Abstract

Introduction: The principles lying at the basis of a balanced dental occlusion cannot be analyzed separately, but only if considering the teeth (and, implicitly, dental occlusion) as integrated into the masticatory system, which includes the masticatory muscles, the temporo-mandibular joint and the maxillary bones. Scope: The scope of the present study was to correlate and establish the interdependence between the morphologically-incorrect prosthetic works and the tissue and functional damages suffered by the neighbouring structures, as a result of some incorrectly-made prosthetic works. Also, the study aims at identifying the factors and limits responsible for a prolonged maintenance of such irreversible pathological modifications within an asymptomatic zone for the patient. Materials and method: The working hypothesis of the present investigation started from the analysis of the various objective signs, versus the morphology of the incorrectly performed prosthetic works. The study, initiated as early as 2009, in a private stomatological clinics (DentEstet, Bucuresti), includes a number of 500 patients (250 women and 250 men), selected among the patients having addressed the stomatological office from various reasons (not always related to the prosthetic pathology of the cases here under investigation). Included in the study have been only the patients with fixed prosthetic works associated with one or several of the previously described objective signs, potentially induced by the iatrogenicity of the prosthetic works. Results: The pathological effects of the iatrogenic works here under analysis, upon both the antagonistic and prosthetic support teeth, may be clinically identified during a minute examination performed prior to producing irreversible final effects (abrasions, fractures, dental mobility, etc.). Such noxious effects of the iatrogenic prosthetic works appear as a false masticatory comfort and as a common functional occlusion, tolerated by the patient, even if not in a perfect equilibrium with all components of the dento-maxillary apparatus. Discussion: The present study involved clinical examination and interpretation of the signs induced by iatrogenic prosthetic works. The main contribution to such signs was brought by the abraded antagonistic teeth, which is the first symptom in most of the cases. The causes leading to the occurrence of these clinical pathological signs are represented by an incorrect realization of the occlusal morphology (from the part of the dental technician) and by the absence of a professional occlusal equilibrium. The trophic chain of these iatrogenies assumes several stages, starting from the preparation of the prosthetic dies (the occlusal space), to the impression technique and materials, patterns’ mounting in the articulator (which prevents a complete simulation of the mandibular movements inside the masticatory system), ending with the final modelling of the prosthetic work. Conclusions: Realization of prosthetic works in full, active collaboration with the dental technician and for each case in part, along with a minute analysis of the works made in the oral cavity, may eliminate several of the conditions favorizing the manifestation of some undesired destructive factors. Checking of the occlusion at regular time intervals, as periodical stomatological controls, should become customary for any stomatologist.

Keywords: tolerated malocclusions, iatrogenic prosthetic factors, pathological abrasion, pathological dental mobility, dental fractures

INTRODUCTION

The principles lying at the basis of a balanced dental occlusion cannot be analyzed separately, but only if considering the teeth (and, implicitly, dental occlusion) as integrated into the masticatory system, which includes the masticatory muscles, the temporo-mandibular joint and the maxillary bones. When intervening – in one form or another – upon the teeth, by the whole range of stomatological manoeuvres, starting from an occlusal obturation up to complex oral rehabilitations, dental occlusion – respectively, the ratio between the two arches – is also modified. The dental arches can not be correctly restored if not avoiding the noxious effects of a possible occlusal interference upon any component of the dento-maxillary apparatus. [1-3]
SCOPE AND MOTIVATION OF THE STUDY

The present study starts from the analysis of some situations, quite frequently appearing in the stomatological office, namely fixed prosthetic restorations, incorrectly realized from the viewpoint of the occlusal morphology, and evaluation of the impact these clinical and technical errors might have upon the other components of the stomatognate system.

The clinical study started from the observation that, during periodical endo-oral examinations of patients, a considerable number of fixed prosthetic restorations – apparently functional for quite a long time period – was observed, even if a more minute examination of the functionality and dynamics of the mandibular movements evidenced major errors, involving deviations from the general principles characteristic to a correct dental occlusion. In most cases, the patients complained of no major symptoms. The situations evidencing spasms of the masticatory muscles, dental sensitivity of the prosthetized teeth or some masticatory discomfort, manifested especially as masticatory inefficiencies, were quite rare. Numerous patients complained of “intolerable” aesthetic incompatibilities, to the detriment of the functional ones.

The scope of the present study was to correlate and establish the interdependence between the morphologically-correct prosthetic works and the tissular and functional damages suffered by the neighbouring structures, as a result of some incorrectly-made prosthetic works. Also, the study aims at identifying the factors and limits responsible for a prolonged maintenance of such irreversible pathological modifications within an asymptomatic zone for the patient.

MATERIALS AND METHOD

The working hypothesis of the present investigation started from the analysis of the various objective signs, versus the morphology of the incorrectly-performed prosthetic works. The most frequently observed signs were: abrasion of the antagonistic teeth, dental mobility of the (bridge) prosthetic abutment teeth, fracture of the antagonistic teeth as well as fracture of the prosthetic works. For the identification of such signs in a high number of patients with fixed prostheses, the existence of a possible “cause-effect” interdependence of these situations was assumed.

The study began in the year 2009, in a private stomatological clinics (Dent Estet, Bucuresti). The criteria applied in the selection of cases were the following: fixed prosthetic works, including both unidental crowns, and prosthetic interventions extended over the whole dental arch. The number of dental units acted as an exclusion criterion. To enter the study, identification of a morphological incompatibility of the prosthetic works comparatively with the other teeth was compulsory, as well as the identification of at least one pathological sign caused by the incorrect prosthetic work. The investigation also included prosthetic works realized from a large range of dental materials, mixed prosthetic works (metalo-ceramic, metalo-composite, metalo-acrylic), metallic or integrally ceramic ones. [4-6]

Each patient was examined exo- and endo- orally, after a previous filling in of an individual examination file including personal data, heredocolateral and personal pathological antecedents. Additionally, the patients were asked to fill in a file expressing their appreciations on the extent of comfort and functional satisfaction of the masticatory system, for the identification of the possible subjective symptoms, as well as the degree of patient’s tolerability to and acceptability of the clinically-identified modifications. [7]

The endo-oral examination included evaluation of the occlusal morphology of the prosthetic works versus the type of morphology of the other teeth. In some situations, the patient showed a more pronounced occlusal morphology of the natural teeth, while the morphology of the occlusal surfaces of the prosthetic works did not mimic the form of the homologous teeth present on the arch. [8,9]

Each case has been recorded with standard impression trays both maxillarily and mandibularly. The impressions were registered with alginate (Hydrogum V. Zhermack), while the patterns were made in gypsum (group IV.)
intercuspidation) occlusion made use of a siliconic material (Occlufast Rock, Zhermack). In the second examination stage, the position of the centric relation of the mandible was also registered. All patients benefited from a complete set of exo-oral (4-5 images with the closed mouth, smiling, left profile and right profile) and endo-oral (5 images, upper arch, lower arch, left occlusion, right occlusion, frontal group occlusion) photographs. According to the complexity of the case and to the requirements of the other stomatological disciplines (endodontics, orthodontics, surgery, etc.), each patient had an orthopantomography or a complete set of periapical radiographies (Pro Max 2D S2, Planmeca). The abutment teeth and also all teeth antagonistic to the fixed prosthetic works have been radiologically examined, after the realization of periapical and of “bite-wing” radiographies.

Special attention has been paid to the condition of the antagonistic teeth in the existent prosthetic works, to the periodontal condition of the abutment teeth, as well as to the present condition of the dental work. Considering that, in the study, oldness of the prosthetic restorations was not viewed as an eliminating criterion, various evolution and progress stages of alteration in the mentioned dental and prosthetic works have been observed. Thus, as a function of the age of the works, the patients have been divided into three categories:

- prosthetic works realized not more than two years ago (not older than two years)
- prosthetic works realized maximum five years ago
- prosthetic works older than five years

The scope of such a classification of the prosthesised patients, according to the oldness of their prosthetic works, was of identifying a possible periodicity of the various clinical signs observed in different stages of the pathological modifications.

RESULTS

- Evaluation of the signs and symptoms monitored during the study

Abrasion of the antagonistic teeth has been evaluated clinically, and the abrasion degree was registered in the examination sheet of the patient. Estimation of the abrasion degree was based on the classification of Smith and Knight [10], as follows: degree I: abrasion only at enamel level, degree II: abrasion extended up to dentin, degree III: abrasion localized at dentin level, yet without opening the dental pulp, and degree IV of abrasion, when destruction is extended up to the pulp room. In certain situations, the antagonistic teeth were coronarily (odontally) restored with composite materials and, in some cases, of silver amalgam.

Graph 1. Abrasion of antagonistic teeth, expressed as percent ratios

The mobility of the abutment teeth from the prosthetic works was the second criterion applied in the initial oral examination of the patient. Appreciation of dental mobility was performed clinically in cases of unidental works or prosthetic restorations restricted to two bridge abutment teeth. In extended prosthetic works, where several abutment teeth were present, each abutment tooth was examined radiologically on either periapical radiographies or orthopantomographies. The extent of bone peridental resorption was evaluated radiologically, comparatively with the other teeth present on the arch, along with the width of the peridental space (lamina dura) – periodontal space. To estimate the degree of mobility, the Miller mobility index (with 3 degrees of mobility) was employed.

Fracture of the antagonistic teeth represented a third evaluation criterion of the negative consequences determined by prosthetic iatrogenies. Analysis of the dental fractures or of the restoration components (composite or Ag amalgam obturations) permitted their identification both
clinically and on experimental patterns. Most of the dental fractures were registered at the level of the lateral teeth cusps, and also of the incisal margin of the frontal group teeth [11,12].

**Fractures of the prosthetic works** represented a distinct entity at the level of dental fractures. In most of the cases here under analysis, fractures of the prosthetic works appeared either at the physionimic component or at the junction of the ceramic component with the metallic skeleton of the prosthetic work. Mention should be made of minor exfoliations, localized in the superficial ceramic layer, up to massive destructions, involving fracture of a whole ceramic cusp. The fractures have been examined both clinically and on the patterns mounted in the articulator.

The study was performed on a number of 500 patients (250 women and 250 men), selected among those having addressed the stomatological office from various reasons (not always related to the prosthetic pathology of the cases here under investigation). Included in the study have been only the patients with fixed prosthetic works associated with one or several of the previously described objective signs, potentially induced by the iatrogenicity of the prosthetic works. Informed consent was obtained from all patients on the utilization of the data and results of the examinations made. The time interval over which the study was performed was 2009 – 2013. The patients included in the study have ages between 21 and 69 years. The patients whose oral rehabilitation involved prosthetic works with implantological support were not included in the study. After examination and analysis of all information obtained by anamnesis, by the questionnaires filled in by patients and also by clinical examination, the following results were obtained: 375 patients (out of whom 210 were men) showed abrasions at the level of the teeth antagonistic to the prosthetic works. Classification of the cases of dental abrasion is showed in the following table:

<table>
<thead>
<tr>
<th>Dental abrasion</th>
<th>Degree 1, only in the enamel</th>
<th>Degree 2, only in dentin</th>
<th>Degree 3, only in dentin (-) pulp room</th>
<th>Degree 4, in dentin (+) open pulp room</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>275</td>
<td>83</td>
<td>15</td>
<td>2</td>
</tr>
</tbody>
</table>

The criterion of dental abrasion of the antagonistic teeth was the most frequently occurring sign in patients with morphologically-incorrect prosthetic works. The difficulty of the “cause-effect” type interdependence was to establish, as exactly as possible, whether teeth abrasion is or is not a direct consequence of the traumatic action of the prosthetic works present on the antagonistic arch. The question to be asked is: how can one differentiate physiological abrasion or the abrasions already existing prior to the application of prosthetic works, from the pathological ones? For an as high precision as possible, analysis was first devoted to the abrasion degree of the teeth directly involved in the study, comparatively with the abrasion degree of the other teeth present on the arch. The obvious signs of traumatic pathological abrasion being manifested as abrasion facets, the study of the patterns mounted in habitual occlusion were put into evidence with their occlusal corresponding element (the morphological elements) from the incorrect antagonistic work. [13]
mobility at the level of the abutement teeth. Examination was made clinically, through palpation of the analyzed tooth and coronary touching in the moment of its contact with its antagonistic element, a slight mobility being perceived in the moment of the dental contact. Radiological analysis performed on periapical or "bite-wing" radiographies permitted to compare the teeth involved in the occlusal trauma with the periodontal space of the other teeth present on the arch, and, consequently, to establish whether the occlusal trauma is provoked by a primary or secondary cause of the pre-existing periodontal affections.

Graph 2. Mobility of abutement teeth, males and females, as ratios

Distribution of the 235 patients (123 men), classified according to the Miller mobility index, as a function of the mobility degree, is the following:

<table>
<thead>
<tr>
<th>Miller mobility index</th>
<th>Degree 1, mobility similar to the physiological one</th>
<th>Degree 2, mobility in vestibulo-oral direction &lt;1mm</th>
<th>Degree 3, mobility in any direction &gt;1mm</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>171</td>
<td>40</td>
<td>24</td>
<td>235</td>
</tr>
</tbody>
</table>

Fracture of the antagonistic teeth represented the third criterion for appreciating the noxious effects of the incorrectly-realized prosthetic works. The study included all situations in which the antagonistic teeth showed traces of dental fractures and of dental restorations on the antagonistic teeth. An a posteriori causality analysis was developed both on static and dynamic examination of the occlusion, both in the oral cavity and on the models. The extent of involvement of the line of coronary fracture did not represent a criterion in the selection of patients. Out of the total number of 500 patients included in the study, 98 (52 of them – men) had coronary lesions occurring as dental fractures. Fracture of the antagonistic teeth represented the criterion most simply to identify, analysis being possible both clinically – in the oral cavity – and on the models of the study.

The last criterion considered and, implicitly, included in the study, referred to the fracture of the incorrectly-realized prosthetic works (or of certain part of theirs). Out of the total number of examined patients, 78 (of whom 61 were men) showed various forms of fractures of their prosthetic works. In all cases, the fractures were partial, of interest being exclusively the physionomic compound of the mixed metalo-ceramic restorations.

Fig 3 Fracture of the physionomic component (ceramics) in a metalo-ceramic prosthetic work incorrectly-realized from the viewpoint of its occlusal morphology

The diagnosis, established both clinically and on the pattern, raised no difficulties in the interpretation or identification of the etiology.

- Correlation and interpretation of results
Out of the total number of examined patients, there were identified 375 cases of dental abrasion of the antagonistic teeth in various stages, 235 cases of pathological mobility, 98 coronary destructions of the antagonistic teeth and 78 destructions of the prosthetic works. The largest part of the negative effects exercised by iatrogenic prosthetic works is represented by abrasion of the teeth antagonistic to the prosthetic restorations (375 cases). The ratio of 75% is
explained by an incorrect or an incorrectly-balanced dental occlusion, even if not felt as such by the patient. Most of these cases, if examined in the first year after application of the work in the oral cavity, evidenced a fine inocclusion – imperceptible for the patient – on the contralateral side. In works older than two years or more, abrasion of the antagonistic teeth was much more advanced, yet the occlusion was bilaterally balanced, as due to the subsequently occurring process of dental abrasion. [14,15]

235 cases (47%) showed mobility of the abutment teeth. In many situations, the primary occlusal (periodontal disease or occlusal trauma) was quite difficult to identify. All cases taken into study evidenced at least two objective signs directly related to the traumatic occlusion. Out of the main objective signs manifested, mention should be made of: an exaggerately reduced or – in some cases – too large occlusal surface, occlusal morphology disagreeing with the other teeth from the arch, prosthetic works extended with insufficient dental support, as well as small-scale edentations solved by prosthetic works with extensions of one or two teeth.

The simultaneous occurrence of two factors was identified in 103 cases, namely abrasion of the antagonistic teeth accompanied by the mobility of the abutment teeth of the prosthetic work. A possible explanation for the association of these two factors may be that, in a first evolutive stage of the iatrogenic process, abrasion of the antagonistic teeth occurred, followed by the mobility of the abutment teeth. Most of such situations appeared in prosthetic works in use for more than 5 years, also leading to an unequal and non-uniform distribution upon the prosthetic support teeth.

The 98 cases of dental fractures at the level of the antagonistic teeth (19.6%) were mainly identified in patients with prosthetic works not older than two years, the manifestation of such situations being attributed to the premature non-identified dental contacts or to the occlusal interferences inside the mandibulary movements. The main part was held by the teeth belonging to the group to which the antagonistic teeth represented metalo-ceramic prosthetic works. Sex distribution is not conclusive (52 men). In all 98 cases here analyzed, signs of dental abrasion were noticed in the antagonistic teeth. The coexistence of the two factors: two clinical signs in the same patient, is explained by the fact that dental abrasion is the result of the centric contacts (maximal intercuspidation, centric relation, habitual occlusion), situations in which the patient was accustomed with a certain comfort, tooth fracture occurring during eccentric, disbalanced movements of the mandible (protrusion, lateral movements, etc.).

A similar cause was discovered in the 78 patients with fractures at the level of the prosthetic restorations (15.6%). In all cases of fractures of the (mainly) ceramic component, some vicious technical executions and modeling of the non-anatomic metallic support have been discovered. Examination of the fractured works on the section of the fracture line evidenced either tiny thickness values (under 0.5 mm) of the ceramic layer, or cuspides whose thickness attained 4 mm, in the absence of the (non-anatomic) support of the subadjacent metallic skeleton.
DISCUSSION

The present study was based on the examination and clinical interpretation of the signs induced by iatrogenic prosthetic works. The main part of the induced signs came from the abraded antagonistic teeth, which, usually, is the first sign observed in most of the cases. The causes producing such pathological clinical signs are represented by an incorrect realization of the occlusal morphology (from the part of the dental technician) and by the absence of a judicious occlusal equilibrium. The trophic chain of such iatrogenicities includes several stages, starting from the preparation of the prosthetic dies (the occlusal space), the impression methods and materials, mounting of the models in the articulator (which does not permit a total simulation of the mandibulary movements inside the maxillary system), up to the final modeling of the prosthetic work. The noxious effects of the incorrectly-realized works could have been simply avoided by a rigorously drawn treatment plan which should anticipate the final results. Knowledge of the criteria upon which a correct occlusion is based, as well as their application when the work is inserted in the oral cavity might assure a much better prognostic. In most of the here discussed cases, the patients complained of no symptomatology, this type of iatrogenicity being “silent” for the patient, with an especially high tolerance degree, which is actually the only explanation for the absence of the subjective loco-regional symptoms. The most frequently recorded sensation was that of a masticatory discomfort or of masticatory insufficiency. In one of the analyzed cases, the patient describes how, prior to the fracture of the ceramic compound in the prosthetic work from the molar zone, prosthetic restoration was decemented four times within 8 months. Repeated cementation and decementation of the prosthetic work within a relatively short time interval might indicate the existence of a prosthetic iatrogenicity manifested as a traumatic occlusion.

The occurrence of dental mobility in the abutment teeth is mainly caused by two factors: overuse of the abutment teeth as a result of some wrong decisions made when configuring the future prosthetic work (extended dental bridges, supported by an insufficient number of abutment teeth) or the manner of transmission of the occlusal forces towards the supporting tissues of the abutment teeth, which represents an undesired result of an incorrect occlusal morphology. Many of the cases under investigation, showing mobility of the abutment teeth, were met in the prosthetic works substituting the group of frontal teeth (both maxilarily and mandibularly), situations in which the body of the bridge acts upon the abutment teeth as an extensiation, inducing – in time – their mobilization.

Dental fractures and also those of the prosthetic works have been the most striking ones, their effects being immediately felt by the patient, who asked for medical assistance. The fractures had been mainly produced by premature non-identified contacts, prior to having the work cemented in the oral cavity.

One of the frequently occurring causes in extended prosthetic works (namely, more than four dental units/teeth) was that of the partial inocclusion works, meaning that the dental contacts were present only on one or at most two teeth of the four ones involved in the prosthetic work. Even if functional, the contacts had an exaggerated intensity, having to compensate for the inocclusion of the other teeth. The patients hardly identify this type of interdental relations (stable contacts on a very reduced number of teeth, the remaining ones being in inocclusion) in due time, which predisposes them to fractures of the antagonistic teeth or even of the whole prosthetic work.
CRITERIA FOR THE EVALUATION AND ESTIMATION OF IATROGENIC PROSTHETIC FACTORS – SEMIOLOGY AND SYMPTOMATOLOGY

CONCLUSIONS

The number of morphologically‑incorrect prosthetic works is quite high, such situations being frequent in the daily practice of any stomatologist. The extent of tolerance and adaptability of dental morphology to such modifications is extremely high, numerous and various differences being observed from one patient to another. Thus, there exist patients with a very low tolerance to occlusional modifications (those who address the dentist the very next day for balancing an obturation performed yesterday) and patients with a high tolerance (having occlusally‑incorrect works, which negatively influences the whole mandibular dynamics), who address the stomatologist very late or at all.

The pathological effects of the iatrogenic works analyzed in the present study upon the antagonistic and prosthetic support teeth may be clinically identified on minute examination, prior to producing irreversible final effects (abrasions, fractures, dental mobility, etc). Such noxious effects of the iatrogenic prosthetic works are masked by a masticatory comfort and by a habitual functional occlusion, tolerated by the patient, even in the absence of a perfect equilibrium with all components of the dento‑maxillary apparatus. This tolerance zone, different from one patient to another, is determined for some time period, until the moment in which one of the components forming the system fails, in the form of: dental abrasion, joint disfunction, myalgia, dental mobility, etc. Any system having no equilibrium tends to have it, such an objective being only a matter of time; the masticatory system is prioritarily belonging to such a type of system.

Realization of prosthetic works as an active collaboration with the dental technician for each case in part, along with a minute analysis of the works from the oral cavity, may eliminate many of the conditions favouring the manifestation of some unwanted destructive factors. Regular checking of the occlusion, as part of the periodical stomatological controls, should become a routine work for each dentist.

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