Benefits of using a Trainer T4K[®] myofunctional appliance after rapid palatal expansion: a prospective study on thirteen patients

C. BOUCHER, M. CHAREZINSKI, A. BALON-PERIN,
F. JANSSENS, N. VANMUYLDER, R. GLINEUR

ABSTRACT

The aim of this study was to observe the effects of treatment with a Trainer T4K[®] myofunctional appliance of thirteen late mixed dentition patients. We conducted thorough clinical examinations that included assessment of breathing and swallowing capabilities and took profile cephalograms and study models for each one. We also selected a control group that had been treated only with palatal expansion so that we could distinguish the effects of myofunctional therapy from those of expansion. We observed significant mandibular growth ($p < 0.05$) of 3.24 mm on the average and a significant decrease in overjet, essentially linked to dento-alveolar effects, in the Trainer T4K[®] group. Swallowing and breathing function also improved in these patients. The two groups had similar maxillary and mandibular expansion.

So we conclude that use of a Trainer T4K[®] myofunctional appliance results in improved antero-postero dental relationships and an improvement in oral functioning.

KEYWORDS

Orthodontics

Maxillary expansion

Functional appliance

Myofunctional therapy.

Address for correspondence:

C. BOUCHER,
Clinique d'orthodontie,
808, route de Lennik,
1070 Bruxelles-Belgique.
carole.boucher@skynet.be

1 - INTRODUCTION

In recent years many studies have been devoted to control of the oral environments influence on cranio-facial growth^{3,4,21,25,28,30}.

Throughout the growth period, the functioning of different muscle groups in the oro-facial complex exerts an influence on the child's morphology. Any muscular imbalance can lead to skeletal and dental deformities.

Insufficient maxillary width, a frequently occurring condition, often results from mouth breathing associated with a low tongue position^{3,4,21,25,28,30}, which deprive the maxilla of growth stimulation and provoke the buccinator to exert force on the dental arch.

Conventional treatment consists of palatal expansion to correct transverse deficiency and to improve nasal breathing^{8,11}. This method is often complemented by neuro-muscular re-education, which is essential to

ensure stability and to encourage balanced growth. Some authors think that neuro-muscular re-education can be achieved by using myofunctional appliances^{16,19,20,26,27,29}, whose primary goal is to restore balanced oro-facial functioning⁶.

We focused our attention on one of these devices: the Trainer T4K® (*Myofunctional Research co, Queensland, Australia*). According to Quadrelli²⁰, the Trainer T4K® appliance can be recommended to correct atypical deglutition, to favour nasal breathing, to encourage muscular balance and to stimulate mandibular growth.

The aim of this prospective study is to assess the changes resulting from wearing the Trainer T4K®, in sagittal and transverse dimensions, following rapid palatal expansion. We compared these measurements with those of the control group, which had been treated only by expansion.

2 - MATERIAL AND METHOD

We carried out our study on 13 patients with Class II skeletal malocclusions (ANB>4°), who were treated for a one-year period. Our sample was made up of 10 girls and 3 boys, whose average age was 10 years and 2 months (8 years 1 month to 12 years 8 months). They all had insufficient transverse width associated with one or more myofunctional problems, such as atypical deglutition, speech defects, muscular imbalance, and breathing difficulties. All would have benefited from orthophonic treatment, which they could not accept because they or their parents

could not schedule appointments or lived at too great a distance from treatment facilities.

Our clinical protocol consisted of:

- Semi-rapid maxillary expansion with a Hyrax 11 mm expander until a classical over-correction was achieved with the palatal cusps of the upper first molar contacting the buccal cusps of the lower first molars.

- A transpalatal arch was cemented in place to serve as a splint retainer one month after termination of activation treatment and a T4K Trainer® appliance (fig. 1) was delivered.

Figure 1
Trainer T4K®, according to Myofunctional Research.

We asked the patients to wear the appliance at night and for 2 hours during the day, when they were to carry out two types of exercises:

- Place the tip of the tongue on the tongue tag of the Trainer T4K®.

- Clench the teeth on the Trainer T4K® ten times in a row for half an hour.

The patients made a record of the exercises they performed on a card furnished for that purpose and checked by us once a month.

We noted correction of molar rotation, derived from activation of the transpalatal arch after the sixth month.

We asked for an ENT assessment before beginning treatment in order to be sure no nasal blockages that could interfere with breathing were present.

Our control group was made up of patients who had had traditional orthophonic re-education. It included consisted of 13 children, 5 girls and 8 boys with an average age of 10 years and 6 months (from 9 years and 11 months to 12 years and 3 months). They showed the same characteris-

tics as the Trainer T4K® group (transverse deficit and myofunctional dysfunction) and had undergone palatal expansion after which they wore a transpalatal arch.

By studying this group we hoped to be able to distinguish the effects accomplished by the Trainer T4K® from those achieved by expansion...

2 - 1 - Measurements

We analyzed the changes derived from wearing the myofunctional appliance on cephalometric radiographs and on plaster casts. We recorded the measurements are recorded at the beginning (T1) and at the end of the interceptive treatment (T3) for both groups. We took new models after completion of palatal expansion (T2) for only the Trainer T4K® group.

2-1-1- We studied the profile cepha- lograms with these analyses

- *Tweed-Merrifield analysis*¹⁵:

- *Angular variables*: I/F, IMPA, SNA, SNB, ANB;
- *Linear variables*: Witz.

• **Pancherz's analysis¹⁸ (fig.2):**

- Dentoskeletal measurements:
 - * Overjet: $is/OL_p - ii/OL_p$;
 - * Molar relation: $ms/OL_p - mi/OL_p$.
- Skeletal measurements (in blue on figure 2):
 - * Maxillary position : ss/OL_p ;
 - * Mandible position : pg/OL_p ;
 - * Condylar head position : co/OL_p ;
 - * Mandibular length : $co/OL_p + pg/OL_p$.
- Dental measurements (in red on figure 2):

- * Position of the upper central incisor with regard to the maxillary: $is/OL_p - ss/OL_p$;
- * Position of the lower central incisor with regard to the mandible: $ii/OL_p - pg/OL_p$;
- * Position of the first upper permanent molar with regard to the maxillary: $ms/OL_p - ss/OL_p$;
- * Position of the first lower permanent molar with regard to the mandible: $mi/OL_p - pg/OL_p$.

Figure 2

Measures realized from a perpendicular line (OL_p) to the occlusal plane (OL) passing by the center of the sella turcica, according to Pancherz¹⁸.

1: co/OL_p	2: ss/OL_p	3: ms/OL_p
4: ii/OL_p	5: is/OL_p	6: mi/OL_p
7: pg/OL_p		

• **Orientation planes¹⁵: SN/ML , SN/PP , SN/OL et PP/ML .**

2 - 1 - 2 - We made twelve different measurements

on the maxillary and mandibular dental casts with a digital sliding calliper (Gaudot Megatool SA, Germany) which is precise to 0.02 mm. precision. There were six cusp measurements: distances between the tips of the canines, between the palatal cusps of the first premolars and between the mesio-palatal cusps of the first molars; and six gingival measurements: at the greatest convexity of the canines at the cervical margins of the first premolars, and at the lingual grooves of the first molars (fig. 3).

2 - 1 - 3 - Deglutition and ventilation

have been assessed, at the beginning and the end of the treatment. Any signs of atypical deglutition have been investigated, by swallowing water: lingual pressure, labial contraction, dental occlusion. A clinical exam, associated with a Rosenthal test (test of effort, consisting of nose breathing 10 to 15 times in order to detect any trouble, acceleration of the pulse, opening of mouth), has lead to determine the

Figures 3 a and 3 b

3 a: maxillary model and 3 b: mandibular model.

Measures have been taken on both jaws:

Cusp measures at the level of the canines, first premolars and first molars.

Gingival measures at the level of the canines, first premolars and first molars.

patient type of ventilation: buccal, nasal or mixed.

• At the beginning of the treatment (T1)

- In the Trainer T4K® group : eight patients were mouth breathers, four breathed through their noses, and one was a mixed nose and mouth breather. Nine patients had atypical deglutition; four of them had adult deglutition.
- In control group : Seven patients were mouth breathers, four were mixed mouth and nose breathers, and two were nose breathers. Ten patients had atypical deglutition; three had adult deglutition.

We ANOVA statistics (SPSS software) to analyse variations among the Trainer T4K group® over the course

of treatment period ($p < 0.05$). We employed a student t-test (SPSS software) to compare the results of the two groups ($p < 0.05$).

• Measurement error

We took the enlargement coefficient into account while recording measurement of each profile cephalogram. We selected at random ten lateral cephalograms upon which ten linear millimetric and ten angular values had been traced and ten models, also at random, for re-measurement in order to estimate measurement error according to the following formula:

Variation coefficient = standard deviation/mean value

We considered variations between the first and second recordings to be insignificant.

3 - RESULTS

3 - 1 - Sagittally

Measurements taken on the profile cephalograms reveal variations between T1 time before treatment and T3 time after treatment (table I).

3 - 1 - 1 - Within the Trainer T4K® group

From a skeletal perspective, we observed several significant changes: advancement of the superior maxilla

	Trainer T4K® group		Differences between groups	
	Average differences between time	Standard-deviation	Absolute value of the difference between the averages of 2 groups	p
Linear variables				
Overjet (is/OLP-ii/OLp)	- 1,41	1,87	2,36	*
Molar relation (ms/OLp-mi/OLp)	- 1,36*	1,95	1,91	*
Maxillary position (ss/OLp)	1,95*	1,78	0,37	NS
Mandibular position (pg/OLp)	3,24*	1,71	2,01	*
Condylar position (co/OLp)	1,22	2,45	0,85	NS
Mandibular length (pg + co/OLp)	3,75*	4,36	2,15	NS
Maxillary incisor (is/OLp-ss/OLp)	- 0,33	1,68	0,57	NS
Mandibular incisor (ii/OLp-pg/OLp)	0,5	2,67	1,34	NS
Maxillary molar (ms/OLp-ss/OLp)	-0,83	3,52	1,49	NS
Mandibular molar (miOLp-pg/OLp)	-0,05	3,88	0,4	NS
Angular variables				
IF	- 1,96	8,60	1,15	NS
IMPA	1,19	3,71	2,57	NS
SNA	0,38	2,13	0,58	NS
SNB	1,12*	1,47	0,66	NS
ANB	- 0,69	1,44	1,19	*
WITZ	- 1,57*	1,72	2,48	*
Planes orientation				
ML/SN	- 0,96	1,61	0,81	NS
PP/SN	0,54	2,83	0,92	NS
OL/SN	0,73	2,17	1,23	NS
PP/ML	- 2,04*	2,68	1,54	NS

*P<0,05

Table I

Mean of the sagittal changes (teloradiographics X-rays) between the beginning (T1) and the end of the treatment (T3): T3-T1 for the Trainer T4K® group and between the both group.

of 1.95 mm, an increase of the ss/O_Lp value. Advancement of the mandible of 3.24 mm, on average, with an increase of the pg/O_Lp value and the angle SNB, during treatment. Mandibular length, $pg/O_Lp+co/O_Lp$, increased by 3.75 mm on average.

From a dento-skeletal point of view, the overjet and the Witz values decreased significantly by 1.88 mm and 1.57 mm respectively. The molar relationship changed significantly, with a decrease of the $ms/O_Lp-mi/O_Lp$ value of 1.36 mm.

From a dental perspective, we made the clinical observation that the upper incisors had tilted palatally, with a decrease of the IF angle and of the $is/O_Lp-ss/O_Lp$ value. We also noted a labial tipping of the lower incisors, with an increase of the IMPA angle and of the $ii/O_Lp-pg/O_Lp$ value. However, all these changes were statistically insignificant.

The only clinically significant alteration was the change in the orientation of the palatal plane with regard to the mandibular plan, where the PP/ML angle decreased by 2.04°.

3 - 1 - 2 - In both groups

The mandibular advancement, statistically significant in both groups, appeared to be greater in the Trainer T4K® group, where there was an increase of pg/O_Lp of 3.24 mm on average, while in the control group there was an increase of pg/O_Lp of 1.23 mm on average.

The overjet decreased significantly in the Trainer T4K® group, where the $is/O_Lp-ii/O_Lp$ value diminished by 1.4 mm on average and increased significantly in the control group by 0.95 mm. Similarly, the ANB angle and the Witz

values changed significantly but in opposite ways. The Trainer T4K® decreased by 0.69° and 1.57 mm and the control group increased by 0.5° and 0.91 mm.

The molar relationship also changed in opposite ways in the two groups: there was an increase of the $ms/O_Lp-mi/O_Lp$ value in the control group of 0.55 mm and a decrease in the Trainer T4K group® of 1.36 mm, which means the extent of the Class II relationship diminished in this group.

The upper incisors tilted palatally, more significantly in the Trainer T4K® group than they did in the control group. However, the difference between the groups was not significant.

There was no significant difference between the two groups in orientation of planes.

3 - 2 - Transversely

The measurements we took on the maxillary and the mandibular on models quantified the changes that occurred between different phases of treatment.

3 - 2 - 1 - In the Trainer T4K group® (table II)

There was significant maxillary expansion from T1 time, before treatment to T2 time, after palate splitting but also during the entire interceptive treatment period (T1-T3). Following completion of rapid palatal expansion there was a significant relapse in maxillary width (T2-T3), 1.2 mm between the canines and 2.6 mm between the

	Maxillary			Mandible		
	Canine	Premolar	Molar	Canine	Premolar	Molar
Gingival measurements	Δc (T2-T1) 3,96	Δp (T2-T1) 4,72	Δm (T2-T1) 6,67	Δc (T2-T1) 0,54	Δp (T2-T1) 0,24	Δm (T2-T1) 0,64
	$\Delta c'$ (T3-T2) -1,13	$\Delta p'$ (T3-T2) -1,75	$\Delta m'$ (T3-T2) -1,96	$\Delta c'$ (T3-T2) -0,26	$\Delta p'$ (T3-T2) 1	$\Delta m'$ (T3-T2) 0,25
	$\Delta c''$ (T3-T1) 2,83	$\Delta p''$ (T3-T1) 2,97	$\Delta m''$ (T3-T1) 4,7	$\Delta c''$ (T3-T1) 0,28	$\Delta p''$ (T3-T1) 1,24	$\Delta m''$ (T3-T1) 0,89
Cuspidian measurements	Δc (T2-T1) 4,4	Δp (T2-T1) 5,68	Δm (T2-T1) 7,41	Δc (T2-T1) 0,71	Δp (T2-T1) 0,18	Δm (T2-T1) 1,31
	$\Delta c'$ (T3-T2) -1,17	$\Delta p'$ (T3-T2) -2,63	$\Delta m'$ (T3-T2) -1,42	$\Delta c'$ (T3-T2) -0,18	$\Delta p'$ (T3-T2) 0,89	$\Delta m'$ (T3-T2) 0,53
	$\Delta c''$ (T3-T1) 3,23	$\Delta p''$ (T3-T1) 3,05	$\Delta m''$ (T3-T1) 4,93	$\Delta c''$ (T3-T1) 0,53	$\Delta p''$ (T3-T1) 1,07	$\Delta m''$ (T3-T1) 1,84

Values statistiquement significatives avec $p < 0,05$

Table II

Mean of the transversal changes during the treatment, in the Trainer T4K® group.

first premolars. Gingivally, the reduction in maxillary width between T2 and T3 was not as great as it was at the level of the cusps of the teeth, 1.75 mm in the first premolar region and insignificant in the canine region...

For the mandible we noted these significant changes: gingivally in the canine region width increased by 0.54 mm between T1 and T2. In the first premolar region width increased by 1.07 mm between the cusps of the teeth and by 1.24 mm gingivally between T1 and T3. In the first molar region the molar width increased by 1.84 between the cusps of the tooth mm between T1 and T3 and by 1.3 mm between T1-T2. Gingivally width increased 0.9 mm between T1 and T3.

3 - 2 - 2 - In the two group

Maxillary and mandibular width appeared to increase to the same extent.

3 - 3 - Clinically

3 - 3 - 1 - In the Trainer T4K group®

At the end of interceptive treatment, T3, five of the eight mouth breathers identified at the beginning of treatment T1, had become nasal breathers. One mouth became a mixed mouth and nasal breather.

Six out of nine patients whose deglutition was infantile at T1 time had achieved adult deglutition patterns at the termination of treatment.

We observe that respiration and deglutition corrected themselves at the same time.

3- 3 - 2 - In the control group

Five mouth breathers out of seven became nasal breathers by time at T3. The over two remained mouth breathers.

Seven patients out of ten suffering from infantile deglutition at T1 time had achieved adult deglutition at the termination of treatment.

4 - CASE REPORT

This young girl was 10 years and 4 months old at the beginning of treatment. In our clinical examination we noted that she had a Class II malocclusion and upper and lower tooth size and arch length discrepancy associated with a narrow maxillary arch, infantile swallowing, and nasal breathing (fig. 4 a and 4 b).

The analysis of profile headplates (fig. 5 a and 5 b) revealed that

mandibular retrognathia and labial tilting of her upper and lower incisors were contributing factors in establishing her skeletal class II malocclusion (tables III and IV).

The treatment plan we prepared to correct this malformation included rapid maxillary expansion to be followed by the cementation of a, transpalatal arch that would serve as a retention splint and complementary

a

b

Figures 4 a and 4 b
Pre treatment intraoral view, from face (fig.4 a) and profil (fig.4 b)

a

b

Figures 5 a and 5 b
Lateral cephalogram (fig. 5 a) and cephalometric exam (fig. 5 b), according to Pancherz¹⁸, at the beginning of the treatment.

	is/OL _p -ii/OL _p	ss/OL _p	pg/OL _p	co/OL _p	co/OL _p +pg/OL _p	is/OL _p -ss/OL _p	li/OL _p -pg/OL _p
T1	6,42	75,19	76,11	9,17	85,28	6,42	-0,92
T3	3,76	78,02	80,84	13,63	94,47	4,23	0
T3-T1	↘ Overjet	Maxillary advancement	Mandibular advancement	↗ Condylar growth	Mandibular lenght	Upper incisors retroclination	Lower incisors proclination

Table III

Evolution of the dento-skeletal, skeletal and dental values, according to Pancherz's analyse¹⁸, during the treatment.

	I/F	IMPA	ANB	SNA	SNB	Witz
T1	110°	96°	6°	82°	76°	1,78
T3	105°	98°	4,5°	82,5°	78°	1,38
T3-T1	-5°	2°	- 0,5°	1°	2°	- 0,4

Table IV

Post treatment cephalometrics results, according to Tweed.

treatment delivered by her wearing a T4K® at night and for two hours during the day. She would use it press her tongue routinely against the languette pad and to clench her teeth on the appliance and relax them ten times and repeat for a half hour. She would visit our office once a month for check-ups and re-motivation if needed.

The patient cooperated diligently during the interceptive treatment period at the end of which she was 11 years and 5 months old. At that time our clinical examination revealed that she had attained a Class I canine and a class II molar relationship, owing to the continuing presence in the arch of

the second deciduas molars. Dental alignment is good correct and an adult deglutition had been re-established (fig. 6 a and 6 b).

The post-treatment analysis of lateral cephalograms (fig. 7 a and 7 b) showed that some mandibular growth had taken place, that the class II skeletal relationship had improved, that the lower incisors had tilted labially, and that the upper incisors had tilted palatally. buccal version of the lower incisors and palatal version of the upper incisors (tables III and IV).

Later, we completed treatment with a fullbanded and bonded appliance to improve the occlusion and to ensure the stability of the result.

Figures 6 a and 6 b
Post treatment intraoral view, from face (fig. 6 a) and profil (fig. 6 b).

Figures 7 a and 7 b
Lateral cephalogram (fig. 7 a) and cephalometric exam (fig. 7 b), according to Pancherz¹⁸, at the end of the treatment.

5 - DISCUSSION

In this study we have reviewed the benefits of the wearing of a Trainer T4K® myofunctional appliance immediately after rapid palatal expansion.

Maxillary constriction is a deformity frequently found in patients who are mouth breathers. In such cases the tongue rests in a low position and

provides no stimulation for maxillary growth^{4,28,30}. The low tongue position also contributes to deglutition and phonation problems. All these patients should receive therapy for correction of their oral malfunctions³ in order to ensure muscular balance, which is essential for the

stability of orthodontic treatment and to ensure the child's future harmonious growth²¹.

By using rapid palatal expansion as an initial procedure, we eliminated the palate's transverse deficit by widening it 5.73 mm on average in both the Trainer T4K[®] group and the control group. Others have found that the use of a myofunctional appliance alone, as reported by Owen¹⁶ for the Fränkel and by Quadrelli²⁰ for the Trainer T4K[®], can stimulate a 2 mm increase in palatal width and an increase of 1.5 mm in distance between maxillary molars on opposing sides of the arch over a one year period.

The analysis of our results showed that mandibular advancement was substantially greater for the Trainer T4K group[®]. This observation seems to be the expression of the activating effect imparted by the appliance's incisal edge-to-edge¹² appliance conception. The increase in length that can be observed only from the skeletal to pogonion value is also greater in the Trainer T4K[®] group (3.24 mm) than in the control group (1.23 mm).

The behavior of angle SNB appeared identical in both groups despite its greater increase in the Trainer T4K[®]. These results parallel those of Usumez's study²⁹ of the Trainer T4K[®]. He reported a non-significant increase of 1°31' of the SNB angle in his Trainer T4K[®], in comparison to his control group. The increase in the same angle in our study was 1°11'.

The apparent contradiction between the values obtained of the bone landmark pogonion and the SNB angle could be explained by the position of teeth exerting an action on the angle and not on the osseous point.

However, for practical reasons, the T4K[®] appliance is not worn on a full time basis, which could explain the low but not negligible extent of the sagittal gain, which was 2 mm.

Ideally a continuous propulsion force on the mandible would be necessary to stimulate the external pterigoidian muscle and to favor condylar growth¹⁴.

Furthermore, according to Graber⁶, the construction of an oral screen should not project a mandibular advancement of more than 3 mm. Beyond this limit, a propulser should be used.

In our study, maxillary advancement appeared to be equivalent in the two groups, both as a result of the rapid palatal expansion as confirmed by the work of Haas⁸, Chung² and Sandikcioglu²³.

In the T4K Trainer[®] group, the overjet decrease can be explained by the tendency of the upper incisors to flair palatally and for the lower incisors to tilt labially: this dento-alveolar effect is a characteristic feature of oral screens^{17,19,27} and myofunctional devices such as the Fränkel^{9,22} appliance. The contact between the appliance and the upper incisors causes their retro-inclination and the buccal screen of the splint sets up a barrier between the teeth and the hyperactive muscles of the chin, in the "Lip Bumper" effect. In cases of dysfunction, this allows the lower incisors to grow forward at a normal pace... Those results are similar to those of Usumez²⁹.

Transversely, the study showed a postexpansion increase in width that was followed by a small contraction, which is greater at the level of the tooth cusps than it is gingivally. The

slight relapse probably derives from a recovery of the tilting of the buccal teeth that had accompanied the separation of the halves of the maxilla...

In the mandible, the increase of inter-canine and inter-molar width are similar to those obtained by Fränkel^{5,13}: 0.5 mm at the canine gingival level and 1.84 mm between the cusps of the first molars, throughout treatment. Statistically, this increase is indistinguishable from that observed in the control group.

Rapid maxillary expansion encourages an increase in mandibular width according to Haas⁸ of 2 mm between molars and 0.5 mm to 1.5 mm between canines. Gryson⁷ reported an inter-molar increase of 0.39 mm and Adkins¹ one of 1.4 mm. Sandstrom²⁴ found an inter-molar mandibular widening of 3 mm and a 2.2 mm increase in distance between canines. Finally, Lima described an inter-molar increase of 1.47 mm and one of 0.39 mm between canines¹⁰. According to all of these authors, the widening is explained by a buccal uprighting of the posterior teeth and not by any real expansion and would result from the action of occlusal forces after the maxillary expansion

as well as the increased distance the enlarged maxilla created between the buccinator muscle and the mandibular arch. This phenomenon is amplified by the difference the increase in width between the cusps of the teeth, 1.84 mm and at the gingival level, 0.9 mm, in the region of the first molars.

Except for three children, who did not outgrow their pattern of infantile swallowing, which, for two of them, was associated with mouth breathing, clinical examinations carried out at the beginning and at the end of the treatment showed significant improvement in breathing and deglutition for all patients. These results are comparable with those of the control group. Patients, who couldn't undergo any orthophonic treatment for practical reasons such as lack of time, got the opportunity to use The T4K Trainer® appliance as an alternative.

It is important to note that without the patient's full cooperation, which is sometimes difficult to obtain, this appliance cannot work satisfactorily. Clinical checkups are essential to support the motivation of patients and to establish a daily schedule for the repetition of the prescribed tongue exercises...

6 - CONCLUSION

Clinical results of our study show significant beneficial myofunctional effects gained from wearing a T4K Trainer® in improving deglutition and breathing capabilities, similar to those derived from conventional orthophonic re-education.

We also observed sagittal effects, notably a significant decrease in overjet that accompanied the palatal expansion as well a clear improvement in tooth positioning.

We can confidently recommend that our therapeutic protocol be used in the treatment of Class II division I patients, whose lower incisors are inclined lingually and upper incisors tilted labially.

Transversally, the Trainer T4K® does not seem to have any additional expansion effect on the mandible beyond that bestowed by the rapid palatal expansion...

REFERENCES

1. Adkins MD, Nanda RS, Currier GF. Arch perimeter changes on rapid palatal expansion. *Am J Orthod Dentofac Orthop* 1990;97:194-9.
2. Chung CH, Font B. Skeletal and dental changes in the sagittal, vertical and transverse dimensions after rapid palatal expansion. *Am J Orthod Dentofac Orthop* 2004;126:569-75.
3. Doual A, Besson A, Cauchy D, Aka A. Retraining in dento-facial orthopedics. An orthodontist's viewpoint. *Orthod Fr*. 2002;73:389-94.
4. Flutter J. The negative effect of mouth breathing on the body and development of the child. *Int J orthod Milwaukee*. 2006;17:31-7.
5. Gibbs SL, Hunt NP. Functional appliances and arch width. *Br J Orthod* 1992;19:117-25.
6. Graber TM. The use of muscle forces by simple orthodontic appliances. *Am J Orthod* 1979;76:1-20.
7. Gryson JA. Changes in mandibular interdental distance concurrent with rapid maxillary expansion. *Angle Orthod* 1977;47:186-92.
8. Haas AJ. Rapid expansion of the maxillary dental arch and nasal cavity by opening the midpalatal suture. *Angle Orthod* 1961;31:73-90.
9. Janson GR, Toruno JL, Martins DR, Henriques JF, De Freitas MR. Class II treatment effects of the Frankel appliance. *Eur J Orthod* 2003;25:301-9.
10. Lima AC, Lima AL, Filho RM, Oyen OJ. Spontaneous mandibular arch response after rapid palatal expansion: a long term study on class I malocclusion. *Am J Orthod Dentofac Orthop* 2004;126:576-82.
11. Loreille JP, Bery A. Changes in nasal breathing caused by maxillary expansion. *Rev Orthop Dento Faciale* 1981;15:193-208.
12. Mahony D. Combining functional appliances in the straightwire system. *J Clin Pediatr Dent* 2002;26:137-40.
13. McWade RA, Mamandras AH, Hunter WS. The effects of Frankel treatment on arch width and arch perimeter. *Am J Orthod Dentofac Orthop* 1987;92:313-20.
14. Moore RN, Igel KA, Boice PA. Vertical and horizontal components of functional appliance therapy. *Am J Orthod Dentofac Orthop*. 1989;96:433-43.
15. Muller L. Cephalometrie et orthodontie. Paris:SPMD,1983:103-223.
16. Owen AH 3rd. Morphologic changes in the transverse dimension using the Frankel appliance. *Am J Orthod* 1983;83:200-17.
17. Owman-Moll P, Ingervall B. Effect of oral screen treatment on dentition, lip morphology, and function in children with incompetent lips. *Am J Orthod* 1984;85:37-46.
18. Pancherz H. The mechanism of Class II correction in Herbst appliance treatment. A cephalometric evaluation. *Am J Orthod* 1982;82:104-13.
19. Prasad VN, Utreja AK. An oral screen for early intervention in lower-lip-sucking habits. *J Clin Orthod* 2005;39:97-100.
20. Quadrelli C, Gheorgiu M, Marchetti C. Early myofunctional approach to skeletal Class II. *Mondo orthod* 2002;2:109-21.
21. Ramirez-Yanez GO, Farell C. Soft tissue dysfunction: a missing clue when treating malocclusions. *Orthop Rev Int Orthop Func*. 2005;1:483-94.
22. Rodrigues de Almeida M, Castanha Henriques JF, Rodrigues de Almeida R, Ursi W. Treatment effects produced by Frankel appliance in patients with Class II, division 1 malocclusion. *Angle Orthod* 2002;72:418-25.

23. Sandikcioglu M, Hazar S. Skeletal and dental changes after maxillary expansion in the mixed dentition. *Am J Orthod Dentofac Orthop* 1997;111:321-7.
24. Sandstrom RA, Klapper L, Papaconstantinou S. Expansion of the lower arch concurrent with rapid maxillary expansion. *Am J Orthod Dentofac Orthop* 1988;94:296-302.
25. Soulet A. Neuromuscular education of orofacial function. *Rev Orthop Dento Faciale*. 1989;23:135-75.
26. Stavridi R, Ahlgren. Muscle response to the oral-screen activator. An EMG study of the masseter, buccinator, and mentalis muscles. *Eur J Orthod* 1992;14:339-49.
27. Tallgren A, Christiansen RL, Ash M Jr, Miller RL. Effects of a myofunctional appliance on orofacial muscle activity and structures. *Angle Orthod* 1998;68:249-58.
28. Ung N, Koenig J, Shapiro PA, Shapiro G, Trask G. A quantitative assessment of respiratory patterns and their effects on dentofacial development. *Am J Orthod Dentofac Orthop* 1990;98:523-32.
29. Usumez S, Uysal T, Zafer S, Basciftci FA, Karaman AI, Guray E. The effects of early pre-orthodontic trainer treatment on Class II, division 1 patients. *Angle Orthod* 2003;74:605-9.
30. Woodside DG, Linder-Aronson S, Lundstrom A, Mc William J. Mandibular and maxillary growth after changed mode of breathing. *Am J Orthod Dentofac Orthop* 1991;100:1-18.