Original Article

Localized Bacteremia in Alveolar Sockets after Tooth Extraction in Type II Diabetic and Non-Diabetic Patients - A Prospective Study

Abstract

Background: Tooth extractions can introduce bacteria into the bloodstream, leading to transient bacteremia. Diabetic individuals are more susceptible due to impaired immunity, delayed healing, and reduced infection clearance. While systemic bacteremia is well-studied, localized bacteremia from the alveolar socket remains underexplored. This study compares post-extraction bacteremia in diabetic and non-diabetic patients to improve infection risk assessment and preventive care. **Objectives:** 1. Compare alveolar socket bacteremia in diabetic and non-diabetic patients. 2. Assess bacteremia prevalence and severity in both groups. 3. Evaluate the impact of diabetes on post-extraction bacteremia. 4. Identify predominant bacterial species and their clinical relevance. 5. Examine associations between bacteremia, glycemic control, healing response, and infection risk. **Materials and Methods:** Sixty patients (30 diabetics, 30 non-diabetics) aged 30–70 from low-to-medium socioeconomic backgrounds were studied. Males predominated among diabetics, females among non-diabetics. Post-extraction socket blood was collected, cultured on blood agar, and incubated at 37°C for 24 hours. Bacterial identification was performed using microscopic examination and confirmatory assays. **Results:** Statistical analysis ($p \leq 0.05$) showed diabetics had higher Streptococcus (56.6%), Enterococcus (26.6%), Klebsiella (3.3%), and Candida (3.3%), while non-diabetics had Enterococcus (40%), Streptococcus (30%), Moraxella (16.6%), and *Escherichia coli* (3.3%). Staphylococcus and Pneumococcus were exclusive to diabetics. **Conclusion:** Localized bacteremia may indicate systemic health risks. Further research is needed to establish clinical correlations, refine treatment protocols, and improve early intervention strategies.

Keywords: *Alveolar socket blood, diabetes mellitus, socket blood bacteremia, tooth extraction*

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Introduction

The association between oral and systemic health is well-documented, particularly the relationship between periodontal disease and diabetes mellitus.[1] It poses increased risks in diabetic patients due to compromised immune function, delayed wound healing, and heightened susceptibility to infections. Given the rising global prevalence of diabetes, understanding its impact on post-extraction bacteremia is essential for optimizing patient management and preventing systemic complications.[2]

This study aims to compare the prevalence, severity, and clinical implications of localized bacteremia in alveolar socket blood following dental extractions in diabetic and non-diabetic patients. It will investigate associations between bacteremia levels, glycemic control, healing response, and infection risk in diabetic individuals. By integrating insights from periodontal and systemic health research, this study seeks to enhance understanding of post-extraction complications in diabetic patients, facilitating the development of targeted preventive and management strategies to improve patient outcomes.[3]

Materials and Methods

The study protocol was reviewed by the Institutional Research and Ethical Board (IREB/2023/OS/01), and ethical clearance was granted. Informed consent from the patients was obtained. The reporting of the study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. A pilot study was conducted, to standardize the method of the blood collection after tooth extraction, storage, and transportation of the swab. The participants included in the pilot study were not considered as a part of the main study.

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The sample size was determined using two-proportion formulas with a 95% confidence interval. Based on the article by Muralidharan *et al.* (2019), Lactobacilli were present in 35%, whereas Spirochetes were present in only approximately 5%. Keeping the P1 as 35 and P2 as 5, where z α % =1.96, d = 5%, were taken. The formula employed to calculate the sample size was "$n = (Z\alpha/2 + Z\beta)\ 2^* (p1\ (1 - p_1) + p_{2\ (}1 - p_2))/(p_1 - p_2)^2$", where $Z\alpha/2$ is the critical value of the normal distribution at $\alpha/2$ (e.g., for a confidence level of 95%, α is 0.05 and the critical value is 1.96), Zβ is the critical value of the normal distribution at β (e.g., for a power of 80%, β is 0.2 and the critical value is 0.84) and $p_1 = 35\%$ and $p_2 = 5\%$ are the expected sample proportions of the two groups. The recommended sample size was 24 per group, which was rounded off to 30 per group. The desired sample size was achieved using convenience sampling.[3] Teeth with moderate to severe gingival inflammation (score ≥2) will be excluded. Participants were aged between 30 and 70 years at the time of sample collection. The extracted teeth must have a Loe & Silness gingival index score between 0 and 1. The study group included Diabetic subjects (Group A) who were on medication and undergoing extraction with a blood glucose level within the range of 90–240 mg/dl. The Control Group consisted of non-Diabetic subjects (Group B) undergoing extraction who were healthy with no other concurrent medical conditions.

The selected study group belonged to low to medium socioeconomic status (per annum income between Rs. 5-10 Lakhs) and reported to the Department of Oral and Maxillofacial Surgery for tooth extraction. The mean age group selected was from 30 to 70 years of age, as Diabetes Mellitus as well as the presence of inherent systemic diseases are prevalent in this range. Patients who met the following criteria were included in the study. Individuals diagnosed with Type 2 Diabetes Mellitus (T2DM) who are on oral hypoglycemic medication (e.g., metformin, sulfonylureas, DPP-4 inhibitors) and not on insulin injections, participants who were on oral antidiabetic medication for at least six months before sample collection, participants having a fasting blood glucose levels between 90 mg/dL and 240 mg/dL, measured using a validated glucometer or laboratory test within the past week, participants must be undergoing tooth extraction due to dental caries and not for other reasons (e.g., periodontal disease, trauma, orthodontic treatment) and individuals with Periodontal Disease-Related Extractions. Patients who met the following criteria were excluded from the study. Individuals with a history of smoking or the use of smokeless tobacco products and participants who had teeth extracted as part of orthodontic treatment.

For sample collection, sterile swabs and Nutrient Broth as a transport medium were employed to maintain bacterial viability. Microbiological analysis was conducted using Blood Agar, MacConkey's Agar, Chocolate Agar, Petri dishes, Gram's stain, and test tubes to facilitate bacterial identification and classification. A strict sterilization protocol was maintained before, during, and after the extraction procedure to minimize contamination. For maxillary tooth extractions, the operating field was positioned approximately 3 inches below the operator's shoulder, forming an angle of 45° to 60° with the floor. In contrast, for mandibular extractions, the patient's chair was adjusted so that the operating field was parallel to the floor and aligned with the operator's elbow level to ensure optimal access and visibility.[4] Single maxillary teeth were extracted using the local infiltration technique, while multiple extractions required a posterior superior alveolar nerve block. Inferior alveolar nerve blocks were applied for both single and multiple mandibular extractions, with the mental nerve block technique employed for anterior mandibular teeth. The standard extraction protocol was followed, including alveolar socket expansion and the use of dental elevators and forceps, adhering to the lever, wedge, and wheel-and-axle principles.[4]

Immediately post-extraction, blood samples were collected from the alveolar socket using sterile swabs suspended in Eppendorf tubes. To prevent salivary contamination, the sample was obtained from the root of the socket. Following sample collection, a pressure pack was applied to the extraction site, and for multiple extractions, simple interrupted sutures were placed. Patients were monitored for one week to assess the occurrence of alveolar osteitis. Samples were subsequently transferred to the microbiology laboratory for further analysis. Primary plating was conducted on Blood Agar, Chocolate Agar, and MacConkey's Agar. Bacteria were classified into gram-positive and gram-negative species using Gram staining. Gram-positive bacteria were identified through the Catalase Test, Bacitracin Susceptibility Test (Streptococcus pyogenes), Optochin Susceptibility Test (Streptococcus pneumoniae), and Bile Esculin Test (Enterococcus and Group D Streptococcus). Gram-negative bacteria were identified using the Indole Test (*Escherichia coli*), Citrate Utilization Test (Klebsiella, Enterobacter), Urease Test (Proteus, Helicobacter, Klebsiella), Motility Test (Proteus, Salmonella), and Oxidase Test (Pseudomonas, Neisseria).

Statistical analysis

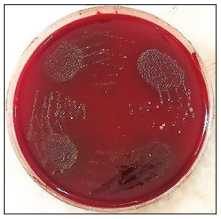
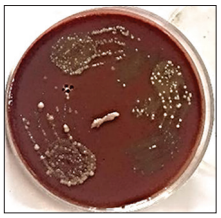
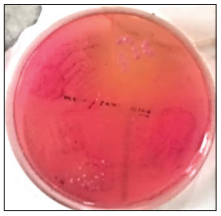
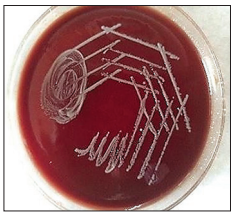
Statistical Analysis was performed using the IBM Statistical Package for Social Sciences (Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). The descriptive summary statistics included percentages, means, and standard deviations. Chi-square Test was used to compare proportions and Z test for proportion was used to compare the two groups. A $P \leq 0.05$ was considered significant for all statistical analyses.

Results

This study included 60 participants, divided into Group A (Diabetics, n = 30) and Group B (Non-Diabetics, n = 30), with mean ages of 41.4 and 53.9 years, respectively. In Group A, extractions were predominantly in the Maxillary Arch, particularly Sextants 14–18 (Left Posterior) and 24–28 (Right Posterior), followed by Sextant 34–38 (Left Posterior) in the Mandibular Arch. In contrast, Group B had more Mandibular Extractions, mainly in Sextant 34–38 (Left Posterior) and Sextant 33–43 (Anterior), with Maxillary Extractions most common in Sextant 14–18 (Right Posterior) [Table 1(a)]. Although statistical significance was not achieved for most findings due to sample size, a significant difference was observed in Streptococcus prevalence between the groups [Table 2]. Bacterial isolates were cultured on Blood Agar, Chocolate Agar, and MacConkey's Agar [Figure 1], with Colony-Forming Units (CFU) categorized as Mild (<10 ≥CFU/mL), Moderate (10≥-10^5 CFU/mL), or Severe (>10^5 CFU/mL) [Table 1(c)]. Streptococcus showed severe growth in Group A, while Enterococcus was predominant in Group B. These findings were confirmed through Gram staining and Biochemical tests [Figures 2 and 3].

The higher prevalence of Streptococcus in Diabetics suggests increased infection susceptibility due to impaired immunity, delayed healing, and altered oral flora, which may lead to complications such as Alveolar Osteitis and Bacteremia. In contrast, Enterococcus dominance in Non-Diabetics may indicate Oral Dysbiosis linked to poor hygiene, antibiotic exposure, or periodontal disease. Extraction site distribution suggests maxillary involvement in diabetics may result from Hyperglycemia-Induced periodontal breakdown, whereas non-diabetics had more mandibular extractions, possibly due to mechanical stress or localized periodontal factors [Table 2].

Figure 1: Isolation and Identification of Microorganisms on Agar Medium

Organism Detected	Result	Description
Streptococcus		Growth of Streptococcus spp. is seen on the blood agar plate
Moraxella		Growth of Moraxella spp. is seen on the blood agar plate
Klebsiella		Growth of Klebsiella spp. is seen on the blood agar plate
Candida		Growth of the Candida spp. is seen on the blood agar plate

Discussion

The oral cavity hosts approximately 700 bacterial species, with systemic health influencing microbial composition. Diabetes mellitus significantly affects oral health, leading to conditions such as periodontal disease (17%), oral candidiasis (12%), tooth loss (12%), mucosal ulcers (11%), halitosis (8%), taste impairment (10%), xerostomia (7%), dental caries (12%), and burning mouth syndrome (10%).[2,5] Despite advancements in treatment, mortality rates remain high. This study utilized alveolar socket blood for systemic disease diagnosis, reducing biases associated with salivary composition influenced by dietary factors. Additionally, modern saliva collection swabs were employed to bind salivary components, enhancing diagnostic precision.[6-8] Blood samples were chosen for analysis due to their enhanced ability to detect microbial colonies. Stringent sterilization protocols were meticulously followed to prevent iatrogenic microbial growth and ensure accuracy. Curettage of the socket, followed by thorough blood cleansing, further optimized diagnostic precision and promoted improved postoperative healing.[5,9] A study by Muralidharan *et al*., analyzed alveolar bone microbiota post-extraction, identifying aerobic and anaerobic species, including Enterococci, Micrococci, Coagulase-Negative Staphylococcus (CONS), Lactobacilli, Spirochetes, Fusobacterium, Candida albicans, and Viridans streptococcus.[3] This study focused solely on aerobic organisms to assess microbial alterations in Type 2 Diabetic patients. While literature emphasizes anaerobes in the oral cavity, facultative anaerobes such as *Escherichia (E.Coli)*, Klebsiella, Staphylococcus, and Streptococcus were also detected in alveolar socket blood samples[10]

Streptococcus spp. was the most prevalent microorganism in Diabetic patients (Group A) (56.6%), followed by Enterococcus (26.6%), while Klebsiella and *Candida* were the least common (3.3%). *Escherichia coli* was not detected. In Non-Diabetic individuals (Group B), Enterococcus (40%) was the most frequently identified, followed by Streptococcus (30%) and *Moraxella* spp. (16.6%), with *E. coli* present in only 3.3%. The detection of aerobic and

Table 1: Parameters for distribution of study participants

(a) Distribution of Study Participants according to the Demographic Parameters		
Parameters	**Diabetic Subjects**	**Non-Diabetic Subjects**
Mean Age	53.93 years	41.4 years
Gender Predilection	Male	Female
Most Common Region of Tooth Extraction	Maxillary Arch	Mandibular Arch
Most Common Sextant	14–18, 24–28, 34–38	34–38, 33–43, 14–18
RBS (Random Blood Sugar) Level Average Calculated for Tooth Extraction in Diabetic Subjects	111–130 mg/dl	-
(b) Percentage of positive microorganisms among Diabetics and Non-Diabetics		
Candida	3.3%	3.3%
Enterococcus	26.6%	40%
Streptococcus	56.6%	30%
Staphylococcus	3.3%	0%
Escherichia coli (E.Coli)	0%	3.3%
Morexella	6.6%	16.6%
Klebsiella	3.3%	3.3%
No Growth	0%	3.3%
(c) Distribution of different Microbes in the Alveolar Socket Blood in Diabetic and Non-Diabetic Study Groups		
Most common microorganisms found	Streptococcus, followed by Enterococcus & Moraxella	Enterococcus, followed by Streptococcus and Moraxella
Other significant microbiomes	Staphylococcus, Pseudomonas, E. Coli	Candida Spp, Klebsiella
Microorganisms most commonly found in Male subjects	Streptococcus	Streptococcus
Microorganism found most commonly in Female subjects	Streptococcus	Enterococcus
Microorganisms found in maxillary region	Enterococcus (14–18 Region), Streptococcus (24–28 Region)	Streptococcus (14–18 Region)
Microorganism found in mandibular region	Streptococcus (34–38 Region)	Enterococcus (34–38 & 44–48 Region), Streptococcus (34–38 Region), Moraxella (34–38 Region)
Microorganisms found within different RBS (Random Blood Sugar) levels	101–110 mg/dl- Enterococcus 90–120 mg/dl- Streptococcus 111–120 mg/dl – *E.Coli* and Pseudomonas- 131–150 mg/dl- Moraxella	-

Table 2: Multiple comparisons of mean difference in fracture resistance in Newton (N) b/w groups using Tukey's post hoc test (the mean differences observed between groups were statistically significant at *P*<0.001)

	Groups		**Total**	***Z* test**	***P***	**Chi-Square test**	**Significance**	**Clinical significance of each Organism**
	Non-Diabetic	**Diabetic**						
Candida	1	1	2	0	1	7.54	0.37	Decreased pH, leading to Oral Candidiasis
Enterococcus	12	8	20	1.04	0.27			Dental caries, primary and secondary endodontic infection
Streptococcus	9	17	26	-2.08	0.03			Higher incidence of caries in diabetics, infective endocarditis, hypertension
Staphylococcus	0	1	1	−1.00	0.31			Prosthetic joint infection and rheumatoid arthritis, acute and chronic hematogenous osteomyelitis
E.Coli	1	0	1	1.00	0.31			Nosocomial infection and sepsis
Morexella	5	2	7	1.2	0.22			Lower respiratory tract infections, chronic obstructive pulmonary, disease chronic bronchitis
Klebsiella	1	1	2	0	1			Diabetes mellitus
No growth	1	0	1	1.00	0.31			
Total	30	30	60					

Figure 2: Confirmatory Test Results for Identification of Isolated Microorganisms

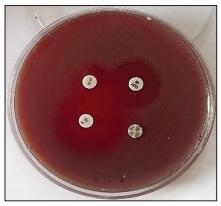
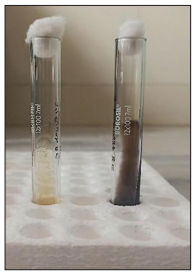
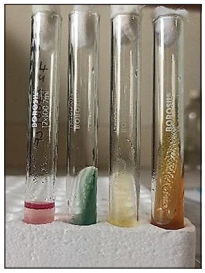
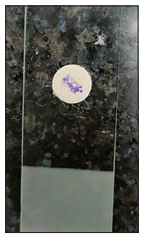
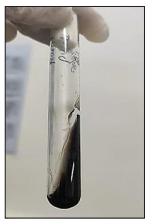
Confirmatory Test	Picture	Description
Bacitracin and cot-sensitive		The culture plate shows sensitivity towards bacitracin and cot
Bacitracin Test-		The yellow test tube represents a positive bacitracin test. Brown test tube shows negative bacitracin test
E. coli Reaction		The test tube shows positive E. coli Reaction
Klebsiella		Klebsiella is positive in the test tubes shown in the picture.
Catalase Test		Catalase Positive
Oxidase Test		Oxidase Positive
Bile Esculin Test		Positive Bile Esculin Test

Table 3: Clinical Significance of Organism found in Alveolar Socket Blood

Organism found in Alveolar Socket Blood	Clinical Significance
E. coli	Nosocomial infection and sepsis
Streptococcus Species	Higher incidence of caries in diabetic group and with infective infective endocarditis
	Hypertension
Staphylococcus Species	Prosthetic joint infection and rheumatoid arthritis
	Acute and chronic hematogenous osteomyelitis
Candida Species	Decreased pH. leading to oral candidiasis
Klebsiella	Diabetes mellitus
Enterococcus	Dental caries
	Primary and secondary endodontic infection
Pseudomonas Species	Underlying heart condition kidney disorders
	Gingival & periodontal diseases chronic obstructive pulmonary disease
Moraxella	Lower respiratory tract infections chronic obstructive pulmonary disease chronic bronchitis

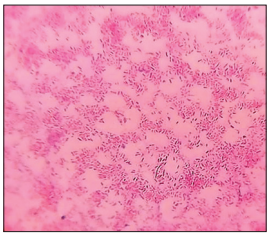
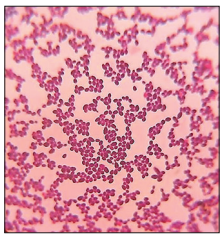
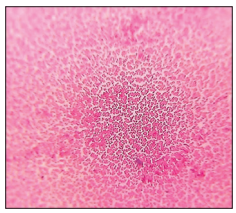
facultative anaerobic organisms suggests their influence on oral microbial load. Findings were analyzed in correlation with existing literature utilizing venous blood, saliva, and plaque samples[11-16] [Table 3]. Demographic factors such as education, income, and socioeconomic status significantly influence oral and overall health. Lower socioeconomic status limits healthcare access, reduces health literacy, and worsens nutrition, increasing systemic and oral diseases. Addressing these disparities through public health initiatives and education is essential for improving health outcomes and preventing long-term complications.[17]

Table 2 also illustrates the correlation between systemic diseases and alterations in oral bacteremia, as determined through venous blood, saliva, and plaque samples. The presence of bacteremia in alveolar socket blood suggests a potential link to systemic conditions. Table 1(b) also summarizes the prevalence of bacterial species in the Diabetic and Non-Diabetic groups. The systemic implications of the detected bacteremia align with findings reported by Parahitiyawa NB *et al*.[18] However, confirmation through specific diagnostic tests is necessary. Identifying microorganisms from extraction sockets may aid in prognosis assessment and comorbidity management.[19,20]

Limitations

This study had several limitations affecting the comprehensiveness of its findings. Species-level microbial differentiation was not feasible within the study duration, limiting precise characterization. The focus on

Figure 3: Microscopic Identification of Microorganisms with Morphological Description

Organism	Microscopic Picture	Description
Gram Negative Bacillus		The histopathogical picture shows gram negative bacillus stained pink
Candida		A small cluster like staining confirming the presence of Candida in the given picture
Moraxella		The classical representation of the Morexella in the given histopathological slide showing Gram Negative Cocci in Pairs

aerobic microorganisms excluded a thorough analysis of anaerobic bacteria, which are significant in oral and systemic infections. Sample collection was optimized for aerobic growth, further restricting anaerobic identification. Additionally, the absence of HbA1c testing in diabetic participants meant diabetes classification relied solely on RBG, FPG, and PPG values, potentially affecting accuracy.

Future recommendations

Given the influence of oral cavity pH, further research is necessary to examine microbial variations in both study and control groups. The American Heart Association (AHA) recommends antibiotic prophylaxis before specific dental procedures, particularly for patients with comorbidities such as diabetes, obesity, cardiovascular disease, and immunosuppression. Future studies should evaluate modifications to existing post-extraction antibiotic protocols. Additionally, the use of prophylactic mouthwashes and antibiotics may help mitigate infection risk in immunocompromised individuals, who are more susceptible to recurrent infections.

Conclusion

Detecting localized bacteremia in alveolar socket blood provides critical insights into oral and systemic health, aiding in early diagnosis and intervention. The presence of bacteria in socket blood reflects alveolar bone status and may indicate underlying systemic conditions such as diabetes or immunosuppression, both of which contribute to delayed healing and increased infection risk. Microbiological analysis allows for targeted antimicrobial therapy, with findings such as Streptococcus predominance in diabetics highlighting the need for prophylactic antibiotics and glycemic control, while Enterococcus in non-diabetics suggests potential periodontal or endodontic infections. However, confirmatory tests, including advanced molecular techniques like PCR and bacterial culture with species identification, are essential to establish definitive microbial correlations and guide appropriate treatment strategies. Establishing standardized diagnostic protocols for routine socket blood analysis can enhance clinical decision-making. Integrating microbiological insights with clinical assessments will help optimize patient outcomes and reduce post-extraction complications.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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