7. *Helena, N. C., Benjamin, M. Wu. Recent advances in 3D printing of biomaterials / N. C. Helena, M. Wu. Benjamin // Journal of Biological Engineering. – 2015. - Vol. 9. – P. 4 - 9.*
8. *Liu, Q., Leu, M. C., Schmitt, S. M. Rapid prototyping in dentistry: technology and application / Q. Liu, M. C. Leu, S. M. Schmitt // Int J Adv Manuf Technol. – 2016. – Vol. 29. – P. 317 - 325.*
9. *Noort, R. The future of dental devices is digital / R. Noort // Dent Mater. – 2017. – Vol. 28. – P. 3 - 12.*
10. *Subburaj, K., Nair, C., Rajesh, S., Meshram, S. M., Ravi, B. Rapid development of auricular prosthesis using CAD and rapid prototyping technologies / K. Subburaj, C. Nair, S. Rajesh, S. M. Meshram, B. Ravi // Int J Oral Maxillofac Surg. – 2017. – Vol. 36 (10). – P. 938 - 943.*
11. *Zein, I., Hutmacher, D. W., Tan, K. C., Teoh, S. H. Fused deposition modeling of novel scaffold architectures for tissue engineering applications / I. Zein, D. W. Hutmacher, K. C. Tan, S. H. Teoh // Biomaterials. – 2020. – Vol. 23. – P. 1169 - 1185.*

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PREDICTING THE LIFE OF A DENTAL IMPLANT USING MATHEMATICAL MODELING METHOD

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ABSTRACT

Today, dental implantology is considered one of the most optimal solutions to the problem of toothlessness, the most convenient method for treating partial restoration of the dentition or dentition of edentulous jaws without damaging the adjacent teeth (8,12,19). Predicting the life of dental implants is an important issue in developing a treatment plan for a successful implantation (1,7). For this, we have created a program that uses mathematical methods and statistics of implanted patients. The program is based on the most important factors related to the longevity of dental implants, the tissues surrounding the implant and the patient's general health as well as lifestyle. In fact, the success of dental implants depends on more than 50 factors, and the selection of the most important ones is a very important aspect when developing a program. In this regard, we used the method of expert analysis. The program is designed for access by implantologists and orthopedic dentists and is consistent with the results of worldwide experiments conducted in recent years.

In this article, we provide detailed information about the program "Forecasting the service life of dental implants" (PSFDI.exe).

Keywords: *prognosis; program; dental implantation; prosthodontics; periimplantitis; dentoalveolar system.*

ПРОГНОЗИРОВАНИЕ СРОКА ФУНКЦИОНИРОВАНИЯ ДЕНТАЛЬНОГО ИМПЛАНТАТА МЕТОДОМ МАТЕМАТИЧЕСКОГО МОДЕЛИРОВАНИЯ


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АННОТАЦИЯ

На сегодняшний день дентальная имплантология считается одним из наиболее оптимальных решений проблемы адентии, наиболее удобным методом лечения частичного восстановления зубного ряда или зубного ряда беззубых челюстей без повреждения соседних зубов (8,12,19). Прогнозирование срока службы зубных имплантатов - важный вопрос при разработке плана лечения для успешной имплантации (1,7). Для этого мы создали программу, использующую математические методы и статистику имплантированных пациентов. Программа основана на наиболее важных факторах, связанных со сроком службы зубных имплантатов, тканями, окружающими имплантат, и общим состоянием здоровья пациента, а также образом жизни. Фактически, успех дентальных имплантатов зависит от более чем 50 факторов, и выбор наиболее важных из них является очень важным аспектом при разработке программы. В связи с этим мы использовали метод экспертного анализа. Программа предназначена для доступа имплантологов и стоматологов-ортопедов и соответствует результатам всемирных экспериментов, проведенных в последние годы.

В этой статье мы предоставляем подробную информацию о программе «Прогноз срока службы зубных имплантатов» (PSFDI.exe).

Ключевые слова: *прогноз; программа; дентальная имплантация; протезирование; периимплантит; зубочелюстная система.*

ABSTRACT

Dental implantology is expected to play a key role in the rehabilitation of the dentition in the future (5,17). Dental implant - when combined with the jaw bone, serves as a base element for bridges and removable dentures. Complications and errors should be avoided so that the implant can grow into the bone without complications or ensure long service life (6,16,18). Among the various complications, bleeding, infection and pain in the area where the implant is located are associated with early complications. Lack of osseointegration in the early stages of maturation, infection of the peri-implant tissues, and fracture of the implant are the reasons for the destruction of the implant (14). Osseointegration of dental implants consists of 3 consecutive stages, which are bone regeneration directly on the surface of the implant:

- The first and most important stage of osseointegration is osteoconduction. This includes the attraction and migration of osteoblasts to the implant surface through the remnants of a blood clot formed around the implant;

- The second stage is direct bone formation as a result of bone matrix mineralization - osteoinduction. Osteogenic cells form a bone matrix when they reach the surface of the implant. At this stage, the processes of contact and distant osteogenesis proceed in parallel;

- The third stage is bone remodeling, consisting of a long cycle of bone resorption and formation, which stabilizes 18 months after the implantation surgery (2,3,10,15).

Thus, given the variety and dynamics of the processes associated with the installation of an implant into the bone, the following should be observed (9,11,13):

- minimization of alterations and exudate products in primary inflammatory reactions to implantation;

- Significant stimulation of proliferative processes by translating them into osteoinduction;

- general reduction in the duration of osseointegration of implantation;

- stabilization of the processes of resorption and ossification;

- ensuring long-term dynamic stability of implants after surgery.

Only if osseointegration is successful can we make a long-term prognosis of implantation. Naturally, it is also important to exclude infection of the peri-implant tissues (2,3,4).

Purpose of the study: prediction of the period of functioning of dentures on dental implants using mathematical modeling method.

We were able to create a program by analyzing the results of our research and the data collected so far in the field of implantology. The program is called Dental Implant Life Prediction (PSFDI.exe). The program was registered in the Intellectual Property Agency of the Republic of Uzbekistan.

Scope: department of hospital orthopedic dentistry, department of surgical dentistry and dental implantology, dental clinics that provide services using dental implants.

This software product is designed to predict the life of a dental implant.

Functionality and specifications: The software calculates the effective service life of fixed dentures based on dental implants. It also allows you to determine the wear rate of the implant and the functional state of the tissues surrounding the implant. The basic factors influencing the duration of the dental implant activity were taken as the basis for the calculations.

Impact category: IBM Pentium

Operating system: Windows 7

- Program size: 32.77 kb.

- Programming language: Visual BASIC 6.0

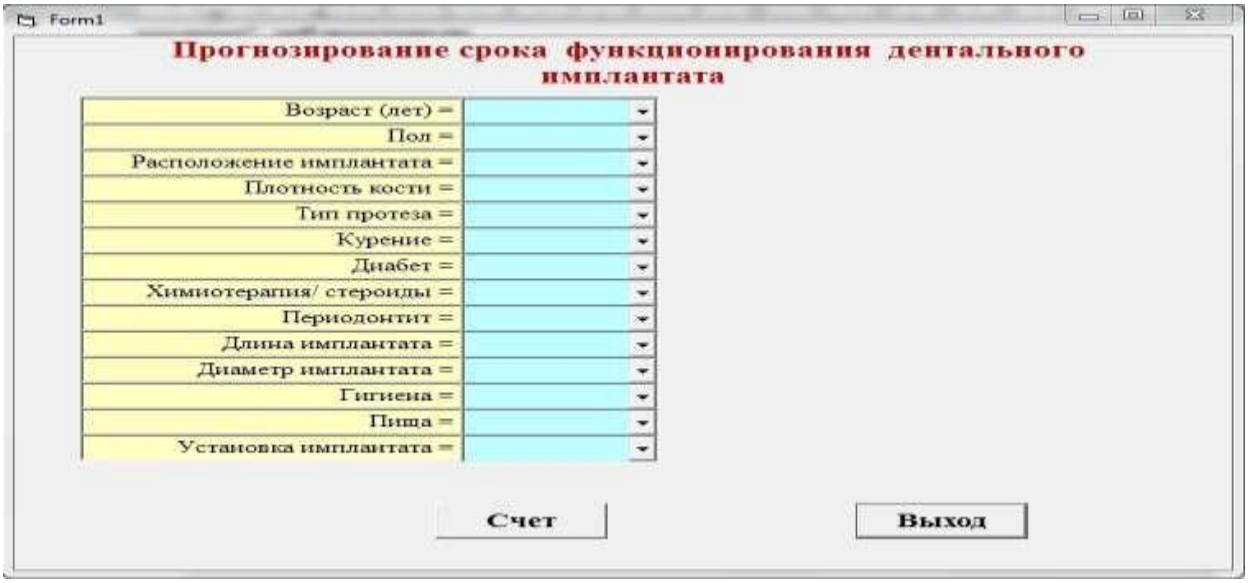

Figure 1. The face of "Forecasting the service life of dental implants" (PSFDI.exe)

The program predicts the service life of dental implants at intervals of 30 years. The program used the following formulas.

Definitions:

K - coefficient of invalidity

Sg - implant life

Sum - the sum of points

Pr - forecast of the service life of the implant

X (i) (i = 1, 14) - values of indicators (in points)

Sum = X (1) + X (2) + x (3) +… .. + X (14)

K = 3 * Sum / 37

Here is the sum of the maximum 37 points.

$$\{Pr = Sg - K * (Sg - 3) /3\}$$

The program works as follows:

The program memory included factors affecting the life of the implant, and each of them was rated according to its severity.

For example:

Place of implantation:	**Points:**
○ Mandibular Anterior	❖ 1
○ Mandibular posterior	❖ 4
○ Maxillary anterior	❖ 2
○ Maxillary posterior	❖ 3

Table 1. Place of implantation and given points

During patient input, the program collects points according to the sum calculation formula:

$$[Sum = X(1) + X(2) + x(3) + \ldots\ldots + X(14)]$$

and the amount is determined by the following formula to determine the invalidity coefficient K:

$$\langle K = 3 * Sum / 37 \rangle$$

Taking into account the 30-year interval, the forecast is made:

$$\{Pr = Sg - K * (Sg - 3) /3\}$$

The necessary information is entered into the program:

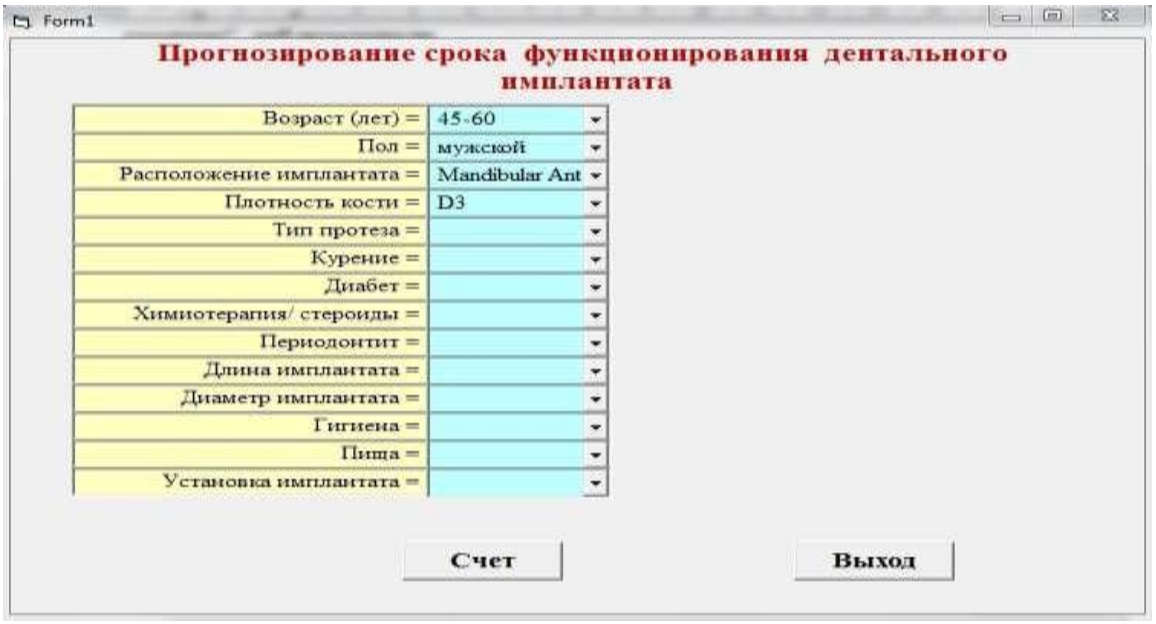

Figure 2. Entering data into the program "Forecasting the service life of dental implants" (PSFDI.exe)

The following key factors are included in the program memory: patient age, gender, implant location, bone density, prosthesis type, smoking, chemotherapy or steroid treatment, periodontal disease, implant length and diameter, hygiene level, pressure on the dental system, implant placement technique. After entering you will receive the result by pressing the "SCORE" button:

Figure 3. Get a prediction using the Dental Implant Life Prediction Tool (PSFDI.exe).

The result can be printed on paper by pressing the "PRINT" button.

Results and discussion. So, according to the data that we entered to test the program, a male patient 45-60 years old with diabetes, who was not treated with chemotherapy and steroids, but who smoked and suffered from periodontitis, the implant was placed in the frontal region of the upper jaw using a two-stage technique we can predict that it will serve almost 15 years.

Testing of the program is still ongoing at the department of department of hospital orthopedic dentistry, the department of surgical dentistry and dental implantology of Tashkent State Dental Institute. We aim to give their general conclusions in the following articles. Discussing the main disadvantages of the program, the program did not cover all 50 factors affecting the life of dental implants. In the future, the discussion of testing the program will be taken into account and we planned to perfect it.

Conclusion. 'Dental Implant Life Prediction (PSFDI.exe)' is a completely new program that is based on mathematical modeling method. This program gives accurate information about the period of functioning of dental implants. It can be applied at the department of hospital orthopedic dentistry, department of surgical dentistry and dental implantology, dental clinics that provide services using dental implants.

Литература/References

1.Afrashtehfar KI, Assery MK. From dental science to clinical practice:Knowledge translation and evidence-based dentistry principles. Saudi Dent J 2017;29:83-92.

2. Bosshardt DD, Chappuis V, Buser D. Osseointegration of titanium, titanium alloy and zirconia dental implants: current knowledge and open questions. Periodontol 2000 2017;73:22-40.

3. Chrcanovic, B. R., Kisch, J., Albrektsson, T., & Wennerberg, A. (2017a). Analysis of risk factors for cluster behavior of dental implant failures. Clinical Implant Dentistry and Related Research, 19, 632–642.

4. Chumachenko EN, Arutynov SD, Lebedenko I.Yu. Mathematical modeling of the tensor-deformed state of dental. - M., 2003. - 261 p.

5. Del Monte S, Afrashtehfar KI, Emami E, Nader SA, Tamimi F. Lay preferences for dentogingival esthetic parameters: A systematic review. J ProsthetDent 2017;118:717-24.

6. Dalago HR, Schuldt Filho G, Rodrigues MA, Renvert S,Bianchini MA. Risk indicators for peri-implantitis. A cross-sectional study with 916 implants. Clinical oral implants research. 2017;28(2):144-50.

7.Gürlek Ö, Gümüº P, Buduneli N. Smokers have a higher risk of inflammatory peri-implant disease than non-smokers. Oral diseases. 2018;24(1-2):30-2.

8. Habilov N. L.,Mun T. O.,Usmonov F.K.,Evaluation of immunological indices in the dynamics of topical application of «Fargals» at patients during the process of adaptation to complete removable plate prosthesis depending on age. /The Fourteenth International Conference on Biology and Medical Sciences,2017- 3-6 p.

9. Jemt, T. A retro-prospective effectiveness study on 3448 implant operations at one referral clinic:A multifactorial analysis. Part II: Clinical factors associated to peri-implantitis surgery and late implant failures. Clin. Implant Dent. Relat. Res. 2017, 19, 972–979.

10. Jemt, T.; Karouni, M.; Abitbol, J.; Zouiten, O.; Antoun, H. A retrospective study on 1592 consecutively performed operations in one private referral clinic. Part II: Peri-implantitis and implant failures. Clin. Implant Dent. Relat. Res. 2017, 19, 413–422.

11. Kulczycki E, Rozkosz EA. Does an expert-based evaluation allow us to go beyond the Impact Factor? Experiences from building a ranking of national journals in Poland. Scientometrics 2017;111:417-42.

12. Naumovich S.S., Naumovich S.A. Modern opportunities and practical application of mathematical modeling in dentistry//Modern stomatology N1 – 2011

13. Rokn A, Aslroosta H, Akbari S, Najafi H, Zayeri F, Hashemi K. Prevalence of peri-implantitis in patients not participating in well-designed supportive periodontal treatments: a cross-sectional study. Clinical oral implants research. 2017;28(3):314-9.

14. Roos-Jansåker AM, Almhöjd US, Jansson H. Treatment of peri-implantitis: clinical outcome of chloramine as an adjunctive to non-surgical therapy, a randomized clinical trial. Clinical oral implants research. 2017;28(1):43-8.

15. Safarov M. T. , Arslanov O. U. , Irisaliev H. I. , Tashpulatova K. M. , Evaluation of the Compensatory-Adaptive Mechanisms of Bridge Prosthetics at the Terminal Dentition Defects with the Use of Intraosseous Implants by the Method of Electromyography, American Journal of Medicine and Medical Sciences, Vol. 10 No. 9, 2020, pp. 657-659.

16. Sahin IO, Gokmenoglu C, Kara C. Effect of concentrated growth factor on osteoblast cell response. J Stomatol Oral Maxillofac Surg 2018;119:477-81.

17. Singh R, Huda I , Nabi A T, Singh S, Nazeer J, To assess risk factors of dental implants failures. IP Ann Prosthodont Restor Dent 2020;6(1):8-10

18. Sivaraman K, Chopra A, Narayan AI, Balakrishnan D. Is zirconia aviable alternative to titanium for oral implant? A critical review. J Prosthodont Res 2018;62:121-33.

19. Valerio Di Mauro, Giuseppe Zuppardi. Orthopedic rehabilitation with dental prostheses on implants using the CAD / CAM system // Modern orthopedic dentistry. 2017. No. 27. P. 20 - 28.