

Original Article

The Impact of Oral Hygiene on the Success of Dental Implant Prosthetics

Anna Alexandrovna Remizova¹, Zarina Ushangievna Sakaeva¹, Zalina Georgievna Dzgoeva^{1*}, Igor Igorevich Rayushkin², Yuliya Igorevna Tingaeva¹, Sergey Nikolaevich Povetkin³, Artem Evgenovich Mishvelov³

¹Department of Dentistry, Faculty of Dentistry, North Ossetian State Medical Academy, Vladikavkaz, Republic of North Ossetia, Russia, 362007.

²Department of Orthopedic Dentistry, Institute of Dentistry named after Borovskiy, I.M. Sechenov First Moscow State Medical University of the Ministry of Health of the Russian Federation (Sechenov University), Moscow, Russia, 119991.

³Department of Food Technology and Engineering, Institute of Life Systems, North Caucasus Federal University, Stavropol, Russia, 355000.

*E-mail ✉ archi4717@yandex.ru

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ABSTRACT

For the first time, the article presents indicators of peri-implant tissue condition and oral hygiene among prosthetic implant users, based on clinical and operational factors such as adherence to medical assessment schedules, availability of gum diseases, and personal oral hygiene practices. Our study focused on long-term radiological and clinical indicators of implant prosthetics effectiveness, as well as hygiene index metrics and the condition of peri-implant and periodontal tissues. Factors that affect the efficiency of implantation, hygiene, and periodontal guides among dental implant patients, as well as the degree to which this effectiveness is reduced, are elaborated on. The findings of the study regarding the importance of systematic medical examinations, professional oral hygiene practices, and comprehensive individual hygiene in preserving hygienic and periodontal indicators among prosthetic implant users are shown. This article looks into how effective different kinds of personal oral hygiene products—such as interdental items, irrigators, and bacteriophage-based “Phagodent” gel—are for people with dental implants. A discussion addresses the subjective assessment of hygiene-related factors concerning prosthetics on implants in people with a strong motivation to care for their oral cavity, as well as in those who do not follow the recommendations for medical examination and professional hygiene.

Keywords: Dental implants, Hygiene, Prosthetics, Teeth

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Introduction

The main complication associated with dental implantation, observed during both the prosthetic stages and various periods of prosthesis use, is inflammation in the peri-implant tissues. This has been revealed through extensive experience with dental implants in Russia [1-8]. Mucositis is a limited inflammatory condition of the gums around implants, while periimplantitis, which involves resorption of the underlying bone tissue, occurs in at least thirty percent

and ten percent of cases, respectively, based on various data three years after prosthetic completion [9-12]. Without treatment, peri-implantitis culminates in implant disintegration; peri-implantitis treatment involves a complex set of challenges that, in addition to the need for inflammation elimination, includes the necessity of restoring bone tissue that has been lost [13-19].

Every investigation targeting the prevention and management of peri-implantitis and mucositis points to the detrimental effect of inadequate oral hygiene [20-

22]. In light of the widely recognized low motivation among the populace to maintain an adequate level of individual oral hygiene, it is crucial to develop effective strategies for maintaining the mouth's hygienic state during implant treatment. Regarding hygiene, there are several factors to consider for patients with implants: throughout the process of implantological treatment, which consists of several orthopedic and surgical stages; in the dynamics associated with implant-supported prosthesis use; growth in the degree of personalized oral hygiene through targeted hygiene strategies and medical assistance.

A researcher outlines a 9-year experience with prosthetics on implants that pertains solely to the extraction of implants caused by peri-implantitis across different implantation circumstances [23-27]. According to the study, the rate of implant removals was 2% after 5 years, increased to 7.6% after 7 years, and reached 7.7% after 9 years. This suggests that the full adaptation phase of the implant to the operating circumstances begins after seven years. The initial state of periodontitis and hygiene have a greater impact on the frequency of implant removal than health status (the implant disintegration rate in patients with periodontitis was 7.9%, compared to 4.1% in those without it; with a satisfactory hygiene level, the rate was 4.3%, while it was 9.5% with an insufficient hygiene level. The frequency of implant removal did not show a significant difference among implants located in various localizations. Nevertheless, disintegration was noted more frequently in Lekholm/Zarb type IV implants (10.5%), cases of complete tooth absence (13.4%), and short implants (12.9%). It has been demonstrated that cementing prostheses onto implants can trigger the onset of peri-implantitis, resulting in an implant disintegration rate of 9.7% over nine years. D. A. Bronstein employed implants in challenging clinical scenarios involving total edentulism, with a 10-year follow-up evaluation of peri-implant tissues [13]. Previously, within that same timeframe, multiple doctors in Moscow evaluated the implantation outcomes for patients with either partial or complete tooth absence. After ten years of loading more than 4,500 implants, 44.6% suffered from mucositis and 30.8% had perimplantitis; mucositis occurs twice as often as perimplantitis within the same implant length. 5.1% of the implants were taken out because of peri-implantitis. Over my ten years of observing the group, the recorded indicators were 30.4%, 40.7%, and 12.5%. It is concluded that, despite the oral cavity having a lower degree of microbial contamination in cases of complete tooth

absence, prosthetics on implants yield better results in cases of partial tooth absence. This can be explained by the lower number of support implants in situations where there is a total absence of teeth, as well as the fact that prosthetics in such instances are mainly removable. A three-year follow-up study conducted by Remizova A. A. on implant prostheses in patients with metabolic syndrome revealed that just 12.7% of those with fixed prostheses and 9.7% of those with removable prostheses on implants maintained a good level of hygiene [28-30]. Implants often exhibited gum recession: 38.2% of patients with fixed prostheses and 39.1% with removable ones; the respective values of the SPI index were 4.77 and 5.83.

A researcher concentrated her studies on the laboratory and clinical assessment of how well toothbrushes are clean for patients with dental implants and orthopedic structures [29, 31-34]. In 476 patients with orthopedic structures on intraosseous implants, she examined the condition of the mouth. Concurrently, 30 individuals used a manual toothbrush to clean their prosthetic structures and natural teeth on implants. The other patients were classified into subgroups according to the duration since their prosthetics were completed and the types of toothbrushes used (electric, sound, ion, ultrasound). The advice given was to brush your teeth for 3 minutes twice daily. The survey encompassed a questionnaire, a survey, and the hygiene indices calculation. Prior to the implementation of differentiated brush use, 70% of implant patients who used a standard manual toothbrush for three months had an unsatisfactory level of hygiene. In contrast, most patients using other brushes achieved sufficient hygiene (79.4-100%). Research has shown that an ultrasonic toothbrush with medium hardness, multi-level brush field trimming, and an average vibration frequency of 96 million times per minute (1.6 MHz) achieves the most effective cleaning results. Based on the index of PLIC, the cleaning efficiency of various toothbrushes is as follows: manual toothbrushes at 47.4%, electric toothbrushes at 52.3%, sound toothbrushes at 61.6%, ionic toothbrushes at 59%, and ultrasonic toothbrushes at 65.3%. As shown by scanning electron microscopy, toothbrush wear after three months was 58.4% for manual types, 41.1% for electric types, 40.9% for sonic types, 42.5% for ion types, and 27.5% for ultrasound types. The data we obtained post-survey was disappointing regarding its implications for patients with implants and their oral hygiene attitudes. 58.5% of those surveyed do not adhere to dental hygiene recommendations, while 31.2% do not meet the conditions of medical examination. With respect to dental care products, the

majority of people (76% of those surveyed) select a manual toothbrush, while the others select an electric toothbrush; 50% of the participants utilize dental irrigators, whereas the use of interdental hygiene products is restricted to 10% or lower. The hygiene value is indicated by a robust positive correlation with the cytological study parameters ($r_s = 0.796-0.962$).

The aim of the article

Justification of the professional oral hygiene periodicity and the individual oral hygiene volume at the implantological treatment stages and dentures use on dental implants.

Objectives of the work

1. Investigate the long-term radiological and clinical indicators of the effectiveness of implant prosthetics, as well as hygiene index indicators and the condition of peri-implant and periodontal tissues.
2. Study the elements that lead to a reduction in the efficiency of hygiene, implantation, and periodontal measures within patients with implants, as well as the degree of this reduction.
3. Examine how regular medical checkups, specialist oral hygiene practices, and comprehensive personal hygiene contribute to maintaining hygienic and periodontal indicators for prosthetic implant users. Compare the effectiveness of individual oral hygiene in different volumes, including irrigators, interdental products, and "Phagodent" gel based on bacteriophages in people with dental implants.
4. Study of the subjective evaluation of the hygienic aspects of implant prosthetics among individuals who are highly motivated for oral care and those who do not follow medical examination schedules or professional hygiene practices.

Materials and Methods

The Department of dentistry №3 of the North Ossetian State Medical Academy of the Ministry of Health of the Russian Federation analyzed the results of

prosthetics on implants of 158 people (the first group), consisting of 93 women and 65 men; 74 patients aged 20 to 40 years and 84 patients aged 40 to 60 years. Before the start of prosthetics, 26 people had a complete absence of teeth (on one or both jaws), while the remaining 132 had a partial absence of teeth (K08.1).

363 titanium intraosseous implants from different companies were previously installed using the classic two-stage method and had different prosthesis designs. Among the prostheses on implants, most were metal-ceramic crowns or non-stretched bridge prostheses (151 prostheses, 106 people, 219 implants), and among the removable ones-with beam fixation on two, three, or four implants (17 prostheses in 17 people on 54 implants); 9 people with the complete absence of teeth (9 prostheses, 51 implants) had fixed dentures on five or six implants with a shortened dental row from the standard dental rows – the so-called conditionally removable dentures; among the fixed prostheses in a small number were all-ceramic crowns and bridges (31 prostheses, 26 people, 39 implants). The first group was divided according to the terms from the moment of completion of prosthetics: one year – 55 people, two years – 51, and three years – 52.

Dispensary control included clinical and index evaluation of periodontal and peri-implant tissues, professional oral hygiene, occlusal correction, and semi-annual orthopantomography [1, 3, 4, 35, 36]. Also, the index examination of hygiene and periodontitis was carried out in the following periods: before the start of treatment (when applying to the clinic), after pre-implantological sanitation of the mouth (including periodontal treatment and professional hygiene, before the manufacture of permanent prostheses (at the end of the period of osseointegration and use of temporary prostheses).

Results and Discussion

Before the implantological treatment initiation, the experimental group exhibited the subsequent markers of cleanliness and periodontal disease (**Table 1**).

Table 1. Before the initiation of implantological therapy, periodontal and hygiene indicators in the examined group.

Index	Value
Oral hygiene index (OHI-S) Green J. C., Vermillion J. R.	$3,8 \pm 0,7$
Gingivitis index (GI) Loe H., Silness J.	$1,3 \pm 0,3$
Muhllemann index (MI) in Cowell modification	$1,2 \pm 0,2$
PMA index (%) in Parma modification	$43,2 \pm 5,5$
Organolectic index (OI)	$2,8 \pm 0,4$

Halimeter index, ppb	304 ± 26
Periodontal pathogens detection (%)	36,7

As per the algorithm for implantological treatment, there were significant variations in the indicators of hygiene and periodontal tissues. Due to dental and periodontal rehabilitation before the installation of the implants, all indicators improved significantly: periodontal pathogens detection-13.3%; Halimeter index-102±14.3 ppb; OI index-0.9±0.2; PMA index-22.2±3.1%; Muhlleman index-0.4±0.1; gingivitis index GI-0.7±0.2; and OHI-S-0.8±0.2.

The period of implant osseointegration (which can last as long as six months) led to a deterioration in average group indicators due to the absence of personal hygiene among many patients: Halimeter index – 206±34.2 ppb; OI index – 1.6±0.3; PMA index – 31.4±9.9%; Muhlleman index – 1.0±0.3; gingivitis index GI – 1.3±0.9; and OHI-S – 1.5±0.3.

Carrying out professional hygiene procedures on patients before the installation of gum shapers or

abutments further enhanced the condition of their periodontal and hygiene health: Halimeter index-99±17.5 ppb; OI index-1.0±0.1; PMA index-24.3±8.1%; OHI-S-0.5±0.1; Muhlleman index-0.5±0.2; and gingivitis index GI-0.7±0.2.

Temporary fixed prostheses, typically made from polymer materials, significantly deteriorated the mouth's hygienic condition due to their plaque-adsorbing properties. This necessitated professional hygiene treatments prior to the placement of permanent prostheses. Thus, the indices OI, PMA, Muhlleman, GI, IGSK, OHI-S, and Galimeter index deteriorated to 1,7±0,3%; 31,8±6,6%; 1,2±0,2; 1,4±0,1; 1,9±0,2; 2,1±0,3; 266±30 ppb.

The experiment involved determining quarterly indicators regarding the dynamics of prostheses on implant functioning before professional hygiene was applied (**Table 2**).

Table 2. Indicators periodontium and hygiene in implant treatment dynamics.

Control	Index	1	2	3	4	5	6	7	8
	Before treatment	3,8	-	1,3	1,2	43,2	2,8	304	36,7
	After sanitation	0,8	-	0,7	0,4	22,2	0,9	102	13,3
	Before implants opening	1,5	-	1,3	1,0	31,4	1,6	206	-
	After professional hygiene and implant opening	0,5	-	0,7	0,5	24,3	1,0	99	-
	Before the start of a permanent prosthesis	2,1	1,9	1,4	1,2	31,8	1,7	266	-
	After professional hygiene and prosthesis fixation	0,8	0,7	0,7	0,5	27,3	0,8	114	18,3
	After 3 month	1,3	1,2	1,1	0,8	31,5	2,0	156	25,0
	After 6 month	1,6	1,1	1,3	0,9	31,9	2,2	168	-
	After 9 month	1,7	1,3	1,1	0,9	32,2	2,3	149	-
	After 12 month	1,6	1,3	1,2	1,0	31,8	2,3	172	26,7

Note: 1 – OHI-S; 2 – hygiene index of super constructor (IHS); 3. GI; 4. MI; 5. PMA 6. OI; 7. Index of Halimeter; 8. Periodontal pathogens.

The performance of professional hygiene in alignment with the specified directives led to the normalization of the listed indicators during the stage of securing permanent prostheses, achieving a result of 0.8±0.2; 0,7±0,1; 0,7±0,1; 0,5±0,1; 27,3±5,4%; 0,8±0,2; 114±13 ppb. The PCR diagnostics of the pathogenic microflora in periodontal pockets conducted at this stage—prior to prosthesis fixation—revealed that the periodontal pathogens content was 18.3%.

Afterwards periodical evaluations of individuals that have prosthetic implants revealed fluctuations in all microbiome titer, marked by a diminishment of these indicators following 3 months, underscoring the natural necessity for professional hygiene at three-

month intervals. By employing this practice, the indicators became stabilized in the year that was observed. The twelve-month indicators, for instance, showed no significant difference from the three-month indicators when evaluated both before and after occupational hygiene. Vor der arbeitsmedizinischen Hygiene lagen die Indikatoren nach zwölf Monaten bei: OI – 2,3 ± 0,3, PMA-Index – 31,8 ± 6,2%, MI – 1,0 ± 0,1, Gingivitisindex GI – 1,2 ± 0,1, IHS – 1,3±0,1, OHI-S – 1,6±0,3, Halimeter-Index – 172 ± 29 ppb sowie bei periodontalen Pathogenen –26,7%; after occupational hygiene, all indicators conformed to the standards for occupational hygiene and the permanent prostheses fixation. The outcomes of the study on

alterations in halimeter index, OI, PMA, MI, GI, IHs, OHI-S, and periodontal pathogens content within the experimental groups are displayed on **Figures 1-4**.

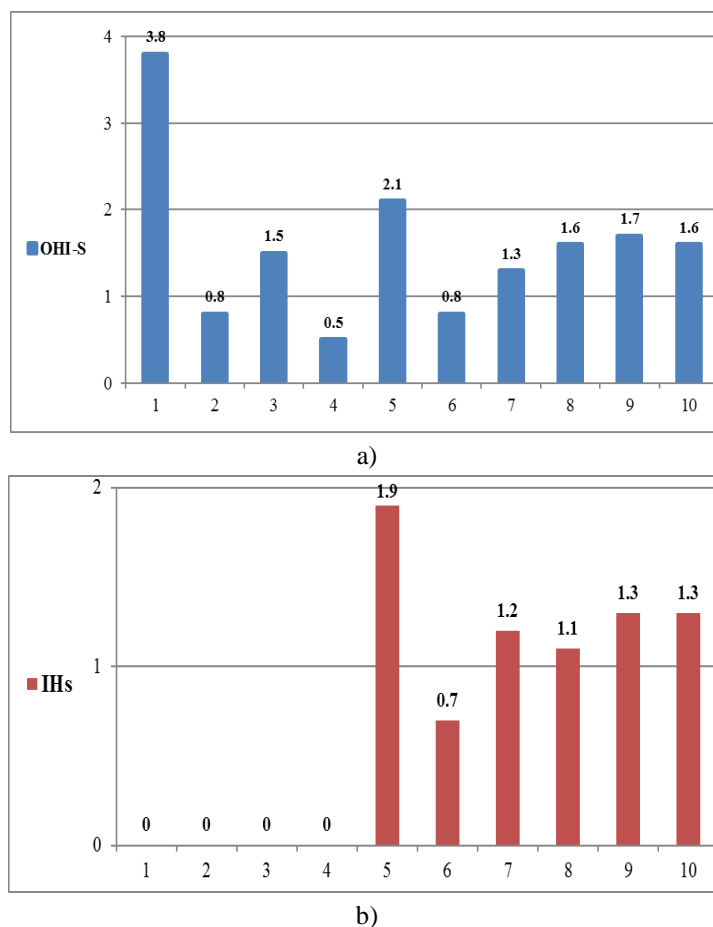
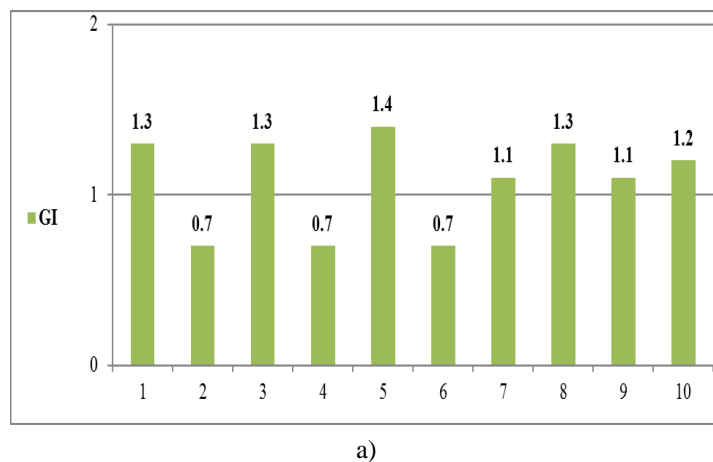
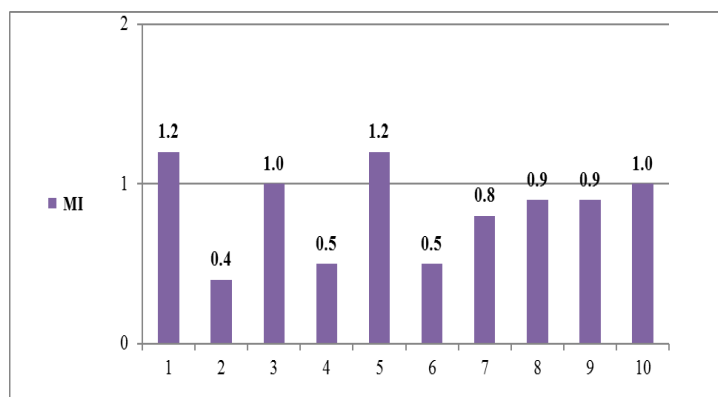


Figure 1. Main indicators data:

a) Alters in OHI-S in the experimental group in the implantological treatment dynamics: 1. Before treatment, 2. After sanitation and professional hygiene, 3. Before implant opening, 4. After professional hygiene and implant opening, 5. Before permanent prosthetics, 6. After professional hygiene and prostheses fixation, 7. 3 months, 8-6 months, 9-9 months, 10-12 months. b) Alters in IHs in the experimental group in the implantological treatment dynamics: 1. Before treatment, 2. After sanitation and professional hygiene, 3. Before implant opening, 4. After professional hygiene and implant opening, 5. Before permanent prosthetics, 6. After professional hygiene and prostheses fixation, 7-3 months, 8-6 months, 9-9 months, 10-12 months.

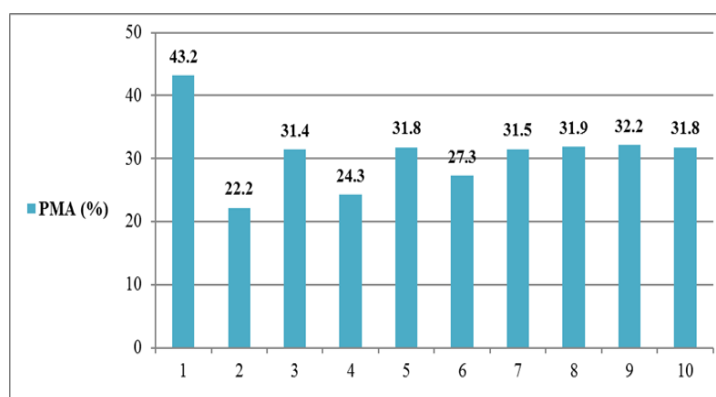




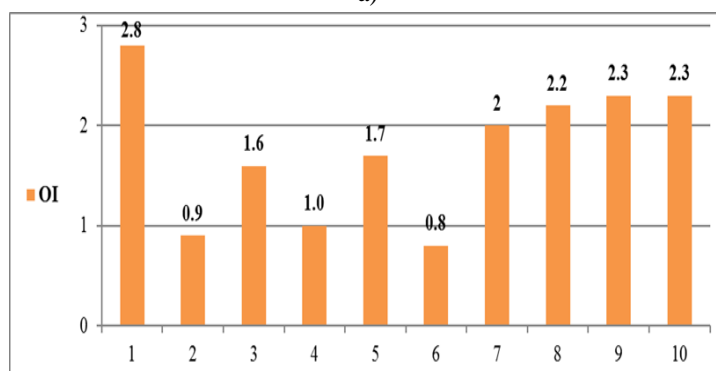
b)

Figure 2. Main indicators data.

a) Alters in GI amongst the experimental group during implantological therapy: 1. Before therapy, 2. After-sanitation and professional hygiene, 3. Before implant opening, 4. Following professional hygiene and implant opening, 5. Before permanent prosthetics, 6. After professional hygiene and prostheses fixation, 7-3 months, 8-6 months, 9-9 months, 10-12 months. b) Alters in MI within the experimental group throughout implantological treatment: 1. Before treatment, 2. Post-sanitation and professional hygiene measures, 3. Before implant opening, 4. Post-professional hygiene and implant opening, 5. Before permanent prosthetics, 6. After professional hygiene and prostheses fixation, 7-3 months, 8-6 months, 9-9 months, 10-12 months



a)



b)

Figure 3. Data on principal indicators: a) Alters in PMA within the experimental group throughout implantological treatment: 1. Before treatment, 2. Following sanitation and professional hygiene, 3. Before implant opening, 4. After implant opening and professional hygiene, 5. Before permanent prosthetics, 6. Following professional hygiene and prostheses fixation, 7. at 3 months, 8 – at 6 months, 9 – at 9 months, 10 – at 12 months. b) Alters in OI within the experimental group during implantological treatment: 1. Before treatment, 2. After sanitation and professional hygiene measures, 3. Before implant opening, 4. After implant

opening and professional hygiene, 5. Before permanent prosthetics, 6. After professional hygiene and prostheses fixation, 7 at 3 months, 8 at 6 months, 9 at 9 months, 10 at 12 months

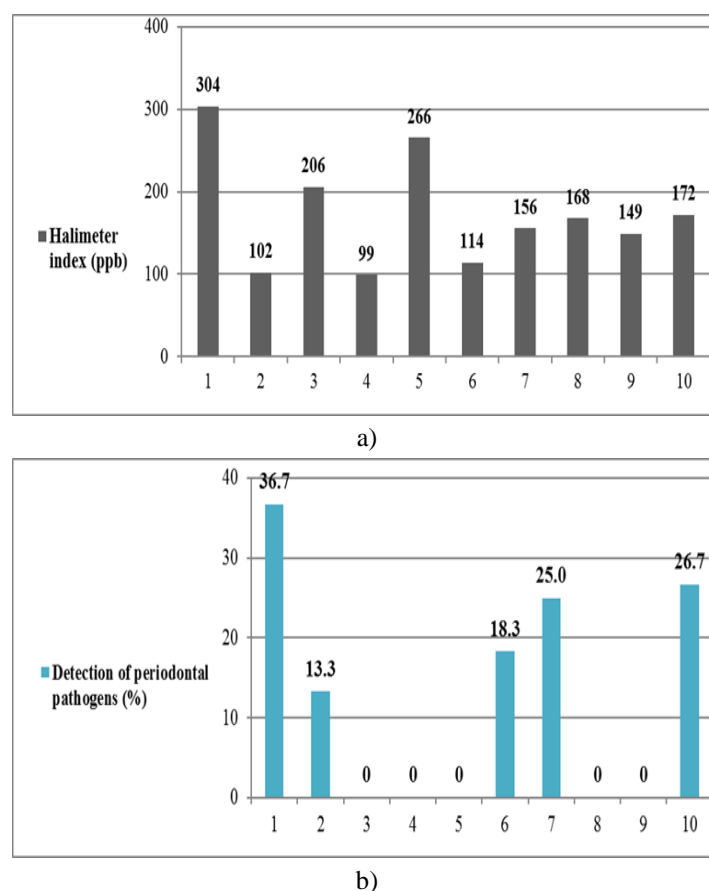


Figure 4. Main indicators data:

a) Halimeter index alters in the experimental group during implantological treatment: 1. Before treatment, 2. Post-sanitation and professional hygiene, 3. Before implant opening, 4. Post-professional hygiene and implant opening, 5. Before permanent prosthetics, 6. After professional hygiene and prostheses fixation, 7-3 months, 8-6 months, 9-9 months, 10-12 months. b) alters in the periodontal pathogens levels in the experimental group during implantological treatment: 1. Before treatment, 2. After sanitation and professional hygiene, 3. Before implant opening, 4. After professional hygiene and implant opening, 5. Before permanent prosthetics, 6. Following professional hygiene and prosthetic fixation, 7. at 3 months, 8. at 6 months, 9. at 9 months, 10. at 12 months.

In the second group, where periodic professional oral hygiene was practiced, there were no recorded instances of peri-implantitis or implant removal one

year after prosthetics; Only two patients (3.3%) exhibited mucositis in individual implants. Data obtained is revealed in **Table 3**.

Table 3. State of hygiene, peri-implant, and periodontal tissues in people with a prosthesis on dental implants (after 1 year).

Index	Value	P
Implant removal frequency	0%	p>0,05
Mucositis detection	3,3%	p<0,05
Peri-implantitis detection (resorption 30%)	0%	p<0,05
Peri-implantitis detection (resorption 50%)	0%	p>0,05
Oral hygiene index (OHI-S) Green J. C., Vermillion J. R.	1,6	p<0,05
The index of superconstructors hygiene (IHs)	1,3	p>0,05
Gingivitis index (GI) Loe H., Silness J.	1,2	p<0,05

Index of Muhlemann in Cowell modification	1,0	p<0,05
PMA index in Parma modification	31,8%	p<0,05
Organoleptic index	2,3	p<0,05
Rate Halimeter (ppb)	172	p<0,05
Periodontal pathogens detection	26,7%	p<0,05

Using the second group as an example, the study investigated how effective professional oral hygiene and three individual oral hygiene options were. A group of patients utilized traditional oral care methods (control group), another group used additional interdental hygiene methods and a dental irrigator (experimental group 1), and the third group distinguished itself from experimental group 1 by applying a gel containing periodontal pathogens bacteriophages, "Fagodent," after hygiene procedures (experimental group 2). The selection of "Phagodent" gel for local preventive treatment is based on the uniqueness of its mechanism, its lack of harmful effects, and its superior effectiveness without leading to dependence when compared to other options such as "Metrogil-Denta" gel. Data regarding how effective "Phagodent" is come from multiple scientific studies [37, 38].

Over a period of 3 years, 3 groups with the same numbers and characteristics were observed while using different sets of hygienic procedures. This confirmed that it is wise to recommend between-tooth hygiene products and an irrigation device besides the conventional oral care regimen (toothbrush, paste, rinse aid). This approach leads to substantial improvements on multiple metrics (OHI-S, MI, and OI). When "Phagodent" gel is used as prescribed, the results are even more impressive, with all hygienic and periodontal indicators showing improvement relative to the conventional hygiene measures volume. Consequently, instances employing "Phagodent", the OI, the PMA index, the MI, the OHI-S, the GI, the IHs, the Halimeter score, as well as the identification of periodontal pathogens in relation to the context of thorough oral hygiene on the course of control after twelve months were 1,2; 0,8; 0,8; 0,5; 23,3

Prozent; 1,2; ppb 133,0; 10.0%, While previous studies have demonstrated the importance of interdental agents and dental irrigators for maintaining hygiene in the presence of implants, the significance of "Phagodent" is not well documented. The data obtained suggest that it can be incorporated into the standard oral care regimen for patients with implants.

We can summarize the study results by saying that the main reasons for a long-term decline in the effectiveness of implant prosthetics—demonstrated by mucositis and perimplantitis (and later, implant

removal)—are insufficient individual oral hygiene and a lack of systematic professional oral hygiene practices. To basically prevent inflammation in peri-implant tissues, it is necessary to carry out hygiene measures in a timely manner during the various stages of implantological treatment: prior to the implantation operation, prior to opening the implants when substituting temporary for permanent prostheses, and every three months while the prostheses are functioning on implants. A comparative study has determined the most effective combination of individual oral hygiene products for implant patients. This includes interdental agents, irrigators, and a gel named "Phagodent," which is based on bacteriophages that specifically target periodontal pathogens. To motivate people effectively to maintain oral hygiene, it is essential to educate them about contemporary dental hygiene methods and to consider their real satisfaction with the outcomes of regular professional oral hygiene.

Conclusion

1. The risk factors identified that cause a significant reduction in the effectiveness of dental implants include irregular dental follow-ups, poor oral hygiene, periodontitis, smoking, being male, advanced age, the design of removable prostheses, and prolonged prosthesis service life. Every three months, professional hygiene services provide a stable and sufficient level of periodontal and hygienic indicators for prosthetic implant users while also reducing the incidence of peri-implantitis.
2. After preimplantation dental and periodontal sanitation, hygienic and periodontal signs worsen as the implants are opened, subsequently before the replacement of temporary prostheses with permanent ones, following 3 months of prosthesis operation on implants. This deterioration necessitates professional oral hygiene before these stages.
3. The incorporation of interdental hygiene practices and an irrigator into the oral care routines of implant users enhances the OHI-S index, OI, and MI. The gel "Parodent", according to bacteriophages targeting periodontopathogenic microorganisms, enhances hygienic and

periodontal indices beyond what is achieved by conventional volume hygienic measures.

4. Survey results of people who do not comply with the requirements of professional oral hygiene and medical examinations show that 50% of dental implant users attribute their inability to fully adhere to their dentist's oral care recommendations primarily to a lack of time; Although two-thirds evaluate personal cleanliness as excellent or good, they notice the development or presence of gum inflammation and halitosis.

Subjective assessment of the prosthesis hygienic aspects used on implants among individuals adhering to systematic occupational health practices, marked by high personal hygiene standards and effective professional care, utilizing all prescribed hygienic measures, reveals a consistent majority opinion regarding the necessity of professional oral hygiene every three months.

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