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Current Evidence on the Effect of Pre-orthodontic Trainer in the Early Treatment of Malocclusion

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Abstract:*Malocclusion poses a great burden worldwide. Persistent oral habits bring about alteration in the activity of orofacial muscles. Non-nutritive sucking habits are shown to cause anterior open bite and posterior crossbite. Abnormal tongue posture and tongue thrust swallow result in proclination of maxillary anterior teeth and openbite. Mouth breathing causes incompetence of lips, lowered position of tongue and clockwise rotation of the mandible. Early diagnosis and treatment of the orofacial myofunctional disorders render great benefits by minimizing related malocclusion and reducing possibility of relapse after orthodontic treatment. Myofunctional appliances or pre orthodontic trainers are new types of prefabricated removable functional appliances claimed to train the orofacial musculature; thereby correcting malocclusion. This review aimed to search literature for studies and case reports on effectiveness of pre-orthodontic trainers on early correction of developing malocclusion. Current literature renders sufficient evidence that these appliances are successful in treating Class II malocclusions especially those due to mandibular retrusion. Case reports on Class I malocclusion have reported alleviation of anterior crowding, alignment of incisors and correction of deep bite with pre-orthodontic trainers. Most promising results with pre-orthodontic trainers are seen in improved nasal breathing, improved swallowing pattern and elimination of habits like tongue thrusting and mouth breathing.*

Keywords: *Pre-orthodontic trainers, Myofunctional appliances, Early orthodontic treatment, Oral habits correction, Prefabricated functional appliance*

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I. Introduction

Evidence suggests that malocclusion poses a great burden worldwide with its prevalence in India ranging from 20% to 41%.[1,2] Orthodontic treatment is required for correction of malocclusion but relapse of malocclusion occurs if any aberrant muscle activity is ignored. Relapse is a dento-alveolar and skeletal change after orthodontic treatment towards the initial malocclusion.[3] Retraining the abnormal muscle tone and function, along with correction of the dento-alveolar system is necessary, in order to avoid the risk of relapse and to attain stable orthodontic results.

Functional appliances offer much benefit as they help in eliminating oral dysfunction by establishing muscular balance and allowing proper growth and development of the jaws. Pre-orthodontic trainers or the myofunctional trainers are new types of prefabricated removable functional appliances which according to the manufacturer's claims, train and exercise the orofacial muscles into their correct position and bring about a state of equilibrium between the forces delivered onto the dento-alveolar system, helping in alignment of the teeth and stimulating proper growth and development of the craniofacial system.

This review aims to present the abnormalities in muscle functions associated with deleterious oral habits in children and effectiveness of pre-orthodontic trainers in the treatment of malocclusions caused by such aberrant muscle functions.

II. Disorders of or facial musculature

Orofacial muscles work in harmony during any oral function like mastication, deglutition, speech, and affect the shape of the arches and position of the teeth.[4] Any alteration in the activity of these muscles can compromise the orofacial morphology, functioning, well-being and oral health-related quality of life from childhood.[5] One of the main functional factors of orofacial dysfunction is the presence of oral habits that influence the development of malocclusion.[4,6,7] Oral habits are repetitive behavior in the oral cavity that result in loss of tooth structure, effect of which is dependent on the nature, onset and duration of these habits.[7,8]

2.1 Effects of oral habits on orofacial musculature

2.1.1. Non-nutritive sucking

Nonnutritive sucking habits are associated with an atypical swallowing pattern and tongue thrust swallow. Persistent non-nutritive sucking habit in children is shown to cause anterior open bite and posterior crossbite in mixed as well as primary dentition.[9,10,11,12,13,14,15,16]

Pacifier sucking and bottle sucking frequently cause protrusion of the upper incisors and the premaxilla, atypical swallowing, anterior open bite and posterior crossbite. Vacuum sucking movements occur with the tongue, lips and the cheek as the tongue presses the nipple against the palate, also generating a high palate and crossing the bite in the posterior region.[17,18] Posterior crossbite is because of this low positioning of the tongue during sucking, along with lack of thrust of the tongue on the palate and increased activity of the muscles of the cheeks that alters the pressure applied by the muscle on the maxillary arch.[8] Such type of sucking jeopardizes the motor development, the position and the strength of the stomatognathic structures.[17]

In case of finger sucking, there is increased pressure from the buccinators to facilitate sucking. Because of presence of a digit in the mouth during sucking, the tongue assumes a lower position. The increased buccinator activity along with absence of tongue pressure and the positioning of the digit into the oral cavity brings about narrowing of the upper arch and protrusion of the anterior teeth. There is increased contraction of the mentalis muscle which contributes to increased overjet. Patients presenting with both, contraction of mentalis muscle and increased overjet, show a tendency for the lower lip to be pushed behind the upper incisors, preventing the reduction of the overjet or interfering in the retention.[19]

Children with pacifier or digit-sucking habits may also demonstrate tongue thrusting activity and/or altered lip-to-tongue resting positions. The depth to which the digit is inserted in the oral cavity affects the lip-to-tongue resting position and also accordingly alters the pressures applied by the muscular walls of the oral cavity.[20]

2.1.2. Tongue thrust

Abnormal tongue posture is seen in children with tongue thrust habit wherein the tongue is placed at a forward position between the teeth and against the lower lip while swallowing, in order to obtain a lip seal, disturbing the equilibrium between the forces exerted upon the teeth.[20,21]

Tongue thrust causes proclination of the maxillary anterior teeth, which may result into increased overjet, midline diastema and also sometimes bimaxillary protrusion.[22,23] The low positioning of the tongue causes lack of thrust on the palate and increased activity of the muscles of the cheeks resulting into an alteration of muscle pressure on the maxillary arch preventing transverse and anterior development of the maxilla,[8,24] leading to unilateral or bilateral posterior crossbite.[25] Lisping or impaired speech might also be observed in some cases.[26] Tongue thrust habit can also be the primary cause of open bite, especially when accompanied with mouth breathing.[8,22]

2.1.3. Mouth breathing

Mouth breathing causes incompetence of lips, lowered position of tongue and increased vertical height of the face due to clockwise rotation of the mandible.[8]

Typical facial features in mouth breathers include presence of long face, narrow nostrils, maxillary constriction at the level of canines, high arched palate and gummy smile associated with malocclusion of class II or, sometimes, class III, with a high prevalence of posterior crossbite and anterior openbite.[8,21,27] Narrowing of the maxilla and the palate is as a result of insufficient support from the tongue due to its lowered posture.

In such cases, the upper lip is generally short and functionless resulting in proclination of maxillary incisors; while the lower lip is large and bulbous, trapped behind proclined maxillary incisors. This constant pressure increases the overjet.8 Constant open jaw and lack of thrust due to low posture of the tongue may also cause a sagittal and transverse maxillary skeletal deficit. There is constant distraction of the mandibular condyle from the fossa which may act as a growth stimulus for excessive mandibular growth. This contributes the role of mouth breathing in some forms of Class III malocclusion.[8,28]

Early diagnosis and treatment of the orofacial myofunctional disorders render great benefits by minimizing related malocclusion and reducing possibility of relapse after orthodontic treatment.

III. Pre-orthodontic trainers

Although functional appliances are largely used in correcting malocclusions, certain drawbacks of these appliances like the bulkiness of the appliance, limited capacity to align teeth, construction with inflexible material, requirement of impression taking and laboratory work lead to the development of pre-orthodontic trainers.[29]

Pre-orthodontic trainers or ‘The Trainer System’ or the Myofunctional trainers are pre-fabricated, removable, flexible appliances which act in a similar manner like myofunctional appliances designed to

stimulate the masticatory and facial muscles with additional function of encouraging the tongue to its correct position along with providing tooth eruption guidance and alignment.[30,31]

In 1992, the Pre-Orthodontic Trainer for Kids™ (T4K®) was introduced by Myofunctional Research Company, Australia, followed by other appliances of The Trainer System™. It consists of various appliances for different age groups, each available in single size. They consist of phase I and phase II appliances wherein phase I appliances are made of silicone and phase II appliances are made up of harder material like polyurethane.[31]

Myobrace System was introduced by the same company in 2004. It also consists of various appliances for different age groups and are available in various sizes.[31] They are available for four treatment stages including habit correction, arch expansion, alignment of teeth and retention.[30] Like trainers, Initial phase appliances are made up of silicone and stiffer material like polyurethane is used in appliances of the later phases.

Myobrace System appliances have similar structural elements as that of the Trainer System appliances; besides an internal hard nylon element, called Inner-Core or Dynamicore. It is claimed by the manufacturer that dynamicore helps resist forces developed on the teeth by buccinators and orbicularis muscles allowing correction of any misaligned teeth by providing better arch shape. This, inner soft and outer hard double structure provides good patient acceptance and compliance. Presence of additional channels at the area of the anterior teeth in the Myobrace System appliance is claimed to enhance its ability to align the teeth as it can deliver a direct force on the teeth.[31]

Both the Trainer system and the Myobrace system appliances do not require any impressions, moulding or fitting procedures. They consist of a single block, premoulded to the parabolic shape of the natural arches which contact both the arches, and it is built on an edge-to-edge incisal relation.[29,32]

These appliances are available in different sizes for primary, mixed and permanent dentition and for different treatment purposes like habit correction, arch development, and Class II/Class III correction and are presented on their website.[33]

Pre-orthodontic trainers rely on the lip seal for retention of the appliance. It is recommended that patient bite down onto the appliance gently and maintain proper lip seal. Proper tongue positioning is extremely important and is achieved by positioning the tongue on a tongue tag on the appliance. Patient is taught and encouraged nasal breathing. There should be no lip activity when swallowing. It is advised that the appliance be worn for 1 to 2 hours during day-time and through the night while sleeping.[33]

IV. Studies on use of pre-orthodontic trainers

4.1. Treatment of Class II malocclusion

There is an increased interest in the use of pre-orthodontic trainers as a modality in the early treatment of Class II malocclusion in the mixed dentition stage, especially in the presence of abnormal oral habit.

Boucher et al. (2008)[34] studied effects of treatment with a Trainer T4K® myofunctional appliance in thirteen late mixed dentition patients with Class II malocclusion with associated myofunctional disorder. All children received semirapid expansion with Hyrax followed by cementation of transpalatal arch. Children in test group were then asked to wear T4K appliance at night and for 2 hours during the day along with 2 myofunctional exercises. Children in the control group did not use the T4K appliance. Authors reported significant mandibular growth of 3.24mm with significant decrease in the overjet in the Trainer T4K group. The authors reported improvement in deglutition and breathing functions with the use of T4K.

Guven et al. (2013) compared the changes caused by Frankel II appliance, fixed anterior bite plane and T4K trainer in 39 patients between age 6 to 12 years, having Class II profile with mandibular retrusion. They found that T4K group along with the other groups showed significant increase in mandibular inter-canine width and reduced overjet. T4K also caused statistically significant decrease in the maxillary arch length and arch depth and an increase in the mandibular arch length. Although it did not seem to perform well in reducing the overbite as much as the anterior bite plane.[35]

Cirgic et al. (2016) compared the effects of Myobrace with the modified Andreason activator in 97 mixed dentition patients having Class II Division I profile with overjet of more than 6mm. Their results showed that both appliances resulted in similar correction in overbite, overjet, sagittal molar relation and lip seal. The authors also reported that treatment for 70% of patients in the Myobrace group was considered unsuccessful, compared to that of 53% in the Activator group, mainly due to poor compliance.[36] Similar study was performed by Szuhanek et al. (2016) and it was found that both the appliances were equally effective in reducing the overjet and overbite, however, the activator caused less discomfort than the Trainer and seemed to be more acceptable.[37]

Atik et al. (2017) compared the effects of Frankel II appliance, T4K trainer and X bow appliance in 54 prepubertal Class II Division I patients, as a result of mandibular retrognathia and relative maxillary constriction. The authors reported that both, Frankel II and Trainer, were found to significantly reduce the overjet and also caused larger increase in the sagittal dimensions of the mandible but the Trainer appliance did not significantly increase the airway dimensions.[38]

Idris et al. (2018) compared the soft tissue and hard tissue changes following treatment with Activator and T4K in 54 Class II Division I patients between age 8 and 12 years. A significant decrease in the ANB angle and a significant greater increase in the facial convexity angle was observed with Activator as compared to T4K. Nasolabial angle significantly decreased with Activator when compared to T4K. Significant reduction in overjet was also observed with Activator appliance as compared to T4K.[39]

Usumez et al. (2004) studied the effects of pre-orthodontic trainer on 20 Class II Division I patients with mixed dentition and reported significant increase in the total facial height, proclination of lower incisors, retroclination of upper incisors and reduction in overjet. Authors reported that these changes were primarily dentoalveolar.40 Similar dentoalveolar changes were reported in a study by Das et al. (2010). Additionally, they found skeletal changes like reduction in the ANB angle and the cant of occlusal plane indicating sagittal growth and forward rotation of the mandible.[41]

Tartaglia et al. (2009), using soft tissue analysis, also found statistically significant increase in the anterior facial height in addition to improved facial divergence and facial convexity with use of pre-orthodontic trainer.[42]

Ferriera in 2017 published a review which included 15 papers (both randomized controlled studies and case reports) describing the effects produced by the prefabricated functional appliance for the treatment of dentoskeletal Class II malocclusion and masticatory muscles dysfunction. The author concluded that pre-orthodontic trainer seemed to have a positive influence on the masticatory and perioral musculature as well as on arch development but it was mainly seen to induce dentoalveolar changes resulting in significant reduction of overjet during treatment of Class II patients.[43]

Ramirez et al. (2007), from their retrospective study, found that statistically significant skeletal changes like increase in transverse dimensions in both the arches at the first premolars and first molars were caused by T4K in 60 Class II Division I preadolescent patients.44 Transverse expansion with T4K was also reported by Kanao et al. (2009), in their 4 case reports.[45]

Tripathi et al. (2011) described a case report of a 10 year old patient having Class II Division I profile with mandibular retrusion, presence of incompetent lips and lip trap treated with T4K trainer. After 9 months of wear of T4K phase 1, 50% reduction in overjet was observed. Nine months of use of T4K phase 2 resulted in complete correction of overjet, molar relationship and lip seal.[46] Similar results were reported in a case, described by Ramirez et al. (2008), with a Class II Division II molar relation with 1 year of T4K treatment.[47]

Vlachakis et al. (2007) described a case with midline shift and lack of space with Class II Division I molar relation. Myobrace was given to this patient for 8 months, to be worn 2 hours during day and overnight, resulting in better arch alignment, improved overbite and overjet along with corrected midline.[48] Iwata et al. (2016) described a case of 9 year old boy with Class II Division I, which was successfully treated in 2 years with T4K phase 1 and 2 along with correction of mouth breathing and tongue thrust.[49] Similarly Wijey et al. (2017) described 2 case reports of patients aged 13 years and 11 years, wherein reduction in overjet and deep bite and elimination of mouth breathing and abnormal swallowing pattern was observed 1 year after use of Myobrace for teens – T1 and T2.[50]

Landau et al. (2010) published a case report of a patient with Class II Division I along with arch length discrepancy, history of habit of thumb sucking till late age, and mouth breathing with tongue thrusting. Treatment included use of T4K trainer for 6 months, followed by an eruption guidance appliance for 9 months and fixed orthodontic treatment for 2 years. Authors found that T4K caused improved lip seal, nasal breathing along with increase in the upper and lower arch width due to improved tongue position and activity.[51]

A similar case of an 8 year old girl with Class II Division I, mouth breathing and thumb sucking habit was reported by Ramirez et al. (2007). Patient showed open bite with posterior cross bite on one side and deviated mandibular midline. Initially a modified quad helix was used but because of lack of patient compliance, T4K was given to be worn for 1-2 hours during daytime and overnight, which eliminated the thumb sucking within 1 month and corrected open bite and cross bite within 18 months. Fixed orthodontic therapy was carried out for 18 months after which T4A was used as a retainer for a year and no relapse occurred. At the end of treatment, the SNA angle was closer to a normal value which suggested that the T4K might have restricted anterior maxillary growth.[52]

Quadrelli, et al. (2002) studied the changes resulting from use of T4K appliance in skeletal Class II cases by means of clinical, radiological, electromyographic, kinesiographical, stabilimetric and rhinomanometric evaluations. It was found that atypical swallowing was corrected and bruxism was reduced along with improved aptitude towards nasal breathing. Significant reduction of open bite and reduction in ANB angle was observed along with significant increase in inter-molar width.[53]

The electromyographic effects of anterior temporal and masseter muscles were studied by Okkessim et al. (2007), while the pre-orthodontic trainer was in mouth during sucking an empty straw, in 10 mixed dentition Class II Division I patients. The results showed that the force exerted by these muscles reduced when the pre-orthodontic trainer was in place.[54] Yagci et al. (2010) evaluated the electromyographic changes in the

masticatory and perioral muscles on sucking, swallowing and clenching in 20 Class II Division I patients after 6 months of preorthodontic trainer treatment and found that the EMG value for clenching of the anterior temporal muscle, mentalis muscle, and masseter muscle decreased significantly; whereas for orbicularis oris muscle, it reduced significantly during sucking as well as clenching.[55] Similar results were reported by Satygo et al. (2014) where they found significantly improved masseter and temporalis muscle function during clenching, after 1 year of treatment with T4K in 36 Class II Division I patients.[56]

Treatment of Class I malocclusion with crowded teeth or/with deep bite To our knowledge there is only one study reported in the literature regarding the use of pre-orthodontic trainers in Class I malocclusions. Dinkova et al. (2014) treated thirty two patients who had deep bite during the early mixed dentition with T4K – phase 1 and 2 and additionally Myobrace trainer was used for those who required teeth alignment. It was observed that reduction of deep bite occurred by 2.5 to 3.5mm at the end of the treatment but 62% cases showed some relapse.[57]

Sporadic case reports present successful outcome of the treatment with pre-orthodontic trainers. Gupta et al. (2010) corrected deep bite and lower midline shift with maxillary and mandibular anterior crowding in a 9 year old child by using T4K phase 1 and 2 for 18 months. Bite was allowed to open by cutting the trainer on the distal aspect, first to accommodate free eruption of lower 1st molars and subsequently cutting near the premolars, such that it is present only anteriorly. At the end, the patient was instructed to wear T4K phase 2 appliance only during nighttime, as a bite holding appliance until the pubertal growth spurt was completed.[58] A similar case was reported by[Sreedevi et al. (2011) in a 10 year old female.[59]

Chrysopoulos et al. (2017) treated an 8 year old 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 resulting into correction of overjet and overbite with improved anterior teeth position and alignment and reduced buccinator and mentalis hyperactivity.[60] Similar results were obtained in the case of 11 year old child, reported by Pujjar et al. (2013).[61]

Vlachakis et al. (2007) described a case of an 8 year old girl, wherein the upper anterior crowding was resolved, facilitating space for eruption of lateral incisors, by use of T4K appliance.[48]

Pai et al. (2016) described a case of a 7 year old girl where distoangular rotation of upper incisors was noted due to toe sucking habit. T4K phase 1 appliance was used successfully for realigning the incisors and retraining the oral musculature.[62]

4.2. Treatment of Class III malocclusion

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

Studies and case reports indicate that treatment with myofunctional trainers have a three dimensional effect: sagittal, transverse and vertical along with training the perioral musculature in their correct position.

V. Conclusion

The literature search revealed very few systematically conducted randomized controlled studies on the subject. This review included case reports in addition to the studies in the hope that some perspective on the effects of pre-orthodontic trainers can be gained from the published case-reports. The authors are aware that case-reports cannot present evidence.

Most promising results with pre-orthodontic trainers are seen in improved nasal breathing, improved swallowing pattern and elimination of habits like tongue thrusting and mouth breathing.

Current literature renders sufficient evidence that these appliances are successful in treating Class II malocclusions especially those due to mandibular retrusion. Case reports on Class I malocclusion cases have reported alleviation of anterior crowding, alignment of incisors and correction of deep bite with pre-orthodontic trainers.

Thus it can be concluded that pre-orthodontic trainers can be used to correct Class II malocclusions and any dental malocclusion caused by various types of habits. Further long-term follow-up studies are required to support the positive effects of the pre-orthodontic trainers.

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