



Pre-Orthodontic Myofunctional Trainers Appliance System: A Review

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Abstract

Aims: One of the biggest problems globally is malocclusion. The action of orofacial muscles is affected by tenacious oral habits. The quick diagnosis and subsequent treatment of orofacial disorders render countless welfares by reducing both related malocclusion and opportunity of relapse subsequently to orthodontic treatment. Pre-orthodontic trainers are innovative types of prefabricated removable functional appliances claimed to train the orofacial musculature; thus correcting malocclusion. This review aimed to search the literature for studies and case reports on the effectiveness of pre-orthodontic trainers on early correction of developing malocclusion and highlight particularly on its structural characteristics and its mechanism of action. Current literature provides sufficient evidence that these appliances are effective in treating Class II malocclusions especially those caused by mandibular retrusion. Case reports on Class I malocclusion have reported relief of anterior crowding, the alignment of incisors, and correction of deep bite with pre-orthodontic trainers. Promising results with pre-orthodontic trainers are realized in improved nasal breathing, improved swallowing pattern, and removal of habits like tongue thrusting and mouth breathing.

الخلاصة

الأهداف: سوء الإطباق له تأثير كبير دولياً. تؤدي العادات الفموية المستمرة إلى حدوث تغيير في نشاط عضلات الفم والوجه. التشخيص والعلاج المبكر للاضطرابات الوظيفية الفموية والوجيهية تؤدي إلى تقليل سوء الإطباق المرتبط بها وتقلل إمكانية الانتكاس بعد العلاج التقويمي. الأجهزة العضلية الوظيفية المدربة ما قبل تقويم الأسنان هي أنواع مبتكرة من الأجهزة الوظيفية الجاهزة القابلة للإزالة وتهدف إلى تدريب عضلات الفم والوجه؛ وبالتالي تصحيح سوء الإطباق. هدفت هذه المراجعة إلى البحث في الدراسات وتقارير الحالات الخاصة حول فعالية الأجهزة العضلية الوظيفية المدربة ما قبل تقويم الأسنان في التصحيح المبكر لسوء الإطباق وتسليط الضوء بشكل خاص على خصائصها الهيكلية وآلية عملها. توفر الدراسات الحالية أدلة كافية على أن هذه الأجهزة فعالة في علاج سوء الإطباق من الدرجة الثانية خاصة تلك الناتجة عن ارتداد الفك السفلي. أشارت تقارير الحالات الخاصة بسوء الإطباق من الدرجة الأولى عن تخفيف الازدحام الأمامي ومحاذاة القواطع وتصحيح العضة العميقة باستخدام الأجهزة الوظيفية المدربة ما قبل تقويم الأسنان. سيتم تحقيق نتائج واعدة مع هذه الأجهزة في تحسين التنفس الأنفي ونمط البلع المحسن وإزالة العادات مثل دفع اللسان والتنفس من الفم.

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INTRODUCTION

Evidence suggests that malocclusion has a limitless weight worldwide (Disha et al.,2017). Orthodontic treatment is mandatory for correction of malocclusion but relapse of malocclusion happens if any aberrant muscle activity is ignored (Danz et al.,2012). Retraining the abnormal muscle tone and function, along with correction of the dento - alveolar system is necessary, to evade the risk of relapse and to achieve stable orthodontic results (Ramirez and Farrell,2005).

The idea of treating orthodontic abnormalities in growing child was identified previously, mainly in Europe. The handling of certain malocclusions must be initiated during the primary or the early mixed dentition as the condition of the primary teeth has a reflective outcome on the development of permanent teeth (Proffit, 2006). Orthodontic appliances of functional type are utmost frequently used during early orthodontics (Nagda and Dixit, 2019). For over a hundred years, the goal of using such appliances was eradicating oral dysfunctions, attaining muscular balance, reducing incisor protrusion and creating moral maxillomandibular relation (Nagda and Dixit, 2019). Different authors worldwide have evaluated the benefits of using functional appliances on skeletal and dentoalveolar parameters (Ferreira, 2017; Idris et al.,2018; Li et al.,2019; Elhamouly et al.,2020).

Although functional appliances are essentially used in correcting malocclusions, certain drawbacks of these appliances as mentioned by Gokce and Kaya (2016): the bulkiness of the appliance, restricted capacity to align teeth, construction with inflexible material, requirement of impression taking and laboratory work, lack of

patient and parental compliance, frequently uncomfortable and patient simply give away of the treatment. Boyd *et al.*, (2021) reviewed reports of cases and described the nature of the problem and strategies for effective solutions of human malocclusion phenotypes in early childhood and associated orofacial myofunctional disorders.

Types of Trainers

Pre-orthodontic trainers or the myofunctional trainers are new types of prefabricated removable functional appliances that agreeing to the manufacturer 's claims, train and exercise the orofacial muscles into their accurate position and bring about a state of equilibrium amongst the forces brought onto the dento-alveolar system(Ramirez and Farrell,2005). Such appliances have a chance to reeducate masticatory and facial muscles, affecting tongue position than any other functional appliance helping in the alignment of the teeth and stimulating correct growth and development of the craniofacial system (Ramirez and Farrell,2005; Ramirez et al.,2007; Anastasi and Dinnella, 2014; Farrell, 2016).

In 1992, T4K® (Pre-Orthodontic Trainer for Kids™) was announced by Myofunctional Research Company, Australia, tailed by other appliances of The Trainer System™. It consists of various appliances for diverse age groups. They consist of phase I and phase II appliances in which phase I appliances are made of silicone and phase II appliances are fabricated of harder material like polyurethane (Anastasi G Dinnella, 2014).

These appliances are existing in different sizes for primary, mixed and permanent dentition and for diverse treatment purposes like habit correction, arch development, and Class II/Class III

correction (Myofunctional Research Company, update 2018). Trainer of Infant type proposed to be used in young 2-5 years children, (T4KTM) Trainers for kids in mixed dentition, (T4ATM) Trainers for adolescents and/or adults , (T4BTM) Trainers with Brackets, (T4CIITM) Trainer for class II malocclusion, (i3) Trainer for class III malocclusion , Trainer Lingua and Myobrace (Myofunctional Research Company, update 2018).

Mechanism of Action of Trainer Appliances

The effects of Trainer appliances on maxilla and mandible have been proved by scientific studies and different clinical cases effectively treated and reported in the existing literature (Usumez et al., 2004; Ramirez et al., 2007). In sagittal plane, this type of functional appliance yields similar outcome to other functional appliances (tooth-borne, tissue-borne, whether fixed (flexible, rigid or hybrid) or removable) planned to encourage the growth of mandible via directing the mandibular position into an edge to edge (Ramirez et al., 2007). Like other functional appliances, Trainer acts by stretching muscular fibers of mandibular protractors muscles. When using Trainer appliance, muscles remain stretched; during the sleep period (10-12) hours, the blood vessels diameter is diminished impeding sufficient blood flow and reducing blood oxygen level and metabolism. Lactic acid accumulates in muscles, causing muscular fatigue. When such appliance is withdrawn, the protruding muscles turn into hypercontractible producing forward and backward movement of the mandible (Van der Linden et al., 2004). This fact clarifies the cause behind inability of patients to relax their mandibles nor preserve the teeth in their maximum intercuspatation

during morning time when trainers are removed from the mouth, especially at the beginning of the treatment (about three to four weeks). After several hours of stretching the muscular fibers, the consequent muscular hypercontractibility yields improved blood circulation and elimination of accrued lactic acid. Altogether, the rise in blood circulation in muscles causes more undifferentiated cells having the capacity to differentiate to myoblasts producing new muscle fibers in protractor muscles (Ramirez, 2009). The anterior mandibular position without associated muscular fatigue was attained by a rise in the muscular fibers and the trained muscles in supplementary treatment (Usumez et al., 2004; Ramirez et al., 2007). The stimulation of dental arches development transversally is the additional outcome of using Trainer T4K (Ramirez et al., 2007). The rise in transverse distances of dental arches associated with T4K Trainer treatment (intermolar, interpremolar and intercanine distance) have been reported. The mechanism of such outcome is akin to action of Fränkel appliance (Firatli and Ulgen , 1996). The buccal shields inhibit cheeks from applying force on buccal aspects of upper and lower molars and premolars. The force is round 2.7 g/cm³ can be raised to 20 g/cm³ in patients with tongue thrusting or digital sucking habits whereas it accomplishes a force of 80 g/cm³ in corners of the mouth and canines regions (Mew et al., 2004). The proper tongue action and position on the lingual side of the teeth and reinforcement the buccal growth of the dentoalveolar region is achieved by counterbalancing such forces. Stretching buccinator and orbicularis oris muscles, is the other effect of buccal shields, creating the zone of tension in the area of muscular insertion. The

created zones of tension excite bone apposition in upper and lower jaws especially in transverse direction (Frost, 2003). The Trainer's presence in the mouth inhibits molar inter-cuspidation owing to silicon surface interposition between the upper and lower component of the appliance. That method enhance dentoalveolar unit's growth vertically, causing teeth positioning in flat occlusal plane guided by occlusal surfaces of appliance (Ramirez et al., 2008). The location of lingual tag in the upper palatal area of Trainer, train and force tongue in more physiological position. Tongue thrust is completely stopped, stimulating dentoalveolar unit development vertically and correction of the open bite problem (Ramirez et al., 2008).

The trainer suggested to be used for 1 to 2 hours a day and 10 to 12 hours during sleep comparable to other Trainer appliances (Myofunctional Research Company, update 2018). During the early mixed dentition period, mouth breathing and incompetent lips are suggestions for use of Trainers (Ramirez, 2009) and Trainer T4K is an appliance of prime (Ramirez et al., 2007). Occasionally reestablishment of nasal respiration enhancement of transversal, sagittal and vertical development was encouraged. Lip incompetence associated with oral breathing is caused by low orbicularis oris activity of and increased mentalis activity and vice versa (Tosello et al., 1999). Using trainer, an improvement of orbicularis oris function consequently leading to physiological competent lips (Tosello et al., 1999).

Indications for Trainer Appliances

These appliances existing in different sizes for primary, mixed and permanent dentition and for diverse treatment purposes like habit correction, arch development, and Class II/Class III correction (Myofunctional Research Company, update 2018). The system of Trainer appliances are used according to the age of patient and indications, with Trainer of Infant type proposed to be used in young 2-5 years children, (T4KTM) Trainers for kids in mixed dentition, (T4ATM) Trainers for adolescents and/or adults, (T4BTM) Trainers with Brackets, (T4CIITM) Trainer for class II malocclusion, (i3) Trainer for class III malocclusion, Trainer Lingua and Myobrace. The indications of this system of Trainer appliances are diverse, however, all of which work similarly. As indicated by the name, these appliances exercise or train craniofacial muscles within physiological load for bones besides stimulating development and growth of whole structures of craniofacial system. Directing muscles of mastication and muscles of the face for working accurately, harmonizing forces of the tongue and cheeks via proper positioning of the tongue during rest and function, Trainer appliances encourage development and growth of maxilla, mandible and dental arches with correct positioning of teeth (Ramirez, 2009). Pre-orthodontic trainers depend on the lip seal for retention of the appliance. It is recommended that the patient bite down onto the appliance mildly and maintain an appropriate lip seal. Proper tongue positioning is really important and is achieved by positioning the tongue on a tongue tag on the appliance. The patient is trained and encouraged nasal breathing. There should be no lip activity once swallowing.

Benefits of Trainer Appliances

Particular advantages, proved by clinical experience, of this type of appliances over other functional appliances: impression is not mandatory, this particularly suitable for un-cooperative kids; complex appliance positioning is not needed due to difficulty in un-cooperative children at this age; material flexibility makes this appliance un-breakable and comfy which is the chief drawback of other types of functional appliances and high acceptance rate by children. System of Trainer appliances seemed to be economical and contented (Ramirez et al., 2008).

Studies on Using of Pre-Orthodontic Trainers

Treatment of Class II malocclusion:

Quadrelli, et al. (2002) deliberated variations subsequent to T4K appliance in skeletal Class II cases by means of clinical, radiological, electromyographic, kinesiographical, stabilimetric and rhinomanometric assessments. It was found that atypical swallowing was corrected and bruxism was reduced besides improved aptitude towards nasal breathing. Significant reduction of open bite and reduction in ANB angle was detected along with the significant increase in inter-molar width. Usumez et al. (2004) studied the effects of the trainer on 20 patients with Class II Division I with mixed dentition and described significant increasing in the total height of the face, proclination in lower incisors, retroclination in upper incisors, and reduction in overjet. Authors reported that these changes were mainly dentoalveolar (Usumez et al., 2004).

The patient exhibited open bite with a posterior crossbite on one side and deviated

mandibular midline. Primarily a modified quad helix was used nevertheless because of lack of patient agreement, T4K was given to be worn for 1-2 hours during the day and overnight, which abolished the thumb sucking within 1 month and corrected open bite and crossbite within 18 months. Fixed orthodontic therapy was done for 18 months after which T4A was used as a retainer for a year and no relapse happened. In the end of treatment, the SNA angle was nearer to a normal value which suggested that the T4K might have limited anterior maxillary growth (Ramirez et al., 2007).

The electromyographic effects of anterior temporal and masseter had been studied by Okkesim et al. (2007), while pre-orthodontic trainer was in the mouth during sucking a hollow straw, in 10 mixed dentition Class II Division I patients. The results exhibited that the force exerted by these muscles reduced once the pre-orthodontic trainer was in place.

In (2009), Tartaglia et al. using soft tissue analysis, found a statistically significant increase in the anterior facial height furthermore to enhanced facial divergence and facial convexity by means of pre-orthodontic trainer.

Using a preorthodontic trainer in individuals showing class II division I malocclusion, dentoalveolar changes were reported in a study of Das and Reddy (2010). Additionally, they found skeletal changes similar to the reduction in the ANB angle and the cant of occlusal plane signifying sagittal growth and forward rotation of the mandible.

Yagci et al. (2010) evaluated the electromyographic alterations in the masticatory and perioral muscles on sucking, swallowing and clenching in 20 Class II Division I patients after 6

months of pre-orthodontic trainer treatment and established that the EMG assessment for the clenching of the anterior temporalis, mentalis, and masseter decreased significantly; whereas for orbicularis oris muscle, it lessened significantly during sucking as well as clenching.

In their comparative study, Guven et al. (2013) compared the changes produced via Frankel II appliance, fixed anterior bite plane and T4K trainer in patients between age 6 to 12 years, having Class II profile with mandibular retrusion. They found that T4K group besides other groups showed a significant increase in mandibular inter-canine width and reduced overjet. T4K also produced a statistically significant decrease in the maxillary arch length and arch depth and a rise in the mandibular arch length (Guyen et al., 2013). Szuhaneck et al. (2016), in a comparative study, found that less discomfort was caused by the activator than the Trainer and appeared to be more acceptable.

Wijey et al. (2017) described 2 case reports of patients aged 13 years and 11 years, wherein decrease in overjet and deep bite and removal of mouth breathing and abnormal swallowing pattern was detected 1 year after use of Myobrace for teens – T1 and T2.

Atik et al. (2017) compared the effects of Frankel II appliance, T4K trainer and X bow appliance in prepubertal Class II Division I patients, as a result of mandibular retrognathia and relative maxillary constriction. They reported that both, Frankel II and Trainer, were found to significantly decrease the overjet and caused a larger increase in the sagittal dimensions of the mandible but the Trainer appliance did not significantly increase the airway dimensions.

In (2017), Ferreira published a review that included 15 papers (both randomized controlled studies and case reports) describing the effects created by the prefabricated functional appliances in the treatment of dentoskeletal Class II problems and masticatory muscle dysfunction. The author concluded that pre-orthodontic trainer appeared to have a helpful effect on the facial and masticatory muscles as well as on arch development but it was mainly seen to induce dentoalveolar changes causing a significant reduction of overjet during treatment of Class II patients.

Idris et al. (2018) compared the soft tissue and hard tissue changes next to treatment with Activator and T4K in 54 Class II Division I patients between age 8 and 12 years. A significant reduction in the ANB angle and a significantly higher increase in the angle of facial convexity was detected using Activator as compared to T4K. Nasolabial angle significantly reduced with Activator while compared to T4K. A significant decrease in overjet was also noticed with the Activator appliance as compared to T4K.

A perfection in facial profile was revealed by Li et al. (2019) in a case report of a girl (10 years) having a Class II Division 1 malocclusion treated by a Trainer for Braces in addition to fixed orthodontic appliances.

Elhamouly et al. (2020) evaluated and compared dentoalveolar effects of T4K against twin block in kids with class II division I malocclusion. The dentoalveolar improvements were significantly toward class I occlusion with twin block than with T4K appliance.

Treatment of Class I Malocclusion with Crowded Teeth or/with Deep Bite:

Vlachakis et al. (2007) defined a case of a girl (8 years), in which the upper anterior crowding was resolved, creating space for lateral incisors eruption, using of T4K appliance.

Gupta et al. (2010) corrected deep bite and lower midline shift with maxillary and mandibular anterior crowding in a 9 years old child using T4K phase 1 and 2 for 18 months. The bite was permitted to open by cutting the trainer on the distal aspect, first to accommodate the free eruption of lower 1st molars and then cutting adjacent the premolars, such that it is existing only anteriorly. At the end, the patient was instructed to wear T4K phase 2 appliance just during nighttime, as a bite-holding appliance until the pubertal growth spurt was completed. A similar case was described by Sreedevi et al. (2011) in a 10 years old female.

Dinkova et al. (2014) treated patients who had deep bite during early mixed dentition with T4K – phase 1 and 2 and Myobrace trainer was used for persons who required teeth alignment. It was detected that reduction of deep bite happened by 2.5 to 3.5mm at the end of the treatment but 62% of cases displayed some relapse.

Pai et al. (2016) designated a case of a 7 years old girl where distoangular rotation of upper incisors was observed because of toe sucking habit. T4K phase 1 appliance was used effectively for realigning the incisors and retraining the oral musculature.

Chrysopoulos et al. (2017) treated a child who had palatally inclined maxillary central incisors and buccally flared maxillary laterals with 6mm overjet and 5 mm overbite, with Myobrace K1 and K2 for 10 months causing into the

correction of overjet and overbite with improved anterior teeth position and alignment and reduced the buccinator and mentalis hyperactivity. Using a preorthodontic trainer in in the case of 11 years old child with forwardly placed upper front teeth and irregular lower front teeth, similar outcomes were attained, as reported by Pujar et al. (2013).

Treatment of Class III Malocclusion:

There are appliances marketed for the treatment of Class III malocclusions but there is no study found in the literature regarding their use in Class III malocclusion treatment.

Generally, studies as well as case reports, show that treatment with myofunctional trainers has a three-dimensional effect: sagittal, transverse and vertical together with training the perioral musculature in their precise position (Ramirez, 2009; Pujar and Pai, 2013 ; Nagda and Dixit , 2019).

CONCLUSION

Most encouraging results with pre-orthodontic trainers are realized in enhanced nasal breathing, better-quality swallowing pattern and removal of habits like tongue thrusting and mouth breathing. Current literature condenses sufficient evidence that these appliances are effective in treating Class II malocclusions chiefly those owing to mandibular retrusion. Case reports on Class I malocclusion cases have stated relief of anterior crowding, alignment of incisors and improvement of deep the bite with pre-orthodontic trainers. Therefore, it can be concluded that pre-orthodontic trainers can be used to treat Class II malocclusions and any dental malocclusion caused by different types of habits.

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