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СОВРЕМЕННЫЕ НАУЧНЫЕ ПРЕДСТАВЛЕНИЯ О ФАКТОРАХ, ВЛИЯЮЩИХ НА УСПЕХ ДЕНТАЛЬНОЙ ИМПЛАНТАЦИИ

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Аннотация

Для полноценной работы стоматолога-имплантолога, занимающегося восполнением зубных рядов с помощью дентальных имплантатов и опирающихся на них протезов, в современных реалиях избыточной вариативности имплантологических систем и супраструктур для них клиницисту необходимо разбираться в критериях, которым должны соответствовать различные элементы конструкций вне зависимости от того, является ли конструкция единичным зубом, мостовидным протезом или полным зубным рядом, восстановленным указанной выше конструкцией. В соответствии с современными научными понятиями, на долгосрочную выживаемость имплантатов и зубов, восстановленных с их помощью, влияют различные механические и биологические факторы, такие, как переключение платформ, вид соединения абатмента с телом имплантата, включая конус, его угол, внутренний или внешний многогранник, вид и форма резьбы, покрытие винта, фиксирующего супраструктуру к шахте дентального имплантата (ДИ), состояние мягких тканей и другие факторы, раскрывающиеся в настоящей статье. Статья будет полезна стоматологам, которые занимаются восполнением зубных рядов с помощью различных видов протезов с опорой на ДИ для ознакомления с современными тенденциями и научно доказанными фактами о различных элементах комплекса «имплантат — протез». Также статья будет полезна для выбора клиницистом имплантологической системы, отвечающей современным критериям надежности и эффективности среди множества вариаций, представленных на рынке медицинских изделий. Коллектив авторов рекомендует статью к ознакомлению студентам старших курсов и ординаторам, обучающимся на стоматологических факультетах медицинских вузов, для более глубокого понимания условий, которые в ближайшем будущем должны будут учитываться ими в практике стоматолога-ортопеда или стоматолога-хирурга.

Ключевые слова: *стоматология, зубной имплантат, зубной абатмент, конструкция зубного имплантата-абатмента, имплантология*

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MODERN SCIENTIFIC CONCEPTIONS ABOUT THE FACTORS INFLUENCING THE SUCCESS OF DENTAL IMPLANTATION

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Annotation

For the full-fledged work of a dentist-implantologist working in the field of replenishment of dentition with the help of dental implants and prostheses based on them in the modern realities of excessive variability of implant systems and suprastructures for them, the clinician needs to understand the criteria that various structural elements must meet, regardless of whether the structure is a single tooth, a bridge, or a full dentition restored with the above structure. In accordance with modern scientific concepts, the long-term survival of implants and teeth restored with their help is influenced by various mechanical and biological factors, such as: switching platforms, the type of connection of the abutment to the implant body, including the cone, its angle, internal or external polyhedron, the type and shape of the thread, the coating of the screw fixing the superstructure to the shaft of the dental implant (DI), the condition of the soft tissues and other factors disclosed in this article. The article will be useful for dentists involved in the restoration of dentition using various types of prostheses based on DI to become familiar with modern trends and scientifically proven facts about various elements of the implant-prosthesis complex. The article will also be useful for the clinician to select an implantological system that meets modern criteria of reliability and efficiency among the many variations presented on the medical device market. The team of authors recommends that the article be read by senior students and residents studying at the dental faculties of medical universities for a deeper understanding of the conditions that in the near future they will have to take into account when following the path of an orthopedic dentist or dental surgeon.

Keywords: *dentistry, dental implant, dental abutment, dental implant-abutment designs, implantology*

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Introduction

A dental implant is an artificial structure used for insertion into the bone tissue of the jaw, followed by osseointegration to support an orthopedic dental structure [23].

At the present stage of development, screw endosseous implants made of titanium with a rough and/or microporous surface are considered the most rational and also the most frequently used [6, 50, 63, 65].

This article will discuss various factors associated with the mechanical capabilities of implant designs, which the authors include: the expected location of the implant platform, the length of the intraosseous part of the DI, its thread, the presence of platform switching, the type of connection between the implant and the abutment and the type of fixation of the prosthesis to the abutment.

The article also discusses biological and bio-social factors, the influence of which may be of interest to readers of this article, such as the anatomy of soft tissues in the area of the implant neck, hygiene and the increased frequency of tooth closure. The last two factors, of course, do not fully depend on the dentist, but the specialist should take them into account when planning treatment.

Aim

To introduce the reader to the main factors influencing the long-term survival of dental implant-supported restorations.

Materials and Methods

The article was prepared based on 70 articles published on Pubmed.

Implant immersion

Currently, there are implants on the market with the intended location of the implant platform at the bone level and at the soft tissue level. Currently, research suggests that there is no clear clinical difference in the rates of marginal bone loss around transgingival and full immersion implants [14, 15, 45], which allows the clinician not to limit himself to choosing only one option for the relationship between the implant edge and the gingival/bone edge.

Short implants

The use of short and ultra-short implants to restore the dentition in edentulous patients is relevant [3, 41]. Installation of implants with a shortened length allows one to avoid complex osteoplastic operations [22, 46], minimizing the traumatic nature of the operation and allowing the installation of implants in patients with contraindications to complex reconstructive interventions, which indicates the possibility of using a wide range of sizes of DI to replace dental defects rows.

Implant thread

According to available data, the load distribution is also influenced by the shape of the thread, for example, Liu Fan et al. determined that trapezoidal (V-shaped) threads distribute the load on the bone more favorably than reverse buttress threads [40]. Arabbeiki et al., in a large study to determine the most favorable thread configurations, also determined that V-shaped threads were the most preferred [7]. According to the available data, a clear influence of the implant thread shape on subsequent osseointegration can be determined [28, 36]. In view of the findings of the various above works, an implant system with a V-shaped or trapezoidal thread should be selected.

Platform switch

The concept of platform switching (PS) emerged some time ago. This concept, currently used by a significant number of both Russian and foreign manufacturers of dental implants (Konmet, Liko-M, Bicon, BioHorizons, Dentium, Megagen, Nobel Boicare, Straumann, etc.) It represents a discrepancy between the dimensions of the abutment and the diameter of the implant, As a result, a step or ledge is formed on the coronal part of the DI body, like the stump of a tooth ground for a crown. In this concept, the diameter of the part of the abutment adjacent to the DI should be less than the diameter of the implant neck. The use of PP reduces the load on the marginal bone due to a more favorable distribution of forces acting on the wall of the DI, while, when using narrower abutments, load transfer is more favorable [18]. It is also known that the body of a DI with PS when exposed to a load is deformed to a lesser extent, however, at the same time, giving less fracture strength [20].

According to a study by Kocak-Oztug et al, biochemical protein parameters for bone surrounding DI with and without PS are different: MCP-1 (Monocyte Chemoattractant Protein 1, a major factor in monocyte trafficking) was higher in implants without platform switching than in DI with PP. The RANKL/OPG ratio (Tumor necrosis factor, which has a positive effect on osteoclastic intraosseous activity to a factor that inhibits osteoclast activity) also differed, indicating less tissue resorption in areas adjacent to the surface of the structure [34]. Clinical studies confirm higher rates of preservation of bone crest tissue, as well as a smaller depth of probing of the soft tissue pocket around the DI with PS compared to DI without PS [31, 52, 68], from which we can conclude that the choice of an implant with PS is more rational, provided that the design planning implies sufficient strength to resist a load that can fracture the neck of the implant.

Type of connection between implant and abutment

The method of connecting (screwing or wedging in the case of implant systems with a Morse taper without a screw) the abutment to the implant body plays an important role in the distribution of load, the likelihood and type of complications. Currently, the most common types of joints are: planar connection with internal hexagon, external hexagon, conical connection with and without anti-rotation hooks [13]. Implants with an internal conical connection without a polyhedron are more difficult to operate and are 17 times less stable; their screws are much more likely to break [37], which should discourage the clinician from choosing this component. A planar design with an externally protruding hexagon can also be considered obsolete, since, although their survival rates are similar to those with other types of connections, in terms of bone loss and the load on the threaded connection and screw

they are inferior to implants with internal connections [17, 33, 39, 67]. When choosing a connection with an internal polyhedron, preference should be given to subtypes with the presence of a cone, as this eliminates microleakage and reduces bone loss [42, 57].

Mendes et al. in an initial study, they determined that the type of connection determines which area of the implant will deform and showed that with an external connection, titanium wear occurs along the periphery of the supporting plane, and with a tapered connection, deformation occurs in the area adjacent to the entire internal bevel [44]. The Morse taper is such a small angle of articulation that when the superstructure is seated in the abutment, it is wedged in like a cold weld; often such systems do not require a fixing screw. Research suggests that it is effective even for the restoration of single molars [10, 56, 69]. However, larger connection angles (as measured between the vertical axis of the DI and the internal slope of the surface) from 12 to 45 showed a consistent reduction in screw load and a more uniform load transfer to the entire body of the DI, which should have a beneficial effect on the quality of the surrounding bone mass [35], which may indicate a certain parity when comparing the advantages and disadvantages of implants between implants with a Morse taper and cones with large angles.

However, Bittencourt et al showed that in a three-unit prosthesis fixed to two DIs, both the type of connection and the method of fixation of the crowns did not significantly affect the stress in the structure [12]. Further studies on extended defects are probably needed. Todd R Schoenbaum et al, in a large systematic review of the literature, using 45,000 CIs, showed that mean bone loss for external hex implants varied little with internal cone implants of less than 22.5°, and bone loss for transmucosal implants was similar to internal cone implants with a wall slope of more than 22.5° and was lower [60], which may also indicate the leveling of the difference between the structural features of implants when used in bridges in comparison with single teeth.

From the point of view of wear of the implant-abutment connection, the most preferred abutment material is titanium, since it causes less damage to the articulation sites in the form of microscratches and rounding of the corners of the polyhedrons of the DI body [30]. In terms of strength, even PEEK abutments showed greater wear resistance than zirconia abutments, but less than titanium, and Jordi Ortega-Martínez et al showed that all PEEK abutments exhibited microleakage from the implant shaft after cyclic loading [49]. The gap sizes for polyetheretherketone were higher than those for zirconium, which, in turn, exceeded the figures corresponding to titanium. Probably, the above should motivate the clinician to abandon all-zirconia abutments in favor of other materials.

Type of fixation of the prosthesis to the abutment

Regarding the type of fixation of the prosthesis to the abutment, which can be either screw or cement. Screw fixation has some advantages over cement, such as eliminating the possibility of cement peri-implantitis and the ability to remove the superstructure without the need to deform it if necessary, but its use is not always possible due to the inclination of the alveolar processes, which requires the use of adhesive or cement fixation for excluding the exit of the screw shaft onto the vestibular surface or the area of the vestibular tubercle [51]. A study by Dena Ali showed that the levels of pro-inflammatory interleukin 1 beta and suPAR protein, which can be used to judge immune activity, were within normal limits in both types of fixation, which suggests that the presence of cement does not provoke an immune response [4]. Current research suggests that the accuracy and effectiveness of cement and screw fixation are not significantly different, so the clinician should choose the type of prosthesis fixation based on the clinical situation, taking into account that the use of cement fixation can reduce the number of corrections and shorten the appointment time, which may be important for some patients [55]. So at the moment, cement fixation when using individual abutments and screw fixation can have parity and be used according to indications in various clinical situations.

In the context of the type of fixation of the prosthesis to the body of the DI, it is worth mentioning the qualitative composition of the screws. Thus, gold screws showed better preload retention compared to titanium [61], being less likely to unscrew, but more often causing such a serious complication as screw fracture [70], which may alert the clinician before choosing gold screws. It has also been shown that anodizing the surface of screws (and/or internal threads) with titanium improved the preload valu [53]; Also, the quantitative value of microdeformations was positively affected by gold plating of screws, reducing damage, which was shown on microcomputed tomography [11]. One thing to know about carbon-coated screws is that they are greatly influenced by the tightening method and the most preferable is a three-stage tightening, which is two repeated tightenings to the required force after the initial tightening [5]. In summary, many types of treatments for implant screw coatings can be considered effective for increasing preload force. Don't forget about the deformation of the screws. It has been shown that the hexagonal hole of the screwdriver is less deformed than the star-shaped one [21], and the screws themselves must be changed, regardless of the type of structure and number of implants, after 5 years of loading [64], and, of course, after use in the dental laboratory [58], where they can be significantly worn due to repeated cycles of fixation and unscrewing during work on the prosthesis.

It is worth noting that various biological and medical liquids/solutions can have different effects on the force of unscrewing the abutment screw, for example, blood in the implant shaft reduces the force of unscrewing by 12%, an oil solution of tetracycline reduced the detorc value more significantly than chlohexidine gel. Artificial saliva had a positive effect on preload, resistance to loosening of screws and their mechanical wear [2, 48].

Based on the above data, coated hex screws are the most reliable, with the main coatings on the market (gold plating, carbon plating, anodizing) having an advantage over

uncoated all-metal screws. You should also stop using disinfecting gels to reduce the likelihood of the abutment screw unscrewing, unless there is a direct indication for this.

Soft tissue

For the long-term functioning of a dentofacial prosthesis supported by an implant, it is also necessary to take into account the qualitative condition of the soft tissues surrounding the implant. According to studies, the implant must be surrounded by at least 2 millimeters of immobile keratinized epithelium to prevent displacement and absorption of biological fluids (saliva, food bolus) into the gingival sulcus of the implant [1, 19, 24]. According to modern data, the health of soft tissues is also influenced by the profile of tooth eruption. Moreover, protrusion angles up to 30% did not have a negative effect on the development of mucositis and peri-implantitis, but further clinical studies are currently required [8].

To maintain the stability of soft tissues, especially in the aesthetically significant area, there is the "One abutment, forever" concept. The technique involves refusing to install a gum former in the patient, replacing it immediately with a permanent abutment, which is initially covered with a temporary one, and then, if necessary, being corrected in the oral cavity, with a permanent crown. The concept allows to reduce the number of procedures associated with unscrewing the superstructure from the implant, minimizing the expected microtrauma to the soft tissues in direct contact with the abutment, which should reduce recession of the gingival margin zenith [27, 29, 32, 54]. Abutment material does not appear to play a role, as Frédéric Dethier et al. in their study showed that biological width histology was indistinguishable for titanium, zirconia, polymethyl methacrylate and veneering ceramic abutments [16].

In view of the above, the clinician can be recommended to compulsorily recreate a layer of keratinized gum around the profile of the implant's abutment eruption profile with angles of appearance no higher than 300. Also, if possible, one should not ignore the concept of "one abutment, forever", if the clinical situation allows it.

Hygiene

Another important factor is the possibility of self hygiene. Any structure in the oral cavity must be designed in such a way as to ensure that the patient can independently clean the dentures from food particles and soft plaque. Accordingly, on a fixed denture or on a fixed part of a denture (if the removable denture is supposed to be fixed to a beam fixed to implants), there should be no undercuts adjacent to the oral mucosa, that is, the part adjacent to the patient's soft tissues should be straight or convex in side of the prosthesis bed [26, 59].

Patients are recommended to use an oral irrigator to improve the quality of rinsing interdental spaces, periodontal grooves and other areas that are difficult to clean, which is confirmed by studies of hygiene indices, such as S. Tütüncüoğlu and his work 2021 [66].

Bruxism

We should not forget about such a condition of patients as bruxism. Bruxism, a patient's condition characterized by an increased frequency of teeth clenching and/or grinding, can often be characterized by fixation or thrusting of the mandible (day and/or night) [38]. The modern approach proposes to transfer this condition from the category of pathological and consider it as a form of chewing activity. It is also believed that occlusal interventions do not affect the development of the condition [43]. Due to the increased frequency or force of tooth closure, the condition is a significant factor in dental rehabilitation planning as it increases the load on all dental prosthetic structures [62]. A clear correlation has now been found between the risk of complications of implant treatment in patients with bruxism compared to patients without it [25]. Based on the articles of A.M. Atlas and Gad H. Naguib [9, 47], we can conclude that a larger number of implants are installed and their diameter is increased in patients with bruxism.

Conclusion

Currently, various implantation systems can offer a large number of variations in implant structure. A dental surgeon and orthopedic dentist need to know about the features of the systems being sold in order to select the most suitable ones in each individual clinical case. The clinician also needs to understand the patient's individual characteristics that influence the treatment plan, such as bruxism, the patient's ability to maintain oral hygiene, and the condition of the soft tissues. Knowledge of the above will allow you to create the most long-lasting structures.

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