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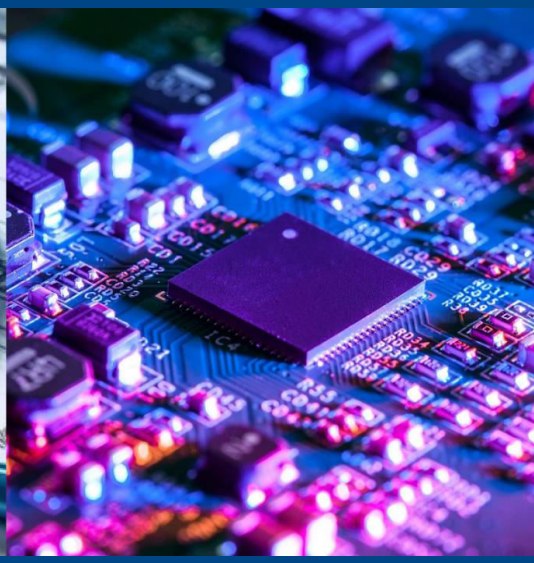

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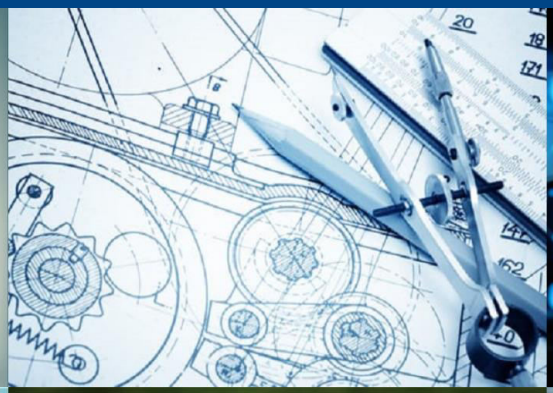

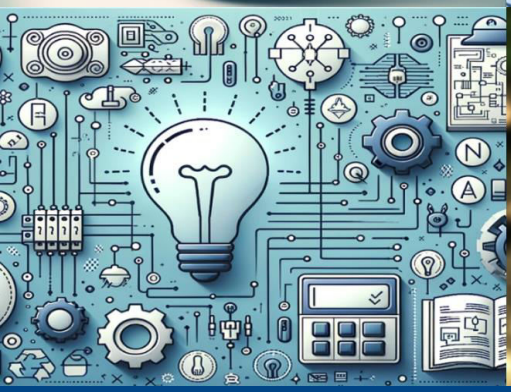

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The Antibiotic Conundrum: Navigating Endodontic Applications

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ABSTRACT: Antibiotics play a pivotal role in managing endodontic infections, particularly in cases where systemic involvement necessitates adjunctive pharmacological intervention. This article critically examines the indications, mechanisms, and limitations of antibiotic use in endodontics, emphasizing evidence-based clinical guidelines. The discussion includes the differentiation between localized and systemic infections, appropriate antibiotic regimens, and the implications of improper prescribing practices. The growing threat of antimicrobial resistance is analyzed in the context of endodontic therapy, underscoring the need for a conservative and targeted approach to antibiotic use.

KEYWORDS: antibiotics, antibiotic prophylaxis, endodontic infections, local uses , systemic use

I. INTRODUCTION

Antibiotics play a crucial role in modern medicine, serving as an effective means to combat bacterial infections. In endodontics, they are commonly used alongside clinical procedures to help manage infections of endodontic origin. However, their use remains a subject of debate due to concerns about overprescription, potential adverse effects, and the increasing issue of antibiotic resistance worldwide. Since endodontic infections are typically polymicrobial, localized treatment is often the preferred approach, with systemic antibiotics reserved for specific cases, such as when an infection spreads or involves systemic complications. This article examines the complex role of antibiotics in endodontic treatment, highlighting evidence-based guidelines, proper prescribing practices, and alternative strategies to reduce dependence on systemic antibiotics. A comprehensive understanding of when antibiotics are indicated, when they should be avoided, and the emerging challenges in their use is essential to enhance patient care while protecting public health.

II. SYSTEMIC ANTIBIOTIC THERAPY

The systemic treatment of endodontic infections relies on antimicrobial pharmacotherapy. Often referred to as "magic bullets," antibiotics have transformed healthcare since Alexander Fleming discovered penicillin in 1928[6]. In 1951, Grossman introduced polyantibiotic paste (PBSC), a combination of penicillin, bacitracin, streptomycin, and caprylate sodium, marking the first reported local application of antibiotics in endodontics. While PBSC demonstrated some therapeutic benefits, it was ineffective against anaerobic bacteria and carried a risk of allergic reactions. As a result, the U.S. Food and Drug Administration (FDA) banned its use in endodontics in 1975. Later, a modified version, PBSN, replaced caprylate sodium with the antifungal agent nystatin.

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Antibiotic therapy in endodontics can serve both therapeutic and curative purposes. Infections may be treated using either systemic or localized antibiotic administration, but prescriptions should always be based on a justified need. In most cases, if the primary cause of infection is adequately addressed, systemic antibiotics are unnecessary.

A. Indications of antibiotic therapy in Endodontics (Fig. 1)[8]

Pain Without Signs and Symptoms of Infection
• Symptomatic irreversible pulpitis
• Symptomatic apical periodontitis (Pain to percussion and biting)
Teeth with Necrotic Pulps and a Radiolucency
Teeth with a Sinus Tract/Parulis (Chronic Apical Abscess)
Acute Apical Abscess in Immunocompetent Patients *(When same visit treatment is an option)*
• Localized fluctuant swellings

B. Conditions NOT requiring antibiotics (Fig: 2)[8]

Acute Apical Abscess in Immunocompromised Patients
• Localized fluctuant swellings
• Patient with systemic disease causing impaired immunologic function
Acute Apical Abscess in Immunocompetent Patients *(When same visit treatment is not an option)*
• Localized fluctuant swellings
Acute Apical Abscess with Systemic Involvement
• Elevated body temperature >100°F
• Malaise
• Unexplained trismus
• Lymphadenopathy
Progressive Infections
• Rapid onset of swelling <24hrs
• Cellulitis or a spreading infection
• Osteomyelitis
Persistent Infection
• Chronic exudation, which is not resolved by regular intracanal procedures and medications

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In clinical practice, drainage may not always be possible; therefore therapeutic antimicrobials can be given as an adjunct to operative treatment and as contingency treatment.

(i) Adjunct to operative treatment:
Most endodontic infections are treated with early drainage and removal of the etiology either by the debridement of the infected root canal system or surgical removal of extra-radicular infection[9]. But in some cases, for example, acute dento-alveolar infection and in cases of systemic involvement with malaise, an elevated body temperature and in immunocompromised patient antibiotics may be indicated along with the operative procedures because there is a diffuse spreading infection or evidence of systemic involvement[9]. In these conditions antibiotics are not an alternative to dental intervention; they are an adjunct to it.

(ii) Contingency treatment:
It is indicated in cases where drainage or removal of the cause of infection by operative treatment is not possible. Therefore, therapeutic antibiotics are prescribed before definitive treatment. The principal purposes of prescribing antibiotic therapy are to limit the local spread of infection, treat systemic disease, and bring about symptomatic relief.[6] However, contingency treatment is not a definitive treatment and should not be considered as an alternative to operative intervention.

Table 1.1: Commonly used antibiotics in Odontogenic infections

DRUGS	POSOLOGY	SIDE EFFECTS
PENICILLIN Penicillin VK	500mg (every 4-6 hours)	Hypersensitivity reactions, gastric alterations
Amoxicillin	500mg (every 8 hours) or 3 g amoxicillin repeated after 8 hours	Diarrhea, nausea, hypersensitivity reactions
Amoxicillin with clavulanate (Co-Amoxiclav)	250/150mg 2 times a day	Diarrhea, nausea, candidiasis, hypersensitivity reactions
CLINDAMYCIN	300mg (every six hours)	Pseudomembranous colitis, Sweet's syndrome and neutropenia
METRONIDAZOLE	500mg (every six hours)	Seizures, anesthesia or paresthesia of the limbs, incompatible with alcohol ingestion
TETRACYCLINE Doxycycline	200mg (every 12 hours)	Tetracycline staining, phototoxicity
MACROLIDES Erythromycin Clarithromycin	250mg (every 12 hours) 250mg (every 12 hours)	Gastrointestinal disorders
QUINILONE Ciprofloxacin	500 mg every 12 hours	Gastrointestinal disorders

III. ANTIBIOTIC PROPHYLAXIS IN ENDODONTICS

Antibiotic prophylaxis in endodontics is prescribed to prevent the infection. The dental procedures that present an infection risk require an appropriate anti-microbial regime. Antibiotics are administered preoperatively to provide adequate tissue concentrations at the time of operation.[10] The most effective use of prophylactic antibiotics is in short-term, high-dosage regimens that are active against the common pathogens. According to ADA, recommendations for antibiotic prophylaxis before dental procedures include **only for patients at the highest risk for adverse outcomes from infective endocarditis[10]:**

1. Prosthetic heart valve
2. Previous infective endocarditis
3. Congenital heart disease (CHD)

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4. Unrepaired cyanotic CHD, including palliative shunts and conduits
5. Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or catheter, during the first six months after the procedure
6. Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device
7. Cardiac transplantation recipients who develop cardiac valvulopathy

All dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa (does not include routine local anesthetic injections through non-infected tissue). The antibiotic regimes that may be used for prophylaxis are given in Table 1.2[10].

Table 1.2: Antibiotic prophylaxis for dental procedures

Standard oral regimen	**Adults**: 2.0g Amoxicillin **Children**: 50mg/kg
Alternative oral regimen for patients allergic to penicillin or patients who are currently taking a penicillin class antibiotic	**Adults**: 2.0g Cephalexin or other 1st or 2nd generation cephalosporin in equivalent dosage OR 600mg Clindamycin OR 500mg Azithromycin or clarithromycin **Children**: 50mg/kg Cephalexin or other 1st or 2nd generation cephalosporin in equivalent dosage OR 20mg/kg Clindamycin OR 15mg/kg Azithromycin or clarithromycin
Patients unable to take oral medications	**Adults**: 2.0g IM or IV Ampicillin OR 1.0g IM or IV Cefazolin or ceftriaxone **Children**: 50mg/kg IM or IV Ampicillin OR 50mg/kg IM or IV Cefazolin or ceftriaxone
Alternative IM/IV regimen for patients allergic to penicillin and unable to take oral medications	**Adults**: 1.0g IM or IV Cefazolin or ceftriaxone OR 600mg IM or IV Clindamycin **Children**: 50mg/kg IM or IV Cefazolin or ceftriaxone OR 20mg/kg IM or IV Clindamycin within 30 minutes before the procedure

IV. LOCAL USE OF ANTIBIOTICS

Nowadays antibiotics are used both systemically and locally in endodontics.[11] However, local antibiotic application mode is considered more effective than systemic administration as systemic antibiotics fail to reach the necrotic pulpless teeth due to absence of blood supply.[5] Various antibiotics which are used in endodontic treatment for local use include:

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- PBSC (polyantibiotic paste):

Grossman, known as father of endodontics, in 1951 proposed PBSC (polyantibiotic paste which suspended in a silicone vehicle, and was a combination of penicillin, bacitracin, streptomycin and caprylate sodium).[5] PBSC contained penicillin to target Gram-positive organisms, bacitracin for penicillin-resistant strains, streptomycin for Gram-negative organisms, and caprylate sodium to target yeasts. All these compounds were suspended in a silicone vehicle. It was the firstly reported local use of an antibiotic in endodontics. Polyantibiotic paste showed therapeutic potential, but due to ineffectiveness against anaerobic species and allergic reactions, the Food and Drug Administration (FDA) prohibited PBSC for endodontic use in 1975.[5] Later, an antifungal version of PBSC named with PBSN, in which Nystatin substituted caprylate sodium, was released.

- Septomixine forte:

It is composed of two antibiotics neomycin and polymyxin B sulphate, (figure 3).[9] Neomycin is bactericidal against Gram-negative rods and ineffective against bacteroids, rickettesia, viruses and fungi. Polymyxin B is bactericidal against Gram-negative bacteria and ineffective against Gram-positive bacteria. This combination is now not recommended for use in endodontic infections because of narrow spectrum of effectiveness.[9]

Fig. 3: Septomixine forte

- Ledermix paste

It was developed by Schroeder and Triadan in 1960.[5] This paste was made commercially available by Lederle Pharmaceuticals in 1962.[5] It contains an antibiotic demeclocycline-HCl (3.2%) and a corticosteroid, triamcinolone acetonide (1%), in a polyethylene glycol base (Figure 4).[9] The paste utilizes corticosteroids to control pain and inflammation related to pulp and periapical diseases. Antibiotic is added to reduce cortico-induced host immune response. Both triamcinolone and demeclocycline are capable of diffusing through dentinal tubules and cementum to reach the periradicular and periapical tissues.[9] It is water soluble, well rinsed out paste and does not result in any systemic side effect when used for endodontic infections.[9]

Fig. 4: Ledermix paste and odontopaste

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- Odontopaste:

It is a zinc oxide-based root canal paste with 5% clindamycin hydrochloride and 1% triamcinolone acetonide (Figure 4).[9] Clindamycin is effective against many endodontic pathogens including Streptococci, Peptostreptococcus, Actinomyces, Fusobacterium, Eubacterium, Propionobacterium, Microaerophilic, Peptococcus, Porphyromonas, Veillonella and Prevotella.[9] This antibiotic paste acts as interim dressing material preventing bacterial repopulation within the root canal. The steroid part, triamcinolone acetonide, can temporarily reduce inflammation and postoperative pain. Odontopaste contains calcium hydroxide at 0.5% level, which has been proven to be optimal for the preservation of the steroid component.[9]

- Triple antibiotic paste (TAP)

TAP was first used by Sato et al containing metronidazole, ciprofloxacin, and minocycline.[13]

Composition[14] -

According to Hoshino et al – Antibiotic (3Mix) is used in the ratio 1:1:1 containing Ciprofloxacin-200mg, Metronidazole-500mg, Minocycline-100mg. Macrogol ointment and Propylene glycol are used in ratio in 1:1 as a carrier to deliver triple antibiotic paste.[15]

According to Takushige T et al – The drugs are powdered and mixed in a ratio of 1:3:3 (3 Mix) and added either with macrogol-propylene glycol (3 Mix-MP) or a canal sealer (3 Mix-sealer).[15]

Triple antibiotic paste is indicated for disinfection of root canal in case of avulsed teeth, traumatic injuries to teeth, revascularization/ regenerative procedures, large periradicular lesion like cyst, root fractures and root canal treatment in primary teeth.[14] TAP has been proved to be biocompatible in various studies performed.[14,13,17] Tetracycline inhibits collagenases and matrix metalloproteinase and increases the level of interleukin-10, an anti-inflammatory cytokine.[17] In addition, metronidazole and ciprofloxacin can generate fibroblasts.[18]

Disadvantages of triple antibiotic paste are antibacterial resistance and tooth discoloration.[15] Thibodeau and Trope have suggested the use of cefaclor instead of minocycline in TAP to prevent tooth discoloration.[14]

V. CONCLUSION

The role of antibiotics in endodontics is primarily adjunctive and should be reserved for cases with clear systemic involvement, such as diffuse swelling, fever, or lymphadenopathy, which are indicative of spreading infection. The management of endodontic infections is predominantly reliant on thorough mechanical debridement, chemical disinfection, and proper canal obturation to eliminate the microbial etiology locally. The overprescription and inappropriate use of antibiotics in endodontics contribute to the growing global threat of antimicrobial resistance, which poses significant challenges to public health. Clinicians must exercise evidence-based decision-making, adhering to established guidelines and prescribing antibiotics judiciously to ensure their efficacy is preserved for future generations. Further research is essential to refine therapeutic protocols and explore alternative strategies to combat endodontic infections without exacerbating the problem of antibiotic resistance.

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