

Evidence-based systemic antibiotic prescription in periodontal and dental implant procedures: A mini-review

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ABSTRACT: Purpose: To evaluate and summarize the available scientific evidence regarding antibiotic prescription protocols in periodontal and dental implant procedures. **Methods:** A bibliographic search was conducted in PubMed, ScienceDirect, Scielo, Cochrane Library, EBSCOhost and Google Scholar up to February 2023. Manual and electronic searches were conducted, including publications in English. Medical Subject Headings (MeSH), free text terms and Boolean operators were used. **Results:** Antibiotic prescription protocols have been restricted due to antimicrobial resistance. While for certain clinical circumstances there are guidelines with clear and unanimous criteria for appropriate antibiotic use, for other conditions evidence showed an insufficiency of available literature and the persistence of crucial issues where no consensus has been reached. (*Am J Dent* 2023;36:287-296).

CLINICAL SIGNIFICANCE: This mini-review summarizes the most up-to-date recommendations regarding the prescription of antibiotics in periodontal and dental implant procedures in order to guide evidence-based decision-making.

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Introduction

To achieve more satisfactory clinical results in periodontics and dental implantology, systemic antibiotics have been used to complement traditional mechanical treatment methods.¹⁻⁴ The use of antibiotics has been justified in the polymicrobial etiology of the main conditions that threaten the integrity of periodontal and peri-implant tissues.^{5,6} Moreover, the large number of microorganisms harbored in the oral cavity has been a matter of concern for clinicians, which has led to the prophylactic use of antibiotics to avoid postoperative complications of infectious origin.^{7,8} In this framework, heterogeneous prescription patterns and overuse of antibiotics among periodontists and implantologists have been reported.^{1,9-14} Therefore, the dental community has played an important role in the loss of susceptibility of microorganisms to available antibiotics, which poses a global public health threat.^{15,16} In fact, studies have shown antibiotic resistance even in the subgingival microbiota.¹⁷⁻²⁰ Additionally, the adverse events and side effects derived from antibiotic use are another issue of concern.^{1,21}

The lack of updated official guidelines that synthesize the scientific literature has hampered the adherence to recommendations on prescription protocols in periodontics and implantology, hindering the ability of clinicians to make judicious decisions.^{1,10,22-25} Consequently, specialists have been submerged in a vast amount of contradictory and obsolete data, which make it difficult to filter the information. However, the situation differs when it comes to certain clinical procedures, as reliable information is limited. This mini-review article evaluated and summarized the available scientific evidence regarding antibiotic prescription protocols in periodontal and dental implant procedures.

Materials and Methods

The bibliographic search was carried out in PubMed, ScienceDirect, Scielo, Cochrane Library, EBSCOhost and Google Scholar up to February 2023. The most recent guide-

lines, umbrella reviews, meta-analyses, systematic reviews, consensus documents, and other publications issued by entities and professionals in the area were included. However, in cases where the availability of information was limited, the authors strove to gather the most reliable and up-to-date data that has been reported.

Manual and electronic searches were conducted and included publications in English. The following combination of Medical Subject Headings (MeSH), free text terms, and Boolean operators were used:

Antibiotic AND ("periodontics" OR "periodontology" OR "periodontal therapy" OR "periodontal treatment" OR "non-surgical periodontal treatment" OR "non-surgical periodontal therapy" OR "surgical periodontal treatment" OR "surgical periodontal therapy" OR "periodontal surgery" OR "periodontal diseases" OR "gingival diseases" OR "gingivitis" OR "periodontitis" OR "gum" OR "gum disease" OR "clinical attachment loss" OR "gingival bleeding" OR "prophylaxis").

Antibiotic AND ("acute periodontal disease" OR "acute periodontal lesion" OR "periodontal abscess" OR "necrotizing periodontal disease" OR "necrotizing gingivitis" OR "gingivitis, necrotizing ulcerative" OR "necrotizing periodontitis" OR "necrotizing stomatitis" OR "endodontic-periodontal lesion" OR "endoperio lesion" OR "endo-perio lesion" OR "endo-periodontal lesion").

Antibiotic AND ("periodontal biopsy" OR "gingival biopsy" OR "oral biopsy" OR "soft tissue removal").

Antibiotic AND ("mucogingival surgery" OR "plastic periodontal surgery" OR "periodontal plastic surgery" OR "mucogingival conditions" OR "mucogingival deformities" OR "vestibuloplasty" OR "frenectomy" OR "labial frenum" OR "free gingival graft" OR "grafting procedures" OR "connective tissue graft" OR "soft tissue augmentation" OR "root coverage" OR "periodontal regeneration" OR "guided tissue regeneration, periodontal" OR "guided tissue regeneration" OR "emdogain" OR "enamel matrix proteins").

Antibiotic AND ("implantology" OR "mucositis" OR "peri-

Table 1. Antibiotic regimens for dental procedures (adapted from AHA 2021 guidelines).³³

Situation	Agent	Adult dosage – (single dose 30-60 minutes before procedure)
Oral	Amoxicillin	2 g
Unable to take oral medication	Ampicillin	2 g IM or IV
	Cefazolin or ceftriaxone	1 g IM or IV
	Cephalexin*†	2 g
Oral option for allergic to penicillin or ampicillin patients	Azithromycin or clarithromycin	500 mg
	Doxycycline	100 mg
	Cefazolin or ceftriaxone†	1 g IM or IV

IM - intramuscular; IV - intravenous.

* Or other first- or second-generation oral cephalosporin in equivalent adult dosing.

† Cephalosporins should not be used in an individual with a history of anaphylaxis, angioedema, or urticarial with penicillin or ampicillin.

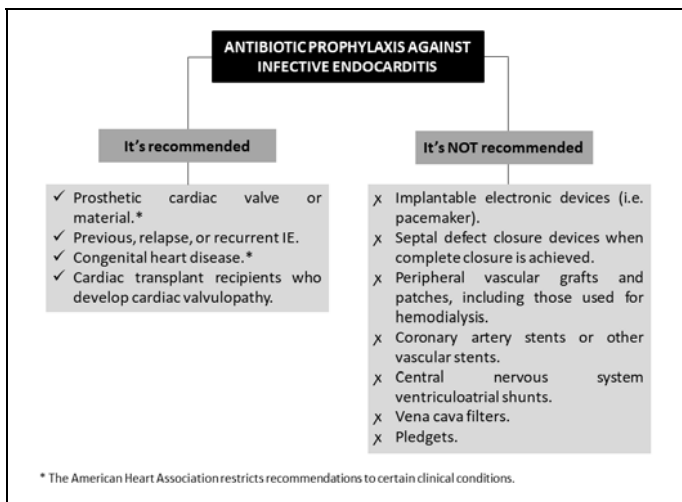


Figure. Antibiotic prophylaxis recommendations for specific clinical conditions before dental procedures (adapted from American Heart Association guidelines).³³

implantitis" OR "periimplantitis" OR "dental implants" OR "dental implant placement" OR "periimplant disease" OR "peri-implant disease" OR "periimplant infection" OR "peri-implant infection").

Antibiotic AND ("regenerative periodontal therapy" OR "periodontal bone surgery" OR "crown lengthening" OR "guided bone regeneration" OR "bone regeneration" OR "socket regeneration" OR "socket preservation" OR "socket augmentation" OR "alveolar ridge preservation" OR "alveolar socket preservation" OR "sinus reconstruction" OR "sinus augmentation" OR "sinus floor augmentation" OR "sinus lift" OR "sinus elevation").

Results and Discussion

The available scientific evidence is presented below in two general sections. First, the use of prophylactic antibiotics in patients with systemic conditions is summarized. The second section addresses the prescribing of antibiotics for different procedures and clinical scenarios of periodontics and dental implantology.

Antibiotic prophylaxis: An overview of its indications in periodontology and dental implantology

Systemic antibiotics can be used prophylactically or therapeutically according to the purpose and time of prescription. Thus, the term antibiotic therapy refers to the use of antibiotics to treat an infection, while the term antibiotic prophylaxis (AP) is employed when the drug is administered to prevent infections, either locally or at a distant site.^{26,27}

In the clinical field, the routine prescription of prophylactic antibiotics in periodontics and implantology in healthy individuals is a controversial issue, given the minimal infection risk associated with most procedures. Currently, it is understood that this practice should be applied with caution.^{7,8,21} Subsequently, this aspect will be further explored.

The use of antibiotics to prevent distant infections is based on the transient bacteremia that occurs secondary to trauma to the oral mucosa, which is colonized by an endogenous microflora.²⁸ Therefore, certain patients require special care to avoid systemic complications, such as infective endocarditis (IE).²⁷ Various guidelines have been published regarding antibiotic prophylaxis against IE, but substantial discrepancies between the provided recommendations have been evident due to the lack of clarification on crucial aspects related to the subject.^{28,29}

Due to the increasing rate of bacteria resistance to antimicrobials and the demonstration that routine activities, such as tooth brushing, represent a main cause of bacteremia, these guidelines have been under review. Consequently, the prescription of antibiotics has been restricted to a smaller number of dental procedures and limited to patients with specific profiles. The regime of use has also been restricted.²⁹ Thus, the National Institute for Health and Clinical Excellence (NICE) of the United Kingdom (UK) presents a more radical position and does not recommend the routine use of antibiotics prior to dental interventions.³⁰ Therefore, under certain circumstances, non-routine management could be considered, which is described in publications of the Scottish Dental Clinical Effectiveness Programme.³¹ On the other hand, the European Society of Cardiology³² and the American Heart Association²⁹ (AHA) share similar ideologies, recommending prophylactic antibiotic use in clinical situations in which the benefits outweigh the possible risks.

The 2007 AHA guideline, updated in 2021, stated that antibiotic prophylaxis should not be recommended for patients at the highest risk of acquiring IE, but rather for those facing the greatest risk of adverse outcomes from IE.^{29,33} The Figure shows in which cases antibiotic prophylaxis is or is not recommended before dental intervention procedures.³³

According to the AHA statements, all dental procedures where the gingival or periapical tissues are manipulated or where a perforation of the oral mucosa is involved require AP to prevent IE. Table 1 shows the antibiotic regimens. Conversely, anesthetic injections through uninfected tissues, dental X-rays, placement or adjustment of removable prosthodontic or orthodontic appliances, exfoliation of primary teeth, and bleed-

ing from trauma to the lips or oral mucosa are clinical situations in which the prescribing of antibiotics is not recommended.^{29,33}

The use of the antimicrobials after an intervention should be limited to those cases in which it inadvertently had not been provided preoperatively, and they can be taken up to 2 hours after the treatment. Consultation of the 2021 AHA guideline is encouraged for further details.³³

Regarding antibiotic use in patients with prosthetic joint implants, in 2012 the Academy of Orthopedic Surgeons (AAOS) and the American Dental Association (ADA) discontinued the routine recommendation of prophylactic antibiotics before dental procedures.^{34,35} Subsequently, in 2016 both organizations published the appropriate AP criteria according to patients' clinical circumstances.^{36,37}

Some authors have considered antibiotic prophylaxis for other clinical scenarios not addressed in this article. The following categories have been mentioned in the literature: immunocompromised individuals; patients who fall under the American Society of Anesthesiology Physical Status Classification System levels 3-5; patients undergoing high-dose irradiation on the jawbones; or patients using bisphosphonates.^{21,27,38}

Systemic antibiotic prescription in periodontics and dental implantology

Gingivitis - The published guidelines state that gingivitis generally responds favorably to conventional therapy and therefore, the use of antibiotics is not warranted. In fact, patients with gingivitis would not obtain significant clinical benefits from their use.^{21,39}

Non-surgical treatment of periodontitis - Even though conventional periodontal treatment has proven to be effective, it has limitations when it comes to treating deep pockets with irregular anatomy, curves, and undulations, as well as areas of furcation and bone defects.^{2,3} Furthermore, the subgingival microbiota is capable of invading the host tissues, such as the epithelium and dentin tubules.^{2,4} Thus, subgingival debridement is unable to achieve a complete change from the microbial profile toward a symbiotic one that is compatible with periodontal health.⁴⁰

In this framework, the adjunctive use of systemic antibiotics has been proposed. Multiple systematic reviews and meta-analyses have shown improvements in periodontal parameters, such as clinical attachment level, probing depth, and bleeding on probing, with the use of systemic antibiotics as adjuvants to subgingival debridement.⁴¹⁻⁴⁵ Nonetheless, certain authors have established that antibiotic therapy can only be expected to yield a small net benefit.⁴⁶ Considering the number of patients suffering from periodontitis, the worldwide problem of bacterial resistance and the potential side effects, the routine use of systemic antibiotics as an adjunct to scaling and root planing is contraindicated. This position is shared by a vast number of publications, several of which have been issued by the European Federation of Periodontology (EFP), the American Academy of Periodontology (AAP), the Scottish Dental Clinical Effectiveness Program, the Faculty of General Dental Practice (FGDP), and the Faculty of Dental Surgery of UK.^{15,21,39,47-49}

The EFP S3 Level Clinical Practice Guideline (CPG) of 2020 established that the prescription of systemic antibiotics should only be considered in particular situations, such as generalized periodontitis stage III in young adults.¹⁵ The FGDP and the Faculty of Dental Surgery of the UK share these same recom-

Table 2. Examples of reported regimens of antibiotic therapy adjunct to subgingival debridement.

Antibiotics	Adult dosage	Frequency	Time period
Amoxicillin + Metronidazole	250-500 mg + 200-500 mg	q8h	3-14 days
Metronidazole	200-500 mg	q8h	7-14 days
Amoxicillin	250-500 mg	q8h	7-8 days
Amoxicillin + clavulanic acid	250-500 mg 125 mg	q8h	10-14 days
Azithromycin	500 mg	q8-24h	3-7 days
Doxycycline	100-200 mg 20 mg (sub-antimicrobial systemic dosing)	q24h q12-24h	5-21 days 3-9 months

Bibliographic sources: Walters & Lai,² Palmer,²¹ American Academy of Periodontology,³⁹ Teughels et al,⁴¹ Garcia et al,⁴⁴ Donos et al,⁶³ Harvey⁶⁴ and Khattri et al.⁶⁵

mendations in their guidelines, which specify the only clinical scenario in which antibiotics are recommended as an adjunct to periodontal therapy, namely, patients < 40 years of age with rapidly progressing periodontal disease (stage III or IV, grade C).²¹ Furthermore, previous publications have already described the rationale for antibiotic use in patients diagnosed with what was formerly known as "aggressive periodontitis".^{39,47,48,50-52}

Another category of patients not considered in the 2020 CPG comprised individuals who had severe and continuing clinical attachment loss, even after receiving appropriate mechanical periodontal therapy and adhering to oral hygiene instructions. Conversely, non-responsive periodontitis, formerly known as "refractory periodontitis," was included in previous publications of the EFP and AAP as a clinical scenario where patients could derive real benefits from adjunctive systemic antibiotics. This suggestion takes into account the possibility of persistent subgingival pathogens and an impaired host immune response.^{39,47,53,54} However, despite the results of a 2016 systematic review, which showed better clinical outcomes with adjunct antibiotic therapy, it was concluded that the available evidence did not support its use unequivocally.⁵⁵

In 2004 the AAP³⁹ justified the use of antibiotics as part of periodontal therapy for patients with systemic conditions predisposing them to periodontitis. Nevertheless, this recommendation must be accepted with caution due to the possible risks. Furthermore, recent evidence suggests that good clinical outcomes can be achieved through the implementation of mechanical therapy and the use of antiseptics alone.^{15,56} The appropriate approach in these cases is to refrain from antibiotic use, especially considering the results of recent meta-analyses that have shown improvements of limited clinical relevance with adjunctive antibiotic therapy in diabetic patients and smokers.^{57,58}

On the other hand, cases of periodontal pockets with purulent exudate and their proper management are scarcely described in the literature. Only one article from 2014⁵⁹ indicates that the treatment requires nothing more than scaling and root planing. In fact, some studies^{40,60} have described positive results with mechanical therapy alone.

As for the drugs to be used, favorable results have been found with metronidazole and azithromycin. However, the most recent meta-analysis showed better clinical outcomes with the combination of amoxicillin with metronidazole, especially in deeper periodontal pockets.⁴¹ Likewise, previous studies corro-

Table 3. Suggested antibiotic therapy for acute periodontal diseases.

Acute periodontal diseases	Antibiotics	Adult dosage	Dosage frequency	Time period
Periodontal abscess	Metronidazole*	200-250 mg	q8h	3 days
	Amoxicillin + clavulanic acid	500 mg + 125 mg	q8h	3 days
	Amoxicillin	Loading dose: 1 g		
		Maintenance dose: 500 mg	q8h	3-7 days
	Azithromycin	500 mg	q24h	3 days
		Loading dose: 1 g		
Necrotizing periodontal disease	Clarithromycin	500 mg	q24h	3 days
	Metronidazole*	200-400 mg	q12h	3-7 days
	Amoxicillin	500 mg-1 g	q8h	3-5 days
		500 mg-1 g	q8h	3-5 days

* First choice drug.

Bibliographic sources: Palmer,²¹ AAP,³⁹ Wray et al,⁷⁶ Leroy et al⁷⁷ and Herrera et al.⁷⁹

borate the efficacy of the prescription of amoxicillin + metronidazole as an adjunct to subgingival debridement.^{42,43,50,61} The combination of these drugs could inhibit a broader spectrum of bacteria, allow a synergistic effect, and decrease the risk of inducing bacterial resistance.^{2,39} However, despite the provided benefits, it is important to note that this drug combination has been associated with a higher frequency of side effects.⁴¹

To date, the most appropriate regimen for adjuvant antibiotic therapy has yet to be defined.^{48,62} The heterogeneity among the suggested protocols is remarkable (Table 2). The only published guideline that offers concrete recommendations suggests using 500 mg of amoxicillin and 400 mg of metronidazole three times a day for up to 5 days in adults. As a second option, the FGDP and the Faculty of Dental Surgery of UK suggest 500 mg of azithromycin once a day for 3 days.²¹

Another aspect that has been debated is the optimal timing of antibiotic use. Despite the lack of studies on the subject, two systematic reviews^{66,67} concluded that systemic antibiotic intake during the active phase of treatment leads to better clinical outcomes than when they are used during the re-evaluation period. Apparently, this approach allows for a better reduction of the microbial load, which in turn facilitates the recolonization of a more beneficial microflora.^{40,66} However, it is emphasized that these results must be confirmed through further studies.⁶⁶

The consensus report of the Sixth European Workshop on Periodontology suggested, based on indirect evidence, that antibiotics should be administered on the day of completing debridement, ideally within the shortest possible time frame (< 1 week).⁴⁷ The matrix of exopolysaccharides (glycocalyx) in the dental biofilm provides protection against the diffusion and effective action of drugs. Therefore, a disruption of the biofilm is required for antibiotics to be truly effective.^{2,47,68} Nevertheless, another publication reports similar results in patients who started antibiotic intake at the beginning or on the last day of periodontal instrumentation.⁴⁰

Surgical treatment of periodontitis - Despite the suggestion of some authors to prescribe antibiotics as part of the surgical treatment of periodontitis,^{39,69,70} most publications indicate that there is insufficient scientific evidence to support their routine use in healthy patients.^{2,47,59,71} In fact, multiple studies report a very low rate of infections related to this type of procedure, with no relevant clinical or microbiological implications derived from antibiotic use.^{7,25,72,73} Thus, recent guidelines make no mention of the intake of antibiotics as an adjunct to periodontal flap surgery.^{15,21,48}

Acute periodontal diseases - This group of conditions encompasses various pathologies, the most important of which are necrotizing periodontal diseases, periodontal abscesses, and endo-periodontal lesions (which can occur in acute or chronic forms).⁷⁴ The guidelines published from 2004 to 2020 indicate that local measures should be considered as the primary treatment approach, reserving antibiotic therapy exclusively for the acute phase and when there is evidence of spreading infection; systemic involvement (e.g., malaise, pyrexia, and lymphadenopathy); or lack of response to the treatment given (especially in cases of necrotizing diseases).^{21,39,48,75,76,77} In addition, reference has been made to the use of antibiotics in severe cases and immunocompromised patients with necrotizing periodontal diseases.^{48,75,76,78,79}

Antibiotics should be administered as an adjunct to mechanical therapy in cases of necrotizing periodontal diseases.^{79,80} Regarding periodontal abscesses, the literature specifies that systemic antibiotics can be prescribed as monotherapy or as an initial treatment if premedication is required due to the patient's profile, if the infection is not well localized, or if adequate drainage cannot be ensured. It should be noted that the Belgian Health Care Knowledge Centre specifies that, in the absence of trismus, the prescription of antibiotics should be avoided unless local measures are provided.⁷⁷ In addition, antibiotic therapy could also be prescribed as an adjunct to local measures only in patients showing evidence of systemic involvement.⁷⁹

Various regimens have been proposed for prescribing antibiotics to patients with acute periodontal diseases (Table 3),^{21,39,76,77,79} except for endo-periodontal lesions, for which no guidelines have been reported. Therefore, since these conditions involve both periodontium and periapical tissues, the suggested protocols for endodontic lesions⁸¹ can be taken into consideration and compared to the periodontal disease regimen to guide evidence-based decision-making (Table 4).

Periodontal soft tissue biopsy - This issue is addressed in only one of the guidelines consulted, which highlights the absence of randomized clinical trials about the effect of systemic antibiotics in these procedures. Therefore, the guidelines do not recommend antibiotic prophylaxis in these cases.²¹ In fact, in various studies where non-malignant gingival lesions were removed, antibiotics were not prescribed as part of the clinical protocol.^{82,83}

Periodontal plastic surgery - The lack of guidelines on the subject is noteworthy, but studies have reported the prescription of antibiotics as part of the care protocol for certain procedures (e.g., subepithelial connective tissue grafting).⁸⁴ Nonetheless, the

Table 4. Antibiotic regimens for endodontic infections (adapted from the recommendations of the European Society of Endodontology and the American Association of Endodontists).⁸¹

Antibiotics	Adult dosage	Dosage frequency	Time period
Penicillin VK	Loading dose: 1 g	Maintenance dose: 500 mg q4-6h	3-7 days
Amoxicillin	Loading dose: 1 g	Maintenance dose: 500 mg q8h or 875 mg q12h	3-7 days
Amoxicillin + clavulanic acid	Loading dose: 1 g	Maintenance dose: 500 mg q8h or 875 mg q12h	3-7 days
Clindamycin*	Loading dose: 600 mg	Maintenance dose: 300 mg q6h	3-7 days
Clarithromycin*	Loading dose: 500 mg	Maintenance dose: 250 mg q12h	3-7 days
Azithromycin*	Loading dose: 500 mg	Maintenance dose: 250 mg q24h	3-7 days
Metronidazole**	Loading dose: 1 g	Maintenance dose: 500 mg q6h	3-7 days

* For penicillin-allergic patients.

** Incorporate it into therapy in cases where other drugs are started, but symptoms worsen after 48-72 hours. It can be used in conjunction with penicillin or clindamycin. If started with penicillin VK, it can be maintained or changed to amoxicillin + clavulanic acid.

Table 5. Recommended antibiotic prophylaxis protocols in guided bone regeneration and maxillary sinus lift surgery

Antibiotic prophylaxis modality	Adult regimen	Procedure in which it is recommended
Short-course	Amoxicillin 2 or 3 g (1h before Surgery). Alternative for allergic patients: clindamycin (unspecified dose).*	GBR Sinus lift surgery (applied only in the absence of Schneider's membrane perforation). Note: some authors suggest providing an additional dose if the procedure lasts more than 3 hours.
Extended	Loading dose: amoxicillin + clavulanic acid 2 g with metronidazole 500 mg (1h before surgery). Maintenance dose: amoxicillin + clavulanic acid 1 g q8h for 7 days and metronidazole 250 mg q8h for 4 days. Amoxicillin + clavulanic acid 875/125 mg q12h for 7 days (starting 24h before surgery). Alternative for allergic patients: doxycycline 100 mg q12h for 7 days (starting 24h before surgery). Loading dose: amoxicillin + clavulanic acid 875/125 mg q12h (starting 24h before surgery). Maintenance dose: amoxicillin + clavulanic acid 875/125 mg q8h for 7 days. Alternative for allergic patients: ciprofloxacin 500 mg q12h for 9 days.	GBR Sinus lift surgery Sinus lift surgery (specially suggested when there is a great risk of Schneider's membrane perforation)

GBD - Guided bone regeneration.

*A higher infection rate has been reported with the use of clindamycin in maxillary sinus elevation procedures. Therefore, it is advisable to opt for other alternatives.

Bibliographic sources: Cucchi et al,⁹⁵ Hai et al,²² Salgado-Peralvo et al,⁹⁴ Salgado-Peralvo et al,⁹⁶ Akers et al.⁹⁸, and Khoury et al¹⁰⁰.

2014 consensus report of the Tenth European Workshop on Periodontology⁸⁵ specifies that the use of peri- or post-surgical systemic antibiotics is generally not recommended in periodontal plastic surgery. This aligns with the information provided in more recent guidelines.²¹ The low rate of infections reported in surgical crown lengthening, frenectomy, free gingival graft, subepithelial connective tissue, coronally advanced flap, and vestibuloplasty may be the reason for this.^{72,86} Nevertheless, the use of antibiotics could be considered in surgeries performed in areas with infected implants or in extensive procedures.⁸⁵

Periodontal tissue regeneration - Regarding the use of membranes for the regeneration of periodontal tissues (i.e., guided tissue regeneration [GTR]), antibiotic prophylaxis is not recommended because there is no evidence of a true benefit in terms of healing or infection rate with its administration.^{21,22} A randomized clinical trial concluded that in situations with adequate asepsis, antibiotic use failed to provide significant advantages in terms of clinical periodontal parameters or postoperative infections in GTR procedures. The only notable effect was a reduction in patient discomfort after the intervention.⁸⁷

The use of enamel matrix proteins (Emdogain) has also been proposed for the regeneration of periodontal tissues.⁸⁸ The available studies are limited, but in summary, the evidence suggests that there are no significant advantages associated with the prescription of antibiotics. This includes the infection rate,

which remains minimal regardless of whether or not these drugs are used.^{7,89}

Osseous surgery - There is no literature available that specifically addresses the usefulness or effectiveness of systemic antibiotics for resective bone surgery procedures (e.g., osteoplasty, surgical crown lengthening with ostectomy). However, it is worth noting that this procedure generally has low morbidity and carries a minimal risk of infection.^{72,90-92}

On the other hand, studies^{7,21,22} have shown low infection rates in regenerative techniques, prompting some authors to advise against antibiotic intake in healthy patients who require socket preservation. Conversely, due to the higher probability of complications of guided bone regeneration (GBR) surgeries, several protocols of antibiotic prophylaxis have been suggested, despite the lack of studies (Table 5).^{22,93,94} Some of the regimens with the greatest scientific support are those presented in the Consensus Report of the Guided Bone Regeneration Symposium of 2016,⁹⁵ with an extended antibiotic prophylaxis proposal, and the short-course alternative of the Spanish Society of Implants of 2022.⁹⁶ Likewise, the use of antibiotics has also been recommended in autologous bone graft procedures (e.g., block bone grafts).²¹

Maxillary sinus elevation is another surgical technique that involves the manipulation of a complex wound with risks of complications such as sinusitis and sinus graft infection, among

Table 6. Systemic antibiotic prescription protocols reported for dental implant placement procedures. Publications of health sciences organizations.

Bibliographic source	Clinical circumstances	Regime	
		No penicillin allergy	Penicillin allergy
Salgado-Peralvo et al ⁹⁶ (Consensus Report of the Spanish Society of Implants)	DIP in routine situations in healthy patients with or without GBR in single or two-stage procedure	Amoxicillin 2 or 3 g (1h before surgery)	Azithromycin 500 mg (1h before surgery)
	Immediate DIP	Loading dose: amoxicillin 2 or 3 g (1h before surgery) Maintenance dose: amoxicillin 500 mg q8h for 5-7 days	Loading dose: azithromycin 500 mg (1h before surgery) Maintenance dose: azithromycin 250 mg q24h for 5-7 days. Loading dose: clarithromycin 500 mg (1h before surgery). Maintenance dose: clarithromycin 250 mg q12h for 5-7 days. Loading dose: metronidazole 1 g (1h before surgery) Maintenance dose: metronidazole 500 mg q6h for 5-7 days
	Healthy patients undergoing sinus lifts with single or two-stage DIP	*Short-course (no Schneider's membrane perforation): amoxicillin 2 or 3 g (1h before surgery) *Long-course (high risk of Schneider's membrane perforation): Loading dose: amoxicillin + clavulanic acid 875/125 mg q12h (starting 24h before surgery) Maintenance dose: amoxicillin 875/125 mg q8h for 7 days	Ciprofloxacin 500 mg q12h for 9 days.
Caiazzo et al ¹⁰¹ (Consensus Report by the Italian Academy of Osseointegration)	DIP in straightforward cases	Amoxicillin 2 g (1h before surgery) *Long-course antibiotic prophylaxis: limited to complex cases (e.g. long surgical time, regeneration procedures)	Clindamycin 600 mg (1h before surgery)
Palmer ²¹ (Good Practice Guidelines from the Faculty of General Dental Practice and Faculty of Dental Surgery, U.K.)	Recommended only for intraoral bone augmentation with DIP	Amoxicillin 3 g (1h before surgery)	Clindamycin 600 mg (1h before surgery)
Leroy et al ⁷⁷ (Belgian Health Care Knowledge Centre) ⁷⁷	DIP	Amoxicillin 2 g (1h before surgery).	Clindamycin 600 mg (1h before surgery)
Other publications			
Salgado-Peralvo et al ⁹⁴ (systematic review)	Augmentation procedures with the insertion of implants in one or two phases	Amoxicillin 2 or 3 g (1h before surgery)	Unspecified
Burtscher & Torre ¹¹⁷ (systematic review)	Immunosuppressed patients with organ transplant	Amoxicillin + clavulanic acid for 5-6 days (starting 12-24h before surgery).	Clindamycin or moxifloxacin (starting 12-24h before surgery)
Romandini et al ¹¹⁵ (systematic review and meta-analysis)	DIP	Amoxicillin 3 g (1h before surgery).	Unspecified
Rodríguez et al ¹⁰⁵ (systematic review and meta-analysis)	DIP	Amoxicillin 1-3 g (1h before surgery).	Unspecified
Esposito et al ¹⁰³ (systematic review)	DIP in ordinary conditions	Amoxicillin 2 or 3 g (1h before surgery).	Unspecified

DIP - Dental implant placement; GBD - Guided bone regeneration.

others.^{22,92,97} Therefore, based on indirect evidence, various regimens of antibiotic prophylaxis have been suggested (Table 5).^{22,98} It is noteworthy that a randomized clinical trial reported no significant differences between short (24-hour) versus extended (7-day) antibiotic prophylaxis applied in patients with maxillary sinus floor augmentation.⁹⁹

Dental implant placement with or without bone regeneration - The use of antibiotics in dental implant procedures has been a controversial issue addressed in multiple publications.²⁷ Therefore, no consensus has been reached on the clinical scenarios in which antibiotic prophylaxis should be administered or the most effective regimen for its use.

The results of a comprehensive review of the literature are summarized below:

1. Three out of five documents (e.g., guidelines and consensus reports) issued by renowned European organizations recommend the prescription of systemic antibiotics in all dental implant placement surgeries, with or without bone regeneration.^{77,96,101} It should be noted that one of the publications highlights that, in certain clinical scenarios, refraining from the use of these drugs could be justified by the modest impact of antibiotics in healthy individuals.⁹⁶ The other entities do not suggest the routine use of antibiotics in healthy patients undergoing simple procedures, but rather limit their administration to complex cases (e.g., immunocompromised patients, immediate implant placement in extraction sockets, and the need for grafting procedures).^{21,102}

2. Seven out of 11 literature reviews, systematic reviews, and

meta-analyses state that the intake of systemic antibiotics by healthy patients under ordinary conditions has been demonstrated to be effective.¹⁰³⁻¹⁰⁹ The remaining publications concluded that there is no relevant benefit of antibiotic prophylaxis in healthy patients undergoing dental implant placement in uncomplicated circumstances.¹¹⁰⁻¹¹³

3. Most articles have shown that systemic antibiotics prevent early implant failure.^{94,103-110,114,115} However, their administration does not have a significant effect in reducing the risk of postoperative infections.^{104,105,109,111,113,114}

4. Only the Consensus Report of the Spanish Implant Society addressed the prosthetic phase of dental implants, indicating that antibiotic use is not justified in the second stage, during impression taking, or when placing an implant-supported prosthesis.⁹⁶

5. Although the most effective antibiotic and regimen for use in implantology has not been fully elucidated,^{107,115,116} several authors favor the prescription of a single preoperative dose of amoxicillin (Table 6).^{21,77,94,101,103,105,107-109,115} Thus, it has been stipulated that extended prophylaxis does not likely carry additional benefits.^{105,108,109,115,116} However, the Spanish Implant Society has recommended the continued use of antibiotics after the intervention when performing immediate implant placement and for maxillary sinus lift procedures (with implant placement in 1 or 2 stages).⁹⁶ Likewise, the need for postoperative antibiotics in immunosuppressed patients who have undergone organ transplants has been described.¹¹⁷

6. The drug choice for penicillin-allergic patients most reported in the literature has been clindamycin. Nonetheless, there is evidence of a higher risk for implant failure due to osseointegration issues and up to six-fold increased risk of postoperative infection with the use of clindamycin.^{100,118-121} This is why the Spanish Society of Implants recommends other antibiotics for allergic individuals, although further studies are needed (Table 6).⁹⁶

Peri-implant diseases - According to three consensus reports and three guidelines, the currently available scientific evidence does not support the routine use of systemic antibiotics in the treatment of peri-implant diseases (e.g., peri-implant mucositis, peri-implantitis, and retrograde/apical peri-implantitis).^{21,48,75,122-124} This has been a topic of debate in the dental community, with recent studies, including an umbrella review, still presenting inconclusive and questionable results.^{125,126}

In this framework, studies with favorable results in clinical parameters after adjunctive antibiotic therapy are reported.¹²⁷ However, most of the evidence indicates minimal effects of limited or no clinical significance.^{122,123,128-131}

Antibiotic prescription could be justified if signs of spreading or systemic infection is detected and in cases of immunocompromised patients.⁷⁵ Nevertheless, no defined protocol exists for these clinical scenarios.^{125,132,133} The Faculty of General Dental Practice and the Faculty of Dental Surgery (UK) have suggested applying the same regimen used for the treatment of periodontitis: amoxicillin 500 mg + metronidazole 400 mg q8h for up to 5 days (first choice) or azithromycin 500 mg q24h for 3 days (second choice).²¹ These recommendations can be justified by the similarity of the bacteria associated with periodontal diseases in relation to the microbiota of peri-implant diseases.¹²⁶

Conclusion

Antibiotic prescription in periodontics and dental implantology remains a controversial issue and requires a more comprehensive approach in the scientific literature to address crucial aspects. Nevertheless, the recommendations from the most recent publications have been summarized to guide evidence-based decision-making. It is hoped that this review will prove valuable to clinicians. However, the need for guidelines with consensus statements regarding prescribing protocols is emphasized. Additionally, other therapeutic alternatives, such as the use of local drugs, should be further explored as part of the antibiotic stewardship efforts in the battle against antimicrobial resistance.

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