
Evaluation of the effects of orthodontic pacifiers on the primary dentitions of 24- to 59-month-old children: preliminary study

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Abstract

This study was designed to compare the occlusions of 24- to 59-month-old children who used orthodontic or conventional pacifiers to the occlusions of a group of controls who had no sucking habits. Information on the habits was collected by parental questionnaires. Ninety-five children were examined for malocclusions involving overbite, overjet, canine, and molar relationships, and posterior crossbites. Users of orthodontic pacifiers had statistically significantly greater overjets, and there was a significantly higher proportion of subjects with open bite in the conventional pacifier group. There was a trend toward a greater number of subjects in the control and orthodontic pacifier groups with overbites $\leq 50\%$. These differences were not clinically significant, however. There appeared to be only minor differences between the occlusions of the two pacifier groups. (Pediatr Dent 14:13-18, 1992)

Introduction

Sucking habits have been implicated as contributing to the etiology of malocclusions in the vertical, transverse, and sagittal planes. In the vertical plane, anterior open bites have been noted in as many as 80% of active pacifier users,¹ though other studies have reported lower prevalences.²⁻⁴ There is general agreement, however, that the severity of the open bite decreases with time, especially after the habit is discontinued.²⁻⁵

Posterior crossbites have been noted before the age of 2 in pacifier users.¹ Prevalence estimates vary between 5 and 19%, depending on whether the habit is still active.¹⁻⁶ In most surveys, posterior crossbites were more common among pacifier users than digit suckers. There is general agreement that posterior crossbites created by sucking habits do not improve spontaneously upon cessation of the habit.

Sagittal malocclusions from sucking habits include disturbances of overjet, canine relationship, and molar relationship. Increased overjet has been reported in 17 to 79% of pacifier users.^{2,7} Some studies^{2,3} have found an increased prevalence of Class II canines in children with sucking habits. Prevalence was, in general, positively correlated with duration of the habit. Similar observations have been made regarding distal step primary molars. There is some agreement that the prevalence of distal step molars is higher in digit suckers than pacifier users.^{3,7}

In the late 1950s, a new design of bottle nipple and pacifier was introduced to the United States. Known as the Nuk™ Functional Orthodontic Nursing Nipple and Orthodontic Pacifier/Exerciser, this design was promoted as encouraging muscular movements that more closely resembled those used by an infant during breast feeding, consequently leading to more normal dental arch development. Two published case reports demon-

strated correction of developing malocclusions using Nuk exercisers.^{8,9} Bishara et al.¹⁰ studied the effects of different types of feeding and nonnutritive sucking in infants from birth to 18 months of age. They found no significant differences in arch dimension changes among all groups in the study. We are unaware of any other study that has compared the occlusions of users of conventional and "orthodontic" pacifiers.

The purpose of this study was to compare the occlusions of children who used conventional or orthodontic pacifiers. The null hypothesis was that no differences would be found in the prevalence of malocclusions between users of orthodontic and conventional pacifiers, as demonstrated by the occurrence of: 1) distal (Class II) primary canine relationship, 2) distal step molar relationship, 3) posterior crossbite, 4) anterior open bite, and 5) increased overjet.

Materials and Methods

Examiner Calibration

Prior to examining subjects, the examiner for the study (MM) was calibrated with an individual having extensive experience in epidemiologic studies (SMA). Examiner reliability was established by examining 25 plaster dental casts representing a variety of occlusions. Neither examiner had treated any of these patients nor were they familiar with any of the patients' dental histories. All models exhibited primary or early mixed dentition.

Criteria were established for the examination by consensus with published definitions. Each examiner independently examined the models on two occasions separated by at least one week. The following parameters were recorded:

1. Terminal plane relationship of the primary second molars, recorded as flush, mesial, or distal step on each side
2. Primary canine relationship, recorded as Class I, II, or III on each side
3. Amount of overjet, measured from the lingual surface of the mesial corner of the most erupted maxillary incisor to the facial surface of the corresponding mandibular incisor, recorded in millimeters
4. Degree of overbite, recorded as $\leq 50\%$, or greater than 50% overlap of the mandibular incisor crown
5. Presence or absence of posterior crossbite, defined by a reversed buccal overjet relationship of two or more opposing primary canines or molars
6. Presence of anterior open bite, measured in millimeters.

These data were analyzed for intra- and interexaminer agreement using per cent agreement and the Kappa statistic for categorical data, and Kendall's tau-b correlation coefficient for the overjet data.

Examination of Subjects

Children were recruited from regional day care centers based on the following criteria:

1. Parental consent for the child to participate in the study
2. Subject's parents ability to recall the child's oral habits and identify the type of pacifier used by the child, if any
3. Completion of a questionnaire by the parents that provided information concerning the duration and type of oral habit, if any
4. Age of 24 to 59 months
5. Good general health and age-appropriate intellectual development
6. Presence of 20 primary teeth.

All examinations were performed by one examiner (MM) using a Rolux[®] portable dental light, a mouth mirror, and a metal millimeter ruler. In each case the examiner was blind to the subject's dental history and questionnaire data. The parameters recorded were the same as those measured in the calibration study.

One hundred and thirty children were examined initially, 95 of whom had reported oral sucking habits. Following review of the questionnaires, subjects with finger-sucking habits were eliminated, and the remaining 79 were assigned to one of three groups: 1) conventional pacifier only ($N = 27$); 2) orthodontic pacifier only ($N = 27$); or 3) no pacifier use (control group, $N = 25$).

Results

Examiner Calibration

Intra- and interexaminer per cent agreement on categorical data in the calibration study ranged from 72 to 88%. The Kappa statistic for intra- and interexaminer reliability ranged from 0.57 to 0.81. For intraexaminer reliability, the Kendall's tau-b values for overjet were 0.87 and 0.91 for the study examiner and the calibrating examiner, respectively. For interexaminer reliability, the value of Kendall's tau-b for overjet was 0.78 and 0.89 for the first and second examinations, respectively. These statistics indicate acceptable intra- and interexaminer reliability.

Examinations

The data from the examination of the children were analyzed using Chi-square analysis and the general linear models ANOVA procedure for unbalanced groups. Two-tailed and unpaired *t*-tests were used to compare the conventional and orthodontic pacifier groups alone. The three study groups were examined to determine whether they differed in terminal plane relationship, canine relationship, overjet, overbite, and the presence of posterior crossbite. Parameters of pacifier use were examined to see whether any of these factors were related to the groups' occlusion. These included the age at which the habit was started and discontinued, hours of pacifier use per day, and duration — in months — of the habit (all as reported by the parents).

A summary of these parameters can be found in Table 1 (next page). The mean age at time of examination was 43.4 months, with a range of 24–59 months. There were no significant differences among groups with respect to age distribution. Most of the children using pacifiers began the habit between birth and three months of age, the mean being 2.8 months. There was no significant difference between the groups in mean starting age. The reported length of pacifier use ranged from 6 to 43 months, with a mean of 28. The hours per day of pacifier use as reported by parents averaged 6.6, with a range of 1–11 hr. There was no significant difference in either parameter between the two pacifier groups.

Subjects who discontinued their habits did so in the range of 6 to 48 months prior to the examination. The mean number of months elapsed since discontinuing the habit and the date of the examination was 12.2. Fourteen (26%) children still used their pacifiers at examination. Seventeen (31.5%) had discontinued the habit 18 months or more prior to the study, with the earliest discontinuation being 52 months prior to examination. There was no difference between the two pacifier groups as to the timing of habit discontinuation.

Table 1. Parameters of pacifier use

Parameter	Group	Range	Mean, SE
Age at examination	Total	24–59 months	43.4 ± 1.07
Mean starting age	Total	0–12 months	2.8 0.33
	Orthodontic		2.2 0.44
	Conventional		3.3 0.48
Duration of use	Total	6–43 months	28.0 1.15
	Orthodontic		28.4 1.78
	Conventional		27.6 1.48
Hours use per day	Total	1–11 months	6.6 0.29
	Orthodontic		6.5 0.45
	Conventional		6.7 0.38
Age habit stopped	Total	6–48 months	30.8 1.22
	Orthodontic		30.6 1.95
	Conventional		30.9 1.51
Time since discontinuation	Total	0–52 months	12.2 1.87
	Orthodontic		11.8 2.86
	Conventional		12.6 ± 2.46

Table 2. Distribution of racial/ethnic groups by pacifier group

Race/Ethnic Group	Pacifier Group			
	Control	Orthodontic	Conventional	Total
African-American	14	18	16	48
Caucasian	8	7	9	24
Hispanic	3	2	2	7
Total	25	27	27	79

Chi-square = 0.94 with d.f. = 4; $P = 0.919$.

There also were no significant differences among groups in gender distribution. The orthodontic and conventional pacifier groups each contained slightly more males than females, with the reverse being true for the control group. Racial/ethnic background was recorded as African-American, Hispanic, or Caucasian. No significant differences were found in this distribution either (Table 2).

Feeding habits (breast, bottle, or both) were distributed comparably among the three groups. Forty-six per cent of the parents reported that their children were primarily breast-fed, while 16% reported primarily bottle feedings. The remaining 38% indicated approximately equal use of breast and bottle feeding.

Terminal plane and canine relationships were evaluated for differences on right and left sides among the three groups. The majority (90%) of canine relationships were Class I, and almost all (96%) of the terminal plane relationships were recorded as flush or mesial step. No differences were found among the groups in the distribution of these sagittal discrepancies. It is

interesting to note, however, that there was a trend toward an association of distal step molars and Class II canines in subjects who had discontinued their pacifier habits within 18 months of the examination.

Table 3 demonstrates the mean overjet of each group. Overjet ranged from 0 to 9 mm among the groups. No cases of anterior crossbite were found. Subjects in the orthodontic pacifier group had a slightly higher mean overjet. This difference, while statistically significant, was of marginal clinical significance. An analysis of overjet as a function of gender, race, and parameters of pacifier use revealed no relationships. The mean overjet also was statistically significantly greater among those subjects with overbites greater than 50% overlap of the lower incisor crown ($P = 0.005$). Again, the differences were not clinically significant.

Overbite was found in 66 children (84%). Most of these (73%) demonstrated overbite

≤ 50% overlap of the lower incisor crown. The distribution of overbites among the three pacifier groups just failed to reach significance ($P = 0.054$, Table 4, next page). There was a higher proportion of children in the orthodontic pacifier and control groups with overbites ≤ 50%, while the conventional pacifier group had a higher proportion of subjects with overbites greater than 50%. The conventional pacifier group also had a

Table 3. Mean overjet of groups

Group	Overjet, mm		
	N	Mean	SE
Control	25	2.12	± 0.25
Orthodontic	27	3.04	0.33
Conventional	27	2.63	0.19
Total	79	2.61	± 0.16

$F = 5.06$, $P = 0.009$.

Table 4. Distribution of overbite among groups

Habit Group	Overbite			Total
	Open bite	≤ 50%	> 50%	
Control	1	18	6	25
Orthodontic	4	19	4	27
Conventional	8	11	8	27
Total	13	48	18	79

Chi-square = 9.28 with d.f. = 4; $P = 0.054$.

Table 5. Distribution of posterior crossbite among groups

Habit Group	Crossbite Classification			Total
	Bilateral	Unilateral	None	
Control	1	3	21	25
Orthodontic	0	7	20	27
Conventional	2	3	22	27
Total	3	13	63	79

Chi-square = 4.37 with d.f. = 4; $P = 0.358$.

Table 6. Distribution of open bite among groups

Habit Group	Open bite		Total
	Yes	No	
Control	1	24	25
Orthodontic	4	23	27
Conventional	8	19	27
Total	13	66	79

Chi-square = 6.28 with d.f. = 2; $P = 0.044$.

higher proportion of subjects with open bites. Overbite was not related to gender, race, or any other parameters of pacifier use.

The distribution of posterior crossbites is shown in Table 5. Crossbites were found in 20% of the children, with unilateral crossbites occurring four times as often as bilateral crossbites. Crossbites were found in 22% of the pacifier users. Subjects with unilateral and bilateral crossbites were significantly younger than were subjects without crossbites ($P = 0.014$). There were no significant differences in the distribution of crossbites among the three groups or between the orthodontic and conventional pacifier groups alone, even when bilateral and unilateral crossbites were combined. The presence of a posterior crossbite could not be related to any other factors of pacifier use.

Open bites ranging from 1.0 to 6.0 mm were recorded in 13 of the 79 children (16.5%). The mean was 0.5 mm (± 0.14 se). There were too few subjects with open bite to allow full statistical comparison. However, in comparing subjects with open bite to those who had overbite, there was a significantly greater proportion of subjects with open bite in the conventional pacifier group, including the two subjects with open bites of 6 mm (Table 6). This is in agreement with the distribution presented in Table 4. The mean open bite for the orthodontic pacifier group, 0.41 mm (± 1.1 se), was about half that of the conventional pacifier group, 0.81 mm (± 1.7 se). Open bite could not be related any parameters of pacifier use, though there was a trend toward a relationship with hours per day of pacifier use.

Discussion

Findings from this study must be considered preliminary because of the relatively small sample size. This led to some Chi-square tables with cells of fewer than five subjects, necessitating caution in interpretation. The groups, however, were well balanced. Subjects were self-selected by the parents for the examinations, and we relied on parental recall for information regarding pacifier use. However, the young age of the children enhanced the likelihood that the information regarding a current or recently discarded habit was accurate. The line drawings in the questionnaire clearly, we believe, distinguished the differences between generic types of conventional and orthodontic pacifiers. More than half of the subjects were African-American, but there were no significant interactions involving race.

The age range of the study extended to 59 months, and may have allowed for self-correction or improvement of some of the occlusal problems in older children who had discontinued the habit at an early age.^{2,11} This would have affected the orthodontic and conventional pacifier groups equally, however. Fewer than a third of the children had discontinued the habit 18 months or more prior to the examination. We noted a nonsignificant trend toward a higher distribution of Class II canines and distal step molars among the children who had discontinued the habit within 18 months of the examination. This was a very small proportion of the sample, however.

It was not possible to assess by questionnaire the muscular intensity with which individual children engaged in their habits. However, the term "intensity" has been used in the literature synonymously with "hours use per day."^{2,5,12} This factor has been related to the degree of change in the occlusion of pacifier and finger suckers, and it was this factor that our questionnaire attempted to estimate. We found no significant rela-

tionships between hours of use per day or duration of use in months and malocclusion in the pacifier groups. We did note, however, a trend toward a higher proportion of open bites among children who reportedly used their pacifiers more hours per day.

There was a preponderance of Class I canine relationships and flush or mesial step terminal plane relationships among our sample. Ravn² found Class II canines on one or both sides in almost 53% of a sample of children with sucking habits. He also noted that children who continued pacifier use to age three had a higher proportion of distal canine relationships than did finger suckers. Ravn² also found distal step terminal plane relationships in almost 30% of that same sample. However, he did not find a relationship between sagittal malocclusion and sucking behavior or duration. Our sample may have comprised a higher percentage of normal sagittal occlusions, though we did find Class II canines and distal step molars more frequently among those subjects who had discontinued the habit within 18 months of the examination.

Ravn² found increased overjet (> 4 mm) in a majority of children with persistent sucking habits. Others⁷ have reported a lower prevalence. Ravn² found that most finger suckers do not have increased overjet compared to users of pacifiers. He did not report a mean overjet measurement, but most of his subjects with pacifier habits fell into the 2–4 mm range. The sample in our study exhibited a mean overjet of 2.6 mm, with a statistically significantly higher mean overjet among the orthodontic pacifier group. However, this difference was less than 1 mm and was not considered clinically significant. Bowden¹³ found only a slight increase in the overjet of pacifier users compared to nonusers that was significant only at 3 years of age. Thereafter, and especially after cessation of the habit, the overjet decreased. The extension of our age range to 59 months probably included children who had discontinued the habit early enough to allow for spontaneous improvement. We also found that subjects with overbites > 50% were significantly more likely to have increased overjets. Perhaps subjects with deeper bites are more likely to affect their overjet relationship with a pacifier habit without concomitant changes in overbite. Perhaps children with deep bites are more likely to position the plastic flange of the pacifier on soft tissue, allowing for more anterior-posterior changes. This finding lacks adequate explanation at this time.

Bowden³ found lower mean overbites in a group of pacifier users compared to nonusers, as did Ravn.² Bowden³ was unable to demonstrate a difference between the overbite in nonusers and in users who had *discontinued the habit before 18 months of age*. Ravn² found some degree of overbite in 68% of his sample of pacifier users, compared to 84% of our sample. About

25% of his sample demonstrated overbite of 50% or more, whereas almost 75% of our group had comparable vertical overlap. We did note a nonsignificant trend for a higher prevalence of subjects with overbites > 50% among users of the conventional pacifiers.

Ravn² stated that sucking habits that persist for three years produce posterior crossbites whereas Svedmyr¹ found them before the age of 2 in some subjects. Evidence of this malocclusion has been noted in 5 to 19% of pacifier users. The prevalence among our subjects was 20%. This range may be explained partially by differences in diagnostic criteria. We recorded a posterior crossbite if any two or more opposing primary canines and/or molars occluded with reverse buccal overjet. Other studies have required that more teeth be in crossbite. Bowden¹³ found lower mean intercanine and intermolar arch widths among pacifier users than nonusers, although this was most clearly the case for the maxillary intermolar dimension. This same finding was not replicated in the finger sucking group. Bowden¹³ did not state in how many subjects the decreased arch width resulted in posterior crossbites. He suggested that posterior crossbites might result more frequently from pacifier sucking because of the horizontal position of the pacifier and the resultant negative intraoral pressure.

Ravn² stated that anterior open bites are the "predominant consequence" of sucking habits. Anterior open bites were present in 16.5% of our sample, in almost 41% of Ravn's², and in 80% of Svedmyr's¹ group of active users. Bowden's³ longitudinal study indicated that, just as with overbite, the open bites tended to improve with time after habit cessation. We noted a higher prevalence of open bite in the conventional pacifier group and a trend toward a relationship with increasing hours of use per day. However, the mean open bites of the two pacifier groups were each less than 1 mm, and they differed by less than 0.5 mm. It is interesting to note that the conventional pacifier group also had a higher proportion of subjects with overbites > 50%. When open bite was classified as "yes" or "no," the conventional pacifier group demonstrated a lower proportion of subjects without open bite, that is, with overbite. This seeming contradiction is related to the relatively lower number of subjects in the conventional pacifier group with overbites ≤ 50% (Table 4), and the relatively higher number of subjects in the conventional pacifier and control groups with the same degree of overbite.

These data cast doubt on the purported advantages of orthodontic pacifiers. However, the data are preliminary. Further investigation of a larger sample of children would allow more rigorous testing, as well as comparisons between children who have discontinued their habits with those who are active pacifier users.

Conclusions

1. No clinically significant differences were found between 24- to 59-month-old users of conventional and orthodontic pacifiers with respect to sagittal, vertical, and transverse occlusal relationships.
2. There were statistically significant differences between the groups in open bite and overjet.
3. There was a trend toward a relationship between hours of use per day and degree of open bite.

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Thumb-sucking, object attachment can be remedied in children

Eight chronic thumb-suckers more than 5 years old and strongly attached to an object were treated successfully in a program that used a taste solution and motivation, according to an article in the *American Journal of Diseases of Children*.

"The treatment, a taste- and reward-based combination, eliminated thumb-sucking in all eight children," the author, Patrick Friman, PhD, from the Department of Pediatric Psychology, Children's Hospital of Philadelphia, noted. The taste solution was applied once in the morning and once in the evening, as well as once each time the parent noticed a thumb-sucking occurrence. Various rewards were given when an entire day passed without an observed instance of thumb-sucking.

Even more important, treatment for thumb-sucking led seven of the eight children to lose interest in their attachment objects subsequently.

Many thumb-sucking children also are attached to an object. Thumb-sucking in children more than 5 years old can lead to complications in health and relationships with family and friends. Thumb-sucking and object attachment appear to ease children's transition between dissimilar conditions (e.g., with caregivers-alone, waking-sleeping), according to the author.

Dr. Friman wrote that thumb-sucking fulfills an important function for some children and in such instances, should not be treated. This includes situations in which a child is sick, disturbed, grieving, injured, adamantly opposed to treatment, or younger than 5 years old. The author concluded that treatment is appropriate when thumb-sucking is an empty habit, even if habitual attachment is practiced concurrently.