



The relationship between malocclusion, lip competence and gingival health in a group of schoolchildren

Relação entre má-oclusão, incompetência labial e saúde gengival num grupo de crianças em idade escolar

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Abstract

Objectives: The aim of this study was to determine the relationship between malocclusion, lip competence and gingival health among a sample of school children. **Material and method:** A multi stage sampling technique was used to randomly select 239 school children. Malocclusion was evaluated and graded from the children's dental casts using the Dental Aesthetics Index (DAI) and Littles' Irregularity Index (LII). The lips were examined for competence according to Jackson's classification. Gingival health was assessed using the Plaque Index and Index of gingival inflammation. **Results:** A mean DAI score of 26.37 ± 6.67 was obtained while the mean score of the LII was 1.88 ± 1.68 mm. Majority of the children (97.1%) had competent lips. Results of correlation tests between DAI scores and the periodontal indices were low and not statistically significant, while that of the LII score and periodontal indices were also low but statistically significant ($p < 0.05$). **Conclusion:** A cause and effect relationship could not be established between malocclusion and gingivitis. A weak correlation exists between malocclusion assessed by the DAI and LII and periodontal indices used. This supports the opinion that prescribing orthodontic treatment solely for the purpose of maintaining periodontal health is not justified.

Keywords: Lip incompetence. Malocclusion. Gingival health.

Resumo

Objetivos: O objetivo deste estudo foi determinar a relação entre má-oclusão, incompetência labial e saúde gengival numa amostra de crianças em idade escolar. **Material e método:** A técnica de amostragem em estágios múltiplos foi utilizada para selecionar aleatoriamente 239 crianças escolares. A má-oclusão foi avaliada e graduada por modelos dentários das crianças utilizando o índice dentário estético (DAI) e o índice de irregularidades de Little (LII). Os lábios foram examinados e classificados – quanto à competência – pela classificação de Jackson. A saúde gengival foi determinada pelo índice de placas e índice de inflamação gengival. **Resultados:** O escore médio DAI de $26,37 \pm 6,67$ foi obtido, enquanto o escore médio LII foi $1,88 \pm 1,68$ mm. A maioria das crianças (97,1%) tinha lábios competentes. Os resultados dos testes de correção entre escores DAI e índices periodontais foram baixos e não estatisticamente significantes, enquanto o escore LII e os índices periodontais foram também baixos, mas estatisticamente significantes ($p < 0,05$). **Conclusão:** Não foi possível estabelecer uma relação de causa e efeito entre má-oclusão e gengivite. Uma correlação fraca existe entre má-oclusão determinada por DAI e LII e os índices periodontais utilizados. Isso suporta a opinião de que prescrever tratamento ortodôntico apenas com a finalidade de manter a saúde periodontal não se justifica.

Palavras-chave: Incompetência labial. Má-oclusão. Saúde gengival.

Introduction

A number of studies have been carried out to investigate the possible aetiological relationship of malocclusion and irregularity of teeth to periodontal disease yet the issue remains controversial (1). Normal occlusion was considered anatomically and functionally essential for the development and maintenance of a healthy dentition (2). Most researchers agree that bacterial plaque is the primary aetiological cause of gingival inflammation and periodontitis (3, 4). Thus conditions that accentuate the retention of soft deposits and plaque such as uneven tooth surfaces, irregularity of teeth, overhanging restorations or ill fitting margins of dental restorations, orthodontic appliances mouth breathing could lead to periodontal compromise (5).

Saxton (6) found that crowding and other irregularities in the position of teeth may also modify the rate of plaque growth. Silness and Roynstrand (7), Helm and Petersen (8) in separate studies found associations between various malocclusion traits and periodontal disease. Geiger et al. (9) carried out detailed examination of the periodontium and characteristics of the occlusion of a cross section of 516 individuals and found that crowding and spacing of teeth were not associated with periodontal destruction. Yet clinical observations show that crowding of teeth may make effective cleaning difficult, predisposing such individuals to periodontal destruction. Tooth malalignment is frequently accompanied by gingival inflammation and may provide

a case for orthodontic treatment (10). Ashley et al. (10) in a study among 201 children aged 11-14 years found no evidence of a relationship between incisor overlap and the amount of plaque present but however reported that overlapping of incisor teeth was directly related to gingivitis.

Results of more recent studies have continued to give conflicting results. Ngom et al. (11) found weak but significant correlations between certain parameters of inter-arch and intra-arch relationship and some indices of periodontal condition. They concluded that providing orthodontic treatment on the ground of the deleterious effect of malocclusion and malpositioned teeth on periodontal condition is justified. Pugaca et al. (12) also found a statistically significant relationship between severity of upper incisor crowding, overbite and periodontal index scores. Abu Alhaija and Al-Wahadni (13) examined the relationship between tooth irregularity and periodontal disease in children and found no association between the number and type of displacement and plaque accumulation, gingivitis, attachment loss and alveolar bone level.

There is some uncertainty about the influence of the lip posture on gingival health, but a commonly occurring clinical phenomenon is hyperplastic gingivitis in anterior segments usually the upper incisor regions, where there is a lack of lip seal (5) Addy et al. (14) found that maxillary and mandibular plaque and bleeding scores increased with decreasing upper lip coverage at rest.

Early studies have shown a close relationship between tooth deposits and periodontal disease. (15). Oral hygiene measures such as tooth brushing and other mechanical cleaning procedures are considered to be the most reliable means of controlling plaque the primary aetiologic agent of periodontal diseases (16). Effective plaque removal is essential to dental and periodontal health throughout life. Although studies on the relationship of these factors have been carried out in many parts of the world, not much has been done in Nigeria. The aim of this study was to determine the relationship between irregularity of teeth, lip competence, oral hygiene status and gingivitis among a sample of children in Ile-Ife, Nigeria.

Material and method

A multi stage sampling technique was used to select 252 school children from the junior secondary section of schools in Ile- Ife southwestern Nigeria. Ethical approval was obtained from the ethics committee of the Obafemi Awolowo University Teaching Hospitals Complex. Approval was also obtained from the appropriate school authorities. Parental and the children's consent were also obtained. The participants were willing to participate. No child was found to be undergoing orthodontic treatment.

Each participant was assessed by two examiners: the first examiner (E.O.O) assessed for plaque accumulation and gingivitis. The Plaque Index (17) was used for assessment of oral hygiene status, while the Index of Gingival Inflammation (18) was used to grade gingivitis. This involves simple tests of gingival condition such as gingival colour, change of contour, readiness to bleed on gentle probing which conditions in the field permit. A gingival index score of 0 indicates no gingivitis, 0.1-1.0 mild gingivitis, 1.1-2.0 moderate gingivitis and 2.1-3.0 severe gingivitis.

After periodontal examination, impressions for dental casts were taken for all the children from which orthodontic evaluation was done. Malocclusion was assessed and graded using the Dental Aesthetics Index (DAI) (19) and Little's Irregularity Index (LII) (20) by the second examiner (K.A.K). The DAI is an orthodontic index that links clinical and aesthetic components mathematically to produce a single score. The 10 components used included the number of missing visible teeth (incisors, canines, and premolars) in the maxillary and mandibular arches,

crowding and spacing in the incisal segments, mid-line diastema, anterior irregularity in the maxillary and mandibular arches, anterior maxillary overjet and mandibular overjet (mandibular protrusion), vertical anterior open bite and the anteroposterior molar relationships are assessed. Scores for each of these morphologic characteristics were determined by direct measurement. The multiplication of these scores by the weighting factor (regression coefficient), a summation of these products, and a constant produced the total DAI score.

Malocclusion was also determined using the Little's irregularity index (1975). From the dental casts the children, the linear displacement of the adjacent anatomic contact points of the mandibular incisors was determined. The sum of the five measurements represents the irregularity index value for each case. The Irregularity Index value is categorized as < 1 mm no crowding, 1-3 mm mild crowding, > 3-6 mm moderate crowding and > 6 mm severe crowding.

The lips were examined for competence with the masticatory and facial muscles at rest. Upper and lower lips were scored separately according to the method described by Jackson. (21). The position of the middle third of the lower border of the upper lip was recorded as 0, 1, 2 or 3 according to its position on the labial surface of the maxillary incisors. The position of the lower lip on the maxillary incisors was recorded similarly but from incisal to cervical. In addition, if the lower lip was trapped behind the upper incisor, a negative classification (-1) was recorded. Competent upper and lower lip position is signified when the combination of scores is 3/1 or 2/2.

Data entry and analysis were done on an IBM-compatible personal computer. The SPSS version 11.0 was used. Descriptive statistics was used to determine the frequency distribution and percentage ratio for each of the variables. *Chi*-square test was used to compare the male and female participants. Correlation coefficient tests were used to determine the relationship between irregularity of teeth and the periodontal health of the children using the malocclusion and periodontal indices.

Results

The final sample consisted of 116 male and 123 female participants, with a mean age of 12.51 ± 1.07 years. Children with incomplete data

were excluded from the analysis. The DAI scores of the children ranged from 15 to 61 with a mean DAI score of 26.37 ± 6.67 . The children were categorized into treatment need groups according to the DAI scores (Table 1). Fifty four percent of the children were in the category where orthodontic treatment need is slight or not indicated, 23.9% in the group where treatment is elective, 12.1% treatment highly desirable and 10% treatment mandatory. There was no significant difference in distribution of the male and female scores. The Little's irregularity index scores ranged from 0 to 9.5 mm with a mean score of 1.88 ± 1.68 mm. The mean for the male and female participants were 2.0 ± 1.87 mm and 1.78 ± 1.48 mm respectively. The difference was not statistically significant.

Table 2 shows the relationship of malocclusion according to the Dental Aesthetic Index (DAI) and Plaque Index score. Majority of the children

in all categories of malocclusion had a score of 2 indicating moderate accumulation of plaque which can be seen by the naked eye, while only 2.5% had a score of 3 indicating heavy accumulation of soft material. There was a significant gender difference in Plaque Index scores ($p = 0.001$).

The relationship of malocclusion according to the Dental Aesthetic Index (DAI) and gingival Index score is shown in Table 3. Majority had mild gingivitis (50.6%), about half of the sample with severe gingivitis were in the "no need for treatment" category of malocclusion. There was no significant gender difference in Gingival Index scores ($p = 0.487$).

Table 4 shows that majority of the participants had mild crowding (51%), none of children with moderate or severe crowding had a plaque index score of 0. There were significant differences in Plaque Index scores between the LII categories.

Table 1 - Sex distribution of dental aesthetic index (DAI) scores

DAI Score	Treatment category	Female N (%)	Male N (%)	Total N (%)
<25	No treatment	69 (28.9)	60 (25.1)	129 (54)
26-30	Treatment elective	27 (11.3)	30 (12.6)	57 (23.9)
31-35	Treatment highly desirable	12 (5.0)	17 (7.1)	29 (12.1)
>36	Treatment mandatory	15 (6.3)	9 (3.7)	24(10.0)

$X^2 = 2.95$ df = 3 $p = 0.400$

Table 2 - Relationship of dental aesthetic index (DAI) and plaque index scores

DAI Score	Treatment category	Plaque index score				Total N (%)
		0 N (%)	1 N (%)	2 N (%)	3 N (%)	
<25	No treatment	3(1.3)	55(23.0)	70(29.3)	1(0.4)	129(54.0)
26-30	Treatment elective	3(1.3)	19(8.0)	32(13.4)	3(1.3)	57(23.9)
31-35	Treatment highly desirable	1(0.4)	8(3.3)	19(8.0)	1(0.4)	29(12.1)
>36	Treatment mandatory	2(0.8)	8(3.3)	13(5.4)	1(0.4)	24(10.0)
		9(3.8)	90(37.7)	134(56.1)	6(2.5)	239(100.0)

Likelihood ratio = 8.481 df = 9 $p = 0.486$; $r = 0.074$ $p = 0.257$

Table 3 - Relationship of dental aesthetic index (DAI) and gingival index scores

DAI Score	Treatment category	Gingival index score				Total N (%)
		0 = no gingivitis N (%)	1 = mild gingivitis N (%)	2 = moderate gingivitis N (%)	3 = severe gingivitis N (%)	
<25	No treatment	39(16.3)	67(28.0)	14 (5.9)	9 (3.8)	129 (54.0)
26-30	Treatment elective	19 (8.0)	22 (9.2)	13 (5.4)	3 (1.3)	57 (23.9)
31-35	Treatment highly desirable	7 (2.9)	18 (7.5)	2 (0.8)	2 (0.8)	29 (12.1)
>36	Treatment mandatory	5 (2.1)	14 (5.9)	3 (1.3)	2 (0.8)	24 (10.0)
		70(29.3)	121(50.6)	32(13.4)	16(6.7)	239(100.0)

Likelihood ratio = 9.259 df = 9 p = 0.414; r = 0.048 p = 0.456

Table 4 - Relationship of Little's irregularity index (LII) and plaque index scores

LII Score	Category	Plaque index score				Total N (%)
		0 N (%)	1 N (%)	2 N (%)	3 N (%)	
<1 mm	No crowding	4(1.7)	34(14.2)	32(13.4)	0(0)	70 (29.3)
1-3 mm	Mild crowding	5(2.1)	41(17.2)	72(30.1)	4(1.7)	122(51.0)
>3-6 mm	Moderate crowding	0(0)	15(6.3)	27(11.3)	1(0.4)	43(18.0)
>6 mm	Severe crowding	0(0)	0(0)	3(1.3)	1(0.4)	4 (1.7)
		9(3.8)	90(37.7)	134(56.1)	6(2.5)	239(100)

Likelihood ratio = 18.623 df = 9 p = 0.029; r = 0.191 p = 0.003

Majority of the children in all LII categories of malocclusion had mild gingivitis. Only 6.7% (Table 5) of them had severe gingivitis about half of whom had mild crowding. The relationship between the PI, GI and malocclusion according to the DAI and LII were examined. Correlations between the DAI scores and PI and GI scores gave low results which were not statistically significant. The relationship between the LII score and PI and GI scores were also low but statistically significant (p = 0.003 and p = 0.004 respectively).

Majority of the children (97.1%) had competent lips (Tables 6 and 7). Only 7 of all the children had incompetent lips 4 of whom were boys. The mean DAI and LII of the children with incompetent

lips were 36.1 ± 3.8 and 2.50 ± 1.35 mm respectively. Of the children with incompetent lip, 4 (57.1%) had PI score of 2 indicating moderate accumulation of plaque which can be seen by the naked eye. Two (28.6%) heavy accumulation of soft material (Table 6). The PI scores were significantly different between the competent and incompetent groups (p = 0.000). Like the rest of the sample, majority of those with incompetent lips had mild gingivitis (Table 7).

Correlation tests between lip competence and the periodontal indices gave generally low results. Significant relationship was found only between lip competence and the Plaque Index (r = 0.145, p < 0.05). One way analysis of variance showed significant differences in Gingival Index scores between the

malocclusion groups according to the LII ($p = 0.023$) which did not reach statistical significance with the DAI.

Discussion

Research on the relationship between irregularity of teeth and periodontal disease has given conflicting results. This could be attributed to the differences in methods of assessing irregularity, the features of malocclusion studied, as well as the differences in the indices of assessment of periodontal health. The mean DAI score of the children in this study was 26.37 ± 6.67 . This is higher than the findings of Otuyemi et al. (22) among school children in Ile-Ife Nigeria and a study among Australian students (23), lower than findings in Japanese students

(24) but similar to the values found among students in the United States of America (25) and among Spanish adolescents. The mean DAI score of the whole Spanish series was 25.6 ± 7.94 (26).

The children were categorized into treatment need groups according to the DAI scores. Similar to previous studies, there was no significant difference in distribution of the male and female scores. The percentage of the children in which treatment is highly desirable and treatment mandatory is similar to the findings of Onyeaso and Aderinokun (27) also in a group of school children in Ibadan, Nigeria, but different from that of Otuyemi et al. (22) in a group of school children in Ile-Ife. The later study had a lower percentage of children in these groups with a large percentage about 75% having no need for treatment. Only about 50% of participants in this study had no need for orthodontic treatment.

Table 5 - Relationship of Little’s irregularity index (LII) and gingival index scores

LII Score	Category	Gingival index score				Total
		No gingivitis N (%)	Mild gingivitis N (%)	Moderate gingivitis N (%)	Severe gingivitis N (%)	
<1 mm	No crowding	25 (10.5)	35 (14.6)	6 (2.5)	4 (1.7)	70(29.3)
1-3 mm	Mild crowding	38 (15.9)	62 (25.9)	15 (6.3)	7 (2.9)	122(51.0)
>3-6 mm	Moderate crowding	7 (2.9)	22 (9.2)	9 (3.8)	5 (2.1)	43(18.0)
>6 mm	Severe crowding	0 (0)	2 (0.8)	2 (0.8)	0 (0)	4(1.6)
		70(29.3)	121(50.5)	32(13.4)	16(6.7)	239(100.0)

Likelihood ratio = 13.378 df = 9 $p = 0.127$; $r = 0.184$ $p = 0.004$

Table 6 - Relationship of lip competence and plaque index score

Lip competence	Plaque index score				Total N (%)
	0 N (%)	1 N (%)	2 N (%)	3 N (%)	
Competent	9 (3.8)	89 (37.2)	130 (54.4)	4 (1.7)	232 (97.1)
Incompetent	0 (0)	1 (0.4)	4 (1.7)	2 (0.8)	7 (2.9)
	9 (3.8)	90 (37.6)	134 (56.1)	6 (2.5)	239 (100)

Likelihood ratio = 8.622 df = 3 $p = 0.035$; $r = 0.145$ $p = 0.025$

Table 7 - Relationship of lip competence and gingival index score

Lip competence	Gingival index score				Total
	No gingivitis N (%)	Mild gingivitis N (%)	Moderate gingivitis N (%)	Severe gingivitis N (%)	
Competent	69 (28.9)	116 (48.5)	31 (13.0)	16 (6.7)	232(97.1)
Incompetent	1 (0.4)	5 (2.1)	1 (0.4)	0 (0)	7 (2.9)
	70 (29.3)	121 (50.6)	32 (13.4)	16 (6.7)	239 (100)

Likelihood ratio = 2.184 df = 3 p = 0.535; r = 0.023 p = 0.727

The mean scores for the LII for both male and female participants in this study was lower than values of 2.78 ± 2.87 mm and 3.26 ± 3.60 mm for females and males respectively found by Bernabe and Flores-Mir (28) among two hundred school children in Peru. There is a possibility that jaw size in Africans may be large due to the toughness of the diet commonly taken. This could have reduced the degree of overlap. There were significant sex differences in PI scores ($p = 0.01$) (Tables 4 and 5).

The male participants exhibited poorer oral hygiene compared with females. This is in agreement with previous studies (29, 30). In spite of the differences in Plaque Index scores, there was however no significant gender difference in the gingivitis assessment. A similar proportion of both the boys and girls had severe gingivitis. While the boys may have been lax with their oral hygiene measures, the hormonal changes of puberty may have affected the gingival health of the girls being adolescents.

The results of this study show a weak correlation between malocclusion assessed by the DAI, LII and the Plaque and Gingival Index scores. Indicating that the presence of occlusal irregularities in some individuals did not make their oral health assessed by the level of plaque accumulation and gingivitis worse than those without irregularities. This is similar to the report by Ashley et al. (10). Abu Alhajja and Al-Wahadni (13) found that there was no association between irregularity of teeth and periodontal diseases in presence of good oral hygiene, but contrasts with earlier studies by Buckley (31) and Griffiths and Addy (32). Buckley found that individual tooth irregularity had a low but statistically significant correlation with plaque, calculus and

gingival inflammation. The varying results may be due to the differences in the assessment of irregularity or malocclusion. Apart from assessing the presence of crowding the DAI also considers other features of malocclusion such as overjet, molar relationship which could have reduced its sensitivity.

The DAI scores were also used to categorize the children into treatment need groups. The result of the correlation tests also indicates that participants in the worse treatment need groups did not have worse oral health than the others. Orthodontic treatment is traditionally prescribed for considerations of aesthetics, function and because of the increased risk of susceptibility to other dental diseases but the findings of this study do not justify prescribing orthodontic treatment solely for the purpose of maintaining periodontal health.

The relationship of the plaque and gingival indices with the Little's Index of Irregularity also gave weak correlations although this was statistically significant. The Little's irregularity Index is a quantitative method for assessing lower anterior alignment. It measures the linear displacement of the adjacent anatomic contact points of the mandibular incisors. Measuring only one feature of malocclusion, which is crowding may make it more sensitive than other indices. The weak value still obtained may however be due to the generally low values of the LII obtained among the participants.

There was a significant difference in the distribution of PI scores among the LII categories, analysis of variance also showed significant differences in gingival index scores between the malocclusion groups according to the LII. There were differences as the degree of crowding varied. This further supports

the opinion of Saxton (6) that crowding and other irregularities in the position of teeth accentuates the retention of soft deposits and plaque, and may also modify the rate of plaque growth.

The absence of lip coverage is thought to diminish the normal cleansing action of saliva so that plaque accumulation is encouraged, dehydration of the tissues may also impair their resistance making them more susceptible to gingivitis. Although the number of the participants with incompetent lips was small, it was therefore not surprising that a significant relationship was found between lip competence and the plaque index. ($r = 0.145$, $p < 0.05$) Addy et al. (14) also found that plaque and bleeding scores increased with decreasing upper lip coverage.

Conclusion

The results of this study show a weak correlation between malocclusion assessed by the DAI and LII and the Plaque and Gingival indices. The presence of malocclusion did not make their oral health worse. A cause and effect relationship could not be established between the presence of malocclusion and periodontal disease. Subjects with greater malocclusions may not necessarily have worse gingival health. Where the oral hygiene measures are thorough, malocclusion is not necessarily accompanied by gingival inflammation. Orthodontic treatment is indicated where the despite thorough oral hygiene measures, a patients home care ineffective in the areas where there is irregularity which may lead to recurrent plaque retention and subsequently gingivitis which may progress to periodontitis if left untreated. Creating good alignment through orthodontic treatment will then result in good gingival health.

Ethics committee

Ethical approval for this research was obtained from the ethics committee of the Obafemi Awolowo University Teaching Hospitals Complex.

Conflict of interest

The authors declared no conflict of interest.

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Received: 01/20/2010

Recebido: 20/01/2010

Approved: 03/25/2010

Aprovado: 25/03/2010