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Original Article

# Exploring the Effect of Periodontal Status and Bone Density on Dry Socket Development: A Case–Control Study

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## ABSTRACT

**Objective:** This case–control study aimed to evaluate the relationship between periodontal status and bone density, as interpreted by the mandibular cortical index (MCI) and the development of dry socket (DS).

**Methods:** The study included 670 patients, of whom 270 developed DS (DS group) and 400 did not develop DS (control group) following tooth extraction. The periodontal examinations and panoramic radiographs of all participants were evaluated, classifying periodontal status according to the 2017 workshop guidelines. If a patient had periodontitis, the stage and grade were also noted. In addition, each patient's bone density was assessed using the MCI score derived from panoramic radiographs. The collected data were analyzed statistically.

**Results:** The incidence of DS was significantly higher in females than in males ($P < .05$). The rates of patients with an MCI class 1 (C1) score and those with periodontitis were higher in the DS group than in the control group. However, no significant relationship was found between the stage and grade of periodontitis and DS ($P > .05$).

**Conclusion:** This study showed that the incidence of DS was higher in female patients than in males, even without the use of oral contraceptives. Although there were notable proportional differences in periodontal status and MCI scores in the DS group, these were not statistically significant. The overall periodontal condition of the patient may not significantly affect the development of DS. Nevertheless, further studies using more objective techniques to measure bone density could be beneficial in exploring the relationship between bone density and DS.

**Keywords:** Dry socket, alveolitis, periodontal diseases, bone density, mandibular cortical index

## INTRODUCTION

Tooth extraction is one of the most frequently performed dental treatments.[1] One of the complications that can develop following extraction is dry socket (DS),[1] which is characterized by the absence of a blood clot in the extraction socket, severe pain, and halitosis.[2] This condition involves the partial or total disappearance of the blood clot in the extraction socket, resulting in the fibrinolysis of the clot.[3,4] Fibrinolysis is primarily induced by bacterial enzymatic activity.[2] Sharp pain, typically starting 2-4 days after extraction, is a characteristic symptom.[2] The incidence of DS following tooth extraction varies between 2% and 4%.[2]

Several factors that may be related to the development of DS have been identified in the literature, with the most prominent examples being smoking and traumatic extraction.[4] Furthermore, gender, age, and the use of oral contraceptives (OCs) have been associated with the development of DS.[5] Other factors, such as the presence of periodontal and periapical infection in the extracted tooth and differences in mandibular-maxillary bone density, have also been suggested to influence DS development.[4] While the prevalence of DS is higher in women compared to men, studies indicate that the risk of DS development is particularly elevated in middle-aged individuals, specifically those in their third and fourth decades of life.[5,6] Research suggests a higher DS risk in the mandible compared to the maxilla, attributing this to bone density differences.[7,8]

Periodontal infection is a broad term encompassing a range of acute or chronic inflammatory diseases affecting

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the supporting tissues of the teeth.[9] The spectrum can range from localized gum infection (gingivitis) to more severe inflammatory reactions accompanied by periodontal tissue loss (periodontitis).[9] The variation in periodontal disease levels is related to the quantity of pathogenic bacteria and the host response.[9] According to the 2017 workshop, individuals are classified into 3 main categories regarding plaque-induced periodontal diseases: healthy, gingivitis, or periodontitis.[10] In this classification system, patients with periodontitis are described based on 2 parameters: stage and grade.[11] The stage indicates the extent of damage caused by the disease, while the grade reflects the rate of progression and prognosis.[11] The extraction of a tooth with periodontal infection is considered to increase the incidence of DS.[4,12-15] This is explained by bacterial clot fibrinolysis, facilitated by the increased bacterial load.[15]

Bone density is related to bone metabolism and varies among individuals.[16] Mandibular and maxillary bones, similar to other skeletal bones, are influenced by conditions affecting bone metabolism.[16,17] To evaluate jawbone density, Klemetti et al.[18] developed the mandibular cortical index (MCI), which allows for assessing jawbone density through the visual evaluation of panoramic radiographs. The MCI consists of 3 scores: C1 for normal cortex, C2 for mild-to-moderate cortex erosion, and C3 for severely eroded cortex.[18] The ease of access to panoramic radiographs and the lack of need for additional equipment are 2 significant advantages of this index system.[18] Taguchi et al.[19] noted that the MCI could be useful for evaluating bone density in patients visiting dental clinics.

Previous studies addressing the relationship between periodontitis and DS development have only focused on the periodontal infection of the extracted tooth.[20-22] These studies did not investigate the general periodontal status of patients in relation to DS. Based on this information, the current study aimed to evaluate the relationship between a patient's overall periodontal status and the development of DS, also examining the stage and grade of periodontitis if present. In addition, the study explored the relationship between factors such as age, gender, and MCI scores, which estimate jawbone density, and DS. The null hypotheses of the study are as follows:

1. The general periodontal status (healthy, gingivitis, and periodontitis) does not affect the incidence of DS.
2. The increase in the stage and grade of periodontitis does not affect the incidence of DS.
3. There is no relationship between MCI and the incidence of DS.

### MAIN POINTS

- Despite the exclusion of patients using oral contraceptives, the incidence of DS was observed to be higher in female patients.
- Despite the expectation that the deterioration of the patient's general periodontal condition (from a healthy periodontium to gingivitis to periodontitis) would increase the incidence of DS, no significant difference was detected.
- Although an increase in the stage and grade of periodontitis was expected to result in a higher incidence of DS, no significant relationship was identified.
- While patients with an MCI C1 score indicating denser jaw bone were expected to have a higher frequency of DS, no significant relationship was established.

## MATERIAL AND METHODS

### Study Registration and Design

This case–control study was approved by the Clinical Research Ethics Committee of Erzincan Binali Yıldırım University on May 11, 2023 (decision number: 2023-10/5 date: May 11, 2023). Written informed consent was obtained from all participants following a thorough explanation of the study. This manuscript was prepared by adhering to the strengthening the reporting of observational studies in epidemiology (STROBE) statement to enhance the reporting quality of observational studies.[23]

### Study Participants

The participants of this study were selected from patients who underwent tooth extractions at Erzincan Oral and Dental Health Hospital in 2023 and 2024. The study included a total of 670 patients, of whom 270 were diagnosed with DS following tooth extraction and 400 were controls without DS. The patients in both the DS and non-DS groups were referred to the periodontology clinic within the first 7 days after extraction. Volunteers were included in the study according to their order of presentation until the target number of patients was reached. The inclusion criteria were as follows: (1) an age between 18 and 60 years; (2) the absence of acute periodontal infection in the tooth extracted; (3) bone loss, if present, confined to the coronal one-third of the root; (4) no additional surgical procedures, such as flap elevation or suturing, performed during tooth extraction; and (v) no reported complications during extraction. Excluded from the study were smokers, individuals using OCs, pregnant women, individuals with diabetes, those with anticoagulant medication use, or blood disorders that could cause coagulation problems. Demographic data, such as age and gender, were recorded for all participants. All dental panoramic radiographs were acquired using the Planmeca ProOne (PLANMECA OY©, Helsinki, Finland) device at 68 kVp, 7 mA, and an exposure time of 9.5 seconds.

### Periodontal Measurements and Classification

Periodontal examination findings, including attachment loss, probing pocket depth, bleeding on probing, and gingival color changes, were recorded. Periodontal examination findings were evaluated in conjunction with the most recent panoramic radiographs, and the classification of periodontal disease was undertaken according to the criteria established by the 2017 workshop.[10] The patients were classified into 3 categories: healthy, gingivitis, and periodontitis. For patients diagnosed with periodontitis, stage and grade scores were documented.[10] All periodontal measurements and classifications were performed by a single specialist (Ö.F.O.).

### Mandibular Cortical Index Evaluation

Each patient's MCI score was determined and recorded using panoramic radiographs. The MCI was obtained by evaluating the panoramic radiographs as described by Klemetti et al.[18] The endosteal margin of the mandibular cortex was examined: if the endosteal margin was smooth, it was scored as C1; if there was a break in the continuity of the endosteal margin, it was scored as C2; and if there was a break in continuity along with porous structures in the cortical layer, it was scored as C3. The evaluation of the panoramic radiographs according to MCI was conducted by a single specialist.

### Statistical Analysis

Data were analyzed using International Business Machiness (IBM) Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM SPSS Corp.; Armonk, NY, USA). Descriptive statistics were presented as mean ± SD values for numerical variables and frequencies and percentages for categorical variables. Differences in means between groups were assessed using Student's *t*-test, while categorical variables were evaluated using Pearson's chi-squared test. Graphical representation was used to depict group staging. Results with *P*-values of <.05 were considered statistically significant.

## RESULTS

Table 1 presents the characteristics of the patients included in the study. The mean age of the 670 patients was 36.23 ± 12.53 years, with 330 females and 340 males. No significant age difference was found between the DS group (mean age: 36.13 ± 12.48 years) and the control group (mean age: 36.31 ± 12.58 years) (*P* = .856).

The rate of female patients was significantly higher in the DS group (57.4%) compared to male patients (42.6%) (*P* < .05). The rate of female patients in the DS group was also significantly higher when compared to that of female patients in the control group (46.2%) (*P* < .05).

Among the 270 patients with DS, 216 (80.0%) had periodontitis, 48 (17.8%) had gingivitis, and 6 (2.2%) were healthy. In the control group, 293 (73.3%) of the patients had periodontitis, 87 (21.8%) had gingivitis, and 20 (5.0%) were healthy. No statistically significant difference was observed between the 2 groups in terms of periodontal status (*P* = .066), although the rate of periodontitis was higher in the DS group (80.0%) compared to the control group (73.3%).

According to the MCI evaluation of the DS group, 134 (49.6%) patients had a C1 score, 114 (42.3%) had a C2

**Table 1.** Clinical Characteristics of the Patients

| Characteristics | n (overall) | DS* | Control | *P* |
|---|---|---|---|---|
| Patients | 670 | 270 | 400 | |
| Age (mean ± SD) | 36.23 ± 12.53 | 36.13 ± 12.48 | 36.31 ± 12.58 | .856 |
| Gender | | | | |
| Male | 330 (49.3%) | 115 (42.6%) | 215 (53.8%) | **.05** |
| Female | 340 (50.7%) | 155 (57.4%) | 185 (46.2%) | |
| Periodontal status | | | | |
| Healthy | 26 (3.9%) | 6 (2.2%) | 20 (5.0%) | .066 |
| Gingivitis | 135 (20.1%) | 48 (17.8%) | 87 (21.8%) | |
| Periodontitis | 509 (76.0%) | 216 (80.0%) | 293 (73.3%) | |
| MCI classification | | | | |
| C1 | 298 (44.5%) | 134 (49.6%) | 164 (41.0%) | .088 |
| C2 | 312 (46.5%) | 114 (42.3%) | 198 (49.5%) | |
| C3 | 60 (9%) | 22 (8.1%) | 38 (9.5%) | |

*DS, dry socket. Values with P < .05 are highlighted in bold.

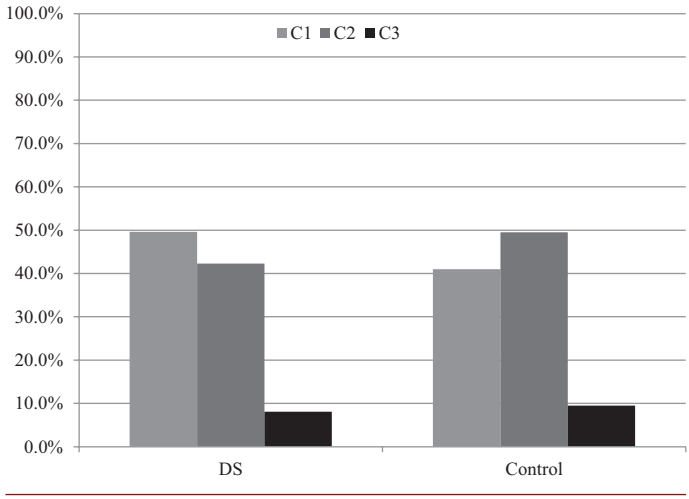


**Figure 1.** Proportional distribution of patients according to mandibular cortical index.

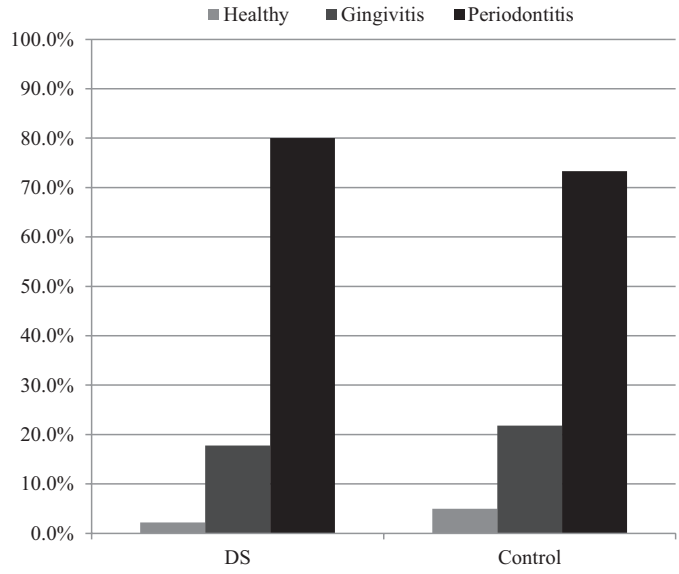


**Figure 2.** Proportional distribution of patients according to periodontal status.

score, and 22 (8.1%) had a C3 score. In the control group, 164 (41.0%) patients had a C1 score, 198 (49.5%) had a C2 score, and 38 (9.5%) had a C3 score. There was no significant difference in the MCI score distribution between the 2 groups ($P = .088$). However, the rate of patients with a C1 score was higher in the DS group (49.6%) compared to the control group (41.0%). The proportional distributions of patients in the DS and control groups based on their MCI scores are shown graphically in Figure 1.

The periodontal classification data of the patients are shown in Table 2. Of the patients with DS, 69 (25.6%) were classified as stage III/IV, 77 (28.5%) as stage II, and 70 (25.9%) as stage I. In the control group, 82 (20.5%) were in stage III/IV, 109 (27.3%) were in stage II, and 102 (25.5%) were in stage I. No significant difference was observed between the groups ($P = .171$). Concerning grade, 15 (5.6%) patients with DS had grade A, 159 (58.9%) had grade B, and 42 (15.6%) had grade C periodontitis. In the control group, 23 (5.8%) were grade A, 223 (55.8%) were grade B, and 47 (11.8%) were grade C. No significant difference was found in the comparison of the grade distribution between the groups ($P = .161$). The proportional distributions of patients in the DS and control groups based on their periodontal condition are depicted graphically in Figure 2.

## DISCUSSION

This case–control study investigated the effect of periodontal status, MCI score, age, and gender on the incidence of DS. The findings indicated that the development of DS had no relationship with periodontal status, increased stage and grade scores in the presence of

**Table 2.** Periodontal Classification of the Patients with Periodontitis

| Periodontal Classification | n (overall) | DS* | Control | *P* |
|---|---|---|---|---|
| Healthy | 26 (3.9%) | 6 (2.2%) | 20 (5%) | .171 (for stage) |
| Gingivitis | 135 (20.1%) | 48 (17.8%) | 87 (21.8%) | .164 (for grade) |
| Periodontitis | | | | |
| Stage | | | | |
| Stage I | 172 (25.7) | 70 (25.9%) | 102 (25.5%) | .171 |
| Stage II | 186 (27.8%) | 77 (28.5%) | 109 (27.3%) | |
| Stage III/IV | 151 (22.5%) | 69 (25.6%) | 82 (20.5%) | |
| Grade | | | | |
| Grade A | 38 (5.7%) | 15 (5.6%) | 23 (5.8%) | .164 |
| Grade B | 382 (57%) | 159 (58.9%) | 223 (55.8%) | |
| Grade C | 89 (13.3%) | 42 (15.6%) | 47 (11.8%) | |

*DS, dry socket.

periodontitis, or higher MCI C1 scores. Therefore, the null hypothesis of the study was confirmed.

In a prospective study addressing the relationship between patient age and DS, it was determined that the incidence of DS was higher among elderly patients, which was considered to be related to the increased difficulty of tooth extractions associated with advancing age.[24] In another study, Oginni et al.[5] reported that the risk of developing DS was highest in the third decade of life. Similarly, a study undertaken by Egauvoen indicated a greater frequency of DS development in the third decade of life.[6] However, the present study revealed no significant difference in patient age between the DS group and the control group, which may be attributable to the age range specified in the inclusion criteria.

In a retrospective study examining the relationship between patient gender and the incidence of DS following tooth extraction, 2214 patients were evaluated. The findings revealed that among patients who developed DS, the ratio of females to males was 2:1.[25] A subsequent study published in 2014 corroborated these results, indicating a higher prevalence of DS among females.[14] In contrast, a study conducted by Oginni et al.[5] found no significant difference in the incidence of this condition between genders. It has been suggested that OC use may contribute to the higher incidence of DS in women.[26] However, the current study excluded patients using OCs, thereby eliminating the potential influence of this factor on the development of DS in female patients. According to the results of this study, the incidence of DS in females was significantly higher than in males. This gender-related difference may be related to hormonal fluctuations during the menstrual cycle and more frequent occurrences of iron and vitamin deficiencies in females. Eshghpour et al.[27] suggested that the menstrual cycle might impact DS development. Furthermore, in a randomized controlled trial, Chapnick and Diamond reported a higher incidence of DS in females, irrespective of OC use.[28]

Previous studies have primarily investigated the association between DS development and the periodontal infection of the extracted tooth.[20-22] It has been suggested that increased bacterial fibrinolytic activity in the extraction site due to infection may play a role in this condition.[3] In a study examining the correlation between oral hygiene levels, which may reflect overall periodontal status, and DS development, Momeni et al.[20] reported an increased incidence of DS in patients with poor oral hygiene after tooth extraction. A multicenter prospective study found that patients who underwent tooth extractions due to periodontal disease had a 7.5 times higher likelihood of developing DS.[21] This increased risk was attributed to the fibrinolytic activity of bacteria responsible for periodontal infections.[21] On the other hand, a study evaluating 340 patients undergoing mandibular third molar extractions determined that teeth extracted due to periodontal involvement did not result in DS in any of the cases.[15] The current study found no significant relationship between periodontal status, categorized as healthy, gingivitis, or periodontitis, and the incidence of DS. Moreover, in the periodontitis group, no significant correlation was found between the stage and grade scores of periodontitis and the incidence of DS. To the best of the author's knowledge, this is the first study to examine the relationship between general periodontal status and DS. The patients' periodontal status was categorized according to the 2017 classification.[10] Therefore, there are no directly comparable studies in the literature. The results obtained suggest that neither periodontal status nor the stage and grade of periodontitis significantly affect DS development.

Adequate blood circulation is essential for desirable healing after tooth extraction.[5] The vascular content of bone tissue varies according to its density.[29] Areas with higher bone density have weaker vascular structures and a reduced capacity to form granulation tissue following trauma.[29] Previous studies investigating the relationship between bone density and DS incidence suggest that the higher density of the mandible compared to the maxilla may influence DS development.[7,8] Taberner et al.[7] reported a higher occurrence of DS cases following extractions in the lower jaw, attributing this to the density difference between the mandible and maxilla. Another study indicated that DS was most frequently observed following extractions of posterior mandibular teeth.[8] This was considered to be due to the dense cortical bone in the lower jaw posterior tooth area, which sets the stage for more traumatic extractions with decreased blood supply.[8] Unlike previous studies, the current study evaluated each patient's bone density using the MCI and assessed the relationship between these scores and DS incidence. In this study, MCI was preferred in the interpretation of bone density due to its practical applicability. Consistent with previous literature, the C1 score of MCI, which represents dense cortex, was found in a higher rate of patients in the DS group, although this difference was not statistically significant. Future studies evaluating bone density with more objective techniques would be beneficial.

This study has certain limitations. It was conducted by a single researcher, which may increase the potential for bias and uncontrolled variables. In addition, the study was conducted with patients in a single region, thereby limiting its generalizability to a broader population.

This study indicates that the incidence of DS is significantly higher in female patients compared to males, even in the

absence of OC use. The data obtained from the study suggest that patient age, periodontal status, periodontitis stage and grade, and MCI do not significantly affect the incidence of DS. Nevertheless, the higher prevalence of periodontitis in the DS group compared to the control group is noteworthy. Studies employing techniques that provide a more objective assessment of bone density could be advantageous in further elucidating this subject. There is also a need for research to be conducted across diverse populations to validate the accuracy of our findings. Furthermore, studies involving larger sample sizes and conducted by multiple researchers would be beneficial.

**Data Availability Statement:** The data that support the findings of this study are available on request from the corresponding author.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the Ethics Committee of Erzincan Binali Yıldırım University (Date: May 11, 2023, Number: 2023-10/5).

**Informed Consent:** Written informed consent was obtained from all participants who agreed to take part in the study.

**Peer-review:** Externally peer-reviewed.

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