Research Article

Effect of oral screen treatment on dentition, lip morphology, and function in children with incompetent lips

Py Owman-Moll

Bengt Ingervall (*University of Bern, Switzerland*)

Suggested Citation

Owman-Moll, P., & Ingervall, B. (1985). Effect of oral screen treatment on dentition, lip morphology, and function in children with incompetent lips. *International Journal of Orofacial Myology*, 11(1), 12-23.

DOI: <https://doi.org/10.52010/ijom.1985.11.1.3>

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](#).

The views expressed in this article are those of the authors and do not necessarily reflect the policies or positions of the International Association of Orofacial Myology (IAOM). Identification of specific products, programs, or equipment does not constitute or imply endorsement by the authors or the IAOM. The journal in which this article appears is hosted on [Digital Commons](#), an Elsevier platform.

Effect of Oral Screen Treatment on Dentition, Lip Morphology, and Function in Children with Incompetent Lips

Py Owman-Moll, D.D.S., and Bengt Ingervall, D.D.S.

Reprinted with permission from *American Journal of Orthodontics*, January 1984.

The effect of treatment with an oral screen was studied in sixteen children with incompetent lips who were compared with a control group of sixteen children who also had incompetent lips. The period of observation was 1 year. The treatment brought about retroclination of proclined maxillary incisors with a resulting decrease in overjet, in the diastema between the incisors, and in arch length. The mandibular incisors proclined somewhat. No change in general intermaxillary relation or in arch width was observed with the treatment. Neither lip morphology nor the electromyographically recorded function of the lips was affected by the treatment. The maximum force that the lips could exert to resist an external force was increased substantially by the treatment. Whether this is of value for the stability of the orthodontic treatment result is not known.

The importance of intermittent forces from the lips, cheeks and tongue for the position of the teeth has been questioned in recent years.¹ This is especially true for the forces exerted during swallowing and speech, while the continuous forces from the resting muscles are thought to be of importance.

In persons with short lips there may be no habitual lip seal, and the lips are then said to be incompetent. Lip incompetence may be defined as the inability to close the lips without strain. Incompetent lips may possibly contribute to protrusion of the teeth by reducing the restricting pressure act-

ing on the teeth from the lips. Apart from their possible influence on the dentition, short lips may also be disfiguring.

During the early mixed-dentition period most children have incompetent lips.² At this time the lips lag behind the facial skeleton in size, but they catch up with the rest of the face during the later part of the mixed-dentition period.³ Although incompetent lips normally improve with growth, in some cases it may be beneficial to try to increase the size of the lips. To achieve this goal, various lip-training exercises have been proposed in the past^{4,5} and more recently.^{6,7,8}

In a study by one of the present authors, active lip training was shown to increase lip size and to improve lip function in patients with incompetent lips.⁸ Upper and lower lip lengths were increased, and the interlabial gap was reduced. Such favorable changes were not found in a control group. The lip training, however, did not affect tooth position. Active lip training was done without the use of any appliance and required considerable motivation and effort on the part of the dentist as well as the children and their parents. Although the results of active lip training (lip exercises) were encouraging with respect to lip changes, we deemed it worthwhile to investigate whether other types of lip training could bring about such changes more effectively.

The oral screen has been described as a suitable appliance for lip training.^{9,10} The screen stretches the lip musculature, providing a force which retroclines proclined maxillary incisors. The lips are strengthened simultaneously.

AUTHOR AFFILIATION:

Dr. Bengt Ingervall
Klinik fue Kieferorthopadie
University of Bern
Freiburgstrasse 7
CH-3010 Bern, Switzerland

The training effect can be increased if the screen is provided with a loop on the labial surface. When the loop is pulled with finger force, the tendency of the screen to be dislodged from the mouth causes the lips to contract to resist the external force. Regular application of external force with accompanying lip contraction is believed to strengthen the lips; that is, it is thought that, as a result of the training, the lips are able to exert more force. The effect on lip function and morphology is largely unknown, while the reported effect on lip strength is contradictory. Giacometti¹¹ reported increased lip strength after exercise with an oral screen, while Eismann¹² did not find such an increase after exercise with prefabricated oral screens. Similar lip exercises that involve pulling on a button placed in the labial vestibule have been shown to increase lip strength.¹³

For patients with Class II malocclusion, the oral screen is constructed with the mandible in lightly protruded position, similar to the therapeutic position used in activator treatment.⁹ The construction bite cannot be as protrusive with an oral screen as with an activator, however, and a screen is said to be of value mainly in cases of mild Class II malocclusion.¹⁰ Whether an oral screen can actually improve a Class II relationship is not known.

The purpose of this study was to investigate the effect of treatment with an oral screen on lip morphology and function in patients with incompetent lips. The effect of the treatment on the dentition was studied at the same time.

PATIENTS AND METHODS

The subjects studied comprised 13 boys and 19 girls, who were randomly divided into two equal groups - a treatment and a control group. The treatment group consisted of 6 boys and 10 girls; the control group, 7 boys and 9 girls.

The children had incompetent lips (no habitual lip seal), a short upper lip, and proclined maxillary incisors with an increased overjet (Table I). Ten of the children in the treatment group and 14 in the control group had Angle Class II malocclusion of one half to one cusp width. The relation, in the

intercuspal position, between the mesial surfaces of the maxillary and mandibular first permanent molars is shown in Table I.

A maxillary median diastema was found in 15 and 14 children in the treatment and control groups, respectively. In addition, a diastema was found between the right maxillary lateral and central incisors in 14 and 13 children, respectively, and between the left central and lateral incisors in 15 and 11, respectively.

BIOMETRY

Overjet and overbite were measured on dental cases after the method of Lundstrom.¹⁴ The width and length of the dental arches were measured as shown in Fig. 1. The dimensions of the dental arches as well as of molar relation and diastemas were measured on casts, with sliding calipers, to the nearest 0.1 mm.

FACIAL MORPHOLOGY

Skeletal, dentoalveolar, and soft-tissue facial morphology were analyzed on profile radiographs taken with the mandible in the intercuspal position (IP) and with lips relaxed. The soft-tissue analysis was also made on radiographs taken with the mandible in the postural (rest) position (PP). The reference points and lines shown in Figs. 2 to 6 were used. The variables listed in Table II were recorded.

LIP FUNCTION

The function of the lips was evaluated electromyographically with bipolar surface electrodes. The electromyographic recording and analysis were done as described by Ingervall and Janson¹⁵ and Janson and Ingervall.¹⁶ The integrated postural (rest) activity of the lips, as well as the integrated activity during chewing of apple and peanuts, were measured. The lip activity during swallowing of apple and of peanuts was measured as the maximum mean voltage amplitude. In addition, the duration of the act of chewing and the number of cycles during chewing were measured.

Table I. Age and details of the dentition in the treatment and control groups (number of children in each group = 16)

	Treatment group		Control group	
	Median	Range	Median	Range
Age (years)	9 $\frac{1}{2}$	8 $\frac{1}{2}$ -13 $\frac{1}{2}$	8 $\frac{10}{12}$	6 $\frac{1}{2}$ -12 $\frac{1}{2}$
Number of permanent teeth	12	10-27	12	11-21
Number of deciduous teeth	11	1-12	10.5	2-12
Number of maxillary teeth in occlusion	6	4-10	6	2-8
Overjet (mm)	7.5	4.0-10.5	7.5	5.0-10.5
Overbite (mm)	2.5	0-4.4	2.8	-3.0-5.2
Upper median diastema (mm)	1.4	0-3.0	0.9	0-2.5
Molar relation, right side (mm)	0.2	-1.7-2.4	-0.9	-2.7-3.7
Molar relation, left side (mm)	0.2	-2.4-2.7	0.0	-3.8-3.4

Table II. Variables recorded in the cephalometric analysis

Skeletal	Dento-alveolar	Soft tissue
n-s	s-n-ss	Upper lip height (ULh)
n-ar	s-n-sm	Lower lip height (LLh)
s-ar	ss-n-pg	Thickness of upper red lip (ULth)
sp-pm	s-ar-tgo	Thickness of lower red lip (LLth)
pm-NSL	NSL/NL	Depth of lower lip curvature (LLc)
pm-NSP	NSL/ML	Relative protrusion of the lips (RLP)
ar-ss	NL/ML	Interlabial gap (ILG)
ar-pgn	ML/RL	Lower lip-upper incisor (LL-is)
n-gn	Beta	
n-sp'	ML/CL	
sp'-gn	IL _s /NL	
is-io	IL _i /ML	
ii-io	IL _s /IL _i

Fig. 1. Reference points for determination of the width and length of the dental arches.

Fig. 2. Reference points used in the cephalometric analysis.

Fig. 3. Reference lines used in the cephalometric analysis.

Fig. 4. Measurement of lip height, lip thickness, and interlabial gap on the profile radiograph.

Fig. 5. Measurement of relative protrusion of the lips on the profile radiograph.

Fig. 6. Measurement of the relationship between the edge of the upper incisor and the crest of the lower lip (LL-is) and of lower lip curvature on the profile radiograph.

Lip strength was measured with the Pommer,¹⁷ a dynamometer equipped with a mouthpiece (Fig. 7). The maximum lip force which the subject can exert in an attempt to prevent the mouthpiece from being pulled loose from the grip between the lips is taken as the maximum lip strength (Fig. 8). At each recording session two measurements of lip strength were made, one before (POM value I) and one simultaneously with electromyographic recording of lip activity during the measurement (POM value II). The procedure used was the same as that described by Ingervall and Janson.¹⁵ During measurement of POM value II, the maximum mean voltage amplitude of the lip activity was recorded electromyographically.

Fig. 7. The Pommeter.

Fig. 8. Measurement of lip strength with the Pommeter.

Fig. 9. An oral screen.

Fig. 10. Lip training with the oral screen.

Treatment with an oral screen

After the initial recordings (Recording I), the children in the treatment group were provided with an oral screen (Fig. 9). The custom-made acrylic screen was extended backward to the first permanent molars and filled the upper and lower buccal folds. It was in contact with the maxillary central incisors, but a small gap (1 to 2 mm) existed between the appliance and the other teeth and the alveolar process. In the midline, it was equipped with a metal loop which extended between the lips. In cases of distal occlusion, the oral screen was constructed in a mandibular position corresponding to neutral occlusion (maximum protrusion of one cusp width). All screens were con-

structed with the bite in a slightly open position (1 to 2 mm in the molar area).

The screen was used nightly, and the children were told to perform lip-training exercises by pulling forward on the loop while trying to resist the force by tightening their lips (Fig. 10). The lip-training exercises were to be performed for 10 minutes twice a day. The children came to the clinic for checkups once a month, during which they were encouraged to continue with the lip-training exercises and the oral screen was adjusted when necessary by the addition of guttapercha to ensure contact with protruding maxillary incisors only.

After 1 year, the initial recordings were repeated in all children (Recording II).

Table III. Variables differing significantly between the treatment and control groups at the start of the investigation (Recording I)

	Median in treatment group	Median in control group	Difference	Significance
<i>Dental arch (mm)</i>				
Upper median diastema	1.4	0.9	0.5	*
Diastema between upper left central and lateral incisors	1.4	0.9	0.5	**
Upper arch width	45.6	44.8	0.8	*
<i>Facial morphology (mm and degree)</i>				
n-s	72.0	68.8	3.2	**
n-ar	92.0	89.8	2.2	*
sp-pm	52.5	50.8	1.7	*
n-sp'	48.5	45.5	3.0	**
ar-pgn	99.3	97.5	1.8	*
s-n-ss	81.8	83.3	-1.5	**
ss-n-pg	4.0	5.3	-1.3	*
ILG in postural position	6.8	8.8	-2.0	*
LL-is in intercuspal position	0.8	-1.0	1.8	**
LL-is in postural position	-1.5	-3.0	1.5	*
<i>Lip function (μV)</i>				
Activity of lower lip during swallowing of peanuts	290	214	76	**

*0.01 < P < 0.05.

**0.001 < P < 0.01.

Statistical Methods

Differences between the groups were tested with Mann-Whitney's U test and differences within groups with Wilcoxon's matched-pairs signed ranks test.

Results

Variables that differed significantly between

the treatment and control groups at the start of the investigation are given in Table III.

The diastemas between the maxillary front teeth as well as the maxillary dental arch width and some skeletal cephalometric dimensions were larger in the treatment group than in the control group (Table III). The maxillary prognathism as well as the interlabial gap was more pronounced in the control group and the lower lip covered less of the maxillary incisors.

Table IV. Variables differing significantly in the treatment group on comparison of the values recorded before (Recording I) and after (Recording II) treatment with an oral screen

	<i>Median before treatment</i>	<i>Median after treatment</i>	<i>Difference</i>	<i>Significance</i>
<i>Dental arch (mm)</i>				
Overjet	7.5	4.5	3.0	**
Overbite	2.5	3.0	-0.5	**
Upper arch width	45.6	46.1	-0.5	*
Lower arch width	44.2	44.7	-0.5	**
Upper arch length	36.7	34.8	1.9	**
Upper median diastema	1.4	0.7	0.7	**
Diastema between upper right central and lateral incisors	1.4	0.7	0.7	**
Diastema between upper left central and lateral incisors	1.4	0.6	0.8	**
Molar relation, right side	0.2	0.6	-0.4	**
Molar relation, left side	0.2	1.0	-0.8	*
<i>Facial morphology (mm and degree)</i>				
n-ar	92.0	93.8	-1.8	*
s-ar	32.8	34.0	-1.2	**
n-gn	112.5	114.8	-2.3	**
n-sp'	48.5	49.0	-0.5	*
sp'-gn	66.0	66.8	-0.8	*
is-io	7.3	4.8	2.5	**
ii-io	1.5	2.3	-0.8	*
NSL/NL	6.8	7.3	-0.5	*
IL _s /NL	116.0	110.5	5.5	**
IL _l /ML	92.5	93.5	-1.0	**
IL _s /IL _l	122.0	125.0	-3.0	*
ULh in intercuspal position	23.3	24.0	-0.7	*
ULh in postural position	23.0	23.8	-0.8	*
LLh in intercuspal position	42.5	43.5	-1.0	**
LLh in postural position	42.3	43.8	-1.5	**
ULth in intercuspal position	13.8	14.0	-0.2	**
ULth in postural position	13.3	14.0	-0.7	**
LLth in intercuspal position	15.3	14.8	0.5	*
ILG in intercuspal position	6.0	4.3	1.7	**
LL-is in intercuspal position	0.8	1.3	-0.5	*
<i>Lip function</i>				
POM value I (g)	175	265	-90	**
POM value II (g)	185	293	-108	**
Amplitude of lower lip during POM recording (μV)	223	273	-50	**

*0.01 < P < 0.05.

**P < 0.01.

The variables that differed significantly in the treatment group on comparison of the values recorded before and after treatment with the oral screen are shown in Table IV, and those that differed between the first and second recordings in the control group are given in Table V.

The overjet decreased in both groups, but the decrease was greater in the treatment group. There was also a reduction in the diastema between the

maxillary front teeth in both groups, but again it was more marked in the treatment group. The change in molar relation and the increase in arch width were similar in both groups. Five children in each group showed an improvement of one half cusp width in occlusion (Angle classification). In the treatment group, but not in the control group, there was a reduction in upper arch length.

Table V. Variables differing significantly in the control group on comparison between Recordings I and II

	<i>Median of Recording I</i>	<i>Median of Recording II</i>	<i>Difference</i>	<i>Significance</i>
<i>Dental arch (mm)</i>				
Overjet	7.5	6.3	1.2	**
Upper arch width	44.8	45.5	-0.7	**
Lower arch width	43.4	43.8	-0.4	**
Upper median diastema	0.9	0.6	0.3	**
Molar relation, right side	-0.9	0.0	-0.9	**
Molar relation, left side	0.0	1.2	-1.2	**
<i>Facial morphology (mm and degree)</i>				
n-ar	89.8	90.8	-1.0	**
s-ar	32.3	33.3	-1.0	**
sp-pm	50.8	52.3	-1.5	*
pm-NSP	16.8	16.5	0.3	*
ar-ss	83.0	84.0	1.0	*
n-gn	110.5	112.0	-1.5	**
ii-io	1.5	1.8	-0.3	*
s-ar-tgo	147.0	149.3	-2.3	*
IL ₄ /NL	116.3	114.5	1.8	*
LLh in intercuspal position	39.8	40.5	-0.7	**
LLh in postural position	40.8	41.3	-0.5	*
ULth in intercuspal position	13.3	12.5	0.8	**
LLc in postural position	7.0	6.3	0.7	*
ILG in intercuspal position	7.0	6.5	0.5	*
LL-is in intercuspal position	-1.0	-0.5	-0.5	**
<i>Lip function</i>				
Activity of upper lip during chewing of apple ($\mu\text{V}^2 \text{ sec}$)	21750	36375	-14625	*

*0.01 < P < 0.05.

**P < 0.01.

The dimensions of the cranial base and facial skeleton increased in a similar manner in both groups. The proclination of the maxillary incisors diminished more in the treatment group than in the control group. There was an increase in mandibular incisor proclination in the treatment group but not in the control group. Consequently, there was a significant change in the interincisal angle in the treatment group but not in the control group.

In the treatment group, both lips increased somewhat in height. In the control group, an increase in lip height was found only for the lower lip. The thickness of the upper lip decreased some-

what in both groups, and in both groups the lower lip covered more of the maxillary incisors at the second recording. The two groups developed differently in thickness of the lower lip and in curvature of the lower lip. A reduction in the interlabial gap was found in both groups, but the reduction was larger in the treatment group than in the control group.

None of the variables measuring the activity of the lips in posture or during chewing and swallowing changed significantly in the treatment group; one of these variables changed in the control group (Table V).

Table VI. Variables differing significantly between the treatment and control groups at Recording II

	Median in treatment group	Median in control group	Difference	Significance
<i>Dental arch (mm)</i>				
Overjet	4.5	6.3	-1.8	*
Upper arch width	46.1	45.5	0.6	*
Lower arch width	44.7	43.8	0.9	*
Upper arch length	34.8	36.9	-2.1	*
<i>Facial morphology (mm and degree)</i>				
n-s	72.3	68.8	3.5	**
n-ar	93.8	90.8	3.0	*
n-sp'	49.0	47.0	2.0	*
ar-pgn	101.3	97.3	4.0	**
is-io	4.8	7.8	-3.0	***
s-n-ss	81.8	84.3	-2.5	*
ss-n-pg	3.5	5.8	-2.3	**
s-ar-tgo	144.0	149.3	-5.3	*
IL _s /NL	110.5	114.5	-4.0	*
IL _s /IL _i	125.0	121.0	4.0	*
ULTh in intercuspal position	14.0	12.5	1.5	**
ULTh in postural position	14.0	12.5	1.5	**
ILG in intercuspal position	4.3	6.5	-2.2	*
ILG in postural position	6.5	9.3	-2.8	**
LL-is in intercuspal position	1.3	-0.5	1.8	*
LL-is in postural position	-1.3	-3.0	1.7	**
<i>Lip function</i>				
Postural activity of upper lip (μV^2 sec)	586	469	117	*
Activity of upper lip during chewing of peanuts (μV^2 sec)	13875	22125	-8250	*
Amplitude of lower lip during swal- lowing of peanuts (μV)	295	202	93	*
Amplitude of lower lip during swal- lowing of apple (μV)	86	119	-33	*
POM value I (g)	265	170	95	***
POM value II (g)	293	188	105	**
Amplitude of lower lip during POM recording (μV)	273	239	34	*

*0.01 < P < 0.05.

**0.001 < P < 0.01.

***P < 0.001.

The lip strength (POM value) increased significantly in the treatment group but not in the control group. An increase in the electromyographically recorded activity of the lower lip during measurement of lip strength was found in the treatment group. This variable did not change in the control group.

Comparison of the two groups at the second registration gave the significant differences shown in Table VI. Note that the overjet, maxillary arch length, and maxillary incisor proclination were smaller in the treatment group. In contrast to the first examination, at the second recording the maxillary diastema was no longer larger in the treatment group than in the control group. The differences between the groups in lip morphology at the second examination were largely the same as were found at the first recording. Regarding lip function, the most consistent finding was a greater lip strength in the treatment group than in the control group at the second recording.

At the start of the investigation the treatment and control groups were essentially alike, but with some exceptions. Thus, the children in the treatment group had, on average, somewhat more pronounced diastemas between the maxillary incisors than the control children. The latter, on the other hand, generally had a somewhat more pronounced lip incompetence than the children in the treatment group. Maxillary prognathism was likewise more pronounced in the control group. The difference between the groups in some skeletal dimensions and in maxillary arch width may be due to the somewhat higher median age of the children in the treatment group.

Effects of Orthodontic Treatment

Treatment with the oral screen was obviously effective in reducing the excessive overjet and the size of the diastema between the maxillary incisors, as these dimensions decreased more in the treatment group than in the control group. Prior to treatment the diastemas were larger in the treatment group than in the control group, whereas there was no difference after treatment. Before treatment the two groups did not differ in overjet but after treat-

ment the overjet was smaller in the treatment group than in the control group. As the result of the greater reduction in overjet in the treatment group, maxillary arch length also decreased significantly in that group and was smaller in the treatment group than in the control group after treatment.

There was no sign of any general intermaxillary change as a result of treatment, since the molar relation developed similarly in both groups. As expected, the effect of the oral screen was a retroclination of the maxillary incisors. The screen did not influence arch widths, as these increased similarly in the two groups. Thus, the findings did not substantiate the statements of Hotz⁹ and Graber¹⁰ that the oral screen brings about a widening of the dental arches by relieving cheek pressure. It is possible that such a widening occurs anterior to the molars, but width dimensions anterior to the molars were not measured in the present study.

The retroclination of the maxillary incisors as a result of treatment is evident from the greater reduction in the IL_s/NL angle in the treatment group than in the control group. Part of the reduction in overjet in the treatment group may have been due to proclination of the mandibular incisors as a result of treatment, as the IL_i/ML angle increased in the treatment group but not in the control group. This is probably an effect of the periodic isolation of the mandibular incisors from lip pressure, increasing the influence of forces from the tongue on the position of the mandibular incisors. This explanation would be in line with findings from treatment with a lip bumper, where the mandibular incisors also procline.¹⁸

Effect on Lip Morphology

There was no marked difference between the two groups in development of lip morphology. In both groups the height of the lower lip increased, and in the treatment group the height of the upper lip also increased. It is impossible to determine whether the increase in upper lip height in the treatment group is a real lengthening of the lip or is due to a changed lip position as a result of the change in maxillary incisor position. Recent research has revealed a complex interaction between

tooth movement and the perioral soft tissues.¹⁹ In both groups, however, the increase in lip height was not greater than was to be expected with normal growth.³

The interlabial gap decreased more in the treatment group than in the control group. Again, it is impossible to determine whether this is due primarily to tooth movement or to a real change in upper lip length. The difference between the two groups in interlabial gap at the end of the investigation was, however, only slightly different from that at the start of the study.

Thus, there was no conclusive evidence that the oral screen affected lip morphology. The changes during the period of observation could all be due to normal growth and/or orthodontic tooth movement.

Effect on Lip Function

The treatment did not affect the electromyographically recorded lip function in any essential way. There was no change in the activity of the lips during natural function in the treatment group, and the differences found between the two groups after treatment were not systematic.

Measurement of lip strength with the Pommeter has been found to have a rather high error, which reduces the possibility of demonstrating correlations between the POM values and other variables.¹⁵ The error does not, however, preclude the meaningful use of POM values for comparisons between or within groups.

Treatment with an oral screen brought about a substantial increase in maximum lip strength, as is evident from the much higher POM value in the treatment group at the end of the experiment. At

the start of the investigation, the median POM values for both groups were lower than average for children of comparable age.^{15,17} At the end of the study, the POM value was still low in the control group, but in the treatment group it was higher than average. Treatment with the oral screen had thus brought about an increase in maximum lip strength from subnormal to higher than average values. It is possible that this effect is of value as a retentive force against the maxillary incisors after treatment. However, it is still not known what the lip strength as measured with the Pommeter means in terms of actual force on the teeth during natural function (and rest). To investigate this question, a study of the force from the lips on the teeth before and after treatment with an oral screen is underway.

Conclusions and Clinical Implications

Lip training with an oral screen has not been shown to affect lip morphology. Thus, it seems to be inferior to active lip training, without the use of any appliance, where positive but small effects of lip morphology and lip function were found. The oral screen can bring about retroclination of proclined maxillary incisors, as can be achieved easily with many types of simple appliances. Lip training with an oral screen has the additional effect of increasing maximum lip strength (the force the lips can exert to resist external forces). Whether this is an advantage for the stability of the treatment result is unknown. A side effect of the treatment may be proclination of the mandibular incisors, which may be desirable or undesirable, depending on the individual case.

REFERENCES

- ¹ Proffit, W.R.: Equilibrium theory revisited: Factors influencing position of the teeth. *Angle Orthod.* 48:175-186, 1978.
- ² McLain, J.B., Steedle, J.R., Vig, P.: Face height and dental relationships in 1600 children: A survey. *J. Dent. Res.* 62: Abstr. 308, 1983.
- ³ Vig, P.S., Cohen, A.M.: Vertical growth of the lips: A serial cephalometric study. *Am. J. Orthod.* 75:405-415, 1979.
- ⁴ Rogers, A.P.: Muscle training and its relation to orthodontia. *Int. J. Orthod.* 4:555-577, 1918.
- ⁵ Rogers, A.P.: Place of myofunctional treatment in the correction of malocclusion. *J. Am. Dent. Assoc.* 23:66-78, 1936.
- ⁶ Cook, M.S.: A lower fixed lingual tongue crib and lip toning exercises: Report of an unusual case. *Br. J. Orthod.* 4:143-148, 1977.
- ⁷ Frankel, R.: Lip seal training in the treatment of skeletal open bite. *Eur. J. Orthod.* 2:219-228, 1980.
- ⁸ Ingervall, B., Eliasson, G.B.: Effect of lip training in children with short upper lip. *Angle Orthod.* 52:222-233, 1982.
- ⁹ Hotz, R.: Orthodontie in der taglichen Praxis, ed. 5, Bern, 1974, H. Huber.
- ¹⁰ Graber, T.M.: The use of muscle forces by simple orthodontic appliances. *Am. J. Orthod.* 76:1-20, 1979.
- ¹¹ Giacometti, F.: Die Vorhofplatte. *Z Stomatol* 44: 217-281, 1947.
- ¹² Eismann, D.: Über Lippenkraftmessungen unter Berücksichtigung der Mundvorhofplatten-therapie. *Fortschr Kieferorthop* 23:222-227, 1962.
- ¹³ Barber, T.K., Bonus H.W.: Dental relationships in tongue-thrusting children as affected by circumoral myofunctional exercise. *J. Am. Dent. Assoc.* 90:979-988, 1975.
- ¹⁴ Lundstrom, A.: Tooth size and occlusion in twins, Basel, 1948, S. Karger.
- ¹⁵ Ingervall, B., Janson, T.: The value of clinical lip strength measurements. *Am. J. Orthod.* 80:496-507, 1981.
- ¹⁶ Janson, T., Ingervall, B.: Relationship between lip strength and lip function in posture and chewing. *Eur. J. Orthod.* 4:45-53, 1982.
- ¹⁷ Posen, A.L.: The application of quantitative perioral assessment to orthodontic case analysis and treatment planning. *Angle Orthod.* 46:118-143, 1976.
- ¹⁸ Bjerregaard, J., Bundgaard, A.M., Melsen, B.: The effect of the mandibular lip bumper and maxillary bite plane on tooth movement, occlusion and space conditions in the lower dental arch. *Eur. J. Orthod.* 2:257-265, 1980.
- ¹⁹ Rains, M.D., Nanda, R.: Soft-tissue changes associated with maxillary incisor retraction. *Am. J. Orthod.* 81:481-488, 1982.