Oral Habits—Part 1: The Dental Effects and Management of Nutritive and Non-nutritive Sucking

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ABSTRACT

Nutritive sucking and non-nutritive sucking are among the most commonly reported oral habits in children. These habits generally cease around four years of age as interaction with other children increases. However, prolonged habits may alter dento-skeletal development, leading to orthodontic problems, which may persist into the permanent dentition. Rewards, reminder therapy, and appliance therapy have been described for the management of nutritive and non-nutritive sucking habits. Reminder therapy includes the use of gloves, thumb-guards, mittens, and tastants applied to fingers. When other modes of treatment have failed, appliance therapy, such as palatal cribs or Bluegrass appliances, may be necessary to prevent the placement of the digit in its sucking position. These tools are very effective and are associated with few adverse effects; however, they must be used with the cooperation of the child and never as punishment. The purpose of this paper is to update clinicians about nutritive and non-nutritive sucking habits in children and their impact on dental/skeletal development, and management options. (J Dent Child 2014;81(3):133-9)

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Children frequently engage in nutritive and non-nutritive sucking, atypical swallowing such as tongue thrusting, mouth breathing, lip sucking, and bruxism. Although such behaviors may be harmless, related habits of sufficient duration, frequency, and magnitude may lead to significant changes in craniofacial development, causing orthodontic problems that can compromise function and esthetics.[1-7]

Although such changes are consistent with Moss' functional matrix theory of craniofacial growth, the relationship between form and function is not clearly understood, and the underlying growth pattern may also influence the impact of habits on development. Common orthodontic problems resulting from oral habits include anterior open bite, increased overjet, posterior crossbite, and long facial height. In severe cases, functional changes, such as deviation of the mandible due to a unilateral crossbite, can result in asymmetrical growth with significant repercussions that may extend into adulthood.

Two main types of sucking have been described: nutritive and non-nutritive. The former is related to the process of obtaining nutrition, and the latter is a habit which may involve sucking of pacifiers (also known as dummies), or digits.[8]

The purpose of this paper, the first of two on the management of habits in pediatric dentistry, was to discuss nutritive and non-nutritive sucking habits and their management in children and adolescents.

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NUTRITIVE AND NON-NUTRITIVE SUCKING

DEVELOPMENT OF SUCKING

Sucking movements, which are among the earliest coordinated muscle activities, develop during prenatal life.[8-12] Oral and gag reflexes emerge at 12 to 16 weeks of gestation, slightly earlier than the sucking reflexes which develop at approximately 24 weeks.[11] By contrast, the highly energetic and complex activity of feeding, involving a suck/swallow/breathe cycle, starts to develop much later in prenatal life and is only fully coordinated by 32 to 34 weeks. The two types of sucking also vary concerning duration, rate, and strength of sucking. Nutritive sucking occurs at a constant rate of one suck per second during breast- or bottle-feeding.[8] Non-nutritive sucking (**NNS**) occurs at a higher rate of two sucks per second and is believed to satisfy an infant's natural sucking urge or as a means of behavioral state modulation.[8] The differences in development and pattern between the two types of sucking may account for the different effects on craniofacial development.

NUTRITIVE SUCKING

Nutritive sucking, which occurs during breast- and bottle-feeding, may influence craniofacial development. Improvement of craniofacial development may be related to the nutritional, immunological, and developmental benefits of breast-feeding, with some investigators reporting lower rates of malocclusion among breast-fed children. However, due to the high rates of NNS, the effect of breast-feeding has been difficult to assess and findings are conflicting, with several studies failing to find any association.[13,14] Nevertheless, there is some evidence that breast-feeding is likely to lead to lower rates of anterior open bite and posterior crossbite than bottle-feeding, due the vastly different patterns of muscle activity between the two forms of feeding.[15-17]

The lack of a continuous flow of milk during breast-feeding places higher demands on the infant's orofacial muscles, encouraging muscle development and growth of the mandible.[18] The action of the infant's mouth during breast-feeding has been described more as a squeezing of the mother's nipple, compared to a pistol-like action of the tongue during sucking of the nursing bottle teat.[17] In addition to that, the nipple of the mother's breast is positioned more anteriorly in the child's mouth, compared to the teat of a nursing bottle which is directed farther back toward the pharyngeal wall, thus displacing the tongue anteriorly. These factors may lead to the development of irregular swallowing patterns, such as tongue thrust, which may, in turn, contribute to malocclusion.

A third mechanism for the association between infant feeding and malocclusion may be explained by the lower rates of non-nutritive habits, particularly pacifier sucking, among children who are breast-fed.[15,18,19] A greater sense of fulfilment and security may satisfy the intuitive sucking needs of an infant, who is then less likely to engage in NNS behaviors.[13,20] Alternatively, the large bottle teat and subsequently increased flow may lead to a preference for the pacifier as the infant grows.[18]

Further research, ideally longitudinal in nature, is needed to confirm the association between nutritive sucking and malocclusion, particularly in the mixed and permanent dentitions. Nevertheless, given the vast evidence for the advantages of breast-feeding and current World Health Organization guidelines, mothers should be encouraged to exclusively breast-feed infants for the first six months of life and continue breast-feeding until 12 months old and beyond with the introduction of appropriate solids.[21,22]

NON-NUTRITIVE SUCKING

There are many benefits from NNS for healthy and preterm infants. In addition to helping calm infants, particularly as an aid to get them to sleep and attenuate crying, NNS has been associated with decreased risk of sudden infant death syndrome.[12,23-25] There are three possible mechanisms for this association: (1) the maintenance of airway patency by pacifiers, which prevents the backward positioning of the tongue during sleep; (2) reduced gastric reflux; and (3) stimulation of respiration, which reduces apneic episodes.[10]

A Cochrane review concluded that preterm infants, whose ability to feed is underdeveloped and who are fed through feeding tubes initially, transition more rapidly to oral feeding if provided with pacifiers.[11] NNS was also found to reduce the length of the hospital stay in preterm infants. The development of sucking is helped by NNS, allowing the infant to progress to nutritive sucking and may also help digestion by stimulating vagal innervation in the oral mucosa, which increases the production of enzymes, such as lipase, insulin, and motilin.[11]

EFFECT OF NNS HABITS ON THE DEVELOPING DENTITION

Although sucking has been shown to be beneficial, particularly early in life, prolonged NNS has been associated with a range of adverse effects on dental and oral development. NNS may be considered normal or acceptable in the first two years of life, but, if extended beyond three to four years of age, may lead to changes in the primary and/or permanent dentitions. The prevalence of NNS in infancy is high, with rates of 40 percent to 90 percent reported. In most cases, it refers to pacifier or digit sucking, although other objects, such as toys and blankets, may also be involved.[26] Pacifier sucking is more common in infancy than digit sucking, and, although uncommon, a child may have both habits.[27] Non-nutritive habits may also be more common among children from higher socioeconomic groups and with mothers who are older or more educated.[26,27]

NNS has been shown to decline in prevalence with increasing age.[27] Pacifier use decreases rapidly from infancy and generally ceases by approximately four years of age, when interaction with other children increases and pacifier sucking becomes very uncommon.[26,27] Digit-sucking prevalence also declines until approximately four years of age, at which point the prevalence steadies until seven years before once again decreasing.[27] A small minority of children continues digit sucking beyond eight years. Overall, the duration of the habit is longer among digit suckers than pacifier suckers, with the difference in the prevalence of pacifier and digit sucking attributed to the ability to remove a pacifier from a child.[26]

NNS is a common habit in children, but malocclusions are only encountered in a small percentage. Several factors may determine the extent to which the primary and permanent dentitions are affected, including the duration, magnitude, and force (intensity) of the habit. The dental manifestations of NNS include anterior open bite, posterior crossbite, increased overjet, and higher risk of developing a Class II malocclusion.

Pacifier and digit sucking have been shown to alter dental development differently. Extended pacifier use has been associated with anterior open bites, Class II molar relationships, and posterior crossbites, while digit sucking may manifest in anterior open bite and increased overjet.[14,26] The anterior open bite associated with pacifier sucking is usually symmetrical. This is due to the shape of the pacifier, which limits its positioning in the mouth, as the pacifier pushes the maxillary four incisors together as a block and in close proximity to each other.[14,26] Digit sucking, however, is associated with an asymmetric open bite, as dictated by the position of the digit in the mouth, with the upper incisors proclined and spaced (Figure 1). The overjet is increased, mostly due to proclination of the maxillary incisors; however, in severe cases of digit sucking, retrusion of the lingual incisors may also contribute.[2]

Pacifier sucking has been associated with posterior crossbite due to a combination of a significant increase in mandibular intercanine width and a decrease in maxillary arch width.[14,27-29] These alterations in arch form may be attributed to increasing muscle contraction. The lower positioning of the tongue in NNS leads to dentoalveolar expansion of the lower arch, and the opening of the upper and lower jaws increases vertical dimension. This effectively heightens muscle contraction in the cheeks near the canine teeth, leading to an inwards or narrowing force directed against the maxillary arch form.[2,26]

Figure 1. An asymmetric open bite and malocclusion in a 10-year-old boy with a digit-sucking habit.

A posterior crossbite can be established as early as 18 months old and, if unilateral, may lead to a functional shift of the mandible upon interdigitation. Such deviation of the jaw upon closing has been associated with long-term complications due to changes in growth and mandibular development.[2,26] Physiological or orthodontic pacifiers are designed to better fit the child's oral structures and prevent palatal distension, thereby limiting adverse effects.[30,31] A small number of studies have compared the impact of these altered designs upon the developing occlusion; generally, the results are mixed, with little clinical difference.[32]

Although both digit and pacifier sucking may lead to malocclusion, the latter has been found to have a more consistent impact on the anterior and posterior occlusions.[26] However, as pacifier sucking is more likely to be of a comparatively reduced duration, the effect on the mixed and permanent dentitions may be less than for prolonged digit sucking.[26,33]

The duration of the habit can be both the time for which the habit actively occurs or the overall time that the child has the habit. Although few studies have investigated the impact of the former, habits of less than six hours duration are unlikely to alter craniofacial development because orthodontic forces of shorter duration are generally inconsequential.[5]

Pacifier sucking for longer than 24 months and digit sucking for longer than 36 months result in significantly higher rates of posterior crossbite and anterior open bite at five years of age.[14]

Of greater concern is the influence of NNS on the mixed and, particularly, permanent dentitions. NNS for more than 36 months was found to significantly increase the risk of malocclusion in the mixed dentition.[6] Among children who used pacifiers beyond four years of age, 23 percent had an anterior open bite at eight years. The prevalence of Class II molar relationships was also significantly higher among children who sucked pacifiers beyond four years of age versus those who had habits of shorter duration. Regarding digit sucking, the prevalence of anterior open bite was significantly higher among those whose habit persisted for longer than 60 months.[6]

In most cases, the malocclusion resulting from NNS improves after cessation of the habit, although this process may take two to five years for complete resolution and is dependent on various factors, including growth pattern, overall duration of the habit, and the presence of other

habits such as tongue thrust.[34,35] Some studies have indicated that posterior crossbites may be more resistant against self-correction than anterior open bites.[26,35] The effect of NNS, if ceased by six years of age, is likely to be transient, leading to spontaneous resolution by eight to 12 years; however, NNS beyond six years of age is less likely to result in spontaneous resolution.[4] Therefore, although habit cessation should be encouraged by approximately three to four years of age, the critical time appears to be six years, beyond which age spontaneous correction of an associated malocclusion is unlikely.

MANAGEMENT OF NNS HABITS

Early dental visits should be used to provide parents with anticipatory guidance by explaining the influence of habits on the developing occlusion.[1] Parents should be encouraged to monitor the frequency and intensity of NNS, particularly in the case of digit sucking, which is more likely to persist beyond four years of age. If the habits do not diminish, intervention may be indicated. Parental nagging and punishment may lead to the opposite of the desired effect, and parents should be encouraged to adopt a more positive approach toward the habit.[1,2]

In addition to providing information to the parents, the effect of the habit should also be carefully explained to the child in age-appropriate language. Between four and six years of age, positive reinforcement through the use of rewards may be sufficient to curb NNS habits. Calendars can be used to track a child's progress and provide rewards. If the child is able to abstain from the habit for three months, this is likely to indicate cessation of the habit.[2]

In cooperative children who express a willingness to cease digit sucking but who require additional assistance, either response prevention therapy or appliance therapy may be successful.[36]

RESPONSE PREVENTION THERAPY

Response prevention therapy is aimed at either physically preventing children from placing their fingers in their mouth or providing an unpleasant taste that discourages children from engaging in the habit. Products such as thumb guards, bandages, gloves, mittens, and hot- and bitter-tasting medicaments have been found to be effective in ceasing both daytime and nocturnal digit sucking.[37,38] Being relatively easy to use and inexpensive, they are recommended as an alterative when rewards and positive reinforcement have failed to curb an NNS habit. However, children often ignore these reminders or remove them, which limits their effectiveness.[39] The small percentage of children who continue NNS into the early mixed dentition is likely to have a more ingrained habit; thus, appliance therapy may be indicated.[2]

APPLIANCE THERAPY

Due to the increased risk of irreversible malocclusion, once the permanent incisors start erupting and other reward-based reminder techniques have failed to correct a digit-sucking habit, the use of removable or fixed appliances may be indicated. However, this must be based on the child's willingness and should not be used as a means of punishment but rather explained as a tool to assist the child in overcoming his or her digit-sucking habit.[2] Lack of cooperation from the child is likely to lead to failure, development of new habits, deformation, or early removal of the appliance.

Palatal cribs of various designs have been used successfully to overcome digit-sucking habits and are designed to prevent both the comfortable positioning of the digit against the palate and any associated tongue thrust, thereby allowing the natural force of the lips to correct an anterior open bite.[2,40,41] The basic design utilizes the permanent first molars or the primary second molars as abutments with a major connecting wire of 0.04-inch stainless steel orthodontic wire extending anteriorly along the palate (Figure 2).[2] The wire forms a fence or crib at the level of the maxillary canines, which extends vertically lingual to the level of the incisor edges of the lower anterior teeth. However the appliance should not lead to any occlu-sal interferences and should have sufficient clearance to allow for the lingual movement of the maxillary incisors. Various other features, such as rakes or spurs, may be incorporated to the design of palatal cribs but may be unnecessarily punitive.[40,42]

The insertion of palatal cribs has been associated with high success rates, resulting in thumb sucking cessation within a week in 80 percent of cases and little relapse after three years.[40,41,43] The appliance is more likely to be successful if in situ for six to ten months, and is associated with significantly higher rates of relapse when removed after three months.[41] The effectiveness of the appliance in improving an anterior open bite is dependent upon various factors, including the presence

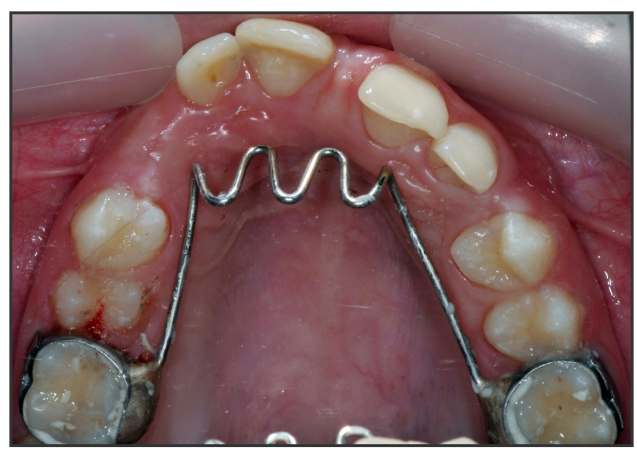

Figure 2. A palatal crib appliance with abutments on the permanent maxillary first molars.

of any additional habits, such as lip sucking, and the patient's dental maturity.[2] Improvement in the alignment of the teeth should be evident within three months of insertion of the appliance, and complete resolution of the anterior open bite is expected by six months.[2] The lack of such resolution may necessitate investigation and management of additional habits or indicate an underlying occlusal discrepancy.

Several minor problems have been reported with the use of palatal cribs. Children with palatal cribs may be initially upset regarding the appliance and experience difficulty eating sticky and hard foods. These are usually accommodated within three to four weeks.[2,40] In addition to that, transient changes in speech, such as slurring and lisping, are corrected once the appliance is removed at the completion of treatment, if not during the active treatment stage.[40] There is little evidence to show that children who undergo appliance therapy develop other compensatory mannerisms, such as nail-biting, scratching of the body, and knuckle-cracking, as reported in digit-sucking children who received palatal crib therapy (e.g., in the control group).[40]

Palatal irritation following insertion of the appliance has been reported in a minority of children and may reflect poor fabrication or be caused by the mechanical irritation of the palatal mucosa and/or tongue due to the upward pushing of the crib by the tongue.[2,40] A simple bending of the crib wire intraorally may relieve any such irritation until the tongue adapts to a new position.

Loss or loosening of palatal cribs has also been reported in a small minority.[40] The risk of dental caries and lack of patient cooperation may contraindicate the use of appliance therapy in some children.[36]

There is currently no clearly prescribed recall schedule for patients undergoing appliance therapy. However, to detect any adverse effects and monitor response to therapy, a review one to two weeks following insertion and then every two to three months thereafter is appropriate.

The Bluegrass appliance was developed as a non-punitive alternative to crib appliances in treating chronic digit sucking.[42] The appliance is provided to children as a distractive toy which they can roll with their tongue instead of digit sucking, leading to cessation of the habit by approximately 12 weeks.[44] Although the appliance prevents the placement of the finger against the palate, its primary goal is not to impede digit sucking but to create a counter conditioning response to the original conditioned stimulus for thumb sucking. The appliance contains a six-sided, Teflon-coated roller or colorful bead(s) slipped over a 0.045-inch stainless steel wire, which is soldered to bands on either the permanent first molars or primary second molars. The roller is positioned at the highest point in the palate but must not contact the palatal mucosa so that it may roll properly when contacted by the tongue. The appliance has been reported to result in fewer complications with speech and eating and is better accepted by patients and parents, although the child's enthusiasm was reported to wane with time.[42]

Both the crib and Bluegrass appliances have been modified further to broaden their applications, and many different variations are currently available.[45-48] In children who have developed a dentoalveolar anterior open bite and posterior crossbite in the mixed dentition due to persistent digit sucking, a quad-helix with a crib attachment can successfully resolve both the malocclusion and the causative habit.[43,45-49] This technique has been shown to lead to a significant increase in overbite due to extrusion of the permanent incisors and downward rotation of the palatal plane, leading to improved skeletal relationships.[43] The Bluegrass appliance has also been incorporated into a quad-helix, with an additional crib attachment in a fixed-removable design that allows easy activation of the quad-helix following insertion.[46]

Removable appliances, such as a Hawley retainer, with a series of loops palatal to the incisors may be effective in treating digit sucking; however, as with any removable appliance, success may be limited due to lack of patient compliance (Figure 3).[2,50]

It appears that the association between NNS and psychopathology is likely to have been overestimated in the past.[51] However, adolescents with persistent habits and who are either unwilling or nonresponsive to treatment may benefit from referral to an appropriate psychologist or medical practitioner for assessment.[2]

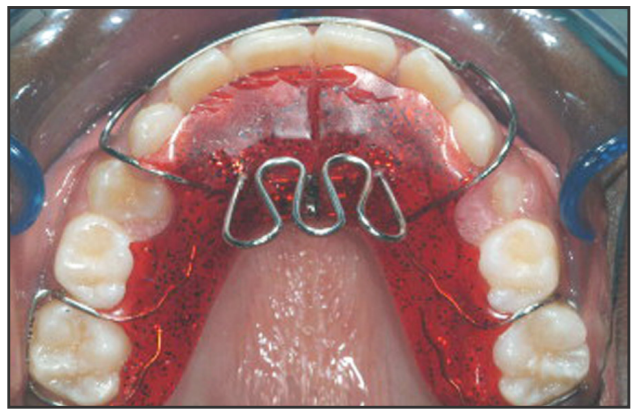

Figure 3. A removable appliance with crib for correction of thumb sucking.

CONCLUSIONS

Nutritive and non-nutritive sucking habits are common in childhood, although most habits cease by four years of age. The role of nutritive sucking on craniofacial development is not yet clearly proven. However, breastfeeding appears to have a favorable influence on craniofacial development, whereas bottle-feeding has been

associated with an increased tendency toward malocclusion.

Prolonged NNS habits—mainly the use of pacifiers and digit sucking—have been shown to result in increased overjet, anterior open bite, and posterior crossbite in the primary and permanent dentitions. To achieve spontaneous resolution of malocclusion, cessation of NNS sucking by three to four years of age is encouraged, but appears critical by approximately six years when the permanent incisors erupt. Habit cessation may be achieved through the use of rewards and positive reinforcement, response prevention therapy, or appliance therapy. Dental practitioners who care for children should provide anticipatory guidance and ensure timely detection of sucking habits. When necessary, referral to appropriate specialists for treatment should be arranged. The management of other habits, such as tongue thrust, lip sucking, oral breathing, and bruxism, is to follow in the second of this 2-part review.

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