Scientific Article

Changes in the dentition secondary to palatal crib therapy in digit-suckers: a preliminary study

Nancy L. Villa, DMD George J. Cisneros, DMD, MMSc

Abstract

This study investigated the effect of the palatal crib appliance used in the correction of open bite malocclusions secondary to fingersucking. Twelve experimental and 12 control subjects were studied for an average of 3.9 months. The sample consisted of patients who were both growing and not growing.

Study models taken before and after the study period were analyzed for changes in the following dimensions: overbite, overjet, arch perimeter, arch length, and incisor angulation. Data were analyzed with student t*-tests to determine statistical significance.*

Partial or complete closure of the open bite was achieved averaging 3.7 mm ± 1.9 mm during the observation period in the experimental group treated with palatal crib therapy. In contrast, the control group displayed a mean bite opening of 0.4 mm ± 0.8. These values were statistically significant at the $P < 0.001$ *level.*

Open bite decreased as incisor angulation ($P < 0.02$), *arch length* ($P < 0.05$), *and arch perimeter* ($P < 0.01$) *decreased. Overjet changes were minimal and statistically insignificant. (Pediatr Dent 19:323–26, 1997)*

Digit sucking has been associated with malocclusion in both the primary and permanent dentition in children.[1–6] Larsson concluded that prolonged finger-sucking caused an anterior open bite malocclusion, leading to a reduction in anterior vertical maxillary alveolar growth.[7]

Haryett et al. found the palatal crib without spurs to be the most effective mechanical method to prevent thumb placement.[8, 9] In addition, they found that 82% of patients treated with cribs stopped sucking within 7 days.

Other investigators have reported on dental changes subsequent to abandonment of the fingersucking habit without appliances.[10–12] Their results all agree with respect to spontaneous bite closure in prepubertal subjects. However, postpubertal subjects did not demonstrate any such improvement.

The literature is devoid of reports concerning dental changes secondary to palatal crib therapy in fingersuckers. The purpose of this study was to compare changes in the dentition of finger suckers treated with palatal cribs with those in an untreated control group with respect to overbite, overjet, arch length, and arch perimeter.

Methods and materials

Twenty-four patients between the ages of 6 and 18 years with digit-sucking habits were selected within a 4-month screening period from the patient population at Montefiore Medical Center, Division of Orthodontics, for inclusion in this study. After consent was received, 12 subjects each were assigned randomly to experimental and control groups. The control group patients received no treatment while the experimental group was treated with palatal crib therapy.

Selection criteria included: normodivergent skeletal pattern (SN-MP< 36°); dentoalveolar anterior open bite, a class I occlusion (as determined by a cephalometric and model evaluation) and an active finger-sucking habit (as determined by patient history).

Records were obtained immediately prior to the study on all patients and included study models, panoramic and cephalometric radiographs, and intra- and extraoral 35 mm slides. Study models were trimmed and oriented as outlined by the American Board of Orthodontics. Each subject was observed monthly. The principle investigator was careful not to provide any behavioral modification instructions to the control group. After 3 months, study models were obtained and compared to the initial pretreatment study models. The following measurements were analyzed for changes: overbite, overjet, arch width, arch length, arch perimeter, and incisor angulation. Measurements were made with calipers to the nearest tenth of a millimeter. Overbite was measured perpendicular to the occlusal plane. Overjet was measured parallel to the occlusal plane. The occlusal plane was defined as the functional occlusal plane, including only the molars and second premolars.

Arch length was defined as perpendicular to a line connecting the mesial of the first molars measured to the labial of the incisal edge of the most prominent central incisor. Changes in arch perimeter were measured according to the method described by Adkins et al.[13] Arch perimeter was measured as the sum of five segments along the circumference of the dental arch spanning from mesial of the first molar on the right side around to mesial of the first molar on the left.

In order to minimize radiographic exposure but still measure changes in incisor angulation, lateral view slides of pre- and post-treatment study models were taken in lieu of a lateral cephalometric radiograph. After testing the technique for reproducibility on 10 random samples, the following was performed. Slides were projected at 10 times magnification, and tracings were made of occlusal contours of the first molar, second premolar, and of the facial contour of the most prominent incisor. Pretreatment slides were projected and traced. Post-treatment slides were then projected to superimpose on the tracing of occlusal contour of the first molar and second premolar. The evaluator was blinded as to group status of each study model. The facial contour of the most prominent incisor in the post-treatment slide was traced in a dotted line. A tangent to

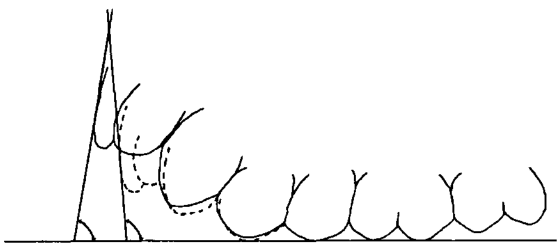

Fig 1. Illustration of measurement of incisor angular changes. Pretreatment study model: solid line. Post-treatment study model: dotted line. A tangent to the functional occlusal plane (first molars and second premolars) was drawn as a reference plane, and tangents to the facial surface of the central incisors of each model were also drawn with the resultant angles to the occlusal plane measured and compared.

the facial incisal two-thirds was drawn for each traced incisor. A tangent to the cusp tips of the first molar and second premolar was drawn to represent the functional occlusal plane (Fig 1). The resultant angles to the functional plane were measured.

All measurements were taken twice and the averages were used for statistical computations. Data were analyzed with student t-tests to calculate statistical significance. Error was evaluated by correlating all first and second measurements obtained.

Results

Overall 10 males and 14 females were studied. Two-thirds of the patients were of Hispanic origin with the remaining third equally distributed between African and European Americans.

Control and experimental groups had no significant differences for age, length of study, initial overbite and overjet, or pretreatment cephalometric angular measurements and vertical proportions (Tables 1, 2).

Arch perimeter changes were statistically significant for maxillary and mandibular arches (Table 3). Maxillary arch perimeter decreased a mean of 2.6 ± 1.8 mm in the experimental group, while the mean for the control group was increased by 0.25 ± 0.5 mm. This differ-

Table 1. Sample characteristics

Characteristics	*Control*	*Experimental*	*Significance*
Age (yrs.)			
Mean	12.1	13.5	NS
SD	3.3	2.8	
Range	8 to 18	10 to 18	
Study Length (mos.)			
Mean	3.1	3.3	NS
SD	0.4	0.8	
Range	2.5 to 4.5	3 to 5	
Overbite (mm.)			
Mean	-4.6	-5	NS
SD	1.9	3	
Range	-2 to -7.9	-2 to -11.8	
Overjet (mm.)			
Mean	5.4	4.6	NS
SD	2.6	2.7	
Range	1.6 to 9	2 to 9	

Table 2. Mean pretreatment cephalometric measurements

Measurements	*Control*	*Experimental*	*Norm*	*Sign.*
SN-MP (°)	32.4	31.4	36	NS
SN-PP (°)	4.4	4.2	8	NS
PP-MP (°)	27.9	26.6	29	NS
ANB (°)	7.9	7.3	3	NS
Ar-Go-MP (°)	122.5	119.8	131	NS
U1-pP (°)	119.3	119.1	110	NS
L1-MP (°)	105.9	104.9	91	NS
UAFH (mm)	50.1	49.6	50	NS
LAFH (mm)	70.3	70.6	65	NS
TAFH (mm)	118.4	119.3	113	NS
Ratio UAFH/TAFH	0.42	0.42	0.44	NS
Ratio LAFH/TAFH	0.59	0.59	0.57	NS

SN-MP (°)=sella nasion plane to mandibular plane
SN-PP (°) = sella nasion plane to palatal plane
PP-MP (°) = palatal plane to mandibular plane
Ar-Go-MP (°) = gonial angle
U1-PP (°) = upper incisor to palatal plane
L1-MP (°) = lower incisor to mandibular plane
UAFH (mm) = upper anterior facial height (N-ANS)
LAFH (mm) = lower anterior facial height (ANS-Me)
TAFH (mm) = total anterior facial height (N-Me)

TABLE 3. CHANGES IN ARCH PERIMETER, LENGTH (MM) AND INCISOR ANGULATION (°)

Arch	*Control*	*Experimental*	*Significance*
Perimeter			
Maxilla			
Mean (S.D.)	0.25 (0.5)	-2.6 (1.8)	$P < 0.01$
Min.	-0.1	-0.1	
Max.	1.1	-5	
Mandible			
Mean (S.D.)	0.18 (0.4)	-1.9 (1.0)	$P < 0.001$
Min.	0	0	
Max.	-0.9	-3	
Length			
Maxilla			
Mean (S.D.)	0.01 (0.33)	-1.4 (1.4)	$P < 0.05$
Min.	0	0.2	
Max.	0.8	-5	
Mandible			
Mean (S.D.)	0.03 (0.19)	1.2 (0.8)	$P < 0.01$
Min.	0	0.1	
Max.	0.4	-2.6	
Incisors			
Maxillary			
Mean (S.D.)	-0.6 (2.1)	4.7 (4.8)	$P < 0.02$
Mandibular			
Mean (S.D.)	0.3 (0.7)	3.4 (2.9)	$P < 0.02$

ence was statistically significant at the $P < 0.01$ level. Mandibular arch perimeter decreased a mean of 1.9 ± 1.0 mm in the experimental group, and the mean for the control group increased by 0.18 ± 0.4 mm with a statistically significant difference at the $P < 0.001$ level.

Arch length changes were analyzed and the mean change in maxillary arch length decreased by 1.4 ± 1.4 mm for the experimental group, and the mean change for the control group was 0.01 ± 0.33 mm. These values were statistically significant at the $P < 0.05$ level. Mandibular arch length decreased by a mean of 1.2 ± 0.8 mm for the experimental group and 0.03 ± 0.19 mm for the control group. This was significant at the $P < 0.01$ level of confidence (Table 3).

The open bites in the experimental group closed by a mean of 3.7 ± 1.9 mm. In contrast, the control group demonstrated a mean bite opening of 0.4 ± 0.8 mm. These values were statistically significant at the $P < 0.001$ level (Table 4). Post-treatment overbite values showed a statistically significant difference between groups at the $P < 0.01$ level (Table 4). Changes in overjet were minimal for both groups and statistically insignificant.

The mean change in angulation of maxillary incisors in the experimental group was represented by a retroclination of 4.7° relative to the functional occlusal plane. This was statistically significant at the $P < 0.02$ level of confidence when compared with the control group, which showed a mean proclination of 0.6.° A positive change in angulation relative to the occlusal plane demonstrates an uprighting (or retroclining) of the incisors. The mean change in angulation of mandibular incisors was 3.4° in the experimental group, which was significant at the $P < 0.02$ level when compared to the control group (Table 3).

Measurement error was minimal, never exceeding 0.02 with correlations of first and second measures ranging from 0.84 to 0.96 in value.

Discussion

Although our study suffers from some marked limitations (small sample size and wide age range) the results were quite dramatic. Improvement in overbite was observed in every patient treated with the palatal crib. Minimal changes were seen in the control group who, in most instances, worsened over time. Within the 3-month study period, palatal crib therapy was found to improve the dental occlusion of digit suckers significantly.

The speed with which the palatal crib appliance in this study allowed for overbite improvement was remarkable. The mean overbite closure observed in the 3-month study period, was 3.7 mm. Larsson's experimental group required 2 years to achieve an increase this great.[12] Bowden reported that the time required for improvement in overbite after cessation of the digital sucking appeared to be between 3 to 5 years.[11]

Significant decreases in maxillary and mandibular arch lengths were observed in the experimental group at the $P < 0.05$ and $P < 0.01$ levels, respectively. Larger changes in arch length were observed in those subjects with excess space prior to treatment. In our study, bite closure seemed to be related to arch length decrease and the severity of the initial open bite. These findings differ markedly from Larsson's results, which showed no change in arch length.[12]

Significant decreases in maxillary and mandibular arch perimeter were observed in the experimental group. Recognition that crowding of the dentition will increase substantially during palatal crib

TABLE 4. MEAN CHANGES IN OVERBITE.

Overbite (mm)	*Control*	*Experimental*	*Signif.*
Initial			
Mean (SD)	-4.6 (1.9)	-5.0 (3.0)	NS
Range	-2.0 to -7.9	-2.0 to -11.8	
Final			
Mean (SD)	-5.0 (2.2)	-1.3 (2.3)	$P < 0.01$
Range	-2.0 to -8.3	2.0 to -5.1	
Net Change			
Mean (SD)	-0.4 (.8)	3.7 (1.9)	$P < 0.001$
Range	0.1 to -2.5	0.8 to 6.7	

therapy is of utmost importance in treatment planning. A case that initially has spacing present might very well require extraction therapy due to the increase in crowding that would follow crib therapy. In the maxillary arch, the average space loss was 2.6 mm. However the results were variable ranging from 5.0 mm to 0.1 mm.

Maxillary and mandibular incisors retroclined during crib therapy to a significant extent. This was consistent with Larsson's cephalometric findings. He reported a mean retroclination of 5° of the maxillary incisors 1 year after weaning. Our subjects showed a mean retroclination of 4.7° within 3 months.

Changes observed in overjet during our study were insignificant. This was due to a concomitant decrease in mandibular arch length as the maxillary arch length and incisor angulation decreased. Larsson also found no change in overjet, but Bowden found that overjet diminished with time following cessation of the habit.[11, 12]

Several investigators report an increase in overbite following cessation of finger sucking.[10-12] They point out that spontaneous correction of anterior open-bite malocclusion is only seen in those patients whose habit is arrested prior to the pubertal growth spurt. However, six of the 12 patients in our experimental group were female and were between 12 and 18 years of age and postmenarcheal. The mean increase in overbite for this postmenarcheal group was 3.8 mm, which was approximately the same as the mean change seen for the six prepubertal subjects (3.6 mm). These studies[10-12] reflect on data obtained from patients not treated with any intraoral aversive devices such as the one used in this study.

The palatal crib appliance used in our study must have acted as a mechanical barrier that prevented finger placement and made sucking difficult, if not impossible. Positive results were seen regardless of the age of the patient. Our small sample size does not allow for any further analysis on the data.

The initial cephalometric skeletal values documented that our samples tended to have slightly lower mandibular plane angles than would have been expected from our mostly Hispanic and black subjects. The favorable skeletal divergence of the study group may have been a contributing factor to the success of treatment observed in this study, because hypodivergent patterns are thought to have more powerful vertically directed musculature.

This preliminary study was conducted over a relatively short period of time and demonstrates the short-term effect of a particular palatal crib design. No comparisons can be made to other techniques or appliances.

Conclusions

1. Palatal crib therapy resulted in a significant decrease in open bite in subjects with a digit-sucking habit when compared to a control group over a 3-month period.
2. Significant differences were also noted in parameters of arch perimeter, arch length, and incisor angulation.

Dr. Villa is in private practice in Madison, New Jersey. Dr. Cisneros is the director of Post Graduate Orthodontics, associate professor of Pediatric Dentistry and Orthodontics, and is the dental director for the Center for Craniofacial Disorders, Albert Einstein College of Medicine/Montefiore Medical Center, Bronx, New York.

1. Gellin ME: Digital sucking and tongue thrusting in children. Dent Clin North Am 22(4):603–19, Oct 1978.
2. Graber TM: Thumb and finger sucking. Am J Orthod 45(4):258–64, 1959.
3. Martinez NP, Hunckler, RJ: Managing digital habits in children. Int J Orthod Fall: 24(3–4):5–8, 1986.
4. Popovich F, Thompson GW: Thumb and finger sucking: Its relation to malocclusion. Am J Orthod 63:148–55, 1973.
5. Ruttle AT, Quigley W, Crouch JT, Ewan GE: A serial study of the effects of finger sucking. J Dent Res 32:739–48, 1953.
6. Swindler DR, Sassouni V: Open bite and thumb sucking in rhesus monkeys. Angle Orthodont 32:27–37, 1962.
7. Larsson E: The effect of finger sucking on the occlusion: a review. Eur J Orthod 9:279–82, 1987.
8. Haryett RD, Hansen FC, Davidson PO, Sandilands ML: Chronic thumb-sucking: the psychologic effects and the relative effectiveness of various methods of treatment. Amer J Orthodont 53:569–85, 1967.
9. Haryett RD, Hansen FC, Davidson PO: Chronic thumb-sucking. A second report on treatment and its psychological effect. Amer J Orthodont 57:(2)164–78, 1970.
10. Baalack IB, Frisk AK: Fingersugning hos 12-åringar.—en frekvens - och bettstudie. Svensk Tandlak Tidskr 60:201, 1967.
11. Bowden BD: The effects of digital and dummy sucking on arch widths, overbite and overjet: A longitudinal study. Aust Dent J 11:396–404, 1966.
12. Larsson E: Dummy and finger sucking habits with special attention to their significance for facial growth and occlusion. Improvement of malocclusion after termination of the habit. Svensk Tandlak Tidskr 65:635–42, 1972.
13. Adkins MD, Nanda RS, Currier GF: Arch perimeter changes on rapid palatal expansion. Am J Orthod Dentofacial Orthop 97:194–99, 1990.
14. Proffit WR: Equilibrium theory revisited: Factors influencing position of the teeth. Angle Orthodont 48:175–86, 1978.
15. Parker JH: The interception of the open bite in the early growth period. Angle Orthodont 41:24–44, 1971.
16. Day AJW, Foster TD: An investigation into the prevalence of molar crossbite and some aetiological conditions. Dent Pract Dent Rec 21:402–10, 1971.
17. Baril C, Moyers RE: An electromyographic analysis of the temporalis muscles and certain facial muscles in thumb and finger sucking patients. J Dent Res 39:3, 536–53, 1960.