

Application of Zirconium Dioxide in Orthopedic Dentistry

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ABSTRACT

Patients expect a miracle from prosthesis. Orthopedists and dental technicians have to meet their anticipations. To achieve this, modern materials are required. The use of alloys of non-precious metals will probably be gradually decreased in future in view of its possible side effects. Therefore, a wide range of alloys has been developed using precious metals. Zirconium dioxide was discovered in 1789 by the German scientist M.H. Klaproth. However, its amazing properties were "re-invented" in just recent years. High mechanical durability, biocompatibility, phase conversion and color of a natural tooth are the basic advantages of zirconium dioxide for producing aesthetic and durable restorations. That's why, zirconium was introduced into medicine and dentistry as an ideal replacement for the metal. Zirconium dioxide is partially stabilized by Yttrium and is responsible for its positive mechanical properties. Color and biotechnique properties determine the production of high quality and aesthetic tooth and implant retained restoration, which is biocompatible.

KEYWORDS: CAD/CAM technologies, zircon, zirconium dioxide, dental prosthesis

Patients expect a miracle from prosthetics. Orthopedists and dental technicians have to meet their anticipations. For this purpose modern materials and technologies are required. The patient's first demand is a natural teeth and a perfect smile.

Increase in aesthetic requirements determines the important role and fast development of researches on orthopedic dentistry. Therefore necessity in various new materials used in stomatologic practice is obvious.

Application of traditional non-precious alloys on the basis of cobalt, nickel and chrome, probably will be gradually reduced due to possible side effects that may develop in patients, susceptible to influence of non-precious metals.

Leading firms of the world have developed a wide spectrum of alloys from precious metals on the basis of gold, platinum and a palladium, which satisfy and meet practically all range of requirements of modern orthopedic dentistry.

Especially widely are elaborated and used in dental practice alloys for metal-ceramic skeletons and metal-composit prosthesis.

Creation of new materials is based on principles - maximally possible combination of high technical characteristics and functional properties of the material.

Zirconium dioxide was discovered in 1789 by German scientist M.N.Klaprot. He discovered the titan as well.

However, attention to unique properties of this material has been paid in recent years. The name - "Zirkon", is related to zirconium - 40 element, which belongs to a next subgroup of 4-th group in the periodic system [4].

In order to receive ceramic material from elementary zirconium, it is necessary to carry out a number of chemical transformations.

The ceramics represents "a burnt material". The basic process, which proceeds at burning is oxidation.

As a result of interaction of zirconium with oxygen zirconium dioxide is formed, which is the basic component of all products incorporated under the general name "Zirkon" [1].

This material combines high mechanical durability and aesthetic properties of live teeth, and possess high

biocompatibility that is a guarantee of a healthy state and natural appearances of gums.

Zirconium dioxide in comparison with aluminium oxide is less fragile and reveals increased durability at a bend.

Such properties conditioned application of this material for producing of dental implants.

For implantation, the following zirconium dioxide - $ZrO_2 + 5\%Y_2O_3$ has been used [3].

Zirconium dioxide has relatively low module of elasticity and the increased hardness that makes it resistant to abrasion.

Zirconium dioxide is distinguished by unique ability to raise the mechanical durability under influence of loadings. It occurs due to phase conversion.

High mechanical durability, biocompatibility, phase conversion and color of a natural tooth are the basic advantages of zirconium dioxide for producing aesthetic and durable restorations [5].

Zirconium dioxide successfully has been used in various areas of techniques and in surgery as well for making of artificial fingers, hips, etc.

Several years ago it has been used in dentistry for making of whole piece ceramic crowns and dental bridges.

For last 7 years this material has taken a worthy place in daily dental practice, and the most perspective area of its application is production of extended prosthesis, distinguished by excellent aesthetic characteristics.

During the long period of time such high-quality materials were not used in dentistry, since they could not be processed with the use of equipments and traditional technologies (moulding, burning or pressing) available at that time.

The first attempt of use of such materials in dentistry has been carried out with the use of technology, at which skeleton of restorations was made from ceramics In-Ceram Zirkonia, which later was burnt and soaked with vitreous faze. However, despite of its name, the basic component of this material is not zirconium dioxide, but aluminium oxide [1].

For processing of ceramic materials on the basis of zirconium dioxide, in various areas of industry the high-efficacious CAD/CAM systems are used successfully [2].

The scientific-research center of firm CYNOVAD for "machine" techniques examines new composition of Zirkon.

It is a material of the second generation on the basis of zirconium dioxide. Ceramic blocks are made by the method of isostatic pressing of zirconium dioxide stabilized with Yttrium oxide. Burning of products or saturation by glass are not required.

High durability of the material allows achieving thickness of skeletons of 0.5 mm and high accuracy of marginal attachment. Owing to this, the special requirements to techniques of preparation of teeth are not required

Restorations can be fixed with the usual cement, and with the help of adhesive methods of fixing as well. The new material possesses a high transparency and biocompatibility. Guarantee period to split - 6 years.

Nowadays, most of experts agree that polycrystal ceramic materials on the basis of zirconium dioxide, tetragonal crystal frame, which is stabilized with Yttrium oxide, has properties, which allow to make extended dental bridges. It is possible in molar areas as well.

Recently the sphere of use of ceramics on the basis of zirconium dioxide has been expanded due to production of primary parts of telescopic restorations, and also external constructions of implants, as far as modern technologies allow to provide high accuracy of production of these thin-walled restorations [1].

The results of research testify that long-term clinical testing of such restorations still proceeds, however the promising results in the course of these testing have already been received.

The long-term clinical tests of the whole peace ceramic dental bridges made with the use of modern CAD/CAM technologies are not completed yet. Unfortunately, it is not enough to make the forecast about durability of such kind of restorations.

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Применение диоксидциркония в ортопедической стоматологии

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Повышение эстетических требований определяют важную роль и быстрое развитие исследований по ортопедической стоматологии и обуславливают необходимость появления разнообразных новых материалов для стоматологической практики. Применение традиционных благородных сплавов на основе кобальта, никеля и хрома, вероятно, постепенно будет сокращаться в связи с развитием частых побочных реакций у пациентов с повышенной чувствительностью к влиянию благородных металлов. Предлагается новая композиция Zirkon - керамический материал на основе диоксида циркония - продукт обработки современными высокопроизводительными CAD/CAM технологиями. Высокая механическая прочность, биосовместимость, фазовый переход и естественный цвет зуба - это основные преимущества диоксида циркония для изготовления эстетических и долговечных реставраций. Однако данные литературы свидетельствуют о том, что долгосрочные клинические испытания цельнокерамических мостовидных протезов, изготовленных с использованием CAD/CAM технологий, пока продолжаются. Вместе с тем полученные предварительные данные вселяют надежду на перспективность метода.

КЛЮЧЕВЫЕ СЛОВА: CAD/CAM технологии, zirkon, диоксид циркония, зубные протезы