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Improvement of self-performed oral hygiene among patients with braces and micro-implants: approbation of specifically designed plaque-controlled regime

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Abstract

Background. Braces and micro-implants may serve as retention points for the dental plaque under the condition of insufficient everyday oral care, thus compromising oral hygiene level of orthodontic patients.

Objective. The assess changes of oral hygiene among orthodontic patients with braces and micro-implants during the use of adapted specifically-designed plaque-controlled regime of self-performed oral hygiene measures.

Material and Methods. Study group was formed out of 30 patients aged 18 to 50 years, who were planned to undergo orthodontic treatment with brace system and micro-implant. During the first month of orthodontic treatment patients used a toothbrush with thin bristles, during the second month – V-toothbrush, and during the third month – a two-row and monobundle toothbrush. The interdental hygiene was provided by the size-adjusted toothbrushes. Clinical assessment was provided with the use of hygienic indices (O'Leary, Green-Vermillion and Turesky).

Results. At the period of first month after orthodontic treatment initiation O'Leary index increased abruptly to 52.6±6.4%, which stands for unsatisfactory oral hygiene level. Values of Turesky and Green-Vermillion indices increased twofold after orthodontic appliance attachment, and after first month of treatment their values were 1.98±0.31, and 2.12±0.34 points, respectively; while after third month of treatment – 0.99±0.1 and 1.19±0.14, respectively.

Conclusions. Oral hygiene conditions were deteriorated among all patients, compared to the pre-treatment situation, which was caused by orthodontic appliances fixation. Oral hygiene of the patients with fixed orthodontic appliances should include usage of two-row toothbrush, which most efficiently clean the plaque above and under the brace arch; and a mono-bundle toothbrush for additional cleaning around brace locks, in gingival area, and around micro-implants.

Introduction

Malocclusion, dental anomalies and dentition deformations represent ones of the most prevalent dental pathologies with 23% to 80% incidence level among different age groups [1, 2, 3, 4]. Several types of orthodontically-associated occlusal deformities may compromise further prosthetic rehabilitation of the patients if registered occlusal deviations would not be partially or fully compensated during complex dental treatment [4, 5, 6].

Orthodontic treatment of specific malocclusion forms may be enhanced by temporary anchorage devices, which uphold controlled tooth movement [7, 8]. Micro-implants provide stable intraosseous support and help to reach quicker patient's recovery [7, 8, 9]. Nevertheless, effectiveness of micro-implant anchorage may be realized only if several conditions would be properly followed: dentist need to choose correct position for intra-osseus fixture placement, implantation procedure should be provided in the most atraumatic manner, peri-implant microenvironment should support successive osteointegration and favorable primary stabilization, micro-implant itself should be produced out of biocompatible material [8, 9]. Except above-mentioned factors proper oral care also remains vital component for successful micro-implant functioning,

while adequate oral hygiene itself should be an obligatory condition of each ongoing orthodontic treatment [10, 11].

Considering results of several observational studies oral hygiene is one of the aspects which in fact may be greatly compromised among dental patients, who use different orthodontic devices [12, 13, 14]. Braces and micro-implants may serve as retention points for the dental plaque under the condition of insufficient everyday oral care [12, 13, 14]. Risk of potential micro-implant loss increases drastically if uncontrolled soft tissue inflammation present at peri-implant area, caused by the accumulation of microbial biofilm [10, 11]. Braces on the other hand correlate with two-three-fold increase in plaque amount and severe progression of dental caries if patient does not control oral hygiene status properly [12, 13, 14]. Some patients with braces develop enamel hypomineralization foci, which leads to enamel white spots occurrence after the treatment. Due to the results of recent study approximately 26% of patients with braces demonstrate signs of white spot lesions, which was associated with poor pre-treatment hygiene status of oral cavity, worsening of oral hygiene during orthodontic treatment and longer orthodontic treatment duration [15].

Changes in oral microbiota after attachment of orthodontic appliances have been described in several previous studies [16, 17]. Braces (simple, self-ligating and lingual), or braces materials (metal, ceramics or plastics) often lead to bacterial growth, due to enormous number of retention points with subsequent enamel demineralization and periodontal inflammation [16, 17]. Braces-associated hygienic difficulties also predispose pathogenic bacteria growth, which in turn increases the risk of gingivitis development [12, 16, 17]. Patients with temporary anchorage devices also develops pronounced changes of oral microflora, which distinct significantly between patients with different oral hygiene conditions [10, 11]. Broadly speaking orthodontic patients with various treatment devices have numerous areas in the oral cavity, where pathogenic bacteria (periodontal pathogens, cariogenic microorganisms and fungi) may multiply, and such effect may be prevented only through thorough mechanical brushing [10, 11, 12, 16, 17].

Nowadays, the assortment of toothbrushes for different individual scenarios is easily available, but recommendations regarding how to correctly choose toothbrush and toothpastes for prevention of orthodontic-related hygienic complications are still not sufficiently systematized. Besides, interdental spaces, and the peri-micro-implant spaces represent areas that require specific attention and usage of adapted items to guarantee its appropriate hygienic cleaning. Considering above-mentioned facts patients informational support, follow-up controls and on-demand correction of individual hygiene skills remain crucial factors for keeping adequate level of oral hygiene as everyday pattern among orthodontic patients.

Objective

The assess changes of oral hygiene among orthodontic patients with braces and micro-implants during the use of adapted specifically-designed plaque-controlled regime of self-performed oral hygiene measures.

Materials and Methods

Study design and study sample

Present research was realized in the form of cross-sectional study following adapted STROBE checklist, while also considering specifics of its realization as pilot study [18]. Study group was formed out of patients cohort of Dental Clinic «Lumiere Perio Dental» (Kyiv, Ukraine) with the use of following inclusion criteria: 1) patient's need and agreement to undergo orthodontic treatment with the use of braces and micro-implant due to the present orthodontic alterations and pre-formulated and approved treatment plan; 2) non-smoking status; 3) absence of clinically detectable sings of periodontitis; 4) agreement regarding strict following of individual oral hygiene rules and taking part in individualized studies regarding correction of personal oral hygienic skills and measures (as a part of present study design); 5) voluntarily agreement to take part in the present research approved by the signature of informed consent form. Considering all above-mentioned inclusion criteria study group was formed out of 30 patients aged 18 to 50 years with following gender distribution: 11 males and 19 females. Study group consisted of patients with maxillary extruded molar, who were planned to undergo orthodontic treatment with brace system (GAC, AO, 3M, Monrovia, CA United States), and micro-implant (Bio-Ray Biotech Corp, Taipei, Taiwan) for extra-traction effect. Before orthodontic treatment, all patients were clinically examined and provided with full sanitization of oral cavity regarding present dental caries and dental plaque.

During complex pre-orthodontic clinical examination data regarding vestibulum depth, dentition condition, occlusion type and pattern has been collected. Additionally, color, consistency and contours of the gingiva and interdental papillae has been assessed due to the adapted criteria. All patients undergone screening PSR-test for the objectification of periodontal status condition [19].

Oral hygiene assessment

Evaluation of oral cavity hygiene level was held with the use of targeted indices (Turesky, Green-Vermillion and O'Leary) as per originally proposed approaches [20, 21, 22]. Dental plaque index (PL) proposed by O'Leary tends to evaluate supragingival dental plaque on four dental surfaces, visualized after staining. Number of stained surfaces were expressed in the percentage value using standard calculation formula.

Simplified oral hygiene index OHI-S (Oral Hygiene Index-Simplified) was used to assess both dental plaque and calculus. The index based on the assessment of vestibular surface of teeth 1.6, 2.6, 1.1 and 1.1, while also lingual surface of teeth 3.6 and 4.6. Dental plaque was assessed in a three-point scale. Oral hygiene index was calculated by the division of summated points for each evaluated teeth on the number of examined teeth, with following interpretation of obtained scores: 0-0.6 corresponds to good oral hygiene level; 0.7-1.6 – to satisfactory oral hygiene level; 1.7-2,5 – to unsatisfactory oral hygiene level; and 2.6-3.0 – to poor oral hygiene level [21].

Turesky plaque scoring was provided by following categorization of identified plaque amount: 1 – no plaque present, 2 – thin margin of plaque with wideness less than 1 mm at the cervical tooth area, 3 – band of plaque is wider than 1 mm, but covering less than 1/3 of the crown, 4 – plaque covering is in the range of 1/3-2/3 of the crown, 5 – plaque covering exceeds 2/3 of the crown. Calculation of Turesky index score was provided by the division of summed score by the number of examined tooth with following results interpretation: 0.0-1.0 – excellent oral hygiene; 1.0-1.5 – good oral hygiene; 1.5-2.0 – fair oral hygiene; 2.0 and higher – poor oral hygiene [20].

Oral hygiene indices were assessed before the orthodontic treatment, and in the periods of 1, 2 and 3 months of the orthodontic treatment.

Specifically-designed plaque-controlled regime of self-performed oral hygiene measures developed for orthodontic patients

Patients' oral cavities were fully sanitized with air-abrasive teeth polishing using glycine powder few days before orthodontic treatment initiation. The polishing by air-abrasive stream was provided while keeping the distance of 3-5 mm from the tooth and applying 5-second rotations at a point. The abrasive stream direction depends on the powder, while cannula-to-surface angle for the glycine-based powder was in the range of 30-60 degrees.

All patients were taught for oral hygienic essentials before orthodontic treatment, while also all of them undergone individualized studies regarding correction of personal oral hygiene skills and measures.

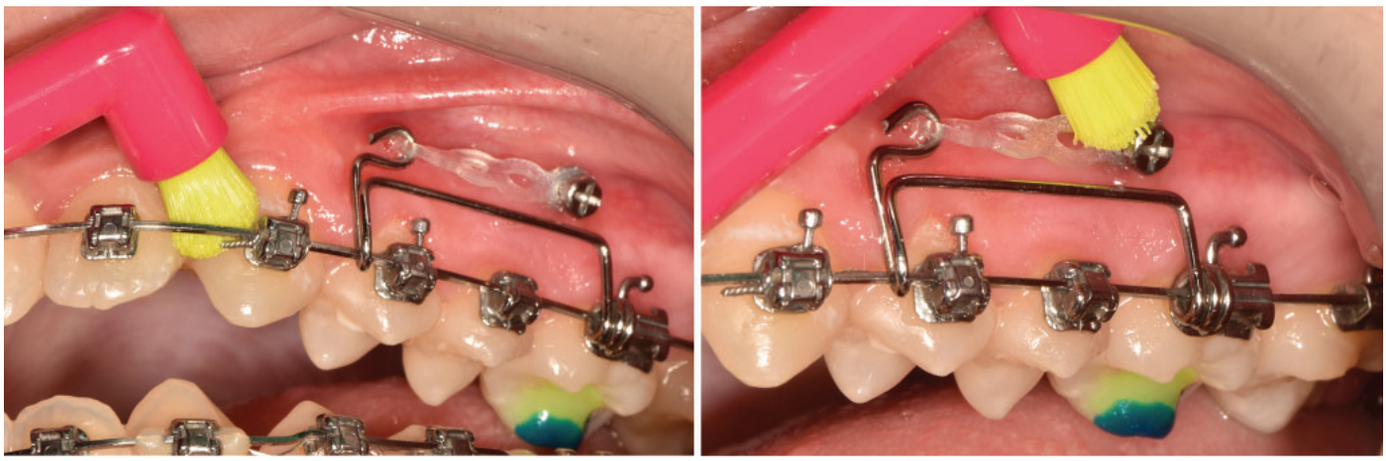
Specifically-designed plaque-controlled regime of self-performed oral hygiene measures developed for orthodontic patients included following components:

1) in-home oral hygiene was provided with the use of GUM Ortho toothpaste (GUM®, SUNSTAR, Singapore) and alcohol-free mouthwash for the period of 3 months monitoring during orthodontic treatment: patients brushed their teeth three times a day for 3 minutes during the study, and used a mouthwash twice a day for a minute, after toothbrushing;

Figure 1. Toothbrush with ultra-thin bristles

Figure 2. V-dental brush

Figures 3a-b. Two-row dental brush



Figures 4a-4b. Mono-bundle dental brush

2) soft toothbrushes with ultrathin bristles (Figure 1), and size-adapted interdental brushes were used during first month of orthodontic treatment: all patients applied horizontal toothbrushing and modified brushing by Bass method, interdental brushing, and mouthwash for one minute, three times a day (after breakfast, dinner and supper) everyday; patients brushed the micro-implant area with the same toothbrush;

3) V-shaped toothbrush (Figure 2) and size-adapted interdental brushes for horizontal toothbrushing were used during second month of orthodontic treatment;

4) two-row toothbrush (Figures 3a-3b) for horizontal brushing and brushing above the braces were used during third month of orthodontic treatment;

5) monobundle toothbrush (Figures 4a-4b) (to brush near the braces locks, at gingival area and micro-implant area) and size-adapted interdental brushes were used during 3 months monitoring period during orthodontic treatment.

Statistical analysis

Statistical processing of Turesky and Green-Vermillion indices' values was held due to the basic inferential statistics principles. Mean parameter was used as a measure of central tendency for O'Leary index. Significancy of the calculated differences among hygienic indices' values, observed at various monitoring time periods, was measured using Student's t-criterion for parametrical variables and Mann-Whitney's U-test for nonparametric variables. Observed outcomes were classified as statistically reliable only under condition of $p < 0.05$ (significance level of 0.95).

Results

The mean O'Leary index within the study group before orthodontic appliances placement was 12.8±5.6%, which stands for a good hygiene level. At the period of first month after orthodontic treatment initiation this index increased abruptly to 52.6±6.4%, which stands for unsatisfactory oral hygiene level, associated with periodontal tissues inflammation, caries, and risk of micro-implant disintegration (Figure 5).

After patients changed toothbrush by the V-shaped toothbrush specially designed for clinical situation with braces, the hygiene index during the second month decreased by 1.5 times to 34.7±6.1% (Figure 6).

Figure 5. Teeth staining for O'Lyrey plaque-test

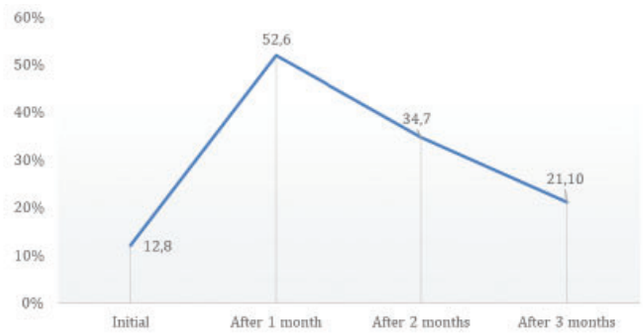


Figure 6. O'Lyrey dynamics at various monitoring periods (mean, %)

Nevertheless, the best oral hygiene values were observed at the end of the third month. At this control period oral hygiene index reached mean value of 21.1±4.9%, which evidenced good oral hygiene while wearing braces.

Similar data were registered regarding changes of Green-Vermillion and Turesky indices: their pre-treatment values were 0.89±0.10 and 0.96 ± 0.18 points correspondingly, while two-fold increase was noted after first month of wearing braces and having micro-implant placed with reaching the mean level of 1.98±0.31 and 2.12±0.34, respectively. At the period of two months of treatment Green-Vermillion and Turesky indices demonstrated values of 1.84±0.21 and 1.95±0.24 points, while at the end of third month of treatment their levels dropped out to 0.99±0.1 and 1.19±0.14, respectively. Such changes were statistically approved during corresponding data processing ($p < 0.05$).

Changes of oral hygiene levels measured with Green-Vermillion and Turesky indices and observed during the period of 3 months of orthodontic treatment demonstrated in Table 1.

Table 1. Green-Vermillion and Turesky indices changes

Indices	Pre-treatment	After 1 month	After 2 months	After 3 months
Green-Vermillion	0.89 ± 0.10	1.98±0.31*	1.84±0.21	0.99±0.1*
Turesky	0.96 ± 0.18	2.12±0.34*	1.95±0.24	1.19±0.14*

* statistically significant changes compare to the values observed during previous monitoring period ($p < 0.05$)

During the monitoring period most patients noted that ultrathin bristles wear off by the end of the month, which proves that metallic brace components lead to quick toothbrush wear.

Discussion

Oral hygiene control during the use of different orthodontic appliances is a prevention method of the periodontal inflammation and dental caries, so dental hygienists may significantly contribute into the success of ongoing orthodontic treatment [10, 12, 13, 23].

Presence of any orthodontic devices deteriorate oral hygiene, and only a toothbrush cannot provide ideal plaque control, which does not depend on the toothbrush producer, or the bristle material. Provided meta-analysis did not revealed differences of plaque and gingival indices' values among orthodontic patients with fixed orthodontic appliances that used either manual or powered toothbrush, based on which authors made conclusion that those changes was not dependent on the type of used brush [24]. Based on the data obtained in present study it could be resumed that the toothbrush configuration and its ability to clean the hardly accessible areas defines its efficiency. All orthodontic patients must be taught to correctly use different toothbrushes, and the size-adjusted interdental brushes.

In present research it was also noted that right after fixation of orthodontic appliances hygienic conditions of oral cavity were deteriorated among all patients of study group compared to the initial situation after pre-treatment sanitation, which was approved also through statistical processing of corresponding hygienic indices. Recent systematic review presented moderate/high evidences regarding significant changes of oral microbiota after orthodontic appliances fixation with increase of S. mutans and Lactobacillus spp. absolute counts, and upgrowth of potentially pathogenic gram-negative bacteria's relative values [17]. Not only quantitative, but also qualitive changes of oral microbiota in supra- and subgingival plaque have been noted among patients with orthodontic appliances in comparison to subjects without such [16]. Considering those facts, it was established that presence of orthodontic devices and associated microbial changes within oral cavity increase risk of caries and periodontitis development among orthodontic patients cohort [16].

Patients enrolled in our study were using GUM Ortho toothpaste for the first 3 months after orthodontic treatment initiation. This toothpaste contains following components: fluoride (1450 ppm), isomalt (protects hard dental tissues against caries), cetylpiridinium chloride 0,05% (CPC) (kills bacteria in oral cavity, and prevents accumulation of plaque), bisabolol, ginger extract, aloe vera and vitamin E (restore oral mucosa, which is mechanically injured by braces). GUM Ortho toothpaste is low-foaming, should be used for long-time brushing, and its gel structure provides better distribution on the surface, and around the braces. But it should be noted that even though in our study patients used similar toothpaste and mouthwashes for several months their oral hygiene levels characterized with reliable differences during each month of monitoring. Such outcome supported evidences regarding dependencies of oral hygiene level on the usage of specific toothbrush and mechanical cleaning items, but not on using peculiar toothpaste [25, 26].

Results obtained in present research coincide with numerous studies, which state that interdental brushes are the most appropriate for the interdental space cleaning [27, 28, 29]. It is particularly important to choose appropriate size of toothbrushes. Oral hygiene regime with the use of the two-row and mono-bundle toothbrush and interdental brush, which was realized during the third month of orthodontic treatment, seems to be the most efficient regarding oral hygiene parameters normalization to their pre-treatment level.

Circumstantial evidences approved higher efficiency of using orthodontic design toothbrush compared to conventional one for plaque control among orthodontic patients [30]. Meanwhile associated meta-analysis has not found any major improvements during the use orthodontic design toothbrush for plaque removal compared to conventional toothbrush [30].

Secondary research endpoint revealed pronounced wear off signs of ultrathin bristles after their contact with metallic brace components. Analogical outcome was noted within classical systematic review of Goh et al., in which authors mentioned that because wear off effect of interdental toothbrushes is increased among orthodontic patients, this in turn increase economic burden of oral hygiene specifically for orthodontic patients [31].

Usage of plaque disclosing agents also seems to improve self-performed dental plaque control among orthodontic patients [32]. In future research it would be reasonable to implement usage of plaque disclosing agents into proposed specifically-designed plaque-controlled regime of self-performed oral hygiene measures developed for orthodontic patients not only at follow-up control visits, but also at home.

Motivation plays a significant role for keeping adequate oral hygiene among orthodontic patients. In randomized controlled study it was found that daily automated messaging of the patients supported significant improvement of oral hygiene status compared

to those who received reminders just once a week [33]. It was interesting to observe that patients who received daily reminders for routine self-performed plaque control at the end of the survey were more motivated for further frequent messages reminding them about the need of performing oral hygiene measures [33].

Based on the results obtained in present study, while taking into account limitations related with relatively small study sample and short period of monitoring, it may be resumed that proposed specifically-designed plaque-controlled regime of self-performed oral hygiene measures developed for orthodontic patients could be efficiently used for the targeted cohort of patients and recommended as a part of complex orthodontic treatment protocol.

Conclusions

Oral hygiene conditions were deteriorated among all patients, compared to the pre-treatment situation, which was caused by orthodontic appliances fixation. Oral hygiene of the patients with fixed orthodontic appliances should include usage of two-row toothbrush, which the most efficiently clean the plaque above and under the braces arch; and a mono-bundle toothbrush for additional cleaning around braces locks, at the gingival area and around the micro-implants. The mono-bundle toothbrush is the best for cleaning the area around micro-implant and brace locks. Interdental hygiene should be provided with interdental size-adjusted brushes. All of above-mentioned measures included into proposed specifically-designed plaque-controlled regime of self-performed oral hygiene for orthodontic patients supported normalization of oral hygiene condition on the third month after orthodontic treatment initiation to the pre-treatment values.

Conflict of Interest

Authors do not have any potential conflict of interests that may influence the decision to publish this article.

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Удосконалення техніки самостійної гігієни порожнини рота у пацієнтів з фіксованою брекет системою та мікроімплантатами: апробація спеціально розробленого режиму самостійної гігієни з контролем зубного нальоту

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A – розробка концепції та дизайну дослідження, B - збір та або систематизація даних дослідження, C - аналіз та тлумачення даних дослідження, D - написання публікації, E - критичне доопрацювання тексту публікації, F- остаточне затвердження.

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Анотація

Вступ. Зафіксовані брекети та мікроімплантати можуть відігравати роль зон акумуляції зубного нальоту за умови недостатнього щоденного догляду за ротовою порожниною, що знижує рівень гігієни ротової порожнини в ортодонтичних пацієнтів.

Мета. Оцінити зміни якості гігієни ротової порожнини у ортодонтичних пацієнтів з брекетами та мікроімплантатами під час використання адаптованого, спеціально розробленого алгоритму самостійної гігієни ротової порожнини з контролем зубного нальоту при виконанні індивідуальних заходів гігієни ротової порожнини.

Матеріали та методи. Групу дослідження сформовано з 30 пацієнтів віком від 18 до 50 років, яким планувалося провести ортодонтичне лікування з використанням брекет-системи та мікроімплантатів. Протягом першого місяця ортодонтичного лікування пацієнти користувалися зубною щіткою з тонкою щетиною, протягом другого місяця – V-подібною зубною щіткою, а протягом третього місяця – дворядною та однопучковою зубною щіткою. Гігієну міжзубних проміжків забезпечували зубними йоржиками, адаптованими за розміром. Клінічну оцінку проводили з використанням гігієнічних індексів (О'Лірі, Грін-Вермільйон та Турескі).

Результати. У перший місяць після початку ортодонтичного лікування індекс О'Лірі різко підвищився до 52,6±6,4%, що свідчить про незадовільний рівень гігієни ротової порожнини. Значення індексів Турескі та Грін-Вермільйона після встановлення ортодонтичної апаратури зросли в 2 рази, після першого місяця лікування становили 1,98±0,31 та 2,12±0,34 бала відповідно, а після третього місяця лікування – 0,99±0,1 та 1,19±0,14 відповідно.

Висновки. Умови гігієни ротової порожнини були погіршені у всіх пацієнтів порівняно з ситуацією до лікування, що було зумовлено фіксацією ортодонтичних апаратів. Гігієна порожнини рота пацієнтів з незнімними ортодонтичними апаратами повинна включати використання дворядної зубної щітки, яка найбільш ефективно очищає наліт над та під дугою фіксованої брекет системи та однопучкової зубної щітки для додаткового очищення навколо замків фіксованої брекет системи, а також в ділянці ясен та навколо мікроімплантатів.

Заява про конфлікт інтересів
Автори не мають потенційного конфлікту інтересів, який може вплинути на рішення про публікацію цієї статті.

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