Radiographic Evaluation of Marginal Bone Height and Density Around Overhanging Dental Restorations

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This study aimed to investigate the marginal bone changes beneath overhanging restorations. The study group consisted of 250 archived panoramic radiographs that had at least one overhanging restoration, examined by two observers. The distance from the cementoenamel junction (CEJ) to the marginal bone crest beneath the overhang was measured with ImageJ software. The same distance was measured from the control sites (the intact surface of the same tooth with overhang, and the same tooth on the contralateral side) to assess bone loss. To evaluate bone density, two regions of interest (ROIs) were chosen: one in the marginal bone beneath the overhang, and the other in the marginal bone adjacent to the intact surface of the same tooth. Wilcoxon paired t test and Mann-Whitney U test were used for comparisons (P < .05). The prevalence of overhangs was 4.3%. Molar teeth (80.8%) and the disto-occlusal cavities (54%) were the most common sites for overhangs. The average bone loss beneath the overhangs was 2.77 ± 1.20 mm, which was significantly different from the control sites (P < .05). The bone density beneath the overhang was significantly lower than at control sites (P < .05). The frequency of overhangs was higher in areas that are difficult to reach, and the height and density of the marginal bone beneath the overhang were decreased compared to control sites. Int J Periodontics Restorative Dent 2022;42:401–408. doi: 10.11607/prd.5424

Overhanging dental restorations, defined as the extension of the restorative material beyond the cavity borders, are one of the iatrogenic factors that facilitate or enhance periodontal disease.1 These restorations cause inadequately polished approximal restoration surfaces, thereby promoting local accumulation of bacterial plaque and leading to periodontal diseases rather than mechanical and chemical irritation.2 Restorations, especially when located subgingivally, may violate the biologic width and result in clinical attachment loss, which is accompanied by bone resorption.3

Despite advances in technology and awareness, overhanging restorations are inevitable in some cases due to several morphologic variations and conditions, such as concavities and irregularities in root anatomy, and inadequate physician skill.4–6 It is reported in previous studies that the prevalence of overhanging restorations varies widely (3.2% to 71%).7–9 This difference in prevalence may be due to the definition of overhangs, the assessment methods, and the restorative material type. Diagnosis of the overhanging restoration can be made with either clinical or radiographic examination; because the conventional clinical examination of contact areas of the posterior teeth is difficult due to the anatomical

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structure, the most reliable way is to combine both of these methods. Even though bitewing radiographs are the gold standard for overhang detection, routinely taken panoramic radiographs can also be used for marginal assessment. In previous studies, marginal bone adjacent to overhanging restorations was evaluated radiographically to detect the mean alveolar bone loss. However, there is no current literature for assessing the change in bone density around the overhang and the relation between alveolar bone.

In the literature, reliable quantitative methods have been used to detect the marginal bone changes associated with periodontitis, systemic diseases, and implants. Similarly, the marginal bone beneath the overhanging restorations could be measured quantitatively using these methods. The aim of this study was to radiographically determine the marginal bone height and density adjacent to an overhanging restoration and to compare findings with marginal bone in other regions. The tested hypothesis was that the height and density of marginal bone adjacent to the overhang would be decreased compared to other regions.

Materials and Methods

Ethical permission was obtained from the Scientific Research Ethics Committee of Trakya University (TÜTF-BAEK 2019/03). Routinely taken panoramic radiographs of 5,724 patients who were admitted to the Department of Restorative Dentistry, Faculty of Dentistry of Trakya University between 2018 and 2020, and who had one or more previous restorations were examined retrospectively. The radiographs that were examined in this study were taken with a panoramic x-ray device (PaX-Flex3D, Vatech) at Trakya University, Faculty of Dentistry, Department of Radiology. None of the radiographs were taken specifically for this study.

Patient radiographs were included in the study if they had at least one overhanging restoration and did not have any restoration on the contralateral side. Patients with deciduous teeth, noncontact fillings, superimposed interdental spaces, and severe systemic disorders were excluded, as were patients under the age of 18. A total of 250 panoramic radiographs met the inclusion criteria and were included to study. The radiographs were recorded in JPEG format, and further analysis was done with ImageJ software (National Institutes of Health).

Panoramic radiographs were viewed with the program and, before the examination, a known distance was used to calibrate the software. All the panoramic radiographs were examined in 100% magnification to ascertain a sensitive marginal bone height measurement. To determine the marginal bone loss adjacent to the overhang, the distance between the cementoenamel junction (CEJ) and the marginal bone level was measured by two observers (M.B.D. and...
and E.A.A.) (Figs 1 and 2). To compare vertical bone loss quantity, the same measurement was done at two control sites: (1) the intact surface of the same tooth with the overhang, and (2) the same surface of the contralateral tooth.

For bone density measurements, the radiographs were magnified (200%) in order to maximize the size of the region of interest (ROI). An ROI of 35 × 35 pixels was chosen in the marginal alveolar bone beneath the overhang, while the other ROI was chosen from the intact surface of the same tooth (Figs 3 and 4). Attention was paid to maintain the same image resolution and ROI size, as anatomical features can affect results. Pixel intensity (PI) of the ROI was measured in Hounsfeld units (HU) by the program (Fig 5).

Statistical analysis was performed with SPSS Statistics for Windows, version 23.0 (IBM). Frequency distributions and percentages were calculated for the categorical data, and the distribution of the data was assessed by Shapiro-Wilk test. Because the distribution pattern was not normal, nonparametric Wilcoxon paired t test and Mann-Whitney U test were used for intragroup and intergroup comparisons, respectively. Spearman correlation was used to determine the relationship between marginal bone loss and bone density values. P < .05 indicated statistical significance.

Results

A total of 250 panoramic radiographs form patients (55.2% women) between the ages of 18 and 67 (mean: 40 ± 12.3 years) with at least one overhanging restoration were included in the study. The prevalence of overhanging restorations was 4.3%. The frequency of overhanging restorations was observed
to be significantly higher (60%) in the maxillary posterior region (Table 1). Overhanging restorations were most commonly observed in molars (80.8%) and the disto-occlusal cavities (54%). The vertical bone loss adjacent to the overhanging restoration was significantly higher (\(P = .001\)) in men (3.03 ± 1.31 mm) than women (2.56 ± 1.07 mm). However, there were no significant differences in PI values between men and women (\(P = .521\)). There was a strong negative correlation between patient age and the vertical bone height adjacent to the overhanging restoration (\(P = .000\)).

The interexaminer agreement analysis yielded a satisfactory ICC between the two observer measurements was 0.995 (95% CI: 0.98 to 0.99; \(P = .00\)) for the vertical distance between the CEJ and the marginal bone adjacent to the overhanging restoration; 0.987 (95% CI: 0.96 to 0.98; \(P = .00\)) for the control intact surface of the same tooth with the overhang; and 0.988 (95% CI: 0.97 to 0.98; \(P = .00\)) for the same tooth on the contralateral side.

Based on the radiographic assessments, the average bone loss adjacent to an overhanging restoration was 2.77 ± 1.20 mm (Table 2).

### Table 1 Frequency and Percentage Distributions of Overhanging Restorations

<table>
<thead>
<tr>
<th>Location</th>
<th>Frequency, n</th>
<th>Percent</th>
<th>(P^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td>150</td>
<td>60%</td>
<td>.002*</td>
</tr>
<tr>
<td>Mandible</td>
<td>100</td>
<td>40%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tooth type</th>
<th>Frequency, n</th>
<th>Percent</th>
<th>(P^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premolar</td>
<td>48</td>
<td>19.2%</td>
<td>.000*</td>
</tr>
<tr>
<td>Molar</td>
<td>202</td>
<td>80.8%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cavity design</th>
<th>Frequency, n</th>
<th>Percent</th>
<th>(P^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesio-occlusal</td>
<td>89</td>
<td>35.6%</td>
<td>.000*</td>
</tr>
<tr>
<td>Disto-occlusal</td>
<td>135</td>
<td>54%</td>
<td></td>
</tr>
<tr>
<td>Mesio-occluso-distal</td>
<td>26</td>
<td>10.4%</td>
<td></td>
</tr>
</tbody>
</table>

A total of 250 restorations were evaluated.
*\(P < .05\).
+aChi square analysis.

### Table 2 Mean Marginal Bone Loss and Statistical Evaluation

<table>
<thead>
<tr>
<th>Measurement location</th>
<th>Mean ± SD</th>
<th>(P^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjacent to the overhanging restoration</td>
<td>2.77 ± 1.20 mm</td>
<td>.000*</td>
</tr>
<tr>
<td>The control intact surface of the same tooth</td>
<td>1.56 ± 0.88 mm</td>
<td>.243</td>
</tr>
<tr>
<td>The same side of the contralateral tooth</td>
<td>1.52 ± 0.83 mm</td>
<td>.000*</td>
</tr>
</tbody>
</table>

*\(P < .05\).
+aWilcoxon paired t test.
+bBetween the location adjacent to the overhanging restoration and the control intact surface of the same tooth.
+cBetween the control intact surface of the same tooth adjacent to the overhanging restoration and the same side of the contralateral tooth.
+dBetween the location adjacent to the overhanging restoration and the same side of the contralateral tooth.
There was a significant decrease when compared with the control intact surface of the same tooth and the same side of the contralateral tooth ($P = .000$ for both). The ICC coefficient between the two observers’ measurements was 0.650 ($95\%$ CI: 0.55 to 0.72; $P = .00$) for the PI between the marginal bone adjacent to the overhanging restoration, and was 0.987 ($95\%$ CI: 0.98 to 0.99; $P = .00$) for the control intact surface of the same tooth. The bone density measurements of marginal bone adjacent to the overhanging restoration were significantly lower than those for the control intact surface of the same tooth ($P = .000$) (Table 3).

There was no correlation between the marginal bone loss and density differences of the bone adjacent to the overhanging restoration and the control intact surface of the same tooth ($P = .981$).

**Discussion**

Diagnosing overhanging restorations is of great importance, and the most accurate evaluation can be performed using both clinical or radiographic examination methods. Standardized bitewing radiographs are primarily preferred for this purpose. Merchant et al.\(^1\) stated that both standardized and nonstandardized bitewing radiographs were useful to accurately detect alveolar bone loss in periodontitis cases. However, panoramic radiographs are more commonly used in routine examinations due to ease of operation, a shorter working time, and avoidance of exposing patients to additional radiography for the requested bitewing scans. Some researchers reported that panoramic radiographs showed acceptable accuracy for marginal bone level measurements compared to periapical and bitewing radiographs.\(^14\,15\) Consequently, marginal bone assessment has been done using panoramic radiographs in recent studies.\(^6\,8\,12\) Therefore, routinely taken panoramic radiographs were used in the present study.

In previous studies, overhang prevalence rates were reported as high as 75.4% and 71%,\(^16\) but this rate is decreasing in recent studies as a result of increasing physician awareness and the development of matrix-wedge systems and materials. In the present study, the prevalence of overhanging restorations was 4.3%, close to the rate reported by Najm et al. (3.2%).\(^9\) Similar to previous studies,\(^6\,8\,12\) the most common site for overhang was the maxillary molars (48.4%). This can be explained by the more complex anatomical structure, the presence of trifurcation, and the indirect sight and access in the maxillary region. In addition, the most common cavity design related to overhang was disto-occlusal (58%), which was in accordance with the literature.\(^6\,8\)

Because overhanging restorations are one of the predisposing factors for periodontal diseases, diagnosis and management of overhangs are crucial. If they remain untreated, marginal bone destruction occurs adjacent to the overhang (Fig 6). If the distance from the CEJ to the alveolar crest is 2 mm, this is considered to be in normal limits, and it can be concluded that there is no associated periodontitis.\(^17\) While 2 mm has been reported as the normal limit in the literature,\(^18\) some researchers have reported it to be from 0.5 to 2 mm.\(^19\) In the present study, the mean value for the distance from the CEJ to the alveolar crest was $2.77 \pm 1.20$ mm for the marginal bone adjacent to

<table>
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<tr>
<th>Measurement location</th>
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<th>$P^a$</th>
</tr>
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<tbody>
<tr>
<td>Adjacent to the overhanging restoration</td>
<td>89.15 ± 27.75 HU</td>
<td>.000*</td>
</tr>
<tr>
<td>The control intact surface of the same tooth</td>
<td>104.36 ± 22.48 HU</td>
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</table>

$^a$Wilcoxon paired $t$ test.

$^*$ $P < .05$. 

HU = Hounsfield units.
The overhang and 1.56 ± 0.88 mm for the control intact surface of the same tooth. The 2.77-mm distance from the CEJ to the alveolar crest is evidence of overhang-associated periodontitis.

The marginal bone loss adjacent to the overhang was significantly higher in men than women ($P = .001$). This is potentially due to the fact that men sometimes care less about oral hygiene and tend to smoke cigarettes more often than women.$^{20,21}$

Even though there was no detectable marginal bone loss beneath the overhangs, density could still be affected. Bone density assessment methods are more commonly used in the analysis of bone quality in osteoporosis and in the evaluation of marginal bone around implants.$^{22,23}$ In the present study, bone density was evaluated by measuring the PI for a desired ROI. This study appears to be unique in that it examined bone density in the marginal bone beneath the overhangs. Fractal dimension analysis (FD) can also be used for trabecular bone assessment. FD provides an image of the structural pattern and bone tissue architecture, and it is useful for detecting bone changes associated with periodontitis, systemic diseases, and implants.$^{24,25}$ Oliveira et al.$^{25}$ stated that the FD and PI methods had similarities in alveolar bone analysis, with a strong positive correlation. However, the marginal bone area adjacent to the overhanging restoration was relatively narrow and inadequate for FD analysis. Therefore, PI was preferred for bone density evaluation in the present study.

ROI size selection depends on its purpose, and thus ROI sizes differ across studies. In a study conducted by Abdulhameed et al.,$^{24}$ the ROI was set to 100 × 200 pixels to analyze the bone around the implant side, using the FD method. On the other hand, Hedström et al.$^{26}$ used an ROI with a standardized area of 1 cm² to detect the relation between PI and the bone mineral density in the heel in the mandibles of elderly women. As can be seen by these examples, the ROI changes according to the method, purpose, and area to be evaluated. There is no standard value in the literature. In the present study, the ROI was set to 35 × 35 pixels, as the area to be examined was narrow, and this was how all PI values were measured.

**Fig 6** Examples of (a and b) mild, (c and d) moderate, and (e and f) severe overhanging restorations.
PI values of marginal bone adjacent to overhang were significantly lower than the control intact surface of the same tooth ($P = .00$). This result confirms the null hypothesis that overhanging restorations can lead to a decrease in bone density. As a result of local irritation of the periodontal tissues and microbial dental plaque retention, overhanging restorations cause changes in the subgingival microbial flora and a decrease in vertical bone height and density. 

Management of overhanging restorations is important in preventing complications. While small and medium overhangs can be easily removed by diamond files and polishing strips, replacing the whole restoration is the best approach for large, inaccessible overhangs. Clinicians should diagnose and manage overhangs before any marginal bone changes occur.

To prevent overhanging restorations, indirect techniques are preferred over direct restorative treatment at sites with excessive dental hard tissue loss. When the direct restorations are indicated, the appropriate and effective use of dental matrix systems and wedges must be taken into consideration.

**Conclusions**

According to the present results and within the limitations of the methodology used, the vertical height and density of marginal bone adjacent to overhang were decreased compared to control sites. Height and density differences of the marginal bone adjacent to the overhanging restoration and the control intact surface of the same tooth were not correlated to each other. Further studies with 3D imaging are necessary to better analyze the relationship between the overhang and its effect on marginal bone.

**Acknowledgments**

The authors declare no conflicts of interest.

**References**


