, Bartz-Schmidt KU, Besch D, Januschowski K. Limitations of the TheraMon®-microsensor in monitoring occlusion therapy. *Acta Ophthalmol*. 2016 Jun 27. [Epub ahead of print]
33. Jena AK, Duggal R. Treatment effects of twin-block and mandibular protraction appliance-IV in the correction of class II malocclusion. *Angle Orthod*. 2010;80:485–491.
34. Jena AK, Duggal R, Parkash H. Skeletal and dentoalveolar effects of Twin-block and bionator appliances in the treatment of Class II malocclusion: a comparative study. *Am J Orthod Dentofacial Orthop*. 2006;130:594–602.