



# Periodontal changes induced by fixed orthodontic therapy

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## Abstract

**Background.** Orthodontic therapy is a complex process involving a series of specialists in the dental field: the oral-maxillo-facial surgeon, the periodontologist, sometimes even the prosthetist, implantologist, or general practitioners. The injuries of the oral mucosa induced by orthodontic therapy include gingival overgrowths, traumatic lesions of the oral mucosa, different degrees of periodontal damage manifested by gingival retraction, alveolar bone resorption.

**Methods.** From a total of 327 subjects who came to the Dental Clinic in Craiova 74 subjects were selected, who presented with gingival overgrowth associated with fixed orthodontic therapy. Subjects' age ranged from 14 to 56 years and experienced bleeding and gingival discomfort as well as alterations in physiognomic function. None of the patients included in the study have systemic diseases and are not under medical treatment. The clinical and statistical study took place between May 2022 and December 2023. Each patient was given a personal record containing personal data as well as oral and systemic health status. The examination of the periodontal status aimed at the evaluation of the following indices: assessment of oral hygiene using the OHI-S index and the O'Leary plaque index, assessment of superficial periodontal status using the Löe/Silness gingival inflammation index, periodontometry was performed in order to determine the depth of periodontal pockets, the level of gingival insertion, and the McGaw gingival overgrowth index. OHI-S index comprises two elements: the Debris Index and the Calculus Index. The purpose of our study is to present the incidence of cases of gingival overgrowth induced by fixed orthodontic therapy and to highlight how certain irritating factors can exacerbate the symptoms of gingival overgrowth of orthodontic etiology.

**Results.** The majority of patients were female, aged between 30 and 55 years. Most clinically examined patients have presented with Grade II gingival hyperplasia. Factors that have exacerbated the symptoms of orthodontically induced gingival overgrowth include: incorrectly adapted prosthetic restorations, unpolished massive coronal fillings, root remnants, bacterial plaque, and tartar. Clinical examination of the oral cavity revealed the presence of gingival inflammation (localized or generalized), simple or complicated, treated and untreated odontal lesions, and coronal fillings made of light-curing composite material of significant size, being unfinished and unpolished, sometimes with sharp edges directly injuring the adjacent gingival mucosa, marginally incorrectly adapted prosthetic works. In the case of child and adolescent patients, significant amounts of bacterial plaque and tartar buildup were observed. In most of the cases examined, it was observed that the gingival overgrowth had a firm consistency, pinkish-reddish colour and gingival bleeding was evident during probing.

**Conclusion.** Gingival overgrowth caused by orthodontics induces a number of important periodontal changes. It is worth noting that gingival overgrowth induced by fixed orthodontic therapy, in most of the cases examined, co-exists

with favouring factors that amplify its severity. In our study, the favouring factors were bacterial plaque and calculus accumulation, sharp-edged odontal lesions, marginally ill-fitting prosthetic restorations or massive unfinished crown fillings. Therefore, removing the contributing factors can help improve the symptoms but also to reverse the inflammatory phenomena.

**Keywords:** gingival overgrowth, orthodontic treatment, fixed orthodontic appliances

## Introduction

Gingival overgrowth is an oral condition frequently encountered in dental offices. The etiology of gingival overgrowth is varied: the accumulation of bacterial plaque [1], hormonal changes occurring during pregnancy [2], puberty [3], administration of drugs: calcium beta-blockers [4], nifedipine [5], verapamil [6], various systemic diseases such as diabetes [7], cardiovascular diseases [8-10], leukemia [11,12], orthodontic therapy [13-17].

Following orthodontic treatment, numerous changes occur, especially at the level of the periodontal tissue [15]. The production mode of gingival inflammation resulting from therapy with fixed dental appliances is not fully elucidated [18]. A series of effects of orthodontic treatment on the periodontium have been demonstrated over time in numerous studies [19,20] including: gingival enlargement [21] that can be localized to one tooth or a group of teeth or generalized [22-24]; alveolar bone resorption, but also root resorption and cementum resorption [25,26], gingivitis, periodontitis [21], gingival recessions [27].

The gingival overgrowth induced by orthodontic therapy can be determined by: poor oral hygiene through the accumulation of bacterial plaque [28], tartar buildup [22,29], the accumulation of chromium and nickel [30]. It is already known that by placing orthodontic braces on the teeth, changes are recorded in terms of the amount of remaining bacterial plaque even after tooth brushing [18]. For that reason, during therapy with orthodontic appliances, it is recommended to maintain a rigorous oral hygiene [31] that requires, in addition to tooth brushing, the use of mouthwash [32] and interdental brushes [33]. From a bacteriological point of view, following the increase in the amount of bacterial plaque, the increased virulence of germs such as: *Prevotella intermedia*, *Porphyromonas gingivalis*, *Aggregatibacter actinomycetemcomitans*, but also of spirochetes is highlighted [18,34]

## Aim of the study

The purpose of our study is to present the incidence of cases of gingival overgrowth induced by fixed orthodontic therapy and to highlight how certain irritating factors can exacerbate the symptoms of gingival overgrowth of orthodontic etiology.

## Methods

From a total of 327 subjects who came to the Dental Clinic in Craiova, we selected 74 subjects who presented with gingival overgrowth associated with fixed orthodontic therapy. Subjects' age ranged from 14 to 56 years and experienced bleeding and gingival discomfort as well as alterations in physiognomic function. None of the patients included in the study had systemic diseases and are not under medical treatment. The clinical and statistical study took place between May 2022 and December 2023. All patients expressed their consent to participate in this study by signing an informed consent form. Each patient was given a personal record containing personal data as well as oral and systemic health status. The examination of the periodontal status aimed at the evaluation of the following indices: assessment of oral hygiene using the OHI-S index and the O'Leary plaque index, assessment of superficial periodontal status using the Löe/Silness gingival inflammation index, periodontometry was performed in order to determine the depth of periodontal pockets, the level of gingival insertion, and the McGaw gingival overgrowth index. OHI-S index comprises two elements: the Debris Index and the Calculus Index. Each of these indices is derived from numerical assessments that indicate the presence of debris or calculus on the predetermined tooth surfaces. O'Leary Plaque Index relies on the observable, uninterrupted plaque along the gingival margin following staining. An assessment is conducted at four or six locations per tooth, and the percentage of tooth surfaces displaying stained plaque is then computed. The Löe modification of the Löe-Silness index was utilized for assessing gingival health. Each tooth was segmented into six surfaces, comprising three facial (mesio-facial, mid-facial, and disto-facial) and three lingual (mesio-lingual, mid-lingual, and disto-lingual). Third molars and teeth with cervical restorations or prosthetic crowns were excluded from the scoring process. The presence (1) or absence (0) of calculus was recorded for the lower anterior teeth (CI). Furthermore, each tooth's lingual surfaces were divided into disto-lingual, medio-lingual, and mesio-lingual, and calculus presence was scored. Following clinical examinations, participants diagnosed with periodontal pathologic conditions received a written report of their condition and were advised to seek oral health consultation.

The clinical examination of the gingival mucosa and the periodontometry were carried out by the dentist A.C.R. Gingivitis of various degrees appeared during orthodontic therapy, 50% of them with onset 6 months after the start of therapy, 42% 12 months after the start of orthodontic treatment, and 8% after more than 1 year. In the case of adolescent patients, who are often diagnosed with gingivitis induced by puberty, we examined the evolution of gingivitis post-orthodontic therapy during 10-14 days, but the lesions resolve. Also, carious lesions started during the orthodontic treatment. In the case of teeth with endodontic treatments, a coronary fracture occurred, which in many cases remained untreated and aggravated the symptoms previously produced by orthodontic therapy. In the case of subjects with prosthetic crowns or bridges, it was observed that the braces came off quickly and required reapplying with dental adhesive 2 or 3 times during fixed orthodontic therapy. It is particularly

important that the examination of the periodontal status is carried out by a single experienced dentist, because the force of action on the periodontal tissue must be correctly directed and constant within the determinations. The instruments used for the clinical examination of the dental surfaces and the periodontium were purchased from the Medesy Italy company. During the periodontal examination, we used the North Carolina periodontal probe.

All the data collected from the patients were stored and processed by the dentist A.C.R. The data were processed in the Excel program and presented in the form of graphs.

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by Ethics Committee of the University of Medicine and Pharmacy of Craiova (approval reference no. 39/01.03.2022).

**Results**

**Clinical aspects (Figure 1)**

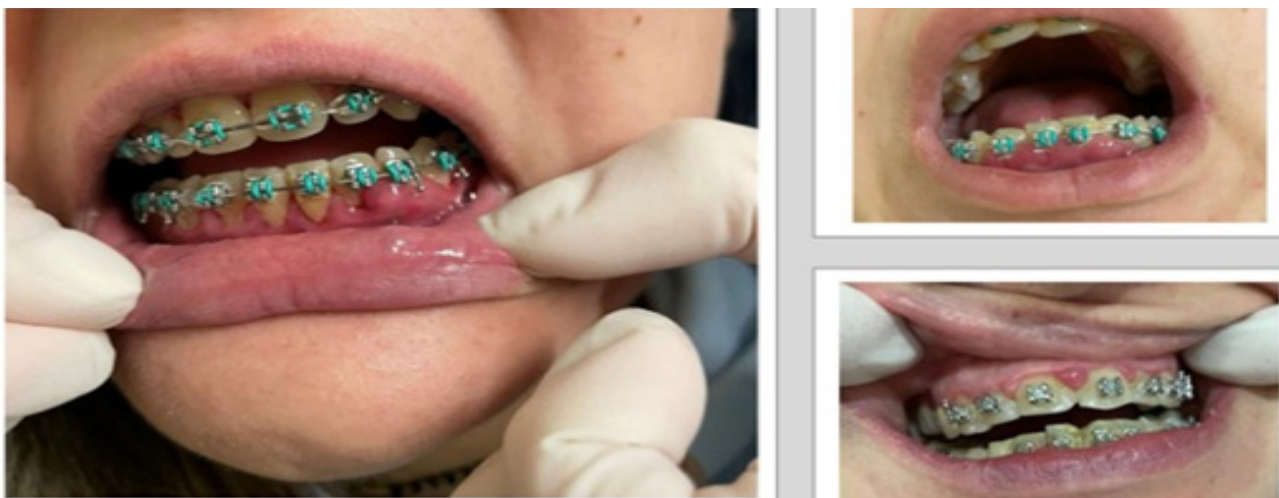


Figure 1. Clinical aspects of gingival overgrowth induced by fixed orthodontic therapy.

**Results of the statistical study (Figures 2, 3)**

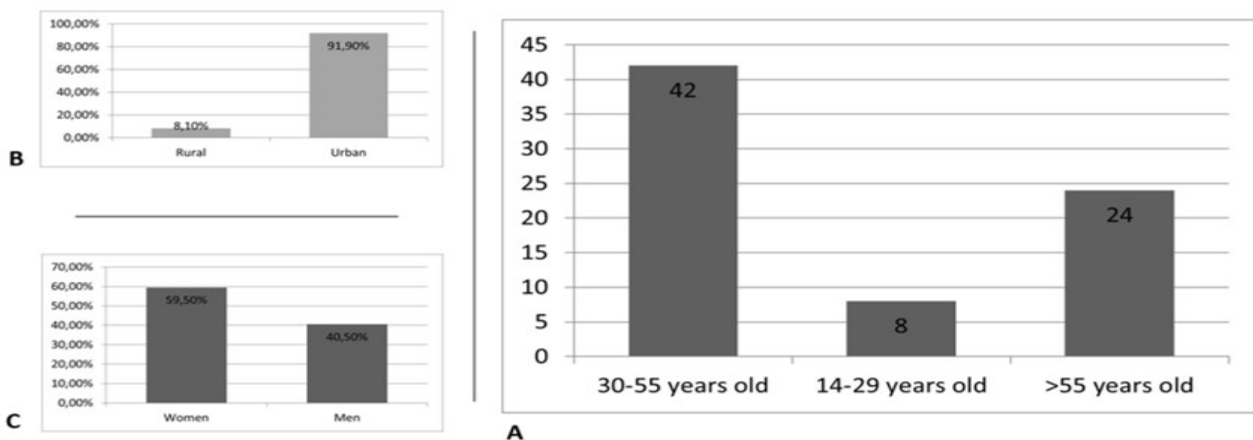


Figure 2. A. Distribution of cases by age; B. Distribution of cases according to the place of origin; C. Distribution of cases by gender.

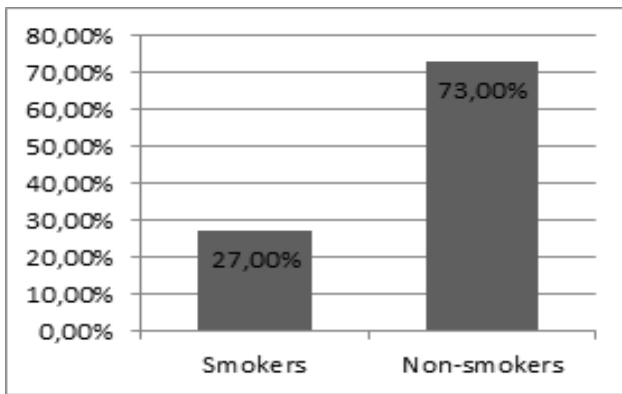


Figure 3. Distribution of cases by smokers/non-smokers.

The patients examined showed lesions of gingival overgrowth as follows:

- 36 had grade 2 gingival overgrowth lesions (2.1-4.0 mm);
- 26 had grade 3 gingival overgrowth lesions (4.1-7.0 mm);
- 12 had grade 1 gingival overgrowth lesions (0.5-2.0 mm).

These lesions were mainly associated with fixed prosthetic work and proximal dental caries in percentages approximately equal to 45%, in smaller percentages associated with overflowing fillings, dentures, and root remnants (Figure 4).

Oral hygiene in the patients taken in the study was good or satisfactory in most cases (38 patients respectively 32 patients), and 14 patients showed mild gingivitis (grade 1 Loe/Silness), 42 showed moderate gingivitis (grade 2 Loe/Silness) and 18 showed severe gingivitis (grade 3 Loe/Silness), in the age groups 14-29 years and 30-55 years (Figure 5).

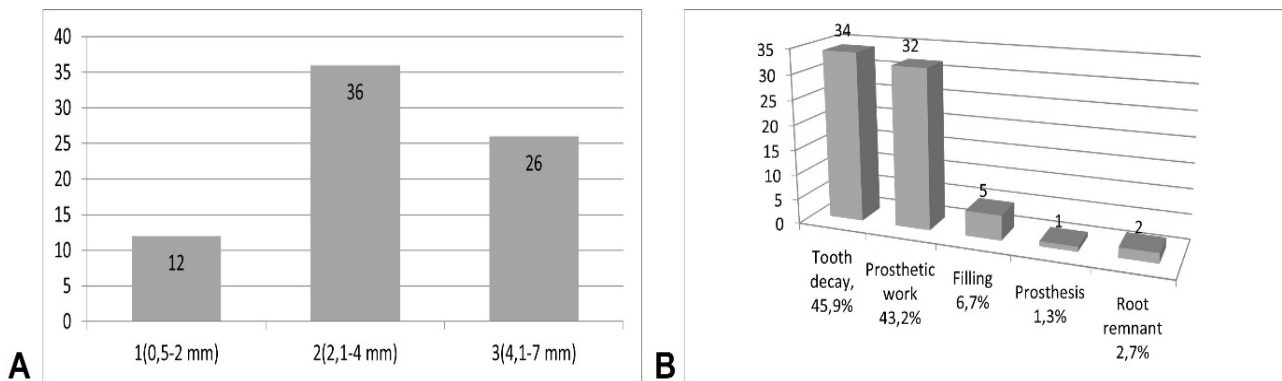


Figure 4. A. Distribution of cases by degree of gingival overgrowth; B. Distribution of local causes that exacerbated gingival overgrowth induced by fixed orthodontic therapy.

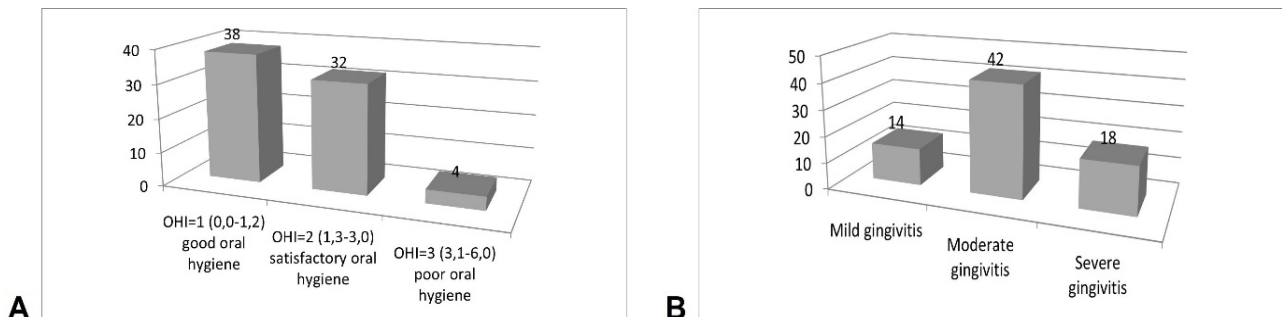


Figure 5. A. Distribution of cases by oral hygiene index (OHI-S); B. Distribution of cases by Loe/Silness gingival index.

Of the local factors causing gingival overgrowth in patients with good or satisfactory oral hygiene, proximal caries were present in 32 patients, fixed prosthetic work in 30 patients, fillings in 5 patients, root remnants occurred in 2 patients and 1 patient had an overdenture on implants, which was used improperly and resulted in overgrowth lesions.

In those with poor oral hygiene, massive coronal destructions were present in two cases and fixed prosthetic work in two others (Figure 6).

According to the degree of gingival overgrowth, regardless of age or background, in patients with good oral hygiene, we found grade 2 GO associated with carious

lesions (6 cases), fixed prosthetic work (4 cases) and overflowing fillings (4 cases) and grade 3 GO associated with significant coronal destruction in 12 cases.

In patients with satisfactory oral hygiene we found grade 1 GO associated with prosthetic work in 6 cases, grade 2 GO caused by incorrectly adapted cervical prosthetic work in 12 cases and significant carious lesions in 6 cases and grade 3 GO in 6 patients with carious lesions (Figure 7).

In patients with unsatisfactory oral hygiene, GO was grade 2 and 3 and was caused by prosthetic work and carious lesions (Figure 8).

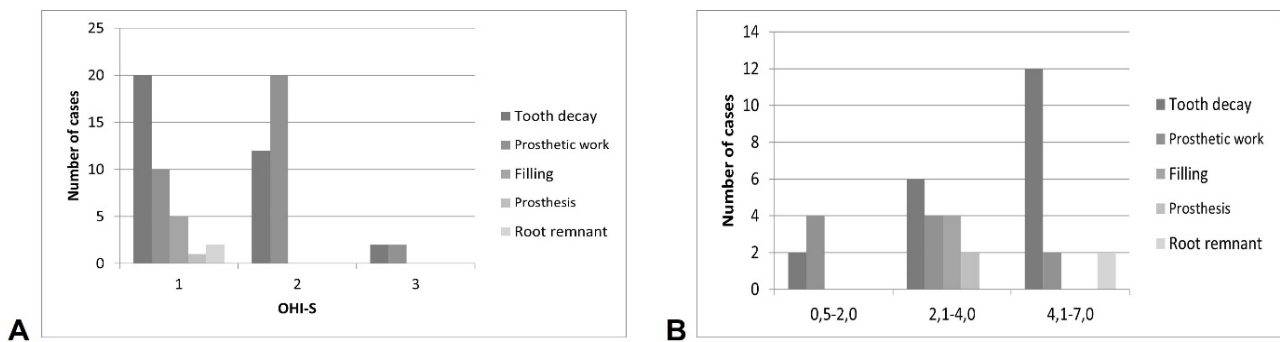


Figure 6. A. Distribution of cases by OHI-S and cause of gingival overgrowth; B. Distribution of cases by McGraw index of gingival overgrowth in patients with good oral hygiene.

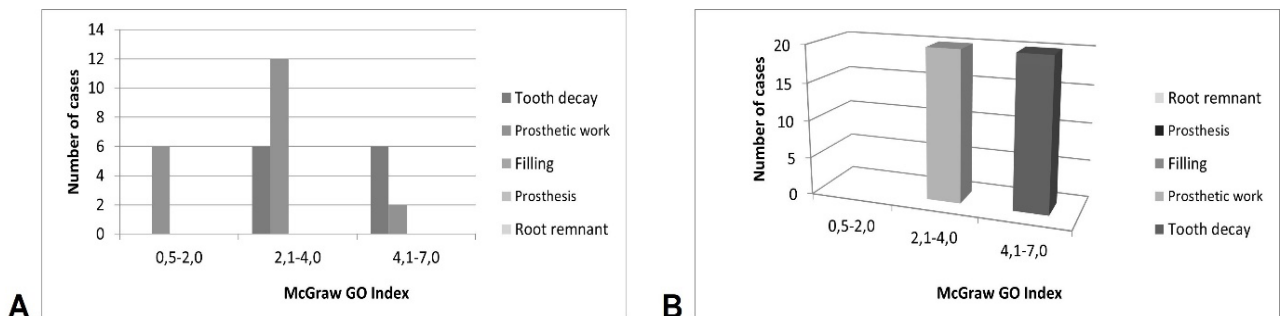


Figure 7. A. Distribution of cases according to McGraw index of gingival overgrowth in patients with satisfactory oral hygiene; B. Distribution of cases by McGraw index of gingival overgrowth in patients with poor oral hygiene.

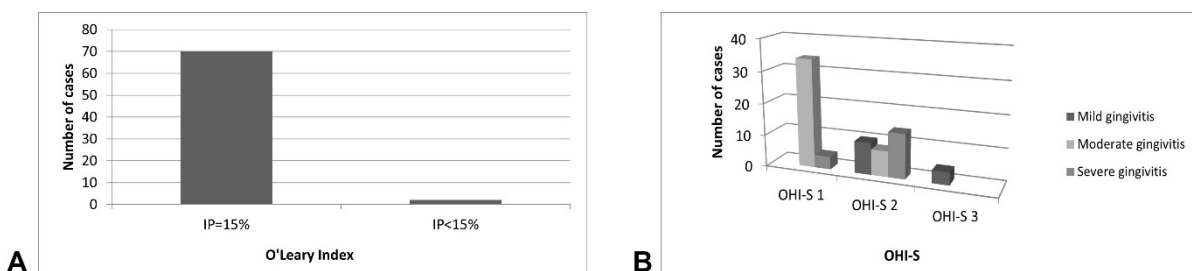


Figure 8. A. Distribution of cases by O'Leary bacterial plaque index; B. Distribution of cases by OHI-S and Loe/Silness gingival index.

On the areas under the action of local irritative factors we found, following the determination of the gingival index, moderate gingivitis in 42 cases and severe gingivitis in 18 cases (Figures 9, 10).

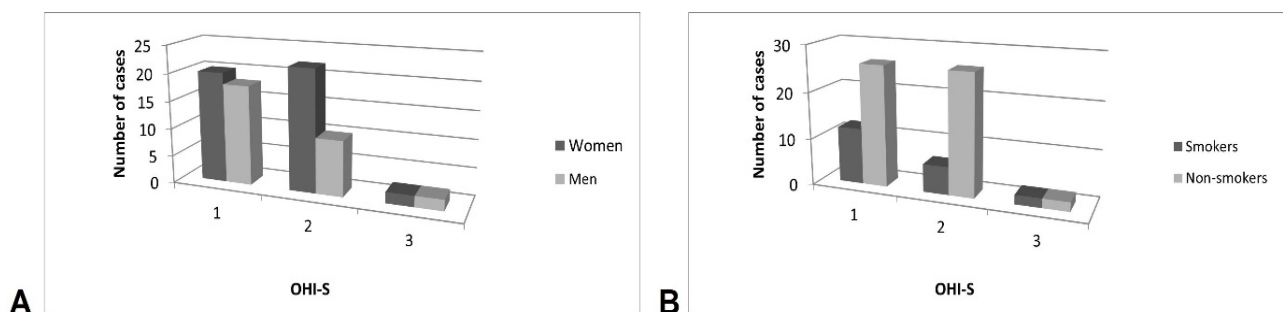
We also found, mild gingivitis and GO grade 1 in 4 patients with prosthetic work, GO grade 2 in 2 patients with carious lesions and in 2 patients with prosthetic work and GO grade 3 in 4 patients with carious lesions and in 2 patients with prosthetic work.

Moderate gingivitis occurred associated with GO grade 1 in 2 patients with carious lesions and in 6 patients with prosthetic work, GO grade 2 in 10 patients with carious lesions, 4 patients with prosthetic work, 5 patients with fillings and in the patient with overdenture and GO grade 3 in 12 patients with carious lesions and 2 patients with root remnants. Severe gingivitis correlated with GO grade 2 in 12 patients with prosthetic work and GO grade 3 in 4 patients with carious lesions and 2 patients with prosthetic work.

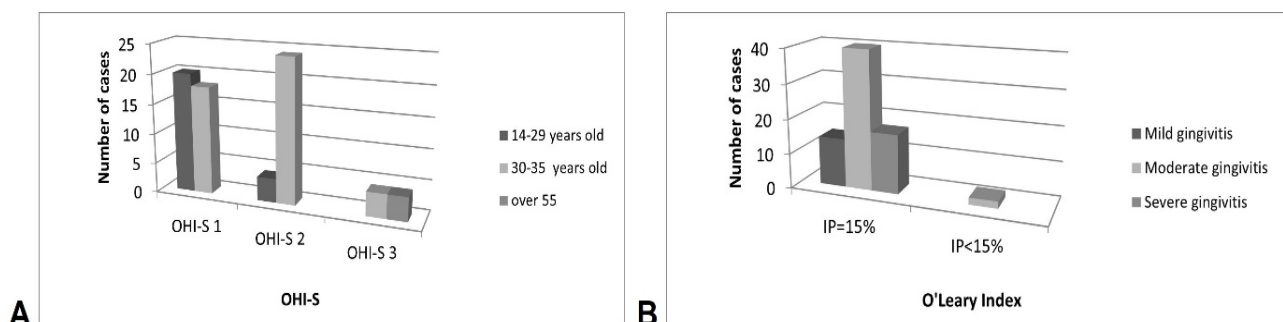
The distribution of cases by MacGaw index and

local cause of GO was as follows: GO grade 1 in 2 patients with carious lesions and in 10 patients with prosthetic work, GO grade 2 in 12 patients with carious lesions and in 18 patients with prosthetic work, 5 patients with fillings and 1 patient with overdenture and GO grade 3 in 20 patients with carious lesions and in 4 patients with prosthetic work and 2 patients with root remnants.

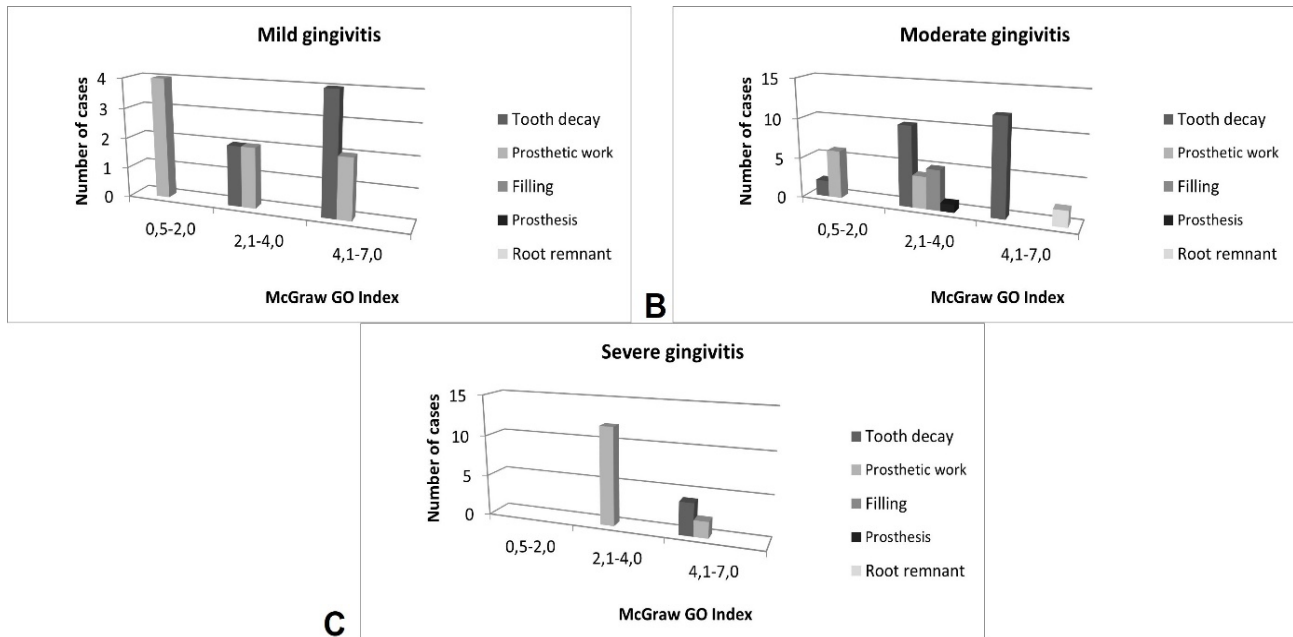
Periodontometry was performed at the level of areas affected by local irritants. The papillary bleeding index on probing (PBI) was determined, which showed in-line bleeding (PBI=2) in 2 patients with carious lesions and in 10 patients with prosthetic work, bleeding in the drop (PBI=3) in 12 patients with carious lesions, in 18 patients with prosthetic work, in 5 patients with fillings and 1 patient with prosthesis and massive bleeding involving large areas of gum or crown (PBI=4) in 20 patients with carious lesions, 4 patients with prosthetic work and 2 with root remnants. At the same time, a small number of false periodontal pockets that did not lead to a change in the gingival insertion could also be observed (Figures 11, 12).



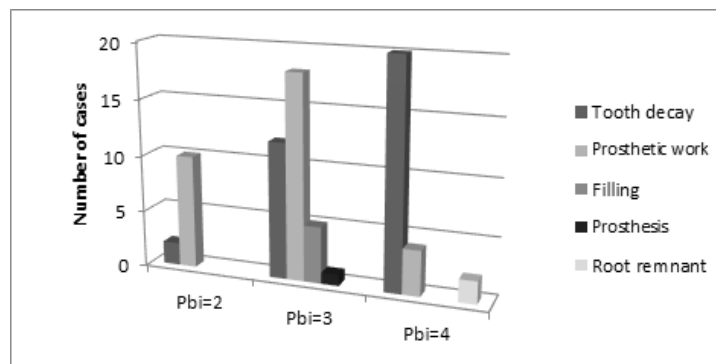
**Figure 9.** A. Distribution of cases by OHI-S and gender; B. Distribution of smoking and non-smoking patients by OHI-S.



**Figure 10.** A. Distribution of cases by OHI-S and age; B. Distribution of cases by O'Leary Bacterial Plaque Index and Löe/Silness Gingival Index.



**Figure 11.** A. Distribution of cases by McGraw Index for mild gingivitis; B. Distribution of cases by McGraw Index for moderate gingivitis; C. Distribution of cases by McGraw GO Index for severe gingivitis.



**Figure 12.** Distribution of cases according to Papillary Bleeding Index at survey and cause of GO.

### Discussion

Clinical examination of the oral cavity revealed the presence of gingival inflammation (localized or generalized), simple or complicated, treated and untreated odontal lesions, and coronal fillings made of light-curing composite material of significant size, being unfinished and unpolished, sometimes with sharp edges directly injuring the adjacent gingival mucosa, marginally incorrectly adapted prosthetic works. In the case of child and adolescent patients, significant amounts of bacterial plaque and tartar deposits were observed. In most of the cases examined, the gingival overgrowth had a firm consistency, pinkish-

reddish colour and gingival bleeding was evident during probing.

Fixed orthodontic therapy involves adjusting dental misalignment using tools like orthodontic bands, brackets adhered to teeth, archwires, ligatures, and additional aids. These fixed appliances can make maintaining oral hygiene more challenging and can lead to the buildup of biofilm on both the teeth and the appliance surfaces [17,35]. It is particularly important for the dentist to insist on educating patients regarding maintenance of oral hygiene during orthodontic therapy. In the literature study, we identified several strategies for motivating patients to maintain oral

hygiene. The motivational strategies employed in the studies analyzed can be broadly categorized into chair-side education, message reminders, behavioral modification, and the Hawthorne effect. Among these, chair-side modified oral hygiene instruction emerged as the most prevalent method for fostering motivation towards oral hygiene in orthodontic patients. This approach involved a comprehensive range of techniques, including verbal and written instruction, utilization of photos, presentation of videos, and visual demonstrations using models or experimental equipment [28,36]. Patients utilized these methods to elucidate the composition and mechanism of plaque formation [28,37], highlight the risks associated with poor oral hygiene, offer recommendations for brushing techniques [28,38], and provide personalized counseling [28,39]. The implementation of modified and enhanced oral hygiene instruction was predominantly carried out by hygienists and orthodontists.

Similar to any medical procedure, orthodontic treatment carries inherent risks alongside its advantages. Among these risks, periodontal complications stand out as one of the most frequent side effects associated with orthodontic therapy. While achieving proper teeth alignment facilitates oral hygiene, the process of orthodontic correction can potentially harm the periodontium in several ways. This includes direct irritation to the gingiva and a potential compromise in the effectiveness of oral hygiene practices, especially in instances involving fixed orthodontic appliances [40]. Many studies have documented a rise in Plaque Index (PI) values within 1-3 months following the installation of an orthodontic appliance [40,41]. The accumulation of bacterial plaque favors the appearance of carious lesions, a fact also demonstrated in our study. Additionally, most patients undergoing therapy with a fixed orthodontic appliance exhibit varying degrees of gingival changes such as gingivitis [40, 41], gingival overgrowth [24], gingival recession [42], root resorption [43]. In agreement with other studies [29,40,44,45] we also identified an increase in the incidence of gingival overgrowth in the case of subjects with fixed orthodontic appliances.

Overhanging dental restorations, subgingival placement of fixed prosthetic work margins, improperly fitted dentures or untreated coronal cavity lesions play an important role in periodontal pathology [46,47].

In general, oral rehabilitation aims to restore the integrity of a tooth or the entire dental arch, taking into account form, function and aesthetics, thus preventing the appearance of other dental or periodontal lesions and the worsening of existing ones.

The gingival mucosa can suffer a number of traumatic injuries resulting from incorrectly performed dental treatments. Fixed orthodontic therapy can be a risk factor for periodontal disease if excessive forces are exerted on the periodontium. Incipient lesions concern the

superficial periodontium and can be represented by mild or moderate gingival inflammation, gingival overgrowth that is reversible after removal of the promoting factor (bacterial plaque, dental calculus). In contrast, advanced lesions are characterized by significant clinical, radiological and tissue changes that produce destruction of the deep periodontium (especially the alveolar bone, periodontal ligament) [46].

The limitations of the study were represented by the refusal of the parents of the underage subjects to collect the gingival overgrowth biopsies. Biopsies of gingival overgrowth offer the opportunity to identify tissue changes and lead to a correct and individualized treatment.

The results obtained proved that fixed orthodontic therapy induces a series of changes in the periodontium. These changes are closely dependent on the presence of favorable factors such as bacterial plaque and tartar accumulation, incorrectly adapted marginal prosthetic works, unpolished mechanical coronal fillings with sharp edges that directly damage the gingival mucosa. The subjects present noisy symptomatology accusing gingival bleeding, gingival discomfort or pain, aesthetic changes on the facial level.

The originality of our manuscript consists in highlighting the clinical aspects of gingival overgrowth induced by fixed orthodontic therapy and carrying out a statistical study aimed at the changes occurring in the periodontium during fixed orthodontic therapy by using rigorous methods to quantify gingival inflammation and periodontal lesions.

## Conclusions

Gingival overgrowth caused by orthodontics induces a number of important periodontal changes. It is worth noting that gingival overgrowth induced by fixed orthodontic therapy, in most of the cases examined, co-exists with favouring factors that amplify its severity. In our study, the favouring factors were bacterial plaque and calculus accumulation, sharp-edged odontal lesions, marginally ill-fitting prosthetic restorations or massive unfinished crown fillings. Therefore, removing the contributing factors can help to improve the symptoms but also to reverse the inflammatory phenomena.

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