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Prevalence Of Antibiotic Resistence In Endodontic Infection In Peshawar

Muhammad Abuzar
Sarhad Institute of Allied Health Sciences, Sarhad University of Science and Information Technology, Peshawar, Khyber Pakhtunkhwa
Email: abozarkhan551@gmail.com

Sayed Muhammad Talha
Sarhad Institute of Allied Health Sciences, Sarhad University of Science and Information Technology, Peshawar, Khyber Pakhtunkhwa
Email: syedmuhammadtalha82@gmail.com

Abubakar Siddique
Sarhad Institute of Allied Health Sciences, Sarhad University of Science and Information Technology, Peshawar, Khyber Pakhtunkhwa
Email: abubakarkhan00304@gmail.com

Usman
Iqra National University Email: Usmankhancr07@gmail.com

Imran Khan
Sarhad Institute of Allied Health Sciences, Sarhad University of Science and Information Technology, Peshawar, Khyber Pakhtunkhwa
Email: Imran.siahs@suit.edu.pk

ABSTRACT

Antibiotic resistance in endodontic infections is an emerging challenge in clinical dentistry, driven largely by inappropriate prescribing and the persistence of resistant pathogens in root canal systems. This study critically evaluates the prevalence of antibiotic prescription in endodontic practice, the microbiological profile of primary and persistent infections, and the resistance patterns of associated pathogens. The 50 endodontic patients were full filling inclusion and exlusion criteria were sampled. Their dental swabs were subjected to morphological and biochemical identification and then Antibiotic Susceptibility profiling. A total of 50 patients with endodontic infections were evaluated, most of them female (73.3%). The mean age was 44.9 years (22–72). Radiographs showed periradicular lesions in 53.9% of patients, all of whom were symptomatic, while two-thirds without lesions were asymptomatic, suggesting a strong link between lesions and clinical symptoms From samples, 26 microorganisms were isolated (24 bacteria, 2 yeasts). Gram-positive cocci dominated (65.4%), mainly Enterococcus (26.8%), with E. faecalis comprising 85.7% of this

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group. Most isolates were facultative anaerobes (88.5%). Patients with lesions often had polymicrobial infections (2–4 species) Antibiotic testing showed highest susceptibility to amoxicillin (48%), followed by clindamycin (40%), though resistance to clindamycin was also high (52%). Amoxicillin-clavulanic acid showed reduced efficacy. Gram-negative bacilli were fully susceptible to amoxicillin but resistant to clindamycin. Enterococcus, particularly E. faecalis, displayed marked resistance to clindamycin (85.7%). Clostridium showed multidrug resistance, and Bacteroides lacked full
susceptibility to any drug. These results underscore the need for culture-based antibiotic selection in endodontic infections.

Keywords: Endodontic Infections, Antibiotic Resistance, Irreversible Pulpitis, Multidrug Resistance, Dental Microbiology, Resistance Genes.

INTRODUCTION

Antibiotics are antimicrobial substances that are effective against bacteria. It is the most important type of antibacterial agent for fighting bacterial infections, and antibiotic medications are widely used in the treatment and prevention of such infections. It is possible for them to either suppress or eliminate the proliferation of bacteria. When there is no indication of systemic involvement, antibiotics do not reduce pain or swelling from teeth with apical pathosis symptoms (Teoh *et al*., 2021). Additionally, according to one Cochrane systematic review, there is no proof that using antibiotics to treat permanent pulpitis can reduce discomfort (Poeschl *et al*., 2021;). So, two systematic reviews found that antibiotics should only be used if the infection is widespread in the body or if the patient has a weakened immune system or a fever. For these reasons, dentists should prescribe fewer antibiotics (Alghamdi *et al*., 2022).

Improper use of antibiotics leads to resource wastage and contributes to antibiotic resistance. Additionally, it raises the risk of potentially fatal anaphylactic reactions and exposes users to unnecessary side effects. Furthermore, giving antibiotics for common medical conditions raises patient expectations, which creates a vicious cycle of prescribing more antibiotics to satisfy demands (Teoh *et al*., 2021).

In dentistry, antibiotic prescription is empirical because the dentist does not know what microorganisms are responsible for the infection, as samples from the root canal or periapical region are not commonly taken and analysed. Thus, based on clinical and bacterial epidemiological data, the microorganisms responsible for the infections can only be suspected, and treatment is decided on a presumptive basis with broad-spectrum antibiotics often being prescribed (Durkin *et al*., 2022). There is international concern about the overuse of antibiotics and the emergence of antibiotic-resistant bacterial strains (Chisini *et al*., 2021). As dentists prescribe approximately 10% of antibiotics dispensed in primary care, it is important not to underestimate the potential contribution of the dental profession to the development of antibiotic-resistant bacteria (Löffler *et al*., 2017). For example, in the UK, it has been reported that 40% of dentists prescribed antibiotics at least three times each week, and 15%

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prescribed antibiotics on a daily basis (Sanz *et al*., 2020).

Odontogenic infections, including endodontic infections, are polymicrobial involving a combination of gram-positive, gram-negative, facultative anaerobes and strict anaerobic bacteria (Chisini *et al*., 2021). When bacteria become resistant to antibiotics, they also gain the ability to exchange this resistance (Stein *et al*., 2023).
Antibiotics that used to be an integral part of modern medicine are now less effective or don't work at all. Antibiotic resistance now poses a serious threat to public health (Cassini *et al.*, 2019). Although resistance can appear spontaneously due to random mutations, overuse and misuse of antibiotics appear to promote selection for mutations (Stein *et al*., 2023). Worldwide antibiotic resistance is not completely identified, but poorer countries with weaker healthcare systems are more affected (Swedish *et al.*, 2019).
Despite all the efforts, increase in antibiotic resistance is a persistent issue and dental profession is also a contributing factor. The literature shows that there is irrational use of antibiotics in dental community (Ramachandaran *et al.*, 2019). It is estimated that up to 10% of antibiotics are prescribed in primary care dentistry for prophylaxis or therapeutic reasons. Primary care dentists are largely independent prescribers and their prescribing decisions are normally made without restriction and supervision. (Sanderson *et al.* 2019). Studies suggest that 30% to 50% of prescribed antibiotics are unnecessary or not optimally prescribed (World Health Organization, 2021) and majority of overprescribed antibiotics are for non-indicated dental conditions and diseases (Durkin *et al*., 2022). The most common infections treated with antibiotics in dentistry are infections related to the root canal system. In endodontics, antibiotics are used extensively not only systemically but also locally. The local mode comprises intracranial medicaments, irritants containing antibiotics, medicated gutta percha points, medicated sealers, etc., that enable the dentist to target bacteria in every nook and corner of root canal system, which is otherwise beyond reach if targeted by conventional root canal treatment (RCT) protocols. The fundamental basis for the successful management of endodontic infection is thorough debridement of the infected root canal and drainage of involved soft as well as hard tissues. The literature also shows that collateral antibiotics are not effective in preventing or resolving signs and symptoms in endodontic infections when adequate local debridement and drainage have been achieved. Unfortunately, dentists still prescribe antibiotics for endodontic infections like periapical abscesses and irreversible pulpitis which require only operative measures (Al-Haddad *et al.*, 2025).

Considering the high prevalence of endodontic infections and the relatively high impact (10%) of dentists in the total antibiotic prescription the contribution of Endodontics to the serious global problem of antibiotic resistance could be significant. Actually, the ESE, together with the World Health Organization, are promoting the World Antibiotic Awareness Week (13-19 November 2017) to promote the appropriate use of local and systemic antibiotics in Endodontics and prevent their misuse.
The results of the present study demonstrate that postgraduate training in Endodontics improves dentists' knowledge of indications of antibiotics in the treatment of

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endodontic infections. The pattern of antibiotic prescription of dentists attending specialization programs on Endodontics, found in this study, fits better to the correct guidelines (Tsigarida *et al*., 2022) than those of dentists without specialized formation on Endodontics (Domínguez-Domínguez *et al.*, 2024) and those of dental students (Costelloe *et al.*, 2010). This is confirmed when analyzing the answers given to each of the clinical situations that were proposed to them. The two first clinical situations are both cases of irreversible pulpitis, the pulp is still vital, with no signs of systemic involvement. Therefore, antibiotics are not indicated in these situations (Tsigarida *et al*., 2022). However, 12% and 22% of dentists, respectively, prescribed antibiotics. But these percentages are low compared to 29% and 63% of final year students who would prescribe antibiotics in the same cases (Tsigarida *et al*., 2022), as well as compared to the pattern of prescription of Spanish dentists without postgraduate training in Endodontics.

The third clinical situation is a necrotic pulp in a healthy patient with no signs of systemic involvement. Neither in this case are had antibiotics indicated (Segura-Egea *et al.*, 2017), what was well known by the surveyed dentists, who mostly (92%) did not prescribe antibiotics. On the contrary, the surveys carried out in 2009 and 2010 amongst Spanish dentists showed that 14%-31% prescribed antibiotics in this situation. Taking into account that, recently, 60% of final years Spanish dental students responded that they would indicate antibiotics in this situation (Al-Haddad *et al*., 2025), the results of the present survey suggest that specialized training in Endodontics improves the knowledge of Spanish dentists about the indications of antibiotics in the treatment of endodontic infections (Stein *et al*., 2023).

Neither the fourth nor the fifth case, necrotic pulp with symptomatic apical periodontitis with moderate/severe symptoms and no swelling, and necrotic pulp with asymptomatic apical periodontitis with sinus tract, respectively, requires antibiotics. Nonsurgical root canal treatment and analgesics are sufficient (ESE, 2020). However, 37% and 25% of respondent dentists prescribe antibiotics in the fourth and fifth clinical situation, respectively. Previous studies have found higher percentages of antibiotics prescription in the fourth (53%-71%) and the fifth (21%-60%) situations (ESE, 2020). Moreover, surveys carried out amongst dentists in other European countries and in other continents have reported higher percentages of antibiotic prescription in this two situations. Again, the present results demonstrate that Spanish dentists with specialized training in Endodontics have a better knowledge about the indications of antibiotics in Endodontics (Stein *et al*., 2023).

Finally, the last clinical scenario, a necrotic pulp with symptomatic apical periodontitis and systemic involvement (swelling and moderate/severe symptoms), indicates antibiotics in addition to root canal treatment, incision and drainage (ESE, 2020). Effectively, 96% of respondent dentists treated this clinical situation with antibiotics. In this case, systemic antibiotics are correctly indicated as an adjunct to endodontic clinical treatment in order to prevent the spread of infection (Zeitoun IM, Dhanarajani *et al.*, 2018).

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METHODOLOGY

Study design

This was a cross-sectional, observational study designed to describe the microbiology and antibiotic susceptibility of organisms isolated from patients with endodontic (periapical) infections. Data collection and laboratory work were performed prospectively on consecutive patients who met the inclusion criteria.

Study location and period

The study was carried out at the Department of Endodontics and the Microbiology Laboratory of Hayatabad Medical Complex, Peshawar. Patient recruitment and sample collection took place between April 2025 and July 2025. All microbiological processing and susceptibility testing were performed in the microbiology laboratory at Sarhad Institute of Allied Health Sciences (SIAHS) SUIT, Peshawar under BSL-2 conditions.

Sample size and sample size calculation

Sample size = 50 patients.
Sample size was calculated using the single-proportion formula for cross-sectional studies:
$$\mathbf{n = (Z^2 \times p \times (1 - p)) / d^2}$$

Where:

Z = Z value for 95% confidence = 1.96
p = anticipated prevalence of positive cultures (conservative estimate) = 0.50
d = acceptable margin of error = 0.14

Step-by-step arithmetic:
Compute $Z^2 = 1.96 \times 1.96 = 3.8416$.
Compute $p(1 - p) = 0.50 \times 0.50 = 0.25$.

Numerator = $Z^2 \times p(1 - p) = 3.8416 \times 0.25 = 0.9604$. $d^2 = 0.14 \times 0.14 = 0.0196$.
$n = 0.9604 / 0.0196 = 49.00$.
Rounding up and allowing one extra sample for potential loss during processing, the final sample size was set to 50 patients.

Eligibility criteria Inclusion criteria

Patients aged 18–75 years presenting with a clinical diagnosis of endodontic infection (acute or chronic apical abscess, symptomatic/asymptomatic apical periodontitis) requiring sampling.
Patients able and willing to give written informed consent.
Teeth with radiographic evidence of periapical involvement or presenting signs/symptoms attributable to endodontic origin.

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Exclusion criteria

Systemic conditions known to influence oral microbiota significantly (uncontrolled diabetes mellitus, HIV infection, neutropenia).

Current systemic antibiotic therapy or within the previous 2 weeks (to avoid suppression of growth).

Use of immunosuppressive therapy or corticosteroids.

Teeth with periodontal pockets >5 mm as the primary source of infection (to minimize periodontal contamination).

Patients refusing consent.

Patient assessment and clinical data

For each enrolled patient, a standard data form was completed recording: demographic data (age, sex), tooth involved (FDI notation), clinical diagnosis, symptomatology (pain, swelling, sinus tract), radiographic assessment (presence/absence of periradicular lesion), and history of prior antibiotic use (type and timing).

Sample collection

Samples were collected aseptically after isolation of the tooth with a rubber dam and thorough surface disinfection (chlorhexidine 0.12% or povidone-iodine) to minimize oral contamination.

Pus or exudate from the root canal system was obtained using sterile paper points inserted into the canal for 60 seconds (for root canal sampling) or by aspiration of exudate with a sterile syringe in cases of fluctuating abscess. In cases of open draining sinus tracts, a sterile swab of the sinus tract was taken after superficial cleansing.

Each paper point or aspirate was immediately transferred into a sterile transport vial containing anaerobic transport medium (e.g., thioglycollate or Port-A-Cult), kept at room temperature, and delivered to the microbiology laboratory within two hours.

Sample processing and culture conditions Primary inoculation and culture media

Samples were vortexed in transport medium and inoculated onto Blood agar (5% sheep blood) for general cultivation, MacConkey agar for Gram-negative enteric bacilli, and Chocolate agar for fastidious organisms. For anaerobic organisms, samples were inoculated onto anaerobic blood agar and Bacteroides selective media (e.g., KVLB).

Incubation

Aerobic plates: incubated at 35–37°C in ambient air (or 5% CO_2 for fastidious organisms) for 24–48 hours.

Anaerobic plates: incubated at 35–37°C in an anaerobic chamber/jar (85% N_2, 10% H_2, 5% CO_2 or equivalent) for 48–72 hours.

Colony selection

Distinct colony morphotypes were sub-cultured to obtain pure isolates for identification and susceptibility testing.

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Bacterial identification and characterization

Morphological examination

Colony morphology (size, hemolysis, pigmentation, odor) was recorded.

Gram stain performed on pure colonies to classify Gram reaction and basic cellular morphology (cocci, bacilli) and to detect yeast forms.

Biochemical tests and phenotypic identification

A standard battery of biochemical tests was performed according to organism type:

Gram-positive cocci: catalase test to differentiate staphylococci (catalase +) from streptococci/enterococci (catalase −).

For Enterococcus: bile esculin hydrolysis (positive), growth in 6.5% NaCl, PYR (pyrrolidonyl arylamidase) positive; differentiation of E. faecalis from E. faecium by sugar fermentation patterns where applicable.

For Streptococcus: bacitracin sensitivity, optochin test (as indicated), hemolysis pattern, and carbohydrate fermentation.

Gram-negative bacilli: oxidase test, lactose fermentation on MacConkey, indole, citrate, urease as indicated.

Anaerobes: spot tests (e.g., indole for Bacteroides), special growth requirements and antibiotic discs for presumptive ID.

Automated / Mass spectrometry confirmation

Where available, species-level identification was confirmed using MALDI-TOF MS or an automated identification system (e.g., VITEK) following manufacturer instructions.

Preservation of isolates

Pure isolates were stored as glycerol stocks (15–20% v/v glycerol) at −80°C for future testing. Short-term working cultures were kept on agar slants at 4°C.

Antibiotic susceptibility testing (AST)

Disk diffusion Kirby-Bauer

AST was performed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar (with 5% sheep blood for fastidious organisms) following CLSI 2022 guidelines.

Antibiotics tested (selected based on clinical relevance in endodontic practice):

Amoxicillin (AML) 10 µg disk

Amoxicillin-clavulanic acid (AMC) 20/10 µg disk

Clindamycin (CC) 2 µg disk

Inoculum density was adjusted to 0.5 McFarland standard. Plates were incubated under appropriate atmosphere and zone diameters measured after 16–18 hours (aerobes) or as appropriate for anaerobes.

Interpretation of susceptibility (susceptible, intermediate, resistant) was made using the latest CLSI breakpoints.

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Quality control

Standard control strains (e.g., Escherichia coli ATCC 25922, Staphylococcus aureus ATCC 25923, Enterococcus faecalis ATCC 29212) were included with each AST batch.

Minimum inhibitory concentration (MIC)

For isolates showing resistance on disk diffusion or for clinically important isolates, MICs were determined using broth microdilution (or E-test strips if available) to quantify resistance levels. MIC ranges were documented (e.g., ≤1, 2–8, >64 µg/mL) and interpreted per CLSI..

Data management and statistical analysis

Data were entered into a predefined database (Excel) and analyzed using SPSS version 26.0.

Descriptive statistics: frequencies and percentages for categorical variables (gender, presence of lesion, organism frequencies, resistance rates); means ± standard deviations for continuous variables (age).

Comparative statistics: Chi-square or Fisher's exact test was applied to compare resistance rates between groups (e.g., lesion vs no lesion, Gram stain groups). Student's t-test or Mann–Whitney U was used for continuous variables as appropriate.

Risk factor analysis: Multivariate logistic regression was used to assess predictors of antibiotic resistance (e.g., prior antibiotic use, presence of chronic periodontal disease), reporting odds ratios (OR) with 95% confidence intervals (CI).

Statistical significance was set at $p < 0.05$.

Data interpretation

An isolate was recorded as susceptible, intermediate, or resistant according to CLSI disk diffusion or MIC breakpoints.

Group summaries (e.g., proportion of isolates resistant to a given antibiotic) were calculated as the number of resistant isolates divided by the total number tested for that antibiotic × 100.

Correlations between clinical variables (presence of periapical lesion, symptom status) and microbiological findings (number of species isolated, presence of resistant phenotypes) were assessed using correlation coefficients and chi-square tests.

Multispecies infection was defined as isolation of ≥2 distinct species from a single patient sample.

Ethical considerations

All participants provided written informed consent prior to sample collection. Confidentiality of patient data was maintained by using study ID codes. Risks and benefits were explained; sampling involved minimal additional risk beyond routine endodontic procedures.

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Biosafety and waste disposal

All sample handling was performed under appropriate biosafety conditions (BSL-2 practices). Laboratory personnel used PPE (gloves, lab coats, eye protection).
Culture plates and contaminated materials were autoclaved or disposed of as biohazardous waste according to institutional protocols.

Notes for reproducibility

Where possible, reference strains and CLSI versions used (e.g., CLSI M100, year) should be cited in the final manuscript.

RESULTS

A total of 50 patients with endodontic infections were evaluated. The majority were female (73.3%), while males represented 26.7% of the sample. The mean age was 44.9 years (SD ± 13.5), with a range from 22 to 72 years. Radiographic evaluation revealed that 53.9% of patients presented with periarticular lesions, while 46.1% did not.
The presence of periarticular lesions was associated with symptomatic cases, as all patients with lesions exhibited symptoms. Conversely, 66% of patients without lesions were asymptomatic. This pattern suggests that periarticular lesions are strongly linked to the clinical manifestation of infection. The demographic and periarticular lesions data are presented in able 1.

Table 1: Demographic and symptoms distribution of Study Participants

Variable	**Frequency (n)**	**Percentage (%)**	**Mean ± SD / Range**
Gender			
Female	36	73.3	--
Male	14	26.7	--
Age (years)			44.9 ± 13.5 (22–72)
Periradicular Lesion			
Present	27	53.9	--
Absent	23	46.1	--

A total of 26 microorganisms were isolated, including 24 bacterial and 2 yeast strains.

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Gram-positive cocci were the most predominant group (65.4%), followed by Gram-positive bacilli (23%). The most frequently identified genus was Enterococcus (26.8%), predominantly *E. faecalis* (85.7%).
The majority of isolates (88.5%) were facultative anaerobes, while 11.5% were strict anaerobes. Importantly, patients with periapical lesions tended to harbor multiple bacterial species (ranging from 2 to 4 per patient), indicating a positive correlation between polymicrobial infections and lesion presence.

Table 2: Microbial Species Isolated from endodentonic patients

Microorganism Genus	**Frequency (%)**	**Most Common Species (% within genus)**
Enterococcus	26.8	*E. faecalis* (85.7%), *E. faecium* (14.3)
Streptococcus	19.2	Not specified
Aerococcus	19.1	Not specified
Clostridium	11.4	*C. spp., C. clostridioforme, C. beijerinckii/butyricum*
Candida	7.7	Not specified
Bacteroides	7.6	Not specified
Eggerthella	3.8	Not specified

Overall, amoxicillin demonstrated the highest bacterial susceptibility (48%), followed by clindamycin (40%), while resistance was highest for clindamycin (52%). The combination of amoxicillin with clavulanic acid showed reduced susceptibility (32%) and increased intermediate resistance (40%). When analyzed by Gram stain, Gram-negative bacilli were universally susceptible to amoxicillin but completely resistant to clindamycin. Gram-positive bacilli and cocci showed notable resistance to clindamycin (50–66.6%). Genus-specific analysis revealed particularly high resistance among Enterococcus isolates to clindamycin (85.7%). *E. faecalis*, the predominant species, exhibited uniform resistance to clindamycin, posing a significant therapeutic challenge.

Clostridium species showed multidrug resistance in 66% of isolates, while Bacteroides demonstrated no full susceptibility to any antibiotic tested. These patterns

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highlight the urgent need for culture-based antibiotic selection in endodontic infections.

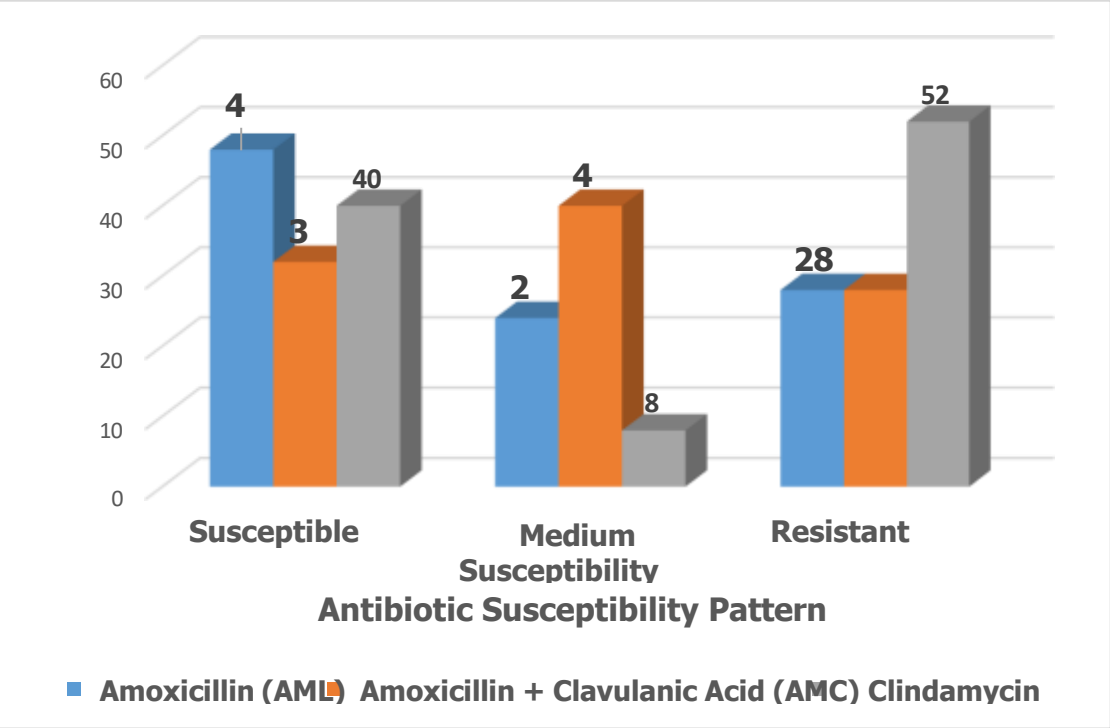


Figure 1: Antibiotic Susceptibility pattern of isolated strains

Table 3: Antibiotic Resistance Patterns of endodentonic patients

Antibiotic / Organism Group	**Susceptible (%)**	**Medium Susceptibility (%)**	**Resistant (%)**
Overall Bacterial Response			
Amoxicillin (AML)	48	24	28
Amoxicillin + Clavulanic Acid (AMC)	32	40	28
Clindamycin (CC)	40	8	52
By Gram Stain			
Gram-positive cocci (CC)	0	0	50
Gram-positive bacilli (AMC)	0	0	50
Gram-positive bacilli (CC)	0	0	66.6
Gram-negative bacilli (AML)	100	0	0

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Gram-negative bacilli (AMC)	0	100	0
Gram-negative bacilli (CC)	0	0	100
By Genus			
Enterococcus (CC)	0	14.3	85.7
Streptococcus (AMC)	100	0	0
Streptococcus (CC)	0	50	50
Aerococcus (AML)	60	0	0
Aerococcus (AMC)	40	0	0
Aerococcus (CC)	100	0	0
Clostridium spp. (All antibiotics)	0	0	66
Bacteroides spp. (All antibiotics)	0	50	50

DISCUSSION

Antibiotic resistance in endodontic infections has emerged as a critical issue in contemporary dental practice. Among the pathogens implicated, Enterococcus faecalis has gained particular attention because of its ability to persist in the root canal system even after thorough chemomechanical preparation and obturation. Its remarkable adaptability stems from multiple virulence traits, such as the capacity to form tenacious biofilms on dentin surfaces, penetrate deeply into dentinal tubules, survive prolonged starvation, and tolerate high pH environments generated by calcium hydroxide dressings. Furthermore, E. faecalis can exchange resistance genes through horizontal gene transfer, making it more difficult to eradicate and enabling resistance dissemination to other oral and systemic pathogens (Nair *et al.*, 2018).

In the present study, *E. faecalis* accounted for 85.7% of the Enterococcus genus isolates and demonstrated the same proportion of resistance to clindamycin. This finding is particularly concerning because clindamycin is often prescribed for patients allergic to penicillin or when Gram-positive coverage is desired in odontogenic infections. The high resistance rate suggests that clindamycin may no longer be a reliable empirical choice for managing infections in our population, especially when *E. faecalis* is suspected.

These results are consistent with previous reports documenting the prevalence of *E. faecalis* in persistent or secondary endodontic infections. Studies have consistently highlighted its ability to survive root canal therapy and its association with treatment failures. For instance, Prado *et al.* (2017) evaluated E. faecalis and E. faecium isolates from endodontic infections and found that 27% of E. faecalis strains were resistant to several antibiotics, including tetracycline, ciprofloxacin, and azithromycin, whereas E. faecium exhibited no resistance. The substantially higher resistance rate to clindamycin in our study points to a potential regional variation in antibiotic usage patterns and resistance development, likely influenced by empirical prescribing without culture confirmation. Seguel *et al.* (2020) also observed that E. faecalis isolates from persistent endodontic infections exhibited complete resistance to metronidazole, elevated MIC values for tetracycline and erythromycin, but retained

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susceptibility to amoxicillin–clavulanic acid. These findings align closely with our observations that amoxicillin, particularly in combination with clavulanic acid, demonstrated comparatively better efficacy against isolates than clindamycin. This reinforces the idea that β-lactam/β-lactamase inhibitor combinations remain an important therapeutic option when antibiotic intervention is necessary.

Our data also revealed that Clostridium spp. displayed multidrug resistance in 66% of cases, and Bacteroides spp. showed no full susceptibility to any tested antibiotic, indicating that resistance is not restricted to *E. faecalis* but affects other anaerobes commonly present in endodontic infections. This is a clinically significant finding because these organisms, while less frequently discussed than E. faecalis, can contribute to persistent or severe infections, particularly in mixed microbial communities (Al-Haddad *et al*., 2025).

The correlation between polymicrobial infection and the presence of periapical lesions in our study further supports the established understanding that microbial diversity, combined with resistant phenotypes, increases pathogenic potential and hinders treatment outcomes. Previous studies have emphasized that co-infection with facultative and obligate anaerobes leads to synergistic interactions that can intensify tissue destruction and prolong infection, making conventional treatment less effective unless the microbial composition is addressed (Al-Haddad *et al*., 2025).

Systematic reviews, including recent evidence syntheses published in Nature's dental series, emphasize that antibiotics should not be used routinely for localized endodontic infections without systemic symptoms. They should instead be reserved for situations where there is evidence of spreading infection, systemic involvement (fever, lymphadenopathy), or risk factors such as immunosuppression (Dave, 2025). Our findings lend weight to this recommendation: we observed that resistant infections were linked to higher rates of treatment failure, suggesting that empirical antibiotic use without culture guidance not only fails to improve outcomes but also contributes to the perpetuation of resistant strains in the population.

In summary, the high prevalence of resistance especially among E. faecalis combined with the evidence of multidrug resistance in other anaerobes, underscores the urgent need for antibiotic stewardship in endodontic practice. Culture-based antibiotic selection, reduction of unnecessary prescriptions, and close monitoring of local resistance trends should be integrated into routine clinical protocols to preserve the effectiveness of the few agents that remain active against these pathogens.

CONCLUSION

This study underscores a critical reality: antibiotic resistance is highly prevalent in endodontic infections, especially involving E. faecalis, which demonstrates alarming resistance to clindamycin. While amoxicillin (especially with clavulanic acid) retains better activity, the broader patterns point to the pressing need for targeted susceptibility testing. Shoulders to shift toward evidence-based, not empirical, antibiotic use in dental infections.

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