RESEARCH PAPER

Microbial Flora and Antibiotic Susceptibility in Odontogenic Fascial Space Infections Among Diabetic and Non-Diabetic Patients: A Comparative Cross-Sectional Study

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ABSTRACT

Background:
Odontogenic fascial space infections can extend rapidly through the face and neck and may be complicated by antimicrobial resistance. Diabetes mellitus may alter host defence and the spectrum of infection, making locally derived microbiological and susceptibility data clinically relevant.

Objective:
To compare the microbial flora and antibiotic susceptibility patterns of odontogenic fascial space infections in diabetic and non-diabetic patients.

Methods:
A comparative cross-sectional study was conducted in a tertiary-care oral and maxillofacial surgery department in Lahore, Pakistan, from 20 February 2024 to 19 August 2025. Eighty participants with moderate-to-severe odontogenic fascial space infections were recruited by non-probability convenience sampling, including 40 diabetic and 40 non-diabetic patients. Pus specimens obtained after incision and drainage underwent Gram staining, aerobic and anaerobic culture and antibiotic susceptibility testing. Data were analysed using IBM SPSS Statistics version 29.0; age was compared using an independent-samples t-test, while categorical comparisons used chi-square or exact tests as appropriate, with $p \leq 0.05$ considered statistically significant.

Results:
The mean age was 43.8 ± 16.1 years in diabetic patients and 25.9 ± 8.5 years in non-diabetic patients. *Staphylococcus aureus* (48.8%) and *Streptococcus* species (40.0%) were the predominant isolates. *Pseudomonas*, *Proteus*, *Klebsiella* and *Escherichia coli* were isolated only from diabetic patients, whereas *Fusobacterium* was identified exclusively among non-diabetic patients. Amikacin showed the highest overall sensitivity in both groups, while susceptibility to several other antibiotics varied between diabetic and non-diabetic patients.

Conclusion:
Microbial distribution and antibiotic susceptibility differed between diabetic and non-diabetic patients in this single-centre sample. The findings support early microbiological sampling and culture-guided antimicrobial

selection, while larger multicentre studies are needed before broad empirical treatment recommendations can be generalised.

Keywords: Amikacin; antimicrobial susceptibility; diabetes mellitus; fascial space infection; odontogenic infection; *Staphylococcus aureus*; *Streptococcus* species.

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INTRODUCTION

Odontogenic fascial space infections arise when dental infection extends beyond the tooth-bearing structures into the potential spaces of the face and neck. Although many odontogenic infections are managed effectively with removal of the source and drainage, advanced disease can compromise the airway or progress to deep neck infection, sepsis and other serious complications, making prompt recognition and appropriate antimicrobial therapy clinically important (Neal & Schlieve, 2022; Mahran et al., 2023). Increasing antimicrobial resistance adds further complexity because the organisms recovered and their susceptibility profiles vary between populations and healthcare settings (Schmid et al., 2026). Recent evidence also highlights the continuing burden of severe maxillofacial space infections and the importance of prompt diagnosis, source control and appropriate antimicrobial therapy (Lou et al., 2024; Meisgeier et al., 2024).

The microbiology of odontogenic space infection is typically polymicrobial and may include aerobic, facultative and anaerobic organisms. Studies from different settings have reported viridans streptococci, *Staphylococcus* species, *Prevotella* species and gram-negative organisms in varying proportions, with substantial heterogeneity in susceptibility to commonly used antibiotics (Walia et al., 2014; Fating et al., 2014; Singh et al., 2014; Umeshappa et al., 2021). More recent tertiary-centre evidence has also demonstrated temporal changes in resistance patterns and reinforced the importance of bacterial culture and susceptibility testing when managing severe infection (Kwon & Kim, 2023). Contemporary culture-based and molecular studies similarly demonstrate heterogeneous, often polymicrobial flora and evolving resistance patterns in odontogenic infections (Vavro et al., 2024; Thol et al., 2025).

Diabetes mellitus is relevant to odontogenic infection because hyperglycaemia and diabetes-related host factors can impair immune responses and are associated with an increased risk of infection and adverse infectious outcomes (Holt et al., 2024). Comparative studies have reported differences between diabetic and non-diabetic patients in the microorganisms isolated, extent of fascial space involvement and clinical course, although findings vary between populations (Chang et al., 2013; Kamat et al., 2015). In South Asia, a multicentre Pakistani study identified viridans streptococci and *Prevotella* among the common organisms in complex odontogenic fascial space infections, illustrating regional variation in microbial patterns (Khattak et al., 2021).

Despite this evidence, direct local comparisons of microbial flora and antimicrobial susceptibility between diabetic and non-diabetic patients in a tertiary-care setting in Lahore remain limited. This is clinically relevant because empirical antimicrobial treatment is frequently initiated before culture results are available, while local resistance patterns may differ from those reported elsewhere. Accordingly, the research question was whether microbial isolates and antibiotic susceptibility patterns differ between diabetic and non-diabetic patients with odontogenic fascial space infections. The rationale was to generate local comparative evidence that could support microbiological surveillance, culture-guided treatment and more informed empirical antibiotic selection without assuming that resistance patterns from other settings are directly transferable.

The aim of this study is to compare microbial flora and antibiotic susceptibility patterns in diabetic and non-diabetic patients with odontogenic fascial space infections, specifically to identify the predominant microorganisms in each group, compare overall antibiotic sensitivity patterns between groups, and describe organism-specific susceptibility patterns for the isolates reported in the study.

MATERIALS AND METHODS

Study Design and Setting

This comparative cross-sectional study was conducted in the Department of Oral and Maxillofacial Surgery, Mayo Hospital, Lahore, Pakistan, to compare microbial flora and antibiotic susceptibility patterns in diabetic and non-diabetic patients with odontogenic fascial space infections. The study was conducted from 20 February 2024 to 19 August 2025. Ethical approval was obtained before participant recruitment from the Ethics Committee of King Edward Medical University/ Mayo Hospital, Lahore, Pakistan.

Study Population, Sampling and Recruitment

The target population comprised patients with moderate-to-severe odontogenic fascial space infections of the head and neck region. Eligible patients presenting to the study department during the study period were recruited using non-

probability convenience sampling. Participants received study information and were enrolled after written informed consent, then classified into diabetic and non-diabetic groups according to the study protocol.

Sample Size

The final sample comprised 80 participants, including 40 diabetic and 40 non-diabetic patients. The sample-size calculation was based on a 5% level of significance, 90% statistical power and expected group proportions of 60.0% and 27.3%, consistent with previously published comparative data (Chang et al., 2013). The published proportions of 60.0% and 27.3% referred to multiple secondary-space involvement in diabetic and non-diabetic patients, respectively, and were used for the original sample-size determination rather than as microbiological outcome proportions.

Eligibility Criteria

Patients with moderate-to-severe odontogenic fascial space infections of the head and neck region requiring surgical drainage were eligible for inclusion. Participants were classified into diabetic and non-diabetic groups according to documented diabetic status and the predefined study protocol. Patients with primary immunodeficiencies and those with congenital defects or bone disorders, including syndromic conditions, Paget's disease and osteomalacia, were excluded.

Data Collection and Clinical Procedures

A detailed clinical history and examination were completed before treatment. Incision and drainage were performed as clinically indicated, and pus specimens were collected from infected sites through an intraoral or extraoral approach. After disinfection of the skin or mucosa, specimens were obtained immediately after the first surgical exploration using culture-and-sensitivity vacuum swabs. Patient information was recorded on a predesigned proforma. Culture and susceptibility reports were obtained within 48-72 hours, and antimicrobial therapy was modified when indicated. Clinical examinations were repeated on postoperative days 5 and 10. These postoperative assessments were not included among the prespecified outcomes analysed in the present report.

Microbiological Procedures and Study Variables

Specimens were submitted for Gram staining, aerobic culture, anaerobic culture and antibiotic susceptibility testing. For aerobic culture, specimens were inoculated onto blood agar, chocolate agar and MacConkey agar and incubated at 35–37°C for 18–24 hours. For anaerobic culture, specimens were inoculated onto anaerobic blood agar and incubated under anaerobic conditions at 35–37°C for 48–72 hours. Antibiotic susceptibility testing was performed using the Kirby–Bauer disk-diffusion method on Mueller–Hinton agar, and results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) M100, 34th edition (2024) criteria. The principal study variables were diabetic status, microbial isolates and antibiotic susceptibility. Age and sex were recorded as baseline characteristics. The primary outcome was the between-group comparison of microbial flora and antibiotic susceptibility patterns; secondary outcomes were the predominant organisms in each group and organism-specific susceptibility patterns. For organism-specific susceptibility summaries, the denominator represents the number of isolates tested against the relevant antibiotic; where testing was incomplete, antibiotic-specific denominators therefore varied.

Operational Definitions

Fascial space infection was defined as odontogenic infection involving one or more facial spaces, characterised by pain and swelling with trismus (interincisal mouth opening ≤35 mm) and pus confirmed by aspiration or incision and drainage. Masticator space infection was defined as involvement of the submasseteric, pterygomandibular, superficial temporal or deep temporal spaces, with severe trismus (interincisal mouth opening ≤25 mm) and radiological or surgical evidence of infection. Empirical antibiotic therapy referred to treatment initiated before culture results. Modification of therapy was considered necessary when susceptibility testing demonstrated resistance to the initial antibiotic and sensitivity to an alternative agent.

Ethical Considerations

All required institutional and administrative permissions for recruitment, clinical procedures, specimen collection, microbiological testing and use of study data were obtained before the relevant procedures. Participation was voluntary. Eligible participants received information about the study, and written informed consent was obtained before enrolment. Participants could decline or withdraw without prejudice to clinical care. Confidentiality, privacy and secure handling of participant information were maintained. The research was conducted in accordance with applicable institutional ethical requirements and the Declaration of Helsinki.

Statistical Analysis

Data were entered and analysed using IBM SPSS Statistics, version 29.0. Continuous data, including age, were summarised as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The mean age of diabetic and non-diabetic patients was compared using an independent-samples t-test. Sex distribution was compared using the chi-square test with continuity correction. Because several expected cell counts were small in the organism-distribution table, the overall microbial distribution was compared using the Fisher-Freeman-Halton

exact test. Between-group comparisons of the recorded antibiotic sensitivity proportions in Table 3 were performed using two-sided Fisher's exact tests. All tests were two-sided, and $p \leq 0.05$ was considered statistically significant.

RESULTS

A total of 80 patients were included, comprising 40 diabetic and 40 non-diabetic patients. Mean age was significantly higher in the diabetic group than in the non-diabetic group (43.8 ± 16.1 vs. 25.9 ± 8.5 years, p<0.001). Males constituted the majority in both groups, accounting for 65.0% of diabetic patients and 87.5% of non-diabetic patients. The difference in sex distribution between the groups was statistically significant (p=0.036). Participant characteristics are presented in Table 1.

Table 1. Baseline characteristics of diabetic and non-diabetic patients with odontogenic fascial space infections

Variable	Diabetic (n=40)	Non-diabetic (n=40)	P-value
Age (years), Mean ± SD	43.8 ± 16.1	25.9 ± 8.5	<0.001
Male	26 (65.0)	35 (87.5)	0.036
Female	14 (35.0)	5 (12.5)	

Note. SD = standard deviation.

Staphylococcus aureus was the most frequently isolated organism overall (48.8%), followed by *Streptococcus* species (40.0%). *Streptococcus* species were more common among non-diabetic patients (52.5%), whereas *Staphylococcus aureus* predominated among diabetic patients (50.0%). *Pseudomonas*, *Proteus*, *Klebsiella* and *Escherichia coli* were isolated only from diabetic patients, whereas *Fusobacterium* was isolated exclusively from non-diabetic patients. Microbial distribution differed significantly between groups (Fisher-Freeman-Halton exact p=0.005), as shown in Table 2.

Table 2. Distribution of microorganisms isolated from diabetic and non-diabetic patients

Organism	Diabetic n (%)	Non-diabetic n (%)	Total n (%)
Streptococcus spp.	11 (27.5)	21 (52.5)	32 (40.0)
Staphylococcus aureus	20 (50.0)	19 (47.5)	39 (48.8)
Pseudomonas spp.	5 (12.5)	0 (0.0)	5 (6.3)
Proteus spp.	2 (5.0)	0 (0.0)	2 (2.5)
Fusobacterium spp.	0 (0.0)	3 (7.5)	3 (3.8)
Klebsiella spp.	1 (2.5)	0 (0.0)	1 (1.3)
Escherichia coli	1 (2.5)	0 (0.0)	1 (1.3)
Total	40 (100)	40 (100)	80 (100)

Note. spp. = species.

Amikacin demonstrated the highest sensitivity in both diabetic (67.5%) and non-diabetic patients (65.0%). Non-diabetic patients exhibited higher sensitivity to piperacillin-tazobactam, meropenem, imipenem and cotrimoxazole, whereas sensitivity to ciprofloxacin and clindamycin was observed predominantly among diabetic patients. The overall susceptibility pattern of the selected antibiotics is presented in Table 3. Using two-sided Fisher's exact tests on the displayed group counts, significant between-group differences were present for piperacillin-tazobactam, meropenem, imipenem, ciprofloxacin, cotrimoxazole and clindamycin, whereas amoxicillin-clavulanate, cefuroxime, ceftriaxone, amikacin and gentamicin did not differ significantly.

Table 3. Overall susceptibility pattern of selected antibiotics among diabetic and non-diabetic patients

Antibiotic	Diabetic Sensitive n (%)	Non-diabetic Sensitive n (%)	P-value
Amoxicillin-clavulanate	19 (47.5)	15 (37.5)	0.498
Cefuroxime	22 (55.0)	19 (47.5)	0.655
Ceftriaxone	18 (45.0)	16 (40.0)	0.821
Piperacillin-tazobactam	9 (22.5)	31 (77.5)	<0.001
Meropenem	7 (17.5)	28 (70.0)	<0.001
Imipenem	10 (25.0)	23 (57.5)	0.006
Ciprofloxacin	14 (35.0)	0 (0.0)	<0.001
Amikacin	27 (67.5)	26 (65.0)	1.000
Gentamicin	14 (35.0)	15 (37.5)	1.000
Cotrimoxazole	4 (10.0)	15 (37.5)	0.008
Clindamycin	7 (17.5)	0 (0.0)	0.012

Note. Sensitivity is expressed as n (%), using the total group denominator (n=40 per group) for these overall patient-level recorded sensitivity proportions. Between-group p-values were obtained using two-sided Fisher's exact tests.

Among *Streptococcus* isolates, diabetic patients showed higher sensitivity to amoxicillin,

amoxicillin-clavulanate and penicillin, whereas non-diabetic patients demonstrated greater sensitivity to piperacillin-tazobactam, meropenem and amikacin. Cefuroxime and ceftriaxone showed good activity against *Streptococcus* isolates in both groups. Organism-specific findings for *Streptococcus* are presented in Table 4.

Table 4. Antibiotic susceptibility pattern among *Streptococcus* isolates

Antibiotic	Diabetic (n=11) Sensitive n (%)	Non-diabetic (n=21) Sensitive n (%)
Amoxicillin	9 (81.8)	10 (47.6)
Amoxicillin-clavulanate	9 (81.8)	10 (47.6)
Penicillin	8 (72.7)	10 (47.6)
Cefuroxime	7 (63.6)	14 (66.7)
Ceftriaxone	7 (63.6)	11 (52.4)
Piperacillin-tazobactam	4 (36.4)	12 (57.1)
Meropenem	2 (18.2)	18 (85.7)
Imipenem	4 (36.4)	8 (38.1)
Amikacin	2 (18.2)	10 (47.6)
Clindamycin	3 (27.3)	0 (0.0)

Note. Sensitivity is expressed as n (%).

Staphylococcus aureus isolates showed different susceptibility patterns in diabetic and non-diabetic patients. Non-diabetic isolates showed higher sensitivity to piperacillin-tazobactam, meropenem, imipenem, amikacin and cotrimoxazole, whereas diabetic isolates showed comparatively greater sensitivity to cefuroxime, ceftriaxone, gentamicin, clindamycin and vancomycin. These findings are presented in Table 5. Because antibiotic-specific testing denominators varied for *Staphylococcus aureus*, these organism-specific percentages are interpreted descriptively and fixed group denominators are not shown in the Table 5 column headings.

Table 5. Antibiotic susceptibility pattern among *Staphylococcus aureus* isolates

Antibiotic	Diabetic Sensitive n (%)	Non-diabetic Sensitive n (%)
Amoxicillin-clavulanate	7 (36.8)	5 (38.5)
Cefuroxime	10 (52.6)	5 (38.5)
Ceftriaxone	9 (47.4)	2 (15.4)
Piperacillin-tazobactam	3 (15.8)	13 (100.0)
Meropenem	4 (21.1)	7 (53.8)
Imipenem	4 (21.1)	12 (92.3)
Ciprofloxacin	8 (42.1)	8 (42.1)
Amikacin	0 (0.0)	12 (92.3)
Gentamicin	5 (26.3)	0 (0.0)
Cotrimoxazole	1 (5.3)	6 (46.2)
Clindamycin	3 (15.8)	0 (0.0)
Vancomycin	4 (21.1)	0 (0.0)

Note. Sensitivity is expressed as n (%) among the Staphylococcus aureus isolates tested against each antibiotic. Antibiotic-specific denominators varied because not every isolate was tested against every agent; therefore, fixed denominators are not shown in the column headings.

Among the less common isolates, *Pseudomonas* species showed high sensitivity to amikacin, gentamicin, piperacillin-tazobactam, meropenem and cephoperazone. *Proteus* species exhibited complete sensitivity to co-amoxiclav, cephalosporins and piperacillin-tazobactam. *Fusobacterium* species demonstrated complete sensitivity to several beta-lactam antibiotics, ciprofloxacin and amikacin. *Klebsiella* and *Escherichia coli* isolates were susceptible to most cephalosporins, piperacillin-tazobactam and selected fluoroquinolones. Figure 1 illustrates the reported distribution of antibiotic resistance among the isolated microorganisms.

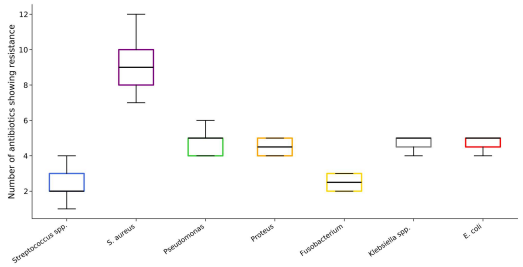


Figure 1. Distribution of antibiotic resistance among microorganisms isolated from odontogenic fascial space infections. The box-and-whisker plots depict the variability in the number of antibiotics exhibiting resistance for each organism.

DISCUSSION

This study found that microbial distribution and antibiotic susceptibility patterns differed between diabetic and non-diabetic patients with odontogenic fascial space infections. *Staphylococcus aureus* was the predominant isolate overall, whereas *Streptococcus* species were more frequent among non-diabetic patients. Several gram-negative organisms were recovered only from diabetic patients, and susceptibility varied between groups and across antibiotics. Amikacin showed the highest overall reported sensitivity in both groups.

These findings address the study question by demonstrating heterogeneity in microbiological and susceptibility patterns within this sample. SExact comparisons showed that statistically significant between-group differences were confined to selected antibiotics rather than being present across all agents.

The predominance of *Staphylococcus aureus* differs from several published series in which viridans streptococci were common or predominant. Walia et al. (2014), Singh et al. (2014) and Kwon and Kim (2023) reported prominent streptococcal involvement, while Umeshappa et al. (2021) described a mixed aerobic and anaerobic profile. Pakistani multicentre data also identified viridans streptococci and *Prevotella* among the common organisms in complex odontogenic fascial space infections (Khattak et al., 2021). The contrast with the present findings may reflect differences in case mix, infection severity, specimen collection, prior antimicrobial exposure or laboratory methods. Fating et al. (2014) similarly demonstrated that organism distribution can vary substantially across orofacial space infections.

The recovery of *Pseudomonas*, *Proteus*, *Klebsiella* and *Escherichia coli* only in diabetic patients should be interpreted cautiously. Diabetes is associated with altered host defence and increased susceptibility to infection (Holt et al., 2024), and previous comparative studies have reported distinct microbiological patterns in diabetic patients (Chang et al., 2013; Kamat et al., 2015). However, the diabetic and non-diabetic groups in the present study also differed in age and sex distribution, and no adjusted analysis was reported. The observed microbial differences therefore represent associations within this sample and cannot be attributed to diabetes alone.

The susceptibility findings are consistent with the value of local microbiological surveillance. A recent systematic review reported substantial variation in resistance to commonly used antibiotics in odontogenic infection, particularly penicillins and clindamycin, and emphasised the role of surveillance and culture-guided treatment (Schmid et al., 2026). Kwon and Kim (2023) likewise reported changing resistance patterns over time. In the present study, susceptibility to several agents varied markedly between groups and organisms. Although amikacin had the highest overall reported sensitivity, the organism-specific findings were heterogeneous; therefore, the data do not justify a single universal empirical regimen. For moderate-to-severe infection, the findings are consistent with prompt source control, drainage where indicated and review of antimicrobial therapy once culture and susceptibility results are available (Neal & Schlieve, 2022; Mahran et al., 2023). Recent susceptibility surveillance and large retrospective analyses further show that resistance patterns vary by organism and antimicrobial agent, supporting local surveillance and culture-directed treatment (Kaneko et al., 2025; Fischer et al., 2025).

Strengths and Limitations

A methodological strength is the direct comparison of diabetic and non-diabetic patients within one tertiary-care setting, with microbiological sampling after surgical drainage and reporting of both overall and organism-specific susceptibility. The study also included aerobic and anaerobic culture. Important limitations include the single-centre design, non-probability convenience sampling and modest sample size, which restrict generalisability. Several organisms occurred in very small numbers, limiting organism-specific comparisons. Not all antibiotics were tested against all isolates, resulting in incomplete susceptibility data and variable denominators. In addition, the cross-sectional design and absence of adjusted analyses mean that potential confounding by age, sex or other clinical factors cannot be excluded. The original sample-size calculation was based on published differences in multiple secondary-space involvement rather than directly on the microbiological primary outcome. In Table 3, overall percentages use the total group denominator, whereas organism-specific testing in Table 5 involved variable antibiotic-specific denominators; these susceptibility findings should therefore be interpreted with appropriate caution.

Future Implications and Recommendations

Larger multicentre prospective studies should use standardised specimen collection, culture and susceptibility methods and record clinically relevant factors such as glycaemic control, infection severity, prior antibiotic exposure and treatment outcomes. Where appropriate, adjusted analyses could determine whether diabetic status is independently associated with particular organisms or resistance patterns. Continued local antimicrobial surveillance may also help refine empirical treatment pathways while preserving culture-guided therapy as the basis for definitive antibiotic selection.

CONCLUSION

In this single-centre study, microbial flora and antibiotic susceptibility patterns differed between diabetic and non-diabetic groups. *Staphylococcus aureus* and *Streptococcus* species were the predominant isolates, while several gram-negative organisms were identified only among diabetic patients. Amikacin showed the highest overall reported sensitivity, although susceptibility varied by organism and group. These findings support early microbiological sampling and culture-directed antimicrobial selection rather than a universal empirical recommendation. Larger multicentre prospective studies with standardised

microbiological methods and adjustment for relevant confounders are needed to confirm the observed patterns.

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AUTHORS' CONTRIBUTIONS

Abdul Wahab Jehangir: Conceptualization, Methodology, Investigation, Data curation, Project administration, Writing – original draft, Writing – review & editing.
Sana Batool Sherazi: Investigation, Data curation, Validation, Writing – review & editing.
Samreen Younas: Methodology, Validation, Formal analysis, Writing – review & editing.
Asad Iqbal Malik: Methodology, Supervision, Validation, Writing – review & editing.
Hafiz Nasir Mahmood: Investigation, Resources, Validation, Writing – review & editing.
Muhammad Gulzar: Formal analysis, Data curation, Visualization, Writing – review & editing.
All authors reviewed and approved the final manuscript and agree to be accountable for the accuracy and integrity of the work.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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