THE USA JOURNALS
THE AMERICAN JOURNAL OF MEDICAL SCIENCES AND PHARMACEUTICAL RESEARCH
(ISSN – 2689-1026)
VOLUME 06 ISSUE05

PUBLISHED DATE: - 29-05-2024
DOI: - https://doi.org/10.37547/TAJMSPR/Volume06Issue05-05 PAGE NO.: - 18-22

RESEARCH ARTICLE Open Access

MODERN ASPECTS OF APPLICATION OF OSTEOPLASTIC MATERIALS IN DENTISTRY

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Abstract
Current trends in the use of osteoplastic substances in dental practice emphasise the importance of restoring bone structure after inflammatory processes, trauma and surgical interventions associated with tooth extraction, which often results in a lack of bone tissue. Natural regeneration rarely provides sufficient new bone volume, which complicates the implantation process.

Keywords Osteoplastic materials, bone microporosity, bone macroporosity, jawbone, regeneration.

INTRODUCTION

The use of osteoplastic materials in dentistry represents a key area of research aimed at bone regeneration, which is one of the most significant areas in modern medicine. Lack of bone mass in the maxillofacial region can be caused by a variety of factors, including trauma, inflammation and complications from surgical procedures such as dental implants and bone grafting.

A variety of categories of osteogenesis-activating materials are available to clinicians: autologous, allogeneic, xenogeneic, and artificial. Their osteoinductive and osteoconductive properties, as well as their tissue compatibility, vary. Choosing the appropriate osteoplastic agent from the wide range of available options to stimulate bone regeneration is a challenging task for the clinician. It is important to consider not only the composition, particle size and quality of the materials, but also the specific condition of the implantation site (type of injury, defect volume, surrounding bone density) as well as the individual patient's characteristics in order to accurately select the osteoregeneration stimulator for each clinical case.

Physiological bone regeneration is not always able to provide the required volume of new bone tissue and can take a significant amount of time. Localised bone deficiency can lead to long-term negative consequences such as deformity and loss of bone structure, exposure of tooth roots and development of neuritis. It can also make implantation impossible and require additional surgical interventions.

Surgical operations on the bones of the facial skeleton have their own peculiarities due to the high probability of infection, especially when treating inflammatory diseases. Infected bone defects such as cysts and cystogranulomas often contain bacteria, which reduces the regenerative potential of the surrounding tissues. Therefore, it is important to choose materials that have both osteoplastic and antibacterial properties.

There are four main groups of osteoregenerative materials:

- Autogenous: materials obtained from the patient himself.

- Allogenic: materials obtained from another person.

- Xenogenic: materials derived from animals.

- Synthetic: artificially created materials.

These materials have varying degrees of osteoinductive potential and can be classified as osteoinductive (promoting bone cell differentiation), osteoconductive (creating a structure for bone cell growth) and osteoneutral (inert space-filling materials). However, this classification is tentative, as many materials have both osteoconductive and osteoinductive properties at the same time.

Materials with osteoplastic characteristics must meet certain criteria: be well tolerated by tissues, not inducing immune responses; have suitable porosity for integration with bone; provide complete and moderately rapid biodegradation consistent with the rate of bone growth; be sterilisable without deterioration of properties; and be affordable.

Autogenous materials are considered one of the most effective and widely used groups of osteoplastic materials. Their advantages include complete compatibility with the receiving bed, minimal risk of rejection, absence of immune reactions and risk of infection. However, they also have disadvantages such as limited amount of available material, additional trauma to the patient and rapid resorption.

Allogeneic materials, representing the next group, also have significant osteoinductive potential, which depends on specific methods of their preparation and preservation. The main disadvantages are the risk of immune reaction, the possibility of transmitting infections such as hepatitis and HIV, and difficulties with legal and ethical aspects.

Xenogenic materials derived from bovine bone are the most common among all types of osteoplastic materials. Their use may be limited due to their high immunogenicity associated with the presence of species-specific proteins. Manufacturers address this problem by removing all proteins that may trigger an immune response, which turns these materials into natural hydroxyapatite with the natural structure preserved. There are chemical and physical methods to purify the material of residual proteins.

Synthetic osteoplastic materials are an economical alternative to natural hydroxyapatite. Their development began in the 1970s and they have evolved considerably since then. Initially, artificial hydroxyapatite was an inert ceramic without osteoinductive properties, but due to scientific advances, synthetic hydroxyapatite and tricalcium phosphate were created in the 1980s and used as bone substitutes.

Studies have shown that altering the calcium to phosphorus ratio in hydroxyapatite allows you to control its properties, including its ability to retain blood clots and promote bone growth. Hydroxyapatite has osteotropic properties, activating osteogenic cell division and differentiation, and osteointegrative properties, creating a strong bond to bone.

There are two main types of hydroxyapatite:

1. Resorbable hydroxyapatite - resorbs quickly in the body and has a high sorption capacity. An example is OsteoGen.

2. Non-resorbable hydroxyapatite - high temperature ceramics produced by heating to 800-1000 °C, has chemical stability and low water solubility. Examples are Reppa Ridge, Interpore, OsteoGraft D, Capse.

Hydroxyapatite is effective for temporary filling of dental root canals and in apical and periodontal surgery, contributing to increased bone volume after surgery.

Modern hydroxyapatite-based biocomposite materials may contain additional components such as antibiotics, antiseptics, regeneration stimulators, anti-inflammatory and antioxidant agents.

The addition of collagen to the hydroxyapatite composition improves its properties by making the material more elastic and resistant to bioresorption, and enhances the osteoinductive effect due to the P-15 peptide, which promotes osteoblast proliferation. The combination of collagen with hydroxyapatite matrix significantly enhances osteoblast proliferation.

Collagen, as a protein, can indeed induce immune responses and be potentially toxic, posing a risk of implant rejection. Special treatment of collagen can minimise these risks, but it is not possible to completely eliminate them. The incorporation of glycosaminoglycans such as chondroitin-4- and chondroitin-6-sulphates, dermatan sulphate and keratan sulphate into the structure of osteoplastic materials can modulate cell differentiation and improve metabolic processes.

Hyaluronic acid and chondroitin sulphate, in particular, play an important role in the formation of bone and cartilage tissue, accelerating the bone repair process. Their use can stimulate osteoregeneration at different stages, especially when combined with hydroxyapatite.

Regeneration stimulators such as growth factors, morphogenetic proteins, and bactericidal components can be used to enhance the osteoinductive potential of the materials. The introduction of bone marrow stromal cells can also enhance the osteoinductive properties of materials.

An ideal osteoplastic material should have a porous structure similar to bone tissue, with a pore size of 100 to 300

μm for optimal osteoinduction. The high crystallinity of hydroxyapatite favours adhesion and differentiation of osteogenic cells, and the presence of collagen enhances this ability.

Porous hydroxyapatite-based ceramics combined with bone marrow cells can undergo fibrovascular transformation and form lamillar bone tissue under experimental conditions. Ectopic bone formation, the process of connective tissue ossification after injury, has also been studied and it was found that porous hydroxyapatite can stimulate the formation of immature bone tissue in experimental animals.

For successful realisation of the osteoregeneration process, a number of conditions must be fulfilled:

1. The presence of osteogenic stem cells of bone and cartilage tissue, which are key elements in the formation of new bone tissue.

2. Optimal concentration of calcium and phosphorus ions, which stimulate proliferation and differentiation of osteogenic precursors, turning them into specialised cells of newly formed bone tissue.

3 The presence of a specific cellular composition in the regeneration area, including osteogenic precursors and supporting cellular elements such as lymphocytes, macrophages and endothelial cells.

Hydroxyapatite, when introduced into the body, interacts with these cells to create a specific bone microenvironment. This favours the binding of calcium phosphates to morphogenetic proteins, increasing their concentration locally and creating conditions for calcium phosphate biodegradation. This, in turn, provides the necessary concentration of calcium and phosphorus ions that promote proliferation and differentiation of osteogenic cells.

Tricalcium phosphate used in synthetic materials has two main crystalline modifications: alpha-TCP and betta-TCP. Both modifications have a high biodegradation rate, but differ in solubility and rate of conversion to hydroxyapatite.

Alpha-TCF with its high resorption rate and antibacterial properties is used in dentistry, while betta-TCF is used in dental surgery due to its macroporosity and osteoconductivity. However, resorption of betta-TCF can be unpredictable, which may lead to early destruction of the material before new bone formation. To address this problem, the use of a polylactide matrix, whose biodegradation rate depends on its molecular weight and porosity, has been proposed.

Calcium sulphate added to autogenous and allogenic material increases the rate of regeneration of bone defects and has found wide application in traumatology due to its osteoregenerative properties.

The production of bone calcium-phosphate cements is indeed a promising area in the development of synthetic osteoplastic materials. These cements, produced by mixing calcium phosphate powders with water or other setting fluid, have unique properties that make them an excellent choice for many clinical applications. The transition from paste to solid state allows them to provide stable support and promote bone regeneration.

The variety of osteotropic materials available allows clinicians to choose the most appropriate option for each case, taking into account the structure and properties of the material as well as the clinical needs of the patient.

Biocomposite materials containing both basic tissue components and active growth factors can significantly improve osteoinductivity and promote more efficient connective tissue regeneration. In particular, bone morphogenetic proteins (BMPs) and their recombinant forms (rhBMPs) fixed on different carriers may play a key role in stimulating bone formation.

CONCLUSIONS

Thus, although bone tissue can regenerate on its own after surgery, the use of regeneration stimulants and osteoconductive materials can significantly accelerate and improve this process. When selecting osteoplastic materials, it is important to consider not only their chemical composition and physical properties, but also the characteristics of the receiving bed, including the nature of the injury and the size of the defect.

An individualised approach to each clinical case and careful treatment planning are key to achieving optimal osteoplastic results. The optimal osteoplastic material should combine a number of positive properties such as reducing postoperative oedema and pain, anti-inflammatory effects, accelerating filling of the bone defect and providing stability of functional load.

REFERENCES

1. Baitus N.A. 2014. Synthetic osteoplastic preparations based on hydroxyapatite in stomatology. Vestnik Vitebskogo gosudarstago meditsinskogo universitet. 13 (3): 29-34.
2. Bezzubov A.E. 2010. Comparative evaluation of bone-plastic materials application for replacement of jaw defects (clinical and experimental research) : autoref. disc. .... Cand. of medical sciences. 20.
3. Deev R.V. 2013. Creation and evaluation of biological action of gene-activated osteoplastic material carrying human VEGF gene. Genes and Cells. 8 (3): 78-85.Hoffer M. 2011. Evaluation of composite resin materials for maxillomandibular fixation in cats for treatment of jaw fractures and temporomandibular joint luxations. Vet. Surg. 40 (3): 357-368.
4. Ingole P.D. 2014. Comparison of intermaxillary fixation screw versus eyelet interdental wiring for intermaxillary fixation in minimally displaced mandibular fracture: a randomized clinical study. J. Oral Maxillofac. Surg. 72 (5): 1-7.
5. Panin A.M. 2014. Novoe pokolenie biokompozicionnyh steoplasticheskih materialov (razrabotka, laboratorno-klinicheskoe obosnovanie, klinicheskoe vnedrenie). [A New generation of biocomposite osteoplastic materials (development, laboratory and clinical rationale, clinical introduction)]: author. dis. Dr. med.Sciences: 48. (in Russian)
6. Reddi A.H. 2013. Morphogenetic messages are in the extracellular matrix: biotechnology from bench to bedside. Biochem. Soc. Trans. 28: 345-349.
7. SHOKIROV Sh. T., MUKIMOV I. I., Characteristics of Anthropometric Indicators

of the Face in Patients with Congenital Cliffs of the Upper LIP and Palate after the Main Stages of the Operation //Central Asian Journal of Medical and Natural Science. – 2023. – T. 4. – №. 1. – C. 38-42.