

# Predisposing Factors to Dental Caries in Children With Cleft Lip and Palate: A Review and Strategies for Early Prevention

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**Objective:** To review predisposing factors contributing to dental caries in patients with cleft lip, cleft palate, or both (CL/P).

**Design:** Patients with CL/P have a higher susceptibility to caries compared with the population group without clefts. A review of the literature was undertaken to determine factors that could account for the compromised oral hygiene and the high caries prevalence in patients with CL/P.

**Results:** After a literature review, modern strategies for the prevention of early childhood caries were developed and should be considered for integration into the overall management protocol of patients with CL/P.

**Conclusions:** Preventive dental care is ever more so important in patients with CL/P compared with patients without clefts.

KEY WORDS: *bacteria, caries, diet, oral hygiene, prevention*

Cleft lip and palate (CLP) is the most common congenital craniofacial abnormality, affecting approximately 1 in every 700 newborns (Das et al., 1995; Bellis and Wohlgenuth, 1999; Mitchell and Wood, 2000). This prevalence rate varies with different ethnic backgrounds, and a rate of approximately 0.18% of pregnancies identified with cleft conditions has been recorded in Victoria, Australia, from 1983 to 2000 (Vallino-Napoli et al., 2004). Patients with cleft lip (CL), cleft palate (CP), or both (CL/P) generally require extensive treatment by an interdisciplinary team of medical and dental specialists to rectify their cosmetic, speech, hearing, psychosocial, and dento-orthopedic problems. Coordination within the CL/P management team is highly important, as the management of each and every health aspect will influence the result of the other. From the oral health care perspective, it is essential to maintain excellent oral health and prevent dental decay. Early loss of teeth could protract and complicate the proposed surgical or orthodontic treatment that could be undertaken at various times from birth to adulthood.

Unfortunately, the majority of studies have shown that patients with CL/P exhibit poor oral hygiene and a higher caries

prevalence (Johnsen and Dixon, 1984; Dahllof et al., 1989; Turner et al., 1998; Wong and King, 1998; Chapple and Nunn, 2001; Kirchberg et al., 2004). The question to be asked is "Do all CL/P teams have protocols in place to provide an early and a long-term preventive approach to the prevention of early childhood caries?" The objective of this paper is to review the factors that could account for the compromised oral hygiene and the high caries prevalence in patients with CL/P. It aims to alert health care professionals about the importance of oral health care so that appropriate preventive programs may be integrated into the management protocol of patients with CL/P. Modern strategies to prevent early childhood caries are presented.

## CARIES PREVALENCE

Numerous studies have investigated caries prevalence in patients with oral clefts. Studies by Lauterstein and Mendelsohn (1964) and Lucas et al. (2000) showed that there were no significant differences in the decayed, missing, and filled (DMF) index between the CL/P group and the control group in the permanent dentition. On the other hand, Johnsen and Dixon (1984), Dahllof et al. (1989), Bokhout et al. (1996a, 1996b, 1997), and Ahluwalia et al. (2004) concluded that patients with oral clefts have a higher caries prevalence compared with patients with no oral clefts. Bokhout et al. (1997) recorded as high as 3.5 times more decayed surfaces in children with oral clefts than in the noncleft control group. The significant difference in the caries prevalence between cleft and noncleft children is more evident in the primary dentition (Dahllof et al., 1989; Hewson et al., 2001). In fact, Hewson et al. (2001) showed no difference in the caries experience of CLP patients in the permanent dentition. Chapple and Nunn

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(2001) stated that the dental caries experience in children with oral clefts in both the primary and permanent dentition increases with age. A multitude of factors could contribute to the higher caries rate in the primary dentition of children with CL/P, such as insufficient parental dietary counseling, insufficient education on toothbrushing technique specific to babies and toddlers with CL/P, the trauma of coping with a baby with CL/P, and the poor accessibility of the toothbrush around the cleft area at this early age.

The inconsistencies in findings among researchers could, in addition, be largely attributed to the multifactorial nature of dental caries, the differences in the methodologies used in research, patients' dental awareness, and differences in cultural practices. This last point was clearly illustrated in the study by Paul and Brandt (1998), who showed that the mean DMF surfaces index for the deciduous or permanent dentition (dfms/DFMS) was significantly higher for children from the Indian subcontinent than for Caucasian children. Dahllof et al. (1989) showed a higher prevalence of caries in the cleft group than in the age- and sex-matched control group according to the decayed, missing, and filled teeth (DMFT) index. However, children with syndromes were included in that study.

Many studies have shown contradictory insights regarding the influence of cleft types on caries prevalence. Chapple and Nunn (2001) and Dahllof et al. (1989) did not find any significant differences in the caries experience among different cleft types, especially in the permanent dentition. The studies that suggested otherwise provided contrasting opinions, too. Paul and Brandt (1998) believed that children with CP or CL had better oral health than those with CLP, which correlated with the findings of Johnsen and Dixon (1984). In addition, Johnsen and Dixon (1984) found that those patients with bilateral CLP had a higher percentage of carious teeth than did the patients with unilateral CLP. In contrast, Bian et al. (2001), who investigated caries experience in Chinese children with CL/P, discovered that patients with CP had a higher prevalence of rampant caries than those with isolated CL.

Bokhout et al. (1996a) showed that 36 of 72 total initial and manifested lesions in children with clefts were localized to maxillary primary incisors. Other studies found that a higher caries prevalence was evident in the primary teeth adjacent to the cleft and in the primary molars (Johnsen and Dixon, 1984; Bokhout et al., 1997). Johnsen and Dixon (1984) illustrated that the carious incisors in children with CP resembled early childhood caries.

#### FACTORS INFLUENCING THE RISK OF CARIES IN PATIENTS WITH CL/P

Given that some ethnic groups with different cleft types demonstrate higher caries prevalence, what are the predisposing factors that may contribute to this? A review of the factors will provide a base from which strategies could be developed specifically for infants and children with CL/P.

#### Oral Hygiene

Substandard oral hygiene practices by patients with CL/P could very well contribute to the high prevalence of dental caries. Patients with oral clefts have been reported in several studies to have poorer oral hygiene when compared with non-cleft patients (Dahllof et al., 1989; Paul and Brandt, 1998; Turner et al., 1998; Wong and King, 1998). Interestingly, Paul and Brandt (1998) found that CP patients had cleaner teeth than did CLP patients, where the latter were found to have more anterior teeth covered with plaque. This suggests that the difficulties in achieving optimal oral health could be a consequence of the inaccessibility to toothbrushing because of the loss of elasticity of the surgically repaired lip, the anatomy of the cleft, and the fear of brushing around the cleft area (Dahllof et al., 1989). The higher incidences of supernumerary teeth and the limited dental arch space attributed to the underdeveloped maxilla may lead to malalignment of teeth in the CL/P patients. Crowding causes restricted access for the toothbrush and the natural cleansing of the teeth by the tongue and saliva (Johnsen and Dixon, 1984). Therefore, the oral hygiene in these patients is compromised.

#### Palatal Cleft and Fistula

In a recent study, Ahluwalia et al. (2004) showed that children with CP have a higher prevalence of dental caries and poorer oral hygiene than do children without oral clefts. The study suggested that the longer oral clearance time of foods and the subsequent generation of fermentable sugars from starches were responsible for such high caries prevalence. Oral cleft patients with a palatal fistula also showed a significantly higher incidence of poor oral hygiene. This could be due to the tenacious nature of the nasal fluid, which drains into the oral cavity and consequently promotes the adherence of plaque to the teeth (Turner et al., 1998). The presence of a palatal cleft and fistula creates a problem of food impaction, and food may escape through the nose and regurgitate into the mouth. This could potentially increase the risk of caries development, as substrates for cariogenic bacteria are present in the mouth for a longer period of time. More clinical studies are required to support this theory.

#### Enamel Hypoplasia

Enamel hypoplasia is frequently evident in the incisor teeth, especially the incisors adjacent to the cleft, and the first molars of patients with CL/P (Dixon, 1968; Johnsen and Dixon, 1984). Hypoplastic defects of the enamel result in roughened surfaces and a reduced mineral content (Johnsen and Dixon, 1984). The roughened surfaces assist cariogenic bacteria adherence and colonization (Li et al., 1994; Pascoe and Seow, 1994). The decrease in thickness and mineral content of the enamel compromises the tooth's resistance to demineralization. Although enamel hypoplasia could increase the tooth's susceptibility to caries, children with clefts have not shown a higher

incidence of caries in the permanent incisors (Kirchberg et al., 2004).

### Intraoral Removable Appliances

Some babies who are born with palatal clefts may be fitted with intraoral appliances shortly after birth. These acrylic-type appliances may be worn up to 18 months of age. The benefits of the appliance include assistance in feeding and speech and provision of guidance for growth and development of the palate (Bokhout et al., 1996a). However, the acrylic appliance can facilitate early colonization of *Mutans streptococci* (MS) and *Lactobacilli* (LB) (van Loveren et al., 1998). Such early colonization predisposes the patients to an early onset of caries in the primary dentition (Bokhout et al., 1996b). It has been suggested that there is an increased caries risk in cleft patients having presurgical infant orthopedics. In fact, it has been shown that children with oral clefts treated with intraoral appliances have a 7.6 times higher chance of exhibiting dental caries at the age of 2.5 years than do children with oral clefts without intraoral appliances (Bokhout et al., 1996a). The prevalence of MS increases with age because MS depend highly on the nonshedding and nondesquamating surfaces such as the acrylic appliance or teeth to colonize (Berkowitz et al., 1975; van Loveren et al., 1998).

### Orthodontic Appliances

Patients with CL/P generally encounter numerous dental and skeletal abnormalities such as hypodontia, supernumerary teeth, abnormality in tooth size and shape, discrepancy in skeletal base relationships, and malalignment of teeth. Combined with surgical bone grafting procedures, several phases of orthodontic treatment are unavoidable in almost all cases. Several studies have shown that patients undergoing fixed appliance orthodontic treatment have a higher risk of dental caries (Gorelick et al., 1982; Mizrahi, 1983; Ogaard, 1989). The surface irregularity of fixed orthodontic attachments makes oral hygiene practice more difficult and provides additional retention areas for food and plaque (Ulukapi et al., 1997). It facilitates the colonization of cariogenic MS and the late colonizer LB, hence providing a negative impact on the caries-susceptible patients with CL/P when they undertake orthodontic treatment. In addition, a change in dietary habits from hard to soft food during orthodontic intervention has been documented. The consistency of a soft diet enhances its retention and impairs the saliva-induced deglutition, allowing sufficient substrates to remain in the mouth for a longer period of time favoring the cariogenic bacteria (Corbett et al., 1981). This results in an increase in acid production and promotes the risk of carious destruction. The majority of patients undergoing fixed appliance orthodontic treatment are at an age when newly erupted teeth are present. These teeth are incompletely mineralized at the time of eruption, which makes them vulnerable to caries destruction (Crabb, 1976). This susceptible period normally continues for the first few years after tooth eruption

(Carlos and Gittelsohn, 1965). This could account for the increased caries prevalence in patients with fixed appliance orthodontic therapy. Fortunately, this risk may be counterbalanced by an increase in the salivary flow rate after the introduction of orthodontic appliances, resulting in a higher buffering capacity and pH, which may help counteract the demineralization process (Andersson et al., 1974; Forsberg et al., 1992; Ulukapi et al., 1997).

### Miscellaneous Factors

Bokhout et al. (1996a) showed that children with oral clefts with poor oral hygiene and dietary habits were more likely to come from low socioeconomic families. The authors believed that parents in a higher socioeconomic class were more likely to comply with general nutritional recommendations and consequently restrict sucrose-rich food consumption. Moreover, Johnsen (1984) found that parents of children with CL/P tended to overindulge their children to offer some satisfaction because of their children's medical conditions. This means that they may provide their children with inappropriate diets that are conducive to caries destruction. This was substantiated by Johnsen and Dixon (1984), who showed that the caries pattern in patients with oral clefts resembled early childhood caries. In the study performed by Lin and Tsai (1999), children with CL/P who were bottle fed at bedtime showed an increased risk of developing baby-bottle tooth decay than did the children with oral clefts who did not take a bottle to bed. The authors also discovered that parents and caretakers of those children who were bottle fed at bedtime lacked motivation to perform regular preventive dental home care for their children. Therefore, limited parental understanding of an appropriate dietary habit and adequate oral hygiene of these children with CL/P has the potential to contribute to the higher caries prevalence (Bian et al., 2001; Lages et al., 2004).

### DISCUSSION

Both cariogenic and noncariogenic bacteria are present as commensal microflora at sound tooth sites. Demineralization occurs when the environmental conditions favor the growth of cariogenic bacteria (i.e., low pH and high availability of fermentable carbohydrates).

Conversely, the buffering capacity of saliva and the salivary ions, proteins, and enzymes can raise the pH of the environment and promote remineralization of the tooth enamel. However, the capacity to do so varies with individuals. Therefore, some individuals are at more risk of caries than others. The high dosage and frequency of consumption of the dietary carbohydrates results in acid production by cariogenic bacteria. As a result, the pH level of the oral environment drops to around the critical pH of 5.5, which enables demineralization of tooth structure to occur.

From a review of the literature, it was evident that patients with CL/P have a higher incidence of dental caries than do patients without oral clefts. The high occurrence of dental ab-

normalities, such as enamel hypoplasia and crowding, and the restricted access to proper oral hygiene because of the tight surgically repaired lips predispose the host to plaque accumulation. In addition, the drainage of nasal fluid from the palatal fistula enhances the stickiness of the dental plaque, which assists further bacteria adherence and colonization. Parents of these children also tend to nurse their children excessively by providing them with a high cariogenic diet that can be trapped between malposed teeth and even in the palatal cleft and fistula. Consequently, sufficient fermentable substrates are exposed to the oral environment for a longer period of time, which could create an acidic environment that favors demineralization.

There are a number of contributing factors to the early establishment of cariogenic bacteria. Patients with CL/P are subjected to several episodes of fixed and removable appliance orthodontic therapies. Orthodontic treatment can begin from birth where presurgical oral appliances are made for some infants to obturate the palatal cleft in order to assist with feeding and speech. Other types of appliances are made to prevent the collapse of the maxillary arch. These appliances promote early establishment of cariogenic bacteria, mainly MS and LB, in the oral cavity. The earlier the colonization of MS, the higher the caries susceptibility and caries experience later on in the children's lives (Alaluusua and Renkonen, 1983).

Colonization of *Streptococcus mutans* (SM) can occur before the eruption of teeth and as young as 3 months of age (Wan et al., 2001). The primary source of SM is usually the mother (Kohler and Bratthall, 1978; Li and Caufield, 1995). Close contact with the mother such as sharing food and utensils and kissing the lips of the child may provide repeated exposures of SM transmission from adult to child (Wan et al., 2003a). In addition, Wan et al. (2003a) found that mothers of infants infected with SM had high SM levels, less frequent toothbrushing, greater plaque levels, and higher daily frequencies of snacking and sugar exposures compared with the mothers of infants without SM infection.

Because of the increased number of factors influencing the risk of caries in patients with CL/P, the patients' susceptibility to caries will be greater compared with individuals without clefts. It is imperative, therefore, to educate parents and health care professionals on the higher caries susceptibility of children with CL/P.

With thoughts of their babies having CL/P, parents are naturally overwhelmed and anxious during the early years of their children's growth and development. They wish to know as much as possible about CL/P. Oral health generally ranks at the lower end of the priority scale, and insufficient attention is devoted toward this area. Parents are usually not aware of their children's increased susceptibility to dental caries, and they unintentionally neglect or are unaware of the importance of good oral hygiene and dietary practices. It is important for a member of the CL/P team, preferably a dentist or dental hygienist, to have early discussions with parents on the significance of maintaining good oral health and dietary habits before the baby is born. Each CL/P team should have an oral

health policy within their management protocol. The recommendations below could be used to assist in the formulation of an oral health policy for infants and children with CL/P.

### Strategies for the Prevention of Early Childhood Caries

The caries susceptibility of infants and children with CL/P varies during different stages of development and treatment need. The following recommendations were recently introduced at the Children's Oral Health Service, Royal Children's Hospital, Brisbane, Australia, and could be considered and incorporated into an oral health policy for patients with CL/P.

1. The transmission of bacteria from parents, usually the mother, to the infant has been well documented (Kohler and Bratthall, 1978; Li and Caufield, 1995). Compared with mothers of infants without SM infection, the mothers of infants with SM infection had higher SM levels, less frequent toothbrushing, greater plaque levels, and increased frequency of daily sugar intake (Wan et al., 2003a). *Recommendation:* The oral health of the parents, particularly the mother, and the parents' dietary habits and level of dental knowledge should be assessed by a dentist and brought up to a satisfactory standard, if necessary, before the birth of the child.
2. Soon after the birth of the baby, parental contact must be established early with the dentist or dental hygienist in the CL/P team. *Recommendation:* Parental education on oral health must be reinforced by a member of the dental team soon after the birth of the baby. Good feeding habits must be developed with emphasis on minimizing the amount of sugar intake and the frequency of snacking.
3. The introduction of intraoral appliances shortly after birth could increase the rate of colonization of SM by increasing the nonshedding surface area. *Recommendation:* Chemotherapeutic agents such as chlorhexidine could be used to clean intraoral appliances when they are removed from the mouth.
4. Close contact such as kissing the baby's lips and sharing food and utensils have been associated with SM colonization (Wan et al., 2003a). *Recommendation:* Parental education on cross-contamination should form a part of the parents' oral health education preferably before and reinforced after the birth of the baby.
5. Some plastic and reconstructive surgeons repair the cleft when the child is around the age of 3 months. After lip repair, cleaning of the gums and teeth when they erupt at 6 months of age may be more difficult because of the loss of elasticity arising from the repaired lip. *Recommendation:* Postsurgical oral health education and demonstration of toothbrushing technique is essential especially around the cleft area. Teeth should be brushed at least once per day.
6. Maintenance of good oral health is essential for both the parents and the infant. *Recommendation:* Regular dental examinations every 6 months should be undertaken by both the parents and the infant or child. Fluoride supplements in

nonfluoridated areas are recommended, and fissure sealants should be placed at risk pits and fissures.

7. The risk of decalcification and caries increases when fixed appliance orthodontic treatment commences because of the increased accumulation of plaque around the attachments and difficulty in cleaning. *Recommendation:* The patient's oral hygiene, sugar intake, frequency of snacking, and consumption of acidic drinks should be reassessed before commencing orthodontic treatment and should be modified as required. A low dose 0.05% daily sodium fluoride mouth rinse is recommended (O'Reilly and Featherstone, 1987). This will strengthen the tooth structure by forming stronger hydroxyfluoroapatite and also exert minor antibacterial activities (Geddes and McNee, 1982; Hicks et al., 2003). Assessment and reinforcement of good oral hygiene and dietary habits should occur at each orthodontic adjustment appointment.
8. Enamel hypoplasia results in rough defects that display an increased surface area for bacteria to adhere and colonize. Increased levels of SM have been associated with enamel hypoplasia, which places the infant at a higher risk of dental caries (Li et al., 1994; Pascoe and Seow, 1994). *Recommendation:* The use of chemotherapeutic agents could be considered at an early age for babies born with CL/P who are at a higher risk of developing dental caries. Weekly brushing of 0.2% chlorhexidine gel has been shown to reduce SM infection (Wan et al., 2003b).

## CONCLUSIONS

Patients with CL/P generally display poorer oral hygiene and higher susceptibility to caries because of the difficulty in achieving adequate plaque control associated with dental anomalies and defects from lips or palate. In addition, patients undergoing fixed appliance orthodontic therapy have a higher risk in developing incipient enamel lesions because of the increased plaque accumulation around the appliance attachments. It is essential to integrate an oral preventive program into the CL/P treatment protocol for these patients before birth in order to establish desirable habits and a favorable oral environment during the overall management of their cleft conditions.

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