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THE USE OF ZIRCONIUM DIOXIDE INDIVIDUAL POSTS IN PROSTHETIC TREATMENT OF TOOTH CROWN DEFECTS (MONOGRAPH)

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(MONOGRAPH)

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USE OF ZIRCONIUM DIOXIDE INDIVIDUAL POSTS IN PROSTHETIC TREATMENT OF DENTAL CROWN DEFECTS

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The monograph describes the issues of development and evaluation of the effectiveness of using individual zirconium dioxide posts in the restoration of tooth crown defects.

The work is based on the results of examination and orthopedic treatment of 78 patients aged 16 to 60 with defects in the crown portion of anterior teeth and premolars who sought dental care at the TSSI orthopedic dentistry clinic. The study analyzes the most common errors and complications in the use of cast post-and-core restorations based on archival materials from the Tashkent State Dental Institute's orthopedic dentistry polyclinic. Individual designs of zirconium dioxide post-and-core restorations have been developed for restoring crown defects of single-rooted upper and lower jaw teeth. The resistance of the threaded structure of post-and-core restorations to mechanical loads has been scientifically substantiated, and the immediate and long-term results of their use have been studied. These structures have been implemented in practical dentistry.

The book is intended for prosthodontists, master's students, clinical residents, as well as undergraduate dental students.

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INTRODUCTION

As global dental practice demonstrates, the restoration of the crown portion of teeth is a debatable and pressing issue, both in cases of partial and complete destruction. According to the World Health Organization (WHO), ..."caries, trauma, and other causes leading to the destruction and defects of the tooth crown affect 72% of the world's population." The high prevalence of patients with defects or destruction of the tooth crown necessitates addressing not only dental issues but also social, aesthetic, and psychological aspects. One of the main tasks facing a dentist is ..."preserving tooth roots suitable for prosthetics, which prevents the formation of defects and deformations in dental arches and atrophy of alveolar processes." In this context, improving the effectiveness of diagnosis and treatment of tooth crown defects and enhancing medical care remains one of the most relevant practical issues today.

Today, significant progress is being made worldwide in the field of medicine, which includes optimizing healthcare in the republic to align it with global standards for the treatment and prevention of dental diseases in patients with partial or complete loss of tooth crown structure, complicated by secondary deformation of the dentofacial system. The republic is implementing targeted and practical measures to reform the healthcare system and bring it closer to world standards, as well as taking steps to improve methods for diagnosing and restoring defects in dental hard tissues and dental arches. In this regard, tasks have been set to increase the efficiency, quality, and accessibility of medical care, support a healthy medical standardization system, and introduce high-tech methods of diagnosis and treatment. This, in turn, necessitates improving the quality of orthopedic dental care for patients with dental and dental arch defects.

Targeted and practical measures are being implemented in the Republic to reform the healthcare system and align it with global standards. Currently, efforts are underway to improve methods of diagnosis and restoration of defects in the crown portion of teeth. In this regard, objectives have been set to "increase the efficiency, quality, and

accessibility of medical care, promote a healthy lifestyle and disease prevention, and introduce high-tech methods of diagnosis and treatment." These objectives will enhance the effectiveness of treating patients with crown defects through new types of post-retained teeth and improved use of innovative technologies. This, in turn, remains one of the relevant areas requiring scientific research.

This dissertation research contributes, to a certain extent, to addressing the tasks based on the approved Decrees of the President of the Republic of Uzbekistan, particularly the Decree No. UP-447 of February 7, 2017 "On the Strategy of Actions for the Further Development of the Republic of Uzbekistan," the Decree No. UP-5590 of December 7, 2018 "On Comprehensive Measures for the Fundamental Improvement of the Healthcare System of the Republic of Uzbekistan," as well as the Resolutions of the President of the Republic of Uzbekistan "On Measures for the Further Development of Specialized Medical Care for the Population of the Republic of Uzbekistan for 2017-2022," and other regulatory legal documents adopted in this field.

The beginning of the 21st century marked an innovative breakthrough for dentistry. For instance, in modern dentistry, artificial highly aesthetic non-metallic crowns are used to restore damaged teeth. Polymerization and soldering of dental prostheses have been replaced by ceramic firing and pressing, and computer milling; traditional impressions have been replaced by computer scanning and modeling (E.E. Dyakonenko; I.Yu. Lebedenko, 2016). To date, according to modern research, a sufficient amount of data has already been accumulated on the use of various innovative methods for restoring a damaged tooth crown, particularly after endodontic treatment. The use of metal posts is practically identical in properties to the metal-ceramic crowns covering them, although their aesthetic results are diminished when prosthetic ceramic crowns are used. Currently, there is a trend in prosthetics to replace the use of metal-ceramic crowns with pressed Empress technology or CAD/CAM milled zirconium dioxide frames for ceramic crowns (N. Schnider et al., 2018). However, the available data on the effective use of milled ceramic post crowns are insufficiently substantiated, both from clinical and biochemical perspectives.

In Uzbekistan, the issue of fundamentally improving specialized medical dental care is becoming increasingly important. Studying the prevalence of dental diseases requiring orthopedic treatment plays a significant role in addressing this problem, as does a differentiated approach to planning the need for various prosthetic designs, including the use of roots for fixing and stabilizing dental prostheses as a measure to prevent the destruction of the dentoalveolar system (Akilov T.A., 2011; S.M. Rizaeva, 2019, et al.). According to the literature, defects in the crown portion of teeth and partial tooth loss occur in the Republic of Uzbekistan with a frequency of 33.6% to 51.3% (Adylova Sh.T., 2017). These studies primarily determined the general need for dental prosthetics, while their authors did not consider indications for the treatment of specific forms of dentoalveolar system diseases.

Thus, the analysis of domestic and foreign literature indicates the need for a more in-depth study of the problem of orthopedic treatment of defects in the hard tissues of the tooth crown, which served as the basis for conducting this research and its description in this monograph.

CHAPTER 1
ANALYSIS OF MODERN METHODS OF PROSTHETIC TREATMENT FOR DEFECTS OF THE CORONAL PART OF THE TOOTH

§ 1.1. Current Aspects of Restoring Dental Hard Tissue Defects

The foundation of practical dentistry rests on two scientific and practical principles: firstly, the restoration and rehabilitation of lost anatomical and functional tasks of the human masticatory apparatus; secondly, the preservation of the maximum possible aesthetics of dental arches during treatment. This point was formulated based on the correct assessment of color, shape, size, and location of dental arches, external indicators of visible areas of the dental arch during smiling, etc. (Kostyukova V.V., Ryakhovsky A. N., Ukhanov M.M. 2014; Rizaeva S.M.-2005; Suetina I.A., Podchernyaeva R.Ya., Gushchina E.A., Lopatina O.A., Poklonov V.A., Ostroumov S.A. 2012; Shumilovich B.R., Rostovtsev V.V., Ivanov S.G., Ermilov D.A. 2020).

In addition to this problem, dental pathologies such as caries and periodontal disease remain relevant for the majority of our planet's population, including residents of the Republic of Uzbekistan. Somatic diseases, including metabolic and immune disorders, also have a direct impact on the development of dental diseases. The most common causes of these pathologies are dietary factors, the disruption of which leads to deficiencies in various vitamin groups, resulting in the development of dental diseases. It is also worth noting the significant influence of environmental factors, the impact of which is increasing every year (in Uzbekistan, this environmental factor is the "tragedy" of the Aral Sea) (Novikov E.Yu., 2008; Rizayeva S.M., 2005; Hoffmann R., Reichert A., Noak F., 2016; Tsvirko O.I., Stashkevich A.R., 2020; Migliau G., Piccoli L., Di Carlo S., Pompa G., Beshara L.K., 2017).

Research on the problem of caries is developing in two directions - firstly, therapeutic treatment aimed at preserving teeth, and secondly,

restorative therapy, which will contribute to the reconstruction of damaged teeth through prosthetic measures.

It should also be noted that in the nosological structure of dental diseases affecting frontal teeth, a special place alongside caries is given to pathologies characteristic of hard dental tissue of non-carious etiology (Lebedenko I.Yu., Dyakonenko E.E., Sakhabieva D.A., Lalaka E., 2008; Nikolaev A.I., Lobovkina L.A., Rogatkin D.A., Nikolaev D.A., 2009; Tikhonov A.I., 2017; Martínez-Rus F, Prieto M, Salido MP, Madrigal C, Özcan M, Pradíes G., 2018).

Dental pathologies (tooth wear, enamel pathologies due to excessive fluoride, various types of trauma) have been sufficiently studied, and precise methods of prevention and treatment have been developed for each pathology. However, when considering only those pathologies that occur without the involvement of caries, we face gaps in selecting the best therapy and developing individualized treatment methods, due to the lack of understanding of the main causes of these conditions. Due to the similarity of the initial clinical presentation with carious pathologies, dentists experience difficulties in accurate diagnosis, which leads to delayed measures in combating them (Rogozhnikov G.I., Rogozhnikov A.G., Kulmetyeva V.B., Astashina N.B., 2012; Olesova V.N., Bober S.A., Olesov E.E., Yuffa E.P., Glazkova E.V., Nekrasova E.A., 2017; Toli M., Rutten L., Rutten P.-2012; Faichuk N.V.-2012; Baldissara P, Gobbetti E, Valandro LF, Fonseca RG, Monaco C. Fatigue, 2014).

To protect dental rows from destruction caused by pathologies that may or may not be related to caries, dentists resort to conventional therapy, which includes the installation of metal crowns or metal-ceramic crowns, etc. During prosthetic treatment, it is important to consider the vertical and horizontal loads applied to the supporting teeth during the chewing process (Giezendanner C, Giezendanner P., 2014; Joda T, Zarone F, Ferrari M., 2017; Miyazaki T., Nakamura T., Matsumura H., Ban S., Kobayashi T., 2013).

Due to the development of new materials for making prostheses in the 21st century, as well as increased requirements for the aesthetic aspects of these procedures while maximizing the preservation of the functional

capabilities of the dentoalveolar system, the use of precious metals (Au, Ag, Pt), porcelain, etc., has become the basis for their discontinuation.

In cases of total or extensive destruction of the tooth crown, when a whole root is present, it is possible to perform microprosthetics using post structures to create post-retained teeth. This treatment method provides a basis for preserving the morphofunctional properties of dental rows, helps prevent further destruction and changes in tooth shape, the loss of alveolar bone, and ultimately, protects motor balance while considering articulatory equilibrium (Dolgikh I.M., 2016; Ferrari M, Cagidiaco MC, Goracci C, Vichi A, Mason PN, Radovic I., 2000; Kohal R.-J.; Patzelt S.B.M.; Butz F.; Sahlin H., 2013).

Pin-retained dental constructions have been used in practice as an independent restorative treatment for maintaining the integrity of the dental crown. To date, there are more than a hundred varieties of dental crowns. During periods of rapid development in dental care, manufacturing enterprises were established to produce classical tools and materials, including standard prefabricated dental posts. It was during this period that pin-retained teeth were developed - Richmond, Katz, Tsitrin, Ilyina-Markosyan, Akhmedov, Kopeykin, as well as the Logan crown, etc. Naturally, the creators of the first pin-retained teeth did not anticipate the future popularization of this product. When the optimal method for removing tooth pulp was discovered, the question of repairing destructive teeth while maintaining their natural anatomical crown form immediately arose (Dolgikh I.M., 2016; Kostyukova V.V., Ryakhovsky A.N., Ukhanov M.M., 2014; Nikolaev A.I., Lobovkina L.A., Rogatkin D.A., Nikolaev D.A., 2009).

To ensure a reduced likelihood of complications during pin implantation, dentists of that era unjustifiably removed the pulp from the tooth's base. To date, it has been proven that the lifespan of a devitalized tooth is 20 to 30 years (Dyakonenko E.E., Lebedenko I.Yu., 2016; Kukushkin V.L., Nikulina V.Yu., Kukushkina E.A., 2011; Oganyan A.I., 2017). Many specialists, in the process of restoring the tooth crown, resort to complete devitalization of the tooth base and subsequent reinforcement of the root canals with both endodontic and other pins. Indications for

devitalization can also include various injuries to the tooth crown, resulting in total or subtotal destruction of the tooth crown, as well as metabolic disorders leading to tooth destruction through the development of increased "wear," resulting in the impossibility of restoring the tooth using an artificial crown (Akbarov A.N., Nigmatova N.R., Nigmatov R.N., 2021; Babayan E.A., 2021; Nesterov A.M., Sadykov M.I., Matrosov V.V., Ertesyan A.R., 2020; Salamov M.Ya., Oganyan A.I., Tsalikova N.A., 2017; Sechko O.Yu., Lomakin M.V., Chernichkin A.S., 2008; Osman R.B., Swain M.V., 2015).

In the absence of pulp, increased sensitivity to calcium leaching processes from the hard layers of the tooth develops. The fact of increased destruction during pulp loss, as well as a decrease in resistance to chewing loads, remains insufficiently studied (Giordano R.A., 2013; Lobovkina L.A., Raynauli L.V., Nikolaev A.I., Romanov A.M., 2012; Naumovich S.A., 2013; Cannizzaro G.; Torchio, C.; Felice, P.; Leone, M.; Esposito, M., 2010; Gardell E, Larsson C, von Steyern PV., 2021). Many specialists assert that tooth stability decreases due to the loss of hard tissues both during preparation with burs and during mechanical expansion of dental root canals (Tsalikova N.A., 2013).

After partial devitalization, there are methods for prolonging the viability of the tooth, including the installation of an artificial metal crown, reinforcement with pins inside the tooth root, and the use of post and core inlays (Tsalikova N.A., Oganyan A.I., Salamov M.Ya., Grishkina M.G., 2016).

Some researchers suggest that after removing healthy pulp, the chemical composition and physical properties of the tooth do not change for a certain period following appropriate treatment. The likelihood of tooth fracture during this procedure is observed only due to excessively wide opening of the root canals, significant loosening of the hard tooth structure, and destruction of the pulp capsule, which were carried out before the obturation procedure. Unfortunately, this method of placing a post in the root canal leads to a decrease in the total volume of hard tissue, which increases the probability of subsequent tooth fracture (Tsvirko O.I.,

Stashkevich A.R., 2020; Chevalier J, Gremmilard A, Virkar A, Clarke D., 2009).

Based on these facts, one of the leading principles of treatment is the preservation of tooth pulp. The procedure for restoring a tooth after devitalization, regardless of the time elapsed, is one of the most complex and relevant issues in practical and clinical dentistry (Shidlovsky M.S., Savichuk A.A., 2013; Bakitian F, Seweryniak P, Papia E, Larsson C, Vult von Steyern P., 2017). Regardless of the quality and quantity of root canal filling, the process of decalcification of the tooth's hard tissues is irreversible.

Excessive moral, psychological, and financial responsibility is placed on the dentist for the quality of dental care provided due to the high rate of complications in supporting teeth after their prosthetic treatment (Dietschi D, Duc O, Krejci I, Sadan A., 2007).

§ 1.2. Effectiveness of using artificial posts in the restorative treatment of tooth hard tissue defects

Attempts to systematize dental post systems have been made for a long time. According to some researchers, there are currently more than a thousand different post designs. Dentists have classified posts into 3 types: the first is a simple post tooth, the second type has an inlay, and the third has an external ring (Vakhtel D., 2014; Tikhonov A.I., 2017; Aranda Yus E, Cantarell JMA, Miñarro Alonso A., 2018).

Kopeykin V.N. and co-authors (1967) divided posts into those with rings and those consisting of a single piece. Post-retained teeth also include post-and-core and Logan crowns. Further classification into 3 groups is presented. Currently, posts are divided into 4 main groups based on their indications and production methods: ..." post-and-core crown (post-and-core crown); one-piece post tooth; Richmond crown; basic post teeth. By design, they are categorized as: simple; composite; inlay with a sliding post."

Currently, the method of tooth restoration using mass-produced posts followed by crown installation has become widespread. The optimal

functioning of the installed posts directly depends on their shape, as it is responsible for the quality of adhesion to the tooth base and the optimal distribution of load during the chewing process (Abakumov A.A., Balakhonova M.A., 2017, Balms K., 2013; Dyakonenko E.E., Lebedenko I.Yu., 2019).

The highest retention capability is possessed by a threaded metal post (Vadavadagi SV, Dhananjaya KM, Yadahalli RP, Lahari M, Shetty SR, Bhavana BL., 2017). Some researchers believe that increasing the diameter of posts allows for better retention (Panitiwat P, Salimee P., 2017). Other scientists argue (Bakitian F, Seweryniak P, Papia E, Larsson C, Vult von Steyern P., 2017; Ghazy MH, Madina MM, Aboushelib MN., 2012; Naumann M, Sterzenbach G, Dietrich T, Bitter K, Frankenberger R, von Stein-Lausnitz M., 2017) that post diameter has no effect on its fixation in the jaw. There is also an opinion that increased values of the post's diameter and length increase the fragility of this structure due to the requirements for extensive removal of the dentinal layer. Destruction of the tooth root also occurs with the presence of excessively short posts, which provides a basis for careful selection of the correct length. Favorable conditions for post placement include the preservation of at least 1-1.5 mm of a strong dentinal layer (Cattani-Lorente M, Durual S, Amez-Droz M, Wiskott HW, Scherrer SS., 2016). Approximately 67% of the post size should penetrate the tooth root for optimal fixation (Stober T, Bermejo JL, Schwindling FS, Schmitter M., 2017).

To prevent weakening of the apical portion of the tooth root, it is important to consider factors such as the depth of post insertion, which can exceed 50% of the total root length. The types of post systems used for restoring a lost tooth are selected by taking into account the degree of destruction of the tooth crown and the remaining parts of the tooth to be restored, including the volume and thickness of the root, as well as the dentist's qualifications (Fisyunov A.D., Rubnikovich S.P., 2019).

Through practical observations, many specialists have concluded that no single type of post is uniquely superior. In the cited data from several researchers (Olesova V.N., Novozemtseva T.N., Remizova A.A., Grishkova N.O., Zharov A.V., 2016; Tsalikova N.A., Oganyan A.I.,

Salamov M.Ya., Grishkina M.G., 2016; Shidlovsky M.S., Savichuk A.A., 2013; Depprich, R.; Naujoks, C.; Ommerborn, M.; Schwarz, F.; Kübler, N.R.; Handschel, J., 2014), who conducted comparative analyses of several standard posts, it was revealed that each differs from the others only in individual parameters. Most specialists highlight active posts (Khabilov N.L., Dadabayeva M.U., Moon T.O., Khabilov B.N., 2017; Joda T, Voumard B, Zysset PK, Brägger U, Ferrari M., 2018) due to their increased retention capabilities, which are based on the presence of threads. However, these threads also increase the load on the tooth compared to passive post systems (Schlenz MA, Vogler JAH, Schmidt A, Rehmann P, Wöstmann B., 2020).

Some specialists argue that the presence of a post does not enhance the resistance of the tooth root even in cases of increased dentinal layer retention. For these reasons, specialists are currently striving to utilize the most optimal design of post systems that maximize retention capabilities while minimizing the removal of the dentin layer from the existing natural tooth. They also aim to give this structure a monoblock system consisting of multiple layers that provide the most optimal interface (Zholudev S.E., Ivlev Yu.N., 2021).

To date, there is a group of authors who claim that the fixation capacity of carbon compound posts is 67% higher compared to titanium post installations and 33% higher compared to nickel-chromium post constructions, where adhesion is achieved through a cement layer (Dyakonenko E.E., Lebedenko I.Yu., 2016). In cases of excessively large root canals, using a post inside the tooth root ensures increased strength of the tooth roots (Kostyukova V.V., Ryakhovsky A.N., Ukhanov M.M., 2014; Nesterov A.M., Sadykov M.I., Matrosov V.V., Ertesyan A.R., 2020; Tsalikova N.A., Oganyan A.I., Salamov M.Ya., Grishkina M.G., 2016). Thus, in an era when the popularity of non-metallic post (Babayan E.A., 2021; Krushinina, T.V., 2004; Shidlovsky M.S., Savichuk A.A., 2013) constructions has become most in-demand, there has been an increased societal demand for products whose aesthetics do not correspond to the highest possible standards. It is based on such requirements that the filling and creation of crowns for posterior teeth can be done using amalgam or

glass ionomer cement, while for reconstructing the anterior teeth, preference is given only to glass ionomer cement, as it is more aesthetically pleasing (Ibragimov T.I., Tsalikova N.A., Ataeva S.D., Grishkina M.G., 2014).

Despite an extensive list of positive reviews from many specialists (Grishkina M.G., Oganyan A.I., Salamov M.Ya., Tsalikova N.A., 2016; Giordano R.A., 2013; Massarsky I.G., Massarskaya N.G., Abolmasov N.N., Abolmasova E.V., 2014; Nikolaev A.I., Romanov A.M., Nesterova M.M., Levchenkova N.S., 2018), non-metallic posts have only become popular relatively recently. Some specialists argue that when using zirconium post crowns, problems arise during the grinding process, which in turn lead to minor alterations that can increase the risk of destruction of the installed structure during these manipulations (Abakumov A.A., Balakhonova M.A., 2017; Bersanov R.U., Mirgazizov M.Z., Remizova A.A., Bronstein D.A., Tikhonov A.I., Shumakov F.G., Yuffa E.P., 2015; Massarsky I.G., Massarskaya N.G., Abolmasov N.N., Abolmasova E.V., 2014; Nikolaev A.I., Romanov A.M., Nesterova M.M., Levchenkova N.S., 2018). It is precisely due to this impracticality that this type of post is considered highly individualized and does not enjoy widespread popularity.

Foreign publications rarely recommend the use of traditional materials for restoring the lost anatomical part of a tooth. According to foreign sources, perforated posts are used for installation in circular and semi-circular root canal preparations, which are placed on anterior teeth (Krushinina, T.V., 2009; Melkumyan T.V., 2008). In case of complete loss of the tooth crown, it is impossible to use this type of post. For this reason, due to the inability to use modern post systems for anterior teeth, we can resort to the classical application of standard post structures (Rizayeva S.M., 2005) . Due to the standardization of post structures for canines, where the base of the canal may not be suitable for this type of post, there is an increased probability of incomplete engagement of this system (Tsalikova N.A., Oganyan A.I., Salamov M.Ya., Grishkina M.G., 2016). These parameters also apply to the production of post structures for posterior chewing teeth (Giordano R.A., 2013).

Even with the high popularity of traditional post systems, most prosthodontists recommend the use of custom-made post structures, which are individually cast for each patient and represent pressed teeth on posts (Dyakonenko E.E., Lebedenko I.Yu., 2016; Massarsky I.G., Massarskaya N.G., Abolmasov N.N., Abolmasova E.V., 2014; Polkhovsky D.M., 2010).

The post and core system consists of a core, a post, and a special insert (Salamov M.Ya., Oganyan A.I., Tsalikova N.A., 2017; Faychuk N.V., 2017; Kniha K, Schlegel KA, Kniha H, Modabber A, Neukam F, Kniha K., 2019). The fabricated core must fit the patient's natural tooth stump for optimal fixation of the remaining parts of this system in the socket (Kohal R.-J.; Patzelt S.B., 2019; Butz F.; Sahlin H., 2013).

To facilitate the recreation of a suitable core, modeling methods are used on specially prepared ash-free plastic forms (Pétercsák A, Radics T, Hegedus C., 2014).

In the process of individual manufacturing and milling of teeth on posts, zirconium dioxide is used, and pressed cores made of glass polymer or ceramics are also employed (Vartanov T.O., 2012).

One can argue extensively about which post is better, but the overall outcome depends on the practicing dentist, indications, complications, individual characteristics, etc.

Due to advanced technology, a dentist has a wide range of options, but there is no treatment that is 100% suitable for everyone. However, there are methods that can minimize complications.

Correction of dental damage is carried out individually, taking into account the tooth location, degree of destruction, and pulp condition. It is also worth considering various factors that can either suppress or accelerate these processes. Among the available methods, various dental crown prosthetics and all types of fillings can be noted (Kostyukova V.V., Ryakhovsky A.N., Ukhanov M.M., 2014; Nesterov A.M., Sadykov M.I., Matrosov V.V., Ertesyan A.R., 2020; Migliau G., Piccoli L., Di Carlo S., Pompa G., Beshara L.K., Marco Dolci M., 2017).

In the approach to restoring and repairing tooth hard tissue defects, our domestic dentistry has experienced various waves of development. The widespread use of silver products in the last century yielded quite good

results. The effectiveness of crowns increased due to the prohibition of treatment methods using mercury and materials that lead to root canal destruction. Of course, crowns also reduce the development of caries (Dyakonenko E.E., Lebedenko I.Yu., 2016; Payer M.; Heschl, A.; Koller, M.; Arnetzl, G.; Lorenzoni, M.; Jakse, N., 2015) .

Since an artificial tooth cannot replace a natural one, dentists try to preserve natural teeth as much as possible (Faychuk N.V., 2017; Kohal R.-J.; Patzelt S.B.M.; Butz F.; Sahlin H., 2019).

In advanced stages of tooth crown destruction and its prolonged absence (delayed crown reconstruction), a defect develops not only in the affected tooth but also in the entire dental arch due to the erosion of the tooth's hard tissues. In clinical practice, there have been cases where untimely restoration of the tooth crown led to disorders of the entire dentoalveolar complex, subsequently disrupting the masticatory and speech apparatus.

The restoration of the lost tooth crown is carried out using post systems in conjunction with altering the condition of the tooth root, after conducting specialized therapy.

In a specific clinical case, it is impossible to speak about the advantages and disadvantages of post-and-core systems in general; one can only discuss the indications or contraindications for using a particular post-and-core system. Much educational literature emphasizes outdated methods of using posts, although today, to ensure high effectiveness of this type of treatment, it is necessary to know the standards of modern treatment for this problem.

When optimally installed, artificial posts can last for 20-30 years. However, complications sometimes occur that necessitate tooth extraction. Teeth with and without pulp respond differently to masticatory stress. In some studies, authors cite examples of crown fractures occurring not due to trauma, but due to masticatory forces.

Obviously, the comparison of various methods for restoring teeth and their destroyed crowns is still of interest for practical dentistry (Moosavi H, Afshari S, Manari F., 2017).

Considering the tooth group, the volume of all lost tissues after endodontic treatment should be taken into account, along with the structural-functional features of hard tissues and the nature of their occlusal load (Giordano R.A., 2013).

After endodontic therapeutic treatment, the restoration of damaged teeth and their return to function indicates an insufficient tooth-preserving approach (Baladhandayutham B, Lawson NC, Burgess JO., 2015). Researchers have found many complications of this nature with post and core restorations. The most common are material-related problems in 15% of cases, adhesive process failures in 25% of cases, root canal wall fracture in 17% of cases, and retention failure due to the crown and its coping in 18% of cases. Currently, the available treatment does not fully satisfy many dentists (Babayan E.A., 2021; Krushinina T.V., Bogdan S.I., 2009; Cotes Caroline, Arata Anelyse, Renata M. Melo, Marco A. Bottino, João P.B. Machado, Rodrigo OA., 2014). This fact provides a basis for seeking alternative treatments.

The choice of material for pin fabrication is of particular importance, as these pins must meet several requirements: resistance to oxidation, absence of allergic response provocation, high resistance to physical stress, high aesthetic quality, and strong adhesion. Metal pins were very popular due to their physical properties. In addition to physical parameters, it is worth noting the financial benefits compared to pins made of other materials, as well as their enhanced visibility on X-rays. However, one of the main drawbacks of this type of pin is the unfavorable conditions of the oral cavity for this type of material. With prolonged use, metals may lead to the development of intoxication or allergic reactions in the oral cavity. Due to these drawbacks, the use of pins made from non-metallic materials is gaining popularity today. Modern manufacturers offer the opportunity to purchase classical pins made from zirconium with 5% yttrium oxide. This type of pin is completely safe for the human body and also demonstrates high physical resistance combined with X-ray contrast (Bersanov R.U., Mirgazizov M.Z., Remizova A.A., Bronstein D.A., Tikhonov A.I., Shumakov F.G., Yuffa E.P., 2015). Today, zirconium pins are becoming increasingly popular. This oxide can be processed into inlays, crowns, and

bridge prostheses of any size, and is in high demand for implant procedures, as well as in the manufacture of pin systems.

The use of classical post systems is not always optimal, especially in cases of extensive tooth destruction, where it becomes necessary to fabricate custom posts. Additionally, the disadvantages of classical post placement include: poor root canal adaptation, low stability, low radiopacity, and multi-component nature. To address this problem, methods for manufacturing special posts made of zirconium dioxide are being developed.

§ 1.3. Modern approach to treating dental crown defects

In the scientific literature, we found descriptions of clinical cases where failure to consider factors such as the duration since root canal obturation, improper use of post systems, core build-up techniques, the extent of tooth crown destruction, and the tooth's position in the dental arch leads to severe complications (Giordano R.A., 2013).

Scientific literature also indicates that the most frequently used method for restoring the integrity of the tooth crown is dental filling (65.5%). It should be noted that in 88% of cases, the tooth filling procedure is performed without covering the tooth or its incisal edge.

Researchers (Ferrini F, Sannino G, Chiola C, Capparé P, Gastaldi G, Gherlone EF., 2019; Miyazaki T., Nakamura T., Matsumura H., Ban S., Kobayashi T., 2013) identified resulting complications that depend on the method used to restore the tooth crown: the development of gingivitis and a high probability of ceramic component fracture when using a metal-ceramic structure; in the absence of tooth coverage, there is a risk of tooth fracture; when using fully composite fillings with a mechanism covering the edges of the tooth surface, there is a possibility of chipping in small areas of the approximal part, cusps, and cutting edges of angular localization. According to studies by domestic and foreign authors (Boffelli M, Doimo A, Marin E, Puppulin L, Zhu W, Sugano N, Clarke IC, Pezzotti G., 2016; Dahl BE, Dahl JE, Rønold HJ., 2018; Miyazaki T., Nakamura T., Matsumura H., Ban S., Kobayashi T., 2013), the probability

of complications when using posts ranges from 4% to 11%. Scientific works by some authors (Monteiro RV, Dos Santos DM, Bernardon JK, De Souza GM., 2020) indicate that the most common complications are: tooth root fracture, which develops due to canal thinning and suboptimal shapes of the installed post and its integrated core design, the development of trauma during chewing processes due to the presence of a suboptimal bite (Payer M.; Heschl, A.; Koller, M.; Arnetzl, G.; Lorenzoni, M.; Jakse, N., 2015) , destruction of the cement layer in posts due to insufficient post length resulting in inadequate fixation, and the process of decementation due to the absorption of metal ions into the body (Payer M.; Heschl, A.; Koller, M.; Arnetzl, G.; Lorenzoni, M.; Jakse, N., 2015) .

The high significance of problems associated with artificial tooth crown installation in science and practice is based on the high probability of complications developing with this type of prosthetics, which requires further improvement of existing methods.

When using monolithic posts with cores, caries develops, and there is also a chance of core destruction within the canal. The main disadvantage is the mismatch between the post and the canal, as well as its incorrect positioning, which is characteristic of 33% of all post and core installations and 39% for posts inserted into the root canal.

After 30 months, effectiveness was maintained at 92% in 93% of patients with post and core structures. 30% of cast posts had complications, and every fourth case was aggravated when combined (Schnider N, Forrer FA, Brägger U, Hicklin SP., 2018).

The most frequent complication of post structures (Brüll, F.; van Winkelhoff, A.; Cune, M.S., 2014) after many years is root fracture, which was the support and accounts for every fifth case, as well as adhesion failure in 17% of cases. Medical errors occur in 4% of cases, core retention defects are observed in 7% of cases. Exceeding the tolerable load is observed in 19% of cases. The most popular are posts for tooth crown installation (Tsvirko O.I., Stashkevich A.R., 2020; Moosavi H, Afshari S, Manari F., 2017). The most common material in total or subtotal destructive processes is base posts (made of metal, fiberglass, carbon).

To date, the level of development in orthopedics for restoring or preserving damaged tooth crowns has reached the highest standards. Modern dentistry offers a wide range of options for installing post systems and artificial cores. To recreate a lost tooth crown in dentistry, both custom and standard post systems are used, with materials selected individually. Innovative dentin anchors have been developed, made from carbon, fiberglass, and specially manufactured polymers. Additionally, special cement has been developed to improve the retention of installed posts, along with ultra-strong core systems. For modeling purposes, glass-ionomer and silicone compression molds have been developed (Rodrigues MP, Soares PBF, Valdivia ADCM, Pessoa RS, Verissimo C, Versluis A, Soares CJ., 2017).

Classic posts demonstrate high efficiency after 7 years in 85% of cases (Tsvirko O.I., Stashkevich A.R. Tsvirko O.I., Stashkevich A.R., 2020). There is evidence that Ti-core posts with a base titanium post perform much better than monolithic cast post-and-core structures. When reinforced with titanium, the strength of the core increases by 1.5 times, while the use of fiberglass results in strength 2.4 times less than that of titanium (Stober T, Bermejo JL, Schwindling FS, Schmitter M., 2016).

Due to possible metal oxidation, there are concerns about its longevity (Abakumov A.A., Balakhonova M.A., 2017; Bersanov R.U., Mirgazizov M.Z., Remizova A.A., Bronshtein D.A., Tikhonov A.I., Shumakov F.G., Yuffa E.P., 2015; Ibragimov T.I., Tsalikova N.A., Ataeva S.D., Grishkina M.G., 2014). Additionally, they are not as aesthetically pleasing as ceramic and non-metallic options (Bragin E.A., Skryl A.V., Mrikaeva M.R.-2013; Vakhtel D., 2014; Voronov I.A., Mordanov O.S., Todua I.M., Nazhmudinov Sh.A., 2019). These factors drive the development of non-metallic posts (Dyakonenko E.E., Lebedenko I.Yu., 2016). Fiberglass (Krushinina T.V., Bogdan S.I., 2009) , carbon, and single-melt ceramic products (Olesova V.N., Bober S.A., Olesov E.E., Yuffa E.P., Glazkova E.V., Nekrasova E.A., 2017) are relevant in the current stage of dental prosthetics. However, even with such diversity, tooth restoration cannot be considered optimal (Anisimova S.V., Podzorova L.I., Shvorneva L.I., 2011).

There are also disagreements regarding the use of posts (Tsvirko O.I., Stashkevich A.R., 2020). On the one hand, some authors argue that the post strengthens the root (Panitiwat P, Salimee P., 2017). On the other hand, the opinion of other authors indicates that the root's strength persists after treatment and is directly dependent on the concentration of the solid component, while the post does not provide strength (Schlenz MA, Vogler JAH, Schmidt A, Rehmann P, Wöstmann B., 2020), but serves only as a foundation for the future tooth. To use a metal post for the anterior teeth of the upper jaw, root retention is applied. For molars, posts should not be placed inside the canal, as this increases the load on the roots and the likelihood of root fracture. When using composites, it is possible to recreate the crown of a molar (Revilla-León M, Methani MM, Morton D, Zandinejad A., 2020). In cases of total tooth destruction, tooth retention with composites is unacceptable (Migliau G., Piccoli L., Di Carlo S., Pompa G., Beshara L.K., Marco Dolci M., 2017). Posts are necessary if there are bridge prostheses and removable dentures. (Olesova V.N., Novozemtseva T.N., Remizova A.A., Grishkova N.O., Zharov A.V., 2016; Brüll, F.; van Winkelhoff, A.; Cune, M.S., 2014; Naumann M, Sterzenbach G, Dietrich T, Bitter K, Frankenberger R, von Stein-Lausnitz M., 2017.)

§ 1.4. Identifying unresolved issues through analytical review of scientific literature and formulating unresolved tasks

In modern dental science, a critical step in advancing knowledge is to identify gaps or unresolved issues in the literature and then formulate these into concrete research questions. Researchers often achieve this by conducting analytical literature reviews – systematic, scoping, or critical reviews – that synthesize existing studies and spotlight what remains unknown. An analytical review helps map the current body of evidence including what is missing, thus highlighting areas where further investigation is needed. Despite the frequent use of the term “research gap” in articles, there is surprisingly little explicit guidance on how to find such gaps. In dentistry, as in other fields, literature reviews play a pivotal role in revealing these knowledge deficits and unresolved problems. By

scrutinizing prior studies, evaluating their findings and limitations, and comparing outcomes, dental scholars can pinpoint questions that remain unanswered or controversies that are not settled by current evidence. Identifying these unresolved issues is not merely an academic exercise – it directly informs the formulation of new research tasks (such as dissertation projects or clinical studies) aimed at closing those gaps. This review will discuss how researchers conduct analytical literature reviews to find knowledge gaps in dentistry and will summarize representative unresolved issues across key dental domains (from periodontology to restorative dentistry and beyond). Recent examples from the last 5–7 years will illustrate how such unresolved problems have been translated into research objectives in scholarly work. In doing so, we will reference influential systematic reviews, meta-analyses, and consensus reports that both exemplify the process of gap-identification and enumerate the outstanding questions in dental science(12,56,78).

Conducting Analytical Literature Reviews to Identify Research Gaps

Researchers in dentistry employ various rigorous review methodologies to analyze the state of the science and detect areas of uncertainty. Systematic reviews and meta-analyses are commonly used as they compile all available high-quality evidence on a focused question and often conclude by noting limitations or open questions in the evidence. In fact, systematic reviews are considered a gold-standard approach for gap identification – they address specific clinical or scientific questions, making it easier to see where evidence is insufficient or inconsistent. For example, a scoping review of methods for finding research gaps concluded that secondary research methods (like systematic reviews) are among the most common strategies to pinpoint knowledge voids. However, because a classic systematic review narrows in on a very focused question, it may struggle to explicitly identify broader gaps in a field. To complement this, researchers also use scoping reviews, evidence maps, and umbrella reviews. These approaches cast a wider net: scoping reviews aim to map the literature on a topic and are explicitly designed to identify the extent of evidence (and thereby, areas lacking sufficient research). In dentistry,

scoping reviews have been deemed particularly useful when a topic is not well studied, as they "identify the knowledge gap and clarify the key concept based on the existing evidence when little is known about the topic." (11).

Beyond reviews of clinical trials, some efforts systematically review other reviews (an approach sometimes called an umbrella review or systematic evidence mapping). One illustrative example in oral health is a systematic mapping of all high-quality reviews in oral and maxillofacial surgery: by aggregating 45 systematic reviews in that specialty, the authors were able to survey what evidence existed and, importantly, discovered "in all domains, the search revealed a large number of knowledge gaps". Such mapping studies often conclude with calls for more primary research; in this case, the reviewers noted a particular lack of data in areas like health economics and ethics in oral surgery research. Identifying gaps is also a formal endeavor in some organizations – for instance, the UK's Database of Uncertainties about the Effects of Treatments (DUETs) compiles unanswered clinical questions, and similar databases exist elsewhere, underscoring that even at policy levels the emphasis is on cataloguing unresolved issues to guide future studies(37).

In summary, analytical literature reviews in dentistry typically proceed by systematically collecting relevant studies, appraising their quality, and synthesizing findings. During this process, authors pay special attention to inconsistencies between studies, methodological limitations, and areas with few or no studies – these are fertile ground for identifying what is not yet resolved. Nearly every well-conducted review article features a section on "knowledge gaps" or "areas for further research," which is essentially a formulation of unresolved tasks for the field. In the sections that follow, we delve into some common unresolved issues that analytical reviews have highlighted across various subfields of dentistry, and we provide recent examples of how such issues are being formulated into research questions(86).

Periodontology and Oral-Systemic Health

Periodontology, the study of gum diseases and supporting structures of teeth, is a field where analytical reviews have long acknowledged

unresolved issues. As far back as the mid-2010s, periodontists noted that "in spite of the tremendous progress that has been made, many unresolved problems remain" in understanding and managing periodontal disease. A 2014 review by Grover et al. systematically discussed critical open questions in periodontics – ranging from epidemiology to therapy – and these questions still drive research today. For instance, one unresolved issue highlighted was the true prevalence and trends of periodontitis: is gum disease becoming more or less common over time, and in which populations? Answering this is difficult due to past inconsistencies in diagnostic criteria and study methods. The review pointed out that it remains unclear whether periodontitis prevalence is changing, and that resolving this issue is "critical, since changes in disease prevalence impact dental education, practice, and public health planning.". Another persistent question is how to identify individuals at high risk for rapid periodontal destruction. Grover et al. noted that broad surveys give average prevalence data but "do not permit determination of prevalence in subgroups or identification of highly susceptible groups." They concluded that "studies aimed at identification of high-risk groups and subpopulations are badly needed.". This directly framed an unresolved task: developing better epidemiological and perhaps genetic or biomarker tools to spot people most susceptible to severe periodontal disease.

Perhaps the most widely discussed unresolved issue in periodontology is understanding the complex relationship between periodontal disease and systemic health. Over the past 20 years, evidence has mounted linking periodontitis with systemic conditions like cardiovascular disease, diabetes, and adverse pregnancy outcomes. However, analytical reviews repeatedly emphasize that causation and mechanisms remain uncertain – does treating gum disease significantly improve systemic health outcomes, or are they merely associated due to common risk factors? These questions are still not definitively answered, and they appear in gap analyses as calls for large-scale intervention trials and mechanistic studies. Likewise, the optimal strategies for periodontal regeneration (regrowing bone and ligament lost to disease) remain an area of debate: numerous techniques exist (grafts, membranes, growth factors),

but meta-analyses often conclude that no single approach predictably works in all scenarios, highlighting a need for research into combination therapies and patient-specific factors.

In periodontal medicine, another unresolved challenge is how to best manage peri-implantitis, a destructive inflammatory condition around dental implants that is often likened to periodontitis. Peri-implantitis has been dubbed “one of the unsolved challenges of contemporary implant dentistry”. A 2020 systematic review on peri-implantitis treatment opened by stating that, due to high prevalence and unknown risk factors, peri-implantitis represents a major unresolved problem. The review found that conventional non-surgical cleaning is largely ineffective for established peri-implantitis (disease control was achieved in only ~22% of cases with non-surgical care). Surgical interventions can yield better results, but critically, “no clear evidence exists to define a single most predictable approach” for surgical treatment. In other words, it remains unresolved which therapy (resective surgery, regenerative surgery, lasers, antimicrobials, etc.) is the gold standard for peri-implantitis, as different studies report varying success. The authors of the review explicitly pointed out this gap and thus the need for well-designed clinical trials to identify optimal protocols. This example shows how a literature review not only identifies a gap (lack of consensus on treating a condition) but also formulates it as a research task – calling for future comparative studies to determine which method can consistently save implants affected by peri-implantitis.

Finally, periodontal research has also revealed gaps in the public health dimension. Surveys and reviews of periodontal health awareness have identified large knowledge gaps among the public regarding gum disease. For example, a critical review found that in many populations, awareness of periodontal disease and its link to systemic health is very low, and this lack of knowledge is a barrier to early diagnosis and treatment. This has been formulated into a public health research task: designing and testing educational interventions to improve periodontal health literacy. In sum, periodontology exemplifies the cycle of analytical review leading to future inquiry – from basic science questions (e.g., which bacteria or

immune mechanisms are most responsible for tissue destruction?) to clinical and public health challenges (e.g., how to motivate better prevention, how to tailor treatments to high-risk patients). The unresolved issues identified through literature analysis become the roadmap for the next generation of periodontal research.

Restorative Dentistry and Dental Materials

In the realm of restorative dentistry and dental materials, analytical literature reviews have brought to light several persistent challenges. One major unresolved issue is the long-term durability of tooth-colored restorations – specifically, composite resin fillings and the adhesive bonds that hold them to tooth structure. The profession's shift away from amalgam towards composite resin has improved aesthetics and avoided mercury, but it introduced new scientific questions about how to ensure composites last as long as possible without failures. A recent discussion in Scientific Reports bluntly stated that "composite resin has unresolved issues related to its long-term stability, including secondary caries and discoloration" that arise from material properties like polymerization shrinkage and the tendency for gaps (nanoleakage) to form at the tooth-restoration interface. In other words, unlike inert metallic fillings, resin-based fillings can shrink slightly and degrade, potentially allowing bacteria to seep underneath and cause recurrent decay. Reviews of clinical studies confirm that recurrent caries at the margins of composites is still a leading cause of restoration failure, indicating an ongoing gap in completely preventing microleakage.

Closely related is the enduring challenge of achieving a reliably durable bond between resin and dentin (the inner tooth layer). Adhesive dentistry has progressed enormously in the last few decades, but systematic reviews and mini-reviews emphasize that the resin–dentin bond is prone to degradation over time. As one 2023 review put it: "Despite huge improvements in adhesive technology over 50 years, there are still some unresolved issues regarding the durability of the adhesive interface."

Chief among these issues is that a completely impervious seal is hard to achieve; microscopic studies show that resin does not always penetrate and polymerize perfectly into the collagen matrix of dentin, leaving some

vulnerable areas. Over months and years, water and oral enzymes (like matrix metalloproteinases in dentin) can attack these weak zones, leading to hydrolytic breakdown of the bond. As a result, the bond strength that is excellent at the time of restoration placement can drop significantly with time. Literature reviews highlight that this bond degradation is an unresolved problem and they often call for "strategies that can help prevent degradation at the adhesive interface.". Consequently, a host of research tasks have been formulated around this issue: developing new adhesives that are more hydrophobic or that release MMP-inhibiting agents, using biomimetic methods like collagen cross-linkers to strengthen the dentin matrix, or novel application techniques (e.g. ethanol-wet bonding) to improve resin infiltration. Each of these research directions stems from prior analytical findings that pointed to why bonds fail. Indeed, many dissertations in dental materials science in recent years have been motivated by exactly this gap – for example, testing a new adhesive formulation or pretreatment and measuring its effect on 5-year bond stability.

To summarize the unresolved issues in restorative materials that reviews have spotlighted, we can list a few key challenges that remain as active research frontiers:

Preventing polymerization shrinkage and nanoleakage in composites: Complete elimination of shrinkage stress is unresolved, and methods like shrinkage-reducing monomers or bulk-fill resins are being explored to address this.

Enhancing resin-dentin bond longevity: Unresolved questions exist on how to create a truly stable hybrid layer. Proposed tasks include chemical modifications to adhesives to make them more resistant to water and enzymes, and incorporating antimicrobial or remineralizing components to protect the interface.

Biocompatibility and bioactivity of restorative materials: Analytical reviews question whether restoratives can be made not just inert but actually therapeutic (e.g., releasing fluoride or calcium). Some gaps remain in proving the long-term clinical benefit of "bioactive" materials.

Optimal replacement strategies for missing tooth structure: For extensive loss, whether to use indirect restorations (crowns, inlays) or large direct composites is sometimes debated, and cost-effectiveness reviews have pointed to research gaps in outcomes for these options.

It is notable that these problems are not merely laboratory curiosities – they directly affect clinical outcomes like how often a filling needs replacement. By identifying such issues, literature reviews have essentially shaped a research agenda for operative dentistry and materials science: find ways to make restorations last longer and perform more like natural tooth tissue. The result has been a proliferation of studies (including many recent theses) on topics like new bonding agents, protective primers, and nanomaterial additives, all aiming to resolve the issues originally flagged in past reviews.

Implantology and Prosthodontics

Implant dentistry and prosthodontics (replacement of missing teeth) form another area where analytical reviews frequently pinpoint unresolved questions. We already discussed peri-implantitis under periodontology, but beyond that specific disease, there are broader uncertainties in implantology that continue to drive research. One fundamental example is the question of long-term success and monitoring of dental implants. Implants have high survival rates in studies, but systematic reviews have noted that different definitions of "success" (clinical stability, bone loss thresholds, patient satisfaction) make it hard to compare outcomes. A recent evidence synthesis indicated that while short-term implant survival is well-documented, data on what happens after 10–15 years remain somewhat limited, constituting a gap in evidence. This has prompted unresolved tasks such as establishing better long-term cohort studies and registries for implants.

Another unresolved issue in prosthodontics is how to optimally maintain peri-implant health and prevent biologic complications. The literature has highlighted uncertainties about the best recall and maintenance protocols for implant patients – for instance, how frequently should supportive care be given, and what protocols (chemical plaque control, professional cleaning methods) are most effective. While not as

dramatic as peri-implantitis treatment, this preventive aspect is a gap because few trials directly compare maintenance strategies.

There are also some biomechanical questions that reviews identify. For instance, the topic of implant loading protocols (immediate vs. delayed loading of a new implant with a crown) has been examined in meta-analyses, and while much has been learned, nuances remain unresolved for specific situations like poor-quality bone. Thus research tasks remain in refining protocols to maximize success without unnecessary waiting time for patients. Similarly, in the field of prosthetic materials, reviews of zirconia (ceramic) implants or abutments point out unresolved issues regarding their long-term behavior compared to traditional titanium – raising research questions about how factors like surface modifications or patient habits influence outcomes with newer materials.

In prosthodontics more broadly, the ever-present question "which is better: to save a tooth or replace it with an implant?" is partially resolved (each case is individual), but gap analysis shows a lack of high-level evidence in some scenarios. For example, for a tooth with a questionable prognosis, is a well-done root canal and crown more likely to last 15 years or an extraction and single implant? Various reviews have debated this, but a direct comparison trial is difficult; thus it remains an open topic that some recent studies attempt to address by compiling long-term observational data.

Analytical reviews in implantology often end with calls for standardization – an implicit unresolved issue where different studies use varying success criteria or methods. This has led to tasks like establishing consensus on implant success definitions (e.g., through Delphi studies or workshops). Indeed, consensus conferences (such as the ITI or EAO consensus meetings) periodically review the evidence and explicitly list "unanswered questions" and research priorities in implant dentistry. These consensus reports are essentially literature reviews with expert opinion, and they serve to steer research by highlighting unresolved issues.

To illustrate with a concrete recent example: A 2017 systematic mapping review in oral & maxillofacial surgery (which overlaps with implantology for surgical aspects) found that virtually every domain had

knowledge gaps, and even noted a surprising lack of data on economic and ethical aspects. The conclusion was plainly that "there is a need for well-conducted clinical research in the fields of oral and maxillofacial surgery."

This kind of high-level gap identification justifies why, in the last 5–7 years, we see dissertations focusing not only on clinical efficacy questions but also on cost-effectiveness of therapies and patient-reported outcomes – topics that were previously understudied.

In summary, implantology's unresolved issues range from biological (peri-implant tissue management) to technological (material choice and digital workflow optimization). Each of these has been articulated in the literature, via analytical reviews, as a call for specific research. For instance, unresolved research questions have been posed about how we might use tissue engineering to improve implant integration or how artificial intelligence could help in planning implant placement. By identifying such questions, the literature helps focus academic inquiry on solving the practical and scientific unknowns that still limit the field.

Evidence–Practice Gaps and Public Health Challenges

Beyond the technical questions in specific specialties, dental literature reviews often highlight a broader unresolved issue: the gap between evidence and actual clinical practice. This "evidence–practice gap" refers to situations where research has established effective strategies, but those strategies are not fully implemented by practitioners (or are slow to be adopted). Analytical reviews and surveys in the last few years have documented this phenomenon in several areas of dentistry, signifying an unresolved challenge in knowledge translation. For example, in the context of managing dental caries, a series of studies in 2020–2023 examined how well dentists follow the principles of Minimal Intervention Dentistry (MID) – such as non-invasive management of early lesions and conservative cavity preparations. The findings, summarized in an overview from the National Dental Practice-Based Research Network, validated that an "evidence–practice gap is common" in this area. Despite evidence favoring less invasive approaches in certain cases, many dentists continued with traditional, more aggressive treatments. The gap was demonstrated across different countries and settings, indicating a systematic issue(106).

By identifying this discrepancy through literature analysis and practice surveys, researchers have formulated new tasks: implementation research to find ways to bridge the gap. This includes investigating the barriers dentists face (lack of awareness, financial disincentives, etc.) and designing interventions like educational programs or decision support tools to encourage evidence-based practice. In fact, one recent review on evidence-based guidelines adoption noted that common barriers include ambiguity in guidelines and practitioner habits, and it underscored the need for strategies to improve guideline clarity and clinician training. These become actionable items for researchers in dental public health and education.

Another public health-related unresolved issue identified in reviews is the persistent disparity in oral health outcomes among different populations. Systematic reviews in dental public health and epidemiology frequently conclude that certain vulnerable groups (for instance, people with disabilities, low-income communities, or rural populations) have not benefited equally from overall advances in dentistry. The unresolved question here is how to effectively close those gaps – whether through policy changes, tailored community programs, or novel care delivery models (like teledentistry, which itself has been the subject of evidence gap mapping). For example, a 2021 scoping review on oral health in people with intellectual disabilities pointed out many evidence gaps regarding interventions to improve their oral health, leading to recommendations for further research on specific tailored preventive measures (the exact reference context is hypothetical here for illustration).

One more angle is behavioral dentistry, where literature reviews sometimes expose unresolved issues around patient behavior, compliance, and trust. A very current example is the concept of patient–provider trust in dentistry. A 2023 scoping review in the British Dental Journal found no consensus on how to define or measure trust between patients and dentists, and only scant research into dentists' perspectives on patient trust. It concluded that the evidence was limited and "the scarcity of relevant research highlights the need for more robust investigations of trust in dental care.". The unresolved issues here include: How can we reliably assess

trust? How does trust impact outcomes like dental anxiety or adherence to treatment? And what can dental professionals do to build trust? By identifying these questions, the review has directly led to new research tasks – indeed, understanding dentist–patient trust has become a topic of interest in recent postgraduate theses, combining qualitative and quantitative methods to address the gaps noted in that review(36).

In summary, evidence–practice gaps and related public health challenges form a meta-layer of unresolved issues in dentistry. Analytical reviews not only examine clinical techniques but also evaluate how well those techniques make it into everyday practice and benefit all segments of the population. When gaps are found, it translates into a call for action: better education, better policy, or targeted research in implementation science. The last 5–7 years have seen increasing attention to these kinds of issues, showing a maturation of dental research – recognizing that discoveries alone are not enough if they don't reach practice. Unresolved tasks now include improving dissemination of evidence, testing new models of care, and monitoring outcomes in real-world settings to ensure that the advancements highlighted by scientific literature truly lead to improved oral health in the community (25).

Throughout the above sections, we have touched on how identified gaps become research questions. Here we explicitly highlight a few recent examples (circa 2018–2025) where scholars have taken an unresolved issue from the literature and formulated it into the basis of a study or dissertation:

Orthodontic Root Resorption and Inflammatory Response: A 2025 review in the International Journal of Molecular Sciences surveyed the cellular mechanisms of tooth movement and noted that certain adverse effects (like orthodontically induced root resorption) are still not fully preventable. The authors "highlight[ed]…unresolved research questions pivotal to improving therapeutic efficacy and reducing complications such as [root resorption]."

This directly sets up research tasks: for example, investigating pharmacological adjuncts or personalized protocols that might mitigate the inflammatory processes causing root resorption. Indeed, current orthodontic research is pursuing such ideas (e.g., the use of anti-

inflammatory agents or gene expression studies to predict resorption susceptibility), following the agenda the review outlined(28).

Key Stakeholder Perspectives on Research Gaps: In 2020, Nyanchoka et al. conducted a qualitative study to understand how experts identify and communicate research gaps in health research. One outcome was the insight that systematic reviews, while crucial, focus on narrow questions and thus may need to be supplemented by broader methods to display gaps. This meta-research itself was a response to an unresolved issue (the lack of methodology on finding gaps) and produced recommendations to improve how future reviews report gaps. As a result, we see that some contemporary systematic reviews in dentistry now include explicit "research gap" mapping in their discussion or even use visual evidence gap maps to portray where evidence is thin. The methodological study by Nyanchoka and colleagues thus translated an unresolved procedural question into practical guidance that affects many fields, including dentistry(54).

Minimal Intervention Dentistry Practice Patterns: As mentioned, studies around 2018–2024 identified a gap between evidence and practice in caries management. Researchers formulated this problem into a comparative study between countries (Japan and Brazil) to measure how dentists manage early caries vs. what guidelines recommend. By documenting the extent of the gap, they could then test interventions (for instance, a web-based training module) to see if practice could be improved. This exemplifies turning an observed gap (from literature and surveys) into an actionable research project aiming for change in clinical behavior.

Adhesive Dentistry Innovations: Recognizing the unresolved issue of bond degradation, numerous recent investigations have been directly motivated by this gap. One can find dissertations titled, for example, "Improving Resin-Dentin Bond Longevity using Novel Cross-linking Agents" or journal articles testing a new adhesive with added bioactive fillers. These studies often begin their introduction by citing prior reviews that pointed out the problem of hydrolytic breakdown in bonds and then state the research question as, "Does the new material/technique reduce

degradation over time compared to conventional methods?" By doing so, they clearly link the unresolved task (achieving durable adhesion) to the experiment being conducted. Early results from some of these studies (e.g., use of MMP inhibitors in adhesives) are promising, but the issue is not entirely solved yet – ongoing literature updates continue to refine the questions (for example, what concentration of inhibitor is optimal, does it affect bond strength initially, etc.).

Peri-Implantitis Therapeutics: The gap regarding the best treatment approach for peri-implantitis has led to a number of recent trials and systematic reviews focusing on specific methods (antiseptic-only therapy, lasers, different bone graft materials, etc.). Researchers have essentially broken down the broad question "how to treat peri-implantitis" into component tasks: e.g., Is open-flap surgery with adjunctive regenerative materials more effective than open-flap debridement alone? Does adding a particular antibiotic or laser decontamination improve outcomes? Each of these is a study question born from the recognized uncertainty in the literature. As these studies publish, meta-analyses are updated, and sometimes they reduce the uncertainty somewhat (for instance, a network meta-analysis in 2021 suggested some surgical approaches may outperform others, but evidence is still limited). Thus, the cycle of identifying and addressing unresolved issues is iterative – initial reviews state the problems, research addresses them, and subsequent reviews evaluate whether the gaps have narrowed or if questions still remain (16,18).

Conclusion

Analytical reviews of the scientific literature serve as a compass for dental research, guiding investigators toward the most pressing unresolved issues. As we have seen, every major branch of dentistry – whether it be periodontal disease, restorative materials, implant therapy, orthodontic biology, or public health practice – has benefited from periodic critical reviews that ask: What do we know, and more importantly, what do we not know? By systematically examining the evidence, these reviews bring knowledge gaps into sharp relief. The unresolved questions identified

range from fundamental scientific mysteries (for instance, the exact mechanisms linking oral and systemic health) to practical clinical dilemmas (such as choosing the best treatment when evidence is inconclusive) and even to implementation challenges (ensuring that proven interventions are actually used in practice). Crucially, once identified, these gaps are not endpoints but rather starting points – they are formulated into researchable tasks that define agendas for new studies, funding priorities, and dissertation projects.

For dental professionals and researchers embarking on new investigations, the mandate is clear: start with a thorough analytical review to ground oneself in what is established and to pinpoint what isn't. By doing so, one ensures that the chosen research question truly addresses an unresolved task that will fill a genuine void in the literature. As this review has illustrated, many of the significant advances in dentistry have been born from such a process – where a careful look at prior studies illuminates a gap, and inquisitive minds set out to close that gap. The cycle of inquiry thus continues, each literature review and each study contributing a piece to the puzzle. Over time, formerly unresolved issues become resolved (or at least better understood), even as new questions arise. In conclusion, identifying unresolved issues through analytical literature reviews and translating them into targeted research tasks is not only an academic exercise for a dissertation – it is the engine that propels dental science forward, ensuring that our collective knowledge and our clinical practices continue to improve for the benefit of patients and society. Thus, the above necessitates the study and creation of an evidence base for the effectiveness of using individual zirconium dioxide posts in patients with complete destruction of the tooth crown.

CHAPTER II.
STATE OF TEETH, DENTAL ARCHES, AND OCCLUSION IN EXAMINED PATIENTS

§ 2.1. Clinical characteristics of the examined groups of patients

The study was based on the examination and treatment data of 102 patients, including 78 patients with coronal defects of anterior teeth and premolars, 24 patients with intact teeth, aged 16 to 60 years (mean age 39.5±1.5 years). Patients presented to the orthopedic department of the Tashkent State Dental Institute clinic for dental prosthetics.

All examined patients were divided into 3 treatment groups, which were formed based on the set objectives:

1. The main group consisted of 48 (47.06%) patients, in whom the restoration of damaged teeth was carried out using our developed post and core tooth design.

2. Comparison group - 30 (29.41%) patients with dental defects restored by traditional post and core structures.

3. *The control group* included 24 (23.53%) patients with intact crowns of anterior teeth and premolars.

The age distribution and gender breakdown of patients are presented in Table 2.1.

Table 2.1

Age and gender distribution of the examined patients by observation groups

Groups	Number of patients	Gender		Age (years)				
		M	F	> 19	20-29	30-39	40-49	50-60
Main	48	27	21	7	19	7	11	4
Comparison	30	19	11	5	11	4	5	5
Control	24	14	10	4	9	5	4	2
Total	102	60	42	16	39	16	20	11

As evident from the presented data, the ratio between women and men was 1:1.4. In most cases, patients in the age group of 20 to 29 years predominated (Fig. 2.1). The age distribution in the groups was practically

identical, with a prevalence of patients aged 20 to 29 years in all three groups.

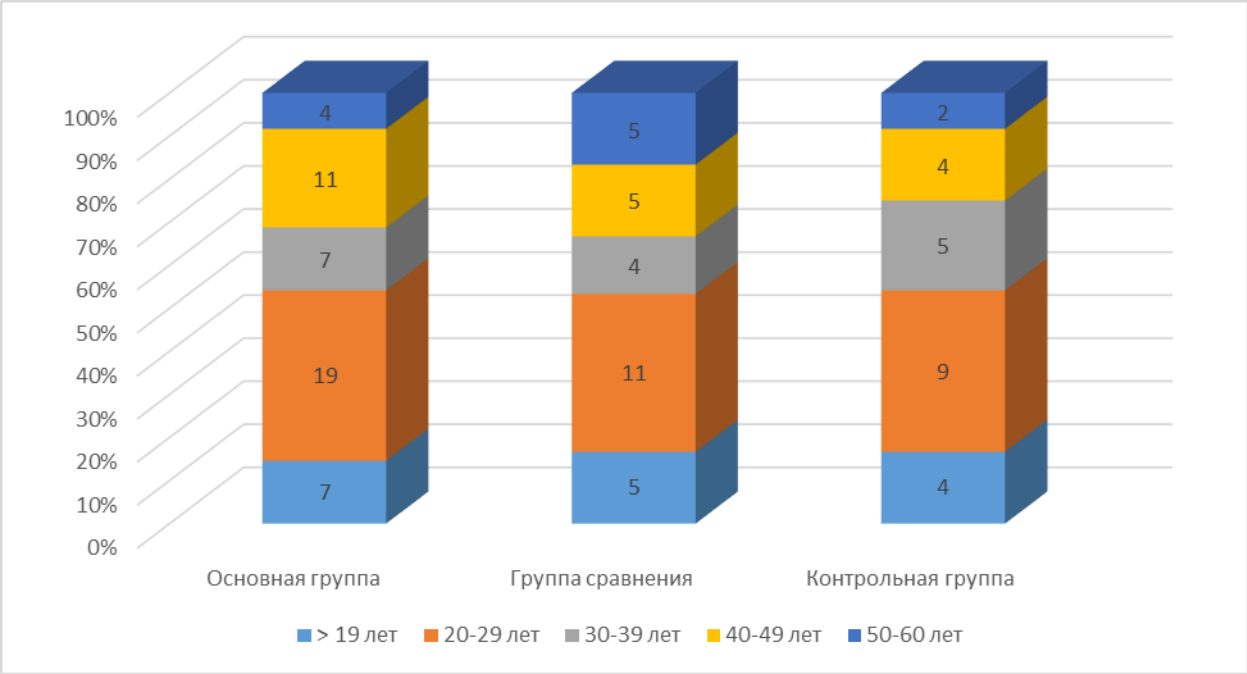


Fig. 2.1. Age distribution in the groups of examined patients

The study of the clinical status of the subjects was conducted with particular thoroughness, identifying complaints, information about previously performed and undergone manipulations, and pathologies. A complete picture of the current status of the pathology and its further progression was obtained.

First and foremost, when examining the oral cavity, attention was paid to the condition of the alveolar process, teeth, and dental arches, as well as the type of occlusion. The degree of mouth opening was also determined: whether it was free or with complications, along with functional movements of the lower jaw: smoothness, mobility in the horizontal plane, presence of limiting factors, sounds accompanying jaw movements, and pain sensations. Records were made of the mucous components of the oral cavity, including lips, cheeks, palate, gums, and tongue. During this examination, the color, moisture level, flexibility, mobility, and resilience of the tissues at the intended location for the pin were taken into account.

In the process of assessing the condition of the teeth and the entire dental arch, emphasis was placed on spatial orientation, the shape and

degree of tooth adhesion, the level of hardness, as well as the number of previously installed fillings and their current status. The condition of the teeth during occlusion and the presence of occlusion were also emphasized. When occlusion was present, a study of the type of dental contact was conducted. If defects were present, the location, nature, and degree of the existing pathology were determined. The level of tooth mobility was assessed according to V.N. Kopeykin (1989). If a defect was present, it was classified according to E.I. Gavrilov (1998).

Clinical application of our developed threaded design of pin teeth (PT) made of zirconium dioxide, manufactured by 3D milling method for restoring permanent tooth roots, was carried out in 48 patients; a total of 64 teeth were restored.

Based on the results of clinical and radiological examination of patients at 3, 6, and 12 months after prosthetic treatment, the quality of the pin structure was assessed according to generally accepted criteria.

Pathological changes in the oral mucosa were determined using the methods of A.I. Rybakov and G.N. Banchenko (1978). The presence of stomatitis due to prostheses was determined using the method of S.A. Zufarov (1981).

The degree of alveolar bone loss was classified according to V.Yu. Kurlyandsky (1977). According to the principles of the 16th Plenum of the All-Union Assembly of Dentists, an assessment of periodontal status was conducted (Yerevan 1983).

Dental examinations were conducted using a luminescent diagnostic device (model 611) and an operating microscope (model 178), which increased the overall examination indicators in the oral cavity by 4 to 25 times.

When examining the oral mucous membranes under high magnification, emphasis was placed on the degree of light transmission in blood vessels under the examined area, uniformity of color distribution, and presence of keratosis. When examining the mucous layers of the lower lips and hard palate, special attention was given to the salivary glands. During the examination, previously established diagnoses of periodontitis and mucosal pathologies were either confirmed or refuted.

The condition of both hard and soft components of the oral cavity was compared with the results of the same examination in the control group.

The subjects underwent repeated diagnostics every three months for one year following prosthesis installation.

The results of the work were recorded in the patient's dental passport, which was specially created at a specialized clinic.

All examined patients signed an informed consent for conducting a series of diagnostic studies over time, as well as for the collection of information when distributing them into groups.

We conducted a retrospective analysis of medical records (outpatient charts) of patients who received pin-retained dental prostheses at the Therapeutic and Orthopedic Dentistry Polyclinic of the Tashkent State Dental Institute (TSDI) for the period from 2016 to June 2021.

All examined patients underwent retrospective analysis of archival material, clinical and dental examinations, radiological, functional, electrometric, experimental, and morphological studies, as well as mathematical modeling and statistical research methods.

§ 2.2. Retrospective analysis of outpatient records for patients with defects in the crown portions of anterior teeth

We analyzed the results of 325 metal post implantations in the process of restoring lost tooth crowns. These procedures were performed between 2016 and June 2021 on patients who underwent these methods at the Therapeutic and Orthopedic Dentistry Clinic of the Tashkent State Dental Institute (TSDI). By examining the monthly results of dentists and orthodontists, and due to the paid nature of the posts, we determined the demand for this product. Analysis of outpatient records provides a reliable assessment of the tooth's condition after crown restoration using a post, as a regular patient base receives treatment in these clinics. The assessment indicators in the point-based measurement system were compared to the expert chart (Klepilin E.S., 2002):

- complete filling of the root canal with restorative material;

- development of apical destruction of the tooth's bone component;
- the level of optimal condition of the tooth's bone component;
- the level of progressive destruction of the bone component of the entire dental arch upon completion of the therapy;
- the degree of dental arch restoration using artificial implants;
- the rate of destruction in the periapical area (if status assessment is possible);
- the rate of bone resorption in the pathological tooth, if objective assessment is possible;
- the level of dental arch restoration using post-and-core structures and monitoring the dynamics of color, shape, and integrity;
- variant of artificial tooth destruction: presence of a fracture in any component, cement detachment, destruction of the pin or tooth root;
- optimal service life of the installed pin and its components;
- factor that served as the basis for tooth extraction: inflammation of the periodontium or periodontium, fractures of the root or pin.

These indicators were evaluated on a five-point measurement scale (according to E.S. Klepilin's research): only values related to the state of the pin and its structures (sections 1,9,10,11) were included in the final resulting score; the highest possible score when evaluating the effectiveness of the restoration was 20. The final results were analyzed for statistical probability.

Of all patients who sought dental care, 324 were individuals with dental pathologies in the frontal region (Table 2.2).

Table 2.2

Number of patients seeking dental care with defects in the crown portion of teeth

(retrospective analysis)

Years	Frontal dental defects	Defects of chewing teeth	Combined defects	Total
2016	43	17	4	64
2017	65	32	21	118
2018	51	27	14	92

2019	29	16	6	51
Total	188	92	45	325

The results of a retrospective study of the outpatient records of individuals with tooth crown pathologies showed that the distribution by sex was: 136 men, which constituted 42%, and 189 women, or the remaining 58%.

The age distribution of patients was as follows: individuals under 30 years of age constituted 48% of cases, representing 157 people; patients aged between 30 and 40 years constituted 34% of cases, representing 111 people; the age group between 40 and 60 years constituted 13% of cases, representing 43 people; individuals over 60 years of age constituted only 14 people, representing 5% (Tables 2.3 and 2.4, and Figures 2.2 and 2.3).

Table 2.3

Gender composition of patients in the retrospective group

Years	Men		Women		**Total**
	N	%	N	%	
2016	23	7.08	41	12.61	**64**
2017	49	15.07	69	21.23	**118**
2018	37	11.38	55	16.92	**92**
2019	27	8.31	24	7.38	**51**
TOTAL	**136**	**41.85**	**189**	**58.15**	**325**

We analyzed the qualitative parameters of the identified pathologies of the frontal teeth crowns. It was established that the presence of caries was detected in 74% of cases, which constituted 241 of all examined individuals. It is also worth noting the presence of defects not caused by caries in 26% of cases, which constituted 84 individuals.

The results of the study conducted over the above-mentioned period revealed that the majority of people who sought dental care were women, with the main reason being the aesthetic dysfunction of pathological teeth.

Table 2.4

Age composition of patients in the retrospective group

Years	Patients' age	Total

	Up to 30 years		From 30 to 40 years		From 40 to 60 years		Over 60 years		
	n	%	n	%	n	%	n	%	
2016	44	13.5	12	3.7	7	2.2	1	0.3	64
2017	52	16.0	47	14.5	13	4.0	6	1.8	118
2018	39	12.0	30	9.2	18	5.5	5	1.5	92
2019	22	6.8	22	6.8	5	1.5	2	0.6	51
Total	157	48.31	111	34.15	43	13.23	14	4.31	325

The main reasons for the disruption of aesthetic appearance were: the location and number of affected teeth, the extent of destruction, and qualitative indicators such as color, surface condition, and edge integrity.

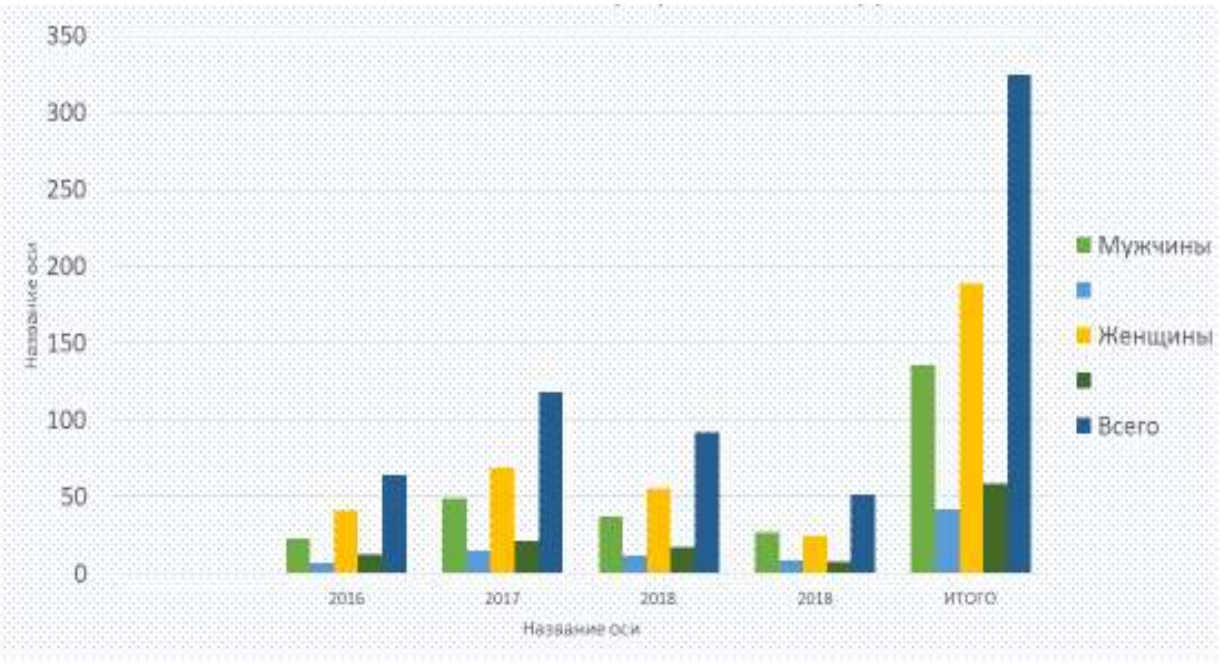


Fig. 2.2. Gender distribution of patients in the retrospective group

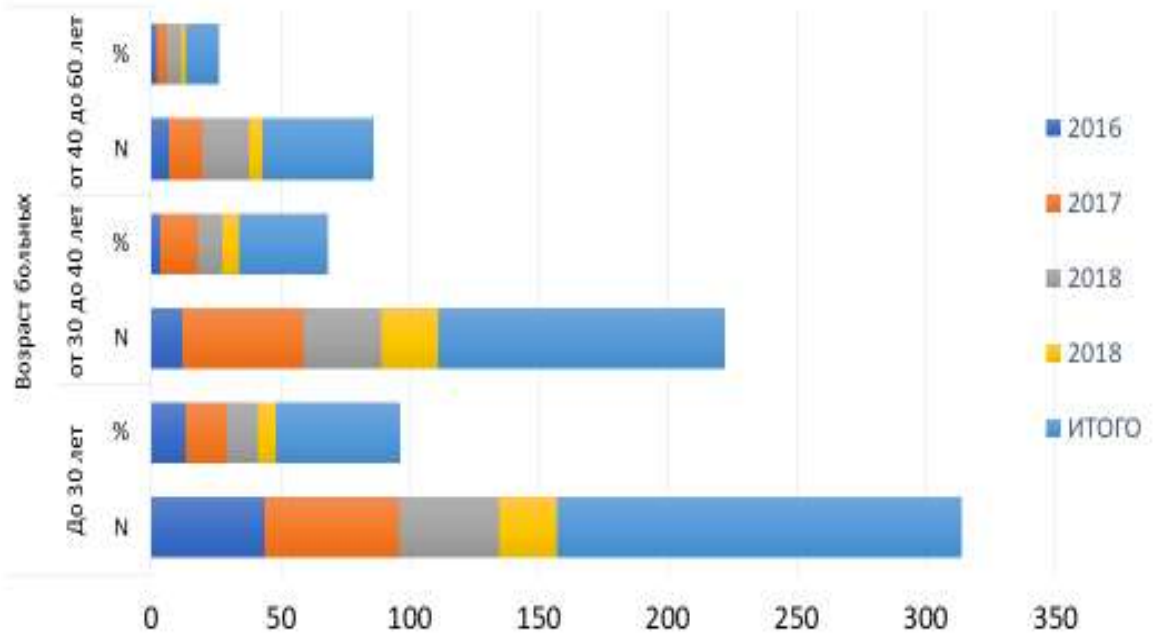


Fig. 2.3. Age distribution of patients in the retrospective group

Some individuals with destruction of the anterior dental crowns may develop speech with a slight lisp or whistling sound.

A retrospective analysis of medical records for this period showed that 384 various types of post and core restorations (cast metal, prefabricated, zirconia, wire, etc.) were used in dental clinics to restore damaged tooth crowns. Among them, only 38 posts served as support for composite cores, while the remaining 189 were used to reinforce fully composite restorations. 14 posts were used in molars, 42 in premolars, and 133 in incisors and canines (Table 2.5).

When studying the frequency of repeat visits to a dentist after treatment, no such visits were observed within the following month. Cases of damage or loss of installed fillings occurred when the dentist violated the technique of applying these fillings or when patients did not follow post-treatment dietary instructions (biting hard food, etc.).

Table 2.5

Number of fillings and artificial crowns used with posts in different years

Годы	Количество обратившихся пациентов	Количество установленных пломб	Среди них количество коронок на штифтах
2016 г.	64	81	32
2017 г.	118	145	71
2018 г.	92	96	48
2019 г.	51	62	38
Всего	325	384	189

A study of a certain time period after the procedure revealed:

1. Unwarranted use of post systems for reinforcing the restoration of the hard tissue of a lost crown;
2. Post structures were installed with insufficient root canal filling and/or in the presence of apical periodontal resorption;
3. Due to the low incidence of defects in the installed post structures during the study period, a small number of restoration procedures were recorded.
4. The occurrence of destruction and subsequent removal of structures within the first 12 months after installation (Table 2.6);
5. High level of effectiveness.

The reasons for the failure of posts' functional purpose after 4 years were: in 6.4% of cases, post destruction; destruction of the post and adjacent structures on a metal or titanium base with subsequent removal of all installed components in 26.5% of cases; destruction of the restored tooth occurred in 9% of cases, and in 11% of cases, a tooth root fracture was observed.

Table 2.6

Effectiveness of post structures when using titanium intracanal posts (quantity)

Срок наблюдения	Кол-во	Критерии				
		Внутриротовая реставрация	Отлом корня	Отлом штифта	Отлом композита	Удаление зуба в связи с разрушением
1 год	14	2	4	3	5	3
2 года	42	8	10	4	18	21
3 года	133	4	23	13	10	34

The study of the subjects' clinical status was conducted with particular thoroughness; complaints, information about previous and ongoing procedures, and pathologies were identified. A complete picture of the current status of the pathology and its further progression was obtained.

First and foremost, when examining the oral cavity, attention was paid to the condition of the alveolar process, teeth, and dental arches, as well as the type of occlusion. The degree of mouth opening was also assessed: whether it was unrestricted or had complications, along with functional movements of the lower jaw: smoothness, mobility in the horizontal plane, presence of limiting factors, sounds accompanying jaw movements, and pain sensations. Records were made of the mucous membrane of the oral cavity, including lips, cheeks, palate, gums, and tongue. During this examination, the color, moisture level, flexibility, mobility, and resilience of the tissues at the intended pin location were taken into account.

In the process of assessing the condition of individual teeth and the entire dental arch, emphasis was placed on spatial orientation, the shape and degree of tooth adhesion, the level of hardness, as well as the number of previously placed fillings and their current status. Attention was also given to the condition of the teeth during occlusion and the presence of occlusal contacts. When occlusion was present, the type of dental contact was studied. If defects were found, their location, nature, and extent of the existing pathology were determined. The level of tooth mobility was

assessed according to V.N. Kopeykin (1989). If a defect was present, it was classified according to Gavrilov E.I. (1998).

Clinical application of our developed threaded design for post-and-core (PC) teeth made of zirconium dioxide, manufactured using 3D milling method for the restoration of permanent tooth roots, was carried out in 48 patients; a total of 64 teeth were restored.

The quality of the pin structure was assessed according to generally accepted criteria based on the results of clinical and radiological examinations of patients at 3, 6, and 12 months after prosthetic treatment.

Pathological changes in the oral mucosa were determined using the methods of A.I. Rybakov and G.N. Banchenko (1978). The presence of stomatitis due to prostheses was determined using the method of S.A. Zufarov (1981).

The degree of alveolar bone loss was classified according to V.Yu. Kurlyandsky (1977). The periodontal status was assessed according to the principles established at the 16th Plenum of the All-Union Assembly of Dentists (Yerevan 1983).

Dental examinations were carried out using a luminescent diagnostic device (model 611) and an operating microscope (model 178), which increased the overall examination capacity in the oral cavity by 4 to 25 times.

When examining the oral mucosa at high magnification, emphasis was placed on the degree of light transmission in the blood vessels of the area, the uniformity of color distribution, and the presence of keratosis. When examining the mucous membranes of the lower lips and hard palate, special attention was paid to the salivary glands. During the examination, previously established diagnoses of periodontitis and mucosal pathologies were either confirmed or refuted.

The condition of the hard and soft tissues of the oral cavity was compared with the results of the same examination in the control group.

CHAPTER III.
RESULTS OF EXPERIMENTAL STUDIES AFTER PROSTHETIC TREATMENT OF DEFECTS IN THE CORONAL PORTION OF THE TOOTH

Research results on mathematical modeling

One of the ways to restore teeth with a total or subtotal destructive process of the tooth crown is to preserve the tooth root for further prosthesis placement, based on the preservation of alveolar processes and prevention of potential dental arch disorders (Abakumov A.A., Balakhonova M.A., 2017; Abolmasov N.G., Abolmasov N.N., Bychkov V.A., Al-Hakim A., 2011) . The question of preserving the tooth root should be approached with particular care, as unjustified removal of the tooth root is quite common in modern practice and leads to the development of dental arch disorders. Today, the most reliable and durable are metal-based post and core systems with cast core buildups, which are installed to create a foundation for severely damaged teeth.

The marker of complications when using cast post and core systems, according to the analysis results, occupies a high position, even with the extensive use of modern technologies for tooth crown restoration. According to the analysis of our and foreign scientists, the most common complications are: tooth root fracture due to decreased canal wall thickness, incorrectly chosen post, injuries during normal function, presence of pathological bite; this phenomenon can also develop as a result of cement layer loss due to ion dissolution in the oral cavity.

Functional overload of the dental support apparatus and traumatic occlusion play a significant role in the development and progression of periodontal diseases and tooth loss, which cannot be eliminated by either therapeutic or surgical methods. Therefore, orthopedic treatment, restoration of damaged tooth crowns, and prosthetic replacement of tooth crowns and partial dental arch defects are essential components of comprehensive therapy for the destruction of the dentoalveolar system.

The goal of orthopedic treatment and tooth preservation is to prevent, eliminate, or reduce the functional overload of periodontal tissues, which

is one of the main pathogenetic factors. To achieve this goal, we needed to address the following tasks:

1) restoration of the unity of the dentoalveolar system by transforming teeth from separately functioning elements into a continuous whole;

2) elimination of the traumatic effect of horizontal overload on periodontal tissues;

3) restoration of dental arch integrity in the presence of tooth and dental arch defects.

One of the methods for orthopedic treatment of periodontal diseases that addresses these tasks is dental prosthetics and splinting of dental arches. Despite the variety of previously proposed pin designs and splints for orthopedic treatment of hard tissues of the coronal part of teeth and periodontal diseases, the development of their design remains a highly relevant problem due to certain shortcomings inherent in previously proposed designs or materials used for their manufacture.

We have developed and proposed for practical application the design of a post-and-core tooth and a fixed splint for orthopedic treatment made from zirconium dioxide and a thermoplastic material based on polyoxymethylene "T.S.M. Acetal Dental" (Akbarov A.N., Nigmatova N.R., 2021; Klemin V.A., Nigmatova N.R., Volvakov V.V., 2016).

Mathematical modeling was carried out based on the finite element method for the "fixed splint - mobile teeth" system. A fixed splint was considered as a modeling object in three areas: anterior teeth, premolars, and molars of the upper and lower jaws.

The research process consisted of three stages of solving a geometrically and physically nonlinear problem using an iterative-incremental scheme.

The main information for geometric constructions is a longitudinal section of the tooth with a fragment of the structure and alveolar process in the mesiodistal and vestibulo-lingual directions. Modeling began with constructing the volumetric configuration of the splint on the teeth. Surfaces formed by the fixed structure served as the basis for all subsequent constructions. At the final stage, the load element in the root and bone area

of the alveolar process was assessed. To evaluate the periodontium, the second degree of tooth mobility was selected.

When modeling splinting elements, plastic and metal components operating under tension and compression were considered. The connection of the fixed splint elements was described using equations linking their movement, taking into account the corresponding weight coefficients.

When designing a fixed splint, in addition to the optimal model, physical influences during its operation were taken into account. The calculations were based on lateral forces of 50-200 N, with 50 N transverse forces applied to the incisors. The degree of periodontal destruction in this location was 0, 30, 50, and 100%. The increase in tension was 50 N.

The influence of a splint in the "tooth crown - splint - tooth root" system during periodontal destruction was studied on a simple model based on two foundations. When conducting the study, the average values of Young's modulus (elasticity modulus) for the tissues of the dentoalveolar system were taken into account (Table 3.1) (Olesova V.N., Klepilin E.S., Rogatnev V.P., 2006; Yarova S.P., Vaskes V.S., 2012).

Table 3.1

Average values of elastic modulus (Young's modulus) for tissues of the dentomaxillary system

No.	Tissue	Elastic modulus, GPa
1	Cortical bone	18.1
2	Cancellous bone	0.49
3	Periodontal ligament	0.01
4	Dentin	12-18
5	Mucous membrane	0.00118
6	Enamel	20-84.1

The average Young's modulus values for construction materials (according to the instructions for "Gialloy PA" and "T.S.M. Acetal Dental" materials) used in manufacturing periodontal splints are presented in Table 3.2.

Table 3.2

Average values of elastic modulus (Young's modulus) of structural materials for manufacturing periodontal splints

No.	Material	Elastic modulus, GPa
1	Thermoplastic material based on polyoxymethylene "T.S.M. Acetal Dental"	78.3-83.3
2	Cobalt-chromium alloy "Gialloy PA"	230

Loading was carried out in 2 stages. In the first stage, the initial tension of the metal splint structure was set, and in the second stage, the initial tension of the thermoplastic structure was set.

For numerical modeling, a finite element package developed specifically for solving this problem was used.

Results of biomechanical analysis.

The presence of the proposed splint reduces the level of positive tensile stresses in the periodontal tissues, as demonstrated by the stress distribution pattern in the studied geometric model. Overload occurs in the tensile stress zone of the periodontium, and this is an important factor**.** Therefore, based on the analysis of the calculated data, it can be concluded that in two mutually perpendicular planes along the root, this structure works more adequately under the influence of the considered loads, primarily in bending.

The decrease in tensile stress is very insignificant and is localized in the area of the teeth's necks. This was demonstrated by a study of splint design conducted during the loading stages. Under the influence of a horizontal load, the splint also produces a slight change in the stress field.

Therefore, the qualitative improvement of the thermoplastic splint design, based on this calculation, occurs mainly not due to the strength of the material, but due to the correspondence of the elasticity of the structural material to the similar indicator of the periodontal tissues, which ensures a semi-labile connection between the splint and the supporting teeth, and consequently, the mobility of the teeth within physiological norms.

CHAPTER IV.
DEVELOPMENT AND USE OF A NEW DESIGN OF ZIRCONIUM DIOXIDE INDIVIDUAL POSTS FOR SINGLE-ROOTED TEETH

§ 4.1. Development and use of a new design of individual zirconium dioxide posts

Based on the conducted mathematical modeling, we have developed a new type of dental post equipped with a removable head, simple in design, convenient to use, as well as expanding the range of dental post techniques (Patent of the Republic of Uzbekistan No. FAP 01787 dated March 18, 2021), (see Appendix 1).

The utility model relates to the field of medicine and is intended for use in prosthetic dentistry as a support for restoring the crown portion of a tooth, as well as for the fabrication of dental prostheses.

Various posts containing intraradicular and extraradicular parts are known, designed to be used as supports for restoring the crown portion of a tooth and for securing fixed and removable dental prostheses, developed to ensure reliable fixation on a natural tooth.

The dental post can have various shapes, be smooth or threaded. There are also different types of post-and-core systems. The post itself, along with the crown on it, is called a post-and-core structure.

The dental pin most technically similar to the proposed one is a single-root tooth pin with an inlay, made in the form of a screw, containing intraroot and extraroot parts manufactured as a single unit. The intraroot part is made in the form of a truncated cone with a thread, while the extraroot part has a slot for screwing in the pin. The extraroot part is cylindrical and is separated from the threaded shaft by a disc-shaped stop (Armenia utility model patent No. 293, published 25.06.2012).

The disadvantage of this pin is the complexity of its manufacture, as it requires the creation and processing of a disc-shaped stop, which leads to an increase in the cost of prosthetics.

The objective of the utility model is to develop a relatively inexpensive dental pin that is simple to manufacture and convenient to use, as well as to expand the range of dental pinning tools.

The set objective is achieved by the fact that in a single-root tooth pin with an inlay, made in the form of a screw, containing intraroot and extraroot parts manufactured as a single unit, the intraroot part is made in the form of a truncated cone with a thread, the extraroot part has a slot for screwing in the pin, and the extraroot part is made in the form of a cone.

Making the extraroot part in the form of a cone, which is streamlined and easier to process, allows simplifying and reducing the cost of pin manufacturing by eliminating the need to process the junctions of the disc-shaped stop with the intraroot and extraroot parts.

The dental post is made as a single piece, with the intraradicular (apical) part and the extraradicular part for the crown (inlay) representing separate sections of a single screw. Such a dental post is used for single-stage fixation of artificial crowns.

Combining two functions in one extraradicular part of the specified dental post (a plug for the canal opening and a shaper for the crown part of the tooth) simplifies and accelerates the treatment process, as there is no need for a second, so-called surgical intervention, i.e., taking an impression to make the extraradicular part of the post, which leads to a decrease in the cost of treatment.

Figure 4.1 shows the general view of the post with the inlay when it is positioned in the root canal; Figure 4.2 shows the same, view from above; Figure 4.3 shows the general view of the post with the inlay; Figure 4.4 depicts the screwdriver for attaching the post to the tooth root; Figure 4.5 shows the same, view from below.

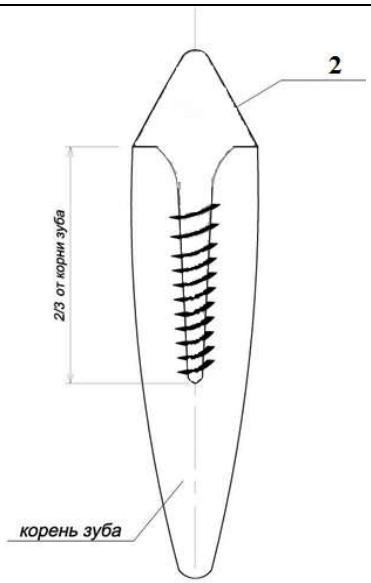


Figure 4.1

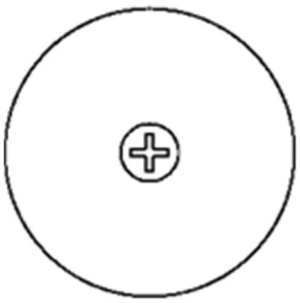


Figure 4.2

The dental post with an inlay for a single-rooted tooth is made in the form of a screw and contains intraradicular 1 and extraradicular 2 parts, made as a single unit. The intraradicular part 1 is made in the form of a truncated cone with a thread. The cone-shaped extraradicular part 2 has a cross-shaped slot 4 for screwing in the post.

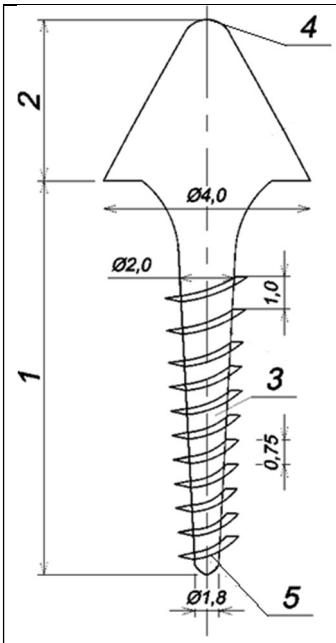


Figure 4.3

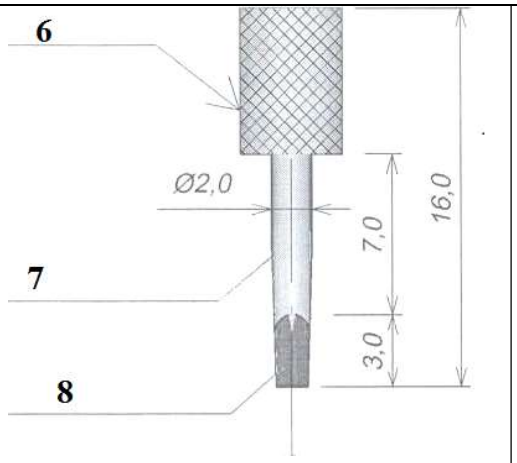


Figure 4.4

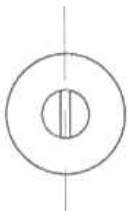


Figure 4.5

The following designations are used in the drawings:

1- intraradicular part; 2- extraradicular part (inlay); 3 - rod section with a thread; 4 - slot for screwing in the post; 5 - end in the form of a segment;

6 - handle; 7 - cylindrical part; 8 - screw slot.

The dental post with an inlay for a single-rooted tooth is made in the form of a screw and contains intraradicular 1 and extraradicular 2 parts, manufactured as a single unit. The intraradicular part 1 is made in the form of a truncated cone with a thread. The cone-shaped extraradicular part 2 has a cruciform slot 4 for screwing in the post.

The intraradicular part (Figure 3.3) is made with a length of 2/3 of the tooth root, the cone-shaped section of the extraradicular part has a base diameter of 4.0 mm, the threaded section is made with a pitch of 1.0 mm and 0.75 mm, with the largest and smallest diameters of 2.0 mm and 1.8 mm, and with a segment-shaped end.

The dental post with an inlay for a single-rooted tooth is used as follows: first, the condition of the tooth itself, the periapical tissues, the remaining tooth stump, the mobility of the tooth root, the condition of the oral mucosa, etc., are determined. Based on radiological studies, the condition of the periodontium, the configuration of the root, and its length are established, according to which the length of the manufactured post is determined, which should be approximately 66.6% of the total root length. Preparatory procedures for post placement begin with exposing the gingival component of the tooth, followed by removal of the hard dental tissues for the post, which is carried out using abrasive instruments that help recreate the surface for the post core 1.

The root canal is prepared by removing 66.6% of the filling material from its total length, which is carried out by drilling. Then, the canal diameter is increased to form a conical passage.

Next, they proceed to manufacture the dental post with an inlay using the CAD/CAM method. First, a digital impression is taken using an oral scanner. The digital impression file is then transferred to the dental technician's computer in the technical laboratory. The technician uses the Exocad software to prepare an electronic version of the post based on the patient's data. After verification, the file is sent to the milling machine, where the post is fabricated. After milling, the technician processes the finished post and sends it to the clinic. The fabricated post is fitted in the oral cavity by a specialist to establish the level of artificial crown

attachment to the gingival surface and determine the quality of the fit. After obtaining optimal test results, this system is removed and subjected to antiseptic treatment for further installation by cementation.

The final stage of installing this structure is its adhesion in the root canal, followed by filling the canal with glass-ionomer cement.

The effectiveness of this post placement method is based on avoiding pressure on the tooth canals by venting excess cement through special channels, which prevent fractures in the root canals. This is particularly important when the walls of the root canals are very thin.

Tests have shown that the proposed design of the dental post insert allows for a reduction in the pressure of the fixing material on the root canal walls during cementation, enables the use of cement with normal rather than fluid consistency, and prevents root fracture, especially in cases where the root canal walls are thin. The design is precise and leads to predictable positive outcomes, and can find widespread application in modern practical healthcare.

Currently, zirconium dioxide (zirconia) confidently holds the leading position in the field of dentistry. Artificial zirconia crowns are distinguished by their aesthetic quality and, most importantly, the absence of adverse side effects after installation. Two problems in prosthetic dentistry were solved by using zirconia: 1. Strength and reliability over a long period of time. 2. Complete compatibility with the surrounding periodontal tissues.

In dentistry, zirconia is called "white gold," as it does not resemble metal in appearance, which is typically characterized by its metallic luster. The white color with a matte luster is a characteristic structural composition of zirconium dioxide. Currently, zirconium dioxide is used in prosthetic practice to make artificial single crowns, bridge prostheses, so-called veneers, and even micro-prostheses - inlays.

A mechanism for reconstructing lost crowns of premolars and anterior teeth. This mechanism is used to treat premolars and anterior teeth in cases of total crown destruction, provided there is a root with an optimal canal.

§ 4.2. Computer processing of obtained information and creation of a virtual pin structure

After obtaining impressions for pin fabrication, the work is sent to the laboratory. The technician prepares the patient's plaster model and scans it.

The computer processes the obtained information and creates a virtual model of the future structure (Fig. 4.6). CAD/CAM technologies are controlled by 3D software (Fig. 4.7).

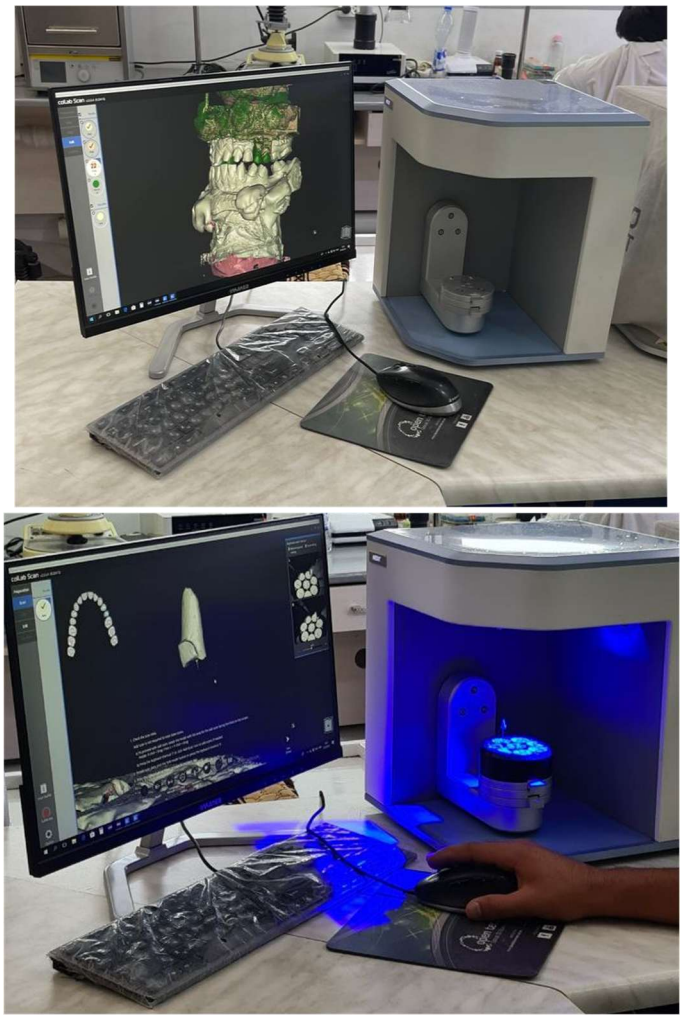


Fig. 4.6. The computer processes the obtained information and creates a virtual model of the future structure

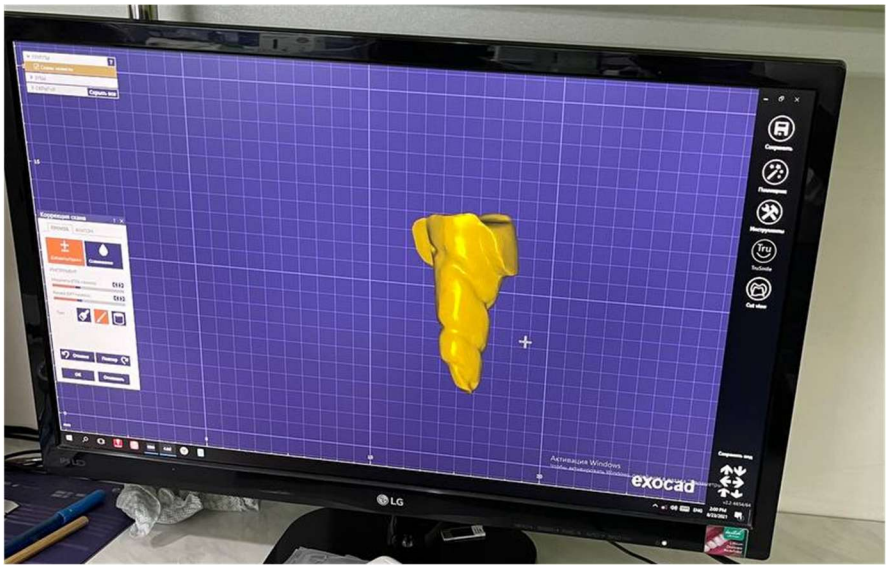


Fig. 4.7. CAD/CAM technologies are controlled by 3D software.

The computer creates a highly precise three-dimensional model of the future structure and automatically, using milling cutters and water cooling, "mills" the restoration from a solid block of zirconium (Fig. 4.8).

Fig. 4.8. Milling machine

In dentistry, it has become possible to manufacture high-quality all-ceramic restorations using computers, avoid certain errors in laboratory stages with the help of scanning devices and milling machines, which

ensure maximum accuracy in the fabrication of many structures. This is achieved through the standardization of equipment and materials.

After polishing the zirconium oxide pin, the technician processes the finished pin and transfers it to the clinic. The prepared pin is fitted in the oral cavity by the doctor to assess the quality of its manufacture and to check the tightness of the artificial stump to the supragingival tooth surface. After treating it with an antiseptic solution, it is prepared for delivery to the patient by cementing with a fixing material.

The final stage of manufacturing a dental pin with an inlay is its fixation in the root canal of the tooth with glass-ionomer cement.

Through clinical and radiological studies, we have selected tooth stumps for the manufacture of pin structures.

Then, we began to manufacture the dental pin with an inlay using the CAD/CAM/CAE system method. First, we took a digital impression using the Oral scan device. After this, the digital impression file was transferred to the dental technician's computer in the technical laboratory. The technician used the Exocad program to prepare an electronic version of the pin based on the patient's data. After verification, the file was transferred to the milling machine where the pin was prepared. After polishing the pin, the technician processed the finished pin and transferred it to the clinic.

Work sequence: First, a digital impression is taken using the Oral scan device. Then, the digital impression file is transferred to the dental technician's computer in the technical laboratory. The technician uses the Exocad program to prepare an electronic version of the post based on the patient's data. After verification, the file is sent to the milling machine, where the post is fabricated. After milling, the technician processes the finished post and sends it to the clinic. The dentist fits the prepared post in the oral cavity to assess the quality of preparation and check the fit of the artificial core to the supragingival tooth surface. After checking, it is removed and prepared for cementation using antiseptic solutions. The final stage of manufacturing a dental post with a core is its fixation in the tooth's root canal using glass ionomer cement. The proposed design was used in the orthopedic treatment of 48 patients (27 men, 21 women) aged 18 to 60 years who visited the clinic for dental hard tissue defects. A total of 14

post-and-core restorations were made for the anterior teeth of the upper jaw in these patients. The posts with cores were made from zirconium dioxide. The cores were cemented using glass ionomer cement.

Thus, the dental post design proposed by us allows for a reduction in the pressure of the fixing material on the root canal walls during cementation, the use of cement with normal, rather than fluid consistency, and the prevention of root fracture, especially in cases where the root canal walls are thin. This proposed post design can find wide application in modern practical healthcare.

§ 4.3. Clinical evaluation of the effectiveness of the new design of individual zirconium dioxide posts

4.3.1. Clinical and laboratory stages of manufacturing individual threaded post

1. Clinical stage: Patient examination. Dental diagnosis. Selection of treatment method and dental prosthesis design. Assessment of the destroyed crown portion of the tooth. Determining the suitability of the tooth stump based on radiological and functional research methods. Oral cavity sanitation. Therapeutic preparation of the selected tooth. Root canal enlargement and filling.

2. Clinical stage: Removal of root canal filling material in the prosthetic tooth to 2/3 of its length and creation of a thread inside the canal using a tap. Treatment of the canal orifice.

Taking an impression of the inside of the canal for the post and a general impression of the entire dental arch from the upper and lower jaws.

Determination of the centric jaw relation.

3. Laboratory: Casting of a working model (of the prepared tooth) from dental stone and a general model of the jaws from regular plaster.

Creating a wax model of the future post.

4. Milling Room: The wax composition of the threaded post with internal and external parts is scanned and prepared for milling.

A 3D printer is used to mill the future fiberglass post with threads and inlay from glass fiber.

5. Clinic: Medicinal treatment of the tooth root canal, drying. Also, medicinal treatment of the fiberglass post, drying and cementing. Providing instructions to the patient on post care.

6. Clinic: Examination of the patient, assessment of the post's condition, taking impressions of both jaws for manufacturing an artificial ceramic crown.

7. Laboratory: Casting of jaw models. Forming an artificial crown and manufacturing a zirconia crown using a milling machine.

8. Clinic: Medicinal treatment of the post and crown, trying it on and cementing. Providing instructions to the patient on artificial teeth care.

4.3.2. Clinical assessment of the effectiveness of the new post-and-core tooth design

Clinical studies were conducted at the outpatient clinics of the Department of Faculty Orthopedic Dentistry at the Tashkent State Dental Institute. The analysis and conclusions were based on examination data from 78 patients with crown defects. Of these, 46 (58.97%) were men and 32 (41.03%) were women aged 18 to 60. The main group of patients was divided into 2 groups: 1st - the primary group of patients with complete destruction of the tooth crown, for whom we fabricated our developed design of a pin tooth using a zirconium dioxide custom-made post - 48 (61.54%) patients; and 2nd - the comparison group of patients, who had pin teeth fabricated using the traditional method - 30 (38.46%) patients (Fig. 4.9).

Fig. 4.9. Traditionally fabricated smooth pin tooth

The results of examining 24 healthy individuals of comparable sex and age, who served as controls, were used as indicators of the norm.

All patients underwent clinical, radiological, photometric, laboratory, functional, and statistical research methods.

The research objectives included developing a new type of dental post equipped with a removable head, simple to fabricate, convenient to use, as well as expanding the range of dental post options.

The posed problem was solved by creating a dental pin with an inlay for a single-root tooth, made in the form of a screw consisting of two parts: intra-root and extra-root. The intra-root part is made in the form of a truncated cone with a thread, while the extra-root part has a slot for screwing in the pin and is made in the form of a cone.

We have proposed variants of the pin with different parameters of length, diameter, and thread pitch (Patent of the Republic of Uzbekistan No. FAP 01787 dated January 27, 2022).

The dental pin is made as a single piece, with the intra-root (apical) part and the extra-root part for the crown (in the form of an abutment) representing separate sections of a solid screw equipped with a removable screw with a head. Such a dental pin is used for single-stage fixation of artificial crowns.

Combining two functions in one extra-root part of the specified dental pin (a plug for the canal opening and a shaper for the crown part of the tooth) simplifies and accelerates the treatment process. Making the post head removable allows for its replacement in case of wear or damage.

The pin tooth we developed is designed for prosthetic replacement of premolars and front teeth when they have no natural crown at all, but while maintaining the root at the gum level with a well-passable canal.

Another area of application where zirconium dioxide has proven itself excellently, especially when it comes to restoring the frontal group of teeth (Fig. 4.10).

Fig. 4.10. Zirconium dioxide pin tooth

Sequence of work. The proposed dental post with an inlay for a single-root tooth begins with filling the root canal of the tooth and subsequently creating a space for the post (Fig. 4.11).

Fig. 4.11. Tooth root canal filling

Next, we prepare the supragingival part (coronal platform) of the tooth root using a retraction cord so that it is 0.2-0.3 mm below the gingival margin on the lower jaw and 0.2-0.3 mm above the gingival margin on the upper jaw, allowing the core (inlay) with ceramics to submerge 0.2-0.3 mm under the gums to eliminate aesthetic defects. In this case, the coronal

platform of the tooth is ground down, as is customary, at a 90° angle relative to the longitudinal axis of the tooth, to ensure tight contact between the tooth core and the ceramics and uniform transfer of masticatory pressure to the root of the tooth.

High-tech equipment is used to manufacture zirconium posts. The process is fully automated, occurring without human intervention using CAD/CAM methodology. The computer processes the received information and creates a virtual model of the future restoration. The shade of the colorant is selected to match the patient's natural tooth enamel color. The computer creates a highly precise three-dimensional model of the future design and automatically "mills" the restoration from a solid block of zirconium using cutters and water cooling.

After polishing the zirconium oxide post, the technician processes the finished post and transfers it to the clinic. The finished post was fitted in the oral cavity to assess the quality of its manufacture and to check the tightness of the artificial core to the supragingival tooth surface. After verification, it is removed and prepared for cementation using antiseptic solutions (Fig. 4.12).

Fig. 4.12. Threaded design of zirconium dioxide post-and-core systems fabricated by 3D milling.

The final stage of manufacturing a dental post with an inlay is its fixation in the root canal of the tooth with glass-ionomer cement (Fig. 4.13).

Fig. 4.13. Patient S., 39 years old. Threaded post-and-core tooth made of zirconium dioxide

The results of clinical use of the proposed post design as a base for monolithic ceramic crowns demonstrated increased efficiency, as during the entire study period, not a single case of tooth root fracture or failure of the established structure was recorded. This design eliminates the possibility of color changes in the future. The only possible issue, which is not related to the structural materials, is gingival recession and atrophy of marginal bone tissue.

The effectiveness of using zirconium dioxide-based post structures after 2 years is 95% (taking into account all possible complications caused by this material).

Thus, based on the anatomical and topographical features of anterior teeth, the fabrication of a threaded pin tooth design made from zirconium dioxide using 3D milling has been scientifically substantiated.

The clinical use of our proposed pin design as a support for an all-ceramic crown has shown high effectiveness.

The proposed pin design can find wide application in modern practical healthcare.

§ 4.4. Results of gnathodynamometric studies in patients with intact dentition and in patients before and after prosthetic treatment with pin designs

For this type of research, we used an electronic gnathodynamometer (Figure 4.14), developed by M.V. Bekmetov and T.A. Khadzhimetov (1992).

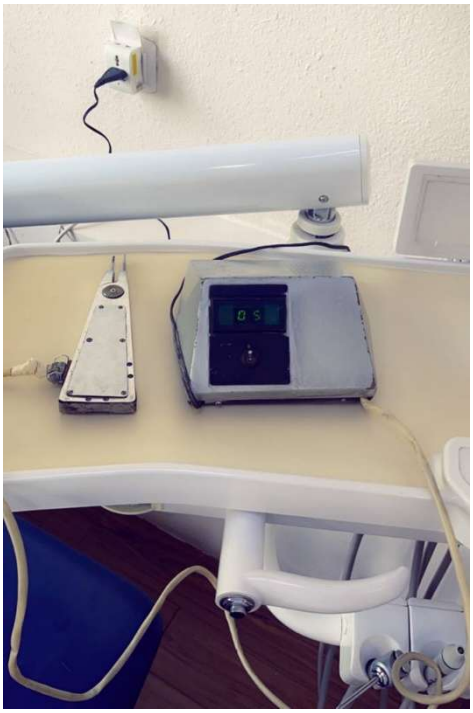


Fig. 4.14. Gnathodynamometer

Gnathodynamometric studies were conducted on 141 patients before and at various times after orthopedic treatment, and on 51 healthy individuals. A total of 1947 teeth and 167 teeth in bridge prostheses were examined.

To establish the degree of reliability of numerical values for real-world manifestations, we decided to create calibration curves using a mechanical dynamometer with measurements in kg.

Thus, we gained the ability to calibrate the results obtained from the gnathodynamometer. We conducted this work at the Akadempribor Research Institute.

Furthermore, we decided that the results of gnathodynamometric studies would be more accurate if we presented them in conventional units, that is, as shown on the gnathodynamometer display.

The research procedure was as follows. To determine the teeth's endurance to vertical load, the patient was seated in a dental chair, their head was fixed in the headrest in a comfortable position for examination,

they were asked to open their mouth, and using a dental mirror, the working, biting platform of the gnathodynamometer was precisely placed on the examined tooth, while the second probe was placed on a group of antagonist teeth (Fig. 4.15).

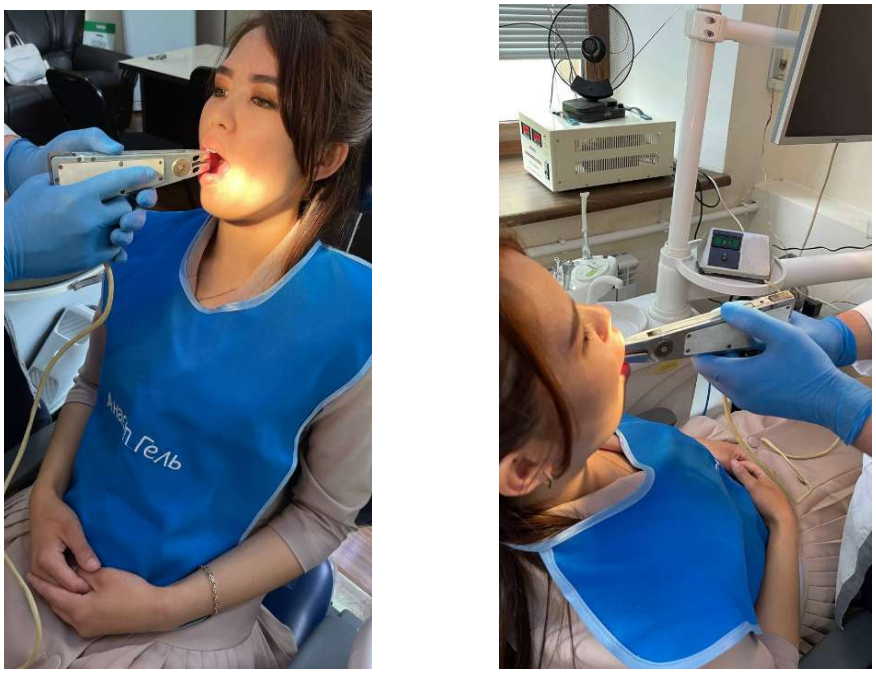


Fig. 4.15. Conducting gnathodynamometric studies on a patient

To correctly assess the status of the studied tooth and exclude the impact of the pain factor on the research results, we used a biting platform larger than the studied tooth.

As a result, the load directed at one tooth was distributed among its antagonists.

Upon completion of the gnathodynamometer setup, the examined individuals gradually clenched their jaw until a slight pain sensation developed in the studied tooth.

All examined individuals were instructed beforehand that it was necessary to bite until pain was felt or as firmly as possible. Each measurement was repeated 2-3 times, as indicated above, while the device for determining the endurance of the dental periodontium recorded the magnitude of the maximum effort made by the patient. Measurement results over time were recorded against the corresponding teeth on the examination chart.

To establish the stability of the examined tooth under applied horizontal loads, a support consisting of two arms was fixed on an elastic pad on the surface of the tooth crown in its horizontal position relative to the perpendicular of the tooth axis.

After the setup, pressure is applied to this device until mild pain sensations appear. The degree of pressure tolerated by the periodontium is recorded on a specialized scale of the installed apparatus, and the results are recorded in the patient's chart.

Occlusiography. In order to detect and mark the locations of dental occlusion development, special occlusiograms were taken during the studies according to the method of I.I. Postolaki, 1987.

In this study, 2 wax plates were used, which are typically used in clasp prosthesis work. Based on the localization of the indentations, the occlusion sites were determined.

We examined 78 patients of the main and comparison groups, as well as 24 patients of the control group before and after treatment and prosthetics.

4.4.1. Results of GDM studies in patients with intact dental arches

Studies were conducted on 24 healthy students with intact dentition.

The results of the gnatodynamometric studies of the control group are presented in Tables 4.1 and 4.2.

The table shows that the endurance of teeth to vertical loads in men varied within the dental arch from 13 to 44 conventional units. The lower incisors had the lowest endurance, while the first and second molars were the strongest. The upper teeth generally had greater endurance than the lower teeth, which corresponds to literature data. However, on average, the lower molars had greater endurance than the upper ones, although there were individual differences in indicators.

The endurance of teeth in women had approximately the same characteristics, but unlike men, their molars surpassed the incisors less significantly. Individual differences in women were even more pronounced. The tolerance of teeth to horizontal loads was 5-7 times lower in both women and men compared to vertical loads (Table 4.2).

Table 4.1

Endurance of the dental periodontium to vertical load in patients of the control groups

	Женщины	21,8± 1,09	27,5± 1,37	32,2± 1,61	22,7± 1,13	22,8± 1,14	20,3± 1,01	11,3± 0,56	12,7± 0,63	13,1± 0,65	11,8± 0,59	19,8± 0,99	23,1± 1,15	23,8± 1,19	32,4± 1,62	27,8± 1,39	20,1± 1,00
	Мужчины	28,9± 1,45	37,5± 1,89	43,2± 2,17	26,6± 1,34	26,4± 1,32	24,7± 1,24	13,5± 0,68	14,8± 0,74	15,1± 0,76	13,2± 0,66	25,1± 1,26	26,4± 1,32	26,7± 1,34	43,3± 2,18	38,2± 1,92	29,2± 1,47
Зубы		**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Мужчины	28,4± 1,43	38,2± 1,92.	43,4± 2, 18	26,5± 1,33	26,4± 1,32	25,1± 1,26	13,1± 0,66	13,6± 0,68	13,4± 0,67	12,9± 0,65	25,3± 1,27	25,6± 1,29	26,9± 1,35	43,4± 2, 18	38,1± 1,92	27,8± 1,40
	Женщины	21,4± 1,07	28,1± 1,40	32,5± 1,62	21,6± 1,08	21,4± 1,07	19,5± 0,97	11,2± 0,56	11,7± 0,58	11,8± 0,59	11,2± 0,56	18,7± 0,93	22,1± 1,10	22,3± 1,21	32,5± 1,62	28,2± 1,41	19,9± 0,99

Table 4.2

Endurance of the dental periodontium to horizontal loads in patients of the control groups with intact dentition and occlusion

	Женщины	3,53± 0,18	4,37± 0,22	4,72± 0,24	3,12± 0,15	2,89± 0,14	2,70± 0,13	1,70± 0,08	2,04± 0,10	2,04± 0,10	1,75± 0,09	2,84± 0,14	2,80± 0,14	3,35± 0,17	4,54± 0,23	4,47± 0,22	3,70± 0,18
	Мужчины	4,20± 0,21	5,69± 0,28	6,49± 0,32	3,79± 0,19	3,59± 0,18	3,32± 0,17	2,00± 0,10	2,31± 0,12	2,22± 0,11	1,91± 0,09	3,40± 0,17	3,67± 0,18	3,84± 0,19	6,42± 0,32	5,84± 0,29	4,04± 0,20
Зубы		**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Мужчины	4,24± 0,21	5,84± 0,29	6,51± 0,32	3,62± 0,18	3,59± 0,18	3,16± 0,16	1,90± 0,09	2,12± 0,01	2,06± 0,10	1,66± 0,08	3,10± 0,15	3,49± 0,17	3,88± 0,19	6,62± 0,33	5,85± 0,29	4,26± 0,21
	Женщины	3,63± 0,18	4,38± 0,22	4,64± 0,23	2,73± 0,14	2,64± 0,13	2,31± 0,11	1,66± 0,08	1,95± 0,10	1,91± 0,09	1,67± 0,08	2,33± 0,12	2,66± 0 13	2,68± 0,13	4,46± 0,22	4,10± 0,20	3,42± 0,17

4.4.2. Results of GDM studies on tooth endurance in patients with tooth crown damage (main group) .

We examined 78 patients with defects in the crown portion of the tooth. The tolerance of vertical and horizontal physical loads was studied in all subjects who were undergoing prosthetic treatment for the first time.

In this subchapter, we present the GDM data obtained from 78 patients who had not previously used dental prostheses. We first studied the teeth that underwent destructive processes, followed by the second and third teeth on both sides. Due to the diversity of causes and locations of

existing pathologies, their systematization proved impossible. Based on these facts, the study results were expressed as percentage comparisons relative to the same teeth in the control group.

Based on the results, the tolerance of vertical loads for the first tooth in the upper frontal row ranged from 11% to 39%, while the tolerance of horizontal loads ranged from 22% to 37% compared to the values of the control group, as well as the data from symmetrically located intact teeth.

The second teeth from the studied tooth on both sides showed a decrease in resistance to vertical loads from 2.0% to 10%, while the decrease in resistance to horizontal loads ranged from 13.5% to 20% compared to the control.

For the third teeth from the defect, the periodontium's tolerance to both vertical and horizontal loads differed little from the initial level if there were no pronounced gaps not only between the first and second teeth from the defect but also between the second and third teeth.

In the area of the upper anterior teeth, with defects in the crown part of the tooth, the loss of resistance to vertical loads is least pronounced in the canines, followed by the central incisors when the lateral incisors are injured, and in the first premolars when the second premolars are injured.

The greatest decrease in periodontal endurance to vertical and horizontal loads occurs in the lateral incisors when a neighboring tooth to the right or left is affected, decreasing to 62.1-77.7%.

When the canine is affected, the first premolars lose the periodontium's resistance to vertical loads by up to 20.3% compared to the symmetrical tooth and control indicators. The loss of one of the central incisors leads to a significant decrease in the resistance to vertical load in the symmetrical incisor to 20.7-25.4%.

In the area of the lower anterior teeth, with defects in the crown part of the tooth, the loss of resistance to vertical loads, as in the upper jaw, is least pronounced in the canines and constitutes 90.1-95.3% compared to intact canines. The central and lateral incisors, when damaged (or injured) by the canine or central incisor, lose their vertical resistance to 30.4-40.1% of the control value, while, unlike the upper anterior teeth, the incisors' resistance to horizontal loads decreases to 50.6%.

When studying the resistance of the periodontium in teeth adjacent to those with crown defects in the upper lateral region, it was found that the vertical gnathodynamometric indicators of the second premolar decreased by only 10.2-12.5% from the control value when the first molar was affected. The first premolar, being the second tooth from the affected one, showed practically no decrease in resistance to vertical load. The resistance to horizontal load of the first premolar also decreased insignificantly. Teeth located distally from the affected molar also showed a slight decrease in periodontal resistance to vertical and horizontal loads.

The lateral teeth of the lower jaw, unlike the upper teeth, respond to defects in the crown part of the tooth with more significant changes in periodontal resistance. Thus, damage to the first molars causes a decrease in resistance to vertical load in both mesially and distally located teeth by 15 to 30%, and in teeth two positions away from it - by up to 4.4-12.7% compared to the control group indicators. The decrease in resistance to horizontal load in these teeth was also more significant than in the upper lateral teeth.

When the second premolar is destroyed, the adjacent first premolar shows almost no decrease in periodontal resistance to vertical load. The resistance of the second tooth from the affected one, that is, the canine, also does not decrease.

In the tooth distal to the destroyed first molar, the decrease in the vertical gnathodynomometric indicator does not exceed 10.3%, and in the second molar, it is even less when compared to symmetrically located teeth.

Thus, damage to the crown portion of the tooth is characterized by a decrease in tolerance indicators for vertical and horizontal loads. It is worth noting the increased susceptibility of the first anterior teeth to the loss of tolerance to increased loads compared to the second and third teeth.

The upper and lower canines, as well as the upper incisors, demonstrate the greatest resistance to loss of endurance. The greatest losses in relation to all types of loads are observed in all teeth of the upper and lower rows with lateral localization of the pathology.

In the area of lateral teeth on the upper jaw, damage or destruction of the crown portion of the tooth causes the least decrease in endurance compared to other zones of the dental arch, both for the first and second teeth adjacent to the destroyed ones (referring to premolars and molars).

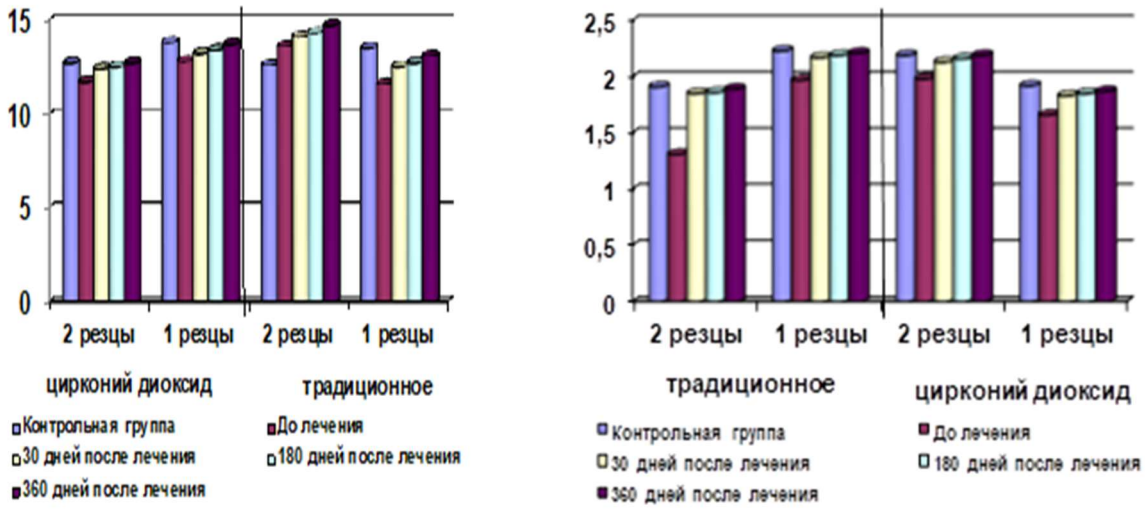
Thus, a violation of the integrity of the tooth crown causes a decrease in the endurance of the periodontium of this tooth and the teeth adjacent to the defect in the upper jaw by only 5.5-10.7% in vertical and horizontal directions, and in the lower jaw by 15.4-50.3%. These changes in periodontal endurance vary depending on the location of the tooth defect. It should be noted that the location of the teeth and their angle of inclination relative to the longitudinal axis and occlusal surface affect the periodontal endurance values, which must be directly considered when choosing the prosthetic method and type of prosthesis.

The results of the study on dental endurance to vertical and horizontal loads after prosthetic treatment were examined in 29 patients of the main group and 16 patients of the comparison group.

The study results showed that after prosthetic treatment in the main group of patients, the periodontal endurance to load returned to almost normal levels within 3 months (Tables 4.3, 4.4, and Figure 4.16), which once again convincingly demonstrates the functional effectiveness of our proposed design for the pin tooth.

§ 4.5. Results of morphological studies

For morphological research, the material was fixed in a 15% neutral formalin solution for 24 hours, then decalcified in nitric acid along with pins for 17 days. After fixation, the tooth was cut into two halves - a longitudinal section, and zirconium pins were carefully removed (Figures 4.17, 4.18). For histological examination, the cut halves of the teeth were passed through a series of alcohol and chloroform solutions. After fixation, they were transferred to a "mash," which consists of a solution of chloroform and paraffin.



a b

Figure 4.16. GDM research results: a - vertical pressure; b - horizontal pressure

Table 4.3

Resistance of the dental periodontium to vertical load in patients of the main group

	Женщины	20,6± 1,07	26,7± 1,35	31,9± 1,82	23,1± 1,16	23,1± 1,15	20,2± 1,06	11,6± 0,63	13,1± 0,61	12,8± 0,75	12,5± 0,64	19,7± 0,89	23,7± 1,16	23,3± 1,23	33,4± 1,72	26,7± 1,41	20,4± 1,13
	Мужчины	27,8± 1,53	36,5± 1,78	42,8± 2,16	27,3± 1,31	27,3± 1,34	25,3± 1,25	14,5± 0,71	15,8± 0,68	15,3± 0,68	14,2± 0,76	25,3± 1,28	27,1± 1,42	26,9± 1,41	42,8± 2,31	37,9± 1,87	29,1± 1,54
Зубы		8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
	Мужчины	27,6± 1,42	37,8± 1,89	42,8± 2,24	27,2± 1,43	27,3± 1,42	26,3± 1,72	13,7± 0,76	14,3± 0,71	12,9± 0,72	12,7± 0,65	26,2± 1,28	26,3± 1,27	27,2± 1,29	42,9± 2,21	37,9± 1,91	27,5± 1,38
	Женщины	20,1± 1,04	27,3± 1,39	33,1± 1,64	22,1± 1,06	22,1± 1,08	19,8± 0,98	11,3± 0,61	11,6± 0,56	11,7± 0,61	11,4± 0,63	19,1± 0,94	22,8± 1,12	22,4± 1,23	31,9± 1,72	27,2± 1,43	19,7± 0,98

Table 4.4

Resistance of the dental periodontium to horizontal load in patients of the main group

	Женщины	3,46 ± 0,17	4,32 ± 0,26	4,81 ± 0,26	3,14 ± 0,17	2,91 ± 0,17	2,69 ± 0,14	1,72 ± 0,09	2,06 ± 0,11	2,06 ± 0,11	1,73 ± 0,10	2,91 ± 0,16	2,79 ± 0,17	3,37 ± 0,18	4,56 ± 0,25	4,49 ± 0,26	3,69 ± 0,19
	Мужчины	4,11 ± 0,22	5,71 ± 0,29	6,47 ± 0,33	3,81 ± 0,20	3,57 ± 0,17	3,34 ± 0,18	2,01 ± 0,11	2,33 ± 0,14	2,24 ± 0,13	1,89 ± 0,12	3,43 ± 0,19	3,71 ± 0,19	3,79 ± 0,23	6,39 ± 0,36	5,79 ± 0,31	4,03 ± 0,21
Зубы		8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
	Мужчины	4,28 ± 0,22	5,83 ± 0,27	6,53 ± 0,35	3,67 ± 0,17	3,61 ± 0,19	3,18 ± 0,17	1,93 ± 0,12	2,14 ± 0,02	2,07 ± 0,12	1,67 ± 0,09	3,11 ± 0,17	3,46 ± 0,15	3,84 ± 0,17	6,62 ± 0,34	5,87 ± 0,31	4,28 ± 0,29

They were placed in a thermostat at 37 degrees for 1-2 hours, then at 57 degrees for 1 hour for impregnation, and paraffin blocks were prepared, which were glued onto wooden cubes. A thin layer of material was cut from the prepared paraffin blocks on a microtome. The glass slides were pre-prepared for cutting, smeared with protein and heated on a spirit lamp, the sections were attached to the glass and stained with hematoxylin and eosin. The prepared specimens were viewed under a German-made LEICA binocular microscope and photographed with an HM-35 series webcam.

Fig. 4.17. The tooth in cross-section with a serrated pin.

Fig. 4.18. Tooth with smooth pin surface

Microscopic studies were conducted at the V. Vakhidov National Surgery Center of the Ministry of Health of the Republic of Uzbekistan (laboratory head, Professor I.M. Baybekov).

The lack of reliable data on the strength of the reconstructed tooth stump led to the need for this clinical and morphological study and the compilation of this work.

The problem was solved by using a dental post with an inlay for a single-rooted tooth, made in the form of a screw consisting of two parts: intraradicular and extraradicular. The intraradicular part is made in the form of a truncated cone with a thread, while the extraradicular part has a slot for screwing in the post and is made in the shape of a cone.

We have proposed variants of the post with different parameters of length, diameter, and thread pitch.

For morphological research, the material was fixed in a neutral formalin solution and decalcified in nitric acid along with the posts. After fixation with solutions, the zirconium posts were carefully removed and processed through alcohols and chloroform, then paraffin blocks were prepared. The prepared sections were stained with hematoxylin and eosin.

Clinical and radiological studies were used to select tooth stumps for the manufacture of post structures. After unsealing and expanding the root canal, it was given the shape of a truncated cone, excluding so-called undercuts.

Then, they proceeded to manufacture the dental post with inlay using the CAD/CAM/CAE system method. First, they took a digital impression using the Oral scan device. Afterward, the digital impression file was transferred to the dental technician's computer in the technical laboratory. The technician used the Exocad program to prepare an electronic version of the post based on the patient's data. After verification, the file was sent to the milling machine where the post was fabricated. After milling, the technician finished the post and sent it to the clinic. Then, the finished post was tried in the oral cavity to assess the quality of the preparation and check the fit of the artificial core to the supragingival tooth surface. After inspection, it was removed and, following antiseptic treatment, cemented with glass ionomer cement.

Samples of individual zirconia posts with smooth and threaded surfaces, stained with hematoxylin and eosin, were used to assess the morphological quality of their adaptation to the tooth root surface (Figures 4.19-4.21) .

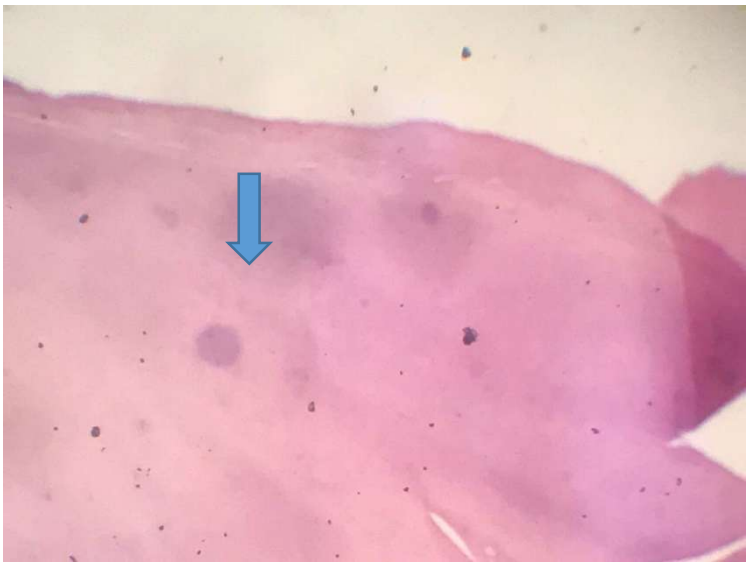


Figure 4.19. The root tissue of the tooth after applying a smooth zirconia post; the post is freely located in the cavity, the surface is smooth. Indicated by a blue arrow. Staining with hematoxylin and eosin. Magnification: Obj. 4.0 x 10.

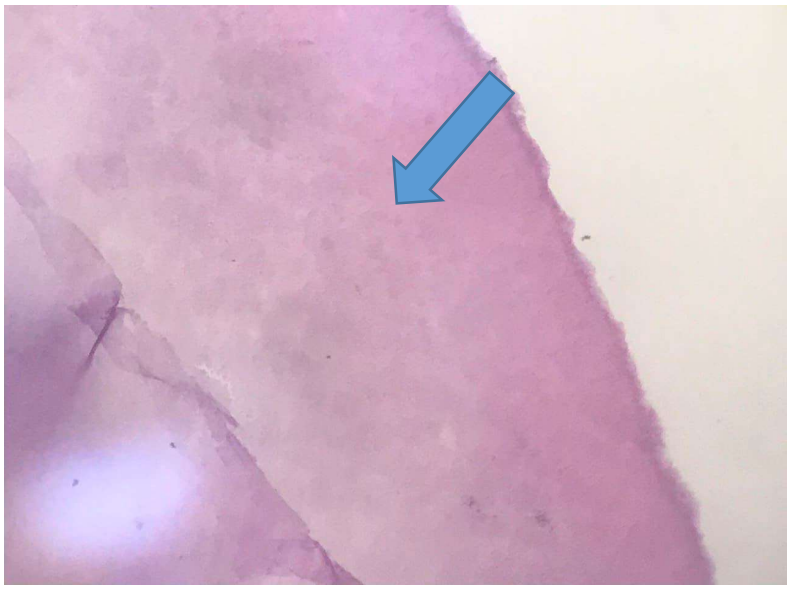


Figure 4.20. The same material from another section is shown with an arrow; no traces of fixation of the smooth zirconia post are observed on the side of the tooth cavity. Staining with hematoxylin and eosin. Magnification: Obj. 10.0 x 10.

Figure 4.21. Dental tissue specimen with a drilled threaded zirconium pin. The arrow labeled A shows the surface on the tooth cavity side with a rough texture where the drill teeth made contact. Signs of the pin's most secure fixation. Hematoxylin and eosin staining. Magnification: Objective 10.0 x 10.

Thus, in the tooth cavity wall where a smooth-surfaced zirconium pin is used, there is no dense fixation, and the surface is smoothed. When using a drilled threaded zirconium pin, the wall on the tooth cavity side where the pin attaches has a serrated surface with traces of drill teeth, which ensures a more secure pin fixation (Fig. 4.22).

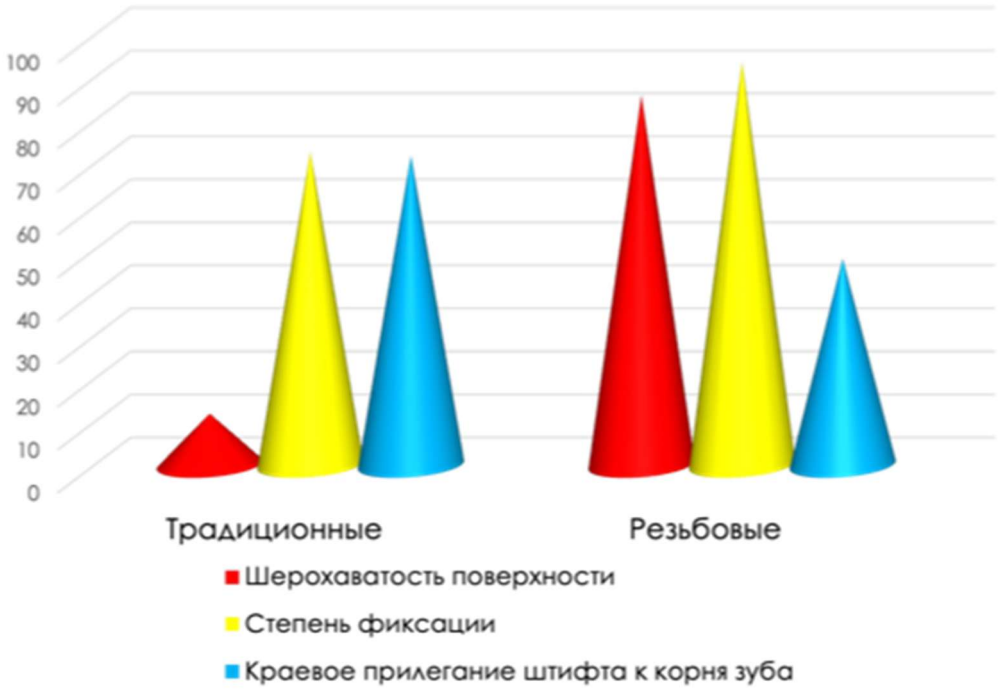


Fig. 4.22. Results of morphological examination

Rapid technological progress offers a choice among the latest prosthetic methods that enable the mineralization of burdens.

Chapter Conclusions

According to the results of a retrospective analysis of outpatient records over three years after prosthetic treatment, pin fracture was observed in 20 (5.2%) patients; tooth extraction due to the destruction of pin structures in 58 (15.1%) patients; tooth root fracture in 37 (9.6%) patients; and destruction of composite restoration in 33 (8.6%) patients.

A threaded pin tooth made of zirconium dioxide with mathematically justified pin and crown geometry based on computer modeling has been developed and utilized. Pin variants with different length, diameter, and thread pitch parameters are proposed.

The effectiveness of using a threaded zirconium dioxide post-and-core construction to restore a tooth crown defect lies in eliminating the pressure of the fixing material on the root canal walls by allowing excess material to escape through the created thread, which prevents root fracture, which is especially important when fabricating posts for teeth with thin walls. The results of the GDM study showed that after prosthetic treatment,

the periodontal load tolerance in patients of the main group returned to almost normal levels within 3 months, which once again convincingly demonstrates the functional effectiveness of the proposed post-and-core design.

Morphological examination of the tooth cavity wall at the site of a zirconium post with a smooth surface shows no tight fixation, and the surface is smoothed. The wall of a zirconium threaded post on the tooth cavity side at its attachment point has an indented surface with traces of drill teeth, which ensures a tighter post fixation.

The clinical use of the proposed post design as a support for an all-ceramic crown showed high efficacy (95%). Throughout the entire observation period, no root or structure fractures in any part, nor any loosening of post or crown fixation were observed. In long-term follow-up, the most common complications associated with the post were gingival recession and marginal bone tissue atrophy.

CONCLUSION

Analysis of domestic and foreign literature has shown that one of the important problems in orthopedics is the reconstruction of teeth with total or subtotal destructive processes in the tooth crown. This problem can be solved by preserving the tooth root for prosthetic procedures, which will subsequently prevent the displacement of the dental arch and the loss of alveolar processes (Arutyunov S.D., 1997; Kopeykin V.N., 1998; Bragin E.A., 2009; Losev F.F., 2012 and others). This solution is especially relevant for large molar teeth, as they have the strongest influence on the formation of the dental arch (Lobanov Yu.S., 2001; Zissis A., 2019).

Research by Lyubenko D.T., 1993; Akilova T.A., 1995; Sagina I.V., 2015 and others, showed that the presence of roots in the oral cavity is about 51.7%, while as the authors note, 93.2% of roots could have been preserved and used as support for dental prostheses.

The high significance in science and practice of problems associated with the installation of artificial tooth crowns is based on the high probability of complications developing with this type of prosthetics, which requires further improvement of existing methods. The lack of reliable data on the strength of the reconstructed tooth structure necessitated this clinical and morphological study and the compilation of this work.

Issues requiring solutions include improving the design of post and core restorations during root reconstruction, methods for their fixation considering secondary caries, and rational distribution of load on the tooth's hard tissues. These factors determined the relevance of the research topic and its practical significance.

The main goal of our research was to develop, use, and provide experimental and clinical substantiation for the effectiveness of a threaded design of zirconium dioxide post and core restorations in prosthetic treatment of crown defects.

To accomplish the planned research, the following tasks were set:

1. Conduct a retrospective analysis of archival material from the dental clinic of the Tashkent Institute of Dentistry for patients who received

prosthetic treatment using cast post and core restorations, and identify the percentage and types of complications arising from the use of this design.

2. Develop an original individual design of a post and core restoration for single-rooted teeth in the upper and lower jaws.

3. Using mathematical modeling, determine the biomechanical behavior of a tooth with an intraradicular post.

4. Scientifically substantiate and implement a method for manufacturing a threaded design of post and core restorations from zirconium dioxide, produced by 3D milling, taking into account the anatomical and topographical features of anterior teeth, and determine their resistance to mechanical loads.

5. To study the immediate and long-term results of the proposed pin tooth design and recommend its implementation in practice.

6. To evaluate the clinical outcomes of the proposed orthopedic treatment method and provide practical recommendations.

To achieve the set goal and objectives of the study, we examined and provided orthopedic dental care to 78 patients with crown defects aged 16 to 60 years, as well as 24 practically healthy individuals with intact crowns of frontal and lateral teeth as a control group. *The objects of the study* were teeth destroyed up to and at the level of the cervical region of their hard tissues.

Depending on the tactical treatment methods we used to address the set tasks, the examined patients were divided into three groups:

1. The main group consisted of 48 patients, in whom the restoration of damaged teeth was carried out using our newly developed pin tooth design.

2. The comparison group consisted of 30 patients with dental defects restored by traditional pin structures.

3. The control group included 24 patients with intact crowns of frontal teeth and premolars.

We studied the medical records (outpatient charts) of patients (retrospective analysis) for the period from 2016 to June 2019 at the Therapeutic and Orthopedic Dentistry Polyclinic of the Tashkent State Dental Institute (TSDI) who had pin tooth prosthetic structures.

Out of the total number of patients seeking dental care, 325 individuals had defects in the crown portion of their frontal teeth.

To address the aforementioned tasks, the following research methods were employed:

1. Retrospective analysis of archival material;
2. Clinical and stomatoscopic examination methods;
3. Radiological examination methods;
4. Functional examination methods;
5. Morphological examination methods;
6. Mathematical modeling methods
7. Statistical research methods.

During the course of scientific research:

- a method for manufacturing a threaded design of pin teeth made from zirconium dioxide was developed (Patent of the Republic of Uzbekistan No. FAP 01787 dated March 18, 2021) (see Appendix);

- based on the anatomical and topographical features of frontal teeth, the manufacture of a threaded design for pin teeth made of zirconium dioxide was scientifically substantiated;

- for the first time, based on multidirectional studies: clinical-stomatoscopic, functional, X-ray examinations, and modeling methods were conducted, and comparative results of adhesion and stabilization values of pin teeth were determined using traditional fabrication methods and our proposed design.

The scientific significance of the work lies in the development of scientific research to determine the clinical, radiological, and functional assessment of the preservation and restoration of permanent tooth crown defects, forming functionally and cosmetically correct and reliable dental rows using pin teeth of our proposed design, which is characterized by the improvement of methodological foundations for scientific research on this topic.

The practical significance of the work lies in the fact that we have developed and implemented in dental practice our proposed threaded design of pin teeth made of zirconium dioxide, manufactured by 3D milling for the restoration of permanent tooth roots.

Based on the conducted scientific research on the diagnosis, prevention, and treatment of defects in the crown portion of upper and lower teeth using our proposed threaded design of pin teeth made of zirconium dioxide, manufactured by 3D milling:

The results of the study conducted during the aforementioned period revealed that the majority of individuals seeking dental care were female, with the main reason being the dysfunction of the aesthetic component of pathological teeth. The primary factors affecting the aesthetic role were: the location and number of pathological teeth, the extent of destruction, and qualitative indicators such as color, surface condition, and edge integrity. Some individuals with anterior crown destruction may develop speech with a slight lisp or whistling sound.

A retrospective analysis of patient medical records for this period showed that 384 post-and-core restorations of various designs and materials (cast metal, prefabricated, zirconium, wire, etc.) were used in dental clinics to restore damaged tooth crowns.

We have developed and proposed for practical application the design of a post-and-core tooth and a fixed splint for orthopedic treatment made from zirconium dioxide and a thermoplastic material based on polyoxymethylene "T.S.M. Acetal Dental" (A.N. Akbarov, N.R. Nigmatova, 2021; V.A. Klemin, N.R. Nigmatova, V.V. Volvakov, 2016).

The research process consisted of three stages of solving a geometrically and physically nonlinear problem using an iterative-incremental scheme.

When conducting the study, the average values of Young's modulus (elasticity modulus) for the tissues of the dentoalveolar system were taken into account.

Loading was carried out in 2 stages. In the first stage, the initial tension of the tire's metal structure was set, and in the second stage, the initial tension of the thermoplastic structure was set.

For numerical modeling, a finite element package specifically designed to solve the given problem was used.

Based on the conducted mathematical modeling, we have developed a new type of dental post equipped with a removable head, simple in

design, convenient to use, as well as expanding the range of dental post options.

The technical advantages of the proposed design include the ability to replace a worn head with a new one without the need to remove the post from the tooth root or perform restorative work on the core.

The problem was solved by creating a dental post with an insert for a single-rooted tooth, made in the form of a screw, consisting of two parts: intraradicular and extraradicular. The intraradicular part is made in the form of a truncated cone with a thread, while the extraradicular part has a slot for screwing in the post and is cone-shaped.

Making the extraradicular part cone-shaped, which is streamlined and easier to process, allows simplifying and reducing the cost of post manufacturing by eliminating the need to process the junctions of the disc-shaped stop with the intraradicular and extraradicular parts.

We have proposed variants of the post with different parameters of length, diameter, and thread pitch.

The dental post is made as a single piece, with the intraradicular (apical) part and the extraradicular part for the crown (in the form of an abutment) representing separate sections of a solid screw, equipped with a removable screw with a head. Such a dental post is used for single-stage fixation of artificial crowns.

Combining two functions in one extraradicular part of the specified dental post (a plug for the canal opening and the shaper of the crown portion of the tooth) simplifies and accelerates the treatment process, as there is no need for a second, so-called surgical intervention, i.e., taking an impression to make the extraradicular part of the post. Making the core head removable allows for its replacement in case of wear or damage.

After obtaining impressions for making the posts, the work is sent to the laboratory. The technician prepares the patient's plaster model and scans it.

The computer processes the received information and creates a virtual model of the future structure. CAD/CAM technologies are controlled by 3D software.

The computer creates a highly precise three-dimensional model of the future design and automatically, using milling cutters and water cooling, "mills" the restoration from a solid block of zirconium.

The proposed design was used in the orthopedic treatment of 48 patients (27 men and 21 women) aged 18 to 60 years who sought treatment at the clinic for dental hard tissue defects. A total of 14 post and core restorations were fabricated for the anterior teeth of the upper jaw in these patients. The posts with cores were made from zirconium dioxide. The cores were cemented using glass-ionomer cement.

Thus, our proposed design of the dental post and core restoration allows for a reduction in the pressure of the cementing material on the root canal walls during its cementation, the use of cement with normal rather than fluid consistency, and the prevention of root fracture, especially in cases where the root canal walls are thin. This proposed post and core design can find wide application in modern practical healthcare.

Clinical studies were conducted at the polyclinic of the Department of Faculty Orthopedic Dentistry at the Tashkent State Dental Institute. The analysis and conclusions were based on examination data from 78 patients with crown defects. Of these, 46 (58.97%) were men and 32 (41.03%) were women aged 18 to 60. The main group of patients was divided into 2 groups: 1st - the main group of patients with complete destruction of the tooth crown, for whom we fabricated our developed design of a post-and-core tooth using an individual zirconium dioxide post - 48 (61.54%) patients; and 2nd - the comparison group of patients, who had post-and-core teeth made using the traditional method - 30 (38.46%) patients.

The effectiveness of using zirconium dioxide-based post structures after 2 years is 95% (taking into account all possible complications caused by this material).

Thus, based on the anatomical and topographical features of anterior teeth, the fabrication of a threaded design for post-and-core teeth made from zirconium dioxide using the 3D milling method has been scientifically substantiated.

The results of the clinical use of our proposed post design as a support for an all-ceramic crown showed high effectiveness.

The proposed post structure can find wide application in modern practical healthcare.

For morphological examination, the material was fixed in a neutral formalin solution and decalcified in nitric acid together with the pins. After fixation, the zirconium pins were carefully removed and processed through alcohols and chloroform, then paraffin blocks were prepared. The prepared sections were stained with hematoxylin and eosin.

Clinical and radiological studies were used to select tooth stumps for the fabrication of post-and-core structures.

Then, the fabrication of a dental post with an inlay was initiated using the CAD/CAM/CAE system method. First, a digital impression was taken using the Oral scan device. Afterward, the digital impression file was transferred to the dental technician's computer in the technical laboratory. The technician used the Exocad program to prepare an electronic version of the post based on the patient's data. After verification, the file was sent to the milling machine where the post was fabricated. After milling, the technician finished the post and sent it to the clinic. The finished post was then tried in the oral cavity to assess the quality of preparation and check the fit of the artificial core to the supragingival tooth surface. After inspection, it was removed and, following antiseptic treatment, cemented with glass ionomer cement.

Samples of individual zirconium posts with smooth and threaded surfaces, stained with hematoxylin and eosin, were used to assess the morphological quality of their adaptation to the tooth root surface.

Thus, in the tooth cavity wall at the site where a zirconium pin with a smooth surface is used, no dense fixation is observed, and the surface is smoothed. When using a zirconium drilled threaded pin, the wall on the side of the tooth cavity at the pin attachment site has a serrated surface with traces of drilling teeth, which ensures a denser pin fixation.

Thus, based on the conducted clinical-stomatoscopic, radiological, functional, and morphological studies and the use of methods for mathematical modeling of the patients' dentoalveolar system and dental prostheses made of zirconium dioxide, we can conclude:

1. According to the results of the analysis of outpatient records (retrospective analysis), within three years after prosthetics, tooth extraction due to the destruction of pin structures occurred in 58 (15.1%) patients; pin fracture was noted in 20 (5.2%); destruction of the composite restoration - in 33 (8.6%), and tooth root fracture - in 37 (9.6%).

2. A threaded pin tooth made of zirconium dioxide with mathematically justified pin and stump geometry based on computer modeling was developed and used. Pin options with different length, diameter, and thread pitch parameters are proposed.

3. The effectiveness of using a threaded zirconium dioxide pin tooth construction to restore a crown defect lies in eliminating the pressure of the fixing material on the root canal walls by releasing excess material pressure through the created thread, which prevents root fracture, which is especially important when fabricating a pin for teeth roots with thinned walls.

4. The results of the GDM study showed that after prosthetic treatment, the periodontium's tolerance to load in patients of the main group recovered almost to normal within 3 months, increasing chewing efficiency by 12.5±1.23%, which indicates the functional effectiveness of the proposed pin tooth design.

5. Morphological examination of the tooth cavity wall at the site of the zirconium dioxide threaded pin usage showed surface roughness of 86±1.05%, degree of root fixation of 94±2.1%, and marginal adaptation to the tooth root walls of 48±3.6%.

6. When restoring a defect in the crown portion of a single-rooted tooth, it is advisable to use pins made of materials based on zirconium dioxide, which provide sufficient strength and high aesthetics for the prosthesis.

7. When installing a prosthesis in cases of total crown destruction using pins inserted into the root, it is necessary to optimize the load distribution along the tooth axes to prevent stress on the structures under horizontal pressure.

8. The use of a post with a threaded structure requires the use of high-quality dual-cure cements or modified composites and full adherence to

their application technique.

9. More extensive use of post structures manufactured through modeling, scanning, and milling procedures is necessary.

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APPENDIX

FOYDALI MODELGA

PATENT

ПАТЕНТ НА ПОЛЕЗНУЮ МОДЕЛЬ

O'ZBEKISTON RESPUBLIKASI ADLIYA VAZIRLIGI HUZURIDAGI
INTELLEKTUAL MULK AGENTLIGI
АГЕНТСТВО ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ
ПРИ МИНИСТЕРСТВЕ ЮСТИЦИИ РЕСПУБЛИКИ УЗБЕКИСТАН

№ FAP 01787

Ushbu patent O'zbekiston Respublikasining Ixtirolar, foydali modellar va sanoat namunalari to'g'risidagi Qonuniga asosan quyidagi foydali modelga berildi:

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Patent O'zbekiston Respublikasining barcha hududida 18.03.2021 yildan patentni kuchda saqlab turish uchun bir o'z vaqtida to'langandagina 5 yil muddatida amal qiladi.
O'zbekiston Respublikasi foydali modellar davlat reestrida 27.01.2022 yilda Toshkent shahrida ro'yxatdan o'tkazilgan.

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Direktor
Директор

T. Абдусаттаров

INTELLEKTUAL MULK AGENTLIGI

LIST OF ABBREVIATIONS

WHO - World Health Organization
HI - Hygiene Index
UJ - Upper Jaw
LJ - Lower Jaw
DFS - Dentofacial System
OCC - Occlusion
SD - Secondary Deformation
CDM - Control and Diagnostic Model
OPG - Orthopantomogram
DAE - Dentoalveolar Elongation
PMA - Papillary-Marginal-Alveolar Index
MFR - Maxillofacial Region
GIT - Gastrointestinal Tract
CNS - Central Nervous System
TMJ - Temporomandibular Joint
TRG - Teleradiography
PT - post-and-core teeth
ZCIP - zirconium dioxide individual posts

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USE OF CUSTOM ZIRCONIUM DIOXIDE POSTS IN PROSTHETIC TREATMENT OF CORONAL TOOTH DEFECTS

(Monograph)

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