

## Evaluation of the relationship between dental erosion and scintigraphically detected gastroesophageal reflux in patients with cerebral palsy

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**Aim:** To evaluate the relationship between dental erosion (DE) and scintigraphically detected gastroesophageal reflux disease (GERD) in patients with cerebral palsy (CP).

**Materials and methods:** Included in the study were 21 CP patients with dental erosion and a control group consisting of 16 CP patients without dental erosion (total of 37 children; 19 male, 18 female; mean age: 12.1 ± 2.8 years). The severity of DE was scored and all patients underwent gastroesophageal reflux scintigraphy.

**Results:** The prevalence of GERD in patients with DE (78.9%) was found to be significantly higher than that in patients without DE (21.1%). The number of teeth affected by erosion was significantly higher in GERD+ patients than in GERD- patients within the DE group [median (quarters): GERD+, 14 (12–20); GERD-, 4 (4–4)]. In patients with DE, a significant correlation between the severity of erosion and the presence of GERD was observed [median (quarters): GERD+, 2 (1–3); GERD-, 1 (1–1)] and there was a statistically significant difference between the distribution of interference ratios in multisurface and 1- or 2-surface affected teeth ( $\chi^2 = 41.827$ ,  $df = 1$ ,  $P < 0.001$ ).

**Conclusion:** The current study has shown that there is a strong correlation between DE and GERD in children with CP.

**Key words:** Gastroesophageal reflux disease, dental erosion, cerebral palsy

### 1. Introduction

Gastroesophageal reflux disease (GERD) is one of the most common chronic gastrointestinal disorders and a main cause of morbidity and impaired quality of life in western countries (1,2). Heartburn and acid regurgitation are typical reflux symptoms, although the extensive spectrum of atypical manifestations of GERD has been reported to include noncardiac chest pain, asthma, cough, laryngitis, impaired voice function, and dental erosion (DE) (3,4).

Dental erosion is defined as the progressive loss of hard dental tissue by a chemical process that does not involve bacteria (5). According to global evidence-based consensus, reflux dental erosion has been identified as one of the possible extraesophageal syndromes of GERD (6). While there are no precise data on the prevalence of extraesophageal manifestations of GERD, it is estimated that approximately 24%–55% of patients with dental erosion have GERD (7,8).

Cerebral palsy (CP) is a nonprogressive disorder affecting both posture and movement, manifested as a

static lesion of the developing brain; it is a common cause of severe physical disability in children (9,10). The motor disorders associated with CP are often accompanied by disturbances in sensation, cognition, communication, perception, and/or seizure disorder (11,12). Patients with CP are often associated with a high incidence of GERD. According to Del Giudice et al. (13), 92% of children with CP had clinically significant gastrointestinal symptoms indicative of GERD, abnormal pH, and/or esophagitis.

Although 24-h intraesophageal pH monitoring is the best technique for the evaluation of gastroesophageal reflux, it is difficult to perform, especially in pediatric patients. On the other hand, gastroesophageal reflux scintigraphy, a physiological quantitative method involving low radiation, is well tolerated by all age groups. Moreover, the sensitivity of scintigraphy in detecting gastroesophageal reflux has been reported to be 75%–100%. These obtained values are consistently higher than those of conventional manometry or barium studies (14).

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Children with CP have a higher risk of dental problems compared with healthy controls (15). The main objective of this study was to investigate the association between dental erosion and GERD in patients with CP. Scintigraphic study was employed as the diagnostic tool for GERD.

## 2. Materials and methods

### 2.1. Study population

The study group was enrolled in a specialized unit that provides medical and social care to children with CP at our hospital. A total of 37 children with CP (19 males, 18 females; mean age:  $12.1 \pm 2.8$  years) were included in the study. The study was approved by the ethics committee of the Gülhane Medical Academy, and signed informed consent was obtained from each parent. The following patients were excluded: those who were tube-fed, had sustained uncontrolled seizures, or had a history of antireflux treatment; patients who were unable to cooperate with the operator during the scintigraphic study; patients whose guardians did not give their consent for participation; and patients who had undergone previous dental restorative treatment for dental erosion.

Patients were divided into 2 groups, those who had dental erosion ( $n = 21$ ) and those who did not have dental erosion ( $n = 16$ ), based on the findings of the dental examination.

A questionnaire that allowed for a more detailed assessment of the patient's common symptoms of reflux, dietary and tooth brushing habits, and socioeconomic status was designed for completion by the parents of the children with CP.

Medications that are known to affect GERD, such as acid-suppressive drugs (i.e. proton pump inhibitors and histamine-2 receptor antagonists), metoclopramide, domperidone, and erythromycin, were discontinued at least 3 days prior to the scintigraphic study.

### 2.2. Dental examination

A detailed dental examination was performed by a pediatric dentist for each patient. The examination was conducted on the facial, occlusal, and lingual surface of every tooth, excluding the wisdom teeth; we used the index for the measurement of erosion previously described by O'Sullivan (16) (Table 1).

### 2.3. Scintigraphic study

Gastroesophageal reflux scintigraphy was performed in all 37 children after a fasting period of at least 4 h. During the procedure, 7.4 MBq of Tc-99m-labeled sulfur colloid suspended in 75 mL of orange juice (200  $\mu$ Ci) was given orally. An additional 25 mL of unlabeled orange juice was given to wash off the radioactive substances from the mouth, pharynx, and esophagus. The patient was then placed in a supine position, and sequential dynamic images (15 s/image) were obtained continuously for 60 min (64

**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	Multisurface
Grade of severity	
Code 0	Normal enamel
Code 1	Matte 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
Area of surface affected	
Code -	Less than half surface area affected
Code +	More than half surface area affected

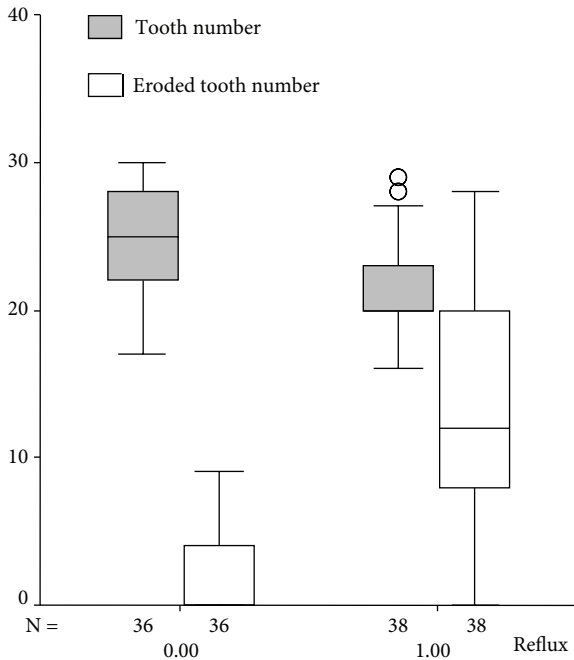
$\times 64$  matrix) with a gamma camera (GE Millennium; GE Medical Systems, Milwaukee, WI, USA). Images were evaluated visually for gastroesophageal reflux, and time-activity curves were generated over esophageal regions of interest.

### 2.4. Statistical analysis

Statistical analysis was performed using Microsoft Excel 2003 and SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Patients with and without dental erosion were compared for the presence of GERD on scintigraphy, taking into consideration age distribution, symptoms, dental hygiene, and socioeconomic status, using the chi-square test. The chi-square test was employed to analyze the differences between the ratios of the affected surface and tissue loss by creating cross-tables. All data were represented as mean  $\pm$  standard deviation (SD), and  $P \leq 0.05$  was considered to be statistically significant.

## 3. Results

The prevalence of GERD in patients with DE (78.9%) was found to be significantly higher than that in patients without DE (21.1%). The number of teeth affected by erosion was significantly greater in GERD-positive (GERD+) patients than in GERD-negative (GERD-) patients within the DE group [median (quarters): GERD+, 14 (12-20); GERD-, 4 (4-4)] (Figure 1). In patients with DE, a significant correlation between the severity of erosion and the presence of GERD was observed [median (quarters): GERD+, 2 (1-3); GERD-, 1 (1-1)] (Figure 2).

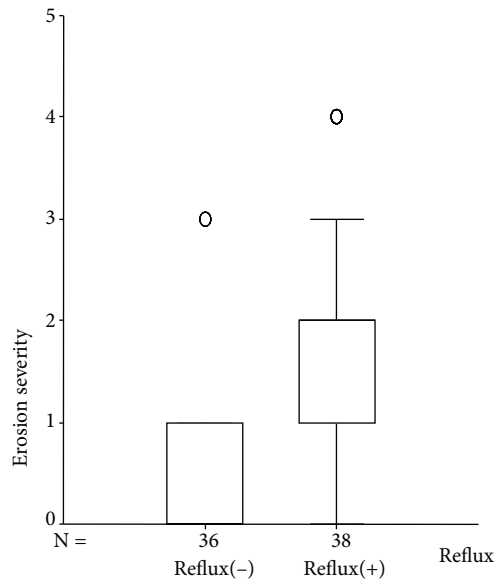


**Figure 1.** Number of eroded teeth in patients with or without reflux.

A total of 21 patients displayed erosion (10 females, 11 males). The type and distribution of erosion are indicated in Table 2. Study groups D and E are not included in Table 2 due to the absence of any erosion. While group F exhibited the highest number of affected teeth (16 observations, 147 teeth), group 2 showed the most extensive tissue loss (8 observations, 93 teeth). In 22 of 29 observations (190 teeth), half to less than half of the surface was found to be affected (Table 2).

Dental erosion in various groups was also classified as multisurfaced or non-multisurfaced depending on the number of surfaces displaying erosion. The surface interference ratios are shown in Table 3. A statistically significant difference in the distribution of interference ratios was observed between multisurfaced and non-multisurfaced DE ( $\chi^2 = 41.827$ ,  $df = 1$ ,  $P < 0.001$ ) (Table 3). While the multisurface erosion observed in the vast majority of affected teeth (93.6%) was 58.9% or less, it was lower in teeth with 1 or 2 surfaces affected (50%) (Figure 3).

Patients with DE were also classified as dentin-positive (dentin+) or dentin negative (dentin-) depending on the extent of tissue loss during erosion. Interference ratios based on tissue loss are shown in Table 4. A statistically significant difference in the distribution of interference ratios between the dentin+ and dentin- was observed ( $\chi^2 = 5004$ ,  $df = 1$ ,  $P = 0.025$ ).



**Figure 2.** Severity of dental erosion in patients with or without reflux.

#### 4. Discussion

Many different techniques are used for the diagnosis of GERD. Of these, endoscopy has gained widespread acceptance. Although endoscopy is a relatively simple procedure and can be performed even in infants weighing under 1000 g, it is an invasive technique (17). A 24-h monitoring of the gastroesophageal pH is considered as the gold standard for GERD diagnosis. In this technique, a pH sensor is transnasally inserted under fluoroscopic guidance, and the patients are monitored for 24 h (18). However, this procedure is difficult to perform in pediatric patients, especially in those with disabilities. Scintigraphy, on the other hand, is a noninvasive technique, and the acquisition procedures of the test meals are standardized. However, the results often depend on the investigator's experience (19). In our study, we used gastroesophageal scintigraphy for the diagnosis of GERD, because this technique is noninvasive and requires no sedation. Because our patients were pediatric patients with CP, the use of this technique was more appropriate for them.

The relationship between dental erosion and GERD in children with CP is relatively underestimated, and our present study makes an effort to address this issue. Our data indicate that GERD is a contributing factor in the development of DE in patients with CP. At present, data supporting supraesophageal manifestation of GERD in CP patients is limited. To date, there are only 2 studies that have specifically assessed the relationship between dental problems and GERD in patients with CP. The first study (20)

**Table 2.** The distribution of erosion.

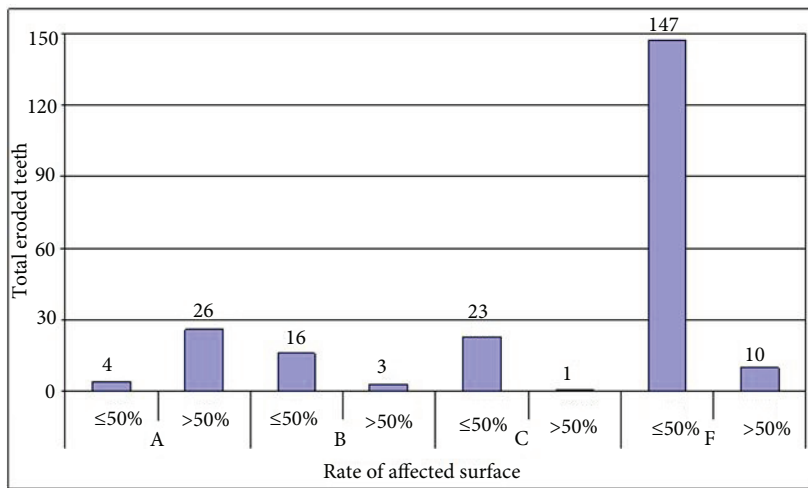
Surface	Loss of surface	Code +		Code -		S	
		N	ST	n	ST	N	ST
A	1	-	-	-	-	-	-
	2	-	-	3	26	3	26
	3	1	4	-	-	1	4
	4	-	-	-	-	-	-
	5	-	-	-	-	-	-
$\Sigma$ A		1	4	3	26	4	30
B	1	1	10	-	-	1	10
	2	1	6	1	3	2	9
	3	-	-	-	-	-	-
	4	-	-	-	-	-	-
	5	-	-	-	-	-	-
$\Sigma$ B		2	16	1	3	3	19
C	1	2	15	-	-	2	15
	2	1	8	-	-	1	8
	3	-	-	1	1	1	1
	4	-	-	-	-	-	-
	5	-	-	-	-	-	-
$\Sigma$ C		3	23	1	1	4	24
F	1	5	42	-	-	5	42
	2	6	79	2	10	8	89
	3	2	14	-	-	2	14
	4	1	8	-	-	1	8
	5	2	4	-	-	2	4
$\Sigma$ F		16	147	2	10	18	157
$\Sigma$	1	8	67	-	-	8	67
	2	8	93	6	39	14	132
	3	3	18	1	1	4	19
	4	1	8	-	-	1	8
	5	2	4	-	-	2	4
$\Sigma$		22	190	7	40	29	230

**Table 3.** Cross-table (cross-tabs) of interference ratios according to the surface of the eroded teeth.

Surface	Interference ratios		Total
	≤50%	>50%	
Multisurface	147 (93.6%)	10 (6.4%)	157
Others	43 (58.9%)	30 (41.1%)	73
Total	190	40	230

**Table 4.** Cross-table (cross-tabs) of interference ratios according to loss of tissue.

Tissue loss	Interference ratios		Total
	≤50%	>50%	
Dentin -	160 (80.4%)	39 (19.6%)	199
Dentin +	30 (96.8%)	1 (3.2%)	31
Total	190	40	230



**Figure 3.** The distribution of interference ratios according to the surfaces of eroded teeth.

showed that 12 out of 21 children with CP demonstrated reflux in 24-h esophageal pH monitoring. Nine of these patients (75%) had moderate or severe erosion, while the other patients devoid of gastroesophageal reflux had very low levels of erosion. In a second study, Su et al. (21) observed that out of a total of 21 CP patients analyzed, 11 out of 15 patients demonstrating DE had a history of gastroesophageal reflux (73%). We evaluated a total of 37 children with CP. The population size was small because we only recruited those patients who received medical and social care at our hospital. Our present results employing gastroesophageal reflux scintigraphy further confirm these previously reported findings.

Feeding difficulties, including problems with swallowing and vomiting, recurrent chest infections, and irritability, are found to be associated with the development of dental erosion in CP (22). Bargen and Austin first discovered the relationship between GERD and dental erosion in 1937, when they concluded that the loss of hard dental tissue could be an indicator and a predominant oral manifestation of GERD (23). The prevalence of GERD has

been found to be high (up to 75%) in children with CP (21,24). The prevalence of GERD was found to be 59% in a study of 29 children with intellectual and severe motor disability (IQ less than 55 and Gross Motor Function Classification System levels I-IV), as evident through 24-h pH monitoring (25). Although the cause of increased GERD frequency in these patients remains unknown, several factors have been proposed to be involved. Persistent supine position, reduced basal lower esophageal sphincter pressure, abdominal compression resulting from scoliosis or spasticity of abdominal muscles thereby increasing intragastric pressure, delayed gastric emptying, and impaired esophageal motor function predispose CP patients to GERD (26).

Both primary and permanent teeth can be affected by DE. Enamel erosion that affects the posterior dentition may be the first indication of GERD. Dahshan et al. (27), in a prospective study evaluating the presence of GERD and DE in children with primary and permanent dentition, reported that posterior teeth displayed more erosion patterns.

Erosion needs to be clearly distinguished from attrition and abrasion. It was reported that palatal surfaces of the maxillary incisors and the occlusal surface of the mandibular first molars are the initial surfaces affected by DE (28). Other surfaces of these teeth are less affected by erosion, owing to their remote location away from the salivary glands that protect them. However, continuous exposure to the factors causing erosion may gradually result in the extension of

DE to palatal and occlusal surfaces of the upper premolars and molars. In our study, we observed that more than one surface of the vast majority of teeth was affected by erosion.

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