

Gastroesophageal reflux in children and its relationship to erosion of primary and permanent teeth

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Gastroesophageal reflux (GOR) is often a self-limiting condition but nevertheless is a common cause of morbidity in childhood. Studies of adult patients with hiatus hernias and GOR have suggested that there is an increased incidence of dental erosion in these individuals. The aim of this study was to investigate the relationship between dental erosion and GOR in children. Fifty-three children aged 2 to 16 yr (mean 4.9 yr) with moderate to severe GOR, defined by pH monitoring, were examined for dental erosion. A questionnaire investigating dietary habits, other relevant medical conditions, and erosion risk factors was also completed. Results showed that the prevalence of dental erosion was low, when compared with the UK National Survey, with only 9 (17%) children showing any signs of erosion, and of these only one had erosion involving dentine. These results suggest that dental erosion may not be as great a problem in children with GOR as it is in adults. It may be that refluxing is limited to the oesophagus, and further work is needed to investigate those children that positively reflux into the mouth.

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Gastroesophageal reflux (GOR), the involuntary passage of gastric contents into the oesophagus, is a common feature of gastro-intestinal disease (1). GOR usually occurs where inappropriate relaxation of the lower oesophageal sphincter results in reflux of stomach contents back into the oesophagus (2, 3). Long term pathological GOR may be complicated by failure to thrive, feeding problems, oesophagitis, anaemia, apnoea, aspiration pneumonia and oesophageal stricture. It is particularly frequent in children with cerebral palsy, and there is a two- to three-fold increase in GOR in patients with asthma, bronchitis and other respiratory disorders (4, 5).

Acid reflux has been shown to reach different levels of the oesophagus with a four- to five-fold lesser acid exposure in the proximal oesophagus compared with the distal oesophagus (6). If the gastric acid occurs proximally enough to cause tooth surface loss, then reports of airway disorders,

such as asthma, could also be expected (4). Gastric acidity ranges from pH 1 to 3, and regurgitation or vomiting of gastric acid into the mouth has been connected with tooth erosion in a number of studies (7–12). In cases of chronic vomiting (7–9), vomiting in bulimia and anorexia (10, 11) and voluntary reflux (12), there is no doubt that gastric acid reaches the oral cavity and probably contributes to tooth surface loss. A large study of 109 adults with gastroesophageal symptoms was performed by JÄRVINEN *et al.* (13) to assess the relationship between GOR and dental erosion. Only 7 of these patients were found to have erosion. BARTLETT *et al.* (14) found an association between palatal erosion and GOR, but comparison with a control group did not reach significant levels.

The literature investigating the role of dental erosion and GOR in children is sparse comprising only a few case reports and small case studies (15–17). TAYLOR *et al.* (15) reported severe GOR

in a child with tooth surface loss. AINE *et al.* (16) examined 17 children attending an out-patient clinic for GOR. They found that 15 out of the 17 children had erosive lesions with 7 of them showing dentine exposure, with more severe erosion seen in those with respiratory symptoms. In contrast, 14 adults and children with dental erosion were investigated by GUDMUNDSSON *et al.* (17) using 24-h pH studies of the oesophagus and the oral cavity. They found no changes in intra-oral pH during a total of 339 oesophageal acid reflux episodes. Extended periods of low intra-oral pH to the level of pH 4–5 were observed, but they were not coincidental with any GOR episodes. The authors concluded that factors such as low salivary buffering capacity were more significant in the development of erosion than GOR.

The aim of the present study was therefore to assess the prevalence of dental erosion in a group of children with proven acid reflux determined by pH monitoring.

Materials and methods

Ethical approval for the study was obtained from both study group hospital ethics committees. Only those consenting to examination were included in the study. The study group consisted of a convenience sample of children attending the General Infirmary at Leeds, and Great Ormond Street Hospital for Children, London, with symptoms of GOR. Only those children whose reflux index was more than 10% (i.e., moderate to severe) were included. Mild reflux was excluded due to its high incidence in the general population. The children at the General Infirmary at Leeds were examined when they were admitted for investigation of GOR, and only those who subsequently were found to have moderate to severe reflux were included in the results. At Great Ormond Street Hospital the children were seen in the Gastroenterology Out-patient Department and only those with moderate to severe reflux were examined. This group of children had already had their pH studies carried out and were taking anti-reflux medications. Ambulatory oesophageal pH studies were performed using standard equipment and probe positioning (18). Anti-reflux medication was discontinued before the procedure. Children with cerebral palsy were excluded from this study because of the difficulty of diagnosis of erosion in mouths where there is a high prevalence of bruxism.

Erosion was measured using the index in Table 1, which measures site, severity and area affected on individual teeth. This index was used as part of a larger study examining risk factors of children with erosion. Calibration exercises were carried out at

Table 1
Index for the measurement of erosion

Site of erosion on each tooth	
Code A	Labial/Buccal
Code B	Lingual/Palatal
Code C	Occlusal/Incisal
Code D	Labial and Incisal/Occlusal
Code E	Lingual/Palatal and Incisal/Occlusal
Code F	Multi surface
Grade of severity	
Code 0	Normal enamel
Code 1	Matt appearance of enamel with no loss of contour
Code 2	Loss of surface contour of enamel
Code 3	Loss of enamel with exposure of dentine
Code 4	Loss of dentine (beyond Amelodentinal Junction)
Code 5	Loss of dentine with pulp exposure
Code 9	Not able to assess (e.g., tooth crowned)
Area of surface affected	
Code –	Less than half area affected
Code +	More than half surface affected

the start of the study to ensure that the examiner was reliable and reproducible using the index. All teeth were examined.

Examinations took place using an adjustable desk lamp style examination light, and a number 4 plane dental mirror. A complete dental charting was also carried out so that teeth covered with crowns, restorations or fissure sealant could be accounted for. Any teeth with large restorations or crowns were excluded from analysis. The children and parents were also questioned regarding acidic aspects of their diet, the consumption and frequency of carbonated and fruit-based drinks, drinking habits such as holding and swishing, and frequency of consumption of fruit- and vinegar-based foods.

A history of bruxism and any relevant medical history was also noted. This included disorders such as asthma, frequent vomiting, and eating/feeding problems. The subjects were questioned, with reference to their medical notes, regarding symptoms of GOR, such as heartburn, and regurgitation of gastric juice. The medications and treatments for GOR were noted together with the date of diagnosis and the length of time each medication had been taken. Oral hygiene history was recorded, including frequency of tooth brushing and the use of fluoride products and any mouth rinses. Oral hygiene and dietary advice was given as appropriate, and children requiring dental treatment had appointments arranged with either their own dental practitioner or the Hospital Dental Service.

In total, 53 of the examined children fulfilled the study entry criteria, 28 from Leeds and 25 from London. There were 32 males and 21 females ranging in age from 2 to 16 yr, with a mean age of 4.85 yr. The age distribution at each site was similar. Almost all children were caries free, with a small number having fissure sealant on first permanent molars. None of the restorations impeded examination for erosion. The majority of the children had no anatomical reason for their reflux, and in three cases from the London group, the GOR was associated with a syndrome. The subjects from Leeds were all newly diagnosed as having GOR and therefore had only been taking anti-reflux medications for a very short period prior to diagnosis, if at all. The group from London had been diagnosed as having GOR for a longer period, with the dates since diagnosis ranging from 3 months to 5 yr.

The children taking part in the study were from a wide geographic catchment area, particularly those referred to Great Ormond Street Hospital. An age- and location-based control group would therefore not be appropriate, nor representative. As this was a convenience sample, it was not possible to arrange for siblings to attend the examination as controls. It was therefore decided that comparisons should be made with the results of the 1993 UK Child Dental Health Survey, which looked at the prevalence of erosion in the child population for the first time (19). The index used to measure erosion in the 1993 study was more basic, dividing erosion into that affecting either enamel only, enamel and dentine, or affecting the pulp, and the only teeth examined were the upper incisors. Nevertheless, it was felt that a comparison could be made with the results found in that study.

Results

Calibration of the examiner showed kappa scores of 0.76–0.88 for reliability and reproducibility of the erosion index. Evidence of erosion was seen in 9 out of 53 (17%) children, 3 from London and 6 in Leeds, with only one child having erosion that involved dentine. This was a 7 yr old boy, and the only teeth so affected were the upper anterior primary teeth. In the other 8 children, the erosion was mild with loss of surface characterisation of some teeth but no dentine involvement.

Table 2 shows the age and sex distribution, teeth affected and severity of erosion in the nine children. The sex distribution was almost equal. The three children from the London group were older than the Leeds group and generally had greater numbers of teeth affected and to a more severe degree. The results of the pH studies showed that both sites

had children with GOR of similar severity. The group of children from London had been diagnosed from between 6 months and 3 yr, and those from Leeds were either new diagnoses or had been diagnosed from between 6 months and 2 yr. They had often been on multiple and changing medications, so it was not possible to correlate this with the results.

In all children with erosion, only the primary dentition was affected, and generally it was the palatal surfaces of the upper primary incisors that had erosive involvement. The older children in the permanent dentition did not appear to have a problem of erosion even in the first permanent molars which would have appeared in the mouth between the ages of 5 and 7 yr.

All children used fluoride toothpaste and had their teeth brushed at least once per day. None of the children resided in a fluoridated area, or used any other fluoride products. No children were using mouth rinses or any other type of oral hygiene product. None of the parents reported any periods of bruxism that might contribute to tooth surface loss. The results of the dietary questionnaire showed that none of the children consumed large quantities of acidic foods and beverages, indeed many of the parents commented that these types of foods and drinks were avoided by the children as they tended to aggravate symptoms of GOR, particularly carbonated drinks. None of the children had any swishing or drink holding habits that might contribute to a prolonged retention of acidic beverages in the mouth.

Discussion

Various methods are used to investigate GOR, including endoscopy with biopsy and contrast radiography. However, 24-h oesophageal pH monitoring is considered the gold standard investigation (20). Computerised data collection allows the results to be analysed and interpreted so that timing of reflux with sleeping, eating and other activities can be monitored. The most useful measurement is the reflux index which indicates the percentage time that the pH is less than 4 in the distal oesophagus. The reflux index enables GOR to be classified into three groups mild (5–10%), moderate (10–20%) and severe (more than 30%) (20, 21). The scoring system emphasises the importance of oesophageal acid clearance on the duration of reflux, rather than the number of reflux episodes. Normal ranges for distal oesophageal pH have been described by BOIX-OCHOA *et al.* (22).

The results of this study show that erosion occurred in only 17% of children with a reflux index of more than 10% (moderate to severe reflux).

Table 2

Table to show age, sex, tooth affected and severity of the children with erosion

Subject	Site	Age	Sex	Teeth affected	Severity codes	Time since Diagnosis
1	London	7	M	54,52,51,61,62,64 75,74,73,83,84,85	2,4,4,4,2 2,2,2,2,2	1 yr
2	London	4	F	52,51,61,62	2,2,2,2	1 yr
3	London	2	M	52,51,61,62	1,3,3,1	6 months
4	Leeds	6	M	54,51,61,64	2,2,1,2	3 months
5	Leeds	2	F	51,61	2,2	0
6	Leeds	2	F	52,51,61,62	2,2,2,2	0
7	Leeds	2	M	51,61	1,1	6 months
8	Leeds	2	F	54,52,51,61,62,64	2,1,2,2,1,2	6 months
9	Leeds	3	M	75,85	2,2	0

The prevalence of dental erosion in this group is in fact lower than that found in the UK National Surveys (19, 23) which examined the upper incisor teeth of children aged 1.5–4.5 yr, 5–6 yr and 11–14 yr. These surveys found the prevalence of palatal erosion in the toddlers to be 19%, with 8% having dentine or pulp involvement. In the 5–6 yr old group, the prevalence was 51% with 24% showing dentine exposure, and in the older group where permanent teeth were examined 28% had erosion of the palatal surfaces of their upper incisors. In the present study, erosion was only found in the primary dentition, and of these only one showed any dentinal involvement.

The present study examined all the teeth, not just the upper incisors. In four of the nine cases with erosion, this tooth surface loss was observed on the molar teeth as well as incisors. It may be that the National Surveys missed some erosion, as they limited their examination to upper anterior teeth. The UK National surveys, although aiming to measure erosion only, may well have measured other types of tooth wear, thus exaggerating their results. This may have also been the case in the present study in cases where teeth were near to exfoliation. As the same problems could have occurred in both studies, there should be no difficulty comparing results.

The present results are different to those found by AINE *et al.* (16). This might be explained by the fact that, in their description of erosion they were also scoring decalcification (white opacities), thus not only scoring true erosion but also early carious lesions, and so making the studies incomparable.

There are several explanations for the decreased prevalence of erosion in the study group. Firstly, children with GOR and gastric symptoms tended to avoid acidic and carbonated foods and beverages as these often aggravated their symptoms; in the National Surveys, diet was considered to be a major contributory factor (19, 23). Secondly, the pH

studies measure the pH in the distal oesophagus and it may well be that these children are not refluxing acid into their mouth. More studies are needed to assess children with GOR and erosion to see whether this small group do actually reflux into the mouth. In relation to this, it is interesting to note that the two children with the most severe erosion also had the most severe GOR, one of which also had severe asthma and the other often vomited. However, it was not possible to find a linear relationship between severity of GOR and severity of erosion. Results in adults have shown that individuals with severe GOR are more likely to have erosion, and that these individuals had had their reflux for longer periods (24). This may explain the present results.

Thirdly, the success of medical management may contribute, with anti-reflux medications preventing acid reflux. This may explain why there were fewer children in the London group with erosion, as this group had already been diagnosed and were taking anti-reflux medications. However, it is not possible to judge exactly how long children had been suffering from GOR, as many may have had GOR long before symptoms prompted referral for investigation.

In this study, detectable erosion was confined to the primary dentition. This is not surprising as the enamel is less mineralised and thinner in primary teeth and more prone to acid erosion (25). Also, gastric reflux into the mouth is much more likely to occur in the young infant, where reflux control mechanisms are immature and where anti-reflux treatment has not yet been instigated.

Many of the children that attended both hospitals for symptoms of GOR also had cerebral palsy. In this group of children, poor muscle control leads to an increase in GOR, often into the mouth. It may be that in these children there is an increase in erosion due to acid from the stomach being regurgitated. However, many of these children have

bruxism (26) and so have occlusal wear due to attrition. It may be that there is a combination of erosion and attrition occurring, thus compounding the problem, but it was felt that due to the difficulty of separating the various types of wear these children should not be included in the present data.

The results of this study suggest that dental erosion is not as great a problem in children with GOR as has been found in adults. Further research is needed to examine children who reflux acid into the mouth, and also to investigate children with cerebral palsy where GOR is a major problem and where the combination of acid erosion and attrition can cause considerable tooth surface loss.

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