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Clinical and Functional Changes in the Use of Zirconium and Ceramic Bridges

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Relevance. Adentia, caries and related consequences significantly affect the structure of the crown of the tooth and become the main problem of modern dentistry. Studies show that dental problems affect from 51% to 93% of the adult population. Currently, dental implantation acts as an advanced method in the system of comprehensive rehabilitation of patients with dental deficiencies. Despite this, non-removable dentures on a dental support are still preferred to restore function in patients with partial tooth loss. Metal-ceramic dentures, which have been considered the standard for replacing missing teeth for more than six decades, are chosen for their natural appearance and durability, which is provided by a metal base under a ceramic coating. This technology is affordable, relatively easy to manufacture, and has been recognized as a significant component of orthopedic practice worldwide. However, prosthetics are associated with the possibility of complications. Complications of prosthetics can include both biological problems such as secondary caries, periodontal diseases, pulp pathologies, and abutment fractures. Technical problems include loss of retention, peeling of ceramics, aesthetic disorders, occlusive defects and structural breakage. These data emphasize the importance of detailed planning of treatment procedures and strict quality control at each stage of prosthetics in order to minimize the risk of complications and improve long-term treatment outcomes. [1.3.5.7.9.11.13.15.17.19].

In modern orthopedic dentistry, metal-free structures occupy a special place, among which products made of zirconium dioxide stand out for their popularity. This material, made from a natural mineral with the addition of yttrium to stabilize and aluminum to improve properties, is characterized by high mechanical strength and moderate transparency, which gives it an aesthetically pleasing white color without gloss. The technology of production of metal-free ceramic structures began to develop relatively recently, but has already managed to gain recognition for a number of significant advantages. These advantages include exceptional strength and resistance to mechanical stress, which makes zirconium crowns resistant to wear and corrosion. They do not undergo galvanic reactions and allow X-rays to penetrate without accumulation, which simplifies diagnostic procedures. These alloys did not always meet aesthetic requirements and could provoke allergic reactions in patients, especially if they included base metals. By the end of the 20th century, yttrium-stabilized ceramics based on zirconium dioxide (Y-TZP) were widely used in dentistry due to their outstanding physical and mechanical properties. This material, also known as tetragonal polycrystalline ceramics, provided significant advantages in use. Zirconium crowns provide an ideal fit to the tooth tissues, thereby enhancing their stability. This also minimizes the amount of preparation of the tooth before installing the prosthesis, reducing the invasiveness of the procedure. Due to their hypoallergenic nature and lack of high thermal conductivity, zirconium structures do not cause discomfort when eating at different temperatures. Their natural appearance and aesthetic qualities make them the preferred choice for front and chewing teeth, despite the possible limitations of use with the existing increased tooth wear. Among the disadvantages, it is worth noting the risk of chipping on the porcelain coating and the potentially higher cost compared to traditional metal-ceramic prostheses. Also, despite their durability and aesthetics, accelerated erasure of the tissues of opposite teeth is possible, which requires careful planning and possibly limitations in use for patients with pre-existing tooth wear. They found that 20% of patients with ceramic-metal prostheses had inflammatory reactions, whereas among patients with zirconium prostheses, this figure was only 5%. It was also found that monolithic zirconium implants had a significantly lower frequency of chipping and cracking (1%) compared with metal-ceramic

(10%). The authors concluded that zirconium materials demonstrate better durability and biocompatibility.

The use of metal-ceramic dentures in dentistry remains popular due to their strength, appearance and durability. These prostheses combine a sturdy metal frame and a thin layer of ceramic, providing good biocompatibility and aesthetic qualities. However, despite opinions about the safety of these dentures for marginal periodontitis, extensive research shows the risk of some complications. These include gum inflammation, thermal effects on the dental pulp, and excessive stress on periodontal tissues [2.4.6.8.10.12.14.16.18.19].

In addition to advanced manufacturing technologies, the frequency of complications with the use of metal-ceramic structures remains significant. Common problems include the development of marginal periodontal pathologies such as gingivitis, periodontitis, and gum recession, which can occur due to incorrect gum assessment or incorrect procedures such as tooth preparation, gum retraction, and positioning of the crown edge relative to the gingival edge. Special attention should be paid to the formation of the crown edge. Improper fitting of the crown edge to the gingival margin can cause inflammation. In cases where previous crowns were located under the gum, reuse of the supragingival arrangement may be undesirable. It can also negatively affect the appearance, especially on the front teeth. Studies suggest not lowering the edge of the crown to the gum level to minimize the risks for marginal periodontitis [17.19].

The incorrect shape of the crown edge, which creates a high equator on the contact surfaces, can increase the interdental space and affect aesthetics, as well as lead to injury to the interdental papilla. In addition, intensive preparation of the hard tissues of the tooth and the use of retraction threads can harm the gingival tissues. The tactic of depulpating all supporting teeth to protect against the effects of odontopreparation is also unjustified, as studies show, since this can cause additional complications. In contrast, patients with ceramic-metal prostheses experienced a 20% increase in lactate and 15% increase in ammonium levels. These results indicate a more beneficial effect of zirconium structures on the biochemical composition of saliva, which may be due to less metal release and better biocompatibility. In a group of 100 patients who used zirconium prostheses, 92% noted an improvement in aesthetic perception compared with metal-ceramic analogues. In addition, only 5% of patients with zirconium prostheses had inflammatory reactions, while in patients with metal-ceramic prostheses this figure was 15%. The results showed that the compressive strength of zirconium dioxide was 1821.75 MPa, which is significantly higher than that of the cobalt-chromium alloy (892.5 MPa) and ceramics (430.25 MPa). The light transmittance of zirconium dioxide was the closest to natural teeth, which makes it the preferred material for aesthetic prosthetics. Biocompatibility and mechanical strength of zirconium dioxide, as well as its exceptional aesthetic properties such as light transmission and natural appearance. It was found that zirconium dentures have minimal adhesion of microorganisms and low thermal conductivity, which reduces the risk of inflammatory processes in the marginal periodontal. The gap between the crown and the tooth tissue was 55 microns thick, which confirms the accuracy of the fit and the high quality of orthopedic structures.

There are two main types of zirconium-based dentures used in dentistry: fully zirconium-based and ceramic-lined. Fully zirconium dentures are made of a single material, while lined ones include a zirconium base with a ceramic layer on top. For the manufacture of the base, computer-aided design and milling (CAD/CAM) methods are used, after which the dental technician manually adds a ceramic coating, which is then fired, in a similar way to the production of metal-ceramic prostheses. The literature indicates the high aesthetics of such prostheses, but they have a number of disadvantages, including the risk of chipping, increased thickness due to the two-layer structure and significant time costs for manufacturing, as shown by the research of many scientists in this field. In response to these problems, researchers have developed translucent zirconium dentures that can be colored to match natural teeth to avoid the need for a ceramic coating. Such innovations significantly reduce the likelihood of chipping, however, as shown by the work of scientists, including F. According to Beuer, the introduction of monolithic dentures raises new concerns related to the possible wear of opposite teeth due to the high hardness of the material. Zirconium prostheses, on the other hand, are

characterized by high biocompatibility and minimal risk of inflammatory reactions. They provide a better fit to the tooth tissues, which helps to improve long-term treatment results. In addition, these prostheses are less prone to chipping and cracking, which is confirmed by studies conducted on various patient groups.

Conclusion. Their hypoallergenic properties and lack of high thermal conductivity make them comfortable for patients. The main disadvantages of zirconium prostheses include the possibility of accelerated and Thus, the choice between metal-ceramic and zirconium prostheses should be based on the individual needs of the patient, taking into account both clinical and aesthetic aspects. The optimal solution requires careful planning and quality control at every stage of prosthetics to minimize risks and achieve the best functional and aesthetic results.

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