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# IMPLANT TREATMENT IN PATIENTS WITH SEVERE TOOTH WEAR ON THE OCCLUSAL SURFACE

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**ABSTRACT** — Examination along with implant treatment was carried out in 21 patients with severe tooth wear on the occlusal surface. This disorder features a variety of clinical symptoms including changes in the facial features and the lower jaw movement amplitude, disturbed canine and incisor guidance, supercontacts, asynchronous operation of the masticatory muscles, etc. We have proposed a treatment algorithm aimed at eliminating these issues.
The temporary non-removable dentures allowed creating occlusal marks (Stage 1) followed with their transfer onto permanent orthopedic structure (Stage 2) using implants. The complexity of the approach to treating this disease, as well as the effectiveness of our method has been confirmed by clinical data and the outcomes obtained through an instrumental study involving electromyography and electronic axiography.
The extra additional research methods employed, such as electromyography and electronic axiography, allowed to assess the activity of masticatory muscles and the lower jaw articulation, thus to ensure occlusal-articulation interaction when restoring the lower facial height.

**KEYWORDS** — increased abrasion, dentures, electromyography, electronic axiography.

## INTRODUCTION

Increased abrasion of the hard dental tissue (IDA) on the occlusal surface entails a number of anatomical, morphological, aesthetic and functional disorders. The prevalence of the issue ranges from 6% to 14.5% [1–3], the most common signs being a decrease in the size of the crowns affecting all teeth, dentin hyperesthesia, supercontacts, alterations affecting the shape of the dental arches, as well as a shortened lower third of the face.

Significant dental abrasion on the occlusal surface involves a change in the lower jaw movement amplitude, which is due to a decrease in the inter-occlusal height. The patient may fail to close the teeth in the previous position; there is also a frequent loss of the function guiding the canines and incisors, whereas the patient's own perception of the bite changes. Increased dental abrasion is an etiological factor behind the temporomandibular joint (TMJ) dysfunction [4–6], it is often accompanied by a partial adentia, which poses certain difficulties for implantation [7].

Considering the negative impact of occlusion-articulation changes due to increased dental abrasion [8], and the risk of changes in bite forces after the implant treatment, restoring the structure on the occlusal surface of dentures appears to play an important role [9, 10]. Lack of occlusion reference marks complicates carrying out rehabilitation measures up to their fullest extent [11–15]. In this regard, the necessary steps include proper remodeling of the occlusion, restoring the lower face height, and monitoring the functioning of the newly designed orthopedic structures, both shortly after setting the dentures, and long-term.

*Aim of the study:*
to improve the effectiveness of orthopedic treatment with implants in patients with increased dental abrasion on the occlusal surface.

## MATERIALS AND METHODS

We examined 26 patients aged 35 to 53, among them 16 males and 10 females, who had increased dental abrasion on the occlusal surface, complicated by partial adentia. 93 implants (Semados) were installed in the patients. The inclusion criteria for the study and further implant treatment were patients with tooth defects of Class III and IV according to Kennedy classification. The exclusion criteria were degenerative changes in the TMJ structural elements.

The data involving the respective medical records, the patients' complaints, as well as the data obtained through clinical and instrumental examinations were analyzed. There were also examinations caried out such as the upper and lower jaw model analysis (Stratos 300 articulator), intraoral radiographs of teeth (Kodak 2000), and computed tomography imaging (Kodak 9000). The electronic axiography was performed with Arcus Digma II (Kavo Germany), electromyography of masticatory muscles — with Synapsis (Neurotech Russia). The statistical data processing for the obtained outcomes was done on the SPSS 25 software package, with the arithmetic mean (M) and the mean square deviation (SD) calculated.

The differences between the samples were evaluated employing the Student's t-test as well as the Mann-Whitney-Wilcoxon U-test, while between the results in the same sample through treatment — with the Student's paired t-test and the Wilcoxon paired test. The results were considered different at a significance value set at $p<0.05$.

## RESULTS AND DISCUSSION

The patients were found to have a 8±1.24 mm decrease in the lower face interocclusal height; deepening nasolabial and chin folds; a deformed dentition; balancing supercontacts of molars in the lateral occlusions (right and left); canine disocclusion; disturbed incisor and canine guidance, as well as a partial adentia.

Since increased dental abrasion on the occlusal surface was accompanied by a significant decrease in the gnathic height, the restorative treatment was carried out in stages. Initially, a special orthopedic preparation was done (9) in the form of occlusal splint-mouthguards, which the patients should use for 3±0.15 months, and which allowed adjusting the TMJ elements prior to the implantation. 2 patients reported pain in the TMJ area, so they were further treated with the mouthguard, and the implantation had to be postponed.

24 patients were found to reveal no complications, and they had temporary fixed dentures (Stage 1) made for them at a set occlusal height according to our manufacturing method (Invention Patent RU 2453290 C1), which ensures functions like chewing, stabilized occlusion, phonetics and aesthetics. The point of the method implies the following: temporary fixed bridge-like dentures were modeled from wax; occlusion analysis was performed in the Stratos 300 articulator; the wax was replaced with a bis-acrylic material (Protemp 3 Garant or Luxatemp). The specific feature about these structures was that on the internal occlusal surface of the bridge-like prosthesis a fiberglass tape (Fiber Splint, Ribbond, and others) was adjusted in order to strengthen the frame of the entire structure. In case of IDA, the thickness of the chewing surface is usually sufficient enough. The manufactured structures were fixed temporarily, after which the occlusion was evaluated with instrumental control performed through electronic axiography and electromyography of the masticatory muscles. The results obtained were as follows (see Table 1, Stage 1).

During the dental implantation, the temporary bridges in the implantation area were removed, with the implants installed, and then the temporary fixation was repeated for the osseointegration period. At the end of the osseointegration, permanent dentures were installed.

In order to ensure the predictability for functioning of the orthopedic structures aimed at long-term positive outcomes, repeated control of the occlusal balance in the arches was carried out, with the following results obtained (Table 1, Stage 2).

The values proposed by V.P. Tlustenko et. al. were accepted as the criteria of the norm [16].

At the Stage 1, the masticatory muscle electromyographic examination testing the maximum jaw compression revealed a significant decrease in the biopotentials amplitude and an approximation to the normal values. The average amplitude indicators of the temporal muscle biopotentials were: 534.6±54.2 μV — on the right and 537.8±54.7 μV — on the left ($p<0.05$ compared to the norm); for the masseter muscles: 598.4±59.2 μV — on the right and 583.7±57.8 μV — on the left ($p<0.01$ compared to the norm). The symmetry factor (Sf), which reflects the activity symmetry both between the two similar muscles on both sides, and between the masticatory and temporal muscles on one side, went up reaching the following values: for the like-named muscles — 0.8±0.1 (temporal muscles) and 0.9±0.1 (masseter muscles, $p=0.002$); for the synergist muscles — 0.8±0.1 (the temporal and the masseter muscles on the right) and 0.8±0.1 (the temporal and the masseter muscles on the left), yet in all cases the value was significantly different from the norm ($p<0.01$). Given that, improving the occlusal relationship, the interalveolar height through temporary structures will allow arriving at significantly optimized activity of the masticatory muscles already at the preliminary treatment stage.

According to the EMG results, 1 month after the permanent prosthetics were completed (Stage 2), the indicators approached the normal values and, regarding the temporal muscles, were as follows: the average biopotential amplitudes — 523.6±52.8 μV (on the right, $p=0.056$ compared to the norm) and 514.9±52.9 μV (on the left, $p=0.226$ compared to the norm), the symmetry factor – 0.9±0.1 ($p<0.001$ compared to Stage 1, and $p=0.002$ – compared to the norm); for the masseter muscles: 551.2±54.2 μV (on the right, $p=0.280$ compared to the norm) and 541.1±53.9 μV (on the left, $p=0.415$ compared to the norm), the symmetry factor was 1.0±0.1. We believe that a slight excess in the indicators, if compared to the normal values, in certain patients, which was observed following the completion of the orthopedic treatment, could be accounted for by the remaining parafunctional activity of the masticatory muscles, which, as the modern ideas hold it, cannot be completely stopped.

***Table 1.*** *EMG indices in patients at Stage 1 and Stage 2 through the orthopedic treatment, as compared with the normal values obtained through a functional test — maximum jaw compression in case of normal occlusion*

| EMG indices | Td A avg. (μV) | Ts A avg. (μV) | Md A avg. (μV) | Ms A avg. (μV) | Sf Td-Ts | Sf Md-Ms | Sf Td-Md | Sf Ts-Ms |
|---|---|---|---|---|---|---|---|---|
| Stage 1 | 534.6±54.2 | 537.8±54.7 | 598.4±59.2 | 583.7±57.8 | 0.8±0.1 | 0.9±0.1 | 0.8±0.1 | 0.8±0.1 |
| Stage 2 | 523.6±52.8 | 514.9±52.9 | 551.2±54.2 | 541.1±53.9 | 0.9±0.1 | 1.0±0.1 | 0.9±0.1 | 0.9±0.1 |
| Normal status | 491.9±52.9 | 495.4±51.2 | 533.4±52.5 | 527.5±54.4 | 1.0±0.1 | 1.0±0.1 | 0.9±0.1 | 0.9±0.1 |
| p Stage 1 – normal | 0.012 | 0.012 | <0.001 | 0.002 | <0.001 | 0.002 | 0.002 | 0.002 |
| p Stage 2 – normal | 0.056 | 0.226 | 0.280 | 0.415 | 0.002 | 0.990 | 0.985 | 0.990 |

***Note:*** *Td — right temporal muscle; Ts — left temporal muscle; Md — right masticatory muscle; Ms — left masticatory muscle; Sf — symmetry factor. The statistical significance is shown in terms of the deviation from the normal value through each of the stages. The difference between Stage 1 and Stage 2 in all cases — p<0.001*

The change in the closure of the arches caused by increased dental abrasion, has a direct link to disturbed articulation of the lower jaw, which can be diagnosed through electronic axiography (Table 2).

The graphical parameters featured a lack of symmetry, a decreased length of the trajectories (this indicative of articular head restricted mobility due to functional overloaded masticatory muscles through their parafunctions), emerging premature interdental contacts that block and change the lower jaw movement, disturbed coordination of the masticatory muscles and the asynchrony of their inclusion in activity. Prior to the treatment, the sagittal articular course angle exceeded the normal values, which could be due to a changed rotation-vs-progress component ratio related to opening the mouth, with the rotational component predominating.

At the temporary structure stage, the sagittal articular course angle decreased to 47.8±4.7° on the right and 48.3±4.1° on the left. The articular trajectories of the lower jaw movements appeared as smooth curves concaved downward with the following linear indicators: 11.7±1.8 mm — the right joint trajectory length, and 12.1±1.9 mm — the left one ($p<0.001$ compared to the norm). However, a number of axiograms revealed a discrepancy between the mouth-opening trajectory and the lower jaw movement trajectory at closing the mouth, whereas the discrepancy exceeded 0.5 mm.

Upon completion of orthopedic treatment, the angles of the sagittal articular course angles decreased on both sides, if compared to the initial values ($p<0.001$) and were 44.6±3.9° on the right and 45.4±4.3° on the left ($p=0.210$ and $p=0.339$ compared to the norm), whereas they also got to feature some relative symmetry of the right and left sides.

An examination of the Gothic angles revealed amplitude symmetry of the lower jaw interincisal point movements, both to the right and to the left. The lines were not observed to have any shortening in the trajectory length, while the trajectories themselves appeared smooth. The protrusion line divided the Gothic angle into two identical parts in 85% of cases.

The obtained features pointed at synchronous performance of the masticatory muscles, as well as the absence of clinically significant dysfunction of the TMJ.

## CONCLUSION

Employing all the above-mentioned preparation stages and orthopedic treatment of IDA on the occlusal surface, the inter-occlusal height and the central ratio of the jaws were identified optimally in view of the data obtained through electromyography and electronic axiography. Individual movements of the lower jaw in three mutually perpendicular planes, as well as the lateral movement amplitudes within the physiologically normal value range, were arrived at. Restored trajectories of protrusion, laterotrusion, mediotrusion and lateroprotrusion further allow optimal sliding of the lower jaw articular head along the articular tubercle slope, whereas disturbance in these principles can affect the TMJ function.

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*Table 2. Angular and linear indicators of electronic axiography during the open-close- mouth test in patients at Stage 1 and Stage 2 of orthopedic treatment, if matched against normal values*

| Indicator | Sagittal articular course angle (°) | | Articular trajectory (mm) | |
|---|---|---|---|---|
| | right | left | right | left |
| Stage 1 | 47.8±4.7 | 48.3±4.1 | 11.7±1.8 | 12.1±1.9 |
| Stage 2 | 44.6±3.9 | 45.4±4.3 | 12.6±2.0 | 12.7±2.8 |
| Normal value | 43.2±3.3 | 44.1±4.5 | 14.8±2.1 | 13.9±2.0 |
| p Stage 1 – norm | 0.001 | 0.003 | <0.001 | 0.004 |
| p Stage 2 – norm | 0.210 | 0.339 | 0.001 | 0.112 |

***Note:** The statistical significance is shown in terms of the deviation from the normal value through each of the stages. The difference between Stage 1 and Stage 2 in all cases — p<0.001*

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