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Impact of reflux, bruxism, age, and plaque index on anterior tooth wear: A cross-sectional clinical evaluation

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MAIN POINTS

- Gastroesophageal reflux disease increases the risk of erosive wear on the palatal surfaces of maxillary anterior teeth.
- Anterior Clinical Erosive Classification is an effective tool in evaluating the severity of dental erosion and the need for clinical intervention.
- Plaque index did not show a significant difference between groups, and dental erosion is thought to be mainly associated with chemical and mechanical factors.
- As the duration of reflux increases, ACEC scores increase, indicating that dental erosion intensifies depending on the duration of the condition.

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ABSTRACT

Aim: This study aims to evaluate the effect of variables such as gastroesophageal reflux disease (GERD), bruxism, plaque index, and age on erosive wear occurring on the palatal surfaces of maxillary anterior teeth, and to objectively measure this wear using the Anterior Clinical Erosive Classification (ACEC).

Materials and Methods: A total of 507 individuals were included. Participants completed self-report questionnaires regarding the presence, previous diagnosis, disease duration, and medication use. Bruxism was assessed through self-report and clinical examination. Erosive wear on maxillary anterior teeth palatal surfaces was measured using ACEC, and plaque accumulation using the Silness and Löe Plaque Index. Statistical analyses included independent sample t-tests and Spearman/Pearson correlation coefficients. Significance was set at $p<0.05$.

Results: Reflux disease was detected in 20.9% of the participants in the study. ACEC scores of individuals reporting reflux symptoms were found to be significantly higher compared to healthy individuals ($p<0.05$). ACEC scores were also found to be significantly higher in individuals with bruxism than those of without bruxism. In contrast, the plaque index did not show a significant difference between the groups. Additionally, a significant and positive relationship was found between the duration of reflux and ACEC scores ($r=0.281$, $p<0.01$). ACEC scores were observed to be higher in individuals receiving reflux treatment compared to those not using medication.

Conclusion: These findings indicate that reflux affects not only the gastrointestinal system but also oral and dental health and emphasize the importance of early diagnosis and intervention for dental erosion in individuals with reflux symptoms. Our study reveals the usability of the ACEC in large populations and sheds light on the multifactorial etiology of dental erosion. It also highlights the need to consider the potential abrasive effects of medications used in reflux treatment.

Keywords: Gastroesophageal reflux disease, Dental erosion, Anterior clinical erosive classification, Tooth wear

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INTRODUCTION

Erosive wear of the teeth and Gastroesophageal Reflux Disease (GERD) are two conditions are two interrelated conditions [1]. GERD, characterized by the backward movement of stomach acid, has heartburn and regurgitation as its main systemic symptoms [2]. Heartburn is described as a burning sensation in the retrosternal area. Clinical symptoms are very common and affect a significant portion of the general population [3]. It has been reported that 20% of the adult population experiences heartburn at least once a week, and 40% at least once a month [4]. According to data from another study, this incidence has been reported as 10-20% in Europe and North America, and 5% in Asia. A study from Turkey showed that its incidence was 33% [5].

Dental erosion is defined as the dissolution of hard dental tissues by acidic factors without bacterial activity. The etiology of erosion may be attributed to extrinsic factors, such as acidic foods, beverages, or medications, or intrinsic factors like stomach acid [6]. The erosive process begins on the tooth surface. Initially, acids or chelating agents remove the tooth's protective pellicle layer, followed by the dissolution of the organic structure and demineralization. In cases of GERD, the

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palatal and incisal surfaces of maxillary teeth and the occlusal surfaces of mandibular teeth are most affected due to the entry of acidic material into the oral cavity [7]. As the disease progresses, erosion may also be observed on the chewing surfaces of the posterior teeth in both jaws. Concurrently, the labial and buccal surfaces generally experience wear in long-term and severe reflux cases. The palatal surfaces of the maxillary teeth are the earliest affected areas because of the limited protective effect of the salivary glands and continuous exposure to gastric acid. Furthermore, the force of regurgitation reaching the mouth from the pharynx can also increase the severity of dental erosion [7, 8]. Studies have shown a significant relationship between GERD and dental erosion [9]. However, the development of erosion does not progress identically in every individual; its progression can be significantly affected by the duration and severity of reflux, diet, medications, and oral hygiene habits [10, 11]. The damaged tooth surface becomes more susceptible to wear from mechanical friction during chewing, swallowing, tongue and cheek movements, or brushing. Tooth brushing performed after an acid attack is particularly damaging, since it can further increase wear on the softened and demineralized tooth surface.

Clinicians often prefer a wait-and-see approach for dental erosion, whereas they tend to proceed directly to treatment for dental caries [8, 12]. Erosion observed in asymptomatic teeth is initially considered insignificant and often left untreated until later ages or until significant symptoms develop. However, it is crucial to determine whether these teeth will eventually require minimally invasive treatment or more invasive procedures at advanced stages. In advanced cases, serious complications such as pulp chamber exposure, complete loss of the tooth crown, vertical dimension loss, and temporomandibular joint dysfunction may develop. Despite these risks, awareness among general physicians is limited; one study found that only 40% were aware that GERD can cause dental erosion [13]. This indicates a clear need for this knowledge to be more widely addressed in medical and dental education.

There is still no definitive consensus in the literature on how to clinically evaluate and determine the causes of tooth wear. While acid erosion is considered the most important cause of tooth wear in many European countries, in some other countries, mechanical wear (attrition, abrasion) is still regarded as the predominant factor. These different approaches can cause confusion in the assessment of tooth wear. Researchers today emphasize the multifactorial etiology of tooth wear and state that attributing it to a single cause can be misleading [14, 15]. This multifactorial perspective is also highly important when evaluating wear on the palatal surfaces of maxillary anterior teeth. Not only GERD, but also factors such as tooth brushing habits, oral hygiene level, clenching and grinding activities (bruxism), and medications can contribute to wear on these surfaces. The Anterior Clinical Erosive Classification (ACEC) systematically grades erosive wear, particularly that arising from intrinsic acid sources, and helps determine the need for clinical intervention [16]. To our knowledge, no comprehensive study in the literature has simultaneously examined reflux, oral hygiene index, and bruxism to evaluate wear on the palatal surfaces of maxillary anterior teeth using the ACEC.

In this context, the aim of our study was to evaluate the tooth wear occurring in the maxillary anterior teeth of patients who presented to the Restorative Dentistry Clinic of Inonu University Faculty of Dentistry using the ACEC and to reveal its relationship with reflux, oral hygiene, and bruxism. The null hypothesis for this study was that the variables of reflux presence, bruxism presence, age, and plaque index had no significant effect on the level of erosive wear occurring on the palatal surfaces of maxillary anterior teeth (ACEC score).

MATERIALS AND METHODS

This study is cross-sectional and observational research. It was conducted at the Restorative Dentistry Clinic of the Faculty of Dentistry, Inonu University, between June and July 2025.

Power analysis

When the effect size was calculated as 0.19, evaluating at least 436 participants was deemed sufficient with a 95% confidence interval and a 5% margin of error. However, in the study, 507 participants were examined, ensuring a reliable estimation of reflux prevalence among individuals attending the clinic.

Participants

Individuals aged between 16 and 70 years who could read and understand Turkish, who did not have missing maxillary anterior teeth, who had at least 20 healthy and clinically controllable teeth in the mouth, and who did not use fixed or removable prostheses were included in the study. Individuals with systemic diseases other than reflux were excluded from the study.

Procedure

Before the study was conducted, volunteer candidates were taken to the waiting room and informed about the study. Those who agreed to participate signed the informed consent form and were admitted to the examination room. For participants under the age of 18, informed consent was additionally obtained from their parents. In this study, adult patients who had previously been diagnosed with gastroesophageal reflux disease (GERD) by a gastroenterologist based solely on typical symptoms, responded to treatment with antisecretory therapy, and had no alarm symptoms were included. Since advanced diagnostic tests for GERD (such as pH monitoring or endoscopy) are only required in suspicious cases or when there is no response to treatment, the individuals included in this study were those diagnosed based on clinical evaluation and response to therapy alone [17,18]. Participants were

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administered a self-report questionnaire regarding the presence of GERD and were asked whether they had previously been diagnosed with reflux. Subsequently, the Anterior Clinical Erosive Tooth Wear Classification index and the Silness & Löe Plaque Index were applied by the dentist. Participants were also administered a self-report questionnaire regarding the presence of bruxism. In addition to the questionnaire results, masseter muscle examination, intraoral examination, and temporomandibular joint evaluation were performed. The masseter muscles were examined by palpation, tooth surfaces were assessed for wear (enamel loss, dentin exposure), and the presence of pain or clicking sounds in the jaw joint was recorded and diagnosis of bruxism was established based on participants' self-report responses and clinical examination findings.

Tests used in the study

Participants were asked to complete the following tests.

Reflux assessment questionnaire

In the study, a questionnaire was administered to evaluate participants' symptoms related to gastroesophageal reflux disease (GERD), questioning whether they had previously been diagnosed with reflux, the duration of the diagnosis, medication use, and lifestyle impacts related to reflux. The questionnaire was prepared based on methods widely used in clinical research that rely on symptomatic assessment rather than diagnostic tests to determine the presence of reflux. In this context, the presence of reflux was evaluated based on the individual's self-report, history of reflux diagnosis, and frequency of symptoms.

Anterior clinical erosive classification (ACEC)

This classification is an objective system that enables the clinical assessment of acid erosion occurring on the palatal surfaces of maxillary anterior teeth [16]. This system assigns a score from 0 to 5 to each of the six anterior teeth in the upper jaw. Scores are determined according to the amount of wear observed at the enamel and dentin levels; a score of 0 indicates no wear, while a score of 5 represents wear characterized by pulp exposure or significant structural loss (Table 1). The average of the scores determined for each tooth is calculated to obtain individual's overall ACEC score. This system allows for the clinical classification of both early and advanced stages of erosive tooth wear and is recognized as a reliable method, especially for assessing wear caused by intrinsic acid sources such as reflux.

Plaque index (PI)

Developed by Silness and Löe in 1964, this index aims to assess the severity of plaque present on the tooth surface [19]. The plaque index, divided into four scores, is performed by evaluating teeth numbered 16, 12, 24, 36, 32, and 44 in the mouth. Each of the four surfaces of these teeth (buccal, lingual, mesial, and distal) is scored between 0 and 3. The scores from the four regions of the tooth are summed and divided by four to provide the plaque index for the tooth according to the scores and criteria below.

Calibration

All examiners underwent a theoretical training period initially conducted on study models and subsequently through practical sessions with dental students. The training included recording indices individually by each of the three examiners on subjects, discussing the findings, and then re-evaluating several subjects to compare results. All examiners scored the same areas and compared their results, discussing their experiences. This process continued until they consistently assigned the same values for each surface and achieved a 90% agreement for the entire mouth.

Statistical analysis

Data were analyzed using IBM SPSS Statistics, version 27.0 (IBM Corp.; Armonk, NY, USA). The Kolmogorov-Smirnov test was used to determine the distribution of the data. For comparing independent groups, the Independent Samples t-Test was applied for parametric data, while the Mann-Whitney U Test was used for non-parametric data. The homogeneity of variance was assessed with Levene's test. Any p value less than 0.05 was considered statistically significant. For correlation analyses, Spearman's rho correlation coefficient was used to assess the relationships between variables. Finally, linear regression analysis was performed to evaluate the predictive effect of independent variables on the dependent variables.

RESULTS

This study involving 507 individuals found that the prevalence of gastroesophageal reflux disease (GERD) was 20.9% and bruxism was 27.6%. Both the GERD and bruxism groups had significantly higher median ages and Anterior Clinical Erosive Classification (ACEC) scores compared to healthy controls, with correlations of r=0.18 and r=0.13 for the GERD group, and r=0.27 and r=0.2 for the bruxism group, respectively (Table 2). A higher plaque index was also found in males (d=0.15), who also had significantly higher ACEC scores (r=0.19). Among those with reflux, individuals on medication had significantly higher ACEC scores (r=0.2) than those not using medication (Table 3). Linear regression analysis identified age as a significant predictor of ACEC scores (R^2 =0.248,p<0.001), while correlation analysis showed a significant positive relationship between the duration of reflux and ACEC scores (r=0.281, p<0.01) (Table 4).

DISCUSSION

This study confirms that both GERD and bruxism are associated with increased dental erosion, with a notable finding

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Table 1. ACE classification

Classification	Palatal enamel	Palatal dentin	Insizal edge length	Facial enamel	Pulp vitality	Suggested therapy
Class I	Reduced	Not exposed	Preserved	Preserved	Preserved	No restorative treatment
Class II	Lost in contact areas	Minimally exposed	Preserved	Preserved	Preserved	Palatal composites
Class III	Lost	Distinctly exposed	≤ 2 mm lost	Preserved	Preserved	Palatal onlays
Class IV	Lost	Extensively exposed	> 2 mm lost	Preserved	Preserved	Sandwich approach
Class V	Lost	Extensively exposed	> 2 mm lost	Distinctively reduced/lost	Preserved	Sandwich approach (experimental)
Class VI	Lost	Extensively exposed	> 2 mm lost	Lost	Lost	Sandwich approach (highly experimental)

Table 2. The summary of the age, ACEC score, and plaque index values according to reflux status, gender, and presence of bruxism among the participants.

	Reflux		p value*	Gender		p value*	Bruxism		p value*
	Present	Absent		Male	Female		Present	Absent	
n	106 (20.9%)	401 (79.1%)		229 (45.2%)	278 (54.8%)		140 (27.6%)	367 (72.4%)	
Age	46(20)A	34(26)B	<0.001	37(27)	36(29)	0.48	46(31)A	35(24)B	<0.001
ACEC	1.66(1)A	1(1)B	0.003	1.33(1)	1.16(1)	0.18	1.66(1.17)A	1(1)B	<0.001
PI	1.37(0.59)	1.29(0.58)	0.29	1.33(0.65)A	1.25(0.59)B	<0.001	1.25(3)	1.29(0.58)	0.259

Groups denoted by different superscript letters (A, B) in the same row are significantly different (p<0.05). All comparisons were performed using the Mann–Whitney U test. Data are presented as median (interquartile range, IQR).

Table 3. The summary of the age, reflux duration, ACEC score, and plaque index values according to medication use, bruxism, and gender status in the reflux group.

	Medication Use		p value*	Bruxism		p value*	Gender		p value*
	Yes	No		Present	Absent		Male	Female	
n	42	64		46	60		40	66	
Age	44.29(2.28)	43.5(1.87)	0.791*	47.09(2.29)A	41.30 (1.79)B	0.046*	48.1(2.44)A	41.21(1.72)B	0.02*
Duration of Reflux (years)	4(9)	5(5)	0.835**	5(7)	2.5(5)	0.005**	5(8)A	4(4)B	0.046**
ACEC	1.83(0.71)A	1.33(0.96)B	0.037**	1.83(1.17)A	1.41(1)B	0.05**	1.91(1.25)A	1.5(0.87)B	0.049**
PI	1.33(0.55)	1.39(0.68)	0.338**	1.25(0.71)	1.47(0.54)	0.082**	1.56(0.56)A	1.29(0.67)B	0.004**

Variables with a normal distribution are presented as mean ± standard deviation (SD) and were analyzed using the independent samples t-test (*). Variables without a normal distribution are presented as median (interquartile range, IQR) and were analyzed using the Mann–Whitney U test (**). Groups denoted by different superscript letters (A, B) in the same row are significantly different (p < 0.05). *p<0.05: independent samples t-test; **p<0.05: Mann–Whitney U test.

Table 4. Correlation and regression analyses of age, reflux duration, and ACEC scores.

Correlation					
		Age	ACEC	PI	Duration of Reflux (years)
Spearman's rho	Age	1	0.488**	0.159**	0.242*
	ACEC	0.488**	1.00	.230**	0.281**
	PI	0.159**	0.230**	1	0.07
	Duration of Reflux (years)	0.242*	0.281**	0.069	1

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

that the ACEC classification, typically used in case reports, is an effective tool for large-scale epidemiological studies. The prevalence of GERD found in this cohort (20.9%) is consistent with reported rates in Turkey and globally, and the mean age of GERD patients was around 43 years [5, 20, 21].

The use of the ACEC is a key strength of this research, as it offers a systematic and quantitative approach to evaluating intrinsic acid-related wear [16]. This classification assesses each palatal surface of the anterior teeth individually for enamel and dentin loss, incisal edge level, presence of facial enamel, and pulp vitality, thus helping to determine not only the presence of wear but also its severity and the need for treatment [16]. In the literature, the ACEC has generally been used in individual case reports and for justifying restorative treatment plans; however, no published studies have been found in which it was systematically applied for data collection in large populations. Various indices have been used by researchers to investigate the presence of dental erosion [22,23]. In this re-

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gard, our study is, to our knowledge, the first clinical research in which the ACEC has been used quantitatively in a large group of individuals to evaluate erosive wear on anterior teeth. Through comprehensive data analysis and simultaneous assessment of factors such as GERD, bruxism, age, and plaque index, the ACEC is considered a valid and applicable tool for epidemiological studies. In this way, the study demonstrates both the practical potential of the ACEC and contributes to the literature on how this classification can be appiled in clinical research into the causes of dental erosion.

In our study, individuals reporting GERD symptoms and those with a history of bruxism had higher ACEC scores on their anterior teeth compared to healthy individuals, whereas the plaque index did not show significant differences between groups. These findings suggest that, in addition to chemical destruction due to intrinsic acid exposure, mechanical stress factors (such as clenching and grinding) may also play a role in the progression of erosive wear. It is known that acidic material reaching the oral cavity due to reflux can cause early-stage wear, especially on the palatal surfaces of the maxillary anterior teeth [24,25]. Indeed, it has been reported that poor eating habits starting in childhood and factors such as bruxism contribute to dental erosion, which often persists into adulthood [26]. The literature also emphasizes that tooth surface damage is more severe in cases where chemical erosion coexists with mechanical wear [15,27]. Our findings that both GERD and bruxism were linked to higher ACEC scores, while the plaque index was not, reinforce the concept of dental erosion as a multifactorial process. This suggests that while classic oral hygiene is crucial for preventing caries, it has little impact on erosion caused by chemical and mechanical factors such as acid reflux and tooth grinding [28,29]. The positive correlation between reflux duration and ACEC scores suggests that the chronicity of reflux is a key driver of progressive erosive wear.

The observation that individuals on GERD medication had higher ACEC scores is particularly interesting. While these medications neutralize stomach acid, some, such as calcium carbonate, may cause abrasive effects on tooth surfaces, contributing to wear [30,31]. This highlights the need for a holistic, interdisciplinary approach to managing patients with both medical conditions and dental erosion.

Correlation analysis revealed a statistically significant and positive relationship between reflux duration and ACEC scores ($r = 0.281$, $p<0.01$). This indicates that as the duration of reflux increases, erosive wear on the anterior teeth also tends to increase. In other words, in individuals with longer-standing reflux symptoms, the acidic wear observed on the palatal surfaces of the maxillary anterior teeth is more severe. Researchers have reported that individuals who have had reflux disease for a longer time experience greater erosive wear on their teeth [32].

Limitations

A primary limitation of this study is its retrospective and cross-sectional design. The data on GERD and bruxism were collected through self-reports and clinical examinations rather than objective diagnostic methods like pH monitoring or polysomnography. This reliance on subjective reporting can introduce bias. Additionally, the study used the ACEC, which focuses exclusively on the palatal surfaces of maxillary anterior teeth, excluding erosion in other parts of the mouth. Future longitudinal studies with more objective diagnostic tools would provide a more robust understanding of the causal relationships between these factors and dental erosion.

CONCLUSION

In conclusion, this study demonstrates that intrinsic and mechanical factors such as GERD and bruxism are strongly linked to the development and severity of dental erosion on the palatal surfaces of maxillary anterior teeth. The lack of a significant relationship with the plaque index suggests that the etiology of erosion is distinct from that of periodontal pathologies. The findings also underscore the importance of a holistic approach to patient care, considering both systemic conditions and the potential abrasive effects of some medications.

Ethics Committee Approval: Ethical approval for this study was granted by the Scientific Research Ethics Committee of Inonu University, Faculty of Health Sciences (Decision number: 2025/7710).

Informed Consent: Participants were informed about the study and their written consent was obtained. For participants under the age of 18, both verbal and written consent were obtained from their parents.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The authors declare no conflict of interest.

Author Contributions: Conceptualization: F.Ö.; Methodology: F.Ö., M.F.K.; Data Collection and/or Processing: F.Ö., T.S., E.Ş.; Analysis and/or Interpretation: F.Ö.; Literature Review: T.S., E.Ş.; Writing – Original Draft: F.Ö.; Writing – Review and Editing: F.Ö., T.S., E.Ş., M.F.K.; Supervision: F.Ö.

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