© Borgis Nowa Stomatol 2018; 23(4): 142-147 DOI: https://doi.org/10.25121/NS.2018.23.4.142

Magdalena Batko[1], Michał Kowalewski[1], Anna Królińska[1], Bartłomiej Górski[2], Wioleta Majdanik[2], *Andrzej Miskiewicz[2]

Comparison of the sensitivity of detecting risk factors for periodontitis using conventional radiography

[1]Student's Science Club, Department of Periodontal and Oral Mucosa Diseases, Medical University of Warsaw
Science Club Coordinator: Andrzej Miskiewicz, MD, PhD
[2]Department of Periodontal and Oral Mucosa Diseases, Medical University of Warsaw
Head of Department: Professor Renata Górska, MD, PhD

Keywords

periodontitis, risk factors, radiography

Summary

Introduction. Periodontitis is a condition of tooth supporting structures, which are responsible for normal dental morphology and function. Bacterial biofilm formation in the presence of local risk factors plays a fundamental role in the development of periodontitis. Early and accurate detection of risk factors which promote dental plaque accumulation is the basis of treatment and prophylaxis.

Aim. The aim of the study was to assess overhanging dental restorations and their impact on the maxillary alveolar process margin and the alveolar mandible based on panoramic radiography. Furthermore, the correlation between the type of restoration and the magnitude of bone loss was analysed.

Material and methods. A retrospective analysis of 200 panoramic radiographs showing restorations in permanent dentition was performed using the Planmeca Romexis Viewer software. Further analysis included 113 radiographs with the presence of a homologous tooth on the opposite side of the dental arch. In the study, we analysed the following variables: age, gender, the bone level, occlusal contact points between the opposite teeth and the condition of the tooth adjacent to overhanging dental restoration. We also assessed the type of incorrect dental restoration according to G.V. Black classification. The obtained data was analysed statistically, with $p < 0.005$ considered statistically significant.
The study was approved by the Bioethics Committee of the Medical University of Warsaw (approval no. KB/115/A/2012).

Results. We obtained data on the prevalence and magnitude of overhanging dental restorations, the type of restoration and the coexisting bone lesion. The largest size of the overhanging dental restoration was associated with Class II (according to G. V. Black) mesio-occlusal-distal cavities (1.15 mm; $p < 0.03$), whereas the smallest ones were observed for occlusal-distal cavities (0.91 mm; $p < 0.001$). The Spearman's rank correlation coefficient between mesio-occlusal-distal cavities and radiographically measured size of bone lesions was positive ($R = 0.51$; $p = 0.03$).

Conclusions. The conducted study revealed a significant positive correlation between the mean size of overhangs and radiographically measured size of bone loss. Adjunctive radiology is an important aid in the detection of risk factors for periodontitis.

Introduction

Chronic periodontitis is an infectious disease responsible for the loss of both connective attachment and the alveolar bone. As a result, periodontal pockets and gingival recessions develop (1). This is the most common form of periodontitis, which usually occurs in adults (2). Periodontal disease is caused by an imbalance between dental plaque microbes interacting with the periodontal tissue and the resulting host response, which is in turn modified by risk factors.

Age, gender, race and genetic factors are determinants of periodontitis. The prevalence of periodontal diseases increases with age due to the accumulation of risk factors over time. The sexual dimorphism observed in periodontitis

is a result of nicotine dependence, poorer hygiene and less frequent check-up dental visits. The disease is more common in men than in women. The socio-economic status, education and income are probably responsible for the differences in the prevalence among races (2). Genetic polymorphism is due to multifactorial inheritance, altered expression of proteins and, consequently, differences in immune response.

Modifiable risk factors for periodontitis include periopathogens found in dental plaque and subgingival biofilm, systemic diseases, such as diabetes mellitus, or diseases with a clinical picture including periodontitis, e.g. histiocytosis. Other risk factors include nicotine dependence, which contributes to supragingival plaque formation and changes in subgingival biofilm; obesity expressed as BMI, increase of which correlates with increased risk of periodontal diseases; socio-economic status (education in particular); and stress (financial one in particular).

Dental plaque plays a key role in periodontal diseases. Its accumulation is associated with increased supply or retention. In addition to malocclusions, congenital anomalies of soft tissues, abnormalities in dental anatomy, carious lesions and reduced antimicrobial activity of saliva, factors that promote dental plaque buildup also include prosthetic restorations and iatrogenic factors. In the latter group, particular attention should be paid to overhanging dental restorations (ODRs), which distort normal anatomical tooth contours and make it difficult to clean the teeth, the interdental spaces in particular.

Interactions between microbes and host factors contribute to periodontal diseases. Bacterial antigens and toxins stimulate the immune system, which responds by producing antibodies and proinflammatory factors. Alveolar bone resorption is a result of increased osteoclast activity compared to that of osteoblasts. Signals that stimulate these cells may be mediated directly by periopathogens or by activated host cells. RANK, which binds RANKL, a ligand produced by a number of cells involved in inflammatory processes and responsible for osteoclast formation and activation, plays a special role in this process (3).

Pathological bone remodelling may manifest on a radiograph as a vertical bone loss, i.e. a bony pocket. This state is due to the partial resorption of the interdental septum reached by proinflammatory signals. This is possible when the septum is wide. Otherwise, the bone within the septum is completely reabsorbed, which results in a vertical bone loss.

An analysis of clinical data along with radiological records is necessary for a correct diagnosis and treatment plan preparation.

The diagnosis of periodontal diseases is based on, among other things, a panoramic radiograph – a multilayer extraoral image. It allows for radiological assessment of periodontal structures, particularly the general condition of the maxillary alveolar process and the alveolar part of the mandible, and the marginal periodontium, including the detection of bone loss around teeth and identification of factors that promote periodontal disorders. Panoramic radiographs are used to evaluate the bone of the interdental septum. Unequal magnification, i.e. larger horizontal magnification compared to the vertical one, is the main disadvantage of panoramic radiography. It is not possible to differentiate between active process and remission, and the degree of bone loss shown in one image does not reflect the disease dynamics. Radiographic images tend to show less severe bone loss than that actually present. At least 30% of the bone mass must be lost before it can be detected on a radiographic image.

Aim

The aim of the study was to assess overhanging dental restorations and their impact on the maxillary alveolar process margin and the alveolar mandible based on panoramic radiography. Furthermore, the correlation between the type of restoration and the magnitude of bone loss was analysed.

Material and methods

This was a retrospective analysis of 200 panoramic radiographs performed in June 2014 in the Department of Dental and Maxillofacial Radiology at the Medical University of Warsaw. A total of 113 images showing ODRs in permanent teeth were included in the analysis. Only images with homonymous teeth in the same arch were included in the analysis. Cases of teeth with overhangs that were treated endodontically or had periapical lesions were excluded from the analysis.

The following variables were analysed: age, gender, the bone level, occlusal contact points between the opposite teeth and the condition of the tooth adjacent to ODR (the same data were analysed for the homonymous tooth). The type of incorrect restoration was also assessed.

Planmeca Romexis Viewer software was used in the study. Interdental marginal bone loss at the overhang was analysed. The type of bone loss was also assessed by classifying it as horizontal, vertical or mixed (combination of horizontal and vertical bone loss). The size of ODR was also evaluated. Other factors that may have an impact on alveolar bone loss were also analysed.

Statistical analysis

The data obtained from the retrospective radiological assessment were analysed statistically. The preliminary analysis for parametric distribution was based on the following normality tests:

- the Lilliefors test,
- the Shapiro-Wilk test,
- the Kolmogorov-Smirnov test.

The normality tests for radiological data distribution showed a non-parametric distribution of numerical data. Therefore, Kruskal-Wallis tests and analysis of variances (ANOVA) were used for further assessment. An assessment of correlations between the type of ODR and the size of bone loss was presented using the Spearman rank correlation coefficient. This coefficient was also used for correlation assessment. Patients in the study group were matched in terms of age and gender, so that a reliable comparison of the obtained data could be performed using appropriate statistical tests. One-way analysis of variance (ANOVA) was used to compare the size of alveolar bone loss at the tooth with an overhang and a corresponding surface of the homonymous tooth in a given dental arch. Statistica 13.1 (StatSoft, USA) was used for statistical calculations. Significance level of $p < 0.05$ was considered statistically significant. The study was approved by the Bioethics Committee of the Medical University of Warsaw (approval no. KB/115/A/2012).

Results

We obtained data on the prevalence and extent of overhanging dental restorations, as well as the types of restorations with overhangs (tab. 1).

The size of an overhang results from the spatial conformation of the filling. MOD restorations are characterised by the largest overhangs (1.15 mm; $p < 0.005$). Lower values were reported for Black's Class II restorations on the distal surface of reconstructed teeth (0.71 mm; NS). Slightly higher, comparable values were reported for occlusal-distal and mesial restorations, 0.91 mm (NS) and 0.79 mm (NS), respectively. The smallest overhangs were reported for mesial-occlusal restorations (0.63 mm; NS) (tab. 2).

The size of overhangs is correlated with the size of restorations. The largest overhangs were observed in MOD, which covers three dental surfaces (0.64 mm ÷ 1.39 mm). In the case of MOD, this is also associated with the reconstruction of two contact points. Furthermore, high values were reported for overhangs on the distal aspect of the reconstructed tooth surfaces (0.18 mm ÷ 1.37 mm) (fig. 1).

This is probably due to difficulty in visual inspection of the reconstruction. The best access and the need to reconstruct only one contact point on the mesial surface allowed for the smallest restoration overhang.

The size of overhang is positively correlated with the magnitude of alveolar bone loss (fig. 2).

The larger the overhang, the more intensely progressing inflammation in the bone, leading to the loss of hard tissue. The most severe bone loss was reported for overhanging MOD restoration, which covers three dental surfaces (3.97 mm; $p < 0.03$; $R = 0.51$). Significantly less severe bone loss was found for restorations involving the occlusal-distal surface (1.86 mm; $p < 0.001$; $R = 0.32$), i.e. restoring only one contact point.

Bone loss increases proportionally with the increasing size of overhang. The smallest bone tissue defects were reported for minor overhangs (< 1.5 mm; NS). For larger ones, difficulty cleaning the interdental spaces and increased risk of dental plaque accumulation in these spaces become factors predisposing to pathological bone remodeling, vertical bone defects (bony pockets) in particular.

Discussion

The present assessment of the correlation between ODRs and the loss of maxillary alveolar bone or the alveolar part of the mandible is one of the first scientific works in this field in Poland. Therefore, the study fills a significant scientific gap in the analysis and assessment of local risk factors for periodontitis. The additional use of panoramic radiography allows for the assessment of marginal periodontal bone tissue. The imaging range including both dental arches makes it impossible to decide whether the structural bone changes are local or generalised.

Periodontal diseases may lead, among other things, to hard tissue loss. Risk factors for periodontal diseases that may be identified using radiography include dental

Tab. 1. Study group characteristics, including patient age and gender, the type of restoration, as well as the size and location of overhang

Age range (years)	Male/female proportion	Percent distribution of types of restorations assessed	Types of teeth analysed	Location	Overhang size
21-73	45% : 55%	OD – 29% MOD – 23% MO – 29% M – 13% D – 6%	Premolars – 32% Molars – 68%	Maxilla – 61% Mandible – 39%	0.5-2.2 mm

OD – occlusal-distal restoration; MOD – mesial-occlusal-distal restoration; MO – mesial-occlusal restoration; M – mesial restoration; D – distal restoration

Tab. 2. A collective presentation of the obtained results with a division into the type of restoration, the prevalence and size of ODRs. The type of ODR was linked with the magnitude of bone loss. Statistically significant values ($p < 0.05$) are marked with an asterisk (*), and the test values (#)

Type of restoration	The prevalence of ODRs including the size			Mean ODR size	Study group vs. control group		
	< 0.5 mm	0.5-2.0 mm	> 2.0 mm		Radiographically measured amount of bone loss	p	R
OD	15%	32%	53%	0.91 mm	1.86 mm*	< 0.001#	0.32#
MOD	11%	28%	61%	1.15 mm*	3.97 mm*	0.03#	0.51#
MO	38%	47%	15%	0.63 mm	0.93 mm	NS	NA
M	51%	31%	18%	0.79 mm	0.52 mm	NS	NA
D	24%	37%	39%	0.71 mm	1.21 mm	NS	NA

OD – occlusal-distal restoration; MOD – mesial-occlusal-distal restoration; MO – mesial-occlusal restoration; M – mesial restoration; D – distal restoration; NS – not significant; NA – not applicable

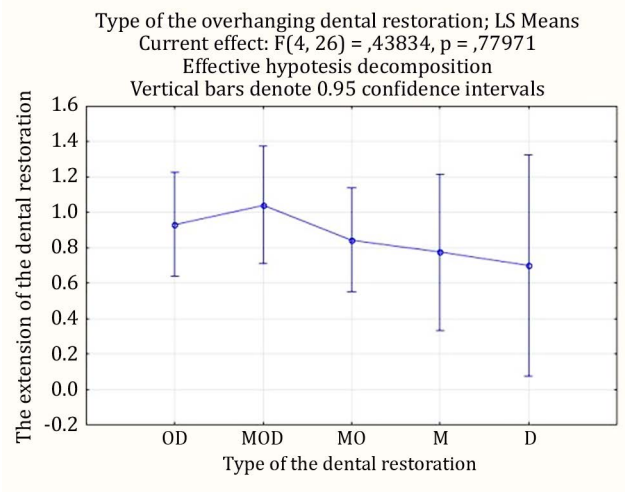

Fig. 1. Multivariate ANOVA taking into account the obtained overhang magnitudes depending on the type of restoration

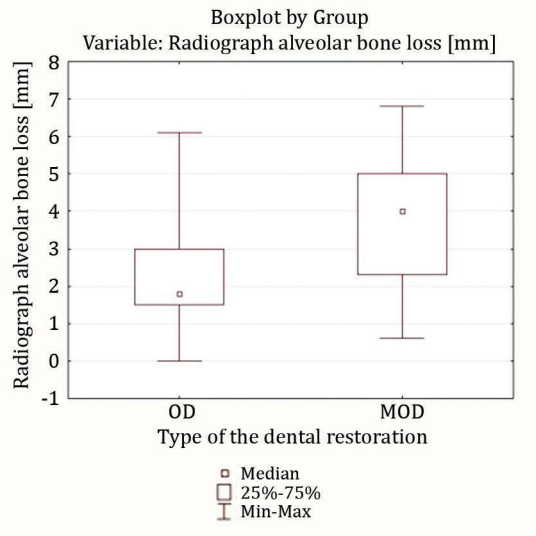

Fig. 2. Selected values (statistically significant as in accordance with table 2) indicating the radiographic extent of bone loss (mm) depending on the type of overhanging Black class II restoration

calculus and all types of conditions that promote dental plaque build-up, such as: dental caries, malocclusions and iatrogenic factors. The latter ones include restoration overhangs, which, by distorting normal tooth contours, cause difficulty cleaning the interdental spaces and cause interdental bone loss due to bacterial biofilm accumulation. The size of restoration, which depends on the size of hard dental tissue loss, was considered in the assessment of bone loss. The type of filling is also important. A positive correlation was found between the size of restored cavity and the magnitude of bone loss. The analysis also showed that the tooth surface to be restored is also of importance. A more difficult direct visual inspection and the need to restore two contact points are risk factors for overhangs. These are most often seen in MOD restorations. They are also associated with the most severe bone loss. The most favourable access to mesial and occlusal surfaces was associated with relatively the smallest overhangs.

Periodontal diseases are caused by imbalance between microbial biofilm and the host's immune system. Particular attention should be paid to *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans*, which are responsible for chronic and aggressive pridontitis. Pathological processes caused by these microbes are promoted by risk factors specified by Genco – both systemic and local (4). According the author, sites of dental plaque retention, such as incorrect restorations, are classified in the latter group.

In his review paper on risk factors, Caton et al. pointed to the important role of periodontal pretreatment, which, in addition to professional dental hygienisation, is also aimed to reduce factors contributing to dental deposit reaccumulation (5). Elimination of risk factors, including ODRs, is of key importance for successful treatment. Black class II restoration overhangs on the contact surfaces of lateral teeth have negative effects on marginal periodontal tissues. Tissue destruction proportional to local aetiological factors is a characteristic feature of chronic periodontitis. Rodriguez-Ferrer et al. conducted a randomised study in patients with overhanging amalgam fillings in lateral teeth (6). In addition to hygienisation procedures, overhangs were eliminated in the study group vs. controls. A change was observed in the initially equivalent baseline status of the assessed periodontal parameters in both groups; negative effects of the local factor in the form of bacterial dental plaque retention were observed in the pathogenesis of chronic periodontitis. According to authors, attention should be paid to the presence of filling overhangs during the initial phase of gingival treatment.

Clinical and radiological studies by Gilmore and Sheiham have also demonstrated a positive correlation between filling overhangs and gingivitis, as well as periodontal bone loss (7). The size of filling overhangs is associated with the magnitude of bone loss. Larger overhangs increase the risk of failure to maintain optimal home hygiene of the interdental spaces, which become the place of increased retention of bacterial biofilm. The thickness of dental plaque contributes to inflammation of tissues surrounding the tooth. Brunsvold and Lane showed the important role of overhanging restorations not only as a risk factor of periodontal diseases, but also as a cause of pathogenic transformation of subgingival bacterial microflora (8). In the present study, we compared the presence of gingivitis, bleeding and bone loss in teeth with conservative restoration overhangs, with an analogous analysis in homologous teeth. We also pointed to the problem of frequent deficit in diagnostic radiology of ODRs and the lack of attempts to eliminate overhangs as a result of failure to diagnose this local risk factor for periodontal disease. ODR is a local factor predisposing to pathological bone remodelling, vertical resorption known as bony pockets in particular.

In his study comparing radiological assessment of panoramic radiographs with clinical periodontal screening, Walsh et al. found that the measurement of the distance between the enamel-cement border and the margin of the maxillary alveolar process/alveolar part of the mandible was statistically significant. An analysis of panoramic radiographs showed a significant correlation between large overhangs (> 1 mm) and the loss of connective tissue attachment, as indicated by CAL > 3 mm (9).

There is also a relationship between the size of marginal periodontal bone loss and the size of restoration. MOD restorations covering three dental surfaces are significantly more destructive for tooth-supporting tissues than filling one or two surfaces with restorative material.This is associated with the need to restore two contact points and thorough preparation of dental walls situated below. Difficulty obtaining optimal access to the treatment field in lateral teeth or problems with the indirect inspection in the case of upper teeth may increase the prevalence of overhangs in molars and maxillary teeth compared to premolars and mandibular dentition.

Corbet et al. emphasised the role of diagnostic imaging in patients with clinically diagnosed periodontal pathology in the planning of periodontal treatment (10).

Furthermore, radiology provides prognostic data on periodontal disease progression. Chapple et al. pointed out that the prognosis is successful if the pathological process of tissue destruction is only local and it is possible to detect and neutralise the responsible local factors (11).

Panoramic radiography, as a review radiological diagnosis, is often performed as an adjunctive examination in patients initiating dental treatment. It allows for a general assessment of maxillary and mandibular bone tissue, as well as generalised defects of the maxillary alveolar process and the alveolar part of the mandible. Furthermore, it allows for a general identification of risk factors for periodontal diseases and, at the same time, local lesions of hard periodontal tissues caused by these factors. The method is helpful in cases of diagnostic difficulties associated with direct inspection of risk areas. This allows for an estimate identification of local causes of periodontal diseases and correction of potential filling overhangs, followed by the implementation of adequate treatment, which takes patient's prognosis into account.

Conflict of interest

None

References

1. Kumar S: Evidence-Based Update on Diagnosis and Management of Gingivitis and Periodontitis. Dent Clin North Am 2019; 63(1): 69-81.
2. Albandar JM: Epidemiology and risk factors of periodontal diseases. Dent Clin North Am 2005; 49(3): 517-532.
3. Park OJ, Kim J, Kim HY et al.: *Streptococcus gordonii* induces bone resorption by increasing osteoclast differentiation and reducing osteoblast differentiation. Microb Pathog 2018; 126: 218-223.

Correspondence

*Andrzej Miskiewicz
Zakład Chorób Błony Śluzowej i Przyzębia
Warszawski Uniwersytet Medyczny
ul. Miodowa 18, 00-246 Warszawa
tel.: +48 (22) 502-20-99
andrzej.miskiewicz@wum.edu.pl

submitted:
4.10.2018
accepted:
25.10.2018

4. Genco RJ: Current view of risk factors for periodontal diseases. J Periodontol 1996; 67 (10 suppl.): 1041-1049.
5. Caton JG, Armitage G, Berglundh T et al.: A new classification scheme for periodontal and peri-implant diseases and conditions – Introduction and key changes from the 1999 classification. J Clin Periodontol 2018; 45 (suppl. 20): S1-S8.
6. Rodriguez-Ferrer HJ, Strahan JD, Newman HN: Effect of gingival health of removing overhanging margins of interproximal subgingival amalgam restorations. J Clin Periodontol 1980; 7(6): 457-462.
7. Gilmore N, Sheiham A: Overhanging Dental Restorations and Periodontal Disease. J Periodontol 1971; 42(1): 8-12.
8. Brunsvold MA, Lane JJ: The prevalence of overhanging dental restorations and their relationship to periodontal disease. J Clin Periodontol 1990; 17(2): 67-72.
9. Walsh TF, al-Hokail OS, Fosam EB: The relationship of bone loss observed on panoramic radiographs with clinical periodontal screening. J Clin Periodontol 1997; 24(3): 153-157.
10. Corbet EF, Ho DK, Lai SM: Radiographs in periodontal disease diagnosis and management. Aust Dent J 2009; 54 (suppl. 1): S27-43.
11. Chapple ILC, Mealey BL, Van Dyke TE et al.: Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol 2018; 89 (suppl.): S74-S84.