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The Role of Antibiotic Prophylaxis in the Prevention of Early Dental Implant Failure: A Systematic Review

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ABSTRACT

Introduction: The routine use of antibiotic prophylaxis in dental implant surgery remains controversial. This systematic review and meta-analysis aimed to evaluate the effectiveness of preoperative antibiotics in preventing early implant failure and postoperative infection in healthy individuals.

Materials and Methods: An electronic search of PubMed, Scopus, ScienceDirect, Web of Science, Google Scholar, and the Cochrane Library was conducted for studies published between 2000 and 2024. Randomized controlled trials and clinical studies comparing preoperative systemic antibiotic administration with placebo or no antibiotic use were included. The primary outcome was early implant failure; secondary outcomes included postoperative infection and complications. Two reviewers independently extracted data using a standardized form. Methodological quality was assessed with the Cochrane RoB 2.0 tool, and certainty of evidence was evaluated using GRADE. Meta-analysis was performed in Review Manager (RevMan) v5.4 using a fixed-effect Mantel-Haenszel model to estimate pooled risk ratios (RRs) with 95% confidence intervals (CIs); heterogeneity was assessed with I2 and Cochrane Q statistics.

Results: Eight studies involving 2,026 evaluable patients met the inclusion criteria. The pooled patient-level implant-failure rate was 2.7% in the antibiotic group and 6.9% in the control group. The overall RR was 0.42 (95% CI: 0.27-0.66; $p < 0.001$), indicating a statistically significant 58% relative risk reduction; the 95% CI did not cross the null (RR = 1). Postoperative infection rates were lower with antibiotics in several trials, although definitions varied across studies (I2 = 0%; Cochrane Q $p = 0.730$).

Conclusion: Preoperative antibiotics significantly reduced early implant failure in pooled analysis, yet absolute event rates remained low in healthy patients. Routine antibiotic prophylaxis should be individualized, balancing modest clinical benefit against antibiotic stewardship principles.

Keywords: Antibiotic; Antibiotic prophylaxis; Dental implant; Implant failure; Implant placement; Preoperative antibiotics.

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Introduction

Tooth loss can significantly affect oral function, esthetics, and overall quality of life. Restoring missing teeth is therefore essential not only for masticatory efficiency but also for maintaining occlusal balance and oral health [1]. Over the past few decades, dental implants have emerged as a reliable and predictable treatment option, offering excellent long-term success rates and biocompatibility [2-3]. Despite these advantages, early implant failure, often caused by infection, inadequate osseointegration, or surgical complications, remains a clinical challenge [4-6]. To minimize such complications, antibiotic prophylaxis has been widely implemented in various surgical fields, especially for immunocompromised patients or those with systemic conditions [7-8,25]. However, in the context of dental implant surgery, most patients are relatively healthy, and the routine use of antibiotics in this population remains a matter of debate [9-10]. Some studies have reported that preoperative antibiotics, particularly amoxicillin, may reduce early implant failure rates [2,6,11], while others have found no significant difference compared with placebo [3]. A major issue contributing to this controversy is the lack of a standardized antibiotic protocol [7,12-14]. Current literature shows wide variation in the type of antibiotic, dosage, and timing of administration across different countries and practitioners [15,22-24]. Moreover, although meta-analyses have suggested a slight statistical benefit of antibiotics, the clinical relevance of this reduction remains uncertain given the low baseline rate of implant failure [14].

At the same time, concerns about antibiotic overuse, increasing bacterial resistance, and potential adverse drug reactions highlight the need for more rational, evidence-based use of these medications [17]. Appropriate antibiotic prescriptions can prevent infections, contributing to favorable surgical outcomes [16,26]. Overall, the prescription of antibiotics in implant dentistry represents a delicate balance between reducing postoperative infection risk and avoiding unnecessary exposure. While prophylactic antibiotics may be justified in high-risk or complex surgical cases, their routine use in healthy individuals undergoing straightforward implant procedures is still not clearly supported by current evidence. This systematic review aims to critically evaluate existing evidence on the effectiveness of antibiotic prophylaxis in preventing early dental implant failure and to clarify whether routine antibiotic administration is justified in healthy patients undergoing implant surgery.

Materials and Methods

Search strategy

A comprehensive electronic search was conducted in July 2024 to identify studies published between 2000 and 2024 across the databases MEDLINE/PubMed, ScienceDirect, Web of Science, Scopus, Google Scholar, and the Cochrane Library. No restrictions were applied regarding language or publication status to ensure the inclusion of all relevant evidence on antibiotic prophylaxis in implant dentistry. The search strategy combined Medical Subject Headings (MeSH) and free-text terms, including "antibiotic", "antibiotic prophylaxis", "preoperative antibiotics", "systemic antibiotics", "dental implant", "implantology", "implant placement", "implant survival", and "implant failure." Boolean operators "AND," "OR," and "NOT" were used to refine the results. In addition, the reference lists of all relevant articles were manually screened to identify additional eligible studies. After duplicate removal, titles and abstracts were screened for relevance, and full texts of potentially eligible studies were retrieved for detailed evaluation.

Research question

This systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Study selection was performed through author consensus based on predefined PICO (Population, Intervention, Comparison, and Outcome) inclusion and exclusion criteria. The Population (P) consisted of clinically healthy individuals undergoing dental implant surgery. The Intervention (I) was preoperative antibiotic prophylaxis administered via oral or intravenous routes, while the Comparison (C) group received either a placebo or no antibiotic treatment. The Outcome (O) was defined as postoperative infection or implant failure, and the Time (T) parameter required a minimum follow-up period of one month after implant placement. Accordingly, the focused research question formulated using the PICOT framework was: "In healthy individuals receiving dental implants, does preoperative antibiotic prophylaxis, compared with placebo or no antibiotic use, reduce the risk of postoperative infection or implant failure after at least one month of follow-up?"

Inclusion and exclusion criteria

Studies were included if they were randomized controlled trials, cohort studies, cross-sectional studies, clinically controlled trials, or prospective or retrospec-

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tive clinical studies that evaluated the effect of preoperative systemic antibiotic administration on postoperative infection rates and/or implant survival or failure. Only human studies involving participants aged 18 years or older (one study included individuals aged 15 years and above) were considered. Eligible participants were medically and orally healthy adults (ASA I or II) with no periodontal disease, oral infection, or medical conditions requiring antibiotic prophylaxis. Included studies evaluated oral or systemic antibiotic administration in patients receiving immediate, early, or delayed dental implants, with a minimum follow-up period of one month. Only full-text articles written in English and published between 2000 and 2024 were included. Studies that included smokers were also accepted.

Studies were excluded if they were duplicate publications, animal studies, or non-clinical reports such as case studies, case series, pilot trials, literature reviews, systematic reviews, meta-analyses, laboratory studies, commentaries, or book chapters. Articles were also excluded if they involved patients with systemic comorbidities, uncontrolled periodontal disease, immunodeficiency, antibiotic allergy, or pregnancy, as well as studies using postoperative antibiotic administration, local antibiotic delivery, or multiple antibiotic regimens. Studies without a control group, those comparing different antibiotic types rather than antibiotic versus no antibiotic therapy, and those involving mini-implants, orthodontic mini-screws, or immediate implants placed in sites with apical pathology were also excluded.

Data extraction

Two reviewers independently extracted study characteristics (design, setting, sample size, demographics, antibiotic regimen, comparator, follow-up duration) and outcome data (early implant failure, postoperative infection, adverse events) using a standardized form. Early implant failure was extracted at the patient level. Discrepancies were resolved by consensus; study authors were contacted when published data were incomplete.

Risk of bias assessment

Methodological quality was assessed independently by two reviewers using the Cochrane Risk of Bias 2 (RoB 2.0) tool. Domains evaluated were: **(1)** randomization process, **(2)** deviations from intended interventions, **(3)** missing outcome data, **(4)** measurement of the outcome, and **(5)** selection of the reported result. Each domain was rated as low risk, some concerns, or high risk, with an overall judgment per study. Disagreements were resolved by discussion.

Statistical analysis and heterogeneity assessment

Meta-analysis was conducted in RevMan v5.4. Pooled RRs with 95% CIs were calculated using a fixed-effect Mantel-Haenszel model when heterogeneity was low; otherwise a random-effects model was considered. Heterogeneity was assessed with Cochrane Q and I2 statistics (I2 of 25%, 50%, and 75% representing low, moderate, and high heterogeneity); $p < 0.10$ for Q was considered indicative of significant heterogeneity.

Assessment of certainty of evidence (GRADE)

The certainty of evidence for the primary outcome (early implant failure) was evaluated using GRADE, considering risk of bias, inconsistency, indirectness, imprecision, and publication bias. Certainty was rated as high, moderate, low, or very low.

Results

Search results

This systematic review followed the PRISMA guidelines. The overall search and selection process is summarized in Figure 1. A total of 619 records were initially identified across the six electronic databases. After removing duplicates, 456 unique articles remained for title and abstract screening, which narrowed the pool to 251 potentially eligible studies. Sixteen reports could not be retrieved, leaving 235 full-text articles for detailed assessment according to the predefined PICO inclusion and exclusion criteria. Following this final evaluation, eight studies met all eligibility criteria and were included in the present systematic review.

Study Characteristics

As summarized in Table 1, eight studies published between 2000 and 2024 were included in this review, most of which were double-blinded randomized controlled trials (RCTs) designed to evaluate the effectiveness of prophylactic antibiotics in improving dental implant success rates. The majority of studies compared a single 2 g oral dose of amoxicillin administered preoperatively with a placebo, assessing primary outcomes such as implant survival, postoperative infection, and adverse events. Sample sizes varied considerably, ranging from 34 to 506 patients (corresponding to 34–972 implants), with follow-up durations spanning from a few days (3–14 days) to several months (up to 6 months). These variations in sample size and follow-up period may in-

fluence the detection of long-term complications and implant success rates. Several studies also examined secondary outcomes, including wound healing, bacterial contamination, and the incidence of postoperative complications. While some trials reported no significant difference between antibiotic and placebo groups, others observed higher implant survival and lower infection rates with antibiotic prophylaxis, particularly in preventing early implant failures. Patient-related factors appeared to influence outcomes. Smoking prevalence ranged from 17.1% to 34.5% among study participants, and multiple studies indicated a potential association between smoking and increased implant failure risk.

Conditions such as diabetes mellitus and prior radiation therapy were generally excluded or limited to mild cases, minimizing their potential confounding effects. Bisphosphonate use was rarely reported and not considered a major influencing factor. Overall, the evidence suggests that preoperative antibiotic prophylaxis may help reduce early implant failures and postoperative infections. However, its routine use remains debated, as clinical benefits seem to depend on patient-specific factors such as general health and smoking status. Larger, long-term studies are needed to establish definitive recommendations for antibiotic use in dental implant surgery.

Qualitative Findings

Implant Failure and Success Rates

Across studies, implant success rates ranged from 92% to 100%. The pooled success rate was 98.7 % in the antibiotic group and 94.1 % in the control group, corresponding to a 4.6 % absolute reduction in failure risk with prophylactic antibiotics, and a 5.7 % failure rate (Table 2).

Infection and Postoperative Complications

Infection and complication rates were consistently higher in placebo groups, though statistical significance varied. Several trials (e.g., Nolan et al., 2014; Mascarenhas et al., 2023) showed fewer postoperative infections with antibiotics, whereas others (e.g., Momand et al., 2022) found minimal differences (Table 3).

Statistical Significance and Effect Modifiers

Only two studies (Kashani et al., 2019; Mascarenhas et al., 2023) reported statistically significant benefits ($p < 0.05$). Smoking prevalence ranged from 17 % to 34 %, and heavy smoking (>10 cigarettes/day) was associated with increased implant failure (up to 8.6 %). Other systemic factors such as diabetes or prior radiation were rarely included or mild (Table 4).

Quantitative Analysis

Meta-analysis Overview

A meta-analysis was performed including all eight eligible studies from Table 1, comprising 2,026 evaluable patients (1,011 antibiotic; 1,015 control). The pooled patient-level implant-failure rate was 2.7% in the antibiotic group and 6.9% in controls. Using a fixed-effect Mantel-Haenszel model, the overall RR was 0.42 (95% CI: 0.27-0.66; $p < 0.001$), indicating a 58% relative risk reduction that reached statistical significance (Figure 2, Table 5).

Heterogeneity and Sensitivity

Statistical heterogeneity was low ($I2 = 0\%$; Cochrane $Q = 5.06$, $p = 0.730$), although clinical diversity remained across trials with respect to surgical technique, operator experience, and antibiotic protocols. Large-sample trials (Esposito et al., Momand et al., Kashani et al.) contributed most of the weight to the pooled estimate.

Clinical Interpretation

The pooled evidence trends toward reduced implant failure and infection with preoperative antibiotics, especially in high-risk or complex cases. However, for healthy individuals, the benefit appears limited. Given the global concern over antibiotic resistance, routine use of prophylaxis in low-risk patients is not justified.

Risk of bias assessment results

RoB 2.0 assessment indicated that six double-blind, placebo-controlled trials (Anitua et al., Esposito et al. 2008/2010, Momand et al., Nolan et al., and Mascarenhas et al.) had low or some concerns overall, particularly regarding randomization and outcome measurement. Kashani et al. (2019) was not placebo-controlled and was judged at some concerns for blinding and allocation concealment. Mauceri et al. (2017) reported no implant failures in either arm and primarily addressed bacterial contamination rather than clinical failure.

GRADE certainty of evidence

For early implant failure, GRADE certainty was rated moderate, downgraded for risk of bias (non-placebo-controlled Kashani trial) and indirectness (Mauceri et al.). The pooled RR was 0.42 (95% CI: 0.27-0.66; $p < 0.001$), with low heterogeneity ($I2 = 0\%$; Cochrane Q $p = 0.730$).

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Table 1. Basics of systematic review.

Citation	Design	Study Aim	Study Period	Settings	Patients/ Implants	Age	Gender	Outcomes Of Investigation	Post-Operative Follow Up	Allergy To Penicillin	Smoking	Periodontal Disease	Diabetes Mellitus	Previous Head And Neck Radiation	Biphosphonates
ANITUA ET AL., 2009 SPAIN (15)	Double-blinded placebo controlled randomised clinical trial Multi-centre	Efficacy and safety of 2 gm amoxicillin orally has been compared with identical placebo tablets 1 h before implant placement of single implants in patients with bone types II and III	January 2006 - September 2007	Dental clinics (8 centers)	n=105 Implants=105	18 75 years mean: 49±12 (Pa) mean: 47±12 (Plb)	F: 70, M: 35 F: 37 (71%), M: 15 (29%) (P) F: 33 (62%), M: 20 (38%) (Pl)	Postoperative infections, microbiological analysis, adverse events and implant failures	At day 3, day 10, and 1 month and 3 months	No	Yes: 18 (17.1%) 10 (19%) (P) 8 (15%) (Pl)	NR	NR	<5000 rads	No
KASHANI ET AL., 2019 SWEDEN (16)	Randomised clinical trial	Compare the outcome of oral implant treatment due to early failures between two groups: one with a single preoperative dose of antibiotic and one without	NR	Dental clinics (5 centers)	n =447 Implants=963	15-91 years mean: 56.0±17.7 (P) mean: 50.8±18.0 (No AB)	F: 243, M: 204 F: 114 (51.1%), M: 109 (48.9%) (P) F: 129 (57.6%), M: 95 (42.4%) (No AB)	Implant failure	At day 7–14, and 4 months	Yes	NR	NR	NR	No	No
NOLAN ET AL., 2014 IRELAND (17)	Prospective double-blind, placebo controlled randomised clinical trial Single centre	To investigate the influence of pre-operative prophylactic antibiotics on post-operative morbidity: swelling, bruising, wound dehiscence and suppuration/ Postop pain and interference with daily activities and successful osseointegration of dental implants	2004-2009	University (1 center)	n =55 Implants=82	Age range NR <40 years: n=16 (P), n=15 (Pl) 40-60 years: n=7 (P), n=10 (Pl) >60 years: n=4 (P), n=3 (Pl)	F: 36, M: 19 F: 16 (59.2%), M: 11 (40.7%) (P) F: 20 (71.4%), M: 8 (28.5%) (Pl)	Osseointegration failure or success, signs of post-op morbidity (swelling, bruising, suppuration and wound dehiscence), post-op pain and interface with daily activities	At day 2, day 7 and at 2nd stage surgery or 3–4 months	No	Yes: 13 (23.6%) 7 (25.9%) (P) 6 (21.4%) (Pl)	No	No	No	NR

Citation	Design	Study Aim	Study Period	Settings	Patients/ Implants	Age	Gender	Outcomes Of Investigation	Post-Operative Follow Up	Allergy To Penicillin	Smoking	Periodontal Disease	Diabetes Mellitus	Previous Head And Neck Radiation	Biphosphonates
ESPOSITO ET AL., 2010 ITALY (18)	Pragmatic double-blinded randomised controlled trial Multi-centre	To compare the effectiveness of 2 g amoxicillin with identical placebo tablets taken orally 1 h prior to implant placement regarding success and complications	April 2008 - November 2009	Dental clinics (10 centers)	n=506 Implants=972	18 86 years mean: 49.1 (P) mean: 47.6 (Pl)	F: 270, M: 236 F: 138 (54.8%), M: 114 (45.2%) (P) F: 132 (52.0%), M: 122 (48.0%) (Pl)	Implant & prosthesis failure, post-op complications (wound dehiscence, suppuration, fistula, abscess, and osteomyelitis) and adverse events (erythema multiforme, urticaria, nausea, vomiting, and diarrhea)	At 1 week, 2 weeks and 4 months	No	Yes: 169 (33.4%) 81 (32.1%) (P) ≤10 cigarettes/ day: 55 (21.8%) >10 cigarettes/ day: 26 (10.3%) 88 (34.6%) (Pl) ≤10 cigarettes/ day: 60 (23.6%) >10 cigarettes/ day: 28 (11.0%)	NR	No	No	No (intravenous)
ESPOSITO ET AL., 2008 ITALY (11)	Double-blinded randomised controlled trial Multi-centre	To compare the efficacy of 2 g amoxicillin with identical placebo tablets taken 1 h prior to implant placement regarding the proportion of placed prostheses, early implant failure, post operative infections and adverse events	September 2006 - March 2007	Dental clinics (11 centers)	n=316 Implants=696	18 78 years mean: 47.8 (P) mean: 47.9 (Pl)	F: 174, M: 142 F: 78 (49.4%), M: 80 (50.6%) (P) F: 96 (60.8%), M: 62 (39.2%) (Pl)	Loss of implants/	At ١ week, ٢ weeks and ٤ months	No	Yes: 109 (34.5%) 59 (37.3%) (P) ≤10 cigarettes/ day: 36 (22.8%) >10 cigarettes/ day: 23 (14.6%) 50 (31.6%) (Pl) ≤10 cigarettes/ day: 28 (17.7%) >10 cigarettes/ day: 22 (13.9%)	NR	No	No	No (intravenous)
MOMAND ET AL., 2022 SWEDEN (19)	Prospective double-blinded randomised controlled trial Multi-centre	To compare the effect of a pre-surgical antibiotic regimen with an identical placebo regimen in healthy or relatively healthy patients receiving dental implants	November 2014 - April 2018	Dental clinics (7 centers)	n=473 Implants=757	18 72 years mean: 57.7 ± 14.2 (P) mean: 57.1 ± 13.7 (Pl)	F: 235, M: 239 F: 118 (49.4%), M: 121 (50.6%) (P) F: 117 (49.8%), 118 (50.2%) (Pl)	Implant failure, postoperative infections and adverse events	At day 7-14 and 3-6 months	No	Yes: 86 (18.1%) 46 (19.2%) (P) 40 (17%) (Pl)	No	No (severe)	Ni	No

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Citation	Design	Study Aim	Study Period	Settings	Patients/ Implants	Age	Gender	Outcomes Of Investigation	Post-Operative Follow Up	Allergy To Penicillin	Smoking	Periodontal Disease	Diabetes Mellitus	Previous Head And Neck Radiation	Biphosphonates
MAUCERI ET AL., 2017 ITALY (14)	Randomised clinical trial	To evaluate if a protocol of antibiotic prophylaxis reduces the physiologically occurring bacterial contamination of the bone particles collected directly from the burs used for preparation of the implant site	September 2014 - February 2015	University (1 center)	n=34 Implants=34	Age range NR (mean: 49.7) mean: 53.5 (P) mean: 50.0 (No AB)	F: 20, M: 14	The number of colonies and identification of various microorganisms from the bone particles collected directly from the implant preparation site	At 1, 3, 6, and 12 months	No	Yes: 10 (29.4%) 5 (27.8%) (P) 5 (31.3%) (No AB)	No	NR	NR	NR
MASCARENHAS ET AL., 2023 BRAZIL (20)	Double-blind randomized placebo-controlled trial	To investigate the influence of antibiotic prophylaxis on postoperative healing, pain, and implants survival of clinically healthy patients undergoing 2 to 4 implants placement by unexperienced operators	August 2018 - January 2021	University (1 center)	n=90 Implants=224	23-70 years mean: 47 (P) mean: 42 (Pl)	F: 58, M: 32 F: 25 (58.1%), M: 18 (41.9%) (P) F: 33 (70.2%), 14 (29.8%) (Pl)	Mouth opening amplitude, referred pain, signs of infection (fistula, ulceration, tissue necrosis, dehiscence, and purulent exudate) and implant survival	At day 2, day 7, and at 3 months	No	No	NR	NR	NR	NR

[a] Pre-operative antibiotics.

[b] Placebo.

Table 2. Comparison of success rates (Implant Level).

Study	Success Rate with Antibiotics	Success Rate with Placebo
Anitua et al., 2009	96.2%	96.2%
Kashani et al., 2019	97.8%	92.5%
Nolan et al., 2014	100.0%	89.3%
Esposito et al., 2010	98.6%	97.3%
Esposito et al., 2008	99.4%	97.5%
Momand et al., 2022	97.9%	97.9%
Mauceri et al., 2017	100.0%	100.0%
Mascarenhas et al., 2023	99.0%	92.3%

Table 3. Infection and postoperative complications.

Study	Infections with Antibiotics	Infections with Placebo
Anitua et al., 2009	6 patients	6 patients
Nolan et al., 2014	0 patients	2 patients with suppuration
Esposito et al., 2010	4 patients (pain/swelling), 2 peri-implant infections	9 patients (various infections, pus, abscesses)
Momand et al., 2022	7 patients (abscesses, fistulas)	12 patients (infections, abscesses)
Mascarenhas et al., 2023	14 patients (swelling, ulceration, dehiscence)	25 patients (swelling, infections, purulent secretion)

Table 4. Summary of statistical findings.

Study	Infections with Antibiotics	Infections with Placebo
Kashani et al., 2019	Yes	$p < 0.0011$
Esposito et al., 2010	No	$p = 0.083$
Esposito et al., 2008	No	$p > 0.05$
Mascarenhas et al., 2023	Yes (implant loss)	$p < 0.05$
Momand et al., 2022	No	$p > 0.05$

Table 5. Patient-level data for meta-analysis of early implant failure.

Patients With Implant Failure (Placebo/No Antibiotic)	Patient Number (Placebo/No Antibiotic)	Patients With Implant Failure (Antibiotic)	Patient Number (Antibiotic)	Study
2	53	2	52	Anitua et al., 2009
29	224	11	223	Kashani et al., 2019
5	28	0	27	Nolan et al., 2014
12	254	5	252	Esposito et al., 2010
8	158	2	158	Esposito et al., 2008
7	235	6	238	Momand et al., 2022
0	16	0	18	Mauceri et al., 2017
7	47	1	43	Mascarenhas et al., 2023

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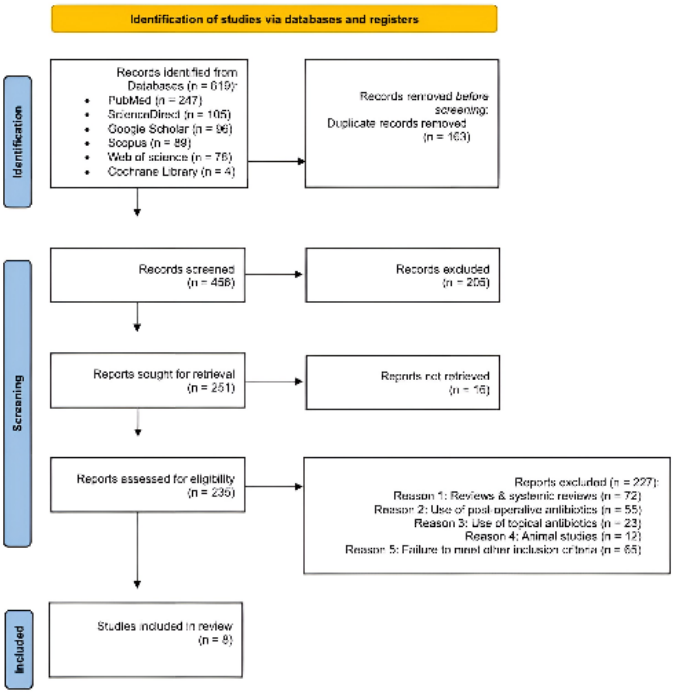


Figure 1. PRISMA flow diagram of literature search strategy.

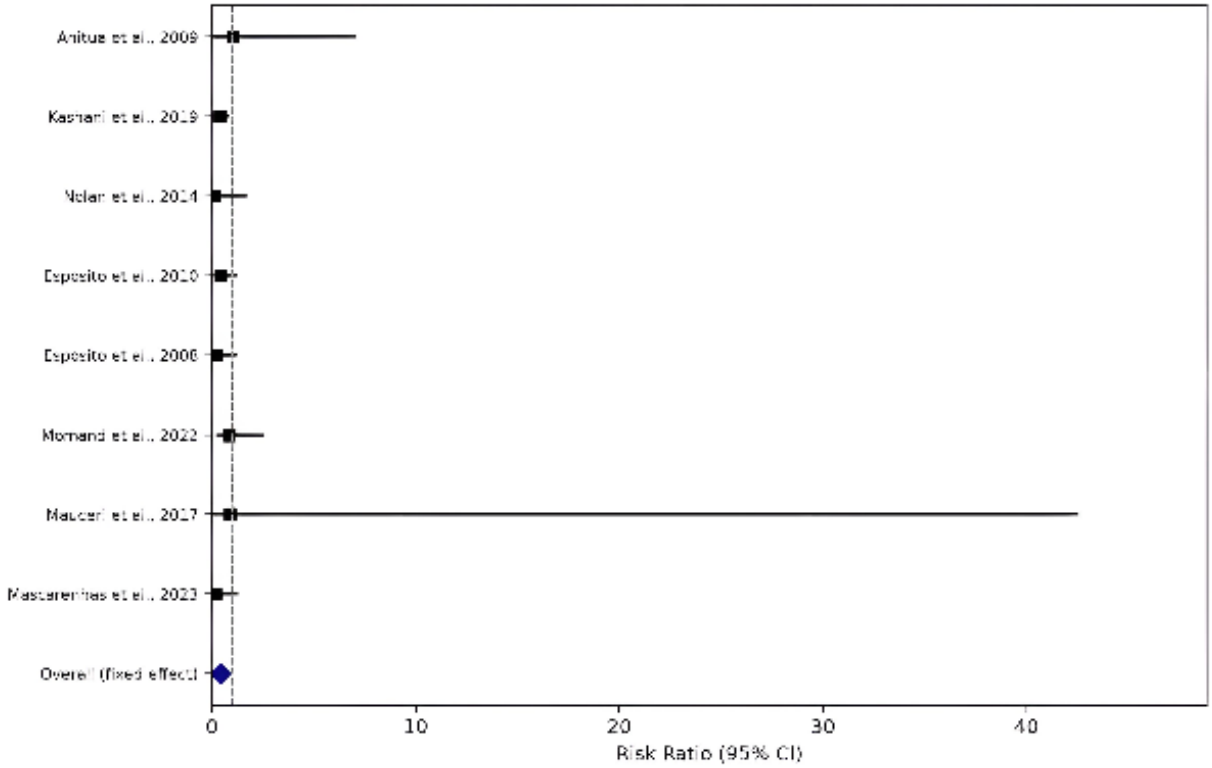


Figure 2. Forest plot comparing patient-level early implant failure between antibiotic and control groups (fixed-effect model: pooled RR = 0.42, 95% CI: 0.27-0.66; $p < 0.001$). Square size represents study weight; horizontal lines represent 95% confidence intervals. RR > 1 indicates increased failure risk in the antibiotic group; RR < 1 indicates reduced failure risk.

Discussion

The present systematic review aimed to evaluate the necessity and effectiveness of antibiotic prophylaxis in dental implant surgery. The pooled evidence from recent randomized clinical trials and systematic reviews demonstrates an ongoing controversy regarding whether routine antibiotic administration provides a clinically meaningful benefit in preventing early implant failure or postoperative infection. Overall, most studies confirm that dental implants have a high success rate even in the absence of antibiotics, with early implant failure rates ranging from 1% to 3% in healthy patients. While some evidence suggests a modest reduction in early failure when antibiotics are used, particularly a single preoperative dose of amoxicillin (commonly 2 g administered one hour before surgery), the overall clinical significance remains questionable [6-7,13]. For example, Momand et al. [8] reported no statistically significant difference between antibiotic and placebo groups (RR = 0.66), suggesting that antibiotic prophylaxis may not substantially influence implant success in otherwise healthy individuals. Similarly, Torof et al. [1] found that although antibiotic use was statistically significant in reducing infection risk, the number needed to treat (NNT > 35) indicated limited clinical benefit. Despite this, several meta-analyses have shown that a single preoperative antibiotic dose may reduce the rate of early implant failure, particularly in procedures performed by inexperienced operators or in complex surgeries involving bone augmentation [6-7]. The network meta-analysis by Tan et al. concluded that a 2 g dose of amoxicillin one hour preoperatively was the most effective protocol, though its advantage diminished when trials with high bias were excluded. This highlights that while antibiotics might offer short-term protective effects, the strength of evidence remains weak.

A recurrent finding across the literature is the lack of a standardized antibiotic protocol, leading to wide variability in clinical practice. Bernabeu-Mira et al. [22] revealed that nearly three-quarters of surveyed clinicians routinely prescribe antibiotics, often extending use into the postoperative period, despite weak supporting evidence. This inconsistency underlines a critical gap between research and clinical behavior. Furthermore, Cuevas-Gonzalez et al. [23] emphasized that overprescription is widespread, with up to 15% of dentists admitting to unnecessary antibiotic use, particularly with amoxicillin or amoxicillin-clavulanate. These findings underscore the urgent need for educational initiatives and antibiotic stewardship programs in dentistry.

Regarding antibiotic choice, amoxicillin remains the most prescribed first-line agent due to its broad coverage and low resistance rate [2,23]. For patients allergic to penicillin, clindamycin has been used, though some studies caution against it due to an observed association with higher implant failure rates. Ikram et al. [2] further reported that complication rates across various antibiotic regimens averaged only 5%, suggesting that antibiotics may not be essential for uncomplicated implant cases. Several reviews have also stressed the broader issue of antibiotic resistance. Ponce Vera et al. [24] and Momand et al. [8] both emphasized that indiscriminate antibiotic use contributes significantly to the global antimicrobial resistance crisis. The German S3 guideline summarized by Ponce Vera and colleagues [24] recommends limiting prophylactic antibiotics to major maxillofacial surgeries or medically compromised patients, while discouraging routine use in healthy individuals undergoing standard implant placement. These conclusions align with contemporary antibiotic stewardship principles and public health priorities.

The antibiotic regimens varied across the included studies, although amoxicillin was the most frequently used agent, administered as a single preoperative dose of 2 g one hour before implant placement in several trials. Other protocols included a higher single dose of 3 g amoxicillin, while clindamycin 600 mg was used as an alternative in patients with penicillin allergy. The discrepancies in outcomes across studies may stem from variations in surgical technique, operator experience, and patient-related risk factors such as smoking or systemic comorbidities. Several studies suggested that antibiotics might provide tangible benefits in high-risk patients—those with compromised immune systems, smokers, diabetics, or those undergoing lengthy or multiple implant procedures [7,15]. Therefore, selective use rather than routine administration may represent the most rational clinical approach. Based on the synthesis of current evidence, routine antibiotic prophylaxis cannot be universally recommended for all patients undergoing dental implant placement. Instead, a risk-based strategy should be adopted, reserving antibiotics for complex cases, immunocompromised patients, or when contamination risk is high. When indicated, a single 2 g preoperative dose of amoxicillin appears to provide adequate prophylaxis. Postoperative antibiotic courses or combination therapies should generally be avoided due to minimal added benefit and increased risk of resistance. The reviewed studies had several methodological limitations. Many investigations, such

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as those by Nolan et al. [17] and Mauceri et al. [14], had small sample sizes, reducing statistical power. Variations in bone quality were another limitation; for instance, Anitua et al. [15] included only Type II and III bone, limiting generalizability. Differences in antibiotic regimens, such as the use of alternative antibiotics for penicillin-allergic patients in the study by Kashani et al. [16], could also have influenced the results. Moreover, most studies focused on short-term outcomes (≤6 months) rather than long-term implant survival. These methodological differences, along with heterogeneity in surgical protocols and patient characteristics, limit the ability to draw definitive conclusions. In summary, while antibiotics can modestly reduce early implant failures and postoperative infections, the benefits are often not statistically significant. The clinical advantage is most apparent in high-risk patients—such as smokers, those with poor bone quality, or immunocompromised individuals—supporting a selective rather than routine use of antibiotics. Future studies with larger sample sizes and longer follow-up are needed to better define the role of prophylactic antibiotics in implant survival and to establish standardized guidelines that balance clinical benefit against the risks of antibiotic overuse and resistance.

Conclusion

This study suggests that routine antibiotic prophylaxis may not be necessary for all dental implant patients. While antibiotics can modestly reduce early implant failures and postoperative infections, the benefits are often not statistically significant. Clinical advantage is most apparent in high-risk patients—such as smokers, those with poor bone quality, or immunocompromised individuals—supporting a selective rather than routine use of antibiotics. Future studies with larger sample sizes and longer follow-up are needed to better define the role of prophylactic antibiotics in implant survival.

Conflict of Interest

There is no conflict of interest to declare.

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