

Emerging Trends Of Odontogenic Infections In Diabetic Patients: A Scoping Review Of Microbial Patterns And Resistance Mechanisms

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ABSTRACT

Background: Diabetes mellitus impairs immune function, increasing the risk of rapid progression of odontogenic infections to cellulitis and deep neck space infections, as well as antibiotic resistance.

Objectives: To evaluate the oral microbiota in odontogenic infections among diabetic patients, identify microbial shifts, and assess antibiotic resistance patterns.

Methods: A scoping review was conducted across multiple databases using predefined inclusion and exclusion criteria.

Results: Nine studies met the criteria, including prospective, retrospective, descriptive, case report, and epidemiological designs. Middle-aged males were more commonly affected. The main sources of infection were posterior teeth, pericoronitis, dentoalveolar abscesses, and space infections, with all cases classified as space infections of odontogenic origin. Dental caries was the most frequent cause, with single cases of pericoronitis, necrotizing fasciitis, and periodontitis. The submandibular space was most often involved. *Streptococcus* spp. predominated, followed by MRSA, *Klebsiella*, *Staphylococcus*, and *Acinetobacter* spp. *Streptococcus* spp. showed high resistance to penicillin, amoxicillin, and amoxicillin-clavulanic acid. MRSA was resistant to most antibiotics except vancomycin, while *Klebsiella* showed resistance to amoxicillin-clavulanic acid.

Conclusions: In diabetic patients, odontogenic infections typically arise from posterior teeth and frequently involve the submandibular space. *Streptococcus* spp. is the predominant pathogen, with notable resistance to commonly prescribed antibiotics. Prompt diagnosis and targeted antimicrobial therapy are essential to prevent severe complications.

Keywords: Antibiotic resistance, Antibiotic sensitivity, Diabetes mellitus, MRSA, Odontogenic infections, Space infections.

INTRODUCTION

Diabetes mellitus (DM) is a long-term metabolic disorder marked by persistent high blood sugar levels due to abnormal insulin production or insulin action or both.^[1] The global incidence of diabetes mellitus (DM) has been surging dramatically, a trend attributed to escalating obesity rates, sedentary habits, and aging demographics. The International Diabetes Federation IDF Diabetes Atlas, in its 11th edition released in 2025, has projected that 589 million adults are presently living with diabetes. By 2050, this number is anticipated to escalate to 853 million reflecting a 46% rise. This will lead to a global health challenge, imposing a burden on health systems, economies, and individuals. Individuals with DM often require repeated or prolonged courses of antibiotics, which heightens their risk of complications. This

situation contributes to various public health challenges, particularly in relation to infectious diseases and the growing problem of antimicrobial resistance.^[2]

The oral cavity serves as a prime example of how microbial imbalance can affect systemic health. Diabetes mellitus notably disrupts the equilibrium, resulting in a hyperglycemic state that fosters microbial dysbiosis, which can lead to xerostomia (dry mouth), increased dental caries, periodontal disease, and oral candidiasis. In those with diabetes, microbial species including Streptococci, Staphylococcus, Prevotella, Leptotrichia, Veillonella, and Candida flourish, whereas beneficial groups like Proteobacteria and Bifidobacteria diminish.^[3] The increasing prevalence of antibiotic resistance among individuals with diabetes is emerging as a major global concern, as various studies have highlighted its widespread nature and associated risk factors. The hyperglycaemic state in diabetic patients not only results in more frequent infections and higher antibiotic consumption but may also foster microbial environments that support the development and proliferation of resistant strains. Moreover, diabetes-related complications, such as dysbiosis in both gut and oral microbiomes, have been associated with a greater occurrence of multidrug-resistant organisms (MDROs), including those resistant to β -lactams, fluoroquinolones, and aminoglycosides. Research indicates that antibiotic resistance primarily stems from hyperglycemia, which facilitates the growth of resistant mutants.^[4] Numerous studies indicate that there are considerable levels of resistance to antimicrobials frequently employed in both local and systemic therapies for oral infections, highlighting the importance of appropriate antibiotic use.

The increasing incidence of odontogenic infections among individuals with diabetes mellitus is a growing concern due to its clinical and epidemiological implications. Although existing research highlights alterations in the oral microbiota of diabetic patients, a comprehensive understanding of how these changes contribute to antibiotic resistance remains limited. Diabetic patients are often exposed to frequent or prolonged antibiotic use, and this, coupled with microbial dysbiosis, may foster the emergence of resistant pathogens. Given the potential risk posed by antibiotic-resistant infections in this vulnerable population, there is a pressing need to conduct a scoping review. Such a review will help explore and map the current evidence on the association between diabetes mellitus and the prevalence of antibiotic-resistant odontogenic infections. It will also provide insights into how diabetes influences microbial susceptibility, thereby informing future research and clinical management strategies.

This scoping review sought to address the following research questions: (i) how diabetes-related alterations in oral microbiota may be associated with antibiotic resistance, (ii) which oral pathogens show higher rates of antibiotic resistance in diabetic patients, and (iii) what gaps exist in current research linking diabetes with antimicrobial resistance.

METHODS

Study design: Scoping review was selected as the appropriate scheme to address the research question “to explore the significant impact of diabetes mellitus on the susceptibility of individuals to anti-microbial resistance” The guidelines for the present scoping review were followed in accordance to 2018 PRISMA protocol extension for scoping reviews (PRISMA-ScR).

Search Strategy: We performed an extensive literature review of pertinent articles sourced from Google Scholar, PubMed, EBSCOhost (including CINAHL, MEDLINE, Health Source/Nursing/Academic Edition, and Academic Search Complete), as well as the WEB of Science electronic databases. The keyword used during search was diabetes, oral microbiota, antimicrobial resistance, odontogenic infections, space infections. The search results were downloaded to Mendeley where duplicates were excluded. We then uploaded the results to Rayyan, an online open-access tool to conduct systematic reviews. Titles and abstracts were screened by two independent reviewers, who studied the complete text of the reports selected in the screening phase. Discrepancies were solved by consensus between reviewers.

ELIGIBILITY CRITERIA

Inclusion criteria: The publications from the period 2000 to 2025 written in English were used for search. Papers and articles [Primary original research including observational studies (cross sectional, cohort, case control), experimental studies, case reports and case series] reported on diabetic specimens/patients with oral or other localized infections of any gender and age exposed to antibiotic usage showing evident or negligent antimicrobial resistance.

Exclusion criteria: editorials, commentaries, systematic review articles and studies lacking a clear focus on both diabetes and antibiotic resistance and studies looking at infections of viral or fungal etiology were also excluded.

Charting of Data

The screening process was conducted using PRISMA extension for scoping review. The two reviewers screened the titles and abstract using Covidence. Standardized data extraction sheet was prepared, to gather data from the chosen articles. The data extracted were name of the author, year of publication, location, aim, study design, study sample, type of micro-organism or infection site, antibiotic resistance observed or not, key findings and prevalence of antibiotic resistance.

Collating, Summarizing, and reporting of results

This scoping review examined the association between antibiotic resistance and odontogenic infections in diabetic patients. Articles were selected based on predefined inclusion and exclusion criteria and subsequently analyzed. The initial search yielded 78 articles, of which 11 duplicates were removed. The remaining 67 articles were screened, and 43 were excluded for not meeting the criteria of including both diabetic patients and antibiotic resistance data. Of the 24 articles assessed for eligibility, 7 were abstracts and 8 were review articles, both of which were excluded according to the study criteria. (Fig 1) Ultimately, 9 eligible articles were included, tabulated alphabetically, and their key details summarized. The assessment findings of the included studies were presented in tabular form. Table 1 outlines the demographic details, including author name, year of publication, country of study, sample size, age/mean age, gender distribution, number of diabetic and non-diabetic participants, and site of infection. Table 2 summarizes the types of bacteria identified in various odontogenic infections, the antibiotics used for their management, the antibiotics to which resistance was observed, and the conclusions of each study.

This scoping review identified nine relevant articles, of which five originated from India, while the remaining four were from China, Japan, New Zealand, and South America. The selected articles comprised of prospective, retrospective, descriptive studies, case reports, and epidemiological surveys. It was noted that males were more commonly affected than females in this study, mostly in the middle-aged group. The identified sources of infection included dentoalveolar abscesses from the posterior tooth, pericoronitis, and space infections. In all studies reviewed, the infections were reported as space infections of an odontogenic origin. Dental caries was the predominant etiological factor, while pericoronitis, necrotizing fasciitis, and periodontitis were each reported in a single case. The most common clinical presentation was space infection, with the submandibular space being most frequently affected (38.17%), followed by involvement of the submental, buccal, canine, and submasseteric spaces. In the majority of cases, multiple anatomical spaces were involved. The microflora reported across the included studies varied but consistently comprised both Gram-positive and Gram-negative bacteria. Streptococcus species were the most frequently identified microorganisms, followed by MRSA, Klebsiella, Staphylococcus, and Acinetobacter spp. Streptococcus demonstrated the highest resistance to penicillin, followed by amoxicillin, amoxicillin-clavulanic acid, cefotiam, cefotaxime, and metronidazole. MRSA exhibited resistance to nearly all tested antibiotics except vancomycin. Klebsiella showed resistance to amoxicillin-clavulanic acid. (Table 3)

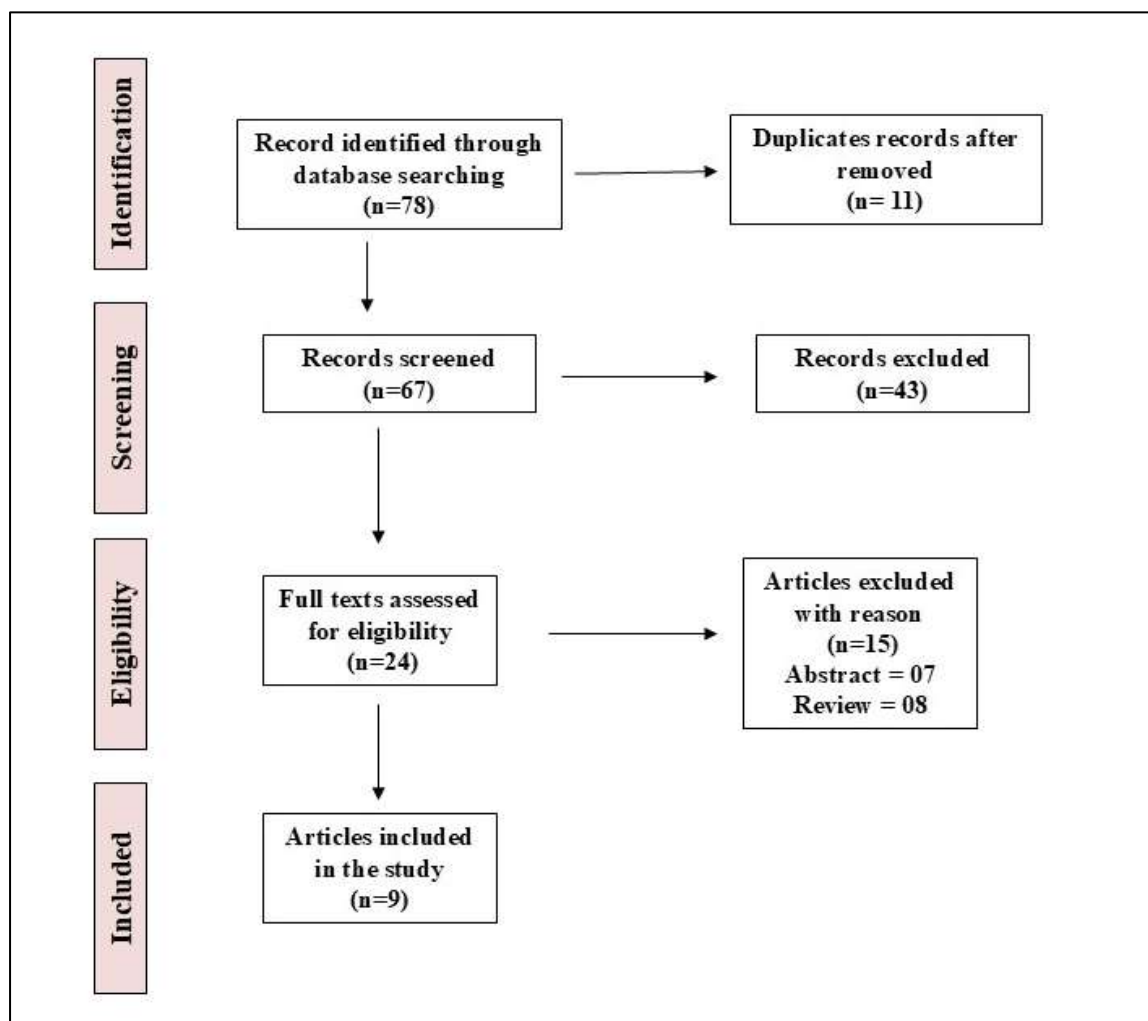


Fig 1 Flowchart of the studies selection method

Table 1: Demographic and clinical profile of included studies

Author & Year	Country	Study design	Sample size	Age/ Mean age	Gender	Diabetes	Site of Infection
Dipesh Rao 2010 ^[5]	India Karnataka	Prospective study	111	45	~	31	Submandibular space 38.71% Buccal space 29% Ludwig's angina 22.58%
Inderdeep Singh Walia 2014 ^[6]	India Wardha	Descriptive study	42	38.40	M=33 F=9	1	Submandibular space, buccal space, submental space, canine space,
Marcelo Guzman-Letelier 2017 ^[7]	South America	Case report	1	42	M	DM	Ludwig's angina from Pericoronitis 38
Rahul Kamath	India	Prospective study	188	10-90	M=30 F=31	61	Submandibular space, Buccal space,

2015 ^[8]							Submental, Submassetric space
Rakesh BS 2021 ^[9]	India Karnataka	Retrospective study	34	20-60	M=21 F=13	DM=11	Dental caries, mand 3 rd molar, mand 2 nd molar
Ruby J Richardson 2024 ^[10]	New Zealand Auckland	Retrospective study	517	10-90	M=344 F=311	DM=257	Odontogenic deep neck infections
Shinnosuke Fukushima 2020 ^[11]	Japan	Case Report	1	71	F	Type 2 DM	Swelling of face with extra oral fistula originating from residual root of left mandibular molar
Tejashree R 2020 ^[12]	India Bangalore	Descriptive study	120	40-65	M= 56 F= 64	60	Dentoalveolar abscess with intraoral or extra oral swelling
WJ Zhang 2010 ^[13]	China	Case report	1	57	M	Type 2 DM	Left mandibular tooth infection causing necrotizing fasciitis

Table 2: Bacterial profile, antibiotic usage, resistance patterns, and study conclusions in odontogenic infections

Author & Year	Bacteria	Antibiotic	Antibiotic Resistance	Conclusion
Dipesh Rao 2010	Streptococcus spp Gram positive K pneumoniae Enterococcus S aureus Pseudomonas	Amoxicillin+ clavulanic acid + metrogyl Cefaperazone + sulbactam+ metrogyl	Amoxicillin	Combination of Amoxicillin, clavulanic acid and metrogyl work effectively in both diabetic and non-diabetics along with control of blood sugar level, surgical drainage of infection yields satisfactory resolution of infection
Inderdeep Singh Walia 2014	S aureus, GAS, Klebsiellasp, Escheria coli, Peptostreptococcussp, S mutans, S milleri, Fusobacterium, Bacteriodes	Gram+ve Penicillin, Erythromycin, Gentamicin, Ciprofloxacin, Cephotaxime Gram-ve Amikacin, Cephotaxime, Cefuroxime, Ciprofloxacin	Gram + ve: aerobes- Penicillin, erythromycin Gram - ve: Amikacin	Drainage, decompression and broad-spectrum antibiotics will resolve odontogenic infections than only use of antibiotics helps for early and effective management

Marcelo Guzman-Letelier 2017	MRSA, Acinetobacter baumannii	Oral Amoxicillin+ Clavulanic acid IV Clindamycin Tigecycline	Resistance to penicillin Resistant to Clindamycin	Diabetes exacerbates macrophage reaction and MMP production to spread infection. Hyperglycemia cause delayed wound healing Diabetics with odontogenic infections have prolonged hospital stay
Rahul Kamath 2015	Klebsiellasp, Streptococcus spp, Staphylococcus aureus, Enterococcus, E coli,	IV Amoxicillin, Clavulanic acid Metronidazole	Amoxicillin Clavulanic acid	Submandibular space was the commonly involved space irrespective of glycemic status Patients with adequate glycemic control responded well to amoxicillin/clavulanic acid Diabetics have longer hospital stay compared to non-diabetics Klebsiellasp was the most common organism isolated in pus; Streptococci were common in non-diabetic
Rakesh BS 2021	Streptococcus spp, Staph spp, Enterosp	Penicillin, Cotrimoxazole, Erythromycin, Clindamycin, Ciprofloxacin, Ceftriaxone, Vancomycin	Penicillin, Cotrimoxazole, Erythromycin, Clindamycin, Ciprofloxacin	Gram -ve bacteria resistant to penicillin, Ceftriaxone, Cefuroxime All Gram +ve bacteria were resistant to penicillin Some Staphylococcus spp and Streptococcus spp were resistant to ciprofloxacin
Ruby J Richardson 2024	Streptococcus spp Mixed anaerobes Staphylococci, Prevotella, Pavimonas	Penicillin Clindamycin Amoxicillin/ Clavunate	Penicillin resistance- MRSA, E coli, Clindamycin resistance- Streptococcus intermedius, Staph aureus	Diabetics showed predominant mixed anaerobes, Strep constellatus, Streanginosus, Staph epidermididis, P micra, E coli Diabetics were associated with resistance of pencillin 28.9%, clindamycin 18.2%,

			Amoxicillin/ Clavunate resistance- Enterobacter cloacae	amoxycillin/ Clavunate 35.7%
Shinnosuke Fukushima 2020	Streptococcus oralis Actinomycesnaeslundii	IV Ampicillin/Sublac tam 3g daily Clindamycin	Penicillin G Ampicillin Ampicillin/ Sublactam Cefotaxime Clarithromycin	Penicillin resistant Viridians Group Streptococci Odontogenic infections are more resistant in diabetics Hyperglycemia exacerbate infections
Tejashree R 2020	Gram Positive Peptostreptococcus Peptococcus Gram Negative Fusobacterium Prevotella Bacteriodes Gram + bac more in non-diabetics Gram - bac more in diabetics	Amoxicillin Amoxicillin + Clavulanic Acid Clindamycin Cefitaxime Metranidazole Ciprofloxacin	Amoxicillin resistance in both groups	Diabetics were more resistant to ciprofloxacin Both groups were 100% resistant to amoxicillin Both diabetics and non- diabetics were sensitive to metronidazole
WJ Zhang 2010	MRSA	IV Ceftriaxone Ornidazone Levofloxacin	Resistant to all antibiotics except Vancomycin	IV Norvancomycin 1gm given 2 times for 6weeks After 50 days no infection good healing of cervical and submandibular regions

Table 3: Summary of the results of the study

Author	Source of infection	Most common micro- organism %	%	Resistance to antibiotic	%
Dipesh Rao 2010 ^[5]	Submandibular space 38.71%	Streptococcus spp	16.13%	Amoxicillin	9.67%
Inderdeep S Walia 2014 ^[6]	Submandibular space 56.34%	Staphylococcus spp	27.50%	Penicillin	38.88%
Marcelo Guzman- Letelier 2017 ^[7]	Ludwig's angina	Acinetobacter baumannii & MRSA	---	Methicillin	---
Rahul Kamath 2015 ^[8]	Submandibular space 24.59%	Klebsiella pneumoniae	24.59%	Amoxicillin Clavulanic acid	13.11%
Rakesh BS 2021 ^[9]	Ludwig's angina	Streptococcus spp	47.05%	Penicillin G	31.2%
Ruby J Richardson 2024 ^[10]	Ludwig's angina	Streptococcus spp	12.57%	Penicillin	64.3% 60.9%

				Amoxicillin/Clavunate Clindamycin	13.6%
Shinnosuke Fukushima 2020 ^[11]	Submandibular Submental Parapharyngeal space	Streptococcus spp	---	Ampicillin Penicillin Ampicillin/Sublactam Cefotiam Cefotaxime	---
Tejashree R 2020 ^[12]	Dentoalveolar abscess	Peptostreptococcus Peptococcus	26.72% 22.41%	Metronidazole Amoxicillin/Clavulanic acid	100% 95%
WJ Zhang 2010 ^[13]	Cervical necrotizing fasciitis	MRSA	---	All Antibiotics except Vancomycin	---

DISCUSSION

Odontogenic infections are common in the head and neck region, most often arising from dental caries and its sequelae. These infections typically originate from pulp and periapical diseases, periodontal diseases, pericoronitis, or because of complications arising from dental procedures.^[7]

Odontogenic infections may be classified as either localized or disseminated. Typically, localized infections can be effectively treated in a chair-side setting. In contrast, disseminated infections spread into fascial spaces, resulting in severe infections that can lead to life-threatening complications such as respiratory obstruction, with a mortality rate ranging from 10% to 40%.^[14] The spread of odontogenic infections can be reduced by employing adjunct antimicrobial therapy, which aids in preventing the advancement to suppuration. The use of antibiotics is especially vital for patients with uncontrolled diabetes.^[15]

The prompt intervention of antibiotics diminishes the complications associated with suppuration and the spread of odontogenic infections. Additionally, it aids in avoiding hospitalization which is cost-effective, and has minimal adverse effects.^[16] Fascial space infections represent a serious type of odontogenic infection that typically arises from neglected infections, delays in obtaining treatment, or underlying health issues such as diabetes mellitus.^[17] The administration of antibiotics for odontogenic infections can lead to antibiotic resistance, which may hinder infection control and result in complications that necessitate hospitalization.^[18]

Bacteria, in their effort to evade the harmful effects of antibiotics, undergo changes that reduce their vulnerability to damage. These adaptations include the modification of the antibiotic, alterations in the permeability of the bacterial cell membrane, and an increase in the concentration of antagonistic metabolites, among others, which contribute to the bacteria's resistance to antibiotics.^[19]

Confronting the detrimental consequences of antibiotic resistance in odontogenic infections, particularly its effect on treatment approaches. Furthermore, the management of patients with diabetes is notably affected. However, research specifically examining antibiotic resistance in odontogenic infections among diabetic patients remains scarce. Thus, the aim of the present scoping review was to explore the significant impact of diabetes mellitus on the susceptibility of individuals to anti-microbial resistance in odontogenic infections.

Odontogenic infections develop in three stages: inoculation, cellulitis, and abscess formation. These infections extend to the periapical region through the pulp chamber and subsequently spread to adjacent tissues. In the case of periapical infections involving mandibular molars, they can perforate the medial cortex of the mandible and spread to the sublingual space if the perforation occurs above the mylohyoid muscle. Conversely, if the perforation is below the mylohyoid muscle, the infection will spread to the submandibular space. When infections breach the lateral borders of the mandible, they can lead to

infections in the vestibular and buccal spaces, depending on the attachment of the buccinator muscle. Infections originating from mandibular third molars may directly spread to the pterygomandibular space, lateral pharyngeal space, retropharyngeal space, the danger space, and ultimately into the mediastinum.^[17] Disseminated infections can either affect one space or several spaces. The buccal space is most often involved in single space infections, while the submandibular space is generally involved when multiple spaces are affected including Ludwig's angina. Flynn TR et al 2006 presented a scoring system to assess the risk to the airway based on the extent of the infection.^[20] The number of spaces involved were individually scored and then the sum was given.

- Score 1 Low risk spaces- vestibular, subperiosteal, infra orbital, buccal space
- Score 2 Medium risk spaces- Submental, submandibular, sublingual, pterygomandibular space, submassetric space, superficial temporal and deep temporal space
- Score 3 High risk spaces- Lateral pharyngeal, retropharyngeal, pretracheal, danger space, mediastinum, intracranial space

Most studies included in this scoping review indicated the involvement of various spaces following odontogenic infections. Of these some studies and case reports referred space infections vaguely as deep neck infections without specifying the spaces affected. Similarly, the submandibular space was frequently noted as the affected area, particularly in cases of Ludwig's angina, which signifies the involvement of the submandibular space along with the submental and sublingual spaces.

In 2022, Timothy Neal and his team carried out two retrospective studies using Flynn's scoring system and found that a severity score of ≥ 5 was associated with increased hospital expenses, more comprehensive post-operative care and the use of opioid medications. The main factor contributing to the spread of odontogenic infections is immunosuppression, especially in those with diabetes. Other contributing factors include obesity, substance abuse, tobacco use, alcohol misuse, and malnutrition. Individuals with diabetes are at a higher risk for infections due to impaired cytokine production, leukocyte recruitment, and leukocyte functionality. This vulnerability to infections is further intensified in patients with poorly controlled diabetes.^[17] Numerous past studies have shown that the microbial flora involved in odontogenic infections is typically diverse, consisting of a polymicrobial community of both aerobic and anaerobic bacteria.^[21,22]

Most odontogenic infections are primarily caused by bacteria, resulting from disturbances in the normal oral flora or the migration of these microorganisms to atypical locations.^[23] Streptococci were the main bacteria responsible for odontogenic infections in both diabetics and non-diabetics. Streptococcus anginosus is an aggressive pathogen that produces bacteriocin known as angicin which enhances membrane permeability and enables compartmental abscess formation in periapical area leading to rapid and aggressive progression.^[24] Streptococcus viridians was the most common bacteria among non-diabetics whereas Klebsiella was the common organism found in diabetics.^[25,26]

In 1974, Sabiston reported that over 65% of the bacteria isolated were anaerobes, which tend to be more virulent and exhibit resistance to antimicrobial agents.^[27] It has been unveiled that aerobic bacteria typically trigger odontogenic infections and establish a conducive environment for anaerobic bacteria to flourish as the infection progresses to a chronic state.^[28]

Rega et al 2006 in their study found that 2:1 anaerobic and aerobic species and suggested that predominance of anaerobic bacteria could be due to delay in treatment which leads to replacement of aerobic organisms by anaerobic following consumption of oxygen.^[29]

A case report by WJ Zhang in 2010 highlighted necrotizing fasciitis resulting from pericoronitis caused by MRSA. This may explain the ineffectiveness of the initially prescribed antibiotic, ultimately leading to the development of necrotizing fasciitis. Therefore, the selection of antibiotics should specifically target MRSA, as demonstrated in WJ Zhang's 2010 study, where MRSA was only susceptible to vancomycin and showed resistance to all other antibiotics.^[13] Typically, MRSA infections are treated with antibiotics such as vancomycin, teicoplanin, or daptomycin, particularly in severe cases. Recent studies have also explored alternative treatments for MRSA, discovering that certain plant extracts exhibit effectiveness against this bacterium.^[30]

The predominant microorganisms in odontogenic infections include Streptococcus and Staphylococcus, with aerobic Streptococcus species being more prevalent in the initial stages. As the infection advances, the microbial flora shifts to anaerobic species such as Klebsiella, Fusobacterium, Prevotella, and Peptostreptococcus, among others.^[31]In their 2019 study, Asif et al. discovered that Staphylococci were the most prevalent bacteria, followed by Klebsiella, Enterococcus, Streptococci, Pseudomonas, Fusobacterium, and Actinomycetes.^[32]Tejashree et al. (2020) found that the prevalent bacterial isolates in non-diabetic patients included Peptostreptococcus, Peptococcus, Fusobacterium, Prevotella, and Bacteroides. In contrast, the common bacterial isolates in diabetic patients were Peptostreptococcus, Fusobacterium, Peptococcus, Prevotella, and Bacteroides. Additionally, they demonstrated that diabetic patients had a higher number of isolates per specimen compared to non-diabetic patients, which was statistically significant.^[33]About 5% of odontogenic infections are attributed to aerobic bacteria, while 35% result from anaerobic bacteria, and the remaining 60% are caused by a combination of both aerobes and anaerobes. The microbial flora associated with odontogenic infections varies between diabetic and non-diabetic individuals.^[34]

AL Farhan et al 2019 revealed that the frequency of bacterial flora in diabetes seen is lesser isolates of Gram positive bacteria and increase in Gram negative bacteria.^[35]Diabetes increases the risk of bacterial infections and their associated complications. Concurrently, chronic odontogenic infections like periodontitis and periapical pathologies worsen insulin resistance and disrupt blood sugar control, illustrating a reciprocal link between bacterial infections and diabetes.^[36]Uncontrolled diabetes is considered immunocompromised due to negative effects of hyperglycemic environment that favours immune dysfunction such as damage to neutrophil function, impairment of antioxidant system and humoral immunity. Hyperglycemia causes increased microbial virulence.^[37]Huang et al. 2005 discovered in their retrospective study that deep neck infections resulting from odontogenic sources were more prevalent in individuals with diabetes compared to non-diabetics. Additionally, a significant proportion of extensive space infections in diabetic patients suggests a compromised immune response that fails to contain the infection.^[38]

Bacteria that have developed resistance to antibiotics are known as superbugs, which are of significant concern. They create a substantial challenge in the management of infections that may result in life-threatening consequences. Antibiotic resistance can be classified into two categories: natural and acquired. Natural antibiotic resistance occurs due to genetically inherited characteristics within the same microbial species, whereas acquired antibiotic resistance emerges when microorganisms are exposed to high levels of antibiotics.^[39]

A systematic scoping review conducted by Carlos M Adrila et al in 2022 indicated that the antibiotic exhibiting the highest level of resistance was penicillin, followed by amoxicillin, azithromycin, and metronidazole. The bacteria demonstrating the greatest antibiotic resistance included Staphylococcus, Streptococcus spp., Peptostreptococcus spp., Bacteroides spp., and Prevotella spp. Among the aerobic and facultative anaerobes, *S. aureus*, *S. viridians*, *S. milleri*, *Klebsiellapneumoniae*, and *Enterococcus* spp. were predominant. The levels of antibiotic resistance among these organisms varied significantly across different antibiotics.^[40]

Dipesh Rao in 2010 introduced metrogyl along with amoxicillin and clavulanic acid especially when there was a history of previous use of antibiotics based on the past studies which suggested that addition of metronidazole to amoxicillin is one of the most effective regimens. The recommended antibiotic regimen along with hyperglycemia control is an effective way for control of odontogenic infections in diabetics.^[5]Inderdeep Walia et al 2014 showed that resistance to penicillin was commonly seen in their study to Gram positive bacteria.^[6]Marcelo Guzman-Letelier 2017 in their case report found that oral amoxicillin and clavulanic acid had very limited response thus replaced with IV tigecycline after MRSA was found on culture and sensitivity.^[7]Wang Zhang et al 2010 found MRSA to be associated with necrotizing fasciitis arising from pericoronitis and was found to be resistant to all antibiotics except vancomycin.^[13]

The systematic review by Cuevas- Gonzalves et al 2020 concluded that the main bacteria was associated with antibiotic resistance to ceftriaxone, penicillin, clindamycin and amoxicillin. The highest resistance

was seen towards penicillin as they are the commonly used antibiotics for β lactamase producing organisms, common causative organisms of odontogenic infections. They opined that antibiotic resistance was due to intrinsic reason- mutation in 23S ribosomal gene that modifies the antibiotic binding sites.^[18] Neeraj Kumar et al 2022 conducted an observational study and noted that the most resistance to antibiotic was seen with cotrimoxazole followed by amoxicillin, erythromycin and azithromycin.^[41] Poveda Roda et al in their study showed resistance erythromycin, azithromycin and Mahella A et al study showed antibiotic resistance to azithromycin and amoxicillin.^[42]

The Streptococci have historically responded well to penicillin and ampicillin, but emerging resistance in the past ten years suggests the need for careful antibiotic selection in odontogenic fascial space abscess cases. However, they remain sensitive to 2nd, 3rd, 4th generation cephalosporins and would be a good alternative. The variation in oral flora may be due to the difference in the methods of collection of samples, generally swabbing methods are ideal for collection of aerobic and needle aspiration was better for anaerobic bacteria. Also, the antibiotic treatment received in dental clinics before visiting tertiary hospital may be a compounding factor for change or decrease in flora. *Klebsiella pneumoniae* spread to deeper tissues by direct extension and are commonly isolated in deep neck infection, necrotizing fasciitis especially in diabetics. They spread to deeper tissues by direct extension and possess multi drug resistance to cephalosporins, aminoglycosides, Fosfomycin, carbapenems. Thus, patients with *Klebsiella* are associated with increased hospital stay. *Klebsiella* are known to be sensitive to ciprofloxacin, cotrimoxazole and doxycycline.^[43] MRSA are resistant to most antibiotics but are sensitive to vancomycin, teicoplanin, or daptomycin.^[30]

A thorough knowledge of antibacterial flora in odontogenic infection and its change in the course of infection is very essential as it leads to the choice of empirical antibiotic to be selected until the culture and sensitivity results are obtained. Selection of inappropriate antibiotics leads to progression of infection into serious complications like respiratory difficulties, necrotizing fasciitis and even death. To avoid such complications empirical antibiotics are administered by clinicians. Moreover, the risk of infection spread is compounded in diabetics patients with odontogenic infections. This can be effectively countered by administering a broad-spectrum antibiotic to cover both aerobic and anaerobic bacteria. Along with administering antibiotics, glycemic control also forms an important component in the effective management of the infection. This scoping review is intended to help the clinicians in selection of antibiotics in patients with odontogenic infections.

LIMITATIONS

Though there are research work on antibiotic resistance in odontogenic infections but its effect on diabetics remains unexplored thus we could find only 9 articles in this regard which included case reports, prospective and retrospective study. The bacteria obtained in each of the study reviewed were polymicrobial, this could be due to lack of standardization of specimen collection, study protocol and antibiotic used. All of which can be overcome by conducting studies with same protocols. All these limitations can be avoided by conducting original research, randomized control trial on this topic. Prospective studies yield better results than retrospective studies as the risk of missing detail always exist with retrospective studies further highlighting the importance of prospective study and randomized control trials.

CONCLUSION

Diabetes greatly heightens the risk and severity of odontogenic infections, while also playing a role in antibiotic resistance along with multidrug resistance. The odontogenic infections are usually comprised of polymicrobial flora however, a predominance of anaerobic bacteria are seen in diabetics. The life-threatening complications that arise from antibiotic resistance in diabetics can be avoided with proper knowledge of the microbial flora, change in its microbiota and its sensitivity as well as resistance to antibiotics. Proper selection of antibiotics along with glycemic control establish successful management preventing complications.

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