WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 3, Issue 9, Sep., 2022

VARIETY OF BONE-PLASTIC MATERIALS AND THEIR MAIN PROPERTIES (LITERATURE REVIEW)

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Annotation
The review summarizes the data of domestic and foreign literature on osteoplastic materials (OPM), provides classifications of materials depending on the origin, composition, production technology and behavior in the body, as well as the mechanisms of the effect of OPM on bone regeneration processes.

Key words: osteoplastic material, allograft, hydroxyapatite, reparative regeneration.

Introduction

The level of modern surgery, armed with various technical means, makes it possible to transfer many types of operations into the category of organ-preserving ones. But it is impossible to fully realize the biological potential of the body in the form of reparative tissue regeneration only due to perfect equipment and tools. Regenerative aspects in surgery are not yet dominant, so scar healing is considered a normal result of surgery [7, 8]. It remains problematic to achieve full tissue regeneration in an adult organism. It is quite natural that the prospect of further development of surgery should be the regenerative direction, i.e. surgery, providing a full structural and functional restoration of organs due to effective stimulation of regeneration.

In this regard, the issue of materials for osteoplastic operations is topical [1-6, 8-10, 15-19, 21, 22]. To replace bone tissue defects in traumatology, orthopedics, surgical dentistry and periodontal surgery, autotissues, allottissues, glass ceramics, synthetic hydroxyapatites, apatite silicates and other materials are used. The best plastic material for replacing bone defects in the implementation of arthrodesis, various types of spondylodesis is compact spongy autobone [1, 4-6, 9]. At the same time, when replacing extensive bone defects, especially in the epimetaphyseal zone, for example, after tumor resection, the autoplasty method remains too traumatic, requiring additional surgical trauma, which results in a painful donor site, as well as the probability of transferring pathologically altered tissue from the donor site to the defect area (tumors, osteomyelitis, tuberculosis). It turns out to be impossible to carry out full-fledged bone autoplasty in children, the elderly and people with systemic changes in bone tissue, osteoporosis [1, 4, 9].

For the successful development of osteogenesis processes, the properties of the implant placed in it are essential. An ideal implant should have the following characteristics [4, 6, 8, 16, 21]:

1. High osteogenic potency,
2. Lack of antigenicity,
3. Ease of obtaining,
4. Convenient for clinical use geometric shape,
5. Constant availability,
6. The ability to biodegrade,
7. Do not interfere with bone formation.

Existing materials that meet the specified requirements to one degree or another can be divided into the following groups according to their composition:

Bioorganic - various types of bone autografts, native and demineralized bone allografts, collagen, fibrin glue, fibrin-collagen paste;

Ceramic - tricalcium phosphate ceramics, hydroxyapatite, allo- and xenogenic deproteinized spongy and cortical fragments, coral, Paris patch (calcium sulfite), etc.

Synthetic polymers - polylactic acid, polyactide-polyglycolide copolymer, polyanhydride and polyorthoester;

Composite - combining the properties of materials of different groups presented above.

According to their properties, biomaterials for bone cavity replacement can be divided into two groups: bioinert materials, bioactive materials [1, 5].

Since there is always an interaction between the biomaterial and the physiological environment, bioinert materials are materials that do not have either a positive or negative effect on bone tissue growth. However, they minimize the formation of a fibrous cap.

Bioactive materials are a matrix for the formation of bone tissue on their surface, i.e. have osteogenic properties (osteoconductive and/or osteoinductive).

Bone allografts are increasingly used due to the increasing availability [8-10, 15, 18]. They are used in the form of small fragments, whole, props, segmental and bone-cartilage grafts, which can be obtained from donors and special donors [10, 15, 18].

Tissue transplantation can become one of the tools of regenerative surgery as a biological method for stimulating reparative regeneration [8]. However, tissue grafting is traditionally considered by surgeons primarily as a way to replace defects resulting from the excision of pathologically altered tissues. Therefore, various aspects of tissue transplantation are developed mainly by specialists in the field of plastic and reconstructive surgery. Numerous studies are devoted to maintaining the viability of transplanted tissues and overcoming the barrier of tissue incompatibility. Hence the great variety of methods of tissue preservation, the purpose of which is the long-term preservation of the native structure of grafts and the reduction of their antigenic properties.

The first successful attempt to generalize knowledge on tissue transplantation was the monograph by P.P. Kovalenko (1975), which is a systematic presentation of the theoretical principles and practical aspects of transplantation. Since the publication of this monograph, a large number of scientific reports have appeared in the literature, clarifying ideas about the fate of transplanted tissues and indicating the ambiguity of the results of operations using tissue transplantation [7, 8].

It is currently believed that preserved allografts undergo gradual resorption and are replaced by newly formed tissue. However, there is still a certain diversity in the interpretation of this process due to differences in theoretical approaches, the lack of a morphological analysis of the properties of transplanted tissues and the main factors affecting the nature and timing of graft resorption and replacement [7, 8, 15, 18].

Varieties of composite materials are also used in the form of granules, ribbons, blocks, etc., consisting, for example, of a mixture of HAP (from 30 to 50%) and binding biopolymers, mainly collagen [1, 2, 5, 10]. The main advantage of such materials is the convenience of working with them - the possibility of adjusting the dimensions directly in the operating room, the plasticity of such material when filling bone defects with it, etc. At the same time, collagen is also partially used by the body as a building material of the organic component of the bone. The disadvantages of composite preparations are related to the fact that the amount of the organic component, selected based on the conditions for obtaining convenient physical and chemical properties, is usually much larger than necessary for bone synthesis, and the quality of collagen does not correspond to the optimal one from the point of view of the body's immune responses. Therefore, when using composite materials, including biopolymers, the manifestation of immune immunity on the part of the body is possible, and the therapeutic effect of such drugs is somewhat less than that of pure HAP, although it is sometimes more convenient to work with them.

With regard to the effect of a graft or implant on bone regeneration processes, according to current knowledge, there are four main mechanisms: Osteoblastic osteogenesis stimulated by transplantation of the so-called determined osteogenic prodromal cells (DOPCs), which have their own bone-forming potential. This principle has long been known in connection with transplantation of autologous cancellous bone [11].

Osteoplastic materials, depending on the effect they have on the surrounding tissues, can be divided into 4 groups: 1) non-toxic biologically active materials - form a direct connection with bone tissue; non-toxic bioinert materials - cause the formation of a fibrous capsule on their surface; non-toxic biodegradable materials - are replaced by bone or fibrous tissue; toxic materials - lead to tissue death.

For the first time, a generalized description of morphological transformations during tissue allotransplantation was given by P.P. Kovalenko, who singled out four periods in this process. The first period is characterized by a polymorphocellular reaction to the graft and the beginning invasion of the recipient's cells along the fibers and vessels of the graft. The second period is characterized by differentiation of cells that have penetrated into the graft and neovascularization. The third period is the period of tissue differentiation. In the fourth period, the final tissue differentiation and the formation of a new tissue, the regenerate, take place [7, 8].

The factor initiating graft resorption is the reaction of cellular immunity with the participation of mononuclear cells and lymphocytes, due to which the graft is destroyed and a regenerate is formed in its place. It follows that the structure of the regenerate formed at the site of the allograft largely depends on the degree of immune inflammation [8]. The above dependence can explain the various outcomes of operations, the extreme of which are: a) fibrosis (scarring) as a result of severe immune inflammation and rapid graft lysis, b) the formation of a coarse fibrous capsule around transplants that are not subject to lysis (for example, preserved in aldehydes).

Graft union is a complex process and depends on the characteristic initial differences in the composition and properties of osteoplastic materials: autologous, allogeneic, xenogenic, synthetic or composite material. Therefore, the issue of systematization of literature data on various types of bone-plastic materials and their ability to complete organotypic restructuring, confirmed by morphological studies, is topical. However, such a comparison is not always possible due to different models and testing times used in the experiment.

The solution to this problem is at the intersection of fundamental and clinical disciplines - cytology, histology, cell biology, materials science, traumatology and orthopedics. The friendly use of the creative potential of specialists in these disciplines will make it possible to find new effective ways to correct various injuries of the skeletal organs.

Список литературы

1. Akemi Yasukawa, Kazuhiko Kandori, Hidekazu Tanaka, Keiko Gotoh Preparation and structure of carbonated calcium hydroxyapatite substituted with heavy rare earth ions // Materials Research Bulletin. - 2012. - V.47,1.5. - P. 1257-1263.
2. В.В. Смирнов, Бакунова Н. В., Баринов С. М., Гольдберг М. А., Куцев С. В., Шворнева JI. И. Влияние времени старения порошков CaCO3 на спекание и свойства керамики // Неорганические материалы. - 2012. - Т.48, № 5. - С.631-636.
3. Bernache-Assollant D., Ababou A., Champion E., Heughebaert M. Sintering of calcium phosphate hydroxyapatite CaЮ(Po4)6(oH)2 I. Calcination and particle growth // J. Europ. Ceram. Soc. - 2003. - V.23, № 2. - P.229-241.
4. Black J. Biological performance of materials: fundamentals of biocompatibility / CRC Press Taylor and Francis Group. - 2006. - P. 497.
5. Cedola A., Mastrogiacomo M., Burghammer M., Cancedda R., Rustichelli F., Komlev V., Lagomarsino S. X-ray microdiffraction for engineered bone study: scaffold resorption analysis // Acta Cryst. - 2006. - A.62. - P. 40-43.
6. Combes C., Bareille R., Rey C. Calcium carbonate-calcium phosphate mixed cement compositions for bone reconstruction // Journal of Biomedical Materials Research Part A. - 2006. - V.79A, 1.2. - P.318-328.
7. Cordaro L., Amade D.S., Cordaro M. Clinical results of alveolar ridge augmentation with mandibular block bone grafts in partially edentulous patients prior to implant placement. // Clin Oral Implants Res. 2002; 13: 103 - 111.
8. Daculsi G, Laboux O, Malard O, Weiss P. Current state of the art of biphasic calcium phosphate bioceramics // J. Mater. Sc.: Mater. Med. - 2003. - V.14. - P. 195-200.
9. Esther W.H. Bodde, Joop G.C. Wolke, Rick S.Z. Kowalski, John A. Jansen Bone regeneration of porous P-tricalcium phosphate (Conduit™ TCP) and of biphasic calcium phosphate ceramic (Biosel®) in trabecular defects in sheep //Journal of Biomedical Materials Research Part A. - 2007. - V.82A, 1.3. - P.711-722.

10. F. Heilmann O. C. Standard F. A. Muller M. Hoffman Development of graded hydroxy apatite/CaCo3 composite structures for bone ingrowth //J Mater S ci: Mater Med. - 2007. - V. 18. - P. 1817-1824.
11. Fugazzotto P.A. GBR using bovine bone matrix and restorbable and nonrestorbable membranes. Part 1: Histologic results. // Int J Periodontics Restorative Dent. 2003; 23: 361 - 369.
12. Global Biomaterial Market (2009-2014) By: marketsandmarkets.com Publishing Date: September 2009 Report Code: BT 1026
13. Huang H.M., Lee S.Y., Yeh C.Y. Resonance frequency assessment of dental implant stability with various bone qualities: a numerical approach. // Clin Oral Impl Res. 2002; Vol 13: № 1: p. 65 - 74.
14. Hugs J.M. and Rakovan J. The Crystal Structure of Apatite, In Kohn M.J., Rakovan J., Hughes J.M. // Phosphates: geochemical, geobiological and materials importance. Series: Reviews in mineralogy and geochemistry. - 2002 -V.48.-P. 1-12.
15. Wagenberg B., Froum S.I. A retrospective study of 1,925 consecutively placed immediate implants from 1988 to 2004. // Int. I. Oral Maxillofac Implants. 2006; Vol. 21, p. 71-78.
16. Wang H.L., Al-Shammari K. HVC ridge deficiency classification: A therapeutically oriented classification. // Int J Periodontrcs Restorative Dent. 2002; 22: 335-343.
17. Wang Horn-Lay, Mish Carl, Neiva Rodrigo F. «Sandwich» bone augmentation technique: rationale and report of pilot cases. // J Perio & implant quarterly. 2005, № 2. pp. 85 - 96.
18. Бакунов В.С., Беляков А.В., Лукин Е.С., Шаяхметов У.Ш. Оксидная керамика и огнеупоры. Спекание и ползучесть: учеб. пособие. / М.: РХТУ им. Д.И. Менделеева. - 2007. - 584 с.
19. Гекманн С.М. Краткий обзор материалов 14 ежегодной конференции Европейской Ассоциации Остеоинтеграции (ЕАО), сентябрь 2005, Мюнхен. // Новое в стоматологии. 2006; № 1 (133): С. 73 - 76.
20. Григорьян А.С., Топоркова А.К. Опыт исследования процессов интеграции имплантационных материалов в костной ткани. // Всероссийское совещание «Биокерамика в медицине». 2006. М. С. 88 - 89.
21. ПРЕИМУЩЕСТВА ВРЕМЕННЫХ НЕСЪЕМНЫХ ФРЕЗЕРОВАННЫХ И ПОЛИМЕРИЗОВАННЫХ ПЛАСТМАССОВЫХ ПРОТЕЗОВ НА ИМПЛАНТАТАХ АН Акбаров, ХБ Нигманович, ХД Нигманович... - БАРҚАРОРЛИК ВА ЕТАКЧИ ТАДҚИҚОТЛАР ..., 2021

22. ПРЕИМУЩЕСТВА ВРЕМЕННЫХ НЕСЪЕМНЫХ ФРЕЗЕРОВАННЫХ И ПОЛИМЕРИЗОВАННЫХ ПЛАСТМАССОВЫХ ПРОТЕЗОВ НА ИМПЛАНТАТАХ АН Акбаров, ХБ Нигманович, ХД Нигманович... - БАРҚАРОРЛИК ВА ЕТАКЧИ ТАДҚИҚОТЛАР ..., 2021