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Research Article

Is Incisor Irregularity Associated with the Frequency of Coronal Surface Caries? A Cross-Sectional study in Al-Madinah, Saudi Arabia

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Abstract

Objectives: The primary aim of this study was to investigate the potential correlation between dental caries and incisor irregularity. The secondary aim is to explore for other risk factors that could be associated with dental caries. Methods: Participants were screened and recruited based on the study's inclusion criteria from Taibah University Dental Hospital, Madinah, Saudi Arabia. Clinical Intra-oral examination for incisors irregularity using Little's Irregularity Index for each arch separately. The frequency of surface caries was calculated by the sum of the decayed, filled lesions per tooth surface (DFS) scores per arch. Followed by a questionnaire to record the participant's demographic data, oral hygiene and dietary habits to control for confounding variables.

Results: 153 adult patients participated in the study with mean age of 29 years old (SD ± 10). The mean Little's Irregularity Index for the upper and lower anterior teeth was 3.61 and 5.44 millimetres, respectively. While the mean DFS scores were 2.24 and 0.58 for the upper and lower anterior teeth, respectively. The mean frequency of daily sugar intake per person was 3.38 times. Multiple linear regression analysis reported that no significant correlation exists between incisor irregularity and DFS scores in either the maxillary or the mandibular arch.

Conclusion: The increase in incisor irregularity was not associated with the increased frequency of carious surfaces in the study sample. However, other factors demonstrated significant positive correlation such as the increased frequency of daily sugar consumption and decreased frequency of tooth brushing. Oral health education and promotion of healthy habits are recommended to minimize the risk of caries development.

Keywords: Caries Risk; Caries; Crowding; Irregularity; Orthodontics

Introduction

Dental caries is among worldwide-most prevalent disease. It affects all age groups of populations. It is a slowly progressing disease that requires indigenous bacteria, local factors, such as diet and oral environment, and time for the disease to occur [1]. Cariogenic diet is a sugary diet that is absorbed by the oral bacteria, then results in acid formation that dissolves the tooth tissue and tooth cavitation will happen subsequently [2]. Latest investigations show that not only classical risk factors, such as plaque or diet, are correlated with individual's caries risk, but other factors like social status and education appears to have a stronger correlation with caries [3]. One of the most common indices to measure the severity dental caries is Decayed, Missing, Filled surface (DMFS) index, it is well-established as the key measure of caries experience in dental epidemiology [4]. Data from the Saudi population clearly shows caries continues to be a major problem. A study in Jeddah, Saudi Arabia demonstrated that caries prevalence rate is more than 95% [5].

Dental crowding, particularly anterior tooth crowding is the most common type of malocclusion. The aetiology of crowding is due to complex interaction of genetic and environmental factors [6]. Crowding takes place when the dental alveolar base length is relatively too small to accommodate all teeth harmoniously. Whereas dental irregularity denotes labio-lingual displacement of adjacent teeth from its ideal contact point without consideration of the

arch length. Incisors irregularity is exacerbated with age due to local remodelling caused by periodontal illnesses, bone resorption, mesial drift, ongoing forward mandibular growth and relapse following orthodontic treatment [6]. The most common index used to quantify the degree of anterior tooth irregularity is Little's Incisor Irregularity Index [7]. It has been suggested that incisor irregularity makes effective oral hygiene more challenging. These malposition seem logical sites for prolonged food accumulation, bacterial and plaque retention, which are important factors for the initiation and progression of dental caries [8]. A cross-sectional study was done to assess the prevalence of malocclusion and orthodontic treatment need and the prevalence of crowding among the Saudi papulation was (47.2%) [9].

Although caries and malocclusion from incisal irregularity can exert negative impact on the quality of life [10,11]. However, only few studies investigated the correlation between caries and malocclusion [12,13]. Yet, their findings were inconsistent and still contradictory. Previous systematic review concluded that there is no reliable evidence regarding the association between dental caries and crowding, and further studies with adequate sample size are required [14]. Another systematic review found an association between caries and crowding but only in the adolescent group [15]. As caries is a preventable disease, improving the understanding of this possible relationship would be beneficial for stakeholders including dental practitioners, public health policy makers and the general population. In Saudi Arabia, although the prevalence of dental caries and malocclusion has been reported separately in several publications [5,9]. However, to the best of our knowledge, there are no study that investigated the association between caries and incisor irregularity. Owing to the unique characteristics and culture of the population of Saudi Arabia. Hence, the primary aim of this study was to investigate the correlation between the frequency of dental caries and the severity of incisor irregularity. The secondary aim was to explore for other risk factors that could be associated with dental caries in Saudi Arabia.

Materials and Methods

A hospital-based cross-sectional clinical study was carried out to assess the correlation of anterior tooth irregularity and the frequency of diseased tooth surface in the population of Al-Madinah, Saudi Arabia.

Inclusion criteria were participants aged 16 years and above in their permanent dentition without physical or mental disabilities. Exclusion criteria were patient who had any missing anterior teeth and previous orthodontic treatment.

Ethical approval was granted from the Research Ethics Committee, College of Dentistry, Taibah University (TUCDREC/16022021/AAAlmarhoumi). All participants were selected on simple random sampling technique and voluntary agreed to participate in the study. Informed consent was signed prior to the clinical examination and data collection.

Intra-oral clinical examination was carried out to measure the anterior tooth irregularity for both the upper and lower arches according to the Little's Irregularity Index. A sum of the linear anatomic contact point displacement from the mesial of the canine to the mesial of the contralateral canine was calculated in millimetres using a sterile stainless-steel ruler held parallel to the occlusal plane. The decayed and filled tooth surfaces (DFS) was measured using a sterile intra-oral mirror and explorer for all four surfaces per tooth (mesial, distal, labial and lingual). The DFS score was then calculated for the upper and lower arches individually by the sum of all affected anterior tooth surfaces in their respected arch. Dental examiners were calibrated by a pilot sample of 10 participants measured twice at 2-week interval. A Cronbach's alpha score of 0.830 indicated a high degree of reliability between the examiners.

To control for confounders, a structured self-administered with close-ended-answer questionnaire was handed to the participants to record demographic data (sex, age, education and income levels), oral hygiene habits (frequency and methods of tooth brushing, the use of cleaning aids such as mouthwash and flossing and the frequency of regular dental check-ups), dietary habits (frequency of sugary snacks and drinks intake per day) and any related medical history or medications that is associated with reduced normal salivary flow.

Statistical analysis

The data was analysed using IBM SPSS version 21 (SPSS version 21.0; IBM corporation, Armonk, NY, USA) statistical software. Statistical significance was set at 0.05 levels. Descriptive and analytical statistical tests were conducted. Frequency of distribution expressed in numbers with percentage for variables in categorical nature. Continuous variables were expressed in mean and standard deviation. Kruskal-Wallis test, Mann-Whitney U and chi squared tests were used to see the differences among various categories of the study participants. Multiple linear regression to see the relationship between the dependent and independent variables.

Results

The total sample size consisted of 153 participants with mean age of 29 years old (± 10). the percentage of females and males were 56.2% and 43.8%, respectively. The average Little's Irregular-

ity Index for the upper and lower anterior teeth was 3.61 and 5.44 millimetres, respectively. While the mean total DFS scores were 2.24 and 0.58 for the upper and lower anterior teeth, respectively. Regarding oral habits and lifestyle, the mean frequency of daily sugar exposure was 3.38 (± 1.69) times. Participants who don't brush their teeth at all were 3.9% and those who brush more than two time per day were 8.5% of the total sample. Full descriptive statistics is found in (Table 1).

Variable		
Gender (n, %)	Female	86 (56.2%)
	Male	67 (43.8%)
Monthly income (n, %)	Low Income	68 (44.4%)
	Mid Income	46 (30.1%)
	High Income	39 (25.5%)
Age (mean, SD)		29 (10)
Little's Irregularity Index (mean, SD)	Upper arch	3.61 (2.80)
	Lower arch	5.44 (2.80)
DFS score (mean, SD)	Upper arch	2.24 (3.20)
	Lower arch	0.58 (1.48)
Frequency of sugar Intake per Day (mean, SD)		3.38 (1.69)
Regular Dental Check-ups (n, %)	No	130 (85%)
	Yes	23 (15%)
Frequency of Tooth Brushing (n, %)	I don't brush	6 (3.9%)
	Once per day	60 (39.2%)
	Twice per day	74 (48.4%)
	More than twice	13 (8.5%)

Table 1: Descriptive statistics for the overall sample.

In comparison to males, females exhibited greater lower incisor irregularity and upper incisor DFS scores. Income level demonstrated statistically significant difference in the frequency of tooth brushing, use of cleaning aids and regular dental visits p-value < 0.001. No significant difference was detected in the frequency of daily sugar intake among the compared groups (Table 2).

In the linear regression analysis, a very mild correlation exists between the DFS scores and the independent factors. However, after controlling for all factors. Incisor irregularity was not statistically significantly correlated with the DFS scores for both the upper and lower anterior teeth (p-value > 0.05). Only frequency of daily sugar intake and persons who do not brush their teeth exhibited statistically significant difference with the DFS scores (Tables 3 and 4).

Discussion

Dental caries is a common oral disease, and its rehabilitation is a costly and time-consuming procedure. Several factors contribute towards its pathogenesis and development, of which, dental crowding was previously investigated but with conflicting results [16]. Therefore, in the current study we aimed to investigate the potential correlation between dental caries and incisors irregularity.

Regression analysis of predictors of the upper and lower carious surfaces revealed that canine to canine irregularity (either upper or lower) had no significant effect on dental caries. However, patients who do not brush their teeth have increased odds for developing carious incidence by 2.1 times when compared to those

Participants characteristics	Male	Female		P-value
Upper incisor irregularity	3.79 [3.24 - 4.34]	3.48 [2.80 - 4.17]		0.48
Lower incisor irregularity	4.59 [3.88 - 5.29]	6.11 [5.54 - 6.68]		0.001*
Upper DFS score	1.66 [1.09 - 2.22]	2.71 [1.92 - 3.50]		0.03*
Lower DFS score	0.63 [0.31 - 0.95]	0.56 [0.21 - 0.90]		0.334
Frequency of sugar intake	3.34 [2.96 - 3.73]	3.42 [3.03 - 3.80]		0.777
Frequency of tooth brushing per day	1.55 [1.37 - 1.73]	1.66 [1.52 - 1.80]		0.333
	Low Income	Middle Income	High Income	P-value
Upper incisor irregularity	3.76 [2.97 - 4.55]	3.78 [3.10 - 4.46]	3.16 [2.35 - 3.97]	0.512
Lower incisor irregularity	5.02 [4.44 - 5.59] [a]	6.46 [5.59 - 7.34] [a]	4.97 [3.92 - 6.02]	0.014*
Upper DFS score	2.83 [1.91 - 3.75]	2.02 [1.14 - 2.90]	1.48 [0.86 - 2.11]	0.093
Lower DFS score	0.73 [0.29 - 1.17]	0.63 [0.22 - 1.03]	0.28 [0.04 - 0.51]	0.307
Frequency of sugar intake	3.67 [3.23 - 4.11]	3.13 [2.59 - 3.66]	3.17 [2.77 - 3.58]	0.164
Frequency of tooth brushing per day	1.43 [1.27-1.58] [a]	1.61 [1.40-1.82]	1.95 [1.73-2.17] [a]	0.001*

Table 2: Independent subgroup analysis. Dependent variables are expressed in mean and [95% Confidence intervals]. (*) denotes statistical significance when p-value < 0.05.

([a]) Denotes statistical significance between the corresponding groups.

Variables	Unstandardised Coefficient B	95% Confidence Interval		p-value
		Lower limit	Upper limit	
Upper Incisor Irregularity	.067	.063	.084	.326
Sugar Intake per day	0.48	0.174	0.787	.005*
Frequency of brushing				
Don't brush	2.111	.251	3.971	.026*
once	.804	.067	1.542	.033*
Twice or more	.497	-.809	1.803	.453

Table 3: Linear regression analysis for the correlation between the DFS scores and incisor irregularity in the upper arch. Statistical significance is denoted by (*) when p-value < 0.05.

Variables	Unstandardised Coefficient B	95% Confidence Interval		Sig.
		Lower limit	Upper limit	
Lower Incisor irregularity	.004	-.058	.065	.907
Sugar Intake per day	.108	.000	.217	.050*
Frequency of brushing				
Don't brush	1.246	.295	2.196	.011*
once	.249	-.129	.627	.195
Twice or more	.147	-.520	.813	.665

Table 4: Linear regression analysis for the correlation between the DFS scores and incisor irregularity in the lower arch. Statistical significance is denoted by (*) when p-value < 0.05.

who brush once or twice daily. Additionally, patients who do not brush their teeth had increased odds for lower carious incidence by 1.2 times when compared to those who brush once or twice daily. Previous literature concluded that for promoting dental health, it's important to focus on frequency, time and duration of tooth brushing. Brushing twice a day with fluoridated toothpaste is effective in preventing dental caries [17].

Analysis of income level among included patients revealed statistically significant association with frequency of brushing and method of brushing. Low-income patients were significantly neglecting tooth brushing while high income patients were significantly keener on regular dental visits and use of cleaning aids. These findings conform with previous studies on the positive association between low socio-economic status and poor oral hygiene [1,3].

Another significant risk factor for the development of dental caries is the quantity and frequency of sugar consumption. Studies have demonstrated that consuming sugars on a regular basis and in large quantities is a significant risk factor for dental caries [18]. The mean frequency of daily sugar exposure in our study was 3.38 (± 1.69) times with no significant difference among various socio-economic groups. Nevertheless, our findings confirms that increased sugar intake per day is significantly associated with increased frequency of dental caries incidence.

In a previous study, Alsulaiman., *et al*. (2019) conducted a study using arch-specific analysis to examine the association between incisor and anterior coronary caries in a US population. Irregularity of maxillary and mandibular incisors was not associated with prevalence of anterior dental caries in 9049 participants whose characteristics were; highly educated, white, middle socioeconomic status, oral health adherence, and oral self-care adult participants [19]. On the contrary, our study included participants from all socio-economic backgrounds with various oral-health-related habits and lifestyles. Nevertheless, our findings conforms with the former study regarding the impact of maxillary or mandibular incisor irregularities on the development of surface caries.

Two older studies report similar findings, Staufer and Landmesser, investigated the risk of anterior crowding on development of anterior caries and concluded that there was no significant association between crowding and prevalence of caries [6]. Stahl and Grabowski researched the prevalence of malocclusion and caries in children and whether there is a relationship between caries prevalence and studied malocclusion. The investigators were unable to find a link between the frequency of caries and malocclusion [20].

In contrast to the previously mentioned results, Buczkowska-Radlinska., *et al*, (2012) investigated the effect of incisor irregularities on the prevalence of anterior caries by combining maxillary and mandibular anterior teeth scores in 67 participants aged 15-19 years. The risk of developing anterior caries was 3.71 times higher in subjects with irregular incisors than in subjects with aligned incisors (i.e., DMFT index > 0 in the maxillary and mandibular anterior segments) [21]. A major difference between our study and this study is the population studied, as our sample was not limited to youth groups. In addition, some limitations of their study design were noted. First, the maxilla and mandible irregularities were combined into one category, as were the DMFT values for the anterior region; this approach did not take into account that incisor irregularities are site-specific. Therefore, this method may overestimate the reported results. Second, their results lacked generalizability due to the limited sample size of only 67 participants.

A major strength of the present study is using Little's Irregularity Index which was reported as valid and reliable method [22]. In addition, we used analytical approach to test the association between anterior coronal caries and incisor irregularity. Maxillary and mandibular irregularity and DFS scores was calculated separately in order to avoid an overestimated result. The analysis did not focus only on brushing alone, it also included various cleaning aids, such as mouthwash and flossing.

When evaluating the findings of this study, certain limitations must be considered. Relatively small sample size specified to the patients who came to Taibah dental college in Al Madinah. Furthermore, because the study is a cross-sectional survey, a causal association could not be clearly demonstrated. The analyses also, due to the limited resources, did not collect data regarding dental environment and other behaviors that may influence caries rate, such as salivary flow tests, oral acidity and bacterial count, preventing a more comprehensive analysis.

Conclusion

The current study assessed the effect of incisor irregularity on development of dental caries. Our results revealed that no sig-

nificant association was detected between the severity of incisors irregularity (either upper or lower) and the frequency of dental caries. However, other factors had significant contribution in the development of dental caries such as frequency of daily sugar intake and tooth brushing. In light of the results of this study, oral health education and promotion of healthy habits is recommended particularly in lower socioeconomic groups to minimize the risk of caries development.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, A.A, upon reasonable request.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare that there is no conflict of interest up to the date of publication.

Ethical Approval

Ethical approval was granted from the Research Ethics Committee, College of Dentistry, Taibah University. Registration number: TUCDREC/16022021/AAAlmarhoumi

Authors Statement and Contribution

Authors testify that all persons designated as authors qualify for authorship and have checked the article for plagiarism. If plagiarism is detected, all authors will be held equally responsible and will bear the resulting sanctions imposed by the journal thereafter.

AAA conceived and designed the study, performed the statistical analysis, revised the final draft of the manuscript and is the corresponding author. RHA, MAA, AAG, ASA, BFA conducted the research, recruited the participants collected and organized data. RHA, MAA and AAG interpreted data, wrote the initial draft of the article. ASA and BFA provided logistic support and cross-checked tables and references. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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