MODERN REPRESENTATION ABOUT OSTEOINTEGRATION OF DENTAL IMPLANTS

Safarov M.T., Tashpulatova K.M., Ruzimbetov H.B.
Department of Hospital Orthopedic Dentistry,
Tashkent State Dental Institute

Annotation. The popularity of dental rehabilitation using the dental implantation method determines the interest of researchers in studying the integration of implants in bone tissue. The purpose of this work is to analyze and systematize data from Russian and foreign publications on the problem of osseointegration of titanium implants.

An analysis of the literature shows that the improvement of research technologies and an interdisciplinary approach to studying the phenomenon of osseointegration of dental implants in recent years have led to a change in traditional ideas on this problem. Summarizes information about physiological processes And cellular interactions, leaking on the "implant – bone tissue" border at different stages of integration. The results of studies are presented that indicate the need to revise ideas about the bioinertness of titanium implants and consider the integration process from an immunological aspect.

Key words : osseointegration , dental implantation, osteoblast, contact osteogenesis.

Today, dental implantation is successfully used for orthopedic rehabilitation patients at various options defects dentition . The relevance of this method of dental treatment is dictated by the high prevalence of partial and complete absence of teeth and the need of patients for effective restoration of the integrity of the dental system in the face of increasing demands for aesthetics and comfort. World experience use prosthetics With support on Dental implants demonstrate the ability to use this method in various clinical situations (both for fixed prosthetics and to improve the fixation of removable structures) and at the same time achieve predictable success in treatment [1–5].

The steady increase in the popularity of dental implantation in recent decades has led to increasing interest among researchers in studying the mechanisms of implant integration in bone tissue. Traditionally, the most favorable method of integration is considered osseointegration , which Per-Ingvar Branemark , the founder of modern dental implantology , defined it as "the obvious direct (immediate) attachment or attachment of living bone tissue to the surface of the implant without the introduction of a layer of connective tissue" [6]. Its achievement is considered a necessary condition for the success of implant-supported prosthetics in the long term [1, 7, 8].

The phenomenon of osseointegration was discovered by P.-I. Branemark by chance, while studying microcirculation V bone fabrics With with help small optical camera, surgically implemented V tibial bone a rabbit. More than for four decades, the following behind this discovery, was accumulated and the extensive scientific database describing the mechanisms of implant integration in bone tissue continues to grow [9–14].

A. A. Kulakov et al . (2012) proposes to consider the integration of an implant into bone tissue as a dynamic process of interaction between living and nonliving, subject to achieving equilibrium of compensatory-adaptive And homeostatic mechanisms, What allows alive and the dead coexist in a single system. The success criteria for such an interaction is the absence of inflammatory, necrotic and allergic processes in the peri-implant tissues, i.e. absence of rejection reactions; formation of morphofunctional determinants of integration process V zone contact between implant And surrounding cloth (in case dental implantation – osteo-like or bone substances); relative stability of these determinants over time [15].

According to literature sources, the following methods of organizing tissues at the implant/bone interface are distinguished:

- osseointegration , as follows from the definition of PI Branemark , is direct contact of the bone with the surface of the implant;
- fibroosteointegration implies Availability connective tissue layer between the bone itself and the implant, consisting of collagen fibers and coarse connective tissue;
- connective tissue integration, which occurs when the surface of the implant is surrounded by fibrous connective tissue.

In the literature, the first two options are described as a normal reaction of the bone to implantation, and the latter is considered as its rejection .

For a long time, the generally accepted theory of osseointegration remains the theory of blood clot retraction « Blood clot retraction theory " [10, 16].

According to this theory, the first phase of the osseointegration process is osteoconduction , the essence of which comes down to the migration and adhesion of mesenchymal cells And osteoblasts To surfaces implant through the remainder of the blood clot. The second phase, osteoinduction , involves the direct formation of bone, the deposition of mineral salts in the newly formed bone matrix. The final stage of bone regeneration around the implant is remodeling , a long process of restructuring, folding from alternating cycles resorption And formation of bone tissue.

The introduction of an implant into the bone is a surgical trauma to the tissue, as a result of which inflammation develops, initial manifestations of resorption and a cascade of vascular-tissue reactions is triggered, followed by regeneration. The condition of the vascular bed and the level of blood supply in the damaged area play an important role in this process. Under conditions of ischemia, there is a tendency towards the formation of fibrous and cartilaginous tissues instead of the formation of bone structures [1, 7, 17, 18].

It was found that even when screwing the implant at high speeds and achieving good primary stability during positioning implant, between him And surrounding bone available gap up to 60 microns. Depending on the degree of trauma of the operation, it may subsequently increase to 100–500 microns in some areas. This space is filled with blood and tissue fluid, which are sources of biologically active substances and proteins necessary to initiate the process of osseointegration of the implant. Although various properties of the implant surface can influence the composition and conformation of binding proteins, cell membrane receptors interact with the titanium surface, and ultimately the initial attachment of cellular elements to it occurs [19, 20].

At the initial stage of osseointegration, the extracellular protein fibronectin and transmembrane heterodimers , integrins, actively participate in the process of recognition and adhesion of cells on the surface of the implant [21, 22].

From the blood poured out from the vessels of the bone bed of the implant, a clot is formed, including platelets, fibrin, vascular growth factors, transforming growth factor, insulin-like growth factor, etc. These components stimulate the formation of new vessels and healing of bone tissue [13,18,].

The network of fibrin fibers allows the migration of osteogenic cells under the influence of growth factors synthesized by platelets to the surface of the implant. Growth factors attract fibroblasts and other undifferentiated cells to the fibrin matrix area and also stimulate their differentiation [24] .

The features of this stage largely determine the further integration of the implant. Tight attachment of a blood clot to the surface of the implant and the formation of fibrin “bridges” between it and viable bone create conditions for the proliferation of osteogenic cells along the fibrin threads towards the implant and the formation of bone on the surface of the implant itself - contact osteogenesis, the main mechanism of osseointegration [15].

Considering significance area And density attachments blood components and bone tissue elements to the implant surface at the initial stages of the integrative process, the need for a developed topography and microrelief of the surface of the intraosseous part of the dental implant is not in doubt today. To create complex topography surfaces With optimal indicators roughness Various processing methods are used, which can be divided into two main approaches:

1) treatment of the implant surface using physical or chemical factors (sandblasting, acid etching, laser processing, etc.);

2) spraying onto the surface of biologically active components that stimulate bone formation (hydroxyapatite, tricalcium phosphate , amino acids, etc.) [1

6–1 2].

However, implant integration only through contact osteogenesis seems to be peculiar ideal model. More likely Total, on In different parts of the bone- implant interface, the processes of contact and distant osteogenesis occur in parallel . Moreover, the latter is characterized by the formation of bone tissue not on the surface of the dental implant, but on the surface of the surrounding bone. Osteogenic cells of the implant bed produce bone matrix towards the implant surface [13,18].

Attachment of osteoblasts to the implant surface is already observed V first days after his installations. Osteoblasts synthesize row osteogenesis marker proteins , such as osteopontin , osteocalcin , sialoprotein , which promote the adhesion of osteogenic cells on the surface of the implant, as well as the fixation of mineral compounds in the newly formed organic bone matrix. Then the construction of a collagen matrix begins directly on the surface of the implant, the deposition of an osteo-like substance, which is subsequently transformed into bone [14–16].

chondroitin sulfate of the main substance take part [17].

Young bone tissue subsequently undergoes long-term structural restructuring. This stage, bone remodeling , combines two multidirectional processes - bone resorption and new bone formation.

Resorption of immature bone occurs primarily as a result of the action of matrix metalloproteinases secreted by osteoclasts. In this case, there is an increase in the activity of the enzyme acid phosphatase. The construction of new bone in the direction of the implant surface occurs due to the high functional activity of osteoblastic cells and is accompanied by the expression of alkaline phosphatase [18, 19].

The remodeling process is closely related to the loading conditions of the implant And V in the end leads To replacement immature bone fabrics more functional full-fledged structure. The result structural perestroika is the connection of the newly formed bone with the surrounding spongy substance [10].

Interdisciplinary research V immunology And implantology in two latest decades significantly enriched And deepened ideas about the mechanisms of reparative regeneration of bone tissue, including during implantation. IN 2012 G. were published results work L. Chen And
K. Rahme , who showed the ability of titanium to form nanoparticles in water at room temperature [11].

There is a growing number of publications reflecting changes in the receptor apparatus of cells of the immune system as a result of exposure to metal nanoparticles [12, 13]. It has been experimentally established that particles of titanium, iron, and silicon oxides can undergo phagocytosis. This study, as well as a number of publications [14–19], demonstrate the need to consider metal alloys not from the position of " bioinertness ," but from the point of view of their immunological compatibility with body tissues.

Leaning on on foreign And own research, IN. IN. Labis , E. A. Bazikyan (2016) showed that there is emission of nano-sized particles from the oxide layer of the surface of dental implants various manufacturers (Nobel Replace , Astra Tech , Straumann , MIS, Alfa-Bio , etc.). By forming conjugates with blood plasma proteins, these nanoparticles are then presented to immunocompetent cells. Cell interactions in the peri-implant fabrics V further determine adaptive immune a reaction that has a regulatory function in determining the course of reparative osteogenesis. The authors also proposed a method for conducting a test for activation of peripheral blood basophils by supernatants of metal nanoparticles With surfaces dental implant, What will allow V In each clinical case, select an implantation system based on the patient's individual sensitivity to a particular material [10].

Immunocompetent cells play an important role in regulating the process of osseointegration at different stages. Interleukins, chemokines , and tumor necrosis factor synthesized by myeloid cells are involved in the regulation of interactions of cells and intercellular substance with the surface of the implant, stimulate angiogenesis [11,13].

During the migration of lymphocytes in the collagen matrix, a selective group of cells accumulates, which can influence the proliferation of fibroblasts and the secretion of collagen proteins [12].

Reparative regeneration of bone tissue around an implant is a complex multi-stage process, the coordination of which involves not only local cellular elements And signaling molecules. The regulatory function is also carried out with the participation of the nervous and endocrine systems, whose action is realized through such biologically active substances as serotonin, β-endorphin, etc. [1-3].

Objective assessment parameters osseointegration implants a lot of research has been devoted to it . A group of scientists with the participation of Dr. T. Albrektsson conducted a morphological study of 33 extracted osseointegrated implants of the Nobel system Pharma . During the work, an average of 70–80% of contacts between bone tissue and the implant surface were found throughout the entire interface. According to the authors, for reliable osseointegration of the implant, it is necessary that at least 60% of the peri-implantation density be bone substance [16, 14].

Professor T. Albrektsson , representative of the Swedish implantological schools, working above problem osseointegration together with P.-I. Branemark , the main factors influencing the integration process are named :

– material, from whom manufactured implant;
– design ;
– quality surfaces implant;

– conditions loads;
– surgical technique at installation implant;
– state bone fabrics around the implant.

IN various domestic and foreign publications Can meet and others factors, however at nearest consideration essence their boils down to the above [14, 15, 16]. In recent decades, work to improve dental implantation techniques has been aimed at optimizing the process in these six areas.

Thus, a large number of studies conducted in this area indicate the high relevance of the problem of osseointegration and the consistently high interest of dentists in finding ways to achieve predictable success with dental implantation. New horizons are opening up in the study of implant integration into bone tissue using an interdisciplinary approach to the problem. It seems that the discovery of immune, humoral and nervous mechanisms regulating the integration process will create additional opportunities for targeted influence on them and will make dental implantation an even more predictable and effective technique.

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