

Current guidelines provide for the systematic assessment of patients' psychosocial status, including the screening for anxiety and depression symptoms, followed by individualized intervention as needed.

Key words: cardiac rehabilitation, physical therapy, occupational therapy, acute coronary syndrome, myocardial infarction, chronic coronary syndrome, coronary artery disease, heart failure

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Автори заявляють про відсутність конфлікту інтересів.

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A – концепція роботи та дизайн, **B** – збір та аналіз даних, **C** – відповідальність за статичний аналіз, **D** – написання статті, **E** – критичний огляд, **F** – остаточне затвердження статті.

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PREVALENCE OF COMPLICATIONS IN DENTAL IMPLANTATION: CAUSES AND PREVENTION (LITERATURE REVIEW)

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Dental implantation at the current stage of development of oral and maxillofacial surgery is recognized as a functionally and biomechanically justified method of rehabilitation of patients with complete or partial adentia. However, the development of perfect differentiated protocols of intraoperative prophylaxis requires an exhaustive analysis of the types, epidemiology, etiopathogenesis and frequency of inflammatory complications. Purpose of the study: to conduct a search and analysis of literary sources of Ukrainian and foreign authors on the causes of occurrence, clinical course and ways to prevent complications during dental implantation at the current stage of development of medical science. A clear differentiation of biological complications into early and late is based on modern chronological criteria. Surgical trauma, thermal necrosis of the bone, violation of asepsis or contamination of the wound with oral microflora act as an etiological stimulus for early complications. Acute inflammatory reactions and primary infection of the surgical wound are early postoperative contaminations. Such infectious processes are diagnosed in about 1.55–1.70 % of installed dental implants at the stage before orthopedic loading. Bacterial contamination of the osteotomy zone against the background of surgical trauma and tissue ischemia causes a rather multifactorial nature of the etiopathogenesis of early inflammatory complications. Mechanical preparation of the bone bed with burs inevitably violates the anatomical and biological integrity of the microcirculatory bed, causing the formation of an ischemic "space of demarcation" between the adjacent bone tissue and the surface of the dental implant. Inflammatory damage to the soft tissues of the mucous membrane around a functioning implant without clinical and radiological signs of loss of adjacent bone tissue is defined as peri-implant mucositis. Thus, the wide range and prevalence of complications after the surgical stage of dental implantation creates the prerequisites for the development of new methods of their prevention, including the optimization of the standard protocol for this surgical intervention, which will take into account the risk factors for the development of complications.

Key words: dental implant, bone tissue, complications, jaw, inflammation.

Connection of the publication with planned research work.

The work is a fragment of the comprehensive initiative theme of the Department of Orthodontics, Bogomolets National Medical University "Improvement of digital and analog protocols for the diagnosis, treatment and prevention of patients of different age groups with dentofacial anomalies" (state registration number 0124U000780).

Introduction.

Dental implantation at the current stage of development of oral and maxillofacial surgery is recognized as a functionally and biomechanically justified method of rehabilitation of patients with complete or partial aden-tia [1, 2]. The overall rate of long-term osseointegration of dental implants, confirmed by world research data, varies within 90–95% [3, 4]. At the same time, even if successful primary mechanical stabilization and full osseointegration are achieved, it is impossible to guarantee the absolute absence of complications in the future. They arise due to chronic or acute inflammatory process, causing a significant clinical, psychological and economic burden [5, 6]. Therefore, the development of perfect differentiated protocols of intraoperative prophylaxis requires a comprehensive analysis of the types, epidemiology, etiopathogenesis and frequency of inflammatory complications.

The aim of the study.

To search and analyze the literary sources of Ukrainian and foreign authors on the causes of occurrence, clinical course and ways to prevent complications during dental implantation at the current stage of development of medical science.

Object and research methods.

This study is a narrative analytical review based on the synthesis and systematization of current scientific literature addressing complications associated with dental implantation. Scientific publications by Ukrainian and international authors were analyzed with regard to the prevalence, etiological and pathogenetic factors, clinical features, and current approaches to the prevention of early and late complications of dental implantation. Particular attention was given to biological complications, impaired osseointegration, the role of bacterial contamination and biofilm formation, as well as risk factors for the development of inflammatory processes in peri-implant tissues. Bibliographic, analytical, and systematic methods were used to evaluate, synthesize, and interpret the available scientific evidence.

Main part.

Traditionally, the types of complications of dental implantation are differentiated by their nature: biological (violation of osseointegration processes, inflammatory phenomena), technical or mechanical (fractures of suprastructures, loosening of fixing screws, destruction of system components), surgical (bleeding, damage to anatomical formations) and aesthetic (metal translucency, recession of the mucous membrane) [7, 8]. A clear differentiation of biological complications into early and late is based on the modern chronological criterion. A completely different etiology, pathogenesis and microbiological profile are inherent in each of these categories, requiring specific approaches to medical support [9].

According to the chronology of occurrence, early complications are recorded from the moment of instal-

lation to orthopedic loading (in the first days or weeks), while late complications appear after successful osseointegration and fixation of the prosthesis (after months or years) [10]. Surgical trauma, thermal necrosis of the bone, violation of asepsis or contamination of the wound with oral microflora act as etiological stimuli for early complications [11]. Their pathogenetic essence lies in the absence of primary osseointegration with the formation of a fibrous capsule around titanium. Late complications arise due to the accumulation of a polymicrobial biofilm on the surface of the structure, their development is characterized by profound immunological dysregulation and activation of osteoclasts [12]. Clinically, early processes are manifested by acute pain, edema, purulent exudation and early mobility of the dental implant, while late pathologies demonstrate bleeding on probing and radiological loss of marginal bone [13, 14].

The period from the moment of intraosseous insertion of the implant to the stage of its functional loading or connection with the gingival former is accompanied by the risk of developing early biological complications [15]. Violation of the subtle physiological mechanism of primary osseointegration is the essence of this process, when direct structural fusion with bone tissue is replaced by connective tissue proliferation and fibrous encapsulation of the implant [4, 16].

Acute inflammatory reactions and primary infection of the surgical wound are early postoperative contaminations. Such infectious processes are diagnosed in about 1.55–1.70% of installed dental implants at the stage before orthopedic loading [15]. Statistically, these figures seem small, but the frequency of primary infections and subsequent rejection can reach 10.00–14.50% in certain risk groups (in patients with uncompensated diabetes mellitus, smokers or elderly people) [17].

A sharp increase in the risk of early rejection when using dental implants of specific sizes has been proven in several retrospective studies. A six-fold increase in the risk of early failure is associated with small-diameter implants (less than 3.5 mm), a two-fold increase in the risk is demonstrated by implants less than 10 mm long. This phenomenon is explained by the insufficient contact area of the titanium surface with bone tissue, which makes it impossible to compensate for the minimal marginal inflammatory resorption in the initial postoperative period [18, 19].

Bacterial contamination of the osteotomy area against the background of surgical trauma and tissue ischemia causes a rather multifactorial nature of the etiopathogenesis of early inflammatory complications [4]. The formation of a bacterial biofilm on the surface of titanium occurs from the first hours after the installation of the structure [11]. Mechanical preparation of the bone bed with burs inevitably violates the anatomical and biological integrity of the microcirculatory bed, causing the formation of an ischemic "space of demarcation" between the adjacent bone tissue and the surface of the dental implant. Infection of this ischemic space can be exogenous (transport of microorganisms from saliva, non-compliance with strict asepsis rules) or an endogenous vector (residual microorganisms in the well after extraction, the presence of unsanitized periodontal pockets) [20, 21]. Tissue metabolism is directly affected by bacterial contamination. If the host immune system is unable to eliminate the infectious agent in the presence

of local hypoxia, clinically significant postoperative infection occurs. It blocks the migration of osteoprogenitor cells, subsequently causing irreversible early rejection [4].

Inflammatory soft tissue lesions of the mucosa around a functioning implant without clinical or radiographic evidence of adjacent bone loss are defined as peri-implant mucositis. Accumulation of bacterial biofilm at the interface between the restoration and soft tissue is the main etiological factor. The presence of localized or generalized bleeding on careful periodontal probing, erythema, hyperemia, and edema of the mucosa characterize mucositis clinically. Complete reversibility is a fundamentally important characteristic of this pathology: inflammation regresses after timely removal of the bacterial biofilm, returning the tissues to a state of physiological normality [22].

A more dangerous irreversible pathological condition that requires surgical intervention is classified as peri-implantitis. It occurs in the tissues around the dental implant, accompanied by inflammation of the mucosa in parallel with progressive loss of supporting bone, and is a plaque-associated process, although its pathogenesis involves profound immunological dysregulation [23]. The diagnosis of peri-implantitis is based on key clinical and radiological criteria: the presence of pronounced soft tissue inflammation in the form of erythema and edema; fixation of bleeding or purulent exudation during periodontal probing; pathological increase in probing depth compared with previous measurements after prosthetics; radiological verification of progressive loss of marginal bone tissue. The presence of bone resorption more than 3 mm from the apical part of the intraosseous implant platform confirms the diagnosis in the absence of previous radiographs [13].

For decades, osseointegration has been perceived by the traditional medical paradigm as an ideal, static and bioinert fusion of titanium and bone tissue. The modern pathogenetic view, based on molecular biology and osteoimmunology, radically rethinks this process. The reaction to a foreign body, which is histologically accompanied by bone demarcation in combination with chronic subclinical inflammation, conceptualizes osseointegration now. The latest BIND (Biofilm-Mediated Inflammation and Bone Dysregulation) hypothesis best describes this phenomenon. The progression of the disease is explained through four stages: physiological homeostasis; pathological homeostasis; pathological exacerbation; pathological dysregulation, which is defined as full-fledged peri-implantitis [4].

The bacteriological profile of inflammatory complications evolves in parallel with the time of their occurrence. Intraoperative contamination with aerobic and facultative anaerobic pathogens most often causes early complications. The dominant positions among them are occupied by gram-positive cocci (specific strains of *Staphylococcus aureus* and *Streptococcus*). The formation of a mature, highly organized polymicrobial biofilm mediates the development of late complications [24]. Gram-negative anaerobic periodontal pathogens of the red and orange complexes *Porphyromonas gingivalis*, *Prevotella intermedia*, *Bacteroides forsythus* and *Actinobacillus actinomycetemcomitans* predominate in this biofilm. Its formation goes through four critical stages: the initial reversible adhesion of planktonic bacteria to the titanium microrelief; irreversible fixation of cells by means of adhesin proteins; growth and maturation of colonies with massive secretion of extracellular polysaccharide matrix; final desquamation of microorganisms for further dissemination of infection deep into the bone tissue [25].

A significant problem for modern surgical dentistry is the phenomenon of antibiotic resistance of microorganisms in the biofilm. The diffusion of antibiotics is physically prevented by the protective polysaccharide matrix. A very high level of resistance to systemic drugs is demonstrated by the microflora isolated from peri-implant pockets. Cases of complete resistance of bacterial isolates to standard doses of amoxicillin and metronidazole have been repeatedly confirmed by studies. The low clinical effectiveness of routine systemic administration of penicillins for the treatment of already formed peri-implantitis is explained by this fact, causing an urgent need for preventive local administration of high-concentration antimicrobial agents during surgery [26].

Conclusions.

Thus, the wide range and prevalence of complications after the surgical stage of dental implantation creates the prerequisites for the development of new methods of their prevention, including the optimization of the standard protocol for this surgical intervention, which will take into account the risk factors for the development of complications.

Prospects for further research.

To develop an author's methodology for the surgical stage of dental implantation in order to minimize the development of complications caused by surgical trauma.

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РОЗПОВСЮДЖЕНІСТЬ УСКЛАДНЕНЬ ПРИ ДЕНТАЛЬНОЇ ІМПЛАНТАЦІЇ: ПРИЧИНИ ТА ПРОФІЛАКТИКА (ОГЛЯД ЛІТЕРАТУРИ)

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Резюме. Дентальна імплантација являє собою метод заміщення дефектів зубного ряду. Загальний показник довгострокової остеоінтеграції дентальних імплантатів, підтверджений даними світових досліджень, варіює в межах 90–95%. Водночас, навіть за умови досягнення успішної первинної механічної стабілізації та повноцінної остеоінтеграції неможливо гарантувати абсолютну відсутність ускладнень у подальшому. Вони виникають через хронічний або гострий запальний процес, спричиняючи значний клінічний, психологічний та економічний тягар.

Мета дослідження: провести пошук та аналіз літературних джерел українських та зарубіжних авторів щодо причин виникнення, клінічного перебігу та шляхів запобігання ускладнень при проведенні дентальної імплантациї на сучасному етапі розвитку медичної науки.

Традиційно диференціюють види ускладнень дентальної імплантациї за їхньою природою: біологічні (порушення процесів остеоінтеграції, запальні явища), технічні або механічні (переломи супраструктур, ослаблення фіксуючих гвинтів, руйнування компонентів системи), хірургічні (кровотечі, пошкодження анатомічних утворень) та естетичні (просвічування металу, рецесія слизової оболонки). Формування бактеріальної біоплівки на поверхні титану відбувається з перших годин після встановлення конструкції. Механічне претупування кісткового ложа фрезами неминує порушує анатомо-біологічну цілісність мікроциркуляторного русла, зумовлюючи формування ішемізованого «простору розмежування» між прилеглою кістковою тканиною та поверхнею дентального імплантату. Бактеріологічний профіль запальних ускладнень еволюціонує паралельно з часом їх виникнення. Інтраопераційна контамінація аеробними та факультативно-анаеробними патогенами найчастіше спричиняє ранні ускладнення. Домінуючі позиції серед них займають грампозитивні коки (специфічні штами *Staphylococcus aureus* та стрептококи).

Таким чином, широкий спектр та розповсюдженість ускладнень після проведення хірургічного етапу дентальної імплантациї створює передумови для розробки нових методів їх профілактики, в тому числі оптимізації стандартного протоколу проведення даного оперативного втручання, який буде враховувати фактори ризику розвитку ускладнень.

Ключові слова: дентальний імплантат, кісткова тканина, ускладнення, щелепа, запалення.

PREVALENCE OF COMPLICATIONS IN DENTAL IMPLANTATION: CAUSES AND PREVENTION (LITERATURE REVIEW)

Kanyura O. A., Bondar T. P., Khliebutin V. V., Rezvina K. Yu., Tkachenko P. I.

Abstract. Dental implantation is a method of replacing defects in the dentition. The overall rate of long-term osseointegration of dental implants, confirmed by world research data, varies within 90–95 %. At the same time, even if successful primary mechanical stabilization and full osseointegration are achieved, it is impossible to guarantee the absolute absence of complications in the future. They arise due to a chronic or acute inflammatory process, causing a significant clinical, psychological and economic burden.

Purpose of the study: to search and analyze literary sources of Ukrainian and foreign authors on the causes of occurrence, clinical course and ways to prevent complications during dental implantation at the current stage of development of medical science.

Traditionally, the types of complications of dental implantation are differentiated by their nature: biological (disruption of osseointegration processes, inflammatory phenomena), technical or mechanical (fractures of supra-structures, loosening of fixing screws, destruction of system components), surgical (bleeding, damage to anatomical formations) and aesthetic (metal translucency, mucosal recession). The formation of a bacterial biofilm on the surface of titanium occurs from the first hours after the installation of the structure. Mechanical preparation of the bone bed with burs inevitably violates the anatomical and biological integrity of the microcirculatory bed, causing the formation of an ischemic “space of demarcation” between the adjacent bone tissue and the surface of the dental implant. The bacteriological profile of inflammatory complications evolves in parallel with the time of their occurrence. Intraoperative contamination with aerobic and facultative-anaerobic pathogens most often causes early complications. The dominant positions among them are occupied by gram-positive cocci (specific strains of *Staphylococcus aureus* and *Streptococcus*).

Thus, the wide range and prevalence of complications after the surgical stage of dental implantation creates the prerequisites for the development of new methods of their prevention, including the optimization of the standard protocol for this surgical intervention, which will take into account the risk factors for the development of complications.

Key words: dental implant, bone tissue, complications, jaw, inflammation.

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Conflict of interest:

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