Original Article

Comparison of the effect of clear twin block and traditional twin block on speech: a randomized clinical trial

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ABSTRACT

Objectives: To compare the effect of clear twin block (CTB) and traditional twin block (TTB) appliances on speech.

Materials and Methods: In this randomized clinical trial, 18 skeletal Class II (Class II, division 1) growing patients were selected and randomly divided into CTB and TTB groups. Objective and semiobjective speech assessment tests were performed for vowel and consonant analyses at four time intervals: before (T0), immediately after (T1), 1 month after (T2), and 3 months after (T3) inserting the appliance. Data were analyzed using analysis of variance and independent *t*-test at the .05 significance level.

Results: Intergroup comparisons showed that the CTB group had less speech distortion immediately after insertion of the appliance ($P < .05$) than the TTB group; however, the differences were not significant at other time intervals. Intragroup comparisons showed that the number of distortions decreased significantly from T1 to T3 in both groups ($P < .05$). In contrast to CTB, the T0–T3 comparison was significant in the TTB group.

Conclusions: Although both appliances had some effects on speech, CTB had less speech distortion immediately after insertion, which is a very crucial moment in patient compliance. Additionally, articulation structures adapted to CTB faster than to TTB. (*Angle Orthod*. 2024;94:608–614.)

KEY WORDS: Clear; Functional appliances; Growth modification; Speech disorders; Twin block

INTRODUCTION

Growth modification is a treatment strategy that encourages patient growth to treat the skeletal Class II condition.[1] Twin block is one of the most commonly used functional appliances for growth modification with positive clinical outcomes.[2,3] Behroozian and Kalman[4] described a method for fabricating a modified twin block called the clear twin block (CTB). CTB is made from thermoplastic sheets instead of wire and acrylic resin. Esthetics, ease of fabrication, and higher patient acceptance have been mentioned as its advantages over the traditional twin block (TTB).[4,5] It was shown that the myofunctional effect of CTB was like TTB.[6]

Speech impairment is one of the deterrent factors in patient cooperation and the success of removable appliances.[7–9] Speech difficulty is probably due to the presence of a foreign body in the oral cavity and on the buccal surface of teeth, which changes tongue and lip mobility and oral sensory perception.[10] It has been reported that various types of fixed and removable orthodontic appliances may influence speech clarity.[11–13] This phenomenon affects patient compliance negatively.[9,14] Therefore, it is important for clinicians to use a suitable appliance for the patient and explain the possible speech changes and their expected duration.[14]

It can be hypothesized that appliances with less speech impairment can be more effective. Authors of some studies have compared the speech effects of different appliances. However, no authors have compared the speech effects of CTB and TTB. This randomized clinical trial included speech assessment analysis using objective and semiobjective tests in patients wearing CTB and TTB.

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AB, MZ, and MRS initiated, conceptualized, and supervised the research work. MZ and AB searched the data and collect the data with collaboration of MRS. All authors have contributed to analyzing the data and writing the manuscript.

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MATERIALS AND METHODS

This randomized clinical trial was conducted at the Department of Orthodontics, Faculty of Dentistry, Tabriz University of Medical Sciences from October 2021 to January 2022.

Sampling

Eighteen growing skeletal Class II, dental Class II division 1 patients in CVMS III or IV attending the Department of Orthodontics and a private office were included in the study and randomly divided into two groups by flipping a coin. The inclusion criteria were overjet $\geq$5 mm, at least full cusp Class II molar relationship, ANB $\geq$ 3 and interincisal angle $\leq$120. After reaching nine samples in each group or five samples in the gender subgroup, the remaining patients were assigned to the next group or subgroup, respectively. Patients with speech disorders were excluded. Written informed consent was obtained from parents or legal guardians of children before including them in the study. CTB and TTB were made according to the method described by Behroozian and Kalman[4] and Clark,[2] respectively. All patients received the same instructions for use and maintenance. This study was approved by the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.-REC.1399.236). This controlled clinical trial was registered under the code IRCT20210927052606N1.

Tests

Speech assessments were performed at four time intervals: T0: before the delivery of the appliance; T1: immediately after wearing the appliance; T2: 1 month after wearing the appliance; and T3: 3 months after wearing the appliance.

Speech tests were conducted by a speech therapist. The patients were seated in an upright position, and a high-quality microphone (BY-M1, Boya, Shenzhen Jiayz Photo Industrial, Shenzhen, China) was placed 15 cm away from their mouth (Figure 1). Then patients were asked to read from the sheet (Table 1). The first line of the sheet included six types of isolated vowels. During recording vowels, the patients were asked to sustain the vowel for 4–5 seconds at a conversational pitch and loudness. The remaining speech stimulators were 60 nonsense syllables for the assessment of consonants.

The microphone was connected to a laptop (X541N, ASUSTeK Computer Inc., China). Recordings were transferred to the computer with a 44.1-kHz sampling rate and 16 bits by Adobe Audition CS6 (Adobe Systems, San Jose, CA, USA), and an additional approximately 10 seconds were recorded before and after reading for noise reduction. For each patient and for each time point, two types of assessments were performed.

Figure 1. Patient reading from the chart while sitting upright, with the microphone placed 15 cm away from the mouth.

(1) *Semiobjective speech evaluation concerning consonants.* The saved voices were analyzed by two other speech therapists. To avoid bias, the recording and analyzing procedures were performed by different speech therapists, and the voices were given codes unrelated to the group numbers. Blinding of the testing therapist was not possible because the appliance could be seen during the audio recording procedure. The number of distortions was recorded for each patient, and the average number of distortions was reported for the groups at each time interval. The consonants were d, t, s, ʃ, ʤ, ʧ, z, n, f, and r, which were combined with ɑ, ɔ, ɪ, u, e, and æ.

(2) *Formant frequency analysis.* Recorded voices were analyzed using PRAAT software (version 5.4.21; Amsterdam, The Netherlands) by their acoustic characteristics (Figure 2). A formant is referred to as acoustic resonance of the human vocal tract and defines resonance frequencies of the vocal tract:

- F1 (first formant): This formant is primarily influenced by the vertical placement of the tongue in the mouth.
- F2 (second formant): This formant is primarily influenced by the horizontal placement of the tongue in the mouth.

Table 1. Speech Stimulators Including 6 Vowels and 60 Syllables for Consonants

Vowels	/a/ - /i/ - /u/ - /æ/ - /e/ - /o/
Syllables	/da/ - /ta/ - /sa/ - /ʃa/ - /za/ - /ʧa/ - /na/ - /ʤa/ - /fa/ - /ra/ /di/ - /ti/ - /si/ - /ʃi/ - /zi/ - /ʧi/ - /ni/ - /ʤi/ - /fi/ - /ri/ /du/ - /tu/ - /su/ - /ʃu/ - /zu/ - /ʧu/ - /nu/ - /ʤu/ - /fu/ - /ru/ /dæ/ - /tæ/ - /sæ/ - /ʃæ/ - /zæ/ - /ʧæ/ - /næ/ - /ʤæ/ - /fæ/ - /ræ/ /de/ - /te/ - /se/ - /ʃe/ - /ze/ - /ʧe/ - /ne/ - /ʤe/ - /fe/ - /re/ /do/ - /to/ - /so/ - /ʃo/ - /zo/ - /ʧo/ - /no/ - /ʤo/ - /fo/ - /ro/

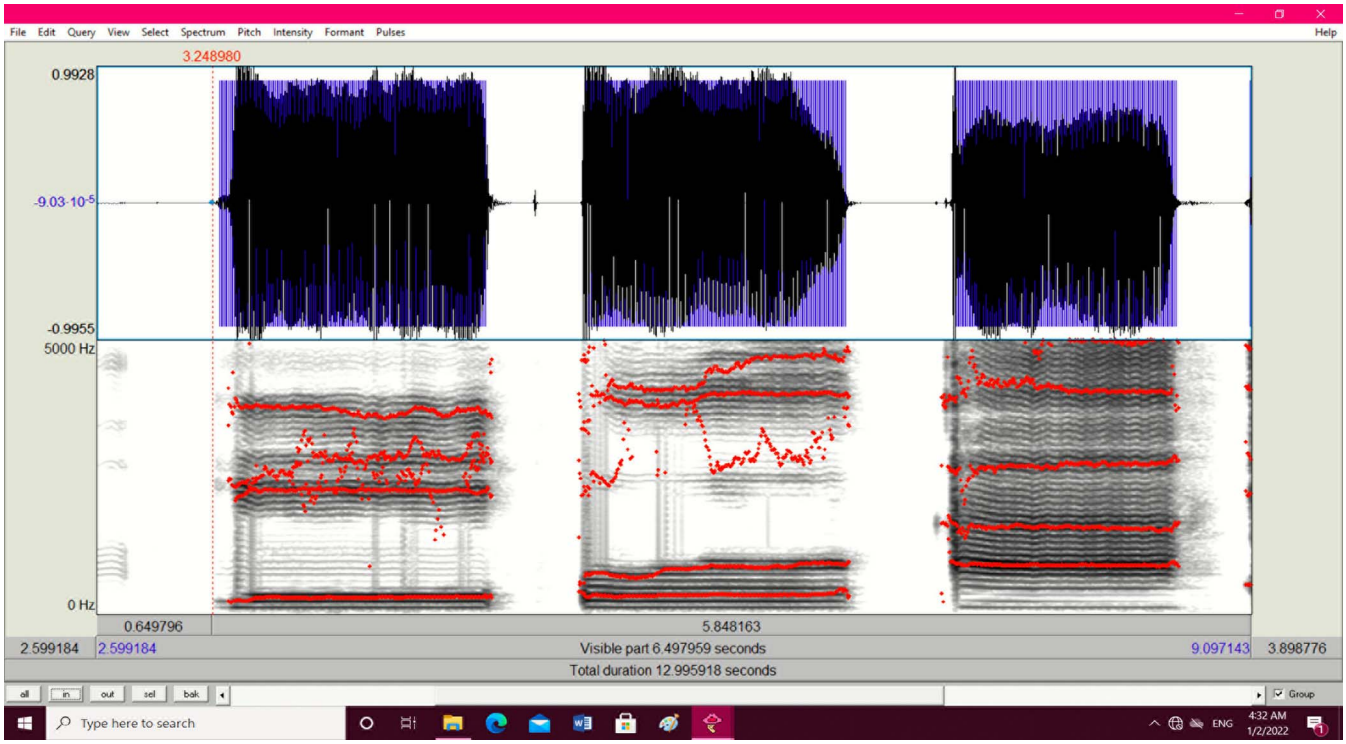

Figure 2. Analysis of the recorded samples by their acoustic characteristics using software.

- F3 (third formant): This formant can contribute to distinguishing between rounded and unrounded vowels.

The specific frequencies of these formants vary depending on the speaker's anatomy and speaking style.[15] Vowels were analyzed to measure three formant frequencies. Linear predictive coding analyses were used to compare variations.

Statistical Analyses

All statistical analyses were performed with SPSS 24 (SPSS Inc., Chicago, IL, USA). Significance for all statistical tests was predetermined at $P < .05$. The Kolmogorov-Smirnov test was used to determine whether the sample was normally distributed. The values indicated that the data were normally distributed. Therefore, repeated measure analysis of variance and independent *t*-test were used for intragroup and intergroup comparisons, respectively.

RESULTS

Eighteen patients (9 [50%] male, and 9 [50%] female) who were undergoing orthodontic treatment were included in the study with an average age of 12.11 years. The pretreatment cephalometric findings including ANB, interincisal angle, and overjet, showed no significant difference between the groups ($P < .05$). The results of speech assessment of consonants are shown in Table 2. Intergroup comparisons showed that the CTB group had less speech distortion immediately after insertion of the appliance ($P < .05$) than the TTB group; however, the difference was not significant at other time intervals. Intragroup comparisons showed that the number of distortions significantly decreased from T1 to T3 in both groups ($P < .05$). In addition, the number of distortions in the TTB group at T3 was significantly higher than at T0, but in the CTB group, the T0–T3 comparison did not reveal significant differences (Figure 3).

Table 3 summarizes the results of the formant frequency analysis. Intergroup comparison showed no significant differences between the groups at

Table 2. Number of Distortions at Each Time Interval. TTB Indicates Traditional Twin Block; CTB, Clear Twin Block

	T0	T1	T2	T3
TTB group	0	15.66[a]	2.55[a]	1.22[a]
CTB group	0	8.33[a]	2.80[a]	0.88
P value	—	0.015[b]	0.76	0.62

[a] Difference with T0 in intragroup comparison was significant. $P < .05$ was considered significant.

[b] Difference between the groups was significant. $P < .05$ was considered significant.

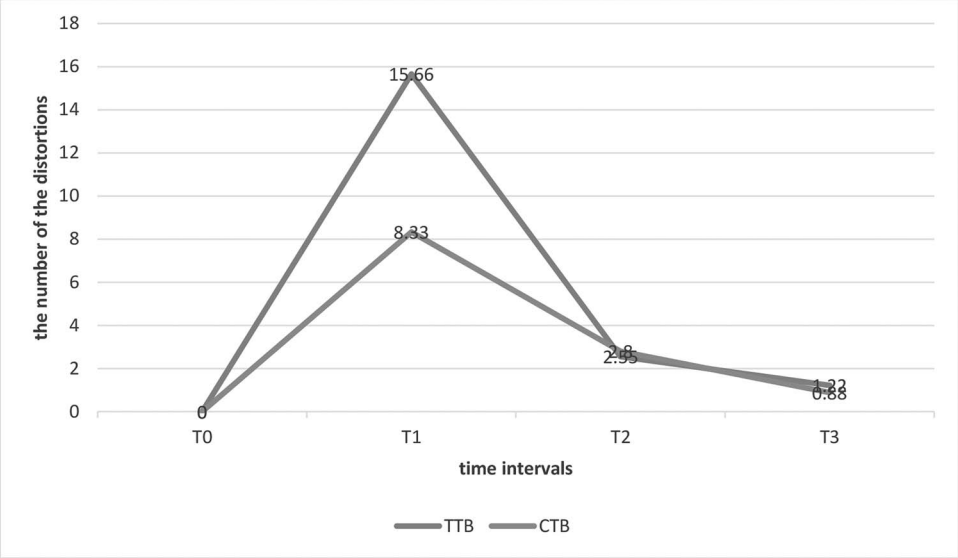

Figure 3. The number of distortions at each time interval. T0: before; T1: immediately after; T2: 1 month after; T3: 3 months after appliance insertion.

T0, T1, and T3. The only significant intergroup difference was observed at T2 in F1a (first formant of/a/), F3a, F3i, F1e, and F1o ($P < .05$). Intragroup comparisons revealed significant changes over time for F2a, F1i, and F1o in the CTB group, and F1a and F1u in the TTB group.

DISCUSSION

Patient compliance and acceptance is a key factor in success of any removable appliance. Speech difficulty is a deterrent factor that may reduce patient cooperation.[4] This, in turn, may inhibit full-time wear of the appliance, especially during school hours or social

Table 3. Amount of F1, F2, and F3 Frequency of Vowels (/a/,/e/,/i/,/o/,/æ/, and/u/) at Each Time Interval. TTB Indicates Traditional Twin Block; CTB, Clear Twin Block

	T0		T1		T2		T3	
	TTB	CTB	TTB	CTB	TTB	CTB	TTB	CTB
/a/								
F1	821.62	837.46	845.52	810.01	860.25[a]	788.29	774.70	808.65
F2	1300.98	1332.27	1275.05	1244.11	1297.92	1292.58	1220.80	1263.58
F3	2902.38	3214.74	2905.50	2994.21	2975.55	3262.67[a]	2865.97	3040.26
/e/								
F1	606.78	552.65	610.73	573.19	629.89[a]	557.14	616.76	545.84
F2	2159.68	1943.49	2017.37	1792.27	1918.41	2075.30	2069.82	1852.98
F3	3003.49	3009.72	2998.12	2960.41	2832.60	3072.43	2948.50	2872.58
/i/								
F1	408.50	465.07	515.60	464.44	445.54	410.14	450.60	382.71
F2	2035.02	2502.24	1958.67	2337.49	2385.41	2574.11	2175.57	2264.61
F3	3313.52	3438.50	3017.77	3327.43	3109.76	3515.78[a]	3176.08	3272.64
/o/								
F1	578.43	572.78	580.01	556.11	572.92[a]	487.52	575.26	547.92
F2	1052.06	960.50	997.40	942.26	989.59	983.71	1039.09	982.57
F3	2924.57	2880.56	3059.14	2728.88	2880.29	2876.10	2771.93	2937.06
/u/								
F1	435.44	465.22	528.81	463.76	460.11	411.05	445.71	452.05
F2	955.65	926.18	986.64	1003.45	869.42	864.50	877.03	1090.01
F3	2764.59	2852.22	2953.98	2933.70	2856.49	2755.61	2693.22	2876.16
/æ/								
F1	951.57	552.65	950.33	921.58	966.80	912.34	921.42	885.41
F2	1710.24	1943.49	1645.87	1622.84	1750.07	1698.93	1604.06	1518.14
F3	2567.98	3009.72	2743.57	2696.60	2574.35	2844.10	2633.38	2508.90

[a] Difference between the groups was significant. $P < .05$ was considered significant.

communications. CTB has been shown to have promising effects in preliminary studies.[6,16] Therefore, this randomized clinical study was conducted on selected skeletal Class II, dental Class II division 1 patients randomly assigned to treatment with CTB or TTB.

Distortion

In the present study, significant speech distortion was found immediately after the insertion of both appliances, which was anticipated according to previous studies on removable appliances and consistent with other studies in which researchers observed the need for a period of patient adaptation for speech production after the insertion of fixed or removable orthodontic appliances.[17–19] Although authors of previous studies investigating speech articulation subjectively showed that adaptation occurred in 2 weeks or less,[20–22] the results of the present study indicated that more time was needed to adapt.

Wan et al.[23] reported less distortion with clear retainers than with Hawley appliances, with a shorter adaptation period in their study than the present study. Speech distortion continued to be significant at least 1 month after insertion, and the adaptation period in the present study was slightly longer than in other studies.[17] Fraundorf et al.[24] reported an average of 2 months for adaptation to clear aligners. This may be because functional appliances move the jaw forward rather than being a simple foreign body in the month. Anterior jaw repositioning changes the dimension of the airway and the position of the tongue relative to other articulators, affecting the articulation of both consonants and vowels. Gurudatta et al.[25] found no significant difference between CTB and TTB, but their study was questionnaire based, and no tests were performed.

The important finding of this study was that, immediately after insertion, the number of speech distortions in the CTB group was significantly lower than in the TTB group. The first moments after appliance delivery are very important for patient acceptance, and CTB has exhibited superiority in this regard. This may be attributed to the less bulky appliance design or to adaptation of the thin, uniformly thick thermoplastic appliance, which follows the anatomy of the teeth. In contrast, the TTB appliance does not necessarily follow the anatomy of the teeth and surrounding structures. In addition, TTB contains wire elements such as a labial bow, which are strange to the tongue and lips, and adaptation to these elements may take longer.

Atik et al.[12] compared speech distortion between clear Essix and Hawley retainers, reporting that Hawley retainers affected articulatory movements in the consonant-vowel combination more prominently than the Essix retainer. Their conclusion was not comprehensive for all consonants and vowels, and they used the voice onset time of the consonants for the analysis. In the present study, distortion was used to count for consonants, which is more clinically relevant to patient cooperation.

The other important finding in this present study was that, after 3 months of use in the CTB group, in contrast with the TTB group, the distortion count returned to the baseline level. The short period needed for patients to adapt to CTB might be explained by the precise adaptation of the appliance to the palatal/lingual tooth surface.[19]

This also might be related to the appliance's wear time. Clear appliances are more user friendly because of their appearance. Therefore, it is anticipated that the wear time of these appliances would be longer than traditional wire and acrylic appliances. Since more wear time can result in faster adaptation, a shorter adaptation period with CTB may be related to greater wear time.[26,27]

Formant Frequency Analysis

Comparison of the results of the formant frequency analysis showed no definite pattern. The only significant difference was at T2, where TTB showed increased F1e, F1i, and F1a than CTB. On the other hand, F3a and F3i were higher in CTB than TTB. Increased F1 means a lower position of the tongue,[28] which might be due to the greater thickness of the acrylic plate in the palatal region in TTB. Increased F3 is interpreted as less rounding of the lips in CTB, which can be attributed to the presence of the material throughout the buccal side of the teeth in CTB. Some questions concerning vowel pronunciation remained unanswered and need to be surveyed. Why was the difference significant only at T2, and why did other vowels not reveal a difference at T2? A possible explanation for the unclear order of vowels compared with the consonants is that pronunciation of the vowels is less affected by intraoral structures like the tongue and teeth. The articulation of the vowel is mainly determined by laryngeal function and vocal cords.

The Tests

Objective and semiobjective tests were used in the current study, which are more reliable than subjective assessments. Examining the effects of the appliances on speech by quantifiable instrumental analysis might help detect changes more precisely than perceptual articulatory tests.[12]

A semiobjective method was used to assess consonants. The consonants cannot be pronounced alone; therefore, syllables (a consonant plus a vowel) were used as a speech stimulator. Objective tests of formant analysis were used to assess vowel pronunciation. PRAAT software reports three formants for each vowel for each patient in Hertz. Any change in F1 reflects the change in the vertical position of the tongue body. The change in the amount of F2 and F3 reflects changes in

the sagittal position of the tongue body and lip roundness, respectively.[28] Therefore, objective and semiobjective tests were used instead of perceptual articulatory tests or questionnaire-based studies to achieve more precise results.

Limitations and Suggestions

- Longer follow-up times are suggested as well as follow-up after cessation of treatment.
- Shorter follow-up intervals are suggested, especially during the first days of appliance insertion to reveal the exact time of adaptation.
- Since side effects of the appliance, like ulcers, drooling, and painful anchorage teeth, rather than the appliance itself can affect the results, it is recommended that such cases from the study be ruled out or at least these implications should be considered interfering factors.
- Since the quality of the articulation of both vowels and consonants can be influenced by the retention of the appliances, the reported difference in speech distortion may be secondarily influenced by appliance retention. Therefore, it is proposed that retention of the appliance be evaluated at each time interval and analyzed at each session.

CONCLUSIONS

- Lower speech distortion was observed immediately after inserting CTB, and adaptation of the articulor structures took place faster in CTB.
- Orthodontists should reassure patients that the potential distortions in speech production are temporary and that adaptation will likely occur during the first month of treatment.

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DISCLOSURES

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