

Post-Operative Antibiotics and Analgesics In Infection Control and Pain Management-Decision Analysis

Research Article

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Abstract

The antibiotics in endodontics, both systemic and local, play a vital role in the success of treatment. Good understanding of the microbiology of various endodontic diseases, the specific antibiotics that are effective against specific aerobic and anaerobic microorganisms should be analysed before prescribing the antibiotics. The aim of this review was to develop a decision tree for the appropriate usage of antibiotics and analgesics in treating the endodontic infections. A brief pubmed search was performed on antibiotics in Endodontics using “MesH” terms, “resistance” and “endodontic microbiology”, “antibiotics in Endodontics”, “locally used antibiotics”. In addition some websites and local guidelines were screened. By developing and adhering to strict protocols in analyzing the endodontic infection and appropriate prescription of antibiotics, the development of antibiotic resistance can be minimised greatly. With a decision tree, the diagnosis and pharmacological management of the pulpal and periapical diseases becomes easier for the dentist in regular clinical practice. In this respect, active management of the infection combining non-pharmacological and pharmacological means can be done with sound knowledge on the endodontic microbiology, various antibiotics used, and their mechanism of action and appropriate dosage of the drug.

Keywords: Antibiotic Prophylaxis; Antibiotic Resistance; Endodontic Microbiology; Local Antibiotics; Systemic Antibiotics.

Introduction

The prophylactic use of antibiotics whether local or systemic, serve as an adjunct to endodontic therapy. The use of antibiotics was first started with the discovery of penicillin by Fleming in 1928 [1]. Administration of systemic antibiotics for treating dental infections had greatly helped in reducing the infection. However the antibiotics are effective only when the primary focus of infection is removed. The prescription of antibiotics for dental infections should be based on clear indications rather than random administration. The dosage of drug prescribed also plays a major role in the efficacy of the antibiotic and knowledge on minimal inhibitory concentration of the drug is mandatory to avoid antibiotic resistance. Over usage of broad spectrum antibiotics has

already led to emergence of resistance to several antibiotics. The resistant genes are also transferred to other strains of bacteria by transduction, transformation, conjugation and vertical transmission.

Endodontic infections are composed of a multitude of pathogenic bacteria that involve gram positive, gram negative, facultative anaerobes and strict anaerobic bacteria, viruses and fungi [1]. The gram negative anaerobic bacterial species are predominantly found in the root canal system [2]. It has been found that the microflora of endodontically treated teeth with persistent infection, chiefly consists of *Enterococcus faecalis* and *Candida albicans* [3]. Dark pigmented bacteria such as *Prevotella* and *Porphyromonas*, eubacteria, fusobacteria and actinomyces have been found in cul-

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tures of acute apical abscess [4, 5]. The endodontic community of micro organisms which are well organized leads to endodontic biofilms due to bacterial signaling, interactions and exchange of nutrients [7]. All these lead to the fact that antibiotic sensitivity of bacteria found in the oral cavity is decreasing and a large number of resistant strains have been detected. In appropriate use of antibiotics also increases the risk of potential anaphylactic reactions and produces unnecessary side effects in patients. The existence of antibiotic resistant bacteria creates the danger of life threatening infections that do not respond to even broad spectrum antibiotics [8].

Previously our team has a rich experience in working on various research projects across multiple disciplines [6-20]. Now the growing trend in this area motivated us to pursue this project.

The aim of this study was to develop a decision tree in analyzing and deciding whether the case requires analgesics alone or in combination with antibiotics. The decision tree would guide the clinician to accurately understand the pathology and arrive at a definitive diagnosis. The judicious use of antibiotics in endodontic therapy would help in preventing the developing antibiotic resistance against common endodontic pathogens.

Materials and Methods

A PUBMED literature search on antibiotics in Endodontics was

performed focusing on English written manuscripts using the MeSH terms “antibiotics in endodontics” and “antibiotic prophylaxis”. With in the reviews all manuscripts focused on commonly used antibiotics and analgesics. The alternate drugs prescribed for patients allergic to penicillin and developing drug resistance among the common endodontic pathogens were also described. In addition the antibiotic prophylaxis regimen for immunocompromised patients have also been discussed.

The Need For Treatment Strategies

The prime focus of Root canal therapy is the removal of foci of infection from the pulp and periradicular tissues and the success of treatment depends on eliminating the entire pathogenic microbes as well as their metabolic by products and the inflammatory mediators either by the host defense itself or with the help of antibiotics and analgesics. With the increasing use of both local and systemic antibiotics in Endodontics, there has been a steady increase in resistance of the common endodontic pathogens.

Endodontic diagnosis is the key step to arrive at an appropriate treatment plan (Table 5). Hence a treatment plan should be established following strict guidelines as to which condition, should the antibiotic be prescribed. The proper understanding of endodontic microbiology and the pharmacokinetics of drugs is essential in avoiding over usage as well as over dosage of antibiotics [4]. The drug dosage should be calculated according to the weight of the

Table 1. Conditions requiring antibiotic prophylaxis.

| Conditions requiring Antibiotic prophylaxis |
|---|
| Impaired immunologic function |
| Complex congenital heart defects/prosthetic cardiac valves/history of infective endocarditis |
| During first 3 months after joint operations |
| Patients undergoing high dose irradiation for treatment of head and neck cancers |
| Patients receiving intravenous bisphosphonate treatment need antibiotic prophylaxis prior to endodontic surgeries |

Table 2. Recommended antibiotic regimens for antibiotic prophylaxis according to AHA Guidelines 2007.

| Clinical situation | Antibiotic | Regimen - single dose 30-60 min before procedure | Regimen - single dose 30-60 min before procedure |
|---|---|--|--|
| | | Adults | Children |
| Oral | Amoxicillin | 2g | 50mg/kg |
| Unable to take oral medication | Ampicillin or Cefazolin or ceftriaxone | 2g IM or IV 1g IM or IV | 50mg/kg IM or IV 50mg/kg IM or IV |
| Allergic to penicillins or ampicillin- oral regimen | Cephalexin or Clindamycin or Azithromycin or Clarithromycin | 2g 600mg 500mg | 50mg/kg 20mg/kg 15mg/kg |
| Allergic to penicillin or ampicillin- unable to take oral regimen | Cefazolin or ceftriaxone Or Clindamycin | 1g IM or IV 600mg IM or IV | 50mg/kg IM or IV 20mg/kg IM or IV |

patient [21]. Overdosage leads to adverse effects and also causes prolonged sensitization of the individual to that particular drug leads to development of resistance to that drug [22].

Strategies Of Antibiotic Usage In Endodontics

Antibiotics are also used as an adjunct in the treatment of endodontic infections to aid the host defenses in effectively eliminating the infection [23] (Table 6).

- Fever > 100 degrees Fahrenheit, malaise, cellulitis, unexplained trismus, lymphadenopathy and swelling beyond a simple localized mucosal enlargement indicators of systemic involvement [24].
- Removal of foci of infection with incision and drainage removes bacterial by products and improves circulation thus improving the

action of prescribed localized or systemic medication. Narrow spectrum antibiotics should be the first choice and minimal inhibitory concentration started so as to control or inhibit bacteremia.

Antibiotic prophylaxis reduces the number of organisms in the blood and also reduces their adhesion to the non-bacterial thrombotic vegetation [25]. Antibiotic prophylaxis is indicated for patients with impaired immunologic function such as Leukemia, HIV/AIDS, end-stage renal disease, dialysis, uncontrolled diabetes, chemotherapy, steroids or immuno suppressive post-transplant medications or inherited genetic defects [26]. Antibiotic prophylaxis is mandatory for individuals with complex congenital heart defects, prosthetic cardiac valves or a history of infective endocarditis, who are at risk of developing infective endocarditis following an endodontic procedure [27] (Table 1). The invasive dental treatment includes all treatments requiring manipulation of

Table 3. Commonly prescribed antibiotics in Endodontics.

| Drug of choice | Loading dose | Maintenance dose |
|----------------------------------|--------------|---------------------------|
| Penicillin VK | 1000mg | 500 mg q4-6h |
| Amoxicillin | 1000mg | 500 mg q8h or 875 mg q12h |
| Amoxicillin with clavulanic acid | 1000mg | 500mg q8h or 875 mg q12h |
| Clindamycin | 600mg | 300 mg q6h |
| Clarithromycin | 500mg | 250 mg q12h |
| Azithromycin | 500mg | 250 mg q24h |
| Metronidazole | 1000mg | 500 mg q6hr |

Table 4. Mechanism of action and effectiveness of commonly used antibiotics in Endodontics.

| Antibiotic | Mechanism of action | Effectiveness |
|--|--|--|
| Penicillin VK [16] | Inhibits cell wall synthesis-inhibiting transpeptidase that catalyze the final step in cell wall synthesis. | Facultative and anaerobic microorganisms associated with endodontic infection. |
| Amoxicillin - analogue of penicillin [16, 17] | During bacterial multiplication, it inhibits the synthesis of mucopeptide, which is an essential component of cell wall. | Effective against gram positive than gram negative. |
| Augmentin- combination of amoxicillin and clavunate [18] | Clavulanate is a competitive inhibitor of the beta lactamase enzyme produced by bacteria to inactivate penicillin + cell wall synthesis inhibition by amoxicillin. | Both gram positive and gram negative. |
| Clindamycin- lincocycline [18] | The target site is ribosome and by binding to the receptor 50s, the protein synthesis is inhibited. | Gram positive facultative microorganisms and anaerobic and certain gram negative bacteria. |
| Clarithromycin and Azithromycin macrolide [18] | The target site is ribosome and by binding to the receptor 50s, the protein synthesis is inhibited. | Both gram positive and gram negative bacteria. |
| Doxycycline- tetracyclines [19] | Bacteriostatic The target site is ribosome and by binding to the receptor 30s, the protein synthesis is inhibited. | Both gram positive and gram negative bacteria. |
| Ciprofloxacin - synthetic fluoroquinolone [20] | Bactericidal Inhibits the enzyme, bacterial gyrase. | Effective against gram negative bacteria, less effective against gram positive species. Has no effect against anaerobes. |
| Metronidazole - nitroimidazole group [43] | Redox reduction release free radicals. | Effective against anaerobes. |

gingival or periapical regions of the tooth or perforation of the oral mucosa or root canal procedures [32]. Prophylaxis against infective endocarditis requires peak serum levels during treatment and immediately after [28]. Prophylaxis prior to surgery requires peak serum levels during treatment when bacteremia might occur due to tissue manipulation and immediately after (Table 2).

Systemic Antibiotics and Analgesics Used In Endodontics

Most endodontic infections are confined within the root canal system and can be successfully managed by local operative treatment without the need for systemic antibiotics [34]. They should be used only as an adjunct to normal debridement and drainage procedures in cases of severe forms of infection and in immunocompromised patients.

Chronic alveolar infections are associated with pulpless teeth which have no blood supply reaching the pulp space. The antibiotic concentration reaching the site of infection is negligible and

unlikely to inhibit bacterial growth [35].

- Penicillin is effective against polymicrobial endodontic infections, has low toxicity and low spectrum of action.
- Clindamycin is preferred in patients allergic to penicillin.
- Amoxicillin and Augmentin have broader spectrum of action and reserved for unresolved infections and immunocompromised patients.
- Metronidazole is effective only against anaerobes. Due to large amounts of bacterial resistance, it should never be used alone in the treatment of endodontic infections [28] (Table 3 and 4).
- Clinical improvement in signs of infection must be the guide for duration of antibiotic treatment. The antibiotic therapy should be discontinued when there is clinical evidence of healing and the symptoms have resolved.

Table 5. Clinical guide to diagnose pulpal and periapical pathologies.

| Clinical condition | Clinical findings | Radiographic findings |
|--|---|-------------------------|
| Symptomatic irreversible pulpitis | Pain No other signs of infection | Nil |
| Pulp necrosis | Non vital teeth | Widening of PDL space |
| Acute apical periodontitis | Pain to percussion and biting | Widening of PDL space |
| Chronic apical abscess | Teeth with sinus tract | Periapical radiolucency |
| Acute apical abscess with no systemic involvement | Localized fluctuant swellings | Nil |
| Acute apical abscess with systemic involvement | Localized fluctuant swellings Elevated body temperature (38 deg. C) Malaise Lymphadenopathy trismus | Nil |
| Acute apical abscess in medically compromised patients | Localized fluctuant swellings Patients with systemic diseases causing impaired immunologic function | Nil |
| Progressive infections. Cellulitis or spreading infection. Osteomyelitis | Rapid onset of severe infection (<24 hours) | Periapical radiolucency |
| Persistent infections | Chronic exudation, not resolved by regular intracanal procedures and medication | Periapical radiolucency |

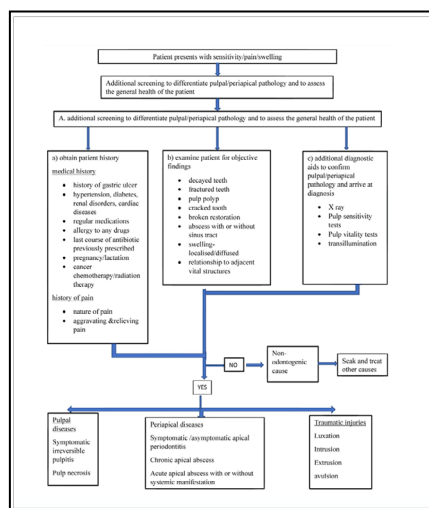
Table 6. Indications for administering antibiotics in a nutshell.

| Conditions not to prescribe antibiotics ²⁵ | Conditions to prescribe antibiotics |
|--|--|
| Symptomatic irreversible pulpitis [26] | Acute apical abscess with systemic involvement/ cellulitis/ medically compromised patients |
| Pulp necrosis | Progressive infections & persistent infections |
| Acute apical periodontitis | Maxillary sinusitis usually presenting with referred pain |
| Chronic apical abscess- clinically seen as localized fluctuant abscess in relation to the apex of the involved tooth | Soft tissue trauma requiring suturing or debridement procedures [27] |
| Acute apical abscess with no systemic involvement | Re-treatment cases/persistent/calitrant cases/ endodontic flare ups/ phoenix abscess |
| Abscess with sinus tract | Regenerative endodontics, surgical endodontics, soft |
| Traumatic injuries such as tooth fracture, luxation injuries of permanent teeth, extrusion | Replantation of avulsed teeth [28] |

Table 7. Locally used antibiotics in Endodontics and uses.

| Locally used antibiotics in Endodontics | Composition | Uses |
|---|---|--|
| Triple antibiotic paste | Mincycline Ciprofloxacin Metronidazole | Intracanal medicament Regenerative endodontics [44] |
| MTAD | 3% doxycycline Citric acid Detergent- polysorbate 80 | Irrigant |
| Tetraclean | 50mg/ml doxycycline Acid Detergent- polypropylene glycol | Irrigant |
| Ledermix paste | 3.2% demeclocycline HCl 1% triamcinolone acetonide in polyethyl- ene glycol base | Pulp capping agent and intracanal medicament |
| Odontopaste | Zinc oxide root canal paste 5% clindamycin hydrochloride 1% triamcinolone acetonide | Intracanal medicament |
| Medicated gutta percha | 10% iodoform 10% tetracycline impregnated gutta percha | Obturation |

Figure 1. Decision tree to arrive at the accurate diagnosis.



• Pain control using analgesic medications such as Narcotics, aspirin and NSAIDS. Narcotic drugs have a more centrally acting potential and tendency of drug dependence, for which it is usually avoided [36]. The NSAIDS and aspirin have a more localized action at the target site and help in reducing inflammatory mediators such as prostaglandins that are responsible for pain [37]. Acetaminophen is also a commonly prescribed analgesic in dentistry [38]. Our institution is passionate about high quality evidence based research and has excelled in various fields [10, 29-38] that lead to interest in better understanding and use of pharmacotherapy in dentistry.

The Development Of A Decision Tree

The right diagnosis helps in appropriate management (Figure 1). Patient history should include medical history for any systemic illness, diabetes, medications regularly taken by the patient, allergy to any drugs, antibiotics, immunocompromised patients such as

old patients as well as patients undergoing radiation therapy, when did the patient have his previous antibiotic course, pregnancy or breastfeeding. In healthy individuals, any bacteremia generated by endodontic procedures are rapidly scavenged by the host immune system and causes no complications [5].

This should be kept in mind to avoid prescribing antibiotics to pulpal pathosis that are generally capable of resolving by itself when the etiology has been removed (Figure 2).

But in case of severe spreading, persistent infections and in immunocompromised patients, the use of antibiotics avoids risk of bacteremia (Figure 3). Life threatening situations such as swelling in the floor of the mouth, difficulty in breathing should be managed in a hospital set up with intravenous administration of antibiotics and constant monitoring of vitals of the patient [39].

When the swelling is diffuse or progressively increases in size and the source of infection cannot be identified such as in cel-

Figure 2. Decision tree for managing pulpal diseases with antibiotics and analgesics.

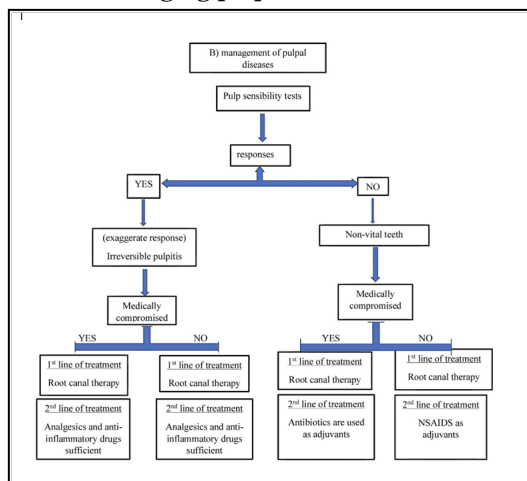
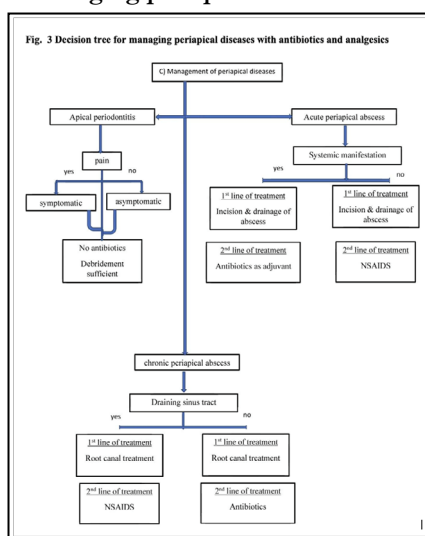


Figure 3. Decision tree for managing periapical diseases with antibiotics and analgesics.



lulitis (severe form of fascial space infection) - immediate broad spectrum antibiotics started and samples sent for culture sensitivity subsequently. In such severe infections, symptomatic therapy along with analgesics are mandatory.

In case of traumatic injuries minimization of bacterial load during the healing phase is found to be beneficial with the help of local and systemic antibiotics [40].

Locally Used Antibiotics In Endodontics

The local application of antibiotics is an effective mode of disinfecting root canals because systemic antibiotics fail to reach the necrotic pulp [41] (Table 7). They are used as irrigants, intracanal medicament, pulp capping agents, obturating material in Endodontics as well as regenerative endodontics. The antibiotic is available at adequate concentrations at the target site. The antimicrobial medication is capable of diffusing through the dentin, the canal irregularities and the apical foramen to reach the periapical tissues [42].

Acknowledgement & Declaration

We would like to acknowledge my mentors and guide for helping me in data collection and analysis and better understanding of the

subject to derive the decision analysis concepts.

Conclusion

Endodontic microbiology is complex and the diseases due to these pathogens should combine the two crucial steps of primarily eliminating the foci of infection followed by administration of analgesics alone or in combination with antibiotics in order to help the host defense in eliminating the pathogenic microbes as well as speedy recovery of periapical tissues. The antibiotics have greatly helped in eliminating infections but should be judiciously used only when indicated. The NSAIDs aid in reducing the pain and inflammation and is one of the best drugs to be given to minimize post-operative pain. This decision tree along with emphasis on antibiotics used, their effectiveness towards specific groups of microorganisms helps in deciding whether the clinical situation demands prescribing analgesics alone or in combination with antibiotics.

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