



Contents lists available at ScienceDirect

# Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology

journal homepage: [www.elsevier.com/locate/jomsm](http://www.elsevier.com/locate/jomsm)

## Review article

# A review of antibiotic prophylaxis protocols in oral and maxillofacial surgery

Paksinee Kamolratanakul\*, Pornchai Jansisyanont

Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Chulalongkorn University, Bangkok, 10330, Thailand

## ARTICLE INFO

### Keywords:

Antibiotic prophylaxis  
Orthognathic surgery  
Dental implant  
Wisdom teeth

## ABSTRACT

**Objective:** To review the current literature on the use of antibiotic prophylaxis and provide comprehensive conclusions for antibiotic protocols in orthognathic surgery, dental implant surgery, and the surgical removal of wisdom teeth.

**Results and conclusions:** The literature revealed that the penicillin group is the most commonly used antibiotic prior to orthognathic surgery, implant surgery, and the removal of wisdom teeth due to its bactericidal effect and that most common pathogens in the oral cavity are susceptible to the penicillins. A preoperative dose of an antibiotic is recommended for all surgical procedures. In contrast, single and extended postoperative antibiotic use remains controversial among clinicians. Clinicians should tailor their use of postoperative antibiotics as is appropriate for each individual case to avoid inappropriate antibiotic use.

## 1. Introduction

Infection is one of the most common postoperative complications in oral and maxillofacial surgery. Many studies have demonstrated the use of antibiotics as a preventive treatment for infection [1,2]. Although antibiotic prophylaxis protocols have been previously described, their appropriate clinical use is still unresolved.

Generally, there are 4 indications for antibiotic prophylaxis [1,2]. First, the antibiotic is administered to prevent bacterial contamination of the sterile field. Second, the procedures have a high infection rate. Third, antibiotic prophylaxis should be considered for surgical procedures where although the incidence of infection is low, there is a high mortality rate following infection. Last, when a foreign body is inserted into the tissue.

There are also some considerations before using antibiotic prophylaxis: 1) The infection rate of the surgical procedure, 2) The appropriate use of an antibiotic, 3) The tissue concentration of the antibiotic, and 4) The duration of antibiotic administration [2].

The infection rate of a surgical procedure depends on the surgical wound's condition and bacterial contamination of the surgical area. The surgical wound can be classified as a clean, clean-contaminated, contaminated and dirty, or infected wound with estimating infection rates of < 1–5%, 3–11%, 10–17%, and > 27%, respectively. Antibiotic prophylaxis should not be used if the infection rate of a specific procedure is  $\leq 5\%$  [3–6].

According to the principles of infection, patient condition, normal flora, and involved microorganisms, the type of surgical procedure and the risk of contamination/infection of the wound have to be considered. Most oral and maxillofacial procedures are classified as a clean contaminated wound, such as orthognathic surgery, impacted tooth removal, and implant surgery [5,7–9].

The selected antibiotic should be bactericidal and effective against the most common micro-organisms that cause infection associated with the procedure to be performed. In the oral cavity, the most common micro-organisms that cause infection are streptococci (aerobic gram positive cocci), bacteroides (anaerobic gram negative rods), and peptococci (anaerobic gram positive cocci). Thus the surgeon should choose the antibiotic that is most effective against the causative microorganism [1,2].

The concentration of antibiotics in the tissue should be at the appropriate level when the bacteria enter the surgical wound. The quantity of antibiotic at the beginning of the surgery should be high enough to make the drug's concentration in the blood 3–4 fold that of the minimum inhibitory concentration. To achieve this, the antibiotic is typically given at twice the treatment dose, 1 h before surgery [1,2,4].

The duration of antibiotic administration can be either a single preoperative dose or extended post-operatively for more than 7 days. The antibiotic should be given post-operatively in the following situations: the patient has a systemic disease that might affect wound healing, the insertion of a foreign body (e.g. a dental implant), has periodontal

\* Corresponding author at: Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Chulalongkorn University, 34 Henri-Dunant road, Pratumwan, Bangkok 10330, Thailand.

E-mail address: [paksinee.k@chula.ac.th](mailto:paksinee.k@chula.ac.th) (P. Kamolratanakul).

<https://doi.org/10.1016/j.ajoms.2018.03.008>

Received 20 June 2016; Received in revised form 19 January 2018; Accepted 20 March 2018

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disease, an inflamed surgical area, an ill-fitting denture, wound dehiscence, poor oral hygiene, inadequate surgical skill, a prolonged operating time, or wound contamination during surgery [4,10–13].

The use of antibiotics is reported to reduce the infection rate, however, inappropriate antibiotic administration can lead to the development of side effects [14]. Most side effects are not serious and are easily resolved. These side effects are complications associated with the gastrointestinal system, resistant bacteria, secondary infection, antibiotic toxicity, adverse reaction, and increased health care cost [7,8,15]. However, some side effects such as an anaphylactic reaction or *Pseudomembranous colitis* can be life threatening. The incidence of pseudomembranous colitis, which is one of the GI side effects, has been increasing [16]. In these cases, the antibiotic used changes the balance of the intestinal micro-organisms, increasing the amount of *Clostridium difficile* sufficiently to cause this condition.

This review of the current literature aims to evaluate and determine whether the use of antibiotic prophylaxis is necessary and outlines the guidelines for antibiotic prophylaxis in a variety of oral and maxillofacial procedures. If there is no consensus for antibiotic prophylaxis for specific procedures, we review what is the most commonly used antibiotic for those procedures. This review focuses on orthognathic surgery, dental implant surgery, and the surgical removal of wisdom teeth.

## 2. Antibiotic prophylaxis in orthognathic surgery

### 2.1. Incidence and risk of infection as a complication

Orthognathic surgery is usually performed in young healthy patients without serious comorbidities. Orthognathic surgery is classified as a clean-contaminated wound and has an infection risk of 3–11%. Chow LK. et al. showed that post-operative infection occurred in approximately 7.4% of all cases (76.8% in complicated cases) [5], whereas other studies reported that the most common complication of orthognathic surgery was unexpected intraoperative osteotomy fracture and postoperative sensory disturbance or nerve injury was with an infection rate of less than 3% [17,18]. In cases with post-operative infection, 2% of the infected cases were related to poor oral hygiene and/or smoking. The specific orthognathic procedure has been shown to affect the infection rate; a trans-buccal approach for mandibular fixation had a greater incidence of infection compared with that of sagittal osteotomy fixation [8,18].

### 2.2. Related microorganisms

Aerobic bacteria (*Streptococci*) and anaerobic gram positive coccid (*Bacteroides*) bacteria are mainly found in infected intraoral orthognathic cases [5,8], however, some reports found the occasional infection of gram-negative rods or actinomycetes [19] or contamination by *Clostridium difficile* [16]. Moreover, Lindeboom et al. found 3/70 patients developed infection demonstrating penicillin-sensitive streptococci in the exudate [20].

### 2.3. Antibiotic regimens

Based on studies of the bacteria that have been found to cause postoperative infection, the use of a member of the beta-lactam antibiotic group such as penicillin, or the intraoral use of amoxicillin with or without clavulanate [7,21–27], ampicillin [21] or a member of the cephalosporin group was recommended [25,27]. There was no significant difference in the infection rate between the use of amoxicillin or ampicillin [28,29] amoxicillin-clavulanic acid or penicillin [26,29], or amoxicillin/clavulanic acid or cefuroxime [25,29]. These data were consistent with a report that showed no significant difference when using penicillin or a non-penicillin [5]. In contrast, Lindeboom et al. found that the administration of clindamycin when performing

orthognathic surgery reduced the incidence of infection [20]. Spaey et al. showed that although the microorganisms found in infected cases were sensitive to amoxicillin-clavulanate and clindamycin, they were resistant to cefazolin [8]. In addition, streptococci, the predominant oral pathogen, showed lower resistance rates to penicillins (3%) compared with clindamycin (16%) [30]. Classen et al. suggested that the administration of antibiotic prophylaxis 2 h prior to the operation reduced the rate of wound infection [31]. However, there are several regimens that have been proposed for the dose and duration of antibiotics used with orthognathic surgery, such as short-term (defined as a single antibiotic dose preoperatively or perioperatively [32] or antibiotic prophylaxis prescribed before or 24 h after surgery [29]) and extended or long-term antibiotic prophylaxis (defined as preoperative, perioperative and postoperative antibiotic administration [32] or antibiotic prophylaxis prescribed for longer than 24 h [29]). Bentley et al. and Baqain et al. reported the benefit of long-term antibiotic prophylaxis [7,24] whereas Jansisyantont et al. and Kang et al. recommended short-term antibiotic prophylaxis [26,27]. A meta-analysis and systematic review by Tan et al. and Oomens et al., respectively, showed the benefit of preoperative antibiotic prophylaxis with or without a single postoperative dose [9,33]. However, Petersen et al. and Danda et al. evaluated surgical site infection after short or long-term antibiotic prophylaxis, finding that infection was more likely to be present in patients who were prescribed short-term prophylaxis compared with those receiving long-term antibiotics and did not find any adverse events associated with any regimens [29,32]. In addition, there was no difference in infection between subjects who received short-term antibiotics postoperatively compared with a single preoperative dose [20,21,29].

### 2.4. Conclusion for antibiotic prophylaxis in orthognathic surgery

Preoperative antibiotic prophylaxis is recommended for orthognathic surgery because most of the studies prescribed penicillin, amoxicillin, or amoxicillin-clavulanic acid (Table 1) [7,20,21,24–28]. This data is consistent with the concept of antibiotic prescription that aims to increase the level of antibiotic concentration in the circulation prior to surgical incision. Moreover, penicillin is effective against the intraoral micro-organism. However, we found that there are differences between the studies concerning the duration of antibiotic treatment. The systematic and the meta-analysis of 4 studies [9,29,32,33] was unclear whether the authors favored short-term or extended-term antibiotic use (Table 2) [9,29,32,33]. Based on the infection risk, microorganisms, and the studies of antibiotic regimens, we recommend that penicillin use is suitable for orthognathic surgery when used as a preoperative dose with short-term postoperative antibiotics (antibiotics that are prescribed within a day after surgery). The extended postoperative dose duration (3–5 days after surgery) remains undefined.

## 3. Antibiotic prophylaxis in dental implant surgery

### 3.1. Incidence and risk of infection as a complication

Dental implants have played an important role in dentistry by restoring either a partially or completely edentulous area. Although the success rate of dental implants is high, the failure rate varies from 0 to 10% [34].

Infection is an important factor related to dental implant failure [35]. Infection following implant surgery can reduce the crestal bone level around the dental implant, the outcome of grafting procedures, and the success rate of the dental implant [13]. Antibiotics have been widely used for dental implant surgery, however sometimes the antibiotics are used inappropriately.

The factors affecting the initial success rate following implant surgery can be divided into 5 groups: 1) the dental implant, 2) bio-mechanical factors, 3) patients' local factors, such as an inadequate

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