Research Article

Estimation of stabilometric indicators with a decrease in the interalveolar distance

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ABSTRACT

Aim: At present, due to the rapid development and improvement of modern technologies and methods of diagnosing, treatment, and prosthetics, dentistry has gone beyond the narrow specialty and cooperates with other medical disciplines. The success of the treatment of a dental patient depends on the possibility of using modern medical technologies and an objective assessment of the functional capabilities of the patient's body, for this purpose we used functional methods: Computer stabilometry, surface electromyography of the chewing muscles and neck muscles, and functional, physiological method for determining jaw relation. **Materials and Method:** This paper presents the data of the estimation of stabilometric indicator in 293 patients with major dental diseases accompanied by a decrease in the interalveolar distance and 102 patients without signs of decreased occlusal vertical dimension. **Results and Discussion:** The cases with the habitual occlusion with signs of decreased occlusal vertical dimension show significant ($P < 0.001$) deterioration of the main indicators of the balance function. Optimization of the jaw relation has led to significant improvement of the coefficient of the equilibrium function and the area of the statokinesigram ellipse. **Conclusion:** The significance of the functional state of the cervical spine in dental patients with a change in jaw relation was noted, which was also confirmed by the results of surface electromyography of the masticatory and cervix muscles.

KEY WORDS: A decrease in occlusal vertical dimension, Balancing function, Computer stabilometrics, Dentistry, dentofacial system, Dysfunction of the temporomandibular joint, Functional physiologic method of normal occlusion registration, Superfacial electromyography of masticatory and cervix muscles, Syndrome of descending occlusion

INTRODUCTION

The state of the body, as a result of the activity of all functional systems, is determined by the effectiveness of regulatory effects, their ability to provide adaptation of the organism to the environment and new living conditions.

Functional changes associated with a decrease in the interalveolar distance may affect not only the masticatory muscles but also the muscles of the head, neck, and spine.[1-4] Patients with jaw disorders, dental defects, and dysfunction of the temporomandibular joint often report pain in the region of the cervix muscles.[5,6] An imbalance in muscle activity leading to neck pain can be caused by a change in jaw relation.

Reduced interalveolar distance (IAD) having developed on the background of dental diseases: Increased erosion of hard tissue teeth, chronic generalized periodontitis, partial loss of teeth of varying length, and localization often leads to disturbance of anatomical and functional relationships of the neuromuscular articular complex of the maxillofacial area, and other systems of the body.[6-10]

The leading symptom of various dental disorders caused by changes in the jaw relation is the increased tone of the chewing muscles. The neuromuscular tone is of reflex nature. The various structures of the motor apparatus (the skeletal muscles, tendons, and fasciations) have sensitive proprioceptors that perceive irritations. Excitement from proprioceptors continuously enters the central nervous system and switches to motor neurons, causing tonic contraction of muscle fibers. Maintenance of normal physiological tone of muscles is carried out by participation of the endocrine system and numerous nervous formations located at different levels of the nervous system: Reticular formation of the trunk of the brain, structures of the middle brain, vestibular nuclei of the medulla

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oblongata, red nuclei, black substance, striopallidary system, cerebellum, and motor regions of the cortex of large hemispheres.[3,11] An important role in the regulation of tone is played by red nuclei. The region below the level of red nuclei is where a tonogenic center lies that are affected by the impulses originating from the proprioceptive system, especially from the muscle contraction proprioceptors of the cervical spine. There have been cases where the restoration of occlusal relations and the function of the TMJ helped to improve posture and vision, reduce back pain, hand tremor, and headaches.[12]

In the maxillofacial region, among the cervix muscles, the thoracic clavicular sacral muscle is given a special role, and its functional activity is important in maintaining and changing the position of the head. The work of the sternoclinic-sacral muscle is synchronized with the muscles involved in the mouth closing, both during chewing and during involuntary compression of the teeth. Muscle weakness is common in patients with TMJ dysfunction.[6,13,14] Afferent impulses from the TMJ enter the sensory, then into the facial nucleus of the trigeminal nerve, altering the EMG activity of the masticatory muscles and disturbing their coordinated function. A peculiar vicious circle occurs.

Patients with bone disorders more often have the pathology of the musculoskeletal system (MSS) than people without occlusion, while normalization of the jaw relation as a result of complex treatment involving the correction of the parts of the dentoalveolar apparatus (DAA) and MSS leads to a significant decrease in the manifestations of functional spinal abnormalities.[15]

Objective of the Research

To develop anatomical and physiological substantiation of methods of effective treatment of dental patients with signs of "descending occlusion" based on the data of a set of diagnostic measures that allow carrying out an integral assessment of morphofunctional connections of the chewing apparatus and the patient's organism.

The following tasks were set in the presented part of the study:

1. To determine the effect of the change of the IAD on the state of the equilibrium function.
2. To evaluate the functional state of the cervical spine in dental patients with terminal defects in the dental arches.

MATERIALS AND METHODS

We examined 395 people aged from 32 to 68 years, with major dental diseases of a dentoalveolar system. 293 (74.2%) patients of the total examined persons had signs of deep occlusion and formed the main group, and 102 (25.8%) patients with no signs of deep occlusion formed the control group. The main group included 228 (77.8%) women and 65 (22.8%) men. The main dental diseases having resulted in a change in the jaw relationships were increased abrasion of hard tissues of teeth in 138 (47.1%) patients, chronic, generalized periodontitis in 125 (42.6%) patients, and partial loss of teeth in 260 (88.7%) patients. 174 (59.4%) patients had a combination of major dental diseases revealed. We performed the determination of diseases using International Classification of Diseases, 10th edition of 1997 (ICD-10).

Research Methods

Instrumental method: The functional physiological test method for the jaw ratio was used to assess the rehabilitation capabilities of the DAA.

Functional methods

Computed stabilometry was used to determine the equilibrium function in patients with major dental diseases, accompanied by a decrease in the IAD. Surface electromyography with recording of bioelectrical activity of masticatory and cervix muscles.

Statistical methods

Statistical processing of the material was performed using a standard package of statistical analysis programs (Statistica for Windows v. 6.0). The critical level of the probability of a zero statistical hypothesis was taken equal to 0.05.

Nonparametric comparison methods were also used: The Mann–Whitney U-test for two independent groups and the Wilcoxon paired Ud test - when assessing the values dynamics during prosthodontic treatment. Differences at $P \leq 0.05$ were considered statistically significant.

The functional and physiological method with the use of the AOTSO device allows determining the optimal mutual arrangement of the anatomical structures of the dentoalveolar system involved in the maintenance of the jaw relation in various planes, evaluating the activity of the masticatory muscles, cervix muscles, and TMJ elements, both in statics and during compression of the jaws. Functional and physiological method allows taking into account the individual functionalities of a patient regardless of the severity level and degree of disease of dental components and identifying the response features of force characteristics of masticatory muscles to the increase (IAD).

We performed an assessment of four functional indicators of dentoalveolar system in all 293 (74.2%) dental patients of the main group with impaired jaw relationships of different origin: The value of the IAD decrease, the integrated value of the

maximum jaw compression force, horizontal and sagittal displacement of the mandible, a curve of jaw compressive force during a consequent change (IAD). 102 (25.8%) patients of control group had no reduction in the occlusal vertical dimension.

RESULTS AND DISCUSSION

The studies on the relationship between the dental arch defects, the jaw relation and the state of the cervical spine, pay much attention to the study of the parameters of body equilibrium, fluctuations of the center of gravity and their relationship with the functional state of the dentoalveolar system.

When a person is in a standing position, continuous fluctuations of the center of gravity help maintain balance. The statokinetic system uses information coming from proprioceptive, tactile, vestibular, and visual receptors. In addition to vision, musculoskeletal and vestibular apparatus, DAS is important in maintaining equilibrium. The DAS proprioceptors include receptors of masticatory muscles, TMJ, and periodontium. Occlusion disorders can reduce proprioception in this area, leading to a disruption in the position of the head. Complex interactions of various parts of the central nervous system contribute to maintaining the necessary tone of the masticatory muscles, which help to keep the correct position of the lower jaw.[6]

All patients with signs of a decreased IAD after determining the constructive jaw relation with the use of the functional and physiological method and the AOTSO device underwent evaluation of their equilibrium function. For this purpose, the method of computer stabilometry was used. Stabilometry is a method for studying the balance of upright stance and a series of transient processes by recording the position, deviations, and other characteristics of the projection of the common center of gravity, or more precisely the pressure center of the feet on the support plane. The pressure center of the feet corresponds to the vertical projection of the center of mass of the human body on the support plane. As you know, maintaining the balance in standing position is a dynamic process. The body of a standing person performs invisible or well-marked movements in various planes around some middle position. The characteristics of the oscillations - their amplitude, frequency, direction, and middle position in the projection to the support plane - are sensitive parameters reflecting the state of various systems that support the balance.

The use of the method of computer stabilometry in dentistry is based on recording the contribution of the proprioceptive sensitivity of the TMJ, masticatory muscles, and maxillofacial tendons to the regulation of the function of the MSS.

The method that was performed with the help of Stabilan-01-2 stabilometer platform (RCH "Ritm," Taganrog, Russia) with special tests has high diagnostic value. Using a special computer program, numerous parameters were evaluated, the main ones being the area of the ellipse of the statokinesiogram (Sel) and the equilibrium function quality factor (EFQ). 21 tests were used to evaluate the effect of various pathological conditions of the dentoalveolar system on postural characteristics of the MSS. A test on a soft mat changes the working conditions of the mechanoreceptors of the sole of the feet but does not affect the work of the muscle receptors.

To analyze the results of stabilometric study, equilibrium functions in patients with a decrease in IAD we used: Standard - the initial dental test No. 9 with closed eyes on a soft mat; - dental stabilometric tests No. 10 and No. 12 - for evaluation of the functional state of the musculo articular system of the dentoalveolar system (in the position of the central occlusion with closed eyes and the test with bilateral dissociated occlusion with closed eyes); tests No. 16 and No. 17 to identify a combination of the pathology of the DAA and the cervical spine (in the position of the central occlusion with the head turning to the right and the left with the eyes closed). The test was considered positive when obtaining ellipse values of the statokinesiogram (Sel), which differ by more than 50% and the coefficient of the equilibrium function (EFQ) by more than 20% with respect to the initial dental test No. 9.

In the course of the research, an algorithm was developed for computer stabilometry and analysis of data obtained with its help in examining dental patients with a decrease in IAD.

We should note the high frequency of the equilibrium dysfunctions by the area of the ellipse of the statokinesogram and the factor of the equilibrium function due to somatic causes (test No. 9). They were observed in 198 (67.6%) patients with defects in jaw ratios [Table 1].

231 (78.8%) patients with a decrease in IAD showed positive dental tests (10 and 12). Tests (10 and 12) are stress tests for the masticatory system. This fact testifies to the dental origin of the disorders of the equilibrium function. 97 (33.1%) patients showed positive reactions to tests 16 and 17, which reflect the

Table 1: The frequency of occurrence of positive tests by the area of the ellipse of the statokinesogram and the factor of the equilibrium function (*n*=293)

Somatic test 9	Dental tests 10, 12	Cervix tests 16, 17
198 (67.6%)	231 (78.8%)	97 (33.1%)

compensatory involvement of the cervix muscles in the functioning of the masticatory system. This fact is confirmed by an increase in the bioelectric activity of the neck muscles during maximum jaw compression and chewing [Table 2].

As data in Table 2 show, simultaneously with the functioning of the dentoalveolar system, the activity of Muscle sternocleidomastoideus increased in 60 (20.3%) patients: During maximum compression of the jaw in 36 (12.2%) and chewing in 24 (8.1%); the activity of Muscle trapezius increased in 37 (12.5%) patients: During maximal compression of jaws in 23 (7.8%) and chewing in 14 (4.7%) patients.

Table 3 shows that according to the surface electromyography data, during the chewing test, the intact state of the musculo articular system of the masticatory vocal apparatus was detected in 65 (22.2%) people, the reduced functional state of the musculo articular system was observed in 134 (45.7%) patients. 94 (32.1%) patients had a sharply reduced functional state of the musculo articular system.

Data in Table 4 show that the control patients without signs of a decrease in the IAD are not characterized by the equilibrium dysfunctions during dental tests. In provocative tests, the cervix muscles were involved in 12 (11.8%) patients. The presence of pathological signs in patients of the control group and patients with a decrease in IAD indicates the formation of a deep pathological process in the DAA and the reaction of other body systems.

Table 2: Incidence of an increased bioelectrical activity of the cervix muscles during maximum jaw compression and chewing (*n*=293)

Muscle	Abs. Number (%)	
	Maximum compression	Chewing
Muscle sternocleidomastoideus	36 (12.2)	24 (8.1)
Muscle trapezius	23 (7.8)	14 (4.7)

Table 3: Functional state of the musculo articular system of the masticatory vocal apparatus according to the surface electromyography data during the chewing test (*n*=293)

The state of the musculo articular system	Score	Total *n*=293 (%)
Intact	0–8	65 (22.2)
Reduced	9–15	134 (45.7)
Sharply reduced	16–27	94 (32.1)

Table 4: The frequency of the equilibrium dysfunctions by the area of the ellipse of the statokinesiogram and the factor of the equilibrium function in control patients (*n*=102)

Somatic, test 9	Dental tests 10, 12	Cervix tests 16, 17
67 (65.8%)	0%	12 (11.8%)

Summary

1. A decrease in IAD from 0.5 to 5.5 mm was detected in all 293 (100%) patients of the main group by a functional physiological method for determining the jaw relation.
2. The assessment of the characteristics of computer stabilometry allowed us to determine the high frequency of the equilibrium dysfunctions by the area of the ellipse of the statokinesiogram and the factor of the equilibrium function. The dental tests 10 and 12 (in central occlusion with closed eyes and a test with bilateral dissociated occlusion with closed eyes) determined the equilibrium dysfunction of the dental genesis in 231 (78.8%) patients with signs of a decrease in the IAD. The tests 16 and 17 (in the central occlusion with a turn of the head to the right and the left with the eyes closed) determined the involvement of the cervix muscles in 97 (33.1%) patients, which indicate the severity of the pathological processes in the DAA.
3. Changes in the jaw relations, especially a decrease in the IAD, can significantly disrupt the topographic and anatomical relations between the elements of the masticatory vocal apparatus and affect the adaptive-compensatory mechanisms of regulation in a complex, multilevel hierarchy of regulatory processes in the body.

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