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Comparative characteristic of oral hygiene items

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Abstract
INTRODUCTION. The problem of pathology of hard tissues of teeth and periodontal diseases doesn't lose its relevance today. This is due to the high ubiquity of this problem and sometimes the patient's ignorance of all types of full-fledged preventive measures.
AIM. To study the effectiveness of SPLAT Sea&Power toothbrushes with two interchangeable heads and a manual toothbrush SPLAT Professional Complete of medium hardness.
MATERIALS AND METHODS. The study was carried out on the basis of the Department of Therapeutic Dentistry of the Federal State Budgetary Educational Institution "PIMU" of the Ministry of Health of the Russian Federation. All respondents were divided into 3 groups: 1 group – 16 people using an electric sonic toothbrush SPLAT Sense&Power with head 1 (sensitive) to perform individual oral hygiene, 2 group – 16 people using an electric sonic toothbrush SPLAT Sense&Power with head 2 to perform individual oral hygiene (whitening), group 3 – 16 people using a manual toothbrush SPLAT Professional Complete of medium hardness to perform individual oral hygiene. An examination of the oral cavity was performed at each visit with fixation in the card of the dental patient 043/Y, assessment of the Green-Vermillion index (OHI-S), dental plaque index PLI (Silness, Loe), interdental hygiene index (HYG), bleeding and gum injury, PMA, SBI indices according to Muhlemann and Son, odor oral and dental hyperesthesia, tooth colors by Vita Bleachedguide.
RESULTS The study involved 48 people of both sexes aged 21 to 49 years. At 1 visit, with a single cleansing, there is a higher efficiency of using electric toothbrushes with head 1 and head 2 compared to manual (1.5 times according to the OHI-S index and 2 times according to the PLI index). For the PLI index, only the difference between a brush with a head 2 and a manual brush is significant. Good cleaning of interdental spaces and areas under the gum line was noted. The level of bad breath decreases when using all types of brushes, however, when using electric brushes, this effect is more pronounced, the difference in effects is statistically significant.
CONCLUSIONS According to the results of the study, it can be concluded that the use of an electric sonic toothbrush with various heads helps to improve the hygienic condition of the oral cavity, effectively remove plaque and reduce its formation over time.

Keywords: hygienic condition of the oral cavity, electric ultrasonic brush, manual brush

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Сравнительная характеристика предметов гигиены полости рта

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Резюме
ВВЕДЕНИЕ. Проблема патологии твердых тканей зубов и заболеваний пародонта сегодня не теряют своей актуальности. Это связано с высокой повсеместной распространенностью данной проблемы и порой незнанием пациента о всех видах полноценных профилактических мероприятий.
ЦЕЛЬ. Исследование направлено на изучение эффективности зубных щеток SPLAT Sense&Power с двумя сменными головками и мануальной зубной щетки SPLAT Professional Complete средней жесткости.
МАТЕРИАЛЫ И МЕТОДЫ. Исследование выполнено на базе кафедры терапевтической стоматологии ФГБОУ ВО «ПИМУ» МЗ РФ. Все респонденты были разделены на 3 группы: 1-я группа – 16 человек, использующие для выполнения индивидуальной гигиены полости рта электрическую звуковую зубную щетку SPLAT Sense&Power с головкой 1 (сенситив), 2-я группа – 16 человек, использующие для выполнения индивидуальной гигиены полости рта электрическую звуковую зубную щетку SPLAT Sense&Power

с головкой 2 (отбеливающая), 3-я группа – 16 человек, использующие для выполнения индивидуальной гигиены полости рта мануальную зубную щетку SPLAT Professional Complete средней жесткости. Выполняли осмотр полости рта при каждом визите с фиксацией в карте стоматологического больного 043/У, оценку индекса Грина – Вермиллиона (OHI-S), индекса зубной бляшки PLI (Silness, Loe), интердентального гигиенического индекса (HYG), кровоточивости и травматизации десен, индексов PMA, SBI по Muhlemann и Son, запаха изо рта и гиперестезии зубов, цвета зубов по Vita Bleachedguide.
РЕЗУЛЬТАТЫ. В исследовании приняло участие 48 человек обоего пола в возрасте от 21 до 49 лет. На 1-м визите при однократном очищении наблюдается более высокая эффективность применения электрических зубных щеток с головкой 1 и головкой 2 по сравнению с мануальной (в 1,5 раза по индексу OHI-S и в 2 раза по индексу PLI). Для индекса PLI значимо только отличие щетки с головкой 2 от мануальной щетки. Отмечено хорошее очищение межзубных промежутков и участков под линией десны. Уровень неприятного запаха изо рта снижается при использовании всех видов щеток, однако при использовании электрической этот эффект более выражен, разница эффектов статистически значима.
ВЫВОДЫ. По результатам проведенного исследования можно заключить, что применение электрической звуковой зубной щетки с различными головками способствует улучшению гигиенического состояния полости рта, эффективному удалению налета и снижению его образования с течением времени.

Ключевые слова: гигиеническое состояние полости рта, электрическая ультразвуковая щетка, мануальная щетка

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INTRODUCTION

The issue of dental hard tissue pathologies and periodontal diseases remains highly relevant today [1]. This is attributed to the widespread prevalence of these conditions and, in many cases, patients' lack of awareness regarding comprehensive preventive measures [2]. According to the literature, the primary causative factors include the formation of dental plaque, both hard and soft deposits, and insufficient control over their development [3]. Consequently, the primary focus of modern dentistry is individual prevention, emphasizing the use of oral hygiene products tailored to various age groups to enhance the regular care of the oral cavity [4]. It is well-established that oral hygiene largely depends on the consistency and correctness of plaque removal [5]. The key tools for personal oral hygiene are individual toothbrushes and toothpaste [6].

The dental market is oversaturated with various types of oral hygiene products and tools [7]. However, the challenge of selecting the most optimal toothbrush – capable of effectively removing dental deposits while minimizing negative impact – remains relevant. A vast array of toothbrushes is available, including manual, electric, and sonic models [8]. They differ in the number and orientation of bristles, materials, bristle height and stiffness, as well as the diversity in the design of the brush head and handle. Manufacturers employ a variety of strategies to enhance the appearance and functionality of toothbrushes, which directly influences their sales performance.

The manual toothbrush is a relatively simple device [9] and has achieved widespread global use. However, the advent of electric toothbrushes has simplified personal oral hygiene. While their operating principle is similar to that of manual toothbrushes [10], the greater number of movements and their optimized orientation provide significantly better results. The development of sonic and ultrasonic toothbrushes is based on increasing the frequency of bristle movements (200–400 Hz or 20,000–40,000 vibrations per minute for sonic toothbrushes, and from 1.6 MHz or over 2,000,000 vibrations per minute for ultrasonic toothbrushes), offering optimal removal of food debris and plaque with minimal effort [11].

AIM

To evaluate the effectiveness of the SPLAT Sense&Power sonic toothbrush with two interchangeable heads and the SPLAT Professional Complete medium-hard manual toothbrush.

MATERIALS AND METHODS

The study was conducted at the Department of Therapeutic Dentistry of PIMU, Ministry of Health of the Russian Federation. All participants were divided into three groups:

Group 1: 16 individuals using the SPLAT Sense&Power sonic electric toothbrush with Head 1 (sensitive).

Group 2: 16 individuals using the SPLAT Sense&Power sonic electric toothbrush with Head 2 (whitening).

Group 3: 16 individuals using the SPLAT Professional Complete medium-hard manual toothbrush.

All study participants were provided with a standard toothpaste from the SPLAT Professional series.

The study included three visits, during which data were collected both before and after the use of the tested product.

Visit 1: The day the volunteer was enrolled in the study and the first use of the assigned products.

Visit 2: Day 14 of the study, with participants continuing the use of the assigned products.

Visit 3: Day 28 of the study, marking the final evaluation of the participants after using the assigned products.

The expected duration of participation in the study was 28 ± 2 days.

Inclusion Criteria:

1. Signing an informed voluntary consent form to participate in the study.

2. Agreement not to use other oral hygiene products during the study.

3. Presence of at least 20 teeth not covered by prosthetic structures.

4. Ability and willingness to follow the study schedule, including attending all visits as per protocol.

5. At the time of enrollment, all participants had a Greene–Vermillion index greater than 1.5 during the first visit.

Exclusion Criteria:

1. History of individual intolerance to the components of the tested products or other oral hygiene products, as well as food allergies.

2. Pregnancy or breastfeeding.

3. Use of medications that could potentially affect gum or enamel conditions during the study.

4. Use of dentures, braces, or other orthodontic devices.

5. Extensive dental caries, periodontal diseases, or other oral conditions.

6. Refusal to follow protocol procedures, including regular tooth brushing with the tested products.

7. Presence of dental calculus on teeth 1.1–1.3, 2.1–2.3, 3.1–3.3, and 4.1–4.3.

8. Presence of old, persistent plaque on teeth 1.1–1.3, 2.1–2.3, 3.1–3.3, and 4.1–4.3.

9. "Overgrown teeth", i.e., unnaturally short teeth due to gingival overgrowth in the areas of 1.1–1.3, 2.1–2.3, 3.1–3.3, and 4.1–4.3.

10. Visible cracks or other defects in the tooth enamel.

11. Smoking, alcohol, or drug addiction.

12. Professional dental cleaning performed less than 90 days before the study (based on medical history and records).

13. Professional teeth whitening, including the use of at-home whitening systems, performed less than 90 days before the study.

14. Other dental procedures, including orthodontic or surgical interventions, performed less than 30 days before the study (based on medical history and records).

15. Continuous use of anti-inflammatory agents, including NSAIDs and corticosteroids.

16. Chemotherapy, radiotherapy, or cytokine therapy within five years prior to the study (based on medical history and records).

17. Clinical manifestations of infectious diseases, hepatitis B or C, or HIV infection (based on medical history and records).

At each visit, all participants underwent an external examination and a dental oral cavity examination, with findings recorded in the dental patient chart 043/U.

The Greene–Vermillion index (OHI-S) was assessed during each visit, both before and after a 2-minute toothbrushing session [12].

The Plaque Index (PLI) by Silness and Loe was evaluated at each visit before brushing and after brushing during the first and second visits.

The Interdental Hygiene Index (HYG) was assessed at each visit before brushing and after brushing during the first and second visits.

Bleeding and gum trauma were evaluated before and after brushing during the first and second visits.

The PMA index, SBI index (by Muhlemann and Son), halitosis assessment, and tooth hypersensitivity were evaluated at every visit.

Tooth color was recorded using the Vita Bleached-guide shade scale before brushing at every visit and after brushing during the first visit [13].

In addition to objective evaluations, participants were surveyed regarding their experience using the products and their preferences.

The data for the parameters were presented based on the nature of the variable, either continuous or categorical.

Categorical variables were analyzed as counts (*n*) and proportions (percentages) of the total number of volunteers exhibiting a specific characteristic.

A brief summary of continuous variables was provided, including the mean, standard deviation, and median.

Variables expressed as proportions of volunteers were evaluated descriptively in percentages.

Statistical Analysis The choice of statistical tests was based on the assessment of the normality of data distribution. Statistical analysis was performed using standard functions in MS Excel and the SPSS Statistics software package.

RESULTS

The study included 48 participants of both sexes, aged 21 to 49 years, with a median age of 28 years. All participants completed the study in full.

During the first visit, after a single cleaning session, the use of electric toothbrushes with Head 1 and Head 2 demonstrated greater effectiveness compared to the manual toothbrush (1.5 times higher for the OHI-S index and 2 times higher for the PLI index). While these differences are indicative, no statistically significant difference was observed for the OHI-S index when accounting for multiple comparisons. For the PLI index, only the difference between the toothbrush with Head 2 and the manual toothbrush was statistically significant. Differences for the HYG index were not significant. Effective cleaning of interdental spaces and areas beneath the gum line was noted (Table 1).

An analysis of changes in oral hygiene status from the beginning of the study to Visits 2 and 3 revealed positive dynamics across all indices (Table 2).

The dynamics differ statistically significantly between the products when accounting for multiple comparisons. For electric toothbrushes with both heads, the dynamics for the OHI-S and PLI indices are similar. However, for the HYG index, the toothbrush with Head 2 is more effective than the one with Head 1. In all cases, the effectiveness of the electric toothbrush in cleaning and preventing plaque accumulation significantly exceeds that of the manual toothbrush (Fig. 1).

Table 1. Indicators of the OHI-S, PLI and HYG indices in 1 session

Таблица 1. Показатели индексов OHI-S, PLI и HYG за одну процедуру

Visit 1	OHI-S Before	OHI-S After	Delta_OHI	PLI_Before	PLI_After	Delta_PLI	HYG_Before	HYG_After	Delta_HYG
Electro1	2.1	1.5	–0.6	2.1	1.4	–0.6	23.2	38.4	15.3
Electro 2	2.3	1.6	–0.7	2.2	1.4	–0.8	15.1	31.4	16.3
Manual	2.3	1.8	–0.5	2.2	1.9	–0.3	15.5	30.3	14.7

Table 2. Indicators of the OHI-S, PLI and HYG indices in the 2nd and 3rd visits

Таблица 2. Показатели индексов OHI-S, PLI и HYG на втором и третьем посещениях

		OHI-S 1.1		OHI-S 2.1		OHI-S 3.1		PLI_1.1		PLI_2.1		PLI_3.1		HYG_1.1		HYG_2.1		HYG_3.1	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Prod	Electro1	2.10	0.57	1.03	0.77	0.30	0.27	2.07	0.61	0.68	0.51	0.27	0.34	23.2	21.0	49.25	27.07	72.34	21.70
	Electro2	2.31	0.55	0.64	0.57	0.24	0.33	2.16	0.80	0.67	0.64	0.16	0.26	15,1	16.9	59.37	26.41	84.38	18.72
	Manual	2.29	0.62	1.46	0.78	1.08	0.62	2.23	0.82	1.74	0.87	0.98	0.65	15,5	14.9	30.29	15.61	37.65	21.94

According to the analysis, the level of halitosis decreases with the use of all types of toothbrushes; however, this effect is more pronounced with the use of electric toothbrushes. The difference in effects is statistically significant (Table 3, Fig. 2).

In the groups using the electric toothbrush with two types of heads, a greater effect in reducing inflammatory manifestations in the oral cavity and bleeding was achieved compared to the manual toothbrush group (2–3 times greater at Visit 2). By Visit 3, the difference becomes somewhat less pronounced (Table 4 and 5).

Statistical analysis reveals a significant difference at Visit 2 between the electric toothbrush 2 group and the manual toothbrush group, while the difference for the electric toothbrush 1 group is indicative (Fig. 3).

On average, with the use of electric toothbrushes, gingival condition improved in 50% of participants by the second week, compared to 30% with the use of a manual toothbrush. By the fourth week, this effect was observed in 100% of participants. The difference between toothbrushes is indicative but not statistically significant.

Table 3. The level of unpleasant odor from the oral cavity

Таблица 3. Уровень неприятного запаха из полости рта

	Smell_1		Smell_2		Smell_3	
	Mean	SD	Mean	SD	Mean	SD
Electro1	3.5	1.3	0.9	1.0	0.1	0.3
Electro 2	3.3	1.2	0.6	0.9	0.1	0.3
Manual	3.0	0.9	1.8	1.2	1.1	1.0

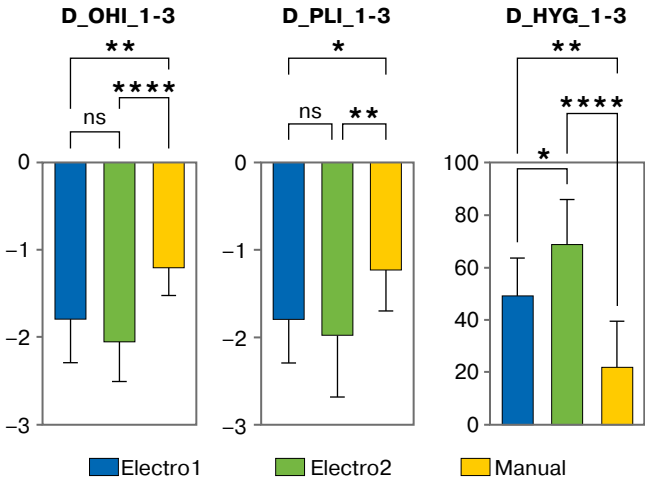

Fig. 1. Comparative characteristics of the OHI-S, PLI and HYG indices in the studied groups

Рис. 1. Сравнительная характеристика индексов OHI-S, PLI и HYG в исследуемых группах

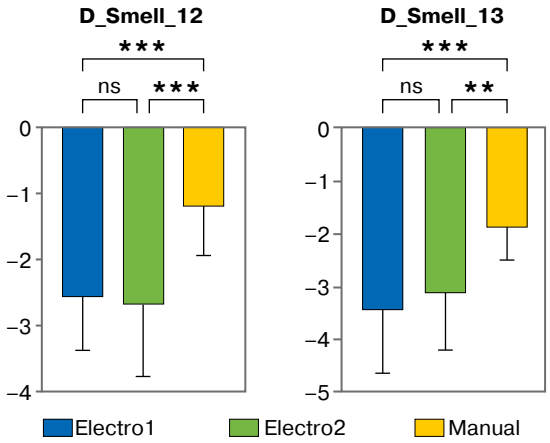

Fig. 2. Comparative characteristics of oral odor in 3 groups

Рис. 2. Сравнительная характеристика запаха из полости рта в трех группах

Table 4. Indicators of the PMA index at 3 visits

Таблица 4. Показатели индекса PMA при трех визитах

		PMA_1		PMA_2		PMA_3	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Prod	Electro1	40.5	21.3	24.0	18.4	11.38	9.32
	Electro2	35.6	16.5	11.6	11.7	8.01	9.34
	Manual	58.4	27.5	45.3	21.2	30.43	18.30

Table 5. SBI index indicators at 3 visits

Таблица 5. Показатели индекса SBI при трех визитах

		SBI_1		SBI_2		SBI_3	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Prod	Electro1	1.98	1.00	0.74	0.73	0.43	0.47
	Electro2	2.19	1.10	0.62	0.82	0.23	0.44
	Manual	2.76	1.11	1.97	1.09	1.21	0.85

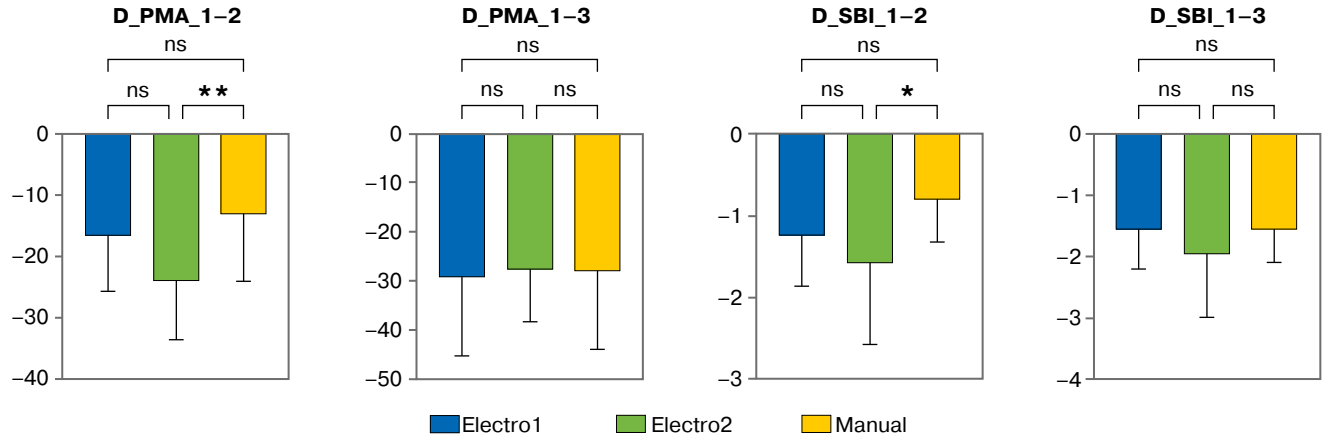

Fig. 3. Comparative characteristics of the PMA and SBI indices in 3 groups

Рис. 3. Сравнительная характеристика индексов PMA и SBI в трех группах

Table 6. Quantitative representation for participants who achieved improved gum health by visits 2 and 3

Таблица 6. Количественное представление участников, у которых наблюдалось улучшение состояния десен на втором и третьем визитах

	Improvement in gingival condition		Sum
	2 weeks	4 weeks	
Electro1	7	9	16
Electro2	9	7	16
Manual	5	11	16

A noticeable improvement in gum condition was observed with the use of all types of toothbrushes, which can be attributed to the overall improvement in oral hygiene (Table 6).

For all toothbrushes, minor gingival trauma was equally noted during the first visit, which may be attributed to the unfamiliarity with the new brush heads and individual characteristics of the participants. Over time, the trauma decreased and eventually resolved completely.

Regarding hypersensitivity, none of the participants in any group reported significant tooth hypersensitivity. Throughout the study, no significant changes in hypersensitivity were recorded in any group, indicating that the use of both electric and manual toothbrushes does not increase tooth sensitivity.

DISCUSSION

The survey results revealed a positive perception of the product among study participants. The electric toothbrush with both types of heads was noted for its convenience and high cleaning efficiency. All participants (100%) stated that they would prefer the tested toothbrush over the ones they had previously used.

CONCLUSION

The results of the study indicate that the use of an electric sonic toothbrush with different heads contributes to improved oral hygiene, effective plaque removal, and a reduction in its formation over time. The findings of the delayed dynamic analysis demonstrate a high level of cleaning efficiency for tooth surfaces and interdental spaces achieved with the electric sonic toothbrush.

The use of innovative oral hygiene products promotes the improvement and maintenance of dental health, prevents pathologies of dental hard tissues and periodontal tissues, and has a positive impact on preserving and supporting overall oral health.

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