Influence of direct prostheses on the condition of the alveolar processes during dental implantation

Vitaliy H. Shuturminskiy, Vasil A. Labunets, Aleksej V. Kirichek

Odessa Medical Institute, International Humanitarian University, Odesa, Ukraine
Department of Orthopedic Dentistry, Institute of Dentistry and Maxillofacial Surgery of National Academy of Medical Sciences of Ukraine, Odesa, Ukraine

Received 2 August 2021; revised 27 September 2021; accepted 6 October 2021
Available online 14 October 2021

KEYWORDS
Osseointegration;
Atrophy of the tissues;
Nylon partial denture;
Polypropylene;
Mucous membrane

Abstract Objective: The purpose of this article is to study of the processes accompanying osseointegration of the dental implants using various plate prostheses as temporary constructions, as well as to compare the dynamics of changes in the state of the jaw alveolar processes.

Materials and methods: The effect of dentures on the condition of the alveolar processes was studied in all patients according to the technique developed by L. Chulak on the 7th, 14th, 30th day and in 3, 6 months. To verify the results, the degree of atrophy of the alveolar processes was also determined by the second method the authors have chosen at the same time as indicated above.

Results: The measurement results confirm linear changes in the height of the alveolar processes of the jaws with a decrease in the tissues of the prosthetic area. Throughout the duration of the examination, atrophy of the tissues of the alveolar processes is observed. Judging by the results obtained during the patients’ study, it can be concluded that when applied as a temporary prosthesis with a dental delayed implantation of a partial denture made of polypropylene, the results of the state of the hard tissues of the mandible alveolar process show a better adaptation of the mucous membrane and slowing of atrophy of the jaw alveolar processes with this type of prosthetics.

1. Introduction

Dental implantation techniques in orthopedic dentistry have gained fairly strong positions in everyday dental clinical practice (Parzham et al., 2020; Saneja et al., 2020). One of the problematic aspects of prosthetics on implants (in a delayed technique) is the period of osseointegration, when the implants remain closed and the defect is compensated by a temporary prosthesis (Marques et al., 2021). The problem is particularly acute in temporary prosthetics with removable dentures for large defects in the dentition (Bae et al., 2017). A complete absence of prostheses for the period of engraftment of dental implants is the only alternative in this case (Yalavarthi et al., 2019). Partial dentures from various plastics are mainly used for the purpose of temporary prosthetics: polymethylmethacrylate, nylon, polypropylene and some others. Debates...
are still ongoing among the scientific community about the benefits and detrimental effect of direct prosthetics with a delayed method of dental implantation (Deng et al., 2018; Poojashree et al., 2019).

Modern methods and technologies of dental implantation are wide and varied, therefore, in many countries, DI is singled out as a separate specialty (implantologist) (Yessenbayeva et al., 2021). On the other hand, this method of dental treatment involves two completely different actions – the installation of dental implants and dentures, so these types of work can be performed by two separate specialists. The surgical phase of dental implant placement should be performed by specialists trained in dental surgery, trained in the appropriate specialization and licensed for this type of treatment. In principle, they can perform a complex of medical manipulations with subsequent prostheses on implants, but existing training and specialization programs are not always fully able to train a dental surgeon in a high level of dentistry. A dental implant is a titanium rod that is inserted under the gum and inserted into the jawbone (Silman and Ali, 2020). Titanium is a strong and bio-inert material in relation to the body, does not cause a negative reaction and is firmly bound to bone tissue – the phenomenon of osseointegration (Branemark). Essentially, an implant is the root of an artificial tooth. Its design consists of two parts – a real implant (root) and a support (head) – a kind of "adapter", which is also made of titanium and creates a connecting connection between the implant and the crown of the tooth.

Dental implants are a method of repairing defects in the tooth, sealing and chewing by using various designs on removable and fixed prostheses based on implants and natural teeth and implants. Treatment of dental implants is very popular among specialists and attracts more and more patients. Research has been done to improve this type of dental care, mainly related to age and lifetime implants. The high efficacy of the dental implant method, its predictability and long-term reliability after treatment are documented. It was decided that, on average, 92% of orthopedic models of dental implants have been in use for more than 10 years.

As a result, the authors made this investigation to conduct a more complete study of the processes accompanying osseointegration of the dental implants using various plate prostheses as temporary constructions, as well as to compare the dynamics of changes in the state of the jaw alveolar processes (Muzykin and Iordanishvili, 2020). The purpose of this article is to study the processes accompanying osseointegration of the dental implants using various plate prostheses as temporary constructions, as well as to compare the dynamics of changes in the state of the jaw alveolar processes.

2. Materials and methods

2.1 Ethical statement

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. A study was approved by National Ethics Commission of the Ministry of Health of Ukraine October 15, 2019, No 1621-A.

2.1. Sample size

The study was conducted at the Odessa Medical Institute. Patients aged 34–55 years, men and women, were invited to participate in the study. The study groups did not include patients with severe somatic diseases such as diabetes mellitus, gastric and duodenal ulcer, rheumatism, a generalized form of periodontitis and a history of jaw fractures. The cause of tooth extraction, the predominance of single or multiple tooth and root extractions, was clarified. Implantation was performed on the lower jaw with free-end edentulous space (1st and 2nd Kennedy classes) (Alageel et al., 2020; Alifah et al., 2018).

The first group included patients (25 people) who did not undergo any orthopedic interventions after the dental implantation operation. The second group included patients (25 people) who received implant prostheses using the traditional technique of acrylic plastic. Patients of the third group (25 people) were constructed artificial dentures from nylon. In the fourth group of patients (25 people), implant prostheses were made of polypropylene.

2.2. Clinical preparation and prosthesis fabrication

The effect of dentures on the condition of the alveolar processes was studied in all patients according to the technique developed by L.D. Chulak (1996) on the 7th, 14th, 30th day and in 3, 6 months. Within the time specified, a functional impression under the pressure of chewing muscles was taken by the same prosthesis. The impression cast model along with the prosthesis was oriented in the standard position so that the plane passing through the three most protruding points of the dental arch was parallel to the base plane of the model. To do this, liquid gypsum was added to the standard elastic designer of the base of the model and the model under investigation was placed with the prosthesis base down. After that, the base shaper with the model and prosthesis was immediately placed on the bottom plate of the device for molding diagnostic models of the jaws. Further on, this entire complex was placed on a VEM-01 dental vibrator. Under the influence of vibration and gravity, the upper movable plate of the device dropped to contact with the three most prominent points on the prosthetic field of the model and pressed the model itself into the gypsum. After that, the vibrator was turned off, the excess gypsum was removed with a spatula, and after its complete hardening, the model was removed from the base shaper.

The model was marked by using graduated dividers at equal intervals (5 mm) along the entire length of the alveolar process in the region of missing teeth. The marking was made from the tooth, medially limiting the defect of the dentition. The markings were coded in letters of the Latin alphabet. The models were studied in an apparatus for measuring models (Lazarin et al., 2020), the working body of which was an inductive measuring device with digital indication. The height of the alveolar process was measured from the border of the prosthesis (transitional fold) to the corresponding point at the apex of the alveolar process. The model was installed on the working platform. The measuring pin of the device was fixed at its lowest position, and with the help of the regulator, the zero position was set on the scoreboard (Batas et al., 2020; De Sousa Ferreira et al., 2021). Then, using the screw, the bracket was lowered so that the measuring pin touched the
corresponding marking on the transitional fold. After that, the pin was lifted and installed at the corresponding marking on the top of the alveolar process.

2.3. Samples collection

The degree of atrophy of the alveolar process was calculated at each marking, which was equal to the difference in height at the given point, measured on the model obtained before prosthetics and the height measured at the indicated period. To verify the results, the degree of atrophy of the alveolar processes was also determined by the second method the authors have chosen at the same time as indicated above (Sivolella et al., 2020). The basis of this method is the measurement of the volume of the polymerized corrective impression mass, which fills the space between the prosthesis and the tissues of the prosthetic area (Ribeiro et al., 2020). After taking the impression with the prosthesis, the impression mass was separated and placed in a vessel with a certain water level. According to the level of change in the volume of displaced water, the volume of atrophy of the alveolar process was calculated (1):

\[ V_{\text{at}} = V_{\text{core mass}} K/t \]

where: \( V_{\text{at}} \) is volume of atrophy of the alveolar process (\( \text{cm}^3 \)); \( V_{\text{core mass}} \) – volume of corrective impression mass (\( \text{cm}^3 \)); \( K \) is the shrinkage coefficient of the impression mass (\( \text{cm} / \text{s} \)); \( t \) is the polymerization time of the corrective mass (s).

The obtained value of the atrophy volume of the alveolar process was correlated with the number of extracted teeth. It is worth noting that in this case, the strength of the bite matters. This can have an impact on the results of the study.

3. Results and discussion

The results of the studies are presented in the Table 1. The analysis of gypsum models showed that there was an increase in the height of the jaw ridge bone in all four groups on the 7th day after direct prosthetics (Table 1, Fig. 1).

This is apparently due to postoperative edema. On the 14th day after the dental implantation operation, the height of the jaw ridge bone begins to decrease. The resorption of the bone tissue of the alveolar process in the groups was statistically reliably revealed to be the same (0.26 mm) of an initially different level. In a month, resorption continues, but still not of the same type: in the patients with polypropylene prostheses, the resorption rate is 2.2, 2 and 1.7 times lower than in the 1st, 2nd and 3rd groups respectively.

The result obtained indicates that in 3 months the height of the jaw ridge bone does not change significantly, i.e., by this time, bone remodeling in the area of osseointegration of the implant apparently comes to an end. At the same time, the least degree of atrophy of the prosthetic bed in the 4th group of the patients is obvious. Because of volume postoperative enlargement of the tissues of the alveolar process, the degree of atrophy was determined in the patients of all groups at the same period (Table 2).

It was statistically reliably revealed that the greatest resorption was observed in the patients who did not use a temporary prosthesis in the dynamics of the study, the smallest – in the patients who used a removable partial prosthesis made of polypropylene as a temporary prosthesis. With all the various modes of modern biotechnology, it is possible to identify some general principles of implant design.

1. **Anatomicality** – conformity with the natural or acquired form as a result of the disease, the size of the structures, the adjacent tissues.
2. **Biocompatibility**, or *bioinertness*, of the implant material.
3. **Suitability** the closest correspondence between the mechanical and physicochemical properties of the implant and the properties of the adjacent tissues or structures to be replaced.
4. **Non-invasive** – minimal damage or careful removal of adjacent tissue during stone implantation and surgery.
5. **Functionality** – the most complete and painless reproduction by implanting the function of alternating natural tissues or organs in volume as close as possible to a healthy state with minimal energy costs.

| Groups | Terms after implantation |
|--------|--------------------------|
|        | 7 days | 14 days | 1 month | 3 months | 6 months |
| 1 group| +0.11 ± 0.08 | −0.15 ± 0.12 | −1.01 ± 0.26 | −1.41 ± 0.37 | −1.63 ± 0.26 |
| 2 group| +0.13 ± 0.03 | −0.13 ± 0.03 | −0.97 ± 0.35 | −1.37 ± 0.41 | −1.59 ± 0.13 |
| 3 group| +0.12 ± 0.09 | −0.12 ± 0.19 | −0.80 ± 0.31 | −0.98 ± 0.29 | −1.18 ± 0.18 |
| 4 group| +0.22 ± 0.19 | −0.08 ± 0.28 | −0.53 ± 0.26 | −0.68 ± 0.19 | −0.81 ± 0.15 |
6. **Integrability** – strong adhesion, the joint of the implant to adjacent tissues due to the shape, structure and condition of the surface.

7. **Stability** – the operation of the implant parts and components as long as possible without corrosion, fatigue, abrasions and other types of wear, without intoxication of the body with the products of the latter (Albugami et al., 2019; Gajapriya et al., 2020; Karlsson et al., 2020).

It can be seen that according to modern concepts of implant biomechanics, only 3 of the 8 factors that determine long-term stability in the body are medical and the rest are purely technical (Fig. 2). The main task in secondary adentia is to determine the need and possibility of using intraosseous implants when choosing an orthopedic method for the dental treatment of patients. According to statistics, complete absence of teeth (complete secondary tooth, tooth loss as a result of an accident, localized ablation or periodontitis) is a fairly common phenomenon in Ukraine. The frequency of complete absence of teeth increases (five times) in each subsequent age group: among the population aged 40 to 49 years, the incidence is 1%, at the age of 50 to 59 years – 5.5%, and among people over 60 years old – 25%. In the general structure of medical care to patients in dental organizations, 17.96% of patients were diagnosed with complete absence of teeth (complete secondary adentation, loss of teeth as a result of an accident, ablation or localized periodontitis) of one or both jaws.

Dental implantology allows you to restore the integrity of the teeth, physiologically more correct distribution of loads on the teeth, restore the lost functions of chewing, speech, solve a number of aesthetic, psychological and other problems, opening up new opportunities to improve the quality of dental rehabilitation. The expected result is possible only with careful planning of treatment taking into account the peculiarities of the processes of bone tissue regeneration and the joint efforts of surgeons, orthopedists, periodontists and dental technicians.

### 4. Conclusions

Judging by the results obtained during the patients’ study, it can be concluded that when applied as a temporary prosthesis with important method fordental delayed implantation of a partial denture made of polypropylene, the results of the state of the hard tissues of the mandible alveolar process show a better adaptation of the mucous membrane and slowing of atrophy of the jaw alveolar processes with this type of prosthetics. Modern dentistry makes extensive use of the dental implantation method, which increases the chances of the dentist during recovery, partial and complete defects in the teeth. Because there is currently no nominal specialty in dental implantology by a physician or specialist, orthopedic treatment of dental malformations with implants has two stages: surgical and orthopedic. Initially, the dental surgeon performs surgeries, during which he performs surgical preparation of the oral cavity and then installs the implants. After completion, the osseointegration of the patient’s implants is transferred to a dentist – an orthopedist who performs tooth restoration using the implants.

### Declaration of Competing Interest

The authors declare that there is no conflict of interest.

### Acknowledgements

None.

**Financial support and sponsorship**

None.

**Ethical approval**

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. A study was approved by National Ethics Commission of the Ministry of Health of Ukraine October 15, 2019, No 1621-A.

### Table 2  Dynamics of changes in the height of the crest of the alveolar processes (in mm$^3$) during prosthetics on implants using various immediate.

| Atrophy volume (mm$^3$) in different groups | Terms after implantation | 7 days | 14 days | 1 month | 3 months | 6 months |
|------------------------------------------|--------------------------|--------|---------|---------|----------|---------|
| 1 group                                  | –6.19 ± 0.12             | –41.66 ± 0.26 | –58.16 ± 0.37 | –67.24 ± 0.26 | –68.89 ± 0.18 |
| 2 group                                  | –5.36 ± 0.03             | –40.01 ± 0.35 | –56.51 ± 0.41 | –65.59 ± 0.13 | –66.83 ± 0.21 |
| 3 group                                  | –4.95 ± 0.19             | –33.00 ± 0.31 | –40.43 ± 0.29 | –48.68 ± 0.18 | –49.91 ± 0.23 |
| 4 group                                  | –3.3 ± 0.28              | –21.86 ± 0.26 | –28.05 ± 0.19 | –33.41 ± 0.15 | –35.48 ± 0.27 |

![Fig. 2  Factors of long-term success of implantation.](image-url)
References

Afifah, S., Masulili, C., Mahendra, R.M.T.A., Dewi, R.S., 2018. The effect of a removable acrylic partial denture based on Kennedy’s classification of masticatory ability. J Stomatol. 71 (4), 339–343.

Alageel, O., Ashraf, N., Bessadet, M., Nicolas, E., Tamimi, F., 2020. Evaluation of the design-driven prediction of removable partial denture retention. J Prosthet Dent. 124 (3), 357–364.

Albugami, R.A., Smith, S., Hassan, M.-A.-S., Almas, K., 2019. Trends in implant dentistry: Implant systems, complications and barriers in Riyadh, Saudi Arabia. Dent Med Probl. 56 (3), 223–230.

Bae, E.B., Kim, S.J., Choi, J.W., Jeon, Y.C., 2017. A clinical retrospective study of distal extension removable partial denture with implant surveyed bridge or stud type attachment. Biomed Res Int. 2, 1–7.

Batas, L., Anagnostou, E., Vouros, I., 2020. Evaluation of a double layer technique to enhance bone formation in atrophic alveolar ridge: Histologic results of a pilot study. J Oral Maxillofac Surg. 78 (12), 2195–2207.

Chulak, L.D., 1996. Clinical, laboratory studies and features of prosthetics for patients suffering from intolerance to acrylic dentures. Odessa State Medical University, Odessa.

De Sousa Ferreira, V.C., Lopes, A.P., Alves, N.M., Sousa, F.R.N., Pereira, K.M.A., Gondim, D.V., Girão, V.C.C., Leitão, R.F.C., Goes, P., 2021. Bisphosphonate-related osteonecrosis induced change in alveolar bone architecture in rats with participation of Wnt signaling. Clin Oral Investig. 25 (2), 673–682.

Deng, K., Chen, H., Zhao, Y., Zhou, Y., Wang, Y., Sun, Y., 2018. Evaluation of adaptation of the polyactic acid pattern of maxillary complete dentures fabricated by fused deposition modelling technology: A pilot study. PLoS One. 13 (8) e0201777.

Gajapriya, M., Sivaswami, V., Ganapathy, D., 2020. Awareness of the various retention modes used for implant dentistry. Drug Invent Today. 14 (3), 299–303.

Karlsson, K., Derks, J., Wennström, J.L., Petzold, M., Berglundh, T., 2020. Occurrence and clustering of complications in implant dentistry. Clin Oral Implants Res. 31 (10), 1002–1009.

Lazarin, R., Ebenezer, S., Benitha, K., Schimmel, M., 2020. The impact of the ITI international team for implantology on implant dentistry: A retrospective and descriptive analysis of 30 years of research support. Int J Oral Maxillofac Implants. 35 (1), e1–e13.

Marques, S., Ribeiro, P., Falcão, C., Rios-Santos, J.V., Herrero-Climent, M., 2021. Digital impressions in implant dentistry: A literature review. Int J Environ Res Public Health. 18 (3), 1–20.

Muzyni, M.I., Iordanishvili, A.K., 2020. Post-extraction regeneration of jaw bone sanogenesis model. Hum Ecol. 2020 (8), 40–48.

Parzham, V., Judge, R.B., Bailey, D., 2020. A 5-year retrospective assay of implant treatments in private practice: The restorative complications of long-span implant-supported fixed and removable dental prostheses. Int J Prosthodont. 33 (5), 493–502.

Poojashree, B., Sengottaiyan, V., Ganapathy, D., 2019. Awareness among dental students on different types of permanent denture base materials used in complete denture. Drug Invent Today. 11, 79–84.

Ribeiro, A.B., Brognara, F., da Silva, J.F., Castania, J.A., Fernandes, P.G., Tostes, R.C., Salgado, H.C., 2020. Carotid sinus nerve stimulation attenuates alveolar bone loss and inflammation in experimental periodontitis. Sci Rep. 10 (1), 19258.

Saneja, R., Bhatnagar, A., Raj, N., Dubey, P., 2020. Semiprecision attachment: A connecting link between the removable and fixed prostheses. BMJ Case Rep. 13 (8), E233744.

Silman, H.K., Ali, A.E., 2020. Breast cancer identification based on artificial intelligent system. Sustain Engineer and Innov. 2 (2), 41–49.

Sivolessa, S., Meggiorin, S., Ferrarese, N., Lupi, A., Cavallin, F., Fiorino, A., Giraudo, C., 2020. CT-based dentulous mandibular alveolar ridge measurements as predictors of crown-to-implant ratio for short and extra short dental implants. Sci Rep. 10 (1), 16229.

Yalavarthi, S., Dhanraj, M.G., Ashish, R.J., 2019. A literature review on the contemporary treatment modalities in implant dentistry. Drug Invent Today. 11 (9), 2136–2139.

Yessentayeva, S.Y., Makarov, V.A., Kalmateyeva, Z.A., Zhakenova, Z.K., Arybashanov, D.T., 2021. Molecular genetic tests in survival factors in patients with NSCLC in the clinical practice of Kazakhstan. Med J of the Islamic Republic of Iran. 35 (1), 1–11.