

## Crowding and Open Bite in Relation to Gingival Inflammation

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### Abstract

In this study we conducted clinical research in order to assess the impact of orthodontic abnormalities (tooth crowding and open bite) on gingival health. For this purpose we have included 90 research subjects, of whom 30 subjects were without orthodontic anomalies serving as a control group, 30 with clinically verifiable frontal teeth crowding and 30 subjects with open bite. During the first visit, orthodontic diagnosis was established, dental plaque presence was noted, gingival inflammation, gingival bleeding, and acquired results were expressed through the following indices: Dental Plaque Index (DPI-Sillnes -Loe), index of Gingival Inflammation INDEX (GII- Loe Sillnes) and the Gingival Bleeding Index (GBI-Cowell).

At this stage the subjects were educated and motivated to maintain their oral hygiene by conventional standard methods (toothbrush type, method of tooth brushing, duration and brushing frequency). Patients have been followed for 2 and 4 weeks since the onset of education and motivation for oral hygiene maintenance. After the second and fourth week since the onset, the presence of the dental plaque has been noted, the condition of gingiva, while the findings from the research are expressed through the above mentioned indexes. The obtained results showed differences in the accumulation of dental plaque between the control group and the subjects with dental crowding and open bite ( $p=0,000$ ). After the second and fourth week of education and motivation undertaken for subjects using standard conventional methods for oral hygiene maintenance, we have noted a significant decrease in the dental plaque volume, and compatible to this, also decreased inflammation and gingival bleeding ( $p=0.000$ ). That difference is much more expressed in the group of subjects with no orthodontic anomalies than those with dental crowding and open bite. There is also a difference in the elimination of dental plaque from open bite and tooth crowding groups, but this difference is not statistically significant ( $p = NS$ ).

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### Introduction

The correct position and shape of the teeth represents an important factor in maintaining the functional and health integrity of the periodontal tissue complex.

Majority of researches and discoveries are showing that there is a significant relationship between the presence of certain teeth malposition and clinical changes in periodontal tissues expressed through relevant clinical

indices. In that group of exceptions that frequently represent a risk factor for periodontal health are numbered: tooth crowding, rotations, inclinations, deep bite, open bite but nevertheless the tooth arches disorders should not be excluded. This condition are thought to have an indirect effect on inflammatory changes in tissues from the periodontal tissue complex, accustomed by the possibility of dental plaque accumulation, but at the same time also impairs the mechanical physiological cleansing of the primary etiologic factor of this oral health condition - specifically the dental biofilm Balazi<sup>1</sup>, Kessler<sup>2</sup>, Hallgren<sup>3</sup>.

Many contemporary authors such as Boyd<sup>4</sup>, Clark<sup>5</sup>, Cavalcanti<sup>6</sup>, concluded that the correct position and shape of the teeth are important factors in maintaining the integrity of the periodontal complex. The authors through

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their research showed that there is a significant relationship between the tooth position and the tissue health of the periodontal complex. In that group of abnormalities they include: frontal region teeth malposition, inclinations, deep bite, open bite, and dental arches disorders.

Alternatively, Posnik<sup>7</sup>, Brite<sup>8</sup> and Farahai<sup>9</sup> are shearing the opinion that the unavoidable treatment of orthodontic abnormalities is essential, and it's not important only for aesthetic reasons but also for functional restoration of both dental arches, besides maximal preserving of the periodontal complex tissue.

The longitudinal study of Avanthakiato<sup>10</sup>, Zacharisson<sup>11,12</sup>, who analyzed 38 adolescents suffering from malocclusion, Class I and Class II, which had premolar extractions, in comparison to similar group of patients with ideal occlusion. However, authors during the study did not detect differences in loss of epithelial adhesion even after five months of orthodontic treatment. But the authors emphasized that the group of subjects with orthodontic treatment has also been included a special program for the maintenance of oral hygiene.

Other authors in their studies do not detect causal links between orthodontic abnormalities and changes in the tissues of the periodontal complex, and furthermore there is no correlation between the tooth positioning and the periodontal tissue status, Gould<sup>13</sup>, Katz<sup>14</sup>.

Contemporary achievements in dental medicine and especially in the area of treatment of orthodontic abnormalities, intend to be more responsive to severe aesthetic and functional deviations, therefore, large numbers of patients regardless of age are seeking help to resolve these problems.

Nowadays, orthodontic treatment is widely accepted in the daily dental practice due to its positive effects on the dento-facial tissue complex. With the application of fixed orthodontic treatment, the clinician can provide the patient with functional occlusion, periodontal complex tissue protection and improved aesthetic appearance.

However, in the course of orthodontic treatment, it is necessary to have in mind also the negative efficacy of therapeutic treatment conditioned by both parties, by the therapist and the patient's side, presented through the clinical objectification of dental plaque accumulation and gingival infiltration, as well as the X-ray

verification of alterations in the alveolar ridge. All these factors are in close relation to orthodontic abnormalities due to the lack of physiological self-cleansing, followed by physiological stimulation deficiency of the periodontal tissues, as well as difficult mechanical cleaning of the teeth. But even during therapeutic treatment, these unwanted effects may arise due to the lack of good oral hygiene of the patient due to placed braces, the use of enhanced tooth delivery forces which have the capacity to overcome the therapeutic effects and to get transformed into pathological forces which can affect the alveolar ridge, Balazi<sup>1</sup>, Chalze<sup>15</sup>. Tooth brushing twice daily is recommended by most of the dentists in order to improve plaque control and to apply anti-carries agents, such as fluoride<sup>16</sup>.

The current research data give clear evidence that the main etiologic factor in the etiology/pathogenesis of gingivitis and periodontal disease is the dental biofilm, or dental plaque, but it cannot be excluded that a large number of additional risk factors of the local or general nature, have the capacity in direct or indirect mode for significant influence on the initiation and progression of the mentioned disorders.

Taking all these into account we set the research goals:

- To assess the importance of tooth crowding and open bite in the accumulation of dental plaque as a dominant etiologic factor in the pathogenesis of periodontal disease, as well as the effect of the same accumulation during oral hygiene maintenance by conventional methods.
- To monitor and evaluate the gingival health status of the investigated study participants.

### Materials and methods

For the realization of the established goals, we investigated 90 adolescents from both genders, and we divided them into three groups: Group A – 30 subjects without orthodontic anomalies  
Group B – 30 subjects with frontal teeth crowding, and  
Group C – 30 subjects with open bite  
Research in the observed patients is carried out in three phases:

Phase 1 - Detection of the presence of the dental plaque as well as the evaluation of gingival condition, expressed through appropriate indexes: Dental Plaque Index (DPI- Sillnes -Loe), Gingival Inflammation Index (GII-Loe-Sillnes) and Gingival Bleeding Index (GBI-Cowel).

Dental Plaque Index (DPI- Sillnes -Loe)

0 - there is no evidence of the presence of the dental plaque in the gingival third of the tooth crown

1- the plaque is noted in thin layers along the margin of gingiva

2- a considerable amount of dental plaque that includes more than one third of the tooth crown but is also present in the gingival sulcus or the periodontal pocket

3- Increased dental plaque on the entire tooth surface as well as in the gingival sulcus, in the interdental space and the periodontal pocket

Gingival Inflammation Index (GII-Loe-Sillnes)

0- there is no inflammation of the gingiva, the color is pale pink with resilient consistency and with a granular structure.

1- considerable minor inflammation, which does not include all gingiva

2- average inflammation, which includes the gingiva as a whole, the color is red with distinct redness and more noticeable edema

3- overall complete gingival inflammation, with very expressed red color and very edematous.

Gingival Bleeding Index (GBI-Cowel)

0- no bleeding after probing

1- bleeding presence 30 seconds after probe

2- immediate bleeding after probe

3- spontaneous bleeding

Phase 2 - motivation and education of subjects for oral hygiene care. Education and motivation was focused on maintenance of oral hygiene using conventional standard methods, consisted of:

- Toothbrush with soft filaments, small compact heads, suitable for marginal gingiva
- Tooth brushing in the morning and evening
- The duration of tooth cleaning should be 3-5 minutes

Phase 3 - after two and four weeks of education and motivation for oral hygiene care, we made the dental plaque presence record again and we evaluated the gingival condition and presented it through the respective indexes.

Statistical evaluation was performed using the Statistic program for Windows 7.1.

## Results

Standard values and standard deviation for the three study groups are showed in Graph 1, respectively the subjects without orthodontic anomalies (control group), subjects suffering from dental crowding in the frontal region and subjects with open bite, during their first, second and third visit.

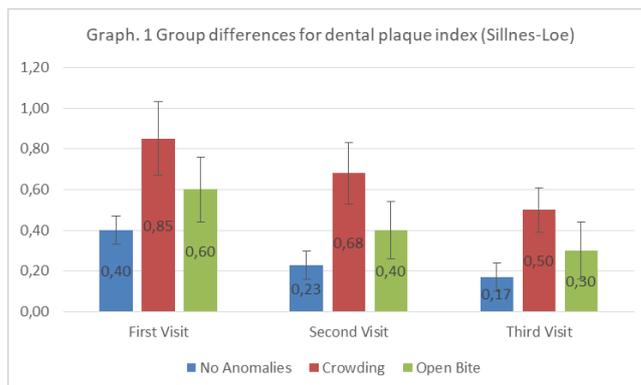
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The average value of the dental plaque index during the first visit of the orthodontic anomalies subjects (Group A), respectively - or the control group was  $0.75 \pm 0.17$ , in the group of subjects suffering from dental crowding in the frontal region (Group B) was  $1.57 + -0.18$  while open bite group (Group C) average value of DPI was  $1.46 + - 0.16$ .

During the second visit, the average value of Dental Plaque Index for Group A was  $0.39 + / - 0.17$ , group B was  $1.11 + / - 0.15$  and in group C these values were  $0.97 + / - 0, 14$ .

During the third visit the dental index values of Group A was  $0,20 + / - 0,10$ , Group B  $0,59 + - 0,11$  and Group C  $0,50 + / - 0,14$ .

Differences in the values obtained for the presence of dental plaque between Group A and Group B during the first visit was 0.82, between Group A and C was 0.65 and between Group B and C is 0.17.



Group	First Visit	Second Visit	Third Visit
A-B	0.000	0.000	0.000
A-C	0.000	0.000	0.000
B-C	N.Sig	N.Sig	N.Sig

**Table 1.** Group differences for dental plaque index (Sillnes-Loe).

The differences between the groups for the values obtained for Dental Plaque Index between Group A and Group B during the second visit were 0.72, between Group A and C 0.58 and between Group B and C were 0.14. Differences in the values obtained for the presence of Dental Plaque between Group A and B during the third visit was 0.39, between Group A and C was 0.30, and between Group B and C was 0.09.

The differences between the groups for the obtained values of the dental plaque index as well as the differences in the significance are presented in Table 1.

The table shows that there is an important statistical difference between the values obtained for the Dental Plaque Index between the control group (Group A), the dental crowding in the frontal region (Group B), and the open bite subjects group (Group C), during the first, second and third visits, as far as study participants these differences are statistically significant ( $p=0.000$  \*\*\*).

The differences between the values for the Dental Plaque Index for subjects with dental crowding in the frontal region (group B) and with open bite (group C) are not statistically relevant during the first, second and third visit (NS).

The second graph shows average values and standard deviations for the Gingival Inflammation Index in the investigated groups.

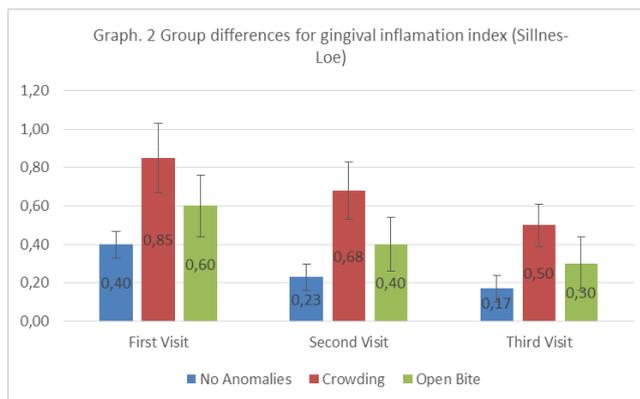
The average value of the Gingival Inflammation Index (GII) during the first study visit of Group A subjects was  $0.60 \pm 0.13$ , for group B  $0.85 \pm 0.15$  and for group C  $0.79 \pm 0.14$ . During the second visit, the values for the GII decreased, and for Group A value was  $0.35 \pm 0.15$ , for Group B  $0.65 \pm 0.14$ , and for Group C  $0.54 \pm 0.16$ .

During the third visit GII values for Group A was  $0.24 \pm 0.15$ , for group B  $0.50 \pm 0.13$  and for group C  $0.35 \pm 0.14$ .

The differences between the values obtained from groups A and B was 0.25, between group A and C 0.19 and between groups B and C 0.06 during the first visit of the investigated subjects.

During the second visit, the differences between the A and B groups for Level GII (Loe-Sillnes) was 0,30, group A and C 0,19 and between B and C 0,11.

These differences during the third visit for Group A and B was 0.26, between Group A and C 0.11 and between Group B and C 0.15.



Group	First Visit	Second Visit	Third Visit
	p value	p value	p value
A-B	0.000	0.000	0.000
A-C	0.000	0.000	0.000
B-C	0.002	0.002	0.05*

**Table 2.** Group differences for Gingival Inflammation Index (Sillnes-Loe).

On the Table 2 it can be noticed that there is a significant difference between the values obtained for the Gingival Inflammation Index (GII), between the control group (Group A), and the dental density in the frontal region subjects (Group B), furthermore between the control group (Group A) and open bite subjects group (Group C) during the first, second and third visit, these differences for GII are statistically significant ( $p = 0.000$  \*\*\*). The differences between values for GII from dental crowding in the frontal region study group (Group B) and open bite subjects (Group C) during the first and second visits are also statistically significant ( $p = 0.002$ ), while after the third visit the difference between the values for these groups did not show statistically significant differences for  $p < 0.05$ .

Graph 3 shows the values for the Gingival Bleeding Index (GBI - Cowell) between the research subjects groups during the first, second and third visit.

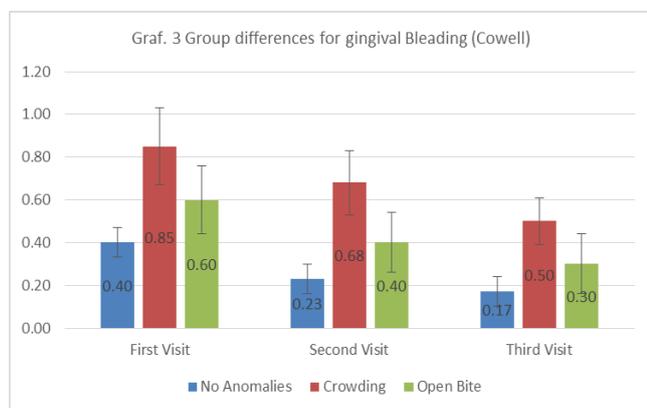
The average values of group A during the first visit was  $0.40 \pm 0.13$ , during the second visit was  $0.25 \pm 0.15$  and during the third visit was  $0.17 \pm 0.10$ . For group B this index during the first visit was  $0.85 \pm 0.15$  during the second visit  $0.69 \pm 0.14$  and during the third visit  $0.45 \pm 0.10$ .

Mean values for the gingival bleeding index, for subjects suffering from open bite anomaly (Group C) during the first visit was  $0.60 \pm 0.16$ , during the second visit was  $0.40 \pm 0.12$  and during the third visit was  $0.27 \pm 0.11$ .

Differences in the obtained values between groups A and B during the first visit was 0.45 during the second visit was 0.44 and during the third visit was 0.28. The difference between group A and C during the first visit was 0.20, during the second visit was 0.15, and after the third visit was 0.10.

Differences between groups B and C during the first visit was 0.25, during the second visit was 0.29 and after the third visit the difference was 0.18.

In table 3, significant differences are showed between the groups of respondents after the first, second and third visits, following the instructions regarding the oral hygiene maintenance.



Group	First Visit	Second Visit	Third Visit
	p value	p value	p value
A-B	0.000	0.000	0.000
A-C	0.000	0.000	0.000
B-C	0.002	0.002	0.05*

**Table 3.** Group differences for gingival bleeding (Cowell).

Table 3 shows that there are statistically significant differences between the values obtained for the gingival bleeding index between groups A and B, A and C after the first, second and third evaluation visits ( $p = 0,000$  \*\*\*).

Significant differences were also noted between gingival bleeding index values between groups B and C after the first and second visit ( $p = 0.002$ ), although after the third visit this difference is insignificant ( $p < 0.05$ ).

## Discussion

The examinations done for the presence of the dental plaque of the examined groups A, B and C, respectively in the groups without orthodontic anomalies, those with teeth crowding

in the frontal region and with open bite, during the first examination visit the lowest value of dental plaque presence was noted among subjects without orthodontic anomalies compared to teeth crowding group in the frontal region and with open bite. We found statistically significant differences and between the dental plaque values in the control group compared to the presence of dental plaque in patients with tooth crowding in the frontal region and open bite subjects ( $p = 0,000$  \*\*\*).

We have also noted small differences in the values obtained between groups of subjects with tooth crowding in the frontal region and open bite, but there was no statistical significance (NS). Dental plaque index values were slightly higher in the tooth crowding in frontal region group compare to open bite group. These results are demonstrating that orthodontic anomalies, namely the teeth crowding in frontal region and open bite have a role although indirect but important in the accumulation of dental plaque. This effect is thought to be accomplished through difficulties in physiological self-cleaning, the mechanical elimination of dental plaque as a dominant etiologic factor in the etio-pathogenesis of the destructive inflammatory changes of the periodontal tissues, in the loss of physiological stimulation in the periodontal tissue complex due to the absence (non-presence) of the physiological stimulation that occurs in these anomalies.

Based on this facts it can be said that the teeth crowding and the open bite are indeed risk factors in the etio-pathogenesis of the periodontal disorders.

The higher values for the dental plaque index for subjects with teeth crowding in the frontal region in relation to the open bite subjects are thought to be due to the creation of dead dental spaces which are absent in open bite cases. These results are compatible with the results of research results obtained by Farahani<sup>9</sup>, Daren<sup>17</sup>, Abu<sup>18</sup>, ABU<sup>19</sup>.

However, the results obtained for gingival inflammation as a consequence of clinical reaction in the presence of dental plaque and risk factors like orthodontic abnormalities of the subjects showed significant differences between the groups and between values for gingival inflammation by the control group and the open bite in the frontal region investigated group ( $p = 0,000$  \*\*\*), during the first, second and third visit.

Significant differences for this variable were recorded between groups B and C, also during the first and second visit ( $p = 0.002$ ), while during the third visit between groups with orthodontic anomalies – teeth crowding in the frontal region and open bite we did not find statistically significant differences ( $p < 0.05$ ).

The second variable in the clinical presentation of gingival inflammation, the Gingival Bleeding Index (Cowell) also showed significant differences between groups.

In fact, the values obtained for the gingival bleeding index are higher in the teeth crowding in the frontal region and open bite subjects compared with the control group without orthodontic anomaly ( $p = 0,000$  \*\*\*). Also, lower values for the gingival bleeding index according to Cowell were found in the open bite compared to the dental density in the frontal region and the statistical significance during the first and second visit was 0.002. These results are in concordance with the results obtained by Balazi<sup>1</sup>, Kessler<sup>2</sup>.

Analyzing the results obtained from researched variables for the presence of dental plaque, gingival inflammation and gingival bleeding in patients without orthodontic anomalies, those with teeth crowding in the frontal region and with open bite, during the second and third visits after the undertaken education and motivation program are able to conclude that variables for gingival inflammation and gingival bleeding are directly dependent on dental plaque variables. But after the elimination of dental plaque variable, the oral hygiene procedure is dependent on the presence of orthodontic abnormalities.

Following the education and motivation of subjects for the maintenance of oral hygiene by conventional methods only with the use of the brush in the morning and in the evening for a duration of 3-5 minutes, the values of dental plaque volume are reduced after the second and third visits. But we have noticed significant differences in the elimination of dental plaque between patients without orthodontic anomalies and orthodontic abnormalities after the first and second visits, which indicates that these subjects have difficulties in mechanical removal of the dental plaque because of the dead spaces which are created due to teeth crowding, but also due to the existing dysfunctionality among open bite subjects as a result of lack of physiological self-cleaning in the region.

Therefore, first and foremost the first treatment priority is the orthodontic treatment of these abnormalities, but also the use of oral-hygienic subtle procedures such as special brushes for the removal of dental plaque, CS, GSP 1000 brushes, Curasept first interdental brush, Curasept ADS, which contains 0.05% chlorhexidine and 0.05% fluoride, Curaprox ADS 705 paste which contains 0.005 chlorhexidine and other fluorides, also the use of mouth rinse containing CPC (Cetylpyridinium chloride) which has shown a high efficacy in preventing dental calculus than the common mouth as was found in a study<sup>20</sup>.

Also using a Periodic Dental Health Evaluation Card may help bettering the oral health as was found in a study where after 3 weeks intervention a significant decrease occurred on the dental plaque index of children in the intervention group compared to control group, because after three weeks intervention the 93.5% of mother have significant good oral health behavior<sup>21</sup>.

## Conclusions

From this carried out study of the three subjects groups, with no orthodontic anomalies, with teeth crowding in the frontal region and open bite, we can present the following conclusions:

1. Orthodontic abnormalities (teeth crowding and open bite) can be considered as a risk factor in the initiation and progression of inflammatory gingivitis.
2. These roles are achieved indirectly, in the teeth crowding in the frontal region, by creating dead spaces which not only serve as retention sites for the dental plaque, but they also obstruct the mechanical and physiological elimination of restricted from the created dead spaces. While among open bite subjects, the highest values of dental plaque in the investigated groups compared with those of the control group are thought to be due to the occurrence and lack of normal physiological self-cleaning.
3. Conventional methods of oral hygiene maintenance have important effects on the mechanical elimination of the dental plaque, but not completely, and due to this fact the recommendation would be the use of additional means for maintaining oral hygiene.
4. The presence of dental plaque in the study groups was followed by inflammatory changes in

the gingiva, expressed in this study through the Gingival Inflammation Index (Sillnes -Loe) and the Gingival Bleeding Index (Cowell).

5. The difference between the gingival inflammation index and the gingival bleeding index is statistically significant ( $p = 0,000^{***}$ ), or the highest significant values for these two indices were obtained from subjects suffering from orthodontic anomalies compare to subjects without anomalies.

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### Declaration of Interest

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