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Association of malocclusions in the smile zone and periodontal disease

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Aim: This epidemiological study evaluated the association of malocclusions in the smile zone and periodontal disease. **Methods:** A population-based cross-sectional study was conducted with 700 adolescents aged 15 to 19. The occlusal conditions assessed were overjet, overbite, mandibular crowding, and spacing. Periodontal Screening and Recording (PSR) determined the presence of periodontal disease. The variables were analyzed using a simple logistic regression model, estimating raw odds ratios. Variables with P<0.20 in simple analyses were tested in multiple regression models. Only the variables with P≤0.05 remained in the final adjusted model after adjusting for the other model variables. Estimating adjusted odds ratios with the respective 95% confidence intervals. **Results:** Periodontal disease was significantly associated with crowding in the anteroposterior region (OR= 1.97; 95% CI: 1.08-3.59), as well as with the presence of open bite (OR= 4.11; 95% CI: 1.57-10.76). **Conclusions:** Malocclusions in the smile's esthetic zone are associated with periodontal disease. Mandibular crowding and anterior open bite increase the risk of periodontal disease.

Keywords: Malocclusion. Periodontal diseases. Periodontal Index.

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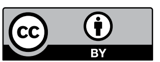

Introduction

The development and progression of periodontal disease are associated with different risk factors. Understanding how such factors change plays an essential role in the treatment and management of individuals[1]. In this context, tooth misalignment is one of the main factors contributing to periodontal disease development[2-5]. The mechanism by which malocclusion can affect periodontal health is intuitive since the disarrangement of the correct positioning of the teeth has an unfavorable environment for maintaining periodontal health. The malocclusion promotes the retention of food residues and the constant accumulation of bacterial plaque and, consequently, its mechanical removal is difficult[1,5-7].

The optimization of dentofacial aesthetics is one of the main reasons for seeking orthodontic treatment; thus, individuals expect to improve facial contour, appearance, and self-esteem since occlusal disorders located in anterior regions play an essential role in the impact of well-being. -social and emotional well-being of these individuals[8,9]. Occlusal conditions such as mandibular crowding, increased overjet, and crossbite seems to be associated with periodontal disease[8,10].

The results of studies that investigated this association were controversial. Conflicts of information can be justified by combining indices to evaluate periodontal disease and crowding without isolating the characteristics. Furthermore, we highlight the difficulty in differentiating crowding from misalignment, which can cause statistical variability caused by a small sample size. Even with ideal oral hygiene control, when teeth are inadequately positioned, especially in the mandibular arch, this is associated with difficulty in removing bacterial plaque and, consequently, gingival inflammation and periodontal problems[6,8,11,12].

The present study aims to answer the following question: What is the relationship between occlusal conditions and adolescent periodontal disease? The study hypothesis is that the malocclusions in the smile region are associated with periodontal disease.

Methods

The study was approved by the Human Research Ethics Committee (#82365917.8.0000.5385). The consent of parents and/or guardians was obtained before data collection, and the assent of underage participants.

A population-based cross-sectional study was carried out involving adolescents enrolled in public schools in a municipality in northeastern Brazil with an estimated population of 86,350 inhabitants and a human development index of 0.661. A representative sample of adolescents aged 15 to 19 enrolled in all public schools in the city was selected. Initially, a complex stratified sampling was conducted at two levels: schools by neighborhoods and students by school. The minimum sample size of 560 participants was calculated using the G*Power Program (G*Power: Statistical Power Analysis, Düsseldorf, Germany), considering a confidence interval (CI) of 95%, a test power of 80%, and an effect size of 1.5.

The sample was increased by 20% to compensate for possible dropouts. Only adolescents with complete permanent dentition were included in the study. Adolescents who underwent previous or current orthodontic treatment and those with an apparent mental and/or physical disability that could influence the results of the oral examination were excluded from the study. The final sample comprised 700 adolescents.

Malocclusion was assessed epidemiologically using a WHO probe using the Dental Aesthetics Index (DAI)[9,12-16]. The DAI is a numerical index designed to assess specific occlusal characteristics and includes parameters of dentofacial anomalies related to clinical and aesthetic aspects. The present study used the occlusion assessment parameters defined by the index: overjet, overbite, mandibular crowding, and spacing. For data analysis, the variables were divided into standard, increased, and decreased overjet (or anterior crossbite), mandibular crowding, and spacing[13].

Overjet was measured in millimeters, considering the distance between the buccal incisor of the most protruding upper incisor and the buccal surface of the corresponding lower incisor. The values considered were ≥ 3 mm = normal overjet, ≤ 0 mm = decreased overjet and > 4 mm = increased overjet. Overbite was measured in millimeters, considering the distance between the incisal edges of the anterior teeth. The values considered were ≥ 3 mm = normal overbite, ≤ 0 mm = anterior open bite and > 4 mm = deep bite. Mandibular crowding included the four lower permanent incisors. Crowding was considered when the space between the right and left lower canines was insufficient to accommodate the four incisors in alignment and was classified as no mandibular crowding and with mandibular crowding. Anterior spacing was considered when the space between the right and left canines was greater than necessary for the normal alignment of the incisors. Spacing in the anterior segment was classified as no spacing, spacing in at least one dental arch, and spacing on the maxillary and mandibular arches[9,12-16].

Periodontal Screening and Recording (PSR) determined the periodontal conditions using a WHO 621 probe (Golgran, São Caetano do Sul, SP)[17]. The following parameters were considered: 0, periodontal health without visible bleeding; 1, periodontal health with bleeding after probing; 2, periodontal health with bleeding and presence of retentive factors; 3, presence of a shallow pocket of 4 to 5 mm; 4, presence of a deep pocket ≥ 6 mm[17]. For the present study, periodontal problems were dichotomized: 0 – 2, with no periodontal disease; 3 – 4, with periodontal disease.

Calibration

A single examiner, previously trained and calibrated, performed the oral examinations. The calibration consisted of a theoretical discussion followed by a practical calibration. The training in question resulted in an intraclass correlation coefficient greater than 0.92, indicating satisfactory inter- and intra-examiner agreement.

Statistical Analysis

A contingency table was constructed between each independent variable and the study outcome (periodontal disease). Logistic regression models were adjusted

between each independent variable and the outcome. Variables that showed P<0.20 in these individual analyses were studied in a multiple logistic regression model. Only the variables with P≤0.05 remained in the final adjusted model after adjusting for the other model variables. Based on the coefficients of the regression models, crude, and adjusted odds ratios with 95% confidence intervals were estimated. Model fit was assessed using the Akaike Information Criterion (AIC). All analyses were performed using the R program (R Foundation for Statistical Computing, Vienna, Austria), with a significance level of 5%.

Results

The final sample comprised 700 adolescents aged 15 to 19, 53.9% female (n= 377) and 46.1% male (n= 323). The descriptive data of the sample is shown in Table 1.

Table 1. Descriptive data of the evaluated variables.

Variable	Category	n (%)
Global	-	700 (100.0%)
Age range	≤ 16 years	489 (69.9%)
	> 16 years	211 (30.1%)
Sex	Male	323 (46.1%)
	Female	377 (53.9%)
Mandibular crowding	Absence	493 (70.4%)
	Presence	207 (29.6%)
Spacing	Absence	572 (81.7%)
	Presence	128 (18.3%)
Maxillary overjet	Absence	697 (99,6%)
	Presence	3 (0.4%)
Anterior open bite	Absence	670 (95.7%)
	Presence	30 (4.3%)
Anterior crossbite	Absence	696 (99.4%)
	Presence	4 (0.6%)

Table 2 presents the crude and adjusted analyses of the associations between malocclusion and periodontal disease. The results showed that periodontal disease was significantly associated with mandibular crowding (OR= 1.97; 95% CI: 1.08-3.59) and anterior open bite (OR= 4.11; 95% CI: 1.57-10.76).

Table 2. Analyzes (crude and adjusted) of associations with the presence of periodontal disease.

Variable	Category	Periodontal disease		OR crude (CI95%)	p-value	OR adjusted (CI95%)	p-value
		Absence	*Presence				
		n (%)	n (%)				
Global	-	650 (92.9%)	50 (7.1%)	-	-	-	-
Age range	≤ 16 years	459 (93.9%)	30 (6.1%)	1		-	-
	> 16 years	191 (90.5%)	20 (9.5%)	1.60 (0.89-2.89)	0.1177		
Sex	Male	297 (92.0%)	26 (8.0%)	1.29 (0.72-2.29)	0.3896	-	-
	Female	353 (93.6%)	24 (6.4%)	1			
Mandibular crowding	Absence	464 (94.1%)	29 (5.9%)	1		1	
	Presence	186 (89.9%)	21 (10.1%)	1.81 (1.01-3.25)	0.0482	1.97 (1.08-3.59)	0.0260
Spacing	Absence	531 (92.8%)	41 (7.2%)	1		-	-
	Presence	119 (93.0%)	9 (7.0%)	0.98 (0.46-2.07)	0.9570		
Overjet	Absence	648 (93.0%)	49 (7.0%)	1		-	-
	Presence	2 (66.7%)	1 (33.3%)	6.61 (0.59-74.21)	0.1257		
Anterior open bite	Absence	626 (93.4%)	44 (6.6%)	1		1	
	Presence	24 (80.0%)	6 (20.0%)	3.56 (1.38-9.16)	0.0085	4.11 (1.57-10.76)	0.0040
Anterior crossbite	Absence	646 (92.8%)	50 (7.2%)	-		-	-
	Presence	4 (100.0%)	0 (0.0%)				

*Outcome. 1: Reference category for independent variables. OR: Odds ratio. CI: Confidence interval.
AIC (empty model)=362.25; AIC (final model)=355.92.

Discussion

The association between malocclusion and periodontal disease awakens interest in the literature. However, the need for standardization of evaluation methods is evident, which compromises comparisons and influences results[1,6,11,18]. Thus, the present study answered the question: What is the relationship between occlusal conditions and adolescent periodontal disease? The study hypothesis was accepted. Our results showed that mandibular crowding and anterior open bite affect adolescent periodontal conditions.

Periodontal disease presents different layers of clinical manifestations, from gingival inflammation to the most severe cases leading to tooth loss[19-21], and age plays a crucial role in this context. Adolescents are commonly affected by milder forms of the disease, although the more severe periodontal disease is less common, and the inflammatory changes associated with periodontal disease occur during this period[21,22].

Several diagnostic methods have been used in epidemiological studies to assess periodontal disease, ranging from detecting retentive factors to identifying bone loss through radiographic examinations[8]. However, the different methods prevent comparison between studies[8,21]. To assess occlusal conditions in the context of a population-based study, we chose to adopt the DAI index criteria. Although we did not use all of its components, the evaluation criteria were clearly and precisely used. Therefore, in the present study, we sought not only to standardize the instruments used to assess these two variables but also to ensure that the assessment was carried out by a single, duly trained, and calibrated evaluator. In addition, it is essential to highlight that one of the study's strengths is that it used a homogeneous and representative sample of adolescents.

Our findings showed that mandibular crowding was associated with periodontal disease in adolescents. The results are in line with the literature, which highlights that periodontal problems, especially gingival bleeding, are associated with lower anterior teeth, suggesting that crowding and the presence of retentive factors may contribute to this association[1,8,21,23].

The anterior open bite was also associated with the presence of periodontal disease. A previous study observed that an anterior open bite favored the accumulation of bacterial plaque, gingival inflammation, and increased clinical probing depth24. The absence of anterior vertical contact, a condition that characterizes an open bite, makes it difficult to adequately clean the area, mainly if other associated conditions, such as inadequate dental positions, are commonly found[24]. Thus, despite the aesthetic and functional impact, anterior open bite influences the health of periodontal tissues and deserves prominence.

Mandibular crowding was the most prevalent condition in the studied population, followed by spacing and anterior open bite. However, only mandibular crowding and anterior open bite were associated with periodontal disease. Concerning the literature, the subject of discussion is the relationship between the presence of maxillary overjet, anterior crossbite, and spacing with the presence of periodontal disease. A study conducted by Bernhardt et al.[8] showed that these conditions are more strongly linked to severe periodontal problems, including gingival trauma, which can accentuate the occurrence of gingival recessions and, consequently, attachment loss. In addition, it is worth mentioning that the frequency of these conditions in our sample population was low.

As a population-based epidemiological study, this study did not collect participant model records. This limitation restricted the capacity to categorize the sample into subgroups. Consequently, future studies are encouraged to establish cutoff points for dental crowding and conduct a more in-depth examination of this association. Finally, our findings highlight the importance of the professional's correct guidance regarding the influence of these malocclusions on the onset and/or progression of periodontal disease. Periodontal-orthodontic treatment is frequently included in adult patients with periodontal disease due to impaired smile esthetics, functional problems, or adjunctive treatment before prosthetic rehabilitation. Our findings suggest that the adolescent patient should be evaluated with the same

care since the orthodontic treatment provides occlusal balance and improves periodontal conditions.

In conclusion, malocclusions in the smile's esthetic zone are associated with periodontal disease. Mandibular crowding and anterior open bite increase the risk of periodontal disease. Periodontal–orthodontic treatment could be included in the follow-up of the adolescent patient.

Conflict of Interest

The authors have no conflict of interest to disclose.

Data Availability

Datasets related to this article will be available to the corresponding author upon request.

Author Contribution

Diego Patrik Alves Carneiro: Conceptualization, Methodology, Data curation, Data analysis, Writing. **Kaarlye Cantarelli Pires Andrade de Melo:** Conceptualization, Methodology, Data curation. **Marcelo de Castro Meneghim:** Writing- Reviewing and Editing. **Silvia Amélia Scudeler Vedovello:** Conceptualization, Methodology, Writing- Reviewing and Editing. All authors actively revised and approved the final version of the manuscript.

References

1. Alsulaiman AA, Kaye E, Jones J, Cabral H, Leone C, Will L, et al. Incisor malalignment and the risk of periodontal disease progression. Am J Orthod Dentofacial Orthop. 2018 Apr;153(4):512-22. doi: 10.1016/j.ajodo.2017.08.015.
2. AlJehani YA. Risk factors of periodontal disease: review of the literature. Int J Dent. 2014;2014:182513. doi: 10.1155/2014/182513. Retraction in: Int J Dent. 2021 Feb 12;2021:8735071. doi: 10.1155/2021/8735071.
3. Sierwald I, John MT, Schierz O, Jost-Brinkmann PG, Reissmann DR. Association of overjet and overbite with esthetic impairments of oral health-related quality of life. J Orofac Orthop. 2015 Sep;76(5):405-20. doi: 10.1007/s00056-015-0300-x.
4. Knight ET, Liu J, Seymour GJ, Faggion Jr CM, Cullinan MP. Risk factors that may modify the innate and adaptive immune responses in periodontal diseases. Periodontol 2000. 2016 Jun;71(1):22-51. doi: 10.1111/prd.12110.
5. Javali MA, Betsy J, Al Thobaiti RSS, Alshahrani RA, AlQahtani HAH. Relationship between malocclusion and periodontal disease in patients seeking orthodontic treatment in Southwestern Saudi Arabia. Saudi J Med Med Sci. 2020 May-Aug;8(2):133-9. doi: 10.4103/sjmms.sjmms_135_19.
6. Silness J, Røynstrand T. Relationship between alignment conditions of teeth in anterior segments and dental health. J Clin Periodontol. 1985 Apr;12(4):312-20. doi: 10.1111/j.1600-051x.1985.tb02297.x.
7. Seong J, Bartlett D, Newcombe RG, Claydon NCA, Hellin N, West NX. Prevalence of gingival recession and study of associated related factors in young UK adults. J Dent. 2018 Sep;76:58-67. doi: 10.1016/j.jdent.2018.06.005.

8. Bernhardt O, Krey KF, Daboul A, Völzke H, Kindler S, Kocher T, et al. New insights in the link between malocclusion and periodontal disease. J Clin Periodontol. 2019 Feb;46(2):144-59. doi: 10.1111/jcpe.13062.

9. Carneiro DPA, Venezian GC, Valdrighi HC, Meneghim MC, Vedovello SAS. Esthetic impact of maxillary midline diastema and mandibular crowding in children in the mixed dentition. Am J Orthod Dentofacial Orthop. 2022 Mar;161(3):390-5. doi: 10.1016/j.ajodo.2020.09.031. Epub 2021 Oct 20.

10. Helm S, Petersen PE. Causal relation between malocclusion and periodontal health. Acta Odontol Scand. 1989 Aug;47(4):223-8. doi: 10.3109/00016358909007705.

11. Ngom PI, Diagne F, Benoist HM, Thiam F. Intraarch and interarch relationships of the anterior teeth and periodontal conditions. Angle Orthod. 2006 Mar;76(2):236-42. doi: 10.1043/0003-3219(2006)076[0236:IAIROT]2.0.CO;2.

12. Gusmão ES, Queiroz RDC, Coelho RS, Cimões R, Santos RL. Association between malpositioned teeth and periodontal disease. Dent Press J Orthod. 2011;16(4):87-94.

13. Cons NC, Jenny J, Kohout FJ, Songpaisan Y, Jotikastira D. Utility of the dental aesthetic index in industrialized and developing countries. J Public Health Dent 1989 Summer;49(3):163-6. doi: 10.1111/j.1752-7325.1989.tb02054.x.

14. de Melo KCPA, Vedovello-Filho M, Furletti-Góis VF, Meneghim MC, Vedovello SAS. Is the adolescent's esthetic concern associated with anterior occlusal conditions or the malocclusion severity level? Angle Orthod. 2021 Jul;91(4):496-501. doi: 10.2319/062320-576.1.

15. Nabarrette M, Brunheroto J, Dos Santos PR, Meneghim MC, Vedovello SAS. Esthetic impact of malocclusions in the anterior segment on children in the mixed dentition. Am J Orthod Dentofacial Orthop. 2021 Jan;159(1):53-8. doi: 10.1016/j.ajodo.2019.11.019. Epub 2020 Nov 19.

16. Silva DAF, Carneiro DPA, Nabarrette M, Vedovello Filho M, Santamaria Jr M, Vedovello SAS. Impact of Dental Aesthetic Index characteristics on the severity levels of malocclusion in a non-White population. Am J Orthod Dentofacial Orthop. 2022 Nov;162(5):e252-6. doi: 10.1016/j.ajodo.2022.08.011.

17. Nobre CM, Fernandes-Costa AN, de Melo Soares MS, Pugliesi DM, de Vasconcelos Gurgel BC. Periodontal disease detection in primary and mixed dentitions. Eur Arch Paediatr Dent. 2016 Oct;17(5):407-11. doi: 10.1007/s40368-016-0248-6.

18. Staufer K, Landmesser H. Effects of crowding in the lower anterior segment--a risk evaluation depending upon the degree of crowding. J Orofac Orthop. 2004 Jan;65(1):13-25. doi: 10.1007/s00056-004-0207-4.

19. Diedrich P. Periodontal relevance of anterior crowding. J Orofac Orthop. 2000;61(2):69-79. doi: 10.1007/BF01300349.

20. Shaju JP, Zade RM, Das M. Prevalence of periodontitis in the Indian population: a literature review. J Indian Soc Periodontol. 2011 Jan;15(1):29-34. doi: 10.4103/0972-124X.82261.

21. Baiju RMP, Peter E, Nayar BR, Varughese JM, Varghese NO. Prevalence and predictors of early periodontal disease among adolescents. J Indian Soc Periodontol. 2019 Jul-Aug;23(4):356-61. doi: 10.4103/jisp.jisp_512_18.

22. Bali RK, Mathur VB, Talwar PP, Chanana HB. National oral health survey and Fluoride mapping, 2002-2003, India. New Delhi: Dental Council of India; 2004.

23. El-Mangoury NH, Gaafar SM, Mostafa YA. Mandibular anterior crowding and periodontal disease. Angle Orthod. 1987 Jan;57(1):33-8. doi: 10.1043/0003-3219(1987)057<0033:MACAPD>2.0.CO;2.

24. Bechtold TE, Briegleb HK. Periodontal and gingival incisor findings in patients with anterior open bite in the mixed dentition. J Orofac Orthop. 2010 May;71(3):199-206. doi: 10.1007/s00056-010-9950-x.