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Assessment of Various Treatment Techniques in Restoring Articulatory Balance in the Mastication Center of Occlusion

Danilo Krstevski, Darko Pop Acev, Zlatko Vlashki

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Danilo Krstevski, Darko Pop Acev, Zlatko Vlashki

International Balkan University, Skopje, N. Macedonia Mito Hadzivasilev-Jasmin 36/2-3 Skopje, N. Macedonia, tel. 389 70 893 934

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Correspondence concerning this article should be addressed to Danilo Krstevski

Email: danilo.krstevski@ibu.edu.mk

Abstract: The dental concept of occlusion is defined as functional contact or relationship between the teeth from the upper and the lower jaw. This equilibrium in the masticatory center of occlusion can be interrupted through various processes of tooth destruction or extraction. These alterations disturb the relationship in the occlusion, noticeably in negative direction.

The dentist's main goal is to restore the mastication center and maintain that occlusal balance. There are different options and techniques concerning the way of restoring the occlusal balance. In this article, we will consider them, describing materials and methods used, as well as their positive and negative sides.

Keywords: occlusion, restoration, implant, zirconia.

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Introduction

Occlusion is an independent complex concept, an interesting discipline, which has a key role in prosthetics. Certainly, knowledge of occlusion and its basic rules is useful for dentists, who tend to penetrate deeply into the physiology of the masticatory system. It is also important in the wider sense of the dental clinical practice.

Occlusion indicates the contact between the teeth from the upper and the lower jaw in the process of mastication (Valentić-Peruzović, M., et al. 2008). Anderson defines the term occlusion as an intimate contact at the moment when the teeth of the mandible come into contact with the teeth of the maxilla (Anderson, D. M. 1994). On the other hand, McNeill defines occlusion as a mutual functional relationship between the basic components of the stomatognathic system, which includes the teeth, the periodontium, the neuromuscular system, the temporomandibular joints and the craniofacial skeleton (McNeill, C. 1997).

Occlusal relations spontaneously change throughout life, but in the meantime, it is very important to be maintained in a harmonious balance. There are many changes in the oral cavity, physiological and pathological that can disturb the equilibrium in the masticatory center, such as the process of decay, tooth abrasion or tooth extraction.

The first permanent molars are the teeth that erupt the earliest and form the occlusion. Since they exist in the mouth for the longest time, they are the most susceptible to various bacterial attacks. Morphologically expressed deep fissures in which food can be retained, in addition to irregular and improper hygiene, is the main reason for their destruction. As a result of various etiological reasons, their damage and occlusal dysfunction occur at a very early age. In general, signs of functional disorders of the permanent dentition are manifested by erosion and abrasion of individual teeth, abrasive helicoid facets and Stillman fissures along the gingiva of the pressure-exposed teeth.

For justified or unjustified reasons, molars are the teeth that most often suffer from chronic diseases and are extracted at an early age. Due to their absence, there is a discontinuity in the dental arch and a loss of the alveolar bone, during which the process of irreversible destruction begins.

Over time, negative changes occur in this region like spontaneous mesio-distal migration of the neighboring agonist teeth that starts towards the free space, as well as elongation of the antagonist teeth (Godon's phenomenon). These changes cause dysfunction of the natural masticatory center (Fig. 1, 2)

The goal of the research presented in this article has been elaboration of the possibilities of restoring the function of lost masticatory center using a multidisciplinary dental approach with a tendency to preserve the remaining teeth in the patient's mouth and avoid inclusion of more teeth in the reconstruction process. With a special emphasis on a non-invasive rational therapy, this approach is enabled by several techniques, as well as the use of modern materials in order to repair the present defect.

Materials and Methods

The advancement of technology and the presence of a range of modern dental materials, have provided many possibilities and different restoration techniques. With their rational combination along with maintenance of good oral health, quality results can be achieved.

While providing endodontic treatments, we applied the Protaper technique. Channel instrumentation was used in the following order: K-file, shaping file S1, shaping file S2, finishing file F1. During the treatment, irrigation with physiological solution and sodium hypochlorite was performed. The final obturation was achieved by cold condensation of gutta-percha and silane. After the endodontic treatment, we applied a retention pin - titanium coin number 9, 10 or 11. The completed endodontic treatments with the final obturation were radiographically confirmed.

In the cases supported by the conservative treatment for restoring the masticatory center, we used various definitive fillings of glass ionomer type (3M ESPE Ketac universal) and nanocomposites of extremely good strength (3M ESPE Filtek Ultimate and Kuraray Noritake).

When there was a greater destruction of the tooth in the coronal part, with the tooth still vital, reconstruction was made in cooperation with a dental laboratory as an inlay, onlay or overlay. This was made by cutting a zirconium oxide block using the IPS e-max CAD software program or with the empress full-press technique. The strength of this material meets the standards of occlusal forces - flexural strength (biaxial) 360 MPa.

Modern technology offers many possibilities for making solo crowns and bridge structures from various types of materials. In the cases shown, we made several types of prosthetic works, starting with classic metal-ceramic crowns to zirconium oxide full ceramic reconstructions.

In cases where the masticatory center was lost as a result of extraction of teeth with a larger bone defect, implantation of Nobel Biocare implants was applied, supplemented with bio oss granular component. A sinus lift intervention was applied in the upper jaw during the implantation phase itself.

Results

Achieving stable results requires implementation of specific principles that include conservative - endodontic, orthodontic, oral - surgical and prosthetic interventions (McNeill, C. 2000).

The selective application of various types of conservative, prosthetic and surgical treatments and techniques that we applied in clinically different cases gave us encouraging positive results. Regular control check-ups were done at 6, 12 and 24 months. They showed functional justification of the treatment that was applied. With regular follow-up, after a period of 2 years, the occlusion was stabilized in the area of the masticatory center, as well as in the entire remaining dentition. The most important thing, inter alia, is that no negative changes were observed in the temporomandibular joint during those follow-ups.

Teeth Restoration With Endodontic Treatment

Occlusal discrepancies can have a harmful effect on individual teeth in terms of their complete destruction, occlusal abrasion, caries development and even fracture of their coronal part. Revitalization is inevitable in cases where the damaged tooth is seriously destroyed and needed as an anchor for prosthetic restoration. Sometimes, when there is an advanced caries process deep into the tooth structure, it is necessary to remove the pulp of the tooth.The same rule of pulp extirpation applies when the tooth is overerupted due to a missing antagonist and its crown should be shortened. This is the result of the fact that more space is required for levelling the prosthetic plane and properly reconstructing the occlusion by a functionally justified prosthetic reconstruction.

For such cases where endodontic treatment was required, we applied the Protaper technique, as one of the modern endodontic techniques. For this technique, we used channel instrumentation in the following order: K-file, shaping file S1, shaping file S2, finishing file F1. The final obturation was achieved with a F1 gutta-percha pin. The complete obturation was radiographically confirmed by retroalveolar images. (Fig. 3, 4, 5).

Restoration After Endodontic Treatment

Following the endodontic treatment and necessary time given, we started with placement of a retention pin (titanium coin)(Fig. 6,7). With a heated instrument, we removed the top part of the gutta-percha and disinfect to obtain a clean working field. Then, with a suitable canal expander (drill) with a slightly larger diameter than the diameter of the Protaper gutta-percha, we processed the canal of the tooth. The length and width of the channel processing was appropriate to the dimension of the retention pin, which is available in several fabricated sizes. When we finished the root canal treatment, which we confirmed with a retro alveolar image, we fixed the retention pin with composite or polycarboxylate cement.

Restoration With Glass-Ionomers

Glass-ionomers as restorative materials are often used due to their biocompatibility. The low degree of irritation of the dental pulp, the diffusion through the dentinal tubules and their adhesiveness make them preferable for a non-invasive therapy. In combination with composites as a "sandwich" technique, they have proved themselves as a good choice in conservative dentistry. No significant dimensional changes have been observed during the bonding process. This reduces the appearance of micro cracks and enables good edge closure of the restorations. The use of GICs is based on their ability to chemically bind to dentin and release fluorides in a long-term, delayed manner. The possibility of occurrence of secondary caries is minimized and the occurrence of secondary or reparative dentine is stimulated. This is important for the engaged teeth in the masticatory center to maintain their vital condition.

In case of deeper carious lesions, the use of GIC enables treatment of teeth without endodontic treatment (biomimetic dentistry), which, in addition to preserving the vitality of the teeth and its biocompatibility, also saves time in the conservative treatment. However, the most important thing is the achievement of keeping the treated tooth in its place, biologically stable and resistant to various diseases.

Restoration With Nanocomposites

Nano-composites are ideal for practical application due to the possibility of improving the approximal contacts and obtaining larger occlusal working surfaces with the antagonists. Certain teeth were selectively leveled and corrected with na-

nocomposite materials at the level of the occlusal prosthetic plane. If the molars were destroyed, but their axial walls were still well preserved, they were restored with nanocomposite fillings. Due to their hardness in the posterior region, we got stable occlusal contact and intimate contact with the adjacent teeth (Fig. 8, 9).

Nano-composite fillers with porcelain particles have consistent and high-quality marginal closure. The great strength of the material and the resistance to masticatory forces favor their choice in the everyday dental practice. Such restorations are also characterized by transparency and opalescence. This is especially significant if, in future, a prosthetic restoration made of metal-free ceramics is performed on them.The use of an inappropriate color can adversely transfuse through the ceramic and aesthetically compromise the prosthetic restoration.

Restoration With Inlay, Onlay and Overlay

Due to saving of hard dental substance and biocompatibility in a general sense, we used ceramic partial compensations for filling occlusal defects. Depending on their size and placement, they were divided into several types (inlay, onlay, overlay).The compensation was made by cutting a zirconium oxide block using the IPS e.max CAD software program or with the empress fullpress technique. Their strength met the standards and flexural strength (biaxial) 360 MPa.

The obtained restoration was characterized by proper anatomo-morphological characteristics of the corresponding part of the tooth that it compensated. Apart from the shape, it also had to match the color, so it was necessary to choose the color before the start of the technical work. Mild tinting and shading were also possible in the glazing phase, if needed. After the trial in the patient's mouth with a standard preparation, we definitively cemented the restoration with ultraviolet polymerization with Panavia SA Plus composite cement of appropriate color (Fig. 10, 11).

Restoration With Crowns or Bridges

When talking about the therapy for the lost chewing center with crowns or bridges, the successful establishment of the chewing function with the newly made prosthetic restorations is of a particular importance. For this type of reconstruction, it was not recommended to immediately prepare the teeth, but more preparations and adjustments were done on studio models, even before the beginning of the actual work.

As the most significant procedure, wax modeling of the teeth (Wax-Up) was done for those studio models. This is how we simulated future fabrication, created occlusal relationship, got a concrete vision and preconceived the final result in the insufficiency zone. We examined the created model from all sides, showed it to the patient, and only then we started the procedure for tooth preparation.

Making Protective Crowns

With the previously made wax models, we obtained the necessary shape and form of the teeth, with a new rehabilitated occlusion established in the insufficiency zone. We also used them in the next phase for the production of temporary protective crowns. We made them using the standard copier method in our dental office from cold polymerizing acrylate.

After hardening of the material, the protective crowns were processed, reoccluded, polished and temporarily fixed in the patient's mouth. The advantage of using protective crowns was great, as we got chemical, physical and bacterial protection of the prepared dental stumps, but also protection of the surrounding marginal gingiva. The possibility of correcting certain deficiencies diagnosed during the chewing function was a very significant advantage of this method (Fig. 12, 13).

Fabrication of Definitive Crowns / Bridges

In order to establish longer-term functional stability of the reconstructed masticatory center, it was necessary to replace the temporary protective crowns with permanent crowns. Fixed definitive prosthetic crowns were made from ZIRCONIA. They were made following the studio models, with which the preparation was visible from all angles in all three dimensions. If necessary, the teeth were prepared additionally. We took a two-phase correction impression that was sent to the dental technician. The laboratory work proceeded with casting of a plaster model with zero expansion.The model was processed, prepared by filling certain undermined areas with scan wax (Scan Wax) and scanned in a suitable scanner. Modeling and shaping of the crowns was done by standard computer software programs, namely, Exocad or 3Shape(Fig. 14, 15). Then, with the cut back program, the vestibular facets were removed. Furthermore, on these already cut vestibular surfaces, modeling with ceramics was performed in layers, with a brush, shaping them with morphological characteristics. In cases of migration of teeth, creative modeling of the second premolar as the first molar was possible.

The data was entered in a software program and a command was given to the CAD / CAM machine to start modeling and shaping the crowns of the prefabricated Zirconium Oxide Block. ZIRCONIA crowns in the posterior region could be completely fabricated - cut from IPS e.max ZirCAD Multilear, where the use of a cut back program was unnecessary. The hardness of the Zirconia material enabled its long-term stability and invariability in the structure - flexural strength (biaxial) 900 MPa. In addition to biocompatibility, the metal-free fixed prosthetic design was distinguished by its natural color, so the color had to be selected before the start of the laboratory work. Shades, aesthetic effects, various pigmentations were possible in the double-glazing phase, which gave us a visual sense in the region (Fig. 16, 17).

Suprastructures on Implants

A key prosthetic issue was the biomechanical loading of the construction placed on implants. At the very beginning, based on panoramic images and studio models, we planned the static positions on the dentoalveolar ridge where the implants were to be placed. Planning the superstructure configuration in advance ensured stable occlusion with multiple occlusal contacts. This was of great importance when implantation was done simultaneously and parallel to the left and right in the posterior region where the vertical dimension was greatly disturbed (Fig. 18).

Only the carefully planned arrangement of the teeth on the superstructure guaranteed us the statics and durability of the construction. After such an analysis, we performed an oral-surgical intervention with implantation of the required number of implants. At least two implants were always implanted in the posterior region according to the essential recommendations already described. During the intervention, proper care was taken for them to be placed in the middle of the alveolar ridge and, if possible, at the planned strategic positions. In the upper jaw, in the posterior region, often, due to long-term absence of teeth, enlargement of the maxillary sinus occurs. In a couple of cases, it was needed to perform an intervention by raising the sinus - sinus lift technique during implantation, which additionally required the application of biocompatible bone and bio membrane.

A period for osseointegration was provided, in which stimulation with ozone and laser therapy was done. After the recommended period, osseointegration was radiographically confirmed and placement of sulcus formers to shape the gingiva followed (Fig. 19).

The prosthetic part began by taking a single-phase open tray or close tray impression. After cleaning up the area, the sulcus formers were returned to the patient's mouth. On the impression, we precisely placed suitable analogues in the direction of the transfer caps and checked their mobility carefully. The impression was sent to the dental laboratory, where the prosthetic construction was made (Fig. 20).

With the Rombrand test, before the glazing part, in the patient's mouth, we performed reocclusion, which was mandatory to ensure free lateral movement of the occlusal cusps, known as freedom in centric. It was mandatory to relieve the stress impacts of the occlusal contacts. Between the antagonists and agonists, along the whole dental arch, multiple contact with at least 3-4 dot contacts per tooth was enabled. After finishing the trial, definite tinting and glazing of the ceramics in the dental laboratory was performed. Afterwards, finished and glazed prosthetic restoration was placed and fixed in the patient's mouth with suitable cement.

Discussion

In clinical practice, occlusion cannot simply be treated as a static contact between the chewing surfaces of the upper and lower teeth. Rather, it is a dynamic mutual physiological process between different tissues and systems. When this balance is interrupted by destruction or extraction of the teeth, a negative effect in the masticatory center occurs. Due to various etiological reasons, the body begins to compensate for the disturbed harmony and occlusal discrepancy in the dental system. Furthermore, this has an adverse effect also on the remaining teeth and the surrounding tissues.

There is evidence that these negative effects of interrupted dental arch and premature dental contacts between agonists and antagonists can be carried over the whole occlusal plane, which results in temporomandibular disorders (Okeson, J. P. 2003).

Occlusion can be classified into three basic types:

- physiological occlusion – normal occlusion, where no dysfunctions are present;
- non-physiological occlusion - traumatic or pathological occlusion with present dysfunctions
- therapeutic occlusion – occlusion meeting specific criteria for treating the negative effects of the resulting trauma (Ash, M. M., & Ramfjord, S. P. 1995).

The "key of occlusion" is a factor that prevents extrusion or overeruption of teeth.

This key is very important for the stabilization of the position of the teeth in the dental arch and their mutual occlusal contact. With each opening and closing of the teeth, this unique pattern of overall occlusal contact confirms and secures the position of the teeth every time. In particular, the key of occlusion should be such that the mesiobuccal tuber of the upper first molar during occlusal contact is positioned between the mesio buccal and medio buccal tuber of the lower first molar.

Accordingly, Edward H. Angle gives the first definition of normal occlusion and clearly defines and classifies the basic types of malocclusion (Corrucini, R. S., & Pacciani, E. 1989) (Kelly, J. et al. 1973). Various occlusal relationships have been analyzed in many professional scientific studies, but the most common and globally accepted parameter is the relationship between the molars, which is classified in class I according to Angle (Kelly, J., & Harvey, C. 1977) (Angle, E. H. 1899).

The best way of supporting structures to compensate 7 the vertical pressure is when the force is directed to the tooth's longitudinal axis. This happens when the tip of the cusp of the lower tooth comes into contact with the opposite central fissure – pit of the upper tooth (Guichet, N. E. 1977). The direction of occlusal forces along the longitudinal axis of the teeth is known as axial loading. Axial loading can be achieved in two ways:

1. By contacting the tips of the cusps with the bottom of the fissure or with the marginal ridges (usually iatrogenic); and

2.By tripotization, which means three dot, reciprocal contacts between the inclined cuspal planes of two antagonist teeth.

These two ways eliminate the forces that do not pass along the longitudinal axis of the teeth and thus allow the supporting structures of the teeth to significantly reduce the potentially harmful forces (Kemper, J. T., & Okeson, J. P. 1982).

The diagnosis of insufficient masticatory center as well as the therapeutic procedures that follow are undoubtedly correlated with our theoretical knowledge in the field of occlusion. In that sense, any superficial approach to this problem is a false and unjustified concept for therapeutic rehabilitation. The partial approach to occlusal problems, where only the relation in the insufficiency zone is taken into account without having a perspective of bilaterally equally distributed occlusion, always ends up with poor and unsuccessful reconstruction.

Conclusion

Multidisciplinary therapeutic interventions in the posterior region, which do not need large and long constructions that include the frontal region, are always practical and effective. They are sufficient to stabilize the posterior occlusion and enable functional rehabilitation of the altered masticatory center. These reconstructions should be completely integrated into the stomatognathic system.

The restoration of the masticatory center requires a thorough systematic approach and a precise plan of the working sequence. It takes a lot of effort, patience and knowledge to solve this complex issue.

The presented clinical cases were performed in collaboration with a team of specialists in the field of dental medicine, supported by creative dental techniques. Non-invasive therapy always comes as the first choice of therapy if there is a way to preserve the remaining natural teeth and still get a satisfying occlusion.

Moreover, the main goal of dental prosthetics is to compensate for a certain insufficient segment and maintain, inter alia, an occlusal harmony within the entire dental system by using correct and rational therapy. Instructions and guidelines for good oral hygiene, as well as regular check-ups should be implemented in order to maintain proper function and have long lasting rehabilitation. This improves the patient's oral health and general well-being.

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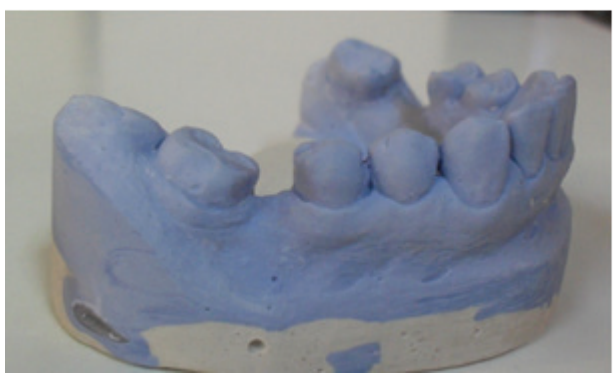
Figures



Figures 1,2

Figure 3

Figure 4

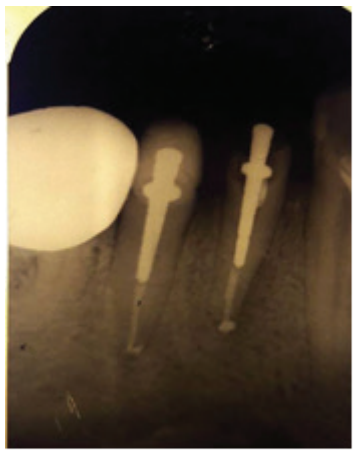


Figure 5

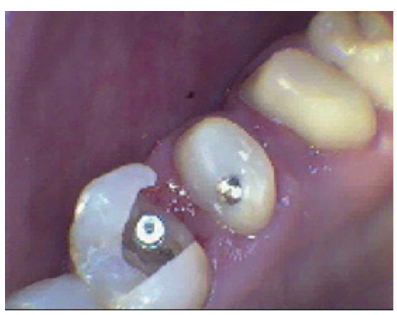


Figure 6

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Figure 9

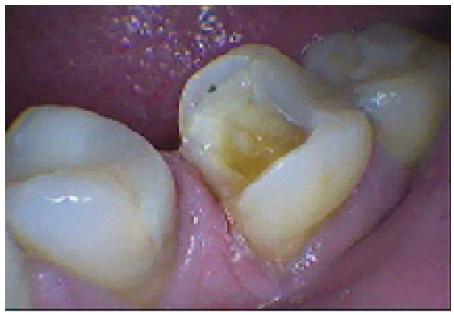

Figure 10

Figure 11

Figure 12

Figure 13

Figure 14

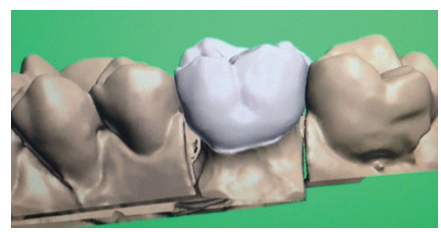

Figure 15

Figure 16

Figure 17

Figure 18

Figure 19

Figure 20