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Evaluation of the incidence of alveolar osteitis following tooth extraction

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Abstract

Alveolar osteitis (AO) is the most common postoperative complication following tooth extraction and remains a significant clinical problem due to severe pain and delayed healing. This retrospective study aimed to evaluate the incidence of AO and analyze demographic, clinical, and procedural factors associated with its development in patients treated at a university-based oral and maxillofacial surgery clinic. Archival records of 35,266 tooth extractions performed between January 1, 2023, and July 11, 2025, were retrospectively reviewed. A total of 375 AO cases were identified and included in the analysis. Data regarding patient age, sex, systemic diseases, extraction region, number of extracted teeth, postoperative presentation time, smoking status, and seasonal distribution were recorded. AO cases were categorized into predefined groups, and statistical analyses were performed using chi-square tests, with the significance level set at $p<0.05$. The overall incidence of AO was 1.05%. AO occurred most frequently in patients aged 21–60 years (82.1%), with a significantly higher prevalence among female patients (58.84%) ($p=0.002$). Mandibular posterior teeth, particularly third molars, showed a significantly higher association with AO ($p<0.001$). Most patients presented ≥7 days postoperatively (66.96%). AO developed predominantly after single-tooth extractions (85.1%). Smoking was significantly associated with AO, with 65.4% of affected patients being smokers ($p<0.001$). No statistically significant seasonal variation was observed. AO was most frequently associated with mandibular molar extractions, female sex, smoking, and delayed postoperative presentation. Although the overall incidence was relatively low, AO remains a distressing complication because of its clinical burden. Identification of high-risk patients and reinforcement of postoperative instructions may contribute to early diagnosis and improved management outcomes.

Keywords: Alveolar osteitis, dry socket, tooth extraction

Introduction

Alveolar osteitis (AO), commonly known as "dry socket," is widely recognized as the most frequent postoperative complication following surgical or non-surgical tooth extraction. Since its first description by Crawford in 1896 [1], AO has been one of the most extensively studied topics; however, its etiology remains not fully understood. Consequently, it has been referred to by various terms, including localized osteitis, postoperative AO, alveolalgia, alveolar sicca dolorosa, septic socket, necrotic socket, localized osteomyelitis, and fibrinolytic alveolitis [2].

Clinically, AO is characterized by the absence of a blood clot within the extraction socket and manifests as a sudden, severe, stabbing pain in and around the extraction site, typically appearing within 1–3 days after extraction. The socket may appear partially or completely empty, often covered by a grayish-yellow layer and/or necrotic tissue [2]. The pain usually intensifies with mastication or suction movements [3].

Although the exact etiology of AO has not been clearly elucidated, the most widely accepted mechanism involves the fibrinolytic breakdown of the blood clot triggered by bacterial invasion. Several factors have been implicated in AO development, including traumatic extraction, patient age and sex, smoking habits, use of oral contraceptives, concentration of local anesthetic, intraligamentary anesthesia, and the anatomical location of the extracted tooth [4].

The reported incidence of AO varies among studies. Daly et al. reported in a review that the incidence ranges between 0.5% and 5% following routine extraction [5]. However, this rate may exceed 30% after mandibular third molar extractions. According

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to Blum, the incidence of AO ranges from 1% to 45% [6]. Recent literature confirms that high incidence rates persist in specialized cases; for instance, Mamoun [7] indicates that the rate in mandibular third molar surgeries can reach 38%.

Postoperative pain associated with AO is typically persistent and resistant to common analgesics, posing a significant burden on both patients and clinicians due to repeated visits for symptomatic management [2]. The use of local agents remains the gold standard in AO management [8]. These include chlorhexidine irrigation, antibiotic dressings (e.g., gauze impregnated with metronidazole or tetracycline), eugenol-based medicaments, and platelet-rich plasma (PRP) applications. Local anesthetic and antiseptic agents have shown some efficacy in reducing pain and promoting healing, although the quality of evidence remains variable [5]. In the absence of infection, antibiotic prescription should be avoided. Incorrect or unnecessary use of chlorhexidine in dry socket management may lead to severe allergic reactions, including anaphylaxis [8]. The current standard approach involves gentle curettage of the socket, irrigation with saline solution, and allowing for biological healing [9].

The aim of this retrospective study was to perform a detailed evaluation of patients who presented with AO following tooth extractions carried out in our clinic between 2023 and 2025.

Material and Methods

This retrospective study was conducted using the archival records of the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Inönü University, and was approved by the Inönü University Ethics Committee (No: 2025/8462, Date: 14 October 2025).

The study included patients aged 18–70 years who were scheduled for the extraction of mandibular third molars. No specific exclusion was made regarding systemic conditions during the formation of the study groups; instead, patients with chronic diseases such as hypertension, diabetes, heart disease, thyroid disorders, rheumatoid arthritis, and asthma were recruited alongside systemically healthy individuals to allow for a comparative analysis. However, patients with a general health status that contraindicted surgical intervention, those with poor cooperation, and pregnant individuals were excluded from the study.

Only patients who underwent tooth extraction at this institution and subsequently developed AO were included in the study. Extractions performed at other healthcare facilities were excluded.

A total of 35,266 tooth extractions performed between January 1, 2023, and July 11, 2025, were retrospectively reviewed, and 375 cases diagnosed with AO were analyzed.

Patients' systemic health status (e.g., diabetes mellitus, hypertension, cardiovascular disease), regular medication use, and smoking habits were also recorded. The relationships between these factors and AO occurrence were analyzed statistically.

AO cases were categorized into four age groups: under 20 years, 21–40 years, 41–60 years, and over 60 years. In addition, patient sex, jaw location (maxilla/mandible), affected region (anterior/posterior), and postoperative onset time of symptoms (postoperative day 1–3, day 4–7, or after day 7) were recorded.

Seasonal distribution of AO cases was analyzed by grouping the cases into autumn (September–November), winter (December–February), spring (March–May), and summer (June–August) periods.

The type of extraction was classified as either closed (simple) or open (surgical). In addition, the potential influence of single versus multiple tooth extractions on AO development was assessed.

All data were obtained from the clinic's patient record system and anonymized to ensure that no personally identifiable information was included.

Results

In terms of age distribution, 24 cases (6.9%) were under 20 years of age, 194 cases (55.9%) were between 21–40 years, 91 cases (26.2%) were between 41–60 years, and 38 cases (11.0%) were over 60 years. The difference among age groups was statistically significant (χ^2=205.588; p<0.001). The majority of AO cases were in the middle-aged group (21–60 years, 82.1%) (Table 1).

Table 1. Comparison of AO cases according to age groupss

Age group	n	%
Under 20 years	24	6.96
21–40 years	192	55.65
41–60 years	**91**	**26.38**
Over 60 years	38	11.01

χ^2 = 205.588; p < 0.001 (Chi-square test)

According to gender distribution, 203 (58.84%) of the AO cases were female and 142 (41.16%) were male. The difference between genders was statistically significant (χ^2=10.032; p=0.002).

When the distribution of systemic diseases was analyzed, the difference among groups was statistically significant (χ^2=93.351; p<0.001). Hypertension was detected in 27.3% (n=21), diabetes mellitus in 23.4% (n=18), heart disease in 14.3% (n=11), and thyroid disease in 11.7% (n=9) of the cases (Table 2).

Regarding the postoperative time of clinical presentation, 49 cases (14.2%) presented on postoperative days 1–3, 65 cases (18.84%) presented on days 4–7, and 231 cases (66.96%) presented on day 7 or later. The difference among the presentation time intervals was statistically significant (χ^2=269.343; p<0.001) (Table 3).

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Table 2. Comparison of AO cases according to systemic disease status

Systemic disease	n	%
Hypertension	21	27.3
Diabetes	18	23.4
Heart disease	11	14.3
Thyroid disorders	9	11.7
Rheumatoid arthritis	3	3.9
Asthma	3	3.9
Gastric disorders	3	3.9
Cancer	2	2.6
Osteoporosis	2	2.6
Psoriasis	2	2.6
COPD	1	1.3
Sjögren's syndrome	1	1.3
Epilepsy	1	1.3

$\chi^2 = 93.351$; $p < 0.001$ (Chi-square test)

Table 3. Comparison of AO cases according to time of presentation to the clinic after extraction

Time of presentation after extraction	n	(%)
1–3 days	49	14.20
4–7 days	65	18.84
≥7 days	231	66.96

$\chi^2 = 269.343$; $p < 0.001$ (Chi-square test)

When evaluated based on the number of extractions, 319 cases (85.1%) developed after single extraction, while 56 cases (14.9%) developed after multiple extractions. The difference between single and multiple extractions was statistically significant (χ^2=184.451; p<0.001).

Regarding the seasonal distribution of AO development, there was no statistically significant difference among spring, summer, autumn, and winter (p>0.05) (Table 4).

Table 4. Comparison of AO cases according to seasonal distribution

Season	n	(%)
Spring	91	26.37
Summer	100	28.98
Autumn	87	25.21
Winter	67	19.42

$\chi^2 = 7.386$; $p = 0.061$ (Chi-square test)

Follow-up was possible in 211 (60.8%) of the AO cases, while 136 (39.2%) could not be reached. Smoking status was evaluated based on the cases that could be contacted. Among these patients, 73 (34.6%) were non-smokers, while 138 (65.4%) were smokers. The distribution of AO cases according to smoking status showed a statistically significant difference (χ^2=20.024; p<0.001) (Table 5).

Table 5. Comparison of AO cases according to smoking status

Smoking status	n	(%)	p value
Non-smoker	73	34.6	0.018*
Smoker	138	65.4	0.004*

$\chi^2 = 20.024$; $p < 0.001$ (Chi-square test)

Statistical Analysis

Demographic and clinical data were presented as frequencies (n) and percentages (%). The one-sample chi-square test was used to compare categorical variables, while the Pearson chi-square test was applied to evaluate the relationship between extraction region (maxillary or mandibular third molar) and extraction type. All statistical analyses were performed using IBM SPSS Statistics 26.0 and MS Excel 2024 software. A significance level of p<0.05 was considered statistically significant.

Discussion

The management of poorly healing wounds has been one of the greatest challenges faced by surgeons throughout history. Although alveolitis has been recognized for more than a century, its exact etiopathogenesis remains incompletely understood. Nevertheless, identifying associated risk factors is clinically important for recognizing high-risk patients, implementing preventive strategies, and providing appropriate patient counseling. Given that AO is characterized by severe pain and frequently necessitates repeated postoperative visits, it represents a significant burden for both clinicians and patients. Numerous local and systemic factors have been implicated in its development [2,10,11]

Previous studies have identified multiple variables that may influence AO occurrence, including traumatic extractions, patient age and sex, smoking habits, oral contraceptive use, anesthetic type and concentration, intraligamentary injections, and the anatomical location of the extracted tooth [4]. Consequently, reported AO incidence rates vary widely in the literature, ranging from 1% to 45% [5,8,10]. Such variability is likely attributable to differences in study populations, extraction complexity, diagnostic criteria, and postoperative follow-up protocols. In the present study, the overall AO incidence was 1.05%, which lies at the lower end of this spectrum and is consistent with rates reported in routine extraction settings.

Sex-related differences in AO incidence have been consistently documented, with most studies reporting a higher prevalence among female patients. Akkurt et al. reported that 62% of

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AO cases occurred in females, while Akinbami et al. found a similar predominance (60.6%), particularly among patients in the fourth decade of life [10]. Interestingly, elevated AO rates in females have been reported even in the absence of oral contraceptive use, suggesting that hormonal fluctuations or sex-related differences in fibrinolytic activity may contribute to susceptibility [2]. In line with these findings, AO was more frequent among female patients in the present study (58.84%), with the highest incidence observed in the 21–40 age group, supporting a potential age–hormone interaction in AO development.

Age distribution has also been shown to significantly influence AO risk. The condition is rare in pediatric patients, possibly due to greater vascularity, faster healing capacity, and generally less traumatic extractions. Tuncay et al. reported no AO cases in patients under 18 years of age [12], whereas Donnell et al. documented a small number of pediatric cases following mandibular molar extractions under general anesthesia [2]. In the present study, only one AO case occurred in a patient younger than 18 years, further supporting the notion that increasing age is associated with a higher risk of AO, likely due to reduced bone vascularity and delayed regenerative potential.

Anatomical location is another well-recognized determinant of AO occurrence. Several studies have demonstrated a clear mandibular predominance, particularly in posterior teeth [13-16]. This has been attributed to denser cortical bone, relatively poorer blood supply, and greater surgical trauma compared with the maxilla. Consistent with these observations, AO occurred significantly more frequently in the mandible (67.2%) in the present study. Moreover, the high incidence observed following mandibular third molar extractions (41.1%) parallels previous reports indicating markedly elevated AO rates in this region [5], emphasizing the role of anatomical and vascular factors in AO pathogenesis.

Seasonal variation in AO incidence remains controversial. While Akkurt et al. reported a higher frequency during winter months [14], both Asutay et al. and the present study found no statistically significant seasonal differences. These discrepancies may reflect regional climatic variations, differences in patient behavior, or inconsistent methodological approaches across studies.

The timing of postoperative presentation is clinically relevant for AO diagnosis and management. Previous studies have reported that patients most commonly present either within the first postoperative day or between days 4 and 7 [14]. Asutay et al. observed that the majority of patients presented seven days or later after extraction [15], a finding consistent with the present study. Delayed presentation may be related to variability in symptom perception, access to care, or delayed clot disintegration.

The role of surgical trauma in AO development remains debated. Some studies have reported a substantial increase in AO risk following traumatic extractions [2,3,13,17,18], whereas others have described paradoxically lower AO rates in multiple or surgically complex extractions [19,20]. These conflicting results may be influenced by confounding demographic and clinical variables. In the present study, a direct association between extraction type and AO could not be established due to imbalanced extraction numbers.

Smoking has consistently been identified as a major risk factor for AO. The cytotoxic effects of nicotine and carbon monoxide, nicotine-induced platelet aggregation, tissue ischemia, and reduced fibrinolytic activity may collectively impair socket healing [18,21]. Additionally, thermal injury and negative pressure during smoking may destabilize the blood clot. In the present study, AO incidence among smokers was 34.6%, supporting previous evidence that smoking substantially increases AO risk. A recent systematic review reported a more than threefold increase in AO incidence among smokers compared with non-smokers [5,22].

The relationship between systemic health and AO remains complex. While some studies have reported higher AO rates in systemically healthy individuals [23], others have identified hypertension, diabetes, and cardiovascular disorders as potential risk factors [10,15]. In the present study, AO was observed more frequently in healthy individuals, although hypertensive patients also constituted a substantial proportion. These findings suggest that systemic diseases may influence AO development indirectly through vascular and healing mechanisms rather than acting as independent determinants.

Finally, several limitations inherent to the retrospective design of this study should be acknowledged. Reliance on clinical records may have introduced variability in AO diagnosis, and the absence of a control group limited adjustment for confounding factors. Additionally, incomplete follow-up data and insufficient documentation regarding female-specific risk factors, such as oral contraceptive use or menstrual cycle phase, may have affected the assessment of certain associations. Prospective studies with standardized diagnostic criteria are warranted to further clarify the multifactorial nature of AO.

Conclusion

In the present study, mandibular teeth, molar teeth, and female gender were identified as risk factors associated with AO. Despite the use of various classical and regenerative treatment approaches for AO given its multifactorial etiology it remains a distressing complication for both patients and clinicians. Clinicians should inform patients at high risk of AO development in advance and emphasize the importance of seeking prompt clinical attention if symptoms occur. Additionally, a follow-up appointment should be scheduled approximately two weeks after extraction to monitor healing and enable early detection of potential complications.

Ethical Approval
Approved by the Inönü University Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, (No: 2025/8462, Date: 14 October 2025).

Patient Consent
Informed consent was waived due to the retrospective design.

Conflict of Interest
The authors declare no conflict of interest.

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