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Is there a relationship between asthma and dental erosion? A case control study

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Summary. *Objectives.* The aims of this study were firstly to assess and compare the prevalence of dental erosion and dietary intake between three groups of children; children with asthma, those with significant tooth erosion but with no history of asthma, and children with no history of asthma or other medical problems. Secondly, to discover whether there was a relationship between medical history and dietary practises of these children and the levels of dental erosion. Thirdly, to measure and compare their salivary flow rates, pH and buffering capacity.
Methods. The study consisted of 3 groups of children aged 11–18 years attending Birmingham Dental Hospital: 20 children with asthma requiring long-term medication, 20 children referred with dental erosion, and 20 children in the age and sex matched control group. Tooth wear was recorded using a modification of the tooth wear index (TWI) of Smith and Knight. Data on the medical and dietary history were obtained from a self-reported questionnaire supplemented by a structured interview. The salivary samples were collected under standard methods for measurements.
Results. Fifty percent of the children in the control group had low erosion and 50% moderate erosion. However, high levels were recorded in 35% of children in the asthma group and 65% in the erosion group. There appeared to be no overall differences in diet between the groups. There was an association between dental erosion and the consumption of soft drinks, carbonated beverages and fresh fruits in all the three groups. More variables related to erosion were found in the erosion and asthma groups. A comparison between the three groups showed no significant differences in unstimulated and stimulated salivary flow rates, or pH and buffering capacity.
Conclusion. There were significant differences in the prevalence of erosion between the three groups, children with asthma having a higher prevalence than the control group. Although there was a relationship between the levels of erosion and some medical history and acidic dietary components, these did not explain the higher levels in asthmatic children. Further investigation is required into the factors affecting the increased prevalence of erosion in children with asthma.

Introduction

The prevalence of dental erosion

There has been considerable interest in investigating the prevalence of dental erosion in children in recent years. Several studies [1–4] have indicated

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a high level of erosion with a significant number of teenagers having exposed dentine.

Recently, two studies published by McDerra, Pollard and Curzon [5] and Shaw, Al-Dlaigan and Smith [6] investigated dental erosion in children and found that children with asthma had more dental erosion than healthy controls. Asthma affects more than three million people in the U.K., a third of them children, and is thought to cause about 2000 deaths a year. In addition, it has been reported that children in Britain and Ireland are more likely to suffer from asthma than youngsters almost anywhere in the world, with approximately 10% of them affected and a rising prevalence [7].

Dietary intake and dental erosion

There is growing evidence of a considerable increase in consumption of potentially erosive foodstuffs and drinks. Borrud *et al*. [8] found a dramatic increase in the consumption of soft drinks and reduction in milk consumption among US children and adolescents and Harnack *et al*. [9] reported that over 82% of 13–18-year-olds consumed soft drinks on a regular basis. Several studies [10–12] have investigated the relationship between erosion and diet. Millward *et al*. [11] observed that the higher the frequency of consumption of carbonated drinks and fruit-based drinks the higher the severity score for erosion. Johansson *et al*. [12] reported a strong correlation between the presence of dental erosion and a high level of consumption of cola-type and other soft drinks. Recently, Al-Dlaigan *et al*. [13] also found a relationship between the prevalence of erosion and the consumption of soft drinks, carbonated beverages, alcoholic drinks, fresh fruits, Vitamin C tablets and foodstuffs in 14 year-old school children in Birmingham, U.K.

Although many studies have investigated the relationship between dietary history and erosion, there are few case control studies of risk factors. However, Jarvinen *et al*. [14], Milosevic *et al*. [15] and O'Sullivan and Curzon [16] all reported an increased risk of erosion with increased acidic drink consumption.

Saliva and erosion

Saliva is considered to be one of the main neutralizing factors in the pathogenesis of dental erosion [17]. Studies have indicated that some sites in the mouth are more prone to erosion than others [17–22]. Small molecules are cleared more rapidly from the mouth in the mandibular incisor region than in the maxillary molar region. The slowest area to clear is the upper incisor region, an area that generally shows high levels of dental erosion. Oral acidity stimulates the salivary glands to produce more saliva and hence clearance of acids will be greatest near the orifices of salivary ducts. Both salivary flow and composition could be important protective factors. Certainly, both may influence the development of erosive lesions. The oral clearance of dietary acid will be related to the rate of secretion and buffering capacity of saliva [17–22].

Recently, O'Sullivan and Curzon [23] compared salivary flow rates, buffering capacity and *Streptococcus mutans* counts in children with erosion matched with a control group and found significant differences for *Streptococi mutans* counts, unstimulated and stimulated salivary pH and buffering capacity. Ryberg *et al*. [24] also found a lowered secretion rate of whole and parotid saliva, decreased secretion of saliva proteins and higher *Streptococcus mutans* counts in asthmatic subjects treated with B_2-adrenoceptor agonists than in matched healthy controls. The effects of the Beta adrenoceptors on salivary composition and flow rate were further investigated by Kargul *et al*. [25]. They considered the effects of salbutamol (Ventolin; GlaxoSmithKline, Harlow, U.K.) and fluticasone proprionate (Flixotide, GlaxoSmithKline) inhalers on plaque and saliva pH in asthmatic children aged 6–14 years. The authors found that pH values decreased in plaque and saliva in the 30 min following inhalation of the drugs.

Further information is needed to identify whether dental erosion is a problem in children with asthma and the possible impact of salivary factors as well as the dietary consumption history in these children.

The aims of this study were firstly to assess and compare the prevalence of dental erosion and dietary intake between three groups of children; children with asthma, those with significant tooth erosion but no history of asthma, and children with no history of asthma or other medical problems. Secondly, to see whether there was a relationship between the medical history and dietary practises of these children and the levels of dental erosion. Thirdly, to measure and compare their salivary flow rates, pH and buffering capacity.

Patients and methods

Sample population and clinical examination

This study involved 60 children who were attending the Unit of Paediatric Dentistry at the University of Birmingham, Dental School and Hospital, U.K. There were 30 girls and 30 boys. The age range of the children was from 11 to 18 years. The sample of these children was divided into three groups as follows:

1) Control group; 20 children (9 boys and 11 girls with a mean age of 12·9 years) with no history of asthma or other significant medical problems. These children were randomly selected and were either attending the Unit of Paediatric Dentistry for routine dental care or had been referred into the hospital for specialist care for reasons other than tooth surface loss, including for orthodontic treatment.

2) Asthma group; 20 children (10 boys and 10 girls with mean age of 13 years) with a history of asthma requiring long-term medication. These children were randomly selected from the patients routinely attending the Unit of Paediatric Dentistry, as with the children in the control group.

3) Erosion group; 20 children (11 boys and 9 girls with a mean age of 14·7 years) referred to the Unit of Paediatric Dentistry with significant tooth surface loss, but with no history of asthma.

Ethical approval was obtained prior to commencement of the study from Birmingham Research Ethics Committee. The children and their parents/carers gave informed consent for participation in the study and an information sheet about the study was given to each patient and his/her parents.

All the children were examined clinically under standard illumination. The surfaces of all teeth present in the mouth were scored for dental erosion according to the criteria of the Tooth Wear Index of Smith and Knight [26], with minor modifications [3]. All the children were examined by the same person (Y.H.A.) who had previously undergone extensive training and calibration exercises in the use of this index. The data were recorded by a trained assistant. In cases of doubt, the lower score was assigned.

To determine the prevalence of dental erosion, all the children were classified into one of the following groups based on their individual tooth surface scores (The incisal edges of maxillary and mandibular anterior teeth and occlusal surfaces of posterior teeth were excluded before categorization due to the potentially high levels of attrition which would have invalidated measurement of tooth surfaces due predominantly to erosion):

- Any child with scores of only 0 and 1 was placed in the low erosion group.
- Any child with at least one score of 2 was placed in the moderate erosion group.
- Any child with at least one score of 3 and/or 4 was placed in the severe erosion group.

Medical history and dietary intake

The data were collected via a structured questionnaire completed after the clinical examination; the children were supervised whilst undertaking this. A small number required help in completing the written questionnaire so they were given a structured interview with standardized prompts. These questionnaires covered details of medical history, which included gastro-intestinal problems such as indigestion, vomiting, heartburn, gastro-oesophageal reflux and the type and frequency of medication. More information was collected about the children with asthma, such as the length of time the child had been suffering from asthma, if the child had been admitted to hospital for asthma and the number of admissions, if there had been any previous medication, the type of current medication and duration of use.

The dietary questionnaire was developed taking account of the main aetiological factors highlighted in the literature involved in development of erosion. The amount and frequency of consumption of some of the most common drinks such as orange squash, apple juice, orange juice, cola, other fizzy drinks, milk, tea, coffee, chocolate, cider, spirits, wine, beer, sport drinks and others were recorded. Some types of fruits and food consumption were also included in the questionnaire such as apples, oranges, bananas, grapes, salad dressing, vinegar, tomato ketchup, pickles, yoghurt, and Vitamin C tablets.

The amount of consumption of drinks, food and fruits per/week was categorized into four groups as follows:

1) No consumption at all.
2) Low consumption (1–7 times per/week).
3) Medium consumption (8–21 times per/week).
4) High consumption (22 or more times per/week).

Saliva investigation

After the clinical examination, all the tests were carried out at the same appointment. Saliva

collections were made in the morning between 9 : 30 am and 12 : 00 am. Each patient was instructed not to eat or drink anything for 1 h preceding an appointment. Before starting saliva collection, each child was given a simple explanation as to the nature and reason for the tests. They were seated in a dental chair in a quiet surgery environment and given time to accommodate to their surroundings.

Unstimulated and stimulated saliva samples were collected from the children.

Unstimulated

The child was asked to bend his/her head forward and, after an initial swallow, allow saliva to drip off the lower lip into the graduated tube (draining method). The child was also asked to spit out at the end of the collection period. The time period for saliva collection was five minutes, as recommended by Dawes [27]. The salivary pH was measured immediately after collection using a pH meter calibrated with buffers of pH 4 and 7. The buffering capacity was measured immediately in the clinic using the Dentobuff Strip Kit (Orion Diagnostica, Espoo, Finland).

Stimulated

The purpose of collecting stimulated saliva was to provide information about the secretory capacities of the salivary glands. Each child was given a 1-gram piece of unflavoured paraffin wax to chew for 30 s. The saliva produced was swallowed initially, then each child was asked to chew at a regular rate for five minutes during which time the saliva was collected in a graduated tube. Mechanical stimulation using an inert stimulus does not add anything to the saliva sample. The salivary pH and buffering capacity were measured as before.

All data were analysed using the Statistical Package for Social Sciences (SPSS release Version 8, Chicago, Illinois, U.S.A.) with analysis of variance. Significance was accepted at the $P < 0{\cdot}05$ level.

Results

The prevalence of dental erosion

The distribution and severity of tooth wear in the 60 children in the current study showed very low levels of erosion in the control group with the majority of scores indicating only loss of surface characteristics (score 1). Much higher levels of dental erosion were seen in the other two groups with 5% and 15% of surfaces in children in the asthma and erosion groups scored 3. Between 8 and 15% of tooth surfaces were excluded from scoring.

Table 1. The prevalence and severity of erosion in control, asthma and erosion groups.

	Level of erosion			
Group	Low	Moderate	Severe	Total (%)
Control				
Number	10	10	0	20
% of total	50%	50%	0	100%
Asthma				
Number	0	13	7	20
% of total	0	65%	35%	100%
Erosion				
Number	0	7	13	20
% of total	0	35%	65%	100%

These data are shown pictorially in Fig. 1. It is apparent that the erosion group of children had more tooth surface loss on the buccal/labial surfaces than those children with asthma. However, this difference was even more marked on the palatal surfaces with 19·3% of surfaces being scored 3 or 4 in the erosion group compared with 4·8% in the asthma group and 0·2% in the controls.

After classifying children into groups based on the tooth surface scores excluding incisal and occlusal surfaces, it was found that 50% of the children in the control group had low erosion (Table 1). No children in the asthma and erosion groups had low erosion. The remaining 50% of the children in the control group had moderate erosion compared with 65% and 35% in the asthma and erosion groups, respectively. Predictably, it was found that a high percentage, 65%, of children in the erosion group had severe erosion compared to 35% of the children in the asthma group; no severe erosion was found in children in the control group. There were no significant differences between boys and girls in any of the three groups of children for the prevalence of dental erosion.

Medical history and dietary intake

As far as the medical history was concerned, 10% in the control, 30% in the erosion and all the children in the asthmatic group stated that they had a medical condition. These comparisons are shown

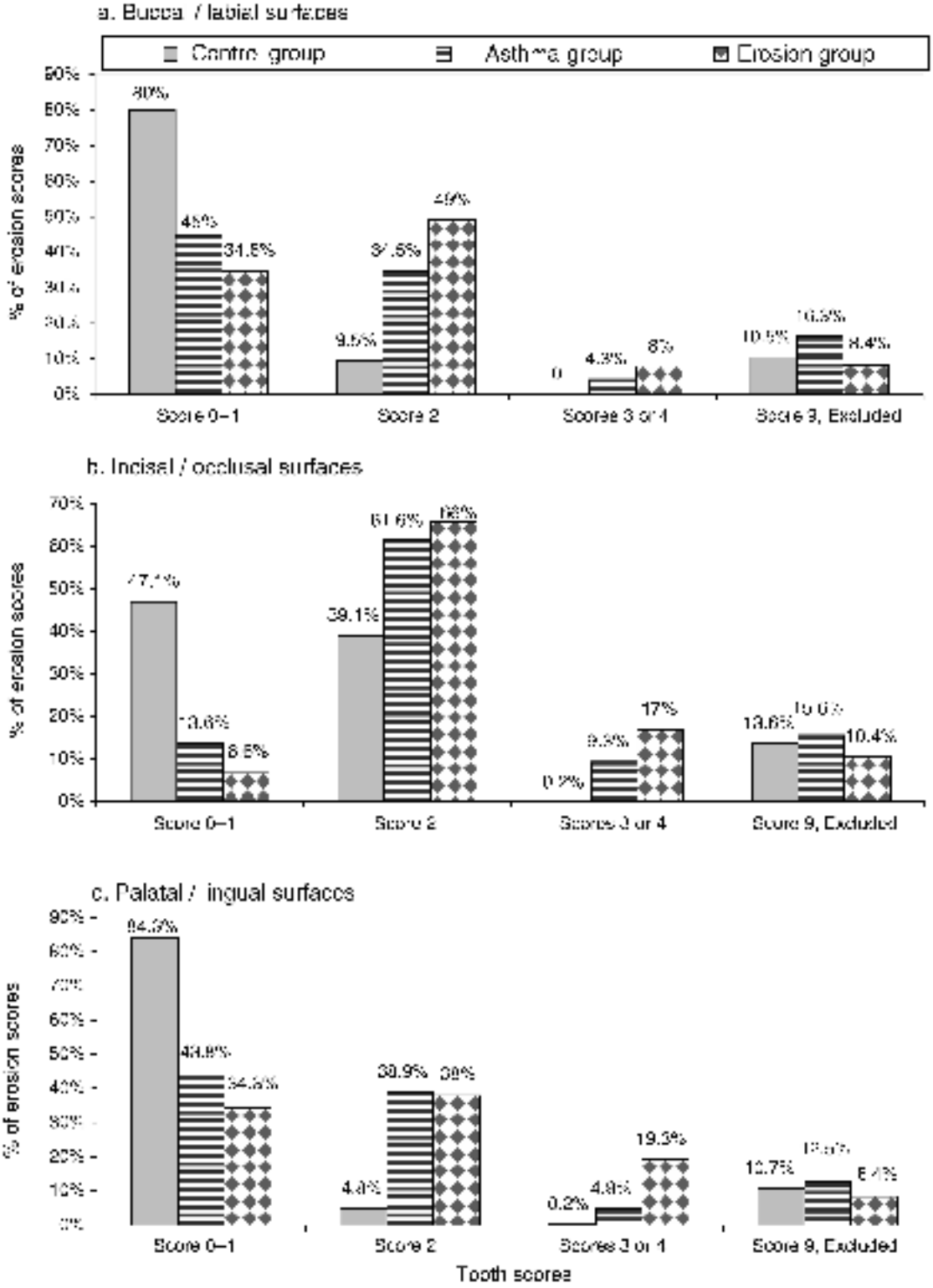

Fig 1. Percentage erosion scores for control, asthma and erosion groups.

Table 2. The percentage of all children with a medical history in control, asthma and erosion groups.

Type of medical condition	Percentage of children with medical condition		
	Control group	Asthma group	Erosion group
Indigestion	5%	10%	5%
Vomiting	–	10%	5%
Heartburn	–	5%	5%
Stomach problems	–	5%	15%
Hay fever	5%	–	20%
Eczema	–	–	5%
Epilepsy	–	5%	–
Allergies	–	5%	15%
Migraines	–	–	5%
Hearing problem	–	10%	–
Other medical conditions	–	10%	10%
Currently taking tablets	–	15%	15%
Currently taking inhalers	–	100%	15%
Currently taking medicine (liquid)	5%	5%	5%

Table 3. Medical history and medication of asthma group children.

The detailed asthma history and medication used by the children	Number of children (%)
Length of time with asthma	
1–5 years	5 (25)
6–10 years	8 (40)
≥ 11 years	7 (35)
Hospital admissions for asthma	
Once	4 (20)
Twice	2 (10)
More than twice, or frequent	3 (15)
Type of medication	
Salbutamol (Ventolin)	14 (70)
Beclomethasone (Becotide)	7 (35)
Terbutaline (Bricanyl)	5 (25)
Fluticasone (Flixotide)	2 (10)
Salmeterol (Servent)	2 (10)
Length of time under medication	
1–5 years	8 (40)
6–10 years	7 (35)
≥ 11 years	5 (25)

in Table 2. In the control group, only one child had indigestion, one had a history of hay fever and one was currently taking medication. However, in the asthma and erosion groups there were more children with a history of indigestion, vomiting, heartburn and stomach problems, in addition to other medical conditions.

It was found that 40% of the children in the asthma group had been suffering from asthma for more than 6–10 years and 35% of them for more than 11 years. Almost half of the children had a history of hospital admissions for asthma treatment (20% once, 10% twice, 15% more than twice). All the children in the asthma group were using medication; 70% were currently using Ventolin, 35% Becotide, 25% Bricanyl, 10% Flixotide and 10% Serevent (Table 3).

In the asthma and erosion groups, more variables were linked to erosion than in the control group; these included having a history of heartburn, vomiting, indigestion and stomach problems.

The dietary investigation showed a high intake of soft drinks in all three groups of children. The majority consumed cola drinks (80–85%) and other fizzy drinks (60–75%). Orange juice and sport drinks showed a higher consumption by children in the asthma group and they also had the highest intake of milk. Spirits, wine, beer and cider were consumed only by a small minority of the children (5–25%) in the three groups. The highest rates of drink consumption per week (22 or more) were seen in soft drinks such as carbonated beverages, orange squash, orange juice, and cola. Children in the control group tended to consume more nonacidic drinks such as tea, milk and chocolate than in the asthma group. There were no statistically significant differences between the groups.

To compare the control, asthma and erosion groups, an analysis of variance was used based on the actual number of intakes of drinks and foods per week. This is shown in Table 4. Again, although there were no statistically significant differences between the groups, some trends were noted. For example, children in the erosion group had a higher mean intake of 15·8 and 12·4 drinks of orange squash and orange juice, respectively, compared with either the control (8·6 and 7·4) or the asthma (11·6 and 5·7) groups. However, some other drinks

Table 4. Mean number of dietary intakes per week in control, asthma and erosion children groups.

	Control		Asthma		Erosion			
Drinks and foods	Mean	SD	Mean	SD	Mean	SD	F ratio	Significance (P)
Orange squash	8·6	7·5	11·6	11·2	15·8	10·1	1·72	0·19
Apple juice	4·6	2·6	5	2·8	3·2	2·6	0·99	0·38
Orange juice	7·4	4·6	5·7	6·1	12·4	10·7	2·21	0·12
Cola	11·4	9·7	9·8	10·2	7·7	7·0	0·70	0·49
Sport drinks	2	1·4	3·1	2·5	6	1·7	2·28	0·15
Apples	5·4	4·3	3·1	2·6	4·8	4·7	1·13	0·33
Oranges	6·3	5·8	4·7	3·8	3·3	4·4	0·91	0·41
Bananas	5·4	5·4	2·3	1·7	4·2	6·1	1·20	0·31
Grapes	5	5·7	2·3	1·8	2·9	2·1	1·67	0·20
Salad dressing	4·8	2·2	3·8	3·2	6	4·2	0·64	0·53
Vinegar	6·3	5·4	3·5	2·6	3·1	2·3	2·80	0·07
Tomato ketchup	6·6	5·5	5·6	3·4	3·4	2·3	2·54	0·09
Yoghurt	5·5	4·2	4·4	3·7	2·8	1·8	1·88	0·16
Vitamin C tablet	7	0	7·4	4·3	3·5	2·5	2·61	0·11

Table 5. Unstimulated and stimulated salivary flow rates, pH values and buffering capacity in control, asthma and erosion group.

Saliva test	Control	Asthma	Erosion
Flow rate, ml/min			
Unstimulated			
Number	20	19	19
Mean	0·44	0·49	0·49
SE	0·052	0·082	0·053
Range	0·10–0·8	0–1·6	0–1·0
Stimulated			
Number	20	20	20
Mean	1·37	1·48	1·49
SE	0·16	0·16	0·16
Range	0·3–2·1	0·3–3·7	0·06–1·8
pH values			
Unstimulated			
Number	20	19	19
Mean	7·3	7·3	7·1
SE	0·062	0·073	0·081
Range	6·8–7·8	6·5–7·7	6·0–7·6
Stimulated			
Number	20	20	20
Mean	7·7	7·6	7·6
SE	0·058	0·064	0·04
Range	7·3–8·3	6·6–8	7·3–7·9
Buffering capacity			
Unstimulated			
Number	20	19	19
Mean	5·4	5·1	4·9
SE	0·14	0·29	0·28
Range	4·5–6·5	4·5–6·5	4·5–6·5
Stimulated			
Number	20	20	20
Mean	6·05	6·15	6·10
SE	0·11	0·13	0·13
Range	5·5–6·5	4·5–6·5	4·5–6·5

such as cola, and fruits such as oranges had a higher mean intake in the control group than in the asthma and erosion groups. These results show the impact of dietary intake in all groups with respect to other possible factors that may also influence the prevalence of erosion, such as medical history and medication.

Saliva investigation

The results are shown in Table 5. Only two children, one from the asthma group and one from the erosion group, were unable to provide an unstimulated saliva sample and all provided a stimulated sample.

Although there was little difference in the mean unstimulated salivary flow between the groups (0·44, 0·49 and 0·49 mL/min), there was quite a range of values with 0·1–0·8 mL/min in the control group, 0·0–1·6 mL/min in the asthma group and 0·0–1·0 in the erosion group. There was also little difference between the groups in the mean stimulated salivary flow rates, but again quite marked individual variation. The analysis of variance showed that there were no statistically significant differences between the groups in the mean of unstimulated salivary flow rate ($P = 0·78$) and in the stimulated salivary flow rate ($P = 0·86$).

The salivary pH values were greater when the salivary flow was stimulated; the mean unstimulated pH was 7·3, 7·3 and 7·1 in the control, asthma and erosion groups, respectively. This rose to 7·7, 7·6 and 7·6 following stimulation, but again there were no statistically significant differences between groups in unstimulated values ($P = 0·25$) and in stimulated values ($P = 0·72$).

The buffering capacity was also very similar between the groups. This, too, rose following the salivary stimulation and most children were found to have a medium to high buffering capacity. There

were no statistically significant differences between the groups in unstimulated buffering capacity values ($P = 0{\cdot}27$) and in the stimulated sample ($P = 0{\cdot}85$).

Thus, a comparison between the three groups showed no significant differences in unstimulated and stimulated salivary flow rates, or pH and buffering capacity, but there were some marked differences between individual participants.

Discussion

Prevalence of dental erosion

Investigation of erosion in this case control current study was undertaken for several reasons. Firstly, to discover whether dental erosion in asthmatic children is common, particularly in this age group, when most of the permanent teeth have erupted and have been exposed to the possible intrinsic and extrinsic aetiological factors that may cause erosion. Secondly, this study aimed to compare this group of asthmatic children with a healthy control group and with children known to have considerable erosion to investigate possible aetiological factors.

There were obvious differences between the three groups as far as the levels of erosion were concerned: very few tooth surfaces in children in the control group had moderate erosion, whereas 45% of surfaces in children with asthma and 52% of surfaces in the erosion group showed moderate erosion. Virtually no surfaces were scored as having more than one third of dentine exposed in the control group, compared with 5% of the asthma group and an alarming 15% of the erosion group (Fig. 1).

However, the sample size in the current investigation was relatively small. Milosevic *et al*. [15] suggested a sample size of 100 when using only a study group and a control group, whereas the use of 3 groups in the present study should facilitate comparison.

It was difficult to find children who had been referred to the hospital specifically with tooth surface loss and no other oral problems, and no history of asthma. The age-matched children in the control and asthma groups were certainly a random sample of patients who were attending the hospital. These children attended for routine dental care with undergraduate students as well as for specialist care such as orthodontic treatment. They could certainly be regarded as representative of children attending a general dental practice. There is, thus, no reason to suppose that the profile would be different in comparison with the general population.

Indeed, interestingly, the prevalence of erosion in the control group, which was selected from the patients attending the Unit of Paediatric Dentistry for routine dental care, was similar to the cluster random sample of 14-year-olds reported from school children in Birmingham UK, by Al-Dlaigan *et al*. [28]. This emphasizes the much higher prevalence of erosion in the asthmatic children. When the type of tooth surface affected was considered, the asthma group scores were higher than the control group in all cases, but lower than those children who were in the erosion group.

Direct comparison with the study published by McDerra *et al*. [5] is difficult due to the differences in diagnostic criteria, but the results are in general agreement in that they observed more erosion in the asthma group than in their control group. Also, this study has shown similar results to that reported by Shaw *et al*. [6] and helps to confirm that children with asthma are at an increased risk of developing dental erosion.

Medical history and dietary intake

Conditions such as vomiting, heartburn and stomach problems were more commonly reported in the asthma and erosion groups and were associated with dental erosion. The prevalence of gastroesophageal reflux disease in patients with asthma has been reported to range from 47 to 64% in children and from 33 to 90% in adults depending on the diagnostic parameters used to define gastroesophageal reflux [29]. Harding [30] reported that gastro-oesophageal reflux symptoms are more prevalent in asthma patients compared with control populations, with a prevalence of approximately 75%. Abnormal oesophageal acid contact times are also more prevalent in asthmatics compared with control populations, with a prevalence of 80%. These studies suggest a definite association between gastroesophageal reflux and asthma.

The findings of the current study support the relationship between gastrointestinal disease and dental erosion, which has been noted by several researchers [31–35]. This may also provide at least a partial explanation of the relationship between asthma and dental erosion.

Most children in the asthma group had been diagnosed for more than 6 years and almost half of

them had been admitted to hospital for treatment for their condition, which was an indication of its severity. Over 70% of them were currently taking Ventolin medication and 60% of the total group had been on medication for over 6 years. The medication and its possible side-effects may also be of considerable significance in the aetiology of dental erosion.

The dietary history, which was taken before any dietary counselling was given, enabled a comparison between the three groups; there were many similarities but some pertinent and significant differences. There was a high intake of soft drinks in all three groups, but in general the erosion group seemed to have a higher proportion of acidic dietary components. Conversely, more children in the control group drank milk, tea and chocolate; which is in agreement with the study by O'Sullivan and Curzon [16]. More children in the asthma group consumed sport drinks. Although the consumption of alcoholic drinks was not quite as high as in the random sample of teenagers (Al-Dlaigan *et al*. [13]), the children in the erosion group consumed significantly more beer, wine and spirits than the others. Consumption of alcohol by these young teenagers appeared to be high, considering current legislation, but is very much in agreement with recent trends shown in both the U.K. and the U.S.A.

The dietary investigation in this group of children with asthma did not suggest that there were significant differences between them and the control group. This does not readily explain the observed higher levels of dental erosion, but without doubt the children with erosion tended to have a diet with more acidic components. When other foods and fruits were considered, it was found that there was variation between the groups. For example, apples and oranges were more frequently consumed by children in the control group than by the erosion group, while bananas and grapes were eaten more by the erosion group and the children with asthma consumed the least fruit. These results are in general agreement with the other case control studies of Jarvinen *et al*. [14], Milosevic *et al*. [15] and O'Sullivan and Curzon [16].

Saliva investigation

This study was the first to investigate the salivary factors of asthmatic children and compare them with erosion and control groups. Collection of saliva for analysis can be a problem, particularly in children; several methods have been used including cannulation of ducts, suction, and spitting. In the current study, the drain and spit methods were used and found to be more acceptable to this age group. Navazesh and Christensen [36] and Navazesh [37] compared the drain and spit saliva collection methods with others and found them to be equivalent in terms of assessment of flow rate.

Only two children out of 60 were unable to produce unstimulated samples. The majority of children had low unstimulated salivary flow rates. However, only 15% to 35% of the children remained at a low flow rate following stimulation. These results were somewhat higher than in the study reported by O'Sullivan and Curzon [23].

The salivary buffering capacity appears to be an important factor in acid neutralization. The results of this study showed that more than 75% of all the children in the three groups had a medium to high buffering capacity in unstimulated samples, and this rose to 95% following stimulation. Thus, there were no statistically significant differences between the mean values for stimulated ($P = 0{\cdot}86$) and unstimulated ($P = 0{\cdot}78$) salivary flow rate, stimulated salivary pH ($P = 0{\cdot}72$) and unstimulated salivary pH ($P = 0{\cdot}25$) and stimulated buffering capacity ($P = 0{\cdot}85$) and unstimulated buffering capacity ($P = 0{\cdot}27$). However, quite marked individual variation was noted as evidenced by the relatively high standard errors, and the sample size was relatively low. It may therefore be possible that salivary factors are clinically relevant in some patients with erosion, although this was not demonstrable in this investigation.

Conclusion

- There were significantly higher levels of erosion in the children with asthma compared with the age and sex matched control groups.
- Factors related to possible gastro-oesophageal reflux in both the children with asthma and those referred with erosion were associated with increasing erosion.
- The higher prevalence of erosion in asthmatic children could not be explained by differences in their diet.
- The most consistent highest risk dietary factors related to erosion were the consumption of soft drinks, carbonated beverages and sport drinks.

- No relationship between salivary flow rate, salivary pH and buffering capacity and dental erosion was shown in these groups of children, although individual variation was considerable.

Résumé. *Objectifs*. Les objectifs de cette étude étaient dans un premier temps d'évaluer la prévalence de l'érosion dentaire et la prise alimentaire au sein de trois groupes d'enfants; enfants asthmatiques, enfants avec érosion dentaire significative mais sans antécédent d'asthme, et enfants sans antécédents d'asthme ni autre problème médical. Dans un deuxième temps, de voir si il existait des relations entre les antécédents médicaux et les habitudes alimentaires de ces enfants et les niveaux d'érosion dentaire. Troisièmement, de mesurer et comparer les taux de flux salivaire, le pH et le pouvoir tampon.
Méthodes. Trois groupes d'enfants âgés de 11 à 18 ans fréquentant l'Hôpital Dentaire de Birmingham ont été inclus dans cette étude : 20 enfants asthmatiques avec traitement à long terme, 20 enfants adressés pour érosion dentaire et 20 enfants appariés en sexe et en âge constituant le groupe témoin. L'atteinte des dents a été enregistrée selon un indice (TWI) modifié de Smith et Knight (26). Les données sur les antécédents médicaux et alimentaires ont été obtenues par questionnaire auto-reporté et par un entretien structuré. Les échantillons salivaires ont été recueillis suivant des méthodes standards de mesure.
Résultats. 50% des enfants du groupe témoin présentaient une faible érosion, et 50% une érosion modérée. Cependant des niveaux élevés ont été relevés chez 35% des enfants asthmatiques et 65% du groupe érosion. Aucune différence dans l'alimentation n'était notable entre les deux groupes. Il y avait une association entre les érosions dentaires et la consommation de boissons sucrées, avec hydrates de carbone et fruits frais dans les trois groupes. Plus de variables liées à l'érosion ont été trouvées au sein des groupes érosion et asthme. Une comparaison entre les trois groupes n'a montré aucune différence dans les taux de flux de salive stimulée et non stimulée, ou de pH et de pouvoir tampon.
Conclusion. Il y avait des différences significatives dans la prévalence de l'érosion entre les trois groupes, les enfants asthmatiques montrant une plus grande prévalence que les enfants témoins. Bien qu'il y ait une relation entre les niveaux d'érosion et certains antécédents médicaux et des composants alimentaires acides, cela n'expliquait pas les niveaux plus élevés chez les enfants asthmatiques. Des investigations ultérieures sont nécessaires au sujet des facteurs en rapport avec la prévalence accrue d'érosion chez les enfants avec asthme.

Zusammenfassung. *Ziele*. Ziel dieser Studie war es, die Prävalenz von Zahnerosionen bei drei Gruppen von Kindern zu erfassen und zu vergleichen: Kinder mit Asthma, Kinder mit vordiagnostizierten Erosionen, aber ohne Asthma, und schließlich Kinder ohne Asthma oder andere Grunderkrankungen. Zusammenhänge zwischen Grunderkrankungen, Ernährungsgewohnheiten auf der einen Seite und dem Ausmaß an Zahnerosionen andererseits sollten ermittelt werden. Schließlich sollten die Speichelfließraten, pH und Pufferkapazitäten ermittelt werden.
Methoden. Einbezogen wurden 3 Guppen von Kindern der Altersgruppe 11–18 Jahre, die im Birmingham Dental Hospital behandelt wurden: 20 Kinder mit Asthma unter medikamentöser Langzeitbehandlung, 20 Kinder die mit der Diagnose Zahnerosion überwiesen worden waren, und schließlich eine Alter- und Geschlechts-gematchte Kontrollgruppe von 20 Kindern. Zahnabrasion wurde registriert mit dem modifizierten TWI nach Smith und Knight. Daten zu Grunderkrankungen und Medikationen wurden von einem Fragebogen bezogen, der durch ein strukturierte Interview ergänzt wurde. Speichelproben wurden mittels Standardmethoden untersucht.
Ergebnisse. 50% der Kinder der Kontrollgruppe zeigten geringe Erosionen, 50% mäßige. In der Asthmagruppe wurden dagegen bei 35% der Kinder hohe Erosionswerte festgestellt, in der Erosionsgruppe bei 65%. Hinsichtlich der Ernährung gab es anscheinend keine Unterschiede zwischen den Gruppen. Es gab eine Assoziation zwischen Zahnerosionen und dem Genuß von Softdrinks, Brausegetränken und Frischobst in allen drei Gruppen. In der Asthmagruppe wurden weitere Variablen identifiziert. Ein Vergleich der Speicheluntersuchungen der drei Gruppen ergab keine Unterschiede bezüglich Fließrate, pH oder Pufferkapazität.
Schlussfolgerung. Es ergaben sich deutliche Unterschiede der Prävalenzen von Erosionen zwischen den Gruppen. Kinder mit Asthma zeigten höhere Prävalenzen als Kinder der Kontrollgruppe. Obwohl es eine Korrelation gab zwischen einigen medizinischen Befunden und säurehaltigen Nahrungsbestandteilen, erklärten diese nicht die

höhere Prävalenz bei Kindern mit Asthma. Weitere Untersuchungen zu diesem Thema sind erforderlich.

Resumen. *Objetivos*. Los objetivos de este estudio fueron primero valorar y comparar la prevalencia de la erosión dentaria y la dieta ingerida entre tres grupos de niños; los niños con asma, aquellos con erosión dentaria significativa pero sin historia de asma y niños sin historia de asma ni otro problemas médicos.

Segundo, ver si había alguna relación entre la historia médica y la dieta de estos niños y los niveles de erosión dentaria. Tercero, medir y comparar sus niveles de flujo salivar, así como el pH y su capacidad tampón.

Métodos. El estudio consistió en tres grupos de niños entre 11 y 18 años de edad atendidos en la clínica odontológica de Birminham: 20 niños con asma que requieren medicación a largo plazo, 20 niños referidos con erosión dentaria y 20 niños equiparables en edad y sexo como grupo control. El desgaste dentario se registró usando una modificación de índice (TWI) de Smith y Knight. Se obtuvieron los datos de la historia médica y nutricional a partir de un cuestionario de autorrespuesta ampliado con una entrevista estructurada. Las muestras salivares se recogieron con métodos de medición estándar.

Resultados. El 50% de los niños del grupo control tenían erosión baja y el 50% erosión moderada. Sin embargo, se registraron niveles altos en el 35% de los niños del grupo de asma y en el 65% del grupo erosión. No aparecieron diferencias en la dieta entre los grupos. Había una asociación entre la erosión dentaria y el consumo de refrescos, bebidas carbónicas y frutas frescas en los tres grupos. Más variables relacionadas a la erosión se encontraron en los grupos de erosión y de asma. Una comparación entre los tres grupos no mostró diferencias significativas en los niveles de flujo salivar estimulado y no estimulado, en el pH y en la capacidad tampón.

Conclusión. Hubo diferencias significativas en la prevalencia de la erosión entre los tres grupos, los niños con asma tenían una prevalencia más alta que el grupo control. Aunque había una relación entre los niveles de erosión y algunas historias médicas y componentes acídicos de la dieta, estos no explicaron los niveles más altos en niños asmáticos. Se requiere más investigación en relación con los factores que afectan al incremento de la prevalencia de la erosión en niños con asma.

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