Iran J Orthod. 2024 June; 19(1):e1160. doi:10.32592/ijorth.19.1.1160.
Published online 2024 June 1

Original Article **Open Access**

Clear Twin Block Versus Traditional Twin Block: a Clinical Electromyographic Comparison

Ahmad Behroozian [1*], Anahita Pourahmad [2], Mahsa Zali [3], Amir Zandesh [2], Naeimeh Motallebi [4]

[1] Associate Professor, Department of Orthodontics, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[2] Student of Dentistry, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[3] Msc of Speech Therapy, Department of Speech Therapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran
[4] Dentist, Tabriz, Iran

*** Corresponding Author:** Ahmad Behroozian
Address: Department of Orthodontics, Faculty of Dentistry, Azadi Boulevard, Tabriz, Iran.
Email: ahmadbehrouzian@gmail.com

Received: 2024 May 03; **Revised:** 2024 May 15; **Accepted:** 2024 May 19

Abstract

Background: Functional appliances such as twin blocks are widely used to treat skeletal Class II malocclusions. Myofunctional effects are one of the critical features of these appliances. The present study aimed to investigate the muscular effects of clear and traditional twin blocks.

Methods: In this randomized clinical trial, 60 skeletal Class II division 1 patient were randomly divided into two groups: clear twin block (CTB) and traditional twin block (TTB). Electromyographic (EMG) evaluation of masseter, anterior temporalis, orbicularis oris, and mentalis muscles was carried out during deglutition, rest, whistling, and forced occlusion before insertion (T1) and six months (T2) after insertion of the appliance. Data were analyzed using independent t-test, paired t-test, and Wilcoxon's signed rank at the 0.05 significance level.

Results: There were no significant differences in T2 values between the groups (P>0.05). The intragroup comparisons showed a significant change from T1 to T2 in the CTB group for the clenching of the masseter muscle and in the TTB group for swallowing and rest position of the anterior temporalis muscle and swallowing of the masseter muscle (P<0.05).

Conclusion: Both CTB and TTB changed the muscular activity of circumoral muscles. No significant difference was found when the post-treatment muscular activity of the two groups was compared.

Keywords: EMG, Clear Twin Block, Muscle, Skeletal Class II

Background

Class II(Cl II) malocclusion is one of the common skeletal problems in orthodontic patients (1). It can be seen in skeletal or dental forms, each presenting with unique clinical manifestations (2). Treatment of skeletal and dental Cl II, division 1 malocclusion, a potential treatment approach, involves modifying the amount and direction of mandibular growth using functional appliances (3,4). Various functional appliances have been developed to stimulate mandibular growth and advance the mandible's position to address Cl II skeletal problems. The twin block appliance is a removable functional appliance introduced by Clark and is widely used to treat skeletal Cl II malocclusions (5). Studies have shown the beneficial effects of the twin block appliance in treating skeletal Cl II malocclusions (6,7). Wire clasps can irritate tissues and might require frequent adjustments. The wire components on the labial surface of teeth can also compromise dental aesthetics, potentially reducing patient cooperation (8). Lack of patient cooperation increases treatment time and impacts treatment results (9).

The clear twin block (CTB) appliance was introduced by Behroozian and Kalman to enhance clinical performance, increase patient cooperation, and address the shortcomings of the traditional twin block (8). This clear device has the same mechanism as the traditional one but uses clear thermoplastic material instead of metal clasps and acrylic bases, and the wire components of traditional twin block (TTB) have been largely eliminated to mitigate these issues.

Different studies have reported varying effects on muscle function during corrective treatment for skeletal Cl II abnormalities. One influential factor in functional appliance efficacy is the ability to alter the functional matrix (10). Electromyography (EMG) is a valuable diagnostic tool that quantitatively measures muscles' electrical activity at rest and during contraction (11). It is used to assess muscle function and can be particularly useful in diagnosing conditions that affect muscle and nerve function, including skeletal abnormalities like Cl II malocclusion (12). In orthodontics, EMG can help evaluate the changes in muscle activity due to the presence of appliances like braces or functional devices and during the follow-up period (13). However, no clinical trial has yet compared the muscular effects of the traditional and clear twin block appliances.

Methods

In this randomized clinical trial, 60 patients requiring growth modification treatment for skeletal Cl II division 1, attending private offices, were selected. The sample size was calculated using GPower software based on statistical power analysis. Based on the type of test used, the alpha level was 0.05, the statistical power was 0.8, and the effect size was 0.73, according to previous studies. The sample size was n=30 for each group. We used the sequentially numbered, opaque sealed envelopes (SNOSE) method for randomization. We obtained written informed consent from parents or legal guardians of children before including them in the study. The patients were randomly assigned to clear twin block (CTB) and traditional twin block (TTB) groups.

The study's inclusion criteria comprised patients in the age range of growth spurt, identified through assessments of cervical vertebrae condition and physiological characteristics (CS2 and CS3). Additionally, both patients and their parents demonstrated a willingness to address the jaw problem, with patients showing cooperation for regular visits and possessing permanent incisors and first molars.

Exclusion criteria encompassed patients exhibiting non-cooperation with regular visits or deviating from the prescribed schedule and wearing protocol of the appliance. Furthermore, failure to adhere to outlined hygiene protocols and any necessity to modify the appliance during treatment, such as missing or breaking the appliance, were grounds for exclusion. The method of fabrication of CTB was based on the Behroozian and Kalman method (8). The use of the appliance was the same for all patients, and health education was provided for all patients. A checklist was provided for the clinician, which they completed during each patient's session. The clinician and speech therapist who ran the EMG test were not blinded because the type of the appliance could be seen extra orally.

At the insertion session, the speech therapist ran the EMG test for each patient (T1), and the second test (T2) was recorded six months after cessation of the treatment.

The patient sat upright, and the pads were attached to the selected regions (14-16). The pads were connected to the surface electrodes of the EMG apparatus (Mega 4, Rashanics, Urmia, I.R.Iran). Then, the patient was asked to do "swallowing, clenching, and rest" maneuvers as described by the clinician (Figure 1). The raw data were gathered with a laptop and Rashanic software (Figure 2).

Figure 1. The patient wearing sEMG pads and surface electrodes testing the muscular activity of the orbicularis oris.

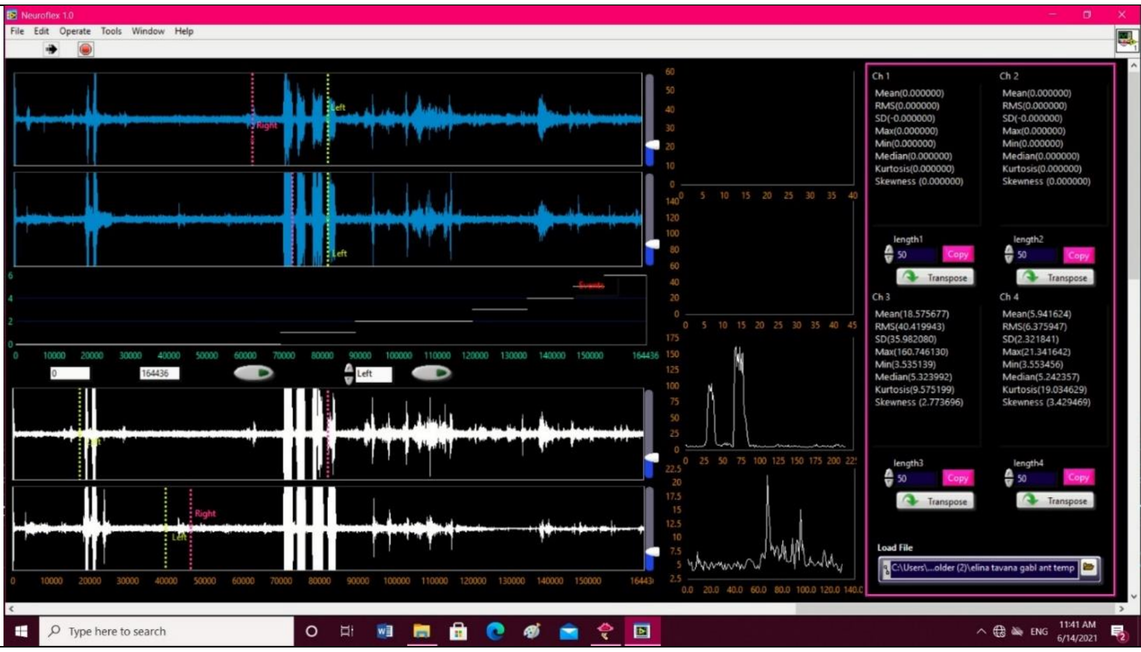

Figure 2. sEMG activity of muscles during voluntary motor tasks. Raw data were registered by sEMG.

Statistical analysis

The distribution of the electromyographic data was analyzed using a one-sample Kolmogorov-Smirnov test. We used an independent t-test to compare the difference in muscle activity between the two groups of patients using different appliances. The statistical significance was set at 0.05.

Results

Sixty (30 CTB, 30 TTB) subjects remained in the study and were analyzed for muscular EMG activity. Data were recorded, and EMG data were analyzed. The Kolmogorov-Smirnov test revealed that the mean EMG activity of the anterior temporalis during rest and swallowing (T2) and the mean EMG activity of the mentalis muscle during rest (T2) were not normal ($P<0.05$); however, the mean EMG activity of other muscles was normal ($P>0.05$).

Tables 1 to 4 show the mean EMG activities of studied muscles during different positions. The reasons for the dropout of some patients were missing regular visits, satisfaction with the treatment and discontinuation of the wearing of the appliance by the patients, breakage of the appliance, and unwillingness to undergo the EMG test at follow-up sessions.

According to the results, as shown in Table 5, there was no significant difference between the two groups of treatment in terms of muscle activity after using appliances (T2) ($P>0.05$).

We used paired t-test and Wilcoxon's signed rank test to compare muscle activity between T1 and T2. According to the results, in the traditional twin block group, there was a significant difference in the activity of the anterior temporalis muscle (rest and swallowing) and the activity of the masseter (swallowing) between T1 and T2 ($P<0.05$). For the patients using the clear twin block, the difference between masseter (clenching) activity between T1 and T2 was significant ($P<0.05$).

Table 1. Comparison of the EMG values during different activities for clear twin block in T1 and T2, parametric data

Clear twin block		T1		T2		P-value
		Mean	SD	Mean	SD	
Masseter	Rest	9.9633	±1.64135	8.5333	±3.51580	0.678
Orbicularis oris	Rest	7.1667	±3.84594	8.7067	±2.70713	0.197
Masseter	Clenching	76.5133	±2.65097	90.2133	±2.86409	0.021
Anterior temporalis	Clenching	45.2067	±6.94510	44.8333	±8.96214	0.965
Masseter	Swallowing	30.6033	±10.98196	32.9167	±10.44048	0.243
Mentalis	Whistling	73.8733	±10.66877	73.4400	±9.04803	0.760
Orbicularis oris	Whistling	75.0733	±8.42005	85.1867	±11.99373	0.153

Table 2. Comparison of the EMG values during different activities for clear twin block in T1 and T2, non-parametric data

		Anterior temporalis rest T1-T2		Anterior temporalis swallowing T1-T2		Mentalis rest T1-T2	
		T1	T2	T1	T2	T1	T2
Clear twin block	Median	5.86	5.25	29.63	34.41	7.80	10.43
	Mean	6.83	4.92	29.57	34.65	9.23	9.37
	Minimum	5.63	4.08	28.46	32.87	5.25	6.44
	Maximum	9.02	5.43	30.63	36.69	14.66	11.25
	P-value	0.109		0.109		1.000	

Table 3. Comparison of the EMG values during different activities for traditional twin block in T1 and T2, parametric data

Traditional twin block		T1		T2		P-value
		Mean	SD	Mean	SD	
Masseter	Rest	5.5460	±1.27543	5.8980	±1.48955	0.625
Orbicularis oris	Rest	6.6740	±2.47699	6.3740	±2.33748	0.141
Masseter	Clenching	71.2440	±10.00553	77.4000	±11.37655	0.121
Anterior temporalis	Clenching	39.6400	±5.82604	42.5520	±5.22465	0.079
Masseter	Swallowing	28.4880	±11.91858	32.7320	±11.23451	0.020
Mentalis	Whistling	81.6780	±7.93527	75.7172	±15.64897	0.459
Orbicularis oris	Whistling	72.2040	±4.51524	80.7660	±6.67449	0.081

Table 4. Comparison of the EMG values during different activities for traditional twin block in T1 and T2, non-parametric data

		Anterior temporalis rest T1-T2		Anterior temporalis swallowing T1-T2		Mentalis rest T1-T2	
		T1	T2	T1	T2	T1	T2
Traditional twin block	Median	5.07	6.60	26.88	27.65	6.45	9.63
	Mean	5.24	6.26	23.80	25.74	7.78	10.35
	Minimum	4.56	5.10	11.32	12.25	2.99	4.25
	Maximum	5.83	7.14	32.24	35.62	17.99	16.75
	P-value	0.043		0.043		0.138	

Table 5. Comparison of T2 values between the groups

	P-value	TTB		CTB	
		Mean	SD	Mean	SD
Masseter, rest	.178	5.89	±1.48	8.53	±3.51
Masseter, clenching	.112	77.40	±11.37	90.21	±2.86
Masseter, swallowing	.982	32.91	±10.44	32.91	±10.44
Anterior temporalis, rest	.071	6.26	±0.88	4.92	±0.73
Anterior temporalis, clenching	.658	42.55	±5.22	44.83	±8.96
Anterior temporalis, swallowing	.141	25.74	±8.70	34.65	±1.92
Mentalis, rest	.773	10.35	±5.14	9.37	±2.57
Mentalis, whistling	.829	75.71	±15.64	73.44	±9.04
Orbicularis oris, rest	.243	6.37	±2.33	8.70	±3.51
Orbicularis oris, whistling	.518	80.76	±6.67	85.18	±11.99

Discussion

Growth modification is the method of choice for skeletal Cl II malocclusion patients of circumpubertal ages, and twin block is one of the most commonly used functional appliances for this purpose (4). CTB is a modification of TTB made from clear thermoplastic sheets instead of acrylic plates and wires (8) .Because of its novelty, some questions about the efficiency and efficacy of CTB must be surveyed. One of these questions concerns comparing the muscular effect of CTB and TTB in treating skeletal Cl II patients.

In this randomized clinical study, we found no significant difference between the final results of CTB and TTB in muscular activity. Therefore, if the muscular response is important in the success of growth modification, and if TTB is an effective appliance, CTB can be as successful.

The first question is, “Why is muscular response important in growth modification?” Muscular activity plays a significant role in the success of growth modification of the jaws, particularly with functional appliances. According to functional matrix theory, forces exerted by muscles and functional activities like chewing influence jaw growth. When muscles pull on specific areas of the jawbone, they stimulate bone deposition and growth in the direction of the force (17). Muscles are an important part of the functional matrix; however, the role of muscles is beyond simply being a component of the functional matrix. Muscles are an active component of growth modification. This means that we need the muscles to maintain the jaws forward, at least in the active phase of the treatment. As a result of growth modification, an increase in the dimensions of the lower jaw or being in a correct relationship with other parts of the face increases the muscular force. Therefore, EMG can detect the success of the growth modification indirectly (18). Facial sutures, where bones connect, are influenced by functional pressures. Balanced muscle activity can promote healthy suture development, impacting jaw growth patterns (19). Balanced muscle function can indirectly influence tooth alignment. When muscles exert proper force, it can create a more favorable environment for teeth to move into and remain in their desired positions during and after orthodontic treatment (20).

While not the sole factor, muscular activity is crucial for successful jaw growth modification, particularly with functional orthodontic appliances. Promoting balanced muscle function and influencing growth patterns can contribute to achieving optimal treatment outcomes.

Electromyography (EMG) is the most objective and reliable technique for evaluating muscle function and efficiency by detecting electrical potentials (21). It makes it possible to assess the extent and duration of muscle activity. It is classified as intramuscular (traditional) and surface

EMG (sEMG). Traditional EMG uses intramuscular electromyography in which a needle and fine-wire electrodes are inserted through the skin into the muscle tissue. This technique detects single motor unit potential (motor unit action potential – MUAP). Another type of EMG is surface electromyography (sEMG), which uses surface electrodes and detects superimposed motor unit action potentials from many fibers, as opposed to the single ones recorded by the intramuscular type (22).

We used sEMG instead of routine EMG. sEMG is a component of the broader EMG field that includes subcutaneous techniques. It is also a part of the biomechanics of movement and represents a unique vehicle for monitoring the function of the neuromuscular system (23,24).

Although sEMG provides a global view of skeletal muscle function, in principle, the analysis of multielectrode recordings enables the assessment of the activity of individual motor units (MU) as well (25). In addition, multichannel sEMG enables the study of the features of multiple muscle systems (23), essentially assuming a quantitative relationship between sEMG and muscle force (26). In a broader context, it can be asserted that sEMG has become a reliable non-invasive correlate of muscle force in addition to the more basics (23). Being a non-invasive and painless measure, sEMG has been applied in motion analysis to assess superficial muscle function, with application in sports, ergonomics, and occupational and rehabilitation medicine. It allows for investigating muscle activation and physiological characteristics (24).

The process of taking sEMG and sticking the pads on the skin is a strange procedure for patients and parents. Despite initial description and obtaining informed consent, some parents rejected the test and were excluded from the study. We propose a bigger sample size to predict these dropouts.

Although the clinicians urged full adherence to usage guidelines, we had no method to determine the patients' wear time, which is crucial to treatment success. We suggest using a method to determine patients' cooperation and exclude those with poor cooperation from the study.

Natural growth by itself, even without an appliance during pubertal ages, may influence the activity of circumoral and masticatory muscles. We suggest adopting a control group (without using any appliance) in conjunction with CTB and TTB groups in the future to rule out the pure effect of the growth in the samples.

Conclusion

No significant difference was found when post-treatment muscular activity of CTB and TTB was compared. However, both appliances changed the muscular activity of circumoral muscles.

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