TELEDENTISTRY METHODS IN ORTHODONTICS AND PROSTHETIC DENTISTRY DURING COVID-19 PANDEMIC

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Abstract: Introduction: Teledentistry is a part of telemedicine. Digital technologies were very useful during the COVID-19 pandemic. CAD/CAM technique and additive manufacturing are main part of them.
Purpose: To demonstrate some of the opportunities of digital technologies in daily dental practice during the COVID-19 pandemic.
Materials and methods: Intraoral scans of different types of patients were performed. Three groups of patients were included in the study: patients for upcoming prosthetic treatment, patients after orthodontic treatment in the phase of retention of the result and patients with parafunctions.
Results: The demonstrated prosthetic restorations were made by CAD/CAM technology and combined 3D printed metal framework with ceramic masses, placed by classical technology. Received retainers were two types – classical Essix, but mold on a printed model, and a printed retainer. Splint was printed with author's design and according to the main rules for bruxism treatment.
Conclusion: The usage of digital technologies as a Teledentistry method in the COVID-19 pandemic has numbers of advantages: reducing the duration and increasing patient in the first clinical stage due to intraoral scanning; reduces work with materials that have been in access to saliva; reducing the number of intermediate stages - casting of working models; reducing the duration of the last clinical stage due to more precisely obtained constructions.
Keywords: CAD/CAM technology, 3D printing, digital impression, intraoral scanning

1. INTRODUCTION

Covid-19 was recognized in December 2019. The World Health Organisation declared a coronavirus (COVID-19) pandemic on 11 March 2020 [World Health Organisation 2020].
According to a report on coronavirus disease 2019 (COVID-19), authors had drawn attention to dental risk, in which asymptomatic patients had been mentioned many times and researchers have shown the role of oral mucosa in COVID-19 infection [Xu, J. et al. 2020]. Due to the desire for indirect contact, telemedicine, teledentistry and telepharmacy were revived [Kilova et al. 2021 (3), Kilova et al. 2020].
Teledentistry is not a new part of the dentistry. It has a long story, but nowadays with digital technologies is more applicable. One of the largest teledentistry project began in 1994 in US military [Rocca et al. 1999]. Teledentistry can be divided in some subunits: teleconsultation, telediagnosis, teletriage and telemonitoring. Teleconsultation involves the use of technology so that the medical professionals and patients can interact with each other bringing health to where ever it is needed. Telediagnosis by the help of mobile phone pictures sometimes is easy and correct, but is not so accurate as clinical examination. Teletriage involves the safe, appropriate and timely disposition of patient symptoms via smartphone by specialists. Monitoring of dental patients require frequent visits of patients to their dentist to monitor the progress of treatment. The use of telemonitoring can replace the frequent physical visits by virtual visits [Mariño et al. 2013, Schweiger et al. 3016].
Modern software allows the creation different types of splints depending on the indications. They can be made by the methods of 3D printing or CAD/CAM milling. 3D printing technology in dentistry is designed to reduce the cost and facilitate the intermediate stages of the construction. It is possible to perform all stages - from preparation (rigid prototype) to the final construction [Dikova et al. 2015, Taneva et al. 2020]. CAD/CAM methods reduce the number of visits, increase bioavailability and visualize the final result [Bakova et al. 2019].

Obtaining this virtual model can be done by scanning directly into the patient's mouth using an intraoral scanner, by scanning a conventional impression of the prosthetic field or a model [Brown et al. 2018]. Digital models are described as extremely accurate. The error in scanning the whole jaw varies from 10 to 50 μm, which is imperceptible [Kim et al. 2017]. The largest deviation with an average value of 149 μm was reported when scanning with an extraoral scanner [Haleem et al. 2019].

In the treatment of fixed structures in many cases the digital impression is absolutely sufficient to complete the treatment. After scanning the both jaws and the bite relation, the information is sent to the dental laboratory. There, a design of the future prosthetic structure is created, which can be finished by CAD/CAM or 3D printer technology and returned to the office [Joondeph 2012].

The retention phase of orthodontic treatment is an important phase in preventing teeth from returning to their initial position. Keeping teeth in the correct position after active removal has always been and continues to be a challenge. The result obtained is unstable and there are many factors influencing long-term retention. It can only be achieved if the forces coming from the periodontal and gingival tissues, from the soft tissues, the occlusal forces and from the residual facial growth are equalized [Johnston et al. 2015].

Retainers are devices applied after active orthodontic treatment to maintain the result until complete remodeling of the hard and soft tissues and / or until the completion of skeletal growth. They are removable and fixed [Sweeney et al 2015]. One of the most commonly used retainers today is the vacuum-formed thermoplastic Essix retainer, proposed by John Sheridan in 1993. Today, traditional vacuum-formed retainers are increasingly being replaced by the same ones but made on 3D printed models rather than gypsum models. The reason for this is the proven advantages in the accuracy and stability of digitally created working models over that of their analogues [Cole 2018]. Therefore, such models are now used to create many other orthodontic appliances - aligners, expanders, transfers for indirect fixation of braces and more. The use of specific materials related to these new technologies requires future studies and experiments on their applicability to individual structures. Retainers still printed have not been sufficiently studied for orthodontic purposes [Reddy et al. 2014].

Bruxism is a common parafunctional habit with a multifactorial ethology (biological, physiological, exogenous, etc.). It is detected after a thorough history of muscle fatigue in the area of m. masseter, pain in the temporomandibular joint and / or ear, tingling, soreness or a feeling of loosening of the teeth. Clinically, abraded tooth surfaces (flat, point and combined) are observed [Hanamura et al. 1987].

Occlusal splints are routinely used to treat dysfunctions of the TMJ and the masticatory system. Hard or soft braces cover the tooth surfaces by eliminating occlusal disharmony, immobilizing the teeth and reducing bruxism [Nakayama et al. 2018]. Many cases of pain reduction after treatment with occlusal splints have been documented [Clark et al. 1991, Hasegawa et al. 2017].

The literature describes two main types (stabilization, reposition) of Okeson splints and four additional (pivot, soft, anterior bite splint, posterior bite splint) [Okeson 2019, Moin et al. 2019]. Digital technologies are included in many contemporary researches [Taneva et al. 2021 (2), Kasnakova et al. 2018].

The purpose of this article is to demonstrate some of the opportunities of digital technologies in daily dental practice during the COVID-19 pandemic.

2. MATERIALS AND METHODS

Intraoral scans of different types of patients were performed. Three groups of patients were included in the study: patients for upcoming prosthetic treatment, patients after orthodontic treatment in the phase of retention of the result and patients with parafunctions. Patients for surgical (non-implantological), therapeutic and periodontal treatment was not included. In these cases, digital technologies have a very limited application.

An intraoral scan of patients with Trios Color on 3Shape was performed. The obtained digital models were subjected to additional software processing for the 3Shape Dental system design.

The cases of prosthetic treatment were completed by CAD / CAM technology or 3D printing. CAD / CAM technology allows producing fixed prosthesis from zirconium ceramics, PMMA polymers, PEEK and others. After the intraoral scanning and computer design, the milling machine is loaded. This is followed by milling, sintering and coloring the ceramics.

In 3D printing, metal-ceramic constructions were made, in which the metal was printed and ceramic masses were applied on it. In this case, additional printing of working models is required. In order to place the ceramics, it is necessary to print a working model with removable dies. After the intraoral scan, a design is made for the metal framework. The applied ceramics were sintered and colored, as the anatomical features were made according to the occlusion of the working model.

Metal framework was printed from a ***LaserForm CoCr dental*** material and it was printed using a ***ProX® DMP 200 Dental system***. Working models were made using a ***Formlabs Form 2 printer*** and ***Model Resin*** or ***Draft Resin*** like a material.

The cases of retention of the orthodontic result were completed in two ways - through a 3D printed retainer and through an Essix retainer (1 mm thickness) on printed models. For the printed retainer it was used ***Dental LT Clear Resin.*** In the cases of parafunctions, 3D printed splints with individual characteristics depending on the occlusal-articulation relationships were made. Splints were made again from ***Dental LT Clear Resin.***

3. RESULTS

They can be divided in three groups:

I. Prosthetic restorations

In the first variant of treatment using CAD/CAM technology, ceramics based on zirconium dioxide were created, fig. 1. The received product was very precise according to preparation junction and antagonists. Work with materials that have been in contact with saliva (classic impressions and models poured from them) and could transmit infection is excluded completely. In a pandemic, this is extremely important!

Fig. 1. Fixed prosthesis made from ceramics based on zirconium dioxide: occlusal view, internal view and intraoral view.

Another variant, not so aesthetic, but just as accurate, is a metal-ceramic crown, made by a combined technology – 3D printed metal and classically applied ceramic masses, fig. 2. The adaptation on a preparation junction was very precise, the occlusion in some of the cases needs little adjustment, because is made by hand, not so accurate like the virtual articulator. Again, the dental technician only works with materials and products that are not in touch by saliva.

Fig. 2. Metal-ceramic crown made by a combined technology: occlusal view, internal view and 3D printed model.

II. Retainers

Two retainers were made for the same patient - a classic Essix retainer and a printed retainer. In order to improve the mechanical and strength properties, Essix retainer is made more extensive palatal, vestibular - to the cervical part of the teeth without injuring the gingiva and papillae. The thickness of Essix material is 1mm before molding. The printed retainer is projected to the cervixes palatally and vestibularly in the front, to the equator in the distal areas vestibularly. The design of printed retainer was made with 0,8 mm thickness. The adaptation to the tooth surfaces of both variants was equally good. Patients were assigned to wear both retainers for the same duration of the day (12 hours) to test their resilience, fig. 3, 4, 5.

Fig. 3. Working model, printed retainer and Essix retainer

Fig. 4. Intraoral view with Essix retainer

Fig. 5. Intraoral view with printed retainer

III. Splints

The made repositioning splint adapts very well on the tooth surfaces of the upper jaw. The splint was made with a thickness of 2.2 mm oclusally and 1 mm vestibularly, medializing the lower jaw and in a balanced occlusion. The borders were to the cervical part palatally, to the equator of the distal teeth and to cover the incisal edge of the frontal teeth, fig. 6.

Fig. 6. Splint – immediately after making and in the patient mount

4. DISCUSSION

Prosthetic restorations based on zirconium dioxide have very good aesthetic qualities. The problematic graying of the cervical part in prosthesis with metal ceramics is absent. However, when using monochrome discs, the natural aesthetics of the smile is not achieved due to the lack of transparency and the transition of colors to darker in the

cervix. The 3D printed framework allows the printing of large structures without the possibility of twisting or bending. The same thickness of the metal is achieved, the same offset from the prepared tooth and as a result a perfect adaptation [Kim et al. 2017, Joondeph 2012].

The thin foil of the Essix retainer is extremely aesthetic and almost invisible during talking and smiling. However, it has unsatisfactory mechanical and strength properties, which necessitates its almost monthly replacement with a new retainer. Printed retainers are still poorly used in orthodontic practice. Although less than 1 mm thick, they can cause displacement of the lower jaw and have beneficial effects [Sweeney et al. 2015, Cole 2018, Reddy et al. 2014].

Splints are the most common method for bruxism treatment. By covering the tooth surfaces, it protects them from mechanical friction between them and the loss of hard tissues. By raising the height, the position approaches the relax position, which aims to eliminate the habit [Nakayama et al. 2018]. Balanced occlusion with the splint does not allow the growth of single teeth and does not overload the periodontium of individual teeth with tight occlusion [Clark et al. 1991, Hasegawa et al. 2017]. Digital technologies allow precise design, equal offset between tooth surfaces and the inner surface of the splint, pre-inspection in central occlusion and articulation [Taneva et al. 2021 (2), Kasnakova et al. 2018].

5. CONCLUSION

The usage of digital technologies as a Teledentistry method in the COVID-19 pandemic has a number of advantages: Reducing the duration (with proper operation, the scan takes between 1 and 2 minutes for the entire jaw) and increasing patient comfort (nausea and discomfort when placing the impression mass in the mouth) in the first clinical stage due to intraoral scanning; Reduces work with materials that have been in access to saliva (classic impressions); Reducing the number of intermediate stages - casting of working models. Dental technicians are protected because they work on digital models and do not have access to saliva residues on the impressions; - Reducing the duration of the last clinical stage due to more precisely obtained constructions.

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