ENDODONTICS

Colleagues for Excellence

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Antibiotics and the Treatment of Endodontic Infections

Welcome to ***ENDODONTICS: Colleagues for Excellence***. . .the newsletter covering the latest in endodontic treatment, research and technology. We hope you enjoy our coverage on the full scope of options available for patients through endodontic treatment and that you find this information valuable in your practice. All issues of this ***ENDODONTICS*** newsletter are available on the AAE Web site at *www.aae.org,* and cover a range of topics on the art and science in endodontic treatment.

Endodontic infections range from being asymptomatic to life threatening. This issue of *ENDODONTICS: Colleagues for Excellence* reviews the objectives of endodontic treatment in managing infected root canal systems, specifically addressing antibiotics and their impact on patients. Guidelines for the prescription of specific antibiotics are provided for use as an adjunct to clinical treatment of the patient.

The Nature of Endodontic Infections

Root canal infections are polymicrobial infections characterized by mostly anaerobic bacteria and some facultative bacteria (1). A tooth with an infected necrotic pulp becomes a reservoir of infection isolated from the patient's immune response. Eventually, bacteria and bacterial by-products will produce a periradicular inflammatory response. With microbial invasion of periradicular tissues, an abscess and cellulitis may develop. The inflammatory response may give rise to both protective and immunopathogenic effects; it may also be destructive to surrounding tissue and contribute to adverse signs and symptoms. Severe infections may develop depending on the pathogenicity of the microorganisms involved and the resistance of the host (Figure 1).

The spread of infection and the inflammatory response will continue until the source of the irritation is removed.

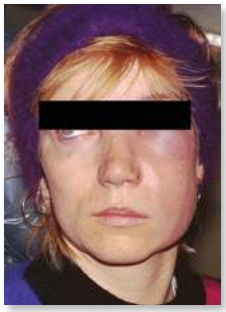

Figure 1: Patient with cellulitis caused by premolar root canal infection.

While normal flora may prevent pathogenic organisms from invading the tissues and causing disease, they may become opportunistic pathogens if they gain access to tissues not previously colonized. Such is the case when normal oral flora gain access to the pulp cavity and periradicular tissues. Microbes associated with endodontic disease include bacteria, fungi and viruses (1).

Clinical signs and symptoms of an infection are the result of damage to the tissues caused by the microbe and the inflammatory response produced by the host. **Patient evaluation and the appropriate diagnosis/treatment of the source of an infection are of utmost importance.**

Clinical Treatment of Endodontic Infections

Soft tissue swelling of endodontic origin should be incised for drainage (Figure 2).

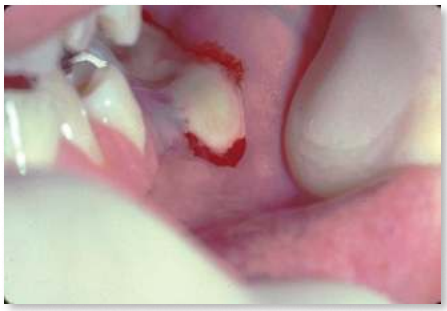

Figure 2: Intraoral drainage of purulent exudate.

In most cases, a drain placed in the incision for 24-48 hours will allow for adequate drainage (Figure 3).

Figure 3: Intraoral drain sutured into incision for drainage.

However, effective treatment of endodontic infections also includes removal of the reservoir of infection by either endodontic treatment or tooth extraction. Successful management of the infected root canal system requires chemomechanical debridement of the root canal system. Three to 12 species of bacteria can usually be cultured from infected root canals

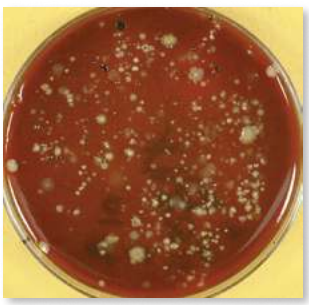

Figure 4: Cultivation of polymicrobial endodontic infection.

(Figure 4); it is important that debridement of the root canal be accomplished aseptically using rubber dam isolation to prevent further microbial contamination.

The objectives for endodontic treatment are removal of the microbes, their by-products and pulpal debris from the infected root canal system. This establishes a favorable condition for periradicular inflammation to resolve. When a patient has signs and symptoms associated with a severe endodontic infection (Table 1), the root canal system should be filled with calcium hydroxide, and the access opening sealed to prevent coronal leakage of bacteria from the oral cavity. If there is continuous drainage, the canal may be left open until the next day. Drainage allows the accumulated irritants and inflammatory mediators to decrease to a level where a healthy patient can initiate healing. However, leaving the tooth open for drainage for a longer time allows gross contamination with no benefit to the patient.

Table 1. Indications for Adjunctive Antibiotics

- Fever > 100° F
- Malaise
- Lymphadenopathy
- Trismus
- Increased Swelling
- Cellulitis
- Osteomyelitis
- Persistent Infection

A regimen of antibiotics is not indicated in an otherwise healthy patient for a small localized swelling without systemic signs and symptoms of infection or spread of infection (2-6) (Tables 1, 2). **Swellings increasing in size or associated with cellulitis should be incised for drainage and adjunctive antibiotics administered.**

Table 2. Conditions Not Requiring Adjunctive Antibiotics

1. Pain without signs and symptoms of infection
   a. *Symptomatic irreversible pulpitis*
   b. *Acute periradicular periodontitis*
2. Teeth with necrotic pulps and a radiolucency
3. Teeth with a sinus tract (chronic periradicular abscess)
4. Localized fluctuant swellings

"Magic Bullets" Versus Resistant Bacteria

The term "antibiotic" is used for chemicals that are produced either by bacteria and/or synthetic antimicrobials produced in a laboratory that kill or inhibit the growth of bacteria. The discovery of penicillin by Fleming in 1928 revolutionized health care for the treatment of bacterial infections such as tuberculosis, pneumonia and syphilis. Because antibiotics are relatively harmless to the host, they can be used to treat infections including those of endodontic origin. However, antibiotics may have adverse effects by altering the normal flora and by producing allergic reactions. The interaction of antibiotics with other drugs may also produce harmful side effects or render them ineffective.

Antibiotics have been called "magic bullets" because they target the organisms producing disease. Unfortunately, the wide use of antibiotics has fostered the selection of resistant bacteria. Antibiotics alter the natural balance of normal flora by selecting for organisms that are resistant. Resistant genes are transferred vertically to all daughter cells. In addition, resistant genes can be transferred horizontally to other strains of bacteria by transduction, transformation and conjugation. Thus, strains of bacteria never exposed to the antibiotic may acquire resistance without ever coming in contact with the antibiotic.

The selection of resistant organisms is enabled when a low dose of an antibiotic is administered, when antibiotics are taken for long periods of time or through noncompliance by patients. Another source of resistant organisms is from the use of low doses of antibiotics in agricultural feed and fertilizers. A prime example of acquired resistance is *Staphylococcus aureus,* which now has resistance to multiple antibiotics including vancomycin. **In addition, the development of resistance by bacteria because of inappropriate prescriptions raises questions and concerns for health care workers.**

Responsible Use of Antibiotics in Endodontic Treatment

Antibiotics are used in addition to appropriate treatment to aid the host defenses in the elimination of remaining bacteria. Narrow-spectrum antibiotics should be the first choice to be prescribed because broad-spectrum antibiotics produce more alterations in the normal gastrointestinal tract and select for additional resistant organisms. Empirical selection of an antibiotic without susceptibility tests is based on knowledge of the organisms usually involved in endodontic infections. Antibiotics are indicated when there is systemic involvement or evidence of spread of infection. Signs and symptoms include: fever above 100 degrees Fahrenheit, malaise, cellulitis, unexplained trismus, lymphadenopathy and swelling beyond a simple localized mucosal enlargement.

Systemic administration of the appropriate antibiotic dosage is usually for five to seven days. Clinical signs and symptoms will usually diminish in two to four days after diagnosis and removal of the cause of the infection. Patients should continue to take the antibiotic for an additional two to three days to prevent rebound of the infections. Noncompliance by a patient not taking the prescribed antibiotic regimen may allow a rebound of the infection. A seven-day prescription is usually adequate.

Incision for drainage is important to remove purulent material consisting of bacteria, bacterial by-products, disintegrated inflammatory cells, enzymes (spreading factors) and other inflammatory mediators. Drainage improves circulation to the infected tissues and improves delivery of a minimum inhibitory concentration of the antibiotic to the area. Because endodontic infections are polymicrobial, no single antibiotic is likely to be effective against all the strains of infecting bacteria. However, it is likely that if an antibiotic is effective against several of the strains of bacteria, it will disrupt the microbial ecosystem.

One of the more common side effects of antibiotic therapy is diarrhea, which results from the antibiotic disrupting the normal balance of intestinal flora. Antibiotic-associated colitis/pseudomembranous colitis has been associated with the use of many antibiotics, but only rarely associated with dental therapy (7). Patients requiring extraoral drainage or hospitalization should be referred to an oral surgeon (Figure 5).

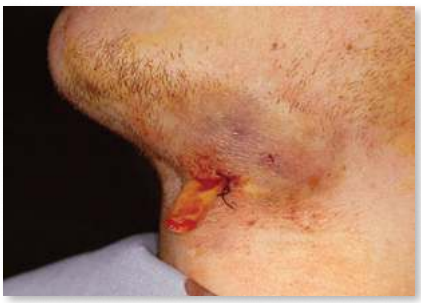

Figure 5: Extraoral drain sutured into incision for drainage.

Some patients, especially immunocompromised patients, are at high risk for infections, and a culture of the infecting organisms with susceptibility testing may be indicated. Identification of the bacteria and results of susceptibility tests may take several days to a couple of weeks, depending on the microbes involved in the infection. Good communication with a laboratory will ensure that the sample is properly collected, transported, cultured and identified. **If there is any question about the patient being medically compromised, or if the patient's condition deteriorates, referral should be considered.**

Types of Antibiotics and Recommended Dosages

Based on recent antibiotic susceptibility tests, **penicillin VK** is the drug of choice for periradicular abscesses (8, 9) (Figure 6).

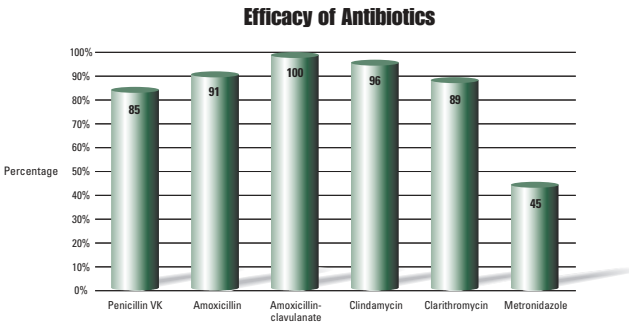

Figure 6: Antibiotic susceptibility for bacteria from endodontic infections.

It is effective against facultative and anaerobic microorganisms associated with endodontic infections. Penicillin VK remains the antibiotic of choice because of its effectiveness, low toxicity and low cost. However, about 10 percent of the population will give a history of allergic reactions to penicillin. To achieve a steady serum level with penicillin VK, it should be administered every four to six hours (10). A loading dose of 1,000 mg of penicillin VK should be orally administered, followed by 500 mg every four to six hours for five to seven days. Following debridement of the root canal system and drainage of facial swellings, significant improvement of the infection should be seen within 48-72 hours.

Amoxicillin is an analogue of penicillin that is rapidly absorbed and has a longer half-life. This is reflected in higher and more sustained serum levels than penicillin VK. Because of these traits, amoxicillin is often used for antibiotic prophylaxis of patients that are medically compromised (11, 12). Amoxicillin may be used for serious odontogenic infections, however, its extended spectrum may select for additional resistant strains of bacteria. The usual oral dosage for amoxicillin is 1,000 mg loading dose followed by 500 mg every eight hours for five to seven days.

The combination of **amoxicillin with clavulanate** (Augmentin™) was the most effective antibiotic combination in recent susceptibility tests (8, 9). Clavulanate is a competitive inhibitor of the beta-lactamase enzyme produced by bacteria to inactivate penicillin. The usual oral dosage for amoxicillin with clavulanate is 1,000 mg loading dose followed by 500 mg every eight hours for five to seven days.

Clindamycin is effective against gram-positive facultative microorganisms and anaerobes. Clindamycin is a good choice if a patient is allergic to penicillin or a change in antibiotic is indicated. Penicillin and clindamycin have been shown to produce good results in treating odontogenic infections (13). Clindamycin is well distributed throughout most body tissues and reaches a concentration in bone approximating that of plasma. The oral adult dosage for serious endodontic infections is a 600 mg loading dose followed by 300 mg every six hours for five to seven days.

Metronidazole may be used in combination with penicillin or clindamycin. If a patient's symptoms worsen 48-72 hours after initial treatment and the prescription of either penicillin or clindamycin, metronidazole may be added to the original antibiotic. **It is of utmost importance to review the diagnosis and treatment to confirm that the management of the infection has been appropriate.** Metronidazole is a synthetic antimicrobial agent that is bactericidal and has activity against anaerobes, but lacks activity against aerobes and facultative anaerobes. Susceptibility tests have shown significant numbers of bacteria resistant to metronidazole (8, 9). It is important that the patient continue to take penicillin or clindamycin, which are effective against the facultative bacteria and those resistant to metronidazole. The usual oral dosage for metronidazole is a 1,000 mg loading dose followed by 500 mg every six hours for five to seven days. When patients fail to respond to treatment, consultation with a specialist is recommended.

Erythromycin is a macrolide that has traditionally been prescribed for patients allergic to penicillin; however, it is not effective against anaerobic bacteria. Erythromycin is no longer recommended for treatment of endodontic infections because of this poor spectrum of activity and significant gastrointestinal upset.

Clarithromycin and **azithromycin** are macrolides that have a spectrum of activity that includes some anaerobes involved in endodontic infection and offer improved pharmacokinetics. Food slows down but does not affect the bioavailability of clarithromycin. Food and heavy metals may inhibit the absorption of azithromycin. The oral dosage for clarithromycin is a 500 mg loading dose followed by 250 mg every 12 hours for five to seven days. The oral dosage for azithromycin is a 500 mg loading dose followed by 250 mg once a day for five to seven days.

Cephalosporins are usually not indicated for the treatment of endodontic infections. First-generation cephalosporins do not have activity against the anaerobes usually involved in endodontic infections. Second-generation cephalosporins have some efficacy for anaerobes, however, there is a possibility of cross-allergenicity of cephalosporins with penicillin.

Doxycycline occasionally may be indicated when the above antibiotics are contraindicated. However, many strains of bacteria have become resistant to the tetracyclines.

Ciprofloxacin is a quinilone antibiotic that is not effective against anaerobic bacteria usually found in endodontic infections. With a persistent infection it may be indicated if culture and sensitivity tests demonstrate the presence of susceptible organisms.

Conclusion

The use of improved culturing and molecular methods now detect the presence of many more organisms in endodontic infections than previously determined. It is important that clinicians understand the nature of polymicrobial endodontic infections and realize the importance of removing the reservoir of infection by endodontic treatment or tooth extraction. The prescription of antibiotics should be considered adjunctive to the clinical treatment of the patient; **antibiotics should not be substituted for root canal debridement and drainage of purulence from a periradicular swelling.**

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American Association of Endodontists
211 E. Chicago Ave., Suite 1100
Chicago, IL 60611-2691
info@aae.org
www.aae.org