Research Article

The Experience of Studying the State of Occlusal Relations in Patients with Generalized Periodontitis Who Require Orthopedic Treatment with Non-Removable Structures Using the “T-Scan system”

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Abstract

Determining the state of occlusal relations in orthopedic dentistry is an important step both for diagnosis and for treatment. For the purpose of their study, 65 patients with chronic GP of the Ist and IInd degree of the development who needed an orthopedic treatment, were used the device "T-Scan III". Patients had a partial (1-3) loss of teeth of III and IV classes according to Kennedy; they were divided into two groups. Group I included 35 patients who had included defects and were not previously prosthetic, group II - 30 patients who had poor-quality bridges of different materials that needed replacement. Control was provided by 20 dentally healthy patients with normal occlusal ratios of dentitions.

We have determined that patients with GP with included defects in the dentition have significant deviations from the even distribution of occlusal loading on the dental rows in both of the studied classes according to Kennedy, especially those who had not previously been prosthetic. It is necessary to use a computerized analysis of occlusion with the help of the apparatus "T-Scan III" to all of these patients at every orthopedic stage of complex treatment. The precise definition of supra-contacts reduces the possibility of errors and allows achievement of the ideal - 50% to 50% -relationship between the left and right parts of the tooth-jaw system during fitting and fixing of orthopedic structures and keeping it in the process of their exploitation.

Keywords

generalized periodontitis; included defects of dentitions; occlusion; T-Scan

Problem statement and analysis of the recent research

All organs of the tooth-jaw system, in particular teeth, jaws, periodontium, temporomandibular joint, chewing muscles and nerves are in functional interconnection, therefore the consequences of occlusion disorders can occur in any of the links of this system, especially in periodontal tissues [7, 10, 15].

It has been determined that occlusal trauma has the greatest importance among all complications of functional disorders in periodontology [1]. It undergoes microscopic changes in the periodontal structures in the area of periodontal ligament, which is clinically manifested by an increase (reverse) movement of the tooth [9]. In patients with generalized periodontitis (GP) most often secondary traumatic occlusion develops, which is caused by a violation of the normal ratio of extra-alveolar and intra-alveolar part of the tooth through the resorption of cells. In this case, the external biomechanical shoulder increases, so that the remaining periodontium has too large loading, which increases the injury and accelerates the resorption of bone tissue cells [6, 12]. These circumstances require precise diagnosis of occlusal relationships to equalize the occlusal area and the strength of the relationship between the dentitions in order to prevent an overload (traumatic occlusion) and under-loading (hypofunction) of periodontal tissues during the orthopedic treatment of the GP [1, 5, 8].

Since most common methods of diagnosis of occlusion are based on subjective sensations of the patient that cannot be the main reference point for occlusion correction, as all the components of the balance of occlusion need to be studied [3, 14], it is important to use a computerized analysis of occlusion at the present stage. This is possible with the help of T-Scan (Tekscan) technique, which completely eliminates the subjective evaluation of the doctor from the process of making a clinical decision [2, 4].

The objective of the research: study of occlusal ratios in patients with GP of developmental stages I and II, which require orthopedic treatment with non-removable structures, with the help of apparatus "T-Scan III".
1. Materials and methods of the research

85 patients aged 20-44 years were examined, among them there were 20 dentally healthy people with normal inter-occlusal ratios of dentitions, and 65 patients with chronic phase of GP of the 1st and IInd degree of development with partial loss of teeth. Group I included 35 patients who had included defects and were not previously treated orthopedically. Group II included 30 patients who had dental bridgeworks made of various materials requiring replacement for a variety of reasons. Defects of dentitions corresponded to classes III and IV according to Kennedy, and the number of lost teeth was from 1 to 3.

To optimize occlusal diagnostics and increase its accuracy, occlusal relationships in the examined groups were evaluated using a digital computer analysis method using the apparatus "T-Scan III" of the firm Tekscan, Inc, USA.

Research methodology. Apparatus "T-Scan III" consists of a handle-sensor, in which a thin supersensitive plate in the form of a dental arch is fixed. The handle-sensor is connected to a personal computer on which the software is previously installed on the basis of the Windows operating system. The interface of this program allows us to enter individual data for each patient (passport data, teeth width, arch width, removed teeth, implants, etc.). After the plate is inserted into the oral cavity, directed it to the dental arch of the upper jaw, one must press the REC button on the sensor-handle and then ask the patient to articulate and unlock the jaws normally for him/her. The peculiarity of this plate and the sensor-handle is also that they allow us to adjust the sensitivity of the thin plate to the particular examinee, because chewing muscles are individual in every person.

After unlocking the jaws, one must press the REC button again to stop the recording from the plate. In several seconds, the software counts data and shows the four internal windows on the monitor.

The first window covers 3D images (in fact, all point contacts throughout the occlusal arch).

In the second window, a 2D image is displayed that shows plane contacts (namely, precise sequence of occlusal contacts), point of application of the summed load on the tooth arch (force vector), and also the distribution of the load as a percentage for each individual tooth, to the left and right occlusal arch. In the second window, there is also a function that automatically calculates the distribution of the percentage load on the individual segments (frontal and chewing areas).

The total vector of occlusal loading - is a conditional trajectory on the chart of occlusion, which reflects the sequence of occurrence of occlusive contacts. Depending on the nature of the premature contacts, the vector may have a variety of directions [13].

In the third window, a graphic representation of the closing force in the time aspect is highlighted, and in the fourth - a graphical representation of the percentage of the full force in a time interval with an interval of 0.015 seconds; in this case, the time of recording the chewing act is automatically calculated, the actual time from the moment of the first contact of the teeth and until the moment of their last contact, and a percentage of the maximum force is given (Fig. 1).

All patient data was stored in a personal computer for further control at various stages of orthopedic treatment and in the remote term after the treatment.

2. Results of the research and their discussion

When working with the apparatus “T-Scan III” to evaluate occlusal ratios one must take into account the balance of occlusion, that is, the percentage ratio of occlusal contacts on the left and right at the final moment of the jaws closing. Normally, the distribution of chewing pressure between the left and right parts of the tooth-jaw system is 50% to 50%, the vector of total force is in the white oval and does not exceed its limit, which characterizes the correct teeth joining (according to the manufacturer - Tekscan, Inc, Boston, USA). The uniform area of the staining of occlusal planes according to each group of teeth is indicated on the 2D and 3D images of occlusiograms.

But we have determined that even in the absence of pathologic in patients, the slightest deviation from this ratio was observed most often, therefore, we took as a norm the interval of 50±3% (with a slight inaccuracy), which in the examined healthy persons on the average was (48.7 at 51.3) ±0.24%. As an example, we show Figure 2, which shows the occlusive relations of a healthy patient H., the percentage distribution of chewing force onto the left and right sides of the occlusal arch which is 48.4% at 51.6%, however, the staining of occlusal planes is uniform and the vector of the total force corresponds to the norm.

At the diagnostic stage in patients of group Iin class III according to Kennedy, who had not been given orthopedic treatment before, the data of the apparatus ”T-Scan III” showed a violation of occlusal ratios. In particular, in patient M. with GP of the 1st degree and the included defect of a class III according to Kennedy (tooth 25 missing), the occlusal ratio was 23.6% at 76.4% (Fig. 3).

Patients of group II with included defects of class III according to Kennedy and poor-quality orthopedic structures requiring replacement because of dental abrasion, fractures, poor-quality adherence or decement etc., occlusal relationships were also affected. In particular, the patient V. in GP of the 1st degree of development, which included the defect of class III according to Kennedy was replaced by a non-removable, solid-bridged metal-plastic construction, at the time of diagnosis, the distribution of occlusal ratios of the left and right sides of the jaws was 74.2% at 25.8% (Fig. 4).

We would like to note that in the majority of patients in the groupII, who had previously had irreversible orthopedic constructions, the imbalance of the percentage was lower than in patients who needed primary orthopedic treatment (group I). This is due to the fact that orthopedic structures required replacement, although had occlusal ratios, were not always significant and still replaced existing dental defects. This is
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Figure 1. Data of the patient P., 28 years old, patient with GP of the 1st degree, with a low-quality non-removable orthopedic structure with supports of teeth 25 and 23, was obtained with the help of the apparatus “T-Scan III” (group II, class III according to Kennedy).

Notes:

a – 3D image, point distribution of chewing forces in the time interval;
b – 2D image, plane distribution of chewing forces in the time interval;
c – total vector of force;
d – percentage distribution of chewing forces of individual teeth;
e – percentage distribution of chewing force on the left and right sides of the occlusal arch (48.5% / 51.5%);
f – graphical representation of the forces of jaw relation in the time interval;
g – oval – the limit of the norm of total vector force: white – ideal norm; gray – within normal limits.

clearly evident in the example of figure 1, where a patient with GP of the 1st degree has a poor-quality metal-plastic structure based on the teeth 25 and 23, but the occlusal ratio was 48.5% at 51.5%, and the vector of total force was in a white oval, which was close to the norm. Such a state of occlusion was provided by redistribution of chewing load on tissues of the periodontium of molars, which is reflected in 3D graphics by red columns (Fig. 1) and testifies supra-contacts on overloaded chewing teeth.

We have determined that the vector of total force in both groups I and II in the vast majority, declined in the opposite side of the defect, although there were variants where due to compensatory mechanisms the tooth-jaw system was rebuilt so that the vector remained within the normal range - in a white oval. In particular, the patient L. with a diagnosis of ”GP of the 1st degree, included defect of class III according to Kennedy in the area of teeth 45-47”, the percentage distribution of occlusal relations of the left and right sides of the jaws was close to the norm and was 54.4% at 45.6% (Fig. 5).

It was recorded on 2D and 3D computer images in patients of both groups that areas with defects in the dentition were not stained (due to the lack of teeth), therefore, the occlusal ratio changed its percentage value (see Figures 3 and 5).

During examination of the patients with GP of the 1st and 2nd degrees with the included defects of dentition, class IV according to Kennedy we have identified other peculiarities of the distribution of chewing pressure. Since the front teeth are not intended by nature for a large load, their presence or absence did not make significant adjustments in the indicators of occlusal relations between the right and left jaws. In the absence of frontal teeth, the vector of total force in patients of group I was placed in the lower part of the gray oval (Fig. 6). Their absence determines the primary occlusal contact of chewing teeth, and at the moment of biting the food patients are forced to shift the lower jaw to the right or left side, pushing it forward.

In patients of the group II class IV according to Kennedy, the vector of total force due to the absence of the front teeth was also found in the lower part of the gray oval, but the existing orthopedic structures, albeit inadequate, contributed to at least some minimal occlusion contact of these teeth and ensured the placement of a vector of total force higher, than in patients of group I, which were not previously treated orthopedically (Fig. 7).
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**Figure 2.** Data of a healthy patient H., 23 years old, was received with the help of the apparatus “T-Scan III”

*Notes:*
- a – 3D image, point distribution of chewing forces in the time interval;
- b – vector of total force in a white oval;
- c – 2D image, plane distribution of chewing forces in the time interval;
- d – percentage distribution of chewing forces of individual teeth;
- e – percentage distribution of chewing forces on the left and right sides of the occlusal arch is 48.4% / 51.6%.

**Figure 3.** Data of a patient M., 35 years old, a patient with GP of the 1st degree, with included defect of dentition of class III according to Kennedy in the area of teeth 24-26 (group I)

*Notes:*
- a – absent tooth 25;
- b – vector of total force is on the opposite side of the defect;
- c – percentage distribution of occlusal relations of the left and right parts of the jaws (23.6% / 76.4%).

Summing up the above-mentioned, we would like to note that the examination of patients with the GP of the 1st and 2nd stages of development with the included defects in the dentition with the help of the computerized system “T-Scan III” showed the expressed deviations from the uniform distribution of occlusal loads on the dental rows both in classes III and IV according to Kennedy, especially in patients who were not previously prosthethized (group I). In this case, the
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Figure 4. Patient’s B. data, 36 years old, a patient with GP of the 1st degree, with a poor-quality non-removable orthopedic structure with supports for teeth 14 and 16. (group II, class III according to Kennedy)

Notes:
- a – poor-quality non-removable, solid-metal, metal-plastic construction with a damaged lining on an occlusal surface with a support of teeth 14 and 16, replacing the missing tooth 15;
- b – vector of total force, which is on the opposite side of the defect;
- c – percentage distribution of occlusal relations of the left and right parts of the jaws (74.2% / 25.8%).

Figure 5. Patient’s L. data, 27 years old, a patient with GP of the 1st degree, with the included defect of class III according to Kennedy in the area of teeth 45-47 (group I).

Notes:
- a – absent tooth 46;
- b – vector of total force is in a white oval;
- c – percentage distribution of occlusal relations of the left and right parts of jaws 54.4% / 45.6%.

patients did not put forward any complaints related to occlusal disorders.

Our study confirmed that with the help of the apparatus “T-Scan III” with its software one can detect a problem with occlusion still at the diagnostic stage, which contributes to the accurate planning of orthopedic treatment, since the diagnosis of the nature of the teetharticulation with computer biometric analysis optimizes occlusal diagnosis. While using this device, more objective and clearer results are obtained, which are based on accuracy and reproducibility [16], and the exact definition of supra-contacts, both during primary diagnosis, and at the stages of fitting or fixing a non-removable orthopedic structure reduces the possibility of errors. With the help of “T-Scan III” program, one can estimate functional
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Figure 6. Data of patient K, 37 years old, patient with GP of the IIInd degree, with included defect of the class IV according to Kennedy in the area of teeth 33-43 (group I).

Notes:
- a – vector of total force;
- b – absent teeth 42, 41, 31, 32;
- c – percentage distribution of occlusal relations of the left and right parts of the jaws (46.5% / 53.8%).

Figure 7. Data of patient Zh., 32 years old, patient with GP of the IInd degree, with the included defect of class IV according to Kennedy in the area of teeth 11-22 (group I).

Notes:
- a – absent tooth 21 (facet with chipped composite);
- b – supporting teeth of metal-plastic construction;
- c – percentage distribution of occlusal ratios (60.7% / 39.3%).

3. The prospect of further research

The prospect of further research is to study the state of occlusal ratios in patients with generalized periodontitis with included dentition defects at different stages of orthopedic treatment.
4. Conclusions

In patients with GP with included dentition defects of classes III and IV according to Kennedy, who are planned orthopedic treatment in the complex one, the computerized analysis of occlusion is used with the help of apparatus “T-Scan III” at different stages: during the diagnosis of occlusal ratios, selective tooth grinding, planning orthopedic treatment, fitting and fixing of orthopedic structures. Pinpointing of supra-contacts reduces the possibility of errors in orthopedic treatment of GP and allows achievement of perfect - 50% to 50% -ratio between the left and right side of the dentofacial system during fitting and fixation of orthopedic structures and keeps it in the course of their exploitation.

References


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