ISSN 1814-6023 (Print)
ISSN 2524-2350 (Online)
UDC 616.31-089.843-008.1-073.756.8
https://doi.org/10.29235/1814-6023-2024-21-3-213-218 Received 08.05.2024

Sergey P. Rubnikovich, Yuliya L. Denisova, Genrikh V. Bogdan

Belarusian State Medical University, Minsk, Republic of Belarus

COMPARATIVE ANALYSIS OF THE STATE OF PERI-IMPLANTATION TISSUES AFTER IMMEDIATE AND DELAYED IMPLANTATION

Abstract. The state of peri-implantation tissues was analyzed according to cone-beam computed tomography. A modified version of the alveolar index (AI_m) is proposed to assess changes in the height of the alveolar ridge in the absence of a tooth and the presence of an implant. It was found that delayed implantation is characterized by more favorable long-term results in comparison with direct implantation.

Keywords: dental implantation, cone beam computed tomography, alveolar index

For citation: Rubnikovich S. P., Denisova Yu. L., Bogdan G. V. Comparative analysis of the state of peri-implantation tissues after immediate and delayed implantation. *Vestsi Natsyyanal'nai akademii navuk Belarusi. Seryya medytsynskikh navuk = Proceedings of the National Academy of Sciences of Belarus. Medical series*, 2024, vol. 21, no. 3, pp. 213–218 (in Russian). https://doi.org/10.29235/1814-6023-2024-21-3-213-218

С. П. Рубникович, Ю. Л. Денисова, Г. В. Богдан

Белорусский государственный медицинский университет, Минск, Республика Беларусь

СРАВНИТЕЛЬНЫЙ АНАЛИЗ СОСТОЯНИЯ ПЕРИИМПЛАНТАЦИОННЫХ ТКАНЕЙ ПОСЛЕ НЕПОСРЕДСТВЕННОЙ И ОТСРОЧЕННОЙ ИМПЛАНТАЦИИ

Аннотация. Проведен анализ состояния периимплантационных тканей по данным конусно-лучевой компьютерной томографии. Предложен модифицированный вариант альвеолярного индекса (AI_m) для оценки изменения высоты альвеолярного гребня при отсутствии зуба и наличии имплантата. Установлено, что отсроченная имплантация характеризуется более благоприятными отдаленными результатами в сравнении с непосредственной имплантацией.

Ключевые слова: дентальная имплантация, конусно-лучевая компьютерная томография, альвеолярный индекс

Для цитирования: Рубникович, С П. Сравнительный анализ состояния периимплантационных тканей после непосредственной и отсроченной имплантации / С. П. Рубникович, Ю. Л. Денисова, Г. В. Богдан // Вес. Нац. акад. навук Беларусі. Сер. мед. навук. – 2024. – Т. 21, № 3. – С. 213–218. https://doi.org/10.29235/1814-6023-2024-21-3-213-218

Introduction. The prevalence of secondary adentia in the Republic of Belarus in patients aged 45 to 64 years is more than 89 % [1]. In this regard, dental implantation is currently becoming highly relevant and is widely used for the rehabilitation of patients with partial or complete secondary jaw adentia.

The choice of immediate and delayed implantation is largely determined by the peculiarities of the local status of the area of the intended implant placement. Thus, as a criterion for the success of dental implantation, the use of an X-ray sign of bone loss less than 1/3 the length of the implant was proposed [2]. In 2007, J. A. Ashuev proposed using the complete overlap of the newly formed bone tissue of the threaded part of the implant as a new criterion for the success of dental implantation [3]. The level of bone resorption relative to the length of the implant (by 1/3, 1/2, more than 1/2) was determined in 2021 by E. E. Olesse to assess the state of implantation [4]. To assess the effectiveness of dental implantation, A. E. Yablokov recommended using the optical density of bone tissue in Hounsfield (HU) units [5–9].

Only isolated studies have been found on this topic without a comparative analysis of the state of peri-implant tissues after immediate and delayed dental implantation.

The aim of the study – to conduct a comparative analysis of the state of peri-implantation tissues after immediate and delayed implantation and to determine the advantages of these techniques to substantiate the choice of treatment method. To achieve the aim of the study, the following tasks were developed:

1. To determine the list of criteria for the effectiveness of dental implantation and to develop a questionnaire for evaluating peri-implantation tissues according to cone beam computed tomography (CBCT).

2. To evaluate the optical density of bone before and after immediate and delayed implantation based on the Hounsfield scale and the C. Mish classification.

3. To determine the alveolar index (AI) before direct implantation.

4. To propose a modified version of the alveolar index (AI_m) to assess changes in the height of the alveolar ridge in the absence of a tooth and the presence of an implant.

5. To compare the results of the studies to justify the choice of the dental implantation method.

Materials and research methods. A comparative analysis of the state of bone tissue in the peri-implantation area after immediate and delayed implantation was carried out according to the results of CBCT in 32 patients with 91 implantations.

Direct implantation was understood as the installation of an implant in the hole of a removed tooth. Under delayed implantation – the installation of an implant, 3 months or more after tooth extraction.

Group A (direct implantation) included 20 patients (6 (30 %) men and 14 (70 %) women) with a mean age of 52.6 ± 11.3 years, who had 30 implants installed. The follow-up period was 10.8 ± 3.5 months.

In group B (delayed implantation), 61 implants were placed in 20 patients (8 (40 %) men and 12 (60 %) women) with a mean age of 50 ± 11.9 years (1 to 7 implants per patient). The duration of follow-up was comparable to group A and amounted to 9.3 ± 2.6 months.

Measurement of bone density before and after implantation, calculation of the value of the alveolar index, the presence of overlap of the newly formed bone tissue of the threaded part of the implant, the degree of bone resorption in the implant area was performed during CBCT using the Planmeca Romexis Viewer 6.0 program on the PLANMECA ProMax 3D device.

To measure bone density before performing delayed implantation, a function built into the program (ellipse) was used to calculate the average bone density in the study area (Fig. 1).

Bone density in Hounsfield units (HU) before direct implantation was measured at five points and the average was calculated: medially in the cervical region, the middle of the root on the medial side, the apex, the middle of the root on the distal side, distally in the cervical region (Fig. 2).

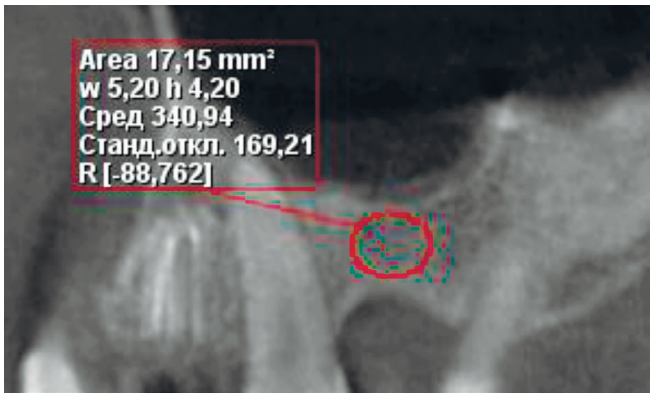


Fig. 1. Section of cone beam computed tomography with bone tissue density measurement

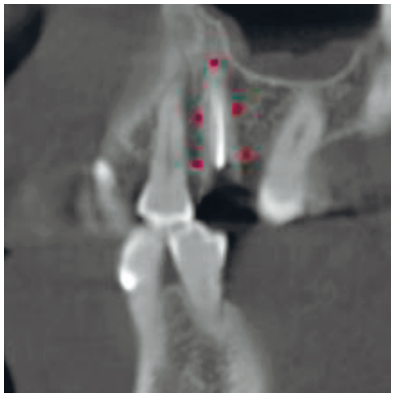


Fig 2. Section of cone beam computed tomography with bone density measurement at five points

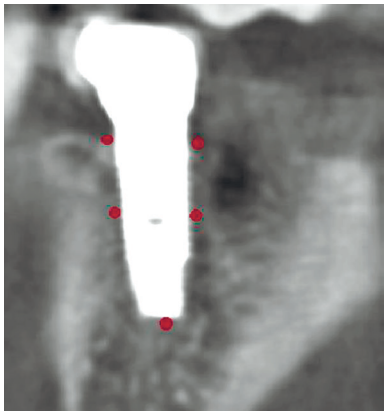


Fig. 3. Cone beam computed tomography slice with bone density measurement after implantation

Bone density after immediate and delayed implantation was assessed in a similar way (Fig. 3).

The measurement of the alveolar index (AI) in the presence of a tooth was carried out according to the method proposed by Yu. L. Denisova [10].

In the absence of a tooth and the presence of an implant, a modified version of the alveolar index (AI_m) was used to assess the change in the height of the alveolar ridge.

The overlap of the newly formed bone tissue of the threaded part of the implant and bone resorption in the implant area were evaluated in the presence or absence of this feature category. The presence of overlap with newly formed bone tissue and the absence of bone resorption were the criteria for inclusion in the study.

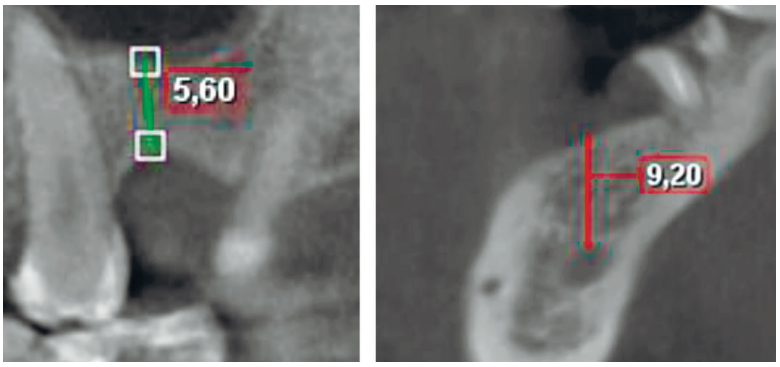
Statistical data processing was carried out using the application software package STATISTICA (version 10-Portable, StatSoft Inc.).

Results and its discussion. To evaluate peri-implantation tissues, a questionnaire was developed that includes a number of criteria for the effectiveness of dental implantation for comparison. The study markers were the values of bone density before and after implantation, the value of the alveolar index, the presence of overlap of the newly formed bone tissue of the threaded part of the implant and the degree of bone resorption in the implant area.

A modified version of the alveolar index (AI_m) is proposed to assess changes in the height of the alveolar ridge in the absence of a tooth and the presence of an implant. To do this, the distance from the alveolar process to morphological structures was measured: on the lower jaw – the channel of the lower jaw, the edge of the body of the lower jaw; on the upper jaw – the bottom of the maxillary sinus (Fig. 4, 5).

$$H = l \cdot KD,$$

where H – the value of the height of the alveolar process; l – the measured distance (from the alveolar process to morphological structures: on the lower jaw – the channel of the lower jaw, the edge of the body of the lower jaw; on the upper jaw – the bottom of the maxillary sinus); KD – the distortion coefficient.



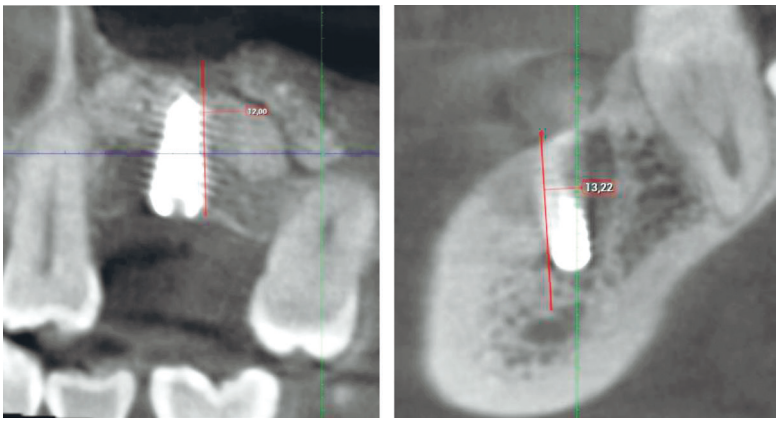
a *b*

Fig. 4. Measured distance (*l*) from the alveolar process to the morphological structures: on the upper jaw – the bottom of the maxillary sinus (*a*); on the lower jaw – the canal of the lower jaw (*b*), the edge of the body of the lower jaw

$$AI_m = \frac{(H_1 - H_2)}{H_1} \cdot 100\ \%,$$

where AI_m – a modified version of the alveolar index; H_1 – the value of the height of the alveolar process at the initial measurement; H_2 – the value of the height of the alveolar process during repeated measurement.

In group A, by the end of the study period, there was a decrease of 16.5 % (92.5 HU) in bone density in the implantation area (from 561.3 (498; 627) HU before implantation to 468.8 (351; 554) HU after) (Fig. 6).



a *b*

Fig. 5. Measured distance (H_2) from the alveolar process to the morphological structures in the presence of an implant: on the upper jaw – the bottom of the maxillary sinus (*a*); on the lower jaw – the canal of the lower jaw (*b*), the edge of the body of the lower jaw

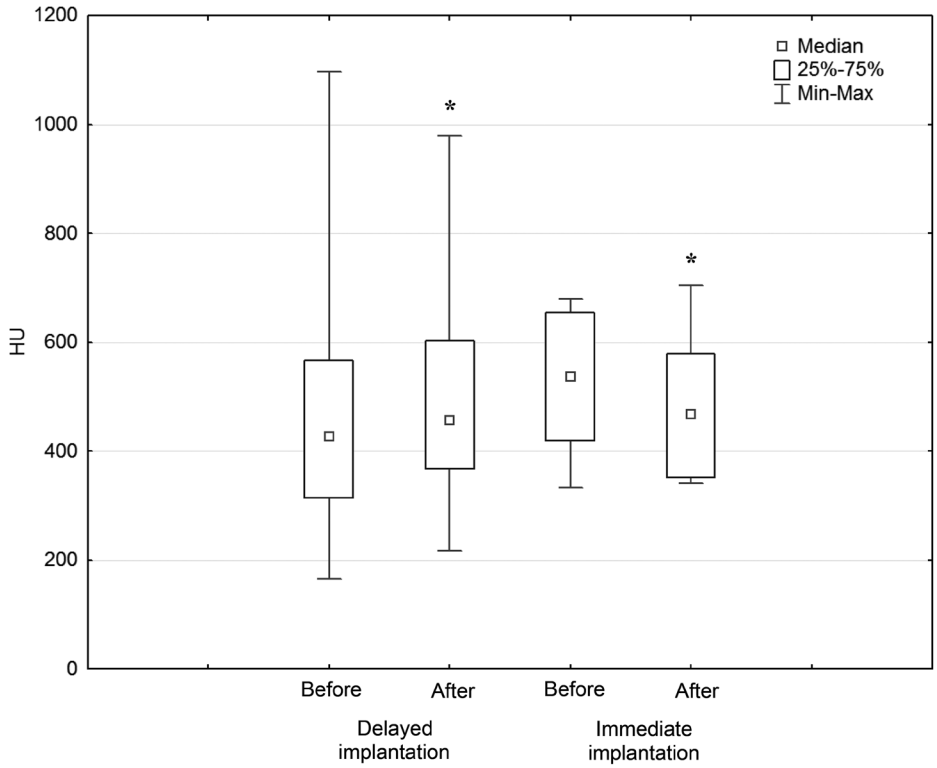


Fig. 6. Dynamics of change in the bone tissue density in the area of implantation in the studied groups * – the presence of statistically significant differences in the average values with respect to the level before implantation ($p \leq 0.05$)

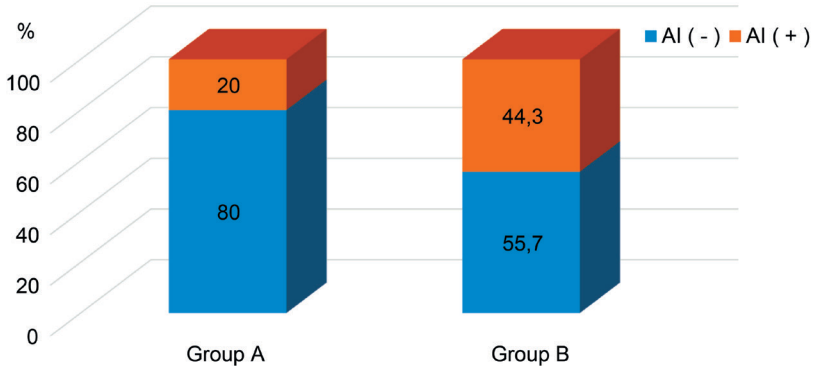


Fig. 7. Positive (+) and negative (–) values of the alveolar index (AI) in the study groups

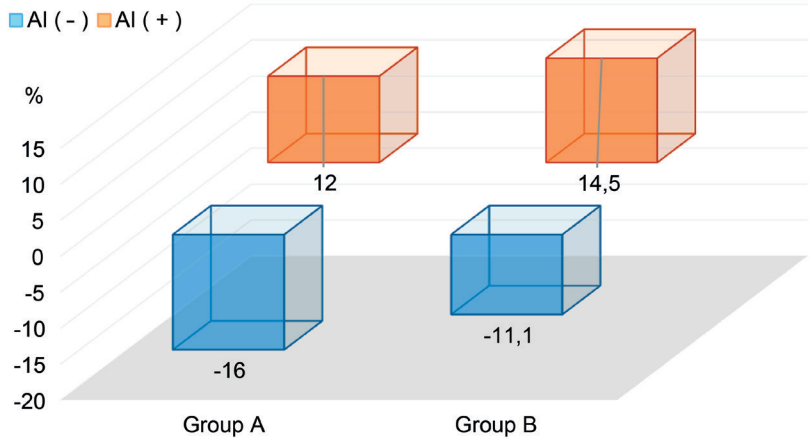


Fig. 8. Alveolar index (AI) in the study groups

Delayed implantation (group B) was characterized by the opposite dynamics of changes with an increase of 7.8 % (35.2 HU) in bone density (from 452.1 (314; 1087) HU initially to 487.3 (216; 979) HU after implantation).

The alveolar index after 10.8 ± 3.5 months with immediate implantation (group A) in 24 (80 %) cases was negative (with an average value of –16.0 ± 8.2 %) and in 6 (20 %) cases) had a positive value (12 ± 3.6 %). Whereas with delayed implantation (group B), after 9.3 ± 2.6 months, a decrease of 24.3 % in the number of negative values of the alveolar index was noted (34 (55.7 %) cases) with an increase in its value by 30.6 % to the level of –11.1 ± 7.1 % (Fig. 7).

There was also a 24.3 % increase in the number of positive index values (27 (44.3 %) cases) with an increase in its index by 2.5 to 14.5 ± 4.1 % (Fig. 8).

In all cases of implantation in the studied groups, the presence of overlap with newly formed bone tissue and the absence of bone resorption were revealed.

Conclusions

1. The developed questionnaire of criteria for the effectiveness of dental implantation can be recommended for use in scientific research for an objective assessment of peri-implantation tissues according to CBCT data.

2. Delayed implantation has no negative effect on bone density and is characterized by a 7.8 % increase in bone density, unlike the results of direct implantation, which is accompanied by a 16.5 % decrease in bone density.

3. The modified version of the alveolar index (AI_m) can be used to objectively assess changes in the height of the alveolar ridge in the absence of a tooth and the presence of an implant.

4. Performing delayed implantation led to a 24.3 % increase in the number of positive values of the alveolar index with an increase in its index by 2.5 % compared with the outcomes of direct implantation, in which negative values (80 %) prevailed with lower numerical values.

5. According to the results of a comparative analysis based on the criteria of CBCT, delayed implantation is generally characterized by more favorable long-term results compared with direct implantation.

Conflict of interests. The authors declare no conflict of interests.

References

1. Rubnikovich S. P., Denisova Yu. L., Karpuk N. A., Andreeva V. A., Karpuk I. Yu. Prevalence of the main orthopedic dental diseases of Vitebsk. *Stomatolog. Minsk* [Dentist. Minsk], 2019, vol. 2, no. 33, pp. 22–27 (in Russian).

2. Dobrovolskaya O. V., Rubanenko V. V. Efficiency Criteria in dental implantation. *Aktual'ni problemi suchasnoi meditsini: Visnik ukraïns'koï medichnoi stomatologichnoi akademiï* [Actual problems of modern medicine: Bulletin of the Ukrainian Medical Stomatological Academy], 2006, vol. 6, no. 4, pp. 13–15 (in Russian).

3. Ashuev Zh. A., Kulakov A. A., Kapanadze G. D. *X*-ray control of bone forming process under direct intraosseous in experiment. *Biomeditsina* [Biomedicine], 2007, no. 6, pp. 167–169 (in Russian).

4. Olesov E. E., Ivanov A. S., Zaslavskii R. S., Ragulin A. V., Romanov A. S. Clinical and radiological assessment of the condition of implants with fixed structures in the dynamics of 20-years follow-up. *Meditsina ekstremal'nykh situatsii* [Medicine of extreme situations], 2021, vol. 4, no. 23, pp. 29–33 (in Russian).

5. Yablokov A. E. Bone tissue optical density evaluation in dental implantation. *Rossiiskaya stomatologiya* [Russian dentistry], 2019, vol. 12, no. 3, pp. 8–13 (in Russian).

6. Garunov M. M., Sevbitov A. V., Dolgalev A. A., Sirak S. V., Solovyeva O. A., Remizova A. A., Dzgoeva M. G., Rubnikovich S. P. Clinical and radiographic assessment of osteointegration of dental implants after remodeling of the perimplant zone. *Meditsinskii vestnik Severnogo Kavkaza* [Medical news of the North Caucasus], 2019, vol. 14, no. 4, pp. 699–701 (in Russian).

7. Rubnikovich S. P., Khomich I. S., Denisova Yu. L. Morphological changes in the bone tissue around dental implants after low-frequency low-intensity ultrasound applications. *Vestsi Natsyyanal'nai akademii navuk Belarusi. Seryya medytsynskikh navuk = Proceedings of the National Academy of Sciences of Belarus. Medical series*, 2020, vol. 17, no. 1, pp. 20–27.

8. Rubnikovich S. P., Denisova Yu. L., Vladimirskaya T. E., Andreeva V. A., Kvacheva Z. B., Panasenkova G. Yu., Volotovskii I. D. Regenerative cell technologies for gingival recession treatment. *Sovremennye tekhnologii v meditsine* [Modern technologies in medicine], 2018, vol. 10, no. 4, pp. 94–104 (in Russian).

9. Rubnikovich S., Maizet A., Denisova Yu., Bykova N., Arutyunov A., Kopylova I., Avanesyan R. The effect of magnetophototherapy on morphological changes of tissues of pathologically changed periodontium. *Meditsinskii vestnik Severnogo Kavkaza* [Medical news of the North Caucasus], 2017, vol. 12, no. 3, pp. 303–307.

10. Denisova Yu. L. Alveolar index (AI) – a new method of radioosteometrii in periodontology. *Stomatolog* [Dentist], 2012, no. 3, pp. 24–28 (in Russian).

Information about the authors

Sergey P. Rubnikovich – Corresponding Member, D. Sc. (Med.), Professor, Rector. Belarusian State Medical University (83, Dzerzhinski Ave., 220116, Minsk, Republic of Belarus). https://orcid.org/0000-0002-7450-3757. E-mail: rubnikovichs@mail.ru

Yuliya L. Denisova – D. Sc. (Med.), Professor. Belarusian State Medical University (83, Dzerzhinski Ave., 220116, Minsk, Republic of Belarus). https://orcid.org/0000-0003-0917-7972. E-mail: denisova-yul@mail.ru

Genrikh V. Bogdan – student. Belarusian State Medical University (83, Dzerzhinski Ave., 220116, Minsk, Republic of Belarus). https://orcid.org/0009-0009-4637-8934. E-mail: bogdangenrikh99@gmail.com

Информация об авторах

Рубникович Сергей Петрович – член-корреспондент, д-р мед. наук, профессор, ректор. Белорусский государственный медицинский университет (пр. Дзержинского, 83, 220116, г. Минск, Республика Беларусь). https://orcid.org/0000-0002-7450-3757. E-mail: rubnikovich@mail.ru

Денисова Юлия Леонидовна – д-р мед. наук, профессор. Белорусский государственный медицинский университет (пр. Дзержинского, 83, 220116, г. Минск, Республика Беларусь). https://orcid.org/0000-0003-0917-7972. E-mail: denisova-yul@mail.ru

Богдан Генрих Васильевич – студент. Белорусский государственный медицинский университет (пр. Дзержинского, 83, 220116, г. Минск, Республика Беларусь). https://orcid.org/0009-0009-4637-8934. E-mail: bogdangenrikh99@gmail.com