
Clindamycin in dentistry: More than just effective prophylaxis for endocarditis?

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Clindamycin is a broad-spectrum antibiotic with activity against aerobic, anaerobic, and β -lactamase-producing pathogens. This antibiotic has been used for many years as prophylactic treatment during dental procedures to prevent endocarditis. However, the spectrum and susceptibility of the bacteria species involved in dental infections indicate that clindamycin would also be an effective treatment option for these conditions. In addition to its antiinfective properties, clindamycin has high oral absorption, significant tissue penetration, including penetration into bone, and stimulatory effects on the host immune system. This review discusses the microbiologic and clinical evidence supporting the efficacy and safety of clindamycin for the successful management of dental infections. (*Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005;100:550-8)

Clindamycin, an antimicrobial agent that has been in use worldwide for more than 3 decades, has been consistently effective in the treatment of infections involving a wide spectrum of facultative and strictly anaerobic bacteria.^{1,2} The clinical value of clindamycin in a number of medical settings is well known, but it has been under-recognized as an antimicrobial agent for use in dentistry.

During the past decade, both the British Society for Antimicrobial Chemotherapy³ and the American Heart Association⁴ revised their recommendations for prophylaxis of infective endocarditis following dental procedures, which has resulted in the routine use of clindamycin by general dental practitioners in the United Kingdom and the United States. In addition, clindamycin is prescribed in other countries not only for prophylaxis of endocarditis but also for the treatment of acute dental infections⁵ and for prophylaxis of local infections following orthognathic surgery.⁶

Historically, the principle reason for the restricted use of clindamycin in dentistry has been concern regarding potential adverse events, in particular, the development of *Clostridium difficile* diarrhea or pseudomembranous colitis. However, a comprehensive review of the risk factors for *C difficile* infection associated with antibiotic therapy revealed that this concern is likely to be unfounded.⁷ Although this therapeutic complication has been reported for many antibiotics, and the potential risk with most agents is stated in the literature, it is becoming increasingly clear that the true incidence of the problem is low for all antimicrobials. It is now recognized that *C difficile*-associated problems are particularly rare when clindamycin is used in outpatient ambulatory care settings.⁸ Indeed, there is ample evidence accumulated over more than 2 decades indicating that clindamycin is not a frequent cause of antibiotic-associated colitis. From a dental perspective, it would appear that the incidence of *C difficile* infection with clindamycin is no greater than that with amoxicillin or amoxicillin/clavulanate, 2 antimicrobial agents frequently used in the management of acute dental infection.⁷ In view of this unwarranted preconception about clindamycin, this review covers the microbiology of dental infections and positions clindamycin in relation to other antimicrobial agents often prescribed in dentistry.

MICROBIOLOGY OF DENTAL INFECTIONS

The commensal oral microflora comprise more than 350 morphologically and biochemically distinct microbial species. Analysis through molecular detection methods indicates a myriad presence of previously

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unknown and uncultivable organisms in the oral cavity. Such a microbial diversity not only has prevented clear identification but also has hindered the etiologic association of these microbes with specific oral infections. It is generally recognized that strict anaerobes comprise a majority of the healthy commensal oral microflora, and they outnumber facultative organisms by a ratio of 100:1 within the gingival crevice.^{9,10} Contemporary microbiologic studies have revealed that the bacteria recovered from dental infections reflect this mixed population of facultative and strictly anaerobic bacteria that also are regarded as indigenous constituents of host oral microflora.

Dentoalveolar and endodontic infections

Microbiologic investigations of acute dental infections undertaken during the past 15 years have confirmed the polymicrobial nature of dentoalveolar and endodontic infections.¹¹⁻¹³ The major facultative isolates have been streptococci, in particular members of the *Streptococcus milleri* group, while the predominant strictly anaerobic isolates have been *Peptostreptococcus*, *Veillonella*, *Prevotella*, and *Actinomyces* species (Table I). Quantitative studies have revealed the viable microbial flora of acute dental abscesses to be approximately 10⁷ colony-forming units/mL. As stated, not only are strict anaerobes isolated more frequently than facultative species, but the organisms occupy nearly 90% of the overall viable mixed flora.^{14,15}

Pathogenicity experiments have revealed that strictly anaerobic species, in particular gram-negative bacilli, are the likely pathogens in periapical infections.¹⁶⁻¹⁸ In addition, abscess models have shown that combinations of bacterial species, such as *S milleri*, anaerobic gram-positive colli, and anaerobic gram-negative bacilli, are more pathogenic when inoculated subcutaneously in pairs into animals than when inoculated separately.^{19,20}

In addition to experimental investigation of the potential pathogenicity of isolates, attempts have been made to relate the association of specific bacterial species and the severity of clinical symptoms. For instance, *Fusobacterium nucleatum* has been recovered more often from patients with severe odontogenic infections.^{21,22}

Periodontal infections

Gingivitis and periodontitis, the most frequently occurring diseases in humans, are essentially initiated by dental plaque, which is recognized as a complex biofilm comprised of an orderly community of bacteria encased in a polymeric matrix derived both from their metabolic products and from the host nutrients. In addition to subgingival plaque bacteria, the specific and

Table I. Predominant bacterial species encountered in acute dental infections

	Dentoalveolar and endodontic	Peri- odontal	Peri- implant
<i>Anaerobic bacteria</i>			
Gram-positive cocci			
<i>Peptostreptococcus</i> species	X	X	
<i>Peptostreptococcus micros</i>	X	X	
Gram-positive bacilli			
<i>Actinomyces</i> species	X	X	X
<i>Eubacterium</i> species	X	X	X
<i>Propionibacterium</i> species	X	X	X
<i>Lactobacillus</i> species	X	X	X
Gram-negative bacilli			
<i>Veillonella</i> species	X	X	X
<i>Prevotella</i> species	X	X	
<i>Prevotella nigrescens</i>	X	X	
<i>Prevotella intermedia</i>	X	X	
<i>Porphyromonas</i> species	X	X	
<i>Porphyromonas gingivalis</i>	X	X	
<i>Bacteroides</i> species	X	X	
<i>Bacteroides forsythus</i>	X	X	
<i>Fusobacterium</i> species	X	X	
<i>Fusobacterium nucleatum</i>	X	X	
Spirochetes			
<i>Treponema denticola</i>			
<i>Treponema sokranskii</i>			
<i>Facultative anaerobic bacteria</i>			
Gram-positive cocci			
<i>Streptococcus</i> species	X	X	
β-hemolytic streptococci	X	X	X
<i>Streptococcus milleri</i> group	X	X	
Gram-positive bacilli			
<i>Lactobacillus</i> species*	X	X	
Gram-negative Coccobacilli			
<i>Actinobacillus</i>	X	X	
<i>actinomycetemcomitans</i>			
<i>Capnocytophaga</i> species			

X, Species encountered in this infection.

*Microorganisms associated with dental caries.

nonspecific defense mechanisms of the host play a critical role in periodontal diseases. At present, the major bacterial pathogens implicated in periodontal disease, so-called periodontopathogens, include *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis*, *Bacteroides forsythus*, *Prevotella nigrescens*, *Fusobacterium* species, *Peptostreptococcus micros*, and *Treponema* species (Table I). Periodontal disease is an archetypal example of a polymicrobial infection, and the synergistic reactions between the microorganisms appear to play a key role in the pathogenic process. As stated, both the specific and nonspecific immune responses of the host to subgingival plaque are considered to play critical roles in the initiation, progression, and recovery from periodontal diseases. One of the most

important components of the host response is the gingival crevicular fluid (GCF), which contains both specific and nonspecific defense factors. These include polymorphonuclear leukocytes that migrate into the gingival crevice, as well as the recently described antimicrobial factors present on epithelia (such as α -defensins, β -defensins, and cathelicidins).²³ The host immune response is essential for maintaining a healthy periodontium. The damage and destruction of periodontal tissues associated with gingivitis and periodontitis are unlikely to occur in the absence of periodontopathic bacteria.²⁴

Peri-implantitis

Peri-implantitis is an emerging form of periodontitis that is a direct consequence of the increasing use of dental implants. Peri-implant disease refers to the general category of pathologic changes that can occur in the hard and soft tissues surrounding an implant. The integration of an implant can be jeopardized by the presence of bacteria in the tissues and the concomitant inflammatory reactions.²⁵ However, most peri-implant disease is plaque-induced, and the spectrum of bacterial species recovered is comparable to that encountered in periodontitis.^{26,27} Bacterial species that have received particular attention in this context include *A actinomycetemcomitans*, *P gingivalis*, *Prevotella intermedia*, and *F nucleatum* (Table I).

In summary, many studies have proven that a wide range of bacterial species that are in essence constituents of the commensal oral microflora cause dental infections. However, it is likely that strict anaerobes, particularly gram-negative bacilli, play a key role in the etiopathology of dental infections, although interactions with other species are a common feature.

ANTIMICROBIAL SUSCEPTIBILITY OF DENTAL INFECTIONS

The global emergence of antibiotic-resistant bacteria is a phenomenon of much concern. Classic examples are the wide prevalence of medically important bacteria, such as *Staphylococcus aureus* and *Streptococcus pneumoniae*, that are resistant to both older and newer generations of penicillin and many other antibiotics. Similarly, some bacterial species recovered from acute dental infections have demonstrated reduced in vitro antimicrobial susceptibility. Although isolates from acute dental infection rarely demonstrated resistance to penicillin 15 years ago, this is no longer the case.²⁸ Resistance to penicillin has increased significantly in gram-negative anaerobic bacilli, in particular *Prevotella*, *Porphyromonas*, *Bacteroides*, and *Fusobacterium* species, owing to their production of β -lactamases. Studies in the United Kingdom indicated that penicillin

resistance in acute dentoalveolar infections rose from 3% in 1986 to 23% of isolates in 1995.^{29,30} Similar incidences of increased penicillin resistance have been reported in the United States (33%),¹³ Sweden (38%),³¹ and Japan (39%).³²

The presence of penicillin-resistant bacteria has been reported to be the cause of treatment failures in head and neck infections of dental origin.^{33,34} The production of β -lactamases not only plays a direct pathogenic role by destroying the drug, but also indirectly "shields" non- β -lactamase-producing, penicillin-sensitive bacteria within the infection.³⁵ The widespread use of penicillin has contributed to this problem, because it has been shown that the administration of penicillin leads to the emergence of β -lactamase-producing bacteria, especially gram-negative bacilli, in sites such as the oropharynx.^{36,37}

Similar patterns of increased resistance to other antibiotics prescribed for dental infections appear not to have been reported.³⁸ Of specific interest is the extremely low incidence of resistance to clindamycin,¹¹ even in countries such as Germany and Japan, where this agent is used frequently to treat acute dental infections.³⁹

USE OF ANTIBIOTICS IN DENTAL INFECTIONS

The majority of acute dental infections can be managed successfully through surgical drainage alone.¹¹ However, occasions do arise when adequate drainage cannot be achieved or the patient has clinical signs of systemic upset. In these circumstances, it may be necessary to provide antimicrobial therapy. Identification of the causative organisms and determination of antimicrobial susceptibility in a specific patient are not practical in a general practice setting, because the specimen cannot be processed fast enough to be of value in making treatment decisions. Even in a hospital setting, microbiologic findings are rarely available to the clinician within the first 48 hours because of the prolonged incubation times required to isolate strict anaerobes. More recently, molecular-based techniques have been developed to provide rapid identification of particular bacterial species, especially penicillin-resistant *Prevotella* species. These techniques may prove helpful for bacterial identification if they become widely available in the future.^{40,41}

At present, recommendations of choice antimicrobial agents for particular forms of dental infections are based on published data. Agents in the penicillin group, principally phenoxymethylpenicillin and amoxicillin, traditionally have been regarded as the antimicrobials of choice in the treatment of acute dental infections in the United Kingdom, while erythromycin traditionally has been used as an alternative agent for patients with

hypersensitivity to penicillins.⁴² However, resistance to these antimicrobial agents has been demonstrated within the oral flora and this observation must be taken into consideration when prescribing these drugs.⁴³ Other antimicrobial agents that have been suggested for the treatment of acute dental infections include metronidazole,⁴⁴ ornidazole,⁴⁵ cephalosporin,⁴⁶ azithromycin,⁴⁷ spiramycin,⁴⁷ amoxicillin-clavulanate,⁴⁸ and clindamycin.^{31,49} Standard dosages usually are used for dental outpatients, although increased dosages and combination therapy have been recommended for severe infections or when surgical drainage cannot be achieved.¹¹ In the treatment of acute dentoalveolar abscess, a high-dosage, short-course (3-g amoxicillin twice in 8 hours) treatment regimen has been found to be as effective as a conventional 5-day course of penicillin (250 mg every 6 hours).⁵⁰ Combination therapy most frequently involves the use of metronidazole with either penicillin or amoxicillin.⁵¹

Referral to a specialist is required when a patient presents with symptoms of cellulitis, difficulty in swallowing, tachycardia, hypotension, raised temperature, lethargy, or dehydration. Specialist care also may be necessary when standard outpatient treatment fails to result in symptomatic improvement. Hospitalization and provision of intravenous antibiotics is necessary when a patient has marked tissue swelling (particularly in the neck), inadequate hydration, and fever. Management of such infections should be aggressive, because rapid systemic involvement can ensue.⁵²

Dental infection remains a significant threat to the patient. Untreated or inadequately treated infections can progress to cause widespread swelling of the tissue spaces in the head and neck (Ludwig's angina), with the spread of infection to the mediastinum. Death from dental infections still occurs, especially in developing countries, due to late intervention and/or treatment failure.^{52,53} Airway management is the sine qua non of therapy, often necessitating intubation or a surgical airway (such as a tracheostomy) as a life-saving measure.⁵³ In children, these infections occur most frequently in the maxilla and can spread rapidly into the periorbital tissues with generalized systemic symptoms.^{54,55} These observations emphasize the importance of timely surgical treatment of dental infection, supported by appropriate antimicrobial therapy.

Periodontal disease

Numerous studies have shown that the clinical outcome of periodontal treatment is improved if specific microbial pathogens are eradicated from the tissues.⁵⁶ Because local scaling and root planing alone cannot achieve this predictably, mechanical treatment has been combined with the delivery of either topical or systemic

antimicrobial therapy.⁵⁷⁻⁵⁹ Agents used in this situation include amoxicillin, clindamycin, metronidazole, tetracycline, and doxycycline. Interestingly, results of recent trials indicate that some of the therapeutic effects are due, in part, to properties other than the antimicrobial activity of these drugs. Some antibiotics have been shown to have antiinflammatory properties that are independent of their antimicrobial activities.^{60,61}

Peri-implantitis

Peri-implantitis has been shown to respond to local mechanical and chemical means of reducing the microbial flora in the immediate vicinity of the implant. However, consideration has to be given to the possibility of causing physical damage to the surface of the implant. Irrigation with an antiseptic, such as chlorhexidine, has been found to be beneficial.⁶² Alternatively, the efficacy of systemic antimicrobial therapy, such as amoxicillin, metronidazole, ornidazole, or tetracycline, has also been investigated.^{62,63}

ANTIMICROBIAL ACTIVITY OF CLINDAMYCIN

Clindamycin works by inhibiting protein synthesis at the bacterial 50S ribosomal subunit, thus interfering with the process of peptide-chain formation in bacteria.⁶⁴ It also may inhibit the binding of aminoacyl-transfer ribonucleic acid (tRNA) or the translocation of messenger ribonucleic acid (mRNA) following amino acid binding on the ribosome, further disrupting protein synthesis.⁶⁵

Clindamycin has a high level of in vitro activity against a variety of facultative and strictly anaerobic bacteria. The spectrum of susceptible gram-positive organisms includes *Actinomyces*, *Eubacterium*, *Lactobacillus*, *Peptostreptococcus*, *Propionibacterium*, and *Staphylococcus* species, including penicillin-resistant strains.⁶⁶⁻⁶⁸ Clindamycin also is effective against β -hemolytic streptococci (groups A, B, C, and G), *Streptococcus viridans* group, and members of the *Smilleri* group. With regard to strict anaerobes, clindamycin has activity against a range of gram-negative species, including *Porphyromonas* species, *Prevotella* species, *Bacteroides fragilis* group, *Veillonella* species, and *Fusobacterium* species, including β -lactamase-producing strains. Although this drug's activity is poor against gram-negative facultative organisms, such as *Eikenella corrodens*, *Haemophilus* species, *Moraxella* species, and *Escherichia coli*, these organisms have not been implicated as major pathogens in dental infections.

In addition to a direct antibacterial effect on ribosomal units, clindamycin has a number of unique pharmacologic features that enhance its clinical efficacy (Table II). Clindamycin is the only proven antibiotic that reduces the adherence of bacteria to the epithelial

Table II. Pharmacologic features of clindamycin

Wide spectrum of in vitro antimicrobial activity that includes those species implicated as pathogens in dental infections
Achievement of high levels in saliva, gingival crevicular fluid, and bone
Reduction of the expression of virulence factors (M protein, capsule, and toxins)
Increased bacterial phagocytosis and killing
Intracellular activity
Activity in conjunction with the host defense system
Suppression of the adherence of bacteria to the mucosal epithelial cells and the expression of virulence factors (such as production of M protein by β -hemolytic streptococci, capsule formation by facultative gram-positive <i>Streptococcus</i> species)
Postantibiotic effect

cells of mucosal surfaces and inhibits the expression of virulence factors. The antimicrobial inhibits the production of M protein by group A β -hemolytic streptococci, thereby inhibiting capsule formation by facultative gram-positive *Streptococcus* species.^{69,70} It also inhibits toxins produced by *Clostridium* species and *S aureus*. Furthermore, clindamycin can inhibit bacterial proteins, toxins, enzymes, and cytokines once bacteria are inside target tissue.⁷⁰ Clindamycin induces morphologic changes on the surface of bacteria that render them more susceptible to being killed and also stimulates chemotaxis, thus promoting mobilization of polymorphonuclear leukocytes to the site of infection and resulting in ingestion of bacteria.

TISSUE CONCENTRATIONS OF CLINDAMYCIN

Clindamycin reaches high concentrations in saliva, GCF, and bone. Several studies have shown that the concentration of clindamycin in these tissues is approximately 40% to 50% of the concentration in serum.⁶⁵ In a recent animal study, Zetner and colleagues found that the mean concentration of clindamycin in mandibular bone in dogs and cats was approximately 3 times the serum concentration after intravenous infusion of clindamycin.⁷¹ In another study, the concentration of clindamycin in bone and other tissue was above the minimal concentration at which 90% of the isolates are inhibited (MIC₉₀) for pathogens that are likely to be introduced into the tissues in patients undergoing oral and maxillofacial surgery.⁷² The ability of this antimicrobial to reach high intracellular concentrations in tissues facilitates activity against intracellular pathogens by enhancing opsonization, phagocytosis, and intracellular killing by macrophages.⁷³ The high intracellular concentration of clindamycin and extended activity inside the bacterium yield a postantibiotic effect by which the antimicrobial remains active although serum concentration levels are subinhibitory.⁷⁴ This postantibiotic effect may vary with the type of bacte-

rium, but 1 in vitro study indicated that the effect of clindamycin on *S aureus* can last from 1.7 to 4 hours, depending on the strain of *S aureus*.⁷⁵

CLINDAMYCIN TOLERABILITY

Clindamycin is well tolerated and, throughout more than 3 decades of wide use, has rarely caused hypersensitivity reactions or other adverse effects.⁷⁶ Anaphylaxis with clindamycin is extremely rare.⁷⁶ Historically, there has been a perceived association between clindamycin and the development of *C difficile*-induced diarrhea and pseudomembranous colitis. However, it is increasingly recognized that this putative association is not justified and is based on limited and outdated information.^{7,77} The long-standing misperception that clindamycin poses a high risk for colitis is based on the fact that antibiotic-associated colitis was first recognized in patients taking clindamycin approximately 30 years ago, well before many of the agents now being routinely used in medicine and dentistry were available. This potential adverse event was studied in an animal model using only clindamycin, with no other antimicrobials investigated for comparative purposes. Thus, it was not known at the time that this effect, although rare, can be observed in many other antimicrobials to the same extent as that seen with clindamycin.⁷⁸

In recent years, the relationship between colitis and antibiotics has been studied far more extensively. Studies involving ambulatory care patients have shown that the likelihood of pseudomembranous colitis is extremely low in a primary care setting, such as in a general dental practice. This research has revealed the incidence of colitis is as low as 6.7 cases per 100,000 antibiotic exposures.⁷⁹ Specific risk factors for the development of *C difficile* infection have now been identified and include any concurrent antibiotic therapy and hospital admission,⁸⁰ factors that are rarely encountered in the treatment of dental infections.

An analysis of 49 published reports involving a spectrum of antimicrobial agents reveals that clindamycin is not the primary antibiotic that causes colitis, but falls within the middle of the range of drugs studied.⁷ The relative risk of developing colitis was higher with the use of amoxicillin-clavulanate than with clindamycin.⁷ Amoxicillin-clavulanate is an antibiotic used widely in medicine and is frequently prescribed for acute dental infections by medical practitioners in the United States and Europe. Further, in the unlikely event of development of pseudomembranous colitis in a patient, this complication now can be treated successfully.

On the strength of the foregoing microbiologic and therapeutic evidence, it is apparent that clindamycin can

play a useful role in the treatment of a number of dental and maxillofacial infections.

CLINDAMYCIN IN THE TREATMENT OF DENTAL AND MAXILLOFACIAL INFECTIONS

Acute dental infections

The efficacy of clindamycin in dental infections has been investigated in 5 prospective, randomized-controlled, clinical trials, and 1 retrospective study, mostly involving management of periapical abscesses (Table III). The clinical trials effectiveness was high, with success rates of 97%-100%. The dosage of clindamycin used in these studies was 600 mg/day (150 mg 4 times daily), except for the retrospective study, in which patients received 1200 to 2400 mg/day. In addition, the clinical improvement in pain, fever, and swelling occurred more rapidly in patients receiving clindamycin than in those given the control therapy (usually penicillin). In practice, the recommended dosing for clindamycin ranges from 150 mg 4 times daily to 300 mg 4 times daily.

In vitro susceptibility tests included in the aforementioned studies demonstrated that the majority of isolates were inhibited by a clindamycin concentration of 1.2 µg/mL or less. Clindamycin inhibited 94%-100% of anaerobic clinical isolates with MIC < 1.2 µg/mL and 90%-100% of aerobic isolates with MIC < 1.0 µg/mL.^{5,31,81} A dose of 300 mg produces a 1.1 µg/mL concentration in GCF after 6 hours, well above serum concentrations (0.1 µg/mL).

Periodontal disease

Four trials involving patients with periodontal disease have shown long-term benefits in the treatment of refractory disease for clindamycin at a dosage of 600 mg/day for 7 days. The endpoints used were clinical features combined with microbiologic outcomes at 1 and 2 years.⁸²⁻⁸⁴ One study revealed that clindamycin was superior to tetracycline at follow-up after 1 year.⁸⁵

Peri-implantitis

There are no clinical trials assessing the efficacy of clindamycin either at the time of implant placement or at subsequent development of peri-implantitis. The drug's spectrum of antimicrobial activity along with the high concentrations achieved in bone indicate that clindamycin could be an effective agent in the management of implant-related infections, an issue deserving further investigation.

CONCLUSIONS

Clindamycin has been used clinically for more than 30 years and has demonstrated a good record of efficacy and safety in a variety of infections, including

Table III. Clinical trials assessing efficacy of clindamycin in the treatment of odontogenic infections

Clinical trial	n	Dosage and regimen	Success rate, %
Schuen 1974 ^{5,31,81,86-88}	36	Clindamycin 150 mg PO q 6 h for 6 days	100
	32	Penicillin V 250 mg q 6 h for 6 days	97
Kannagara 1980 ⁸⁸	10	Clindamycin phosphate 300-600 mg IV or IM q 6 h for 5 days	100
	25	Penicillin 4-20 million units q 24 h for 5 days	80
Gilmore 1988 ⁸¹	28	Clindamycin 150 mg PO q 6 h for 7 days	100
	27	Phenoxymethyl penicillin 250 mg q 6 h for 7 days	100
Mangundjaja 1996 ⁸⁷	74	Clindamycin 150 mg PO q 6 h for 7 days	100
	73	Clindamycin 150 mg PO + ibuprofen 600 mg PO q 6 h for 7 days	99
Mangundjaja 1990 ⁵	52	Clindamycin 150 mg PO q 6 h for 7 days	100
	54	Ampicillin 250 mg PO q 6 h for 7 days	98
von Konow 1992 ³¹	30	Clindamycin 150 mg PO q 6 h for 7 days	97
	30	Phenoxymethyl penicillin 1 g q 12 h for 7 days	97

PO, by mouth; IV, intravenous; IM, intramuscular.

Adapted from Ehrenfeld et al.⁸⁹

odontogenic infections. Nevertheless, the use of this agent has been limited, generally owing to concern about the development of antibiotic-associated pseudomembranous colitis. However, data indicate that the association between clindamycin and pseudomembranous colitis is unfounded, because it rarely occurs in outpatients treated with clindamycin. The occurrence of pseudomembranous colitis is no greater with clindamycin than with many other commonly used antibiotics.

Clindamycin is a unique antimicrobial that achieves high tissue (including bone) concentrations, penetrates intracellularly, increases phagocytosis, inhibits toxin production, and has a postantibiotic effect. A review of the microbiologic and clinical literature relating to maxillofacial infections has revealed this antimicrobial to be a highly effective agent in the field of dentistry. On this basis, clindamycin should be considered as a first-line antimicrobial for all dental infections.

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