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Clinical reasoning of improved diagnostic methods and orthopaedic treatment of patients with pathological tooth wear, co-existent denture defects and dentition deformities

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Abstract

The objective of the research was to increase the efficiency of complex diagnostics and the proposed orthopaedic treatment of patients with pathological dental abrasion, co-existent denture defects and dentition deformities based on a comparative assessment of the temporomandibular joint state. According to the results of our study, the use of both diagnostic and proposed orthopaedic methods of treatment with the aim of preparing patients with pathological tooth wear, co-existent denture defects and dentition deformities for orthopaedic treatment by gradual normalization of the vertical dimension of occlusion applying occlusive splints has several advantages over conventional methods of treatment. When using the Cadiax Compact system, there were determined the basic parameters that indicated functional disorders of the temporomandibular joint in patients of Group IV (the experimental group) with generalized form of pathological tooth wear, co-existent denture defects and dentition deformities. According to the results of clinical and condylographic study, gradual bite opening using splint set with a thickness of 1.0 to 5.0 mm until complete restoration of occlusive vertical dimension to normalize the jaw relationships in patients of Group IV (the experimental group) with generalized form of pathological tooth wear, co-existent denture defects and dentition deformities contributed to significant improvement of the biomechanical parameters of mandibular movements in the vertical, sagittal and transversal planes.

Keywords: pathological tooth wear, Cadiax Compact system, temporomandibular joint dysfunction, denture defects, condylography, splint

Introduction

Problem statement and analysis of the recent research

During chewing, there is a constant contact between the teeth and their antagonists which results in gradual loss of dental hard tissues.

Dental abrasion occurs in both primary dentition and permanent dentition being a compensatory adaptive reaction of the dentition to functional changes in the periodontium, masticatory muscles, elements of the temporomandibular joint (TMJ). However, depending on the severity of this process, there are physiological and pathological wearing away of dental hard tissues. The pathological wearing away of dental hard tissues is a relatively fast process which does not correspond to the patient's age and is accompanied by pathological changes in the entire dentition^[1, 2]. Nowadays the term "pathological tooth wear" combines different states of the dentition with a common clinical characteristic, namely excessive loss of enamel and dentin. The process of tooth wear has multifactorial etiology. The term "the loss of tooth surface" which included all the etiological factors was proposed by Eccles^[3]. According to modern concepts, pathological tooth wear or erosive and abrasive progressive loss of dental hard tissues results from three processes, namely: attrition (the loss of enamel, dentin, or restoration by tooth-to-tooth contact), abrasion (the pathological wearing off involving the dental hard tissue via mechanical processes involving foreign objects) and erosion (loss of dental hard tissues by non-bacteriogenic acid)^[4, 5, 6, 7]. According to the results of our study, which included 230 patients, the prevalence of pathological dental abrasion was found to be 58.6%, the predominance of generalized nature of lesions was observed in 81.5% of cases and the increased incidence of pathological tooth wear was observed among residents of Ivano-Frankivsk region at the age of 50-59 years^[8]. The number of patients with the aforementioned pathology depends on living conditions, age, the presence of comorbidity, genetic predisposition^[9]. The most common symptoms of the pathological wearing away of dental

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hard tissues are deformations of their anatomical shape, hyperesthesia of the affected teeth making it difficult for a person to take food, damage to the occlusal surface relief resulting in the loss of occlusive vertical dimension as well as creating conditions for the formation of unstable contacts of antagonistic teeth, changes in the position of the lower jaw when closing, changes in masticatory and phonetic functions [2]. These changes are significantly complicated in case of coexistence of pathological dental abrasion and denture defects alongside with dentition deformities. If denture defects are not detected and treated timely, they get complicated by dentition deformities of various nature which manifest themselves as tooth displacements toward different directions and abnormal configuration of occlusal curves. Severe dentition deformity is observed when the mandibular movement in the sagittal plane is blocked, which results in pathological changes in the TMJ [10]. In the clinical picture of dysfunction syndrome, the following symptoms can be identified: pain, crackling and popping sounds in the joint, headache, chewing muscle fatigue, pain in the muscles, the dislocation of the lower jaw to the side, diminished hearing, dry mouth [11]. Typical symptom is pain in the joint and masticatory muscles due to reduced inter-alveolar height and distal dislocation of the articular head. With time, distal dislocation of the articular head leads to masticatory muscular parafunctional activity of compensatory nature as well as to the formation of so-called gliding occlusion when the patient tries to aim the jaw into the correct position, but it returns to the habitual occlusion [12]. Therefore, the normalization of the jaw relationships is the primary goal of orthopaedic treatment of patients with pathological dental abrasion, denture defects alongside with dentition deformities. To achieve this goal, electronic methods of condylographic study and occlusive splints can be used in order to prepare patients for orthopaedic treatment. Modern condylographs provide the registration of mandibular movements using the Cadiax Compact system which allows analysing characteristics of dislocation of the hinge axis of the TMJ articular heads in three planes and calculating the parameters required for individual adjusting of articulator [13, 14, 15]. To carry out complex diagnostics, the trajectory of the TMJ movement is recorded during mouth opening and closure - from the position of complete jaw closure to the maximum possible mandibular movement downward and vice versa. Articular settings calculated using the Cadiax Compact system on the basis of the results obtained during the course of the research can be used for individual adjusting of articulator without further processing. Furthermore, this system allows storing all the data obtained in paper form. Temporary prosthesis and occlusive splints provide good occlusal relationships for masticatory muscle functioning due to eliminating habitual closure of the lower jaw [16, 17, 18, 19].

Thus, the high prevalence of the pathological wearing away of dental hard tissues among adult population is caused by the lack of the development and improvement of diagnostic and therapeutic measures with the use of electronic methods of condylographic study and occlusive splints which are essential at the preparatory stage of orthopaedic treatment.

The objective of the research was to increase the efficiency of complex diagnostics and the proposed orthopaedic treatment of patients with pathological dental abrasion, co-existent denture defects and dentition deformities based on a comparative assessment of the TMJ state.

Materials and Methods

All the patients were divided into 4 groups: Group I included 25 patients with intact dentitions; Group II comprised 30 patients with generalized form of pathological tooth wear and preserved dentition continuity; Group III consisted of 35 patients with generalized form of pathological tooth wear and co-existent denture defects; Group IV included 35 patients at the age of 30-59 years with generalized form of pathological tooth wear, co-existent denture defects and dentition deformities. In Group IV (the experimental group), there were used diagnostic and therapeutic measures to prepare patients for treatment, and all the patient underwent orthopaedic treatment of comorbidity. Clinical evaluation was carried out on the basis of the patients' complaints, life history and past medical history, physical examination data. The examination was carried out according to the developed charts: for denture defects, Kennedy classification was used; for dental abrasion, the classification proposed by Bhushan M.H. (the degree of abrasion, the extent of affected area, distribution, hyperesthesia) was applied; for dentition deformities, Gavrilovs classification was used. Patients of the experimental group with generalized form of pathological tooth wear, co-existent denture defects and dentition deformities complained of aesthetic problems due to tooth wear and tooth discoloration, difficulty in mastication, discomfort in jaw closure, extremely sensitive teeth, unpleasant sensation and pain in masticatory muscles and the TMJ. When examining patients with Grade I pathological tooth wear (up to 1/3 of crown height), the reduction in the inter-alveolar height was found to be insignificant; on the face, there were no signs, or they were barely noticeable. In patients with Grade II pathological tooth wear (from 1/3 to 2/3 of crown height) and those with Grade III pathological tooth wear (from 2/3 of crown height to the gum line), significantly reduced inter-alveolar height, reduced height of the lower facial third, upper lip shortening, significantly pronounced nasolabial and submental folds and downturned corners of the mouth were observed. When examining the oral cavity, the shape of crowns was found to be significantly changed; wear facets on the functional surfaces of all the teeth were seen; the process of dental wear was oriented either in vertical or horizontal direction depending on occlusion type; denture defects and dentition deformities of various nature which manifested themselves as tooth displacements toward different directions and abnormal configuration of occlusal curves were observed.

The study of diagnostic models was carried out to determine the degree of tooth wear, the extent of affected area, the state of the dentition and distribution of pathological tooth wear; the analysis of diagnostic models in articulator was conducted to determine the nature of occlusal relationships between dentures and natural teeth that is of special importance in diagnosing TMJ pathology. The study was designed to conduct the analysis of dislocation of the hinge axis of the TMJ articular heads in three planes using the Cadiax Compact system in study groups that were selected for the research, and to calculate the parameters required for individual adjusting of articulator for patients of Group IV (the experimental group). In addition, we have proposed to use in clinical practice a new method of fabricating completely transparent splints made of hard Erkodent Erkodur blanks (Germany) with a thickness of 1.0 to 5.0 for the upper or lower jaw to prepare patients of Group IV for orthopaedic treatment.

Results and Discussion

Nowadays there are no distinct recommendations on the splint type and the time needed to correct it. Therefore, for normalization of occlusal relationships in patients of Group IV (the experimental group) with generalized form of pathological tooth wear, co-existent denture defects and dentition deformities, gradual bite opening was carried out within 14 days, 1 and 3 months using splint set with a thickness of 1.0 to 5.0 mm until complete restoration of occlusive vertical dimension. Gradual application of splint set allows preventing further tooth wear without affecting the periodontium; splints are aesthetic and do not interfere with pronunciation. The material, of which splint set is made, provides better fixation and correction of occlusion to the optimal thickness over the entire dentition allowing the lower jaw to move into the position at which the state of functional balance of the dentition is restored.

The following changes were observed when examining patients with Grade II pathological tooth wear, co-existent denture defects and dentition deformities in case of using splints within 1 month: the restoration of the vertical dimension of occlusion and the height of the lower facial third; the restoration of the jaw relationships and elimination of muscle dysfunction symptoms. In case of using splints within 1 month, 3 months and more in Grade III tooth wear, the vertical dimension of occlusion, the height of the lower facial third, and the jaw relationships were restored; typical symptoms of dysfunction syndrome such as pain, crackling and popping sounds in the joint, headache, chewing muscle fatigue, pain in the muscles, the dislocation of the lower jaw to the side, diminished hearing, dry mouth were eliminated. When using the Cadiax Compact system, there were determined the basic parameters that indicated the restoration of the TMJ function in patients.

At the stage of reasonable orthopaedic treatment, in addition to the recording of the vertical dimension of occlusion obtained, aesthetic requirements for the prosthesis design were considered and depending on the defect, porcelain-

fused-to-metal, bugel or partial removable laminar dentures were used.

The registration of mandibular movements was carried out using the Cadiax Compact system. The study of the movements of the hinge axis of the TMJ articular heads in patients of Group I (the control group) revealed synchronous dislocations of the articular heads during protrusive movements with the length of 10.38 ± 0.18 mm to the right and 9.75 ± 0.15 mm to the left, respectively; their trajectories coincided with each other in all the patients of the given group. The trajectories of the articular head dislocations in mouth opening were symmetrical constituting 12.08 ± 0.14 mm to the right and 11.58 ± 0.19 mm to the left. Mediotrusive dislocations of the articular heads to the left and to the right with the length of 10.32 ± 0.17 mm and 10.58 ± 0.19 mm, respectively, were symmetrical (Table 1). In patients of Group II with generalized form of pathological tooth wear and preserved dentition continuity, the length of the articular head dislocations during protrusive movements was 8.46 ± 0.12 mm to the right and 8.94 ± 0.15 mm to the left. During vertical movements, that corresponded to mouth opening and closure in case of the articular head dislocations, their length was 10.12 ± 0.16 mm to the right and 9.71 ± 0.13 mm to the left. Mediotrusive dislocations of the articular heads to the right and to the left were 8.76 ± 0.14 mm and 8.16 ± 0.11 mm in length, respectively. In patients of Group III with generalized form of pathological tooth wear and co-existent denture defects, asymmetrical dislocations of the articular heads during lower jaw movements were found; during protrusion, their length was found to be 6.74 ± 0.17 mm to the right and 6.27 ± 0.22 mm to the left. During mouth opening, the trajectories of the articular head movements were of different length, namely 8.71 ± 0.2 mm to the right and 8.06 ± 0.19 mm to the left. Mediotrusive dislocations of the articular heads to the left and to the right with the length of 7.1 ± 0.18 mm to the right and 6.8 ± 0.19 mm to the left were asymmetrical.

Table 1: Biomechanical parameters of the TMJ in patients with pathological tooth wear (M±m, mm)

Observation period	Protrusive movements, mm		Vertical movements, mm		Right mediotrusive, mm	Left mediotrusive, mm
	right	left	right	left		
Group I	10.38±0.18	9.75±0.15	12.08±0.14	11.58±0.19	10.32±0.17	10.58±0.19
Group II (without denture defects)	8.46±0.12	8.94±0.15	10.12±0.16	9.71±0.13	8.76±0.14	8.16±0.11
Group III (with denture defects)	6.74±0.17	6.27±0.22	8.71±0.2	8.06±0.19	7.1±0.18	6.8±0.19
Group IV (with denture defects and dentition deformities – before treatment)	6.06±0.23	5.81±0.18	7.83±0.19	7.64±0.22	5.68±0.2	5.93±0.24
Stage 1 - 4 weeks	6.38±0.17	6.42±0.25	7.09±0.21	8.03±0.22	5.91±0.26	5.98±0.24
Stage 2 - 3 months	7.24±0.21	7.53±0.23	8.01±0.2	8.05±0.19	6.85±0.24	7.04±0.2

In patients of Group IV with generalized form of pathological tooth wear, co-existent denture defects and dentition deformities, there were revealed asynchronous and asymmetrical dislocations of the articular heads during lower jaw movements. Their lengths were found not to coincide with each other during protrusion constituting 6.06 ± 0.23 mm to the right and 5.81 ± 0.18 mm to the left. During mouth opening, the trajectories of the articular head movements did not coincide with each other being asymmetrical and of different length, namely 7.83 ± 0.19 mm to the right and 7.64 ± 0.22 mm to the left. Mediotrusive dislocations of the articular heads to the left and to the right were asymmetrical having a twisted form and an uneven trajectory. Their lengths were the following: 5.68 ± 0.2 mm to the right and 5.93 ± 0.24 mm to the left. The results obtained indicated functional

disorders of the TMJ and masticatory muscle dysfunction in pathological tooth wear in combination with denture defects and dentition deformities.

Conclusions

1. According to the results of our study, the use of both diagnostic and proposed orthopaedic methods of treatment with the aim of preparing patients with pathological tooth wear, denture defects and dentition deformities for orthopaedic treatment by gradual normalization of the vertical dimension of occlusion applying occlusive splints has several advantages over conventional methods of treatment.
2. When using the Cadiax Compact system, there were determined the basic parameters that indicated functional

disorders of the TMJ in patients of Group IV (the experimental group) with generalized form of pathological tooth wear, co-existent denture defects and dentition deformities.

3. According to the results of clinical and condylographic study, gradual bite opening using set of splints with a thickness of 1.0 to 5.0 mm until complete restoration of occlusive vertical dimension to normalize the jaw relationships in patients of Group IV (the experimental group) with generalized form of pathological tooth wear in combination with denture defects and dentition deformities contributed to significant improvement of the biomechanical parameters of mandibular movements in the vertical, sagittal and transversal planes.

Prospects for further research

The results of our study have indicated that there is a need for implementation of diagnostic and therapeutic measures to prepare patients with pathological dental abrasion, co-existent denture defects and dentition deformities for orthopaedic treatment that will prevent significant disorders of the dentition.

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