Concise Review

Antimicrobial Activity of Antibacterial Sutures in Oral Surgery: A Scoping Review

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Objective: The aim of this scoping review was to explore and synthesise the current evidence on the antimicrobial activity of antibacterial suture materials used in oral surgery.
Methods: The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews. A bibliographic search was carried out in the PubMed and Scopus databases to retrieve all human clinical studies that investigated the antimicrobial efficacy of antibacterial-coated sutures used in oral surgery. Included studies were screened and extracted independently by 2 examiners. Data were tabulated and qualitatively described.
Results: The search initially returned 150 articles and resulted in 5 included studies after the duplicates' removal and the full-text screening. Selected studies were published from 2014 to 2019. Three studies (60%) were randomised clinical trials, whilst the remaining studies did not report information on randomisation. The antimicrobial agents for coated sutures included triclosan and chlorhexidine. In almost all the studies, antibacterial-coated sutures exhibited lower bacterial retention compared to those without coating.
Conclusions: Within limitations, the antimicrobial-coated sutures employed in oral surgery exhibited good results in terms of their microbicidal activity when compared with sutures that were not coated. Considering the high variability and confounding factors identified in the included studies, more high-quality research is needed to confirm these results. Antimicrobial-coated sutures could represent a promising and clinically valid strategy to reduce microbial colonisation in oral surgery. The reduced bacterial adherence is likely to improve the clinical success of the surgical procedures. Yet, the cost–benefit ratio of antimicrobial-coated sutures should be assessed in larger clinical trials to confirm their efficacy over conventional noncoated sutures.

Introduction

Sutures in surgery, especially in oral surgery, are pivotal for the healing of surgical sites.[1] However, sutures tend to attract bacteria to their surface[2,3] due to intrinsic characteristics (eg, braided vs monofilament) and external factors such as the deposition of fibrinogen and fibronectin during the healing process, which can favor bacterial colonisation.[4–8] The bacterial retention within sutures should be minimised to reduce postoperative infection risk.[9]

As it is reliable, easy to use, and stable, the black braided silk suture is one of the most common sutures used in oral surgery.[10] The prolonged and delayed healing associated with black braided silk sutures has led to the exploration of alternative suture materials. Antibacterial suture materials are coated or treated with antimicrobial agents to promote healing and prevent postsurgical infection.[11] Antibacterial suture materials currently available include polymers or absorbable materials (ie, polyglactin 910, polyglecaprone 25, polydioxanone) coated with antibacterial substances (ie, triclosan or chlorhexidine).[12–16] Triclosan is a phenolic derivative antibacterial agent with antiseptic and bacteriostatic activity both against Gram-positive bacteria and to a lesser extent against Gram-negative bacteria.[14] Since 2003, in the US, the Vicryl Plus suture has been covered by triclosan, a substance already used for about 20 years as an additive to oral hygiene products such as toothpastes and mouthwashes[17,18] with documented biocompatibility.[19,20] Chlorhexidine exhibits a

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broad antibacterial spectrum, bacteriostatic and bactericidal effects, and high biocompatibility indexes.[21,22] It is also effective against most Gram-negative and Gram-positive bacteria.[23]

In the literature, results on antibacterial efficacy of the antimicrobial-coated sutures in the human body are conflicting. A remarkable decline in the number of microorganisms on the surface of these sutures has been reported,[17,24,25] although most referred to skin bacteria.[17,25] Due to saliva, specific microorganisms, quality of tissue involved, and local factors, sutures placed in the oral cavity behave differently than those placed outside it.[26–29]

The antimicrobial effects of new antibacterial-coated sutures in oral surgery are still unclear. Thus, the aim of this scoping review was to assess the antimicrobial activity of antibacterial suture materials in oral surgery in order to provide an updated synthesis of the current studies and provide useful insights for future research.

Materials and methods

This scoping review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews[30] and focussed on the following research question: What is the antimicrobial activity of antibacterial-coated suture materials employed in oral surgery?

Search strategy

A literature search was conducted in PubMed and Scopus databases to identify articles published from January 2013 to May 2023 that investigated the antimicrobial activity of antibacterial sutures used in oral surgery. The following strings were adopted for each database: (antibacterial suture oral surgery) OR (antimicrobial suture oral surgery) OR (antimicrobial suture oral surgical site) OR (antibacterial suture oral surgical site) OR (anti-bacterial suture oral surgery) OR (anti-microbial suture oral surgery) OR (anti-microbial suture oral surgical site) OR (anti-bacterial suture oral surgical site) OR (antimicrobial suture periodontal surgery) OR (anti-bacterial sutures periodontal surgery) OR (anti-microbial sutures periodontal surgery) OR (oral surgery vicryl plus). No language restriction was used. Reference lists of the included studies were further screened for other pertinent studies. Principal peer-reviewed scientific journals in oral surgery and miscellaneous were also hand-searched (*Journal of Clinical Periodontology, Periodontology 2000, Journal of Periodontology, Journal of Dental Research, Clinical Oral Implants Research, Clinical Oral Investigations, International Journal of Oral & Maxillofacial Implants, International Journal of Oral and Maxillofacial Surgery, BMC Oral Health, Odontology, Oral Surgery Oral Medicine Oral Pathology Oral Radiology, International Journal of Implant Dentistry, Journal of Cranio-Maxillofacial Surgery, Journal of Oral and Maxillofacial Surgery*).

Eligibility criteria

All human clinical studies (ie, cohort studies, randomised clinical trials, quasi-experimental studies, case reports, and case series) exploring the antimicrobial activity of antibacterial-coated sutures used in any field of oral surgery were considered suitable for inclusion. The exclusion criteria regarded the study design (ie, in vitro and ex vivo studies and animal studies), article type (ie, editorials, commentaries, short communication, and reviews), peer revision (ie, abstracts and preprint articles), and language (ie, studies without an English abstract).

Studies selection

Two authors independently reviewed studies and decided which studies to include. Disagreement was solved through discussion or by the decision of a third expert reviewer. The references were managed using EndNote software (EndNote X9; Thomson Reuters).

Data extraction

For each study, the following items were tabulated: author, year, and country; study design; sample size; population; intervention; control; type of surgery; suture removal time; methodology; main results; and additional information. Data were extracted independently by 2 reviewers. Any discrepancies were solved by discussion or intervention of a third reviewer.

Results

Search findings

The electronic search resulted in 150 articles. After exclusion of duplicates, 129 abstracts were reviewed and the full texts of 10 studies were screened. Finally, 5 studies were included for qualitative analysis[2,6,26,31,32] (Figure). The characteristics of the included studies are shown in the Table.

General characteristics of the included studies

The selected studies were published from 2014 to 2019; 3 were conducted in India,[6,31,32] one in Germany,[2] and one in Spain.[26] Three studies were randomised clinical trials,[6,26,32] one of which was a split-mouth study.[26] The other studies did not report any information on randomisation.[2,31] Blinding of operators with regard to type of suture was reported in 3 studies.[6,26,31] The sample size ranged from 10[32] to 40[31] patients with ages between 18 and 60 years. Sex of participants was specified in 3 studies, with a slight preponderance of females.[6,26,31] Almost all studies enrolled healthy patients, except for the one by Pelz et al,[2] which did not report information on the health status of patients enrolled. Types of surgery were 3 dental extractions[2,26,31]—2 of which included third molars[2,26]—and 2 periodontal surgeries.[6,32]

All antimicrobial-coated sutures were braided (ie, multifilament) except for polyglecaprone 25 + triclosan, which was monofilament.[26] Antimicrobial-coated sutures used were absorbable polyglactin 910 + triclosan,[2,31] resorbable polyglycolic + triclosan,[6] polyglecaprone 25 + triclosan,[26] polyglactin 910 + chlorhexidine,[32] and polyglicolic + chlorhexidine.[6]

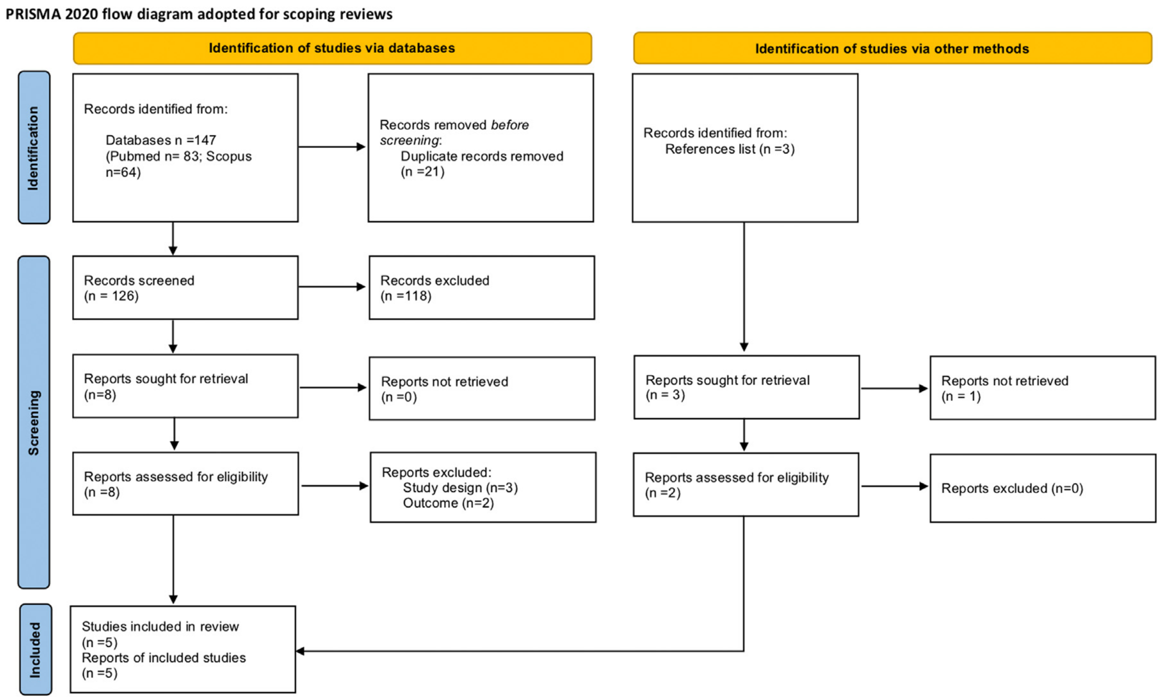

Figure – Flowchart of the review process.

Control groups used absorbable polyglactin 910,[2,31,32] braided natural black silk,[26] and resorbable polyglycolic sture materials.[6] Suture removal time ranged from a minimum of 3 days[26] to a maximum of 8 days.[6] Postoperative rinses were suggested in 2 studies,[6,26] one of which used warm water[6] and the other which used saline solution.[26] No postoperative antibiotic therapy was administered in one study,[6] and another study reported antibiotic therapy until 7 days after surgery[26]; 3 studies did not clarify whether antibiotics were used[2,32] or the time frame for which they were prescribed.[31]

In all studies, the method to assess antimicrobial activity was the evaluation of the number of bacterial colonies detected on the sutures after their removal, with morphologic bacteria characterisation also carried out.[2,6,26,31,32] Additionally, the examination of suture materials was performed with scanning electron microscopy (SEM)[26] or confocal laser scanning microscopy (CLSM) to analyse the biofilm.[6] Biochemical analysis and in vitro susceptibility tests were used to characterise the isolated aerobic bacteria and to determine the antibacterial effect of the coated suture, respectively.[2]

Summary of findings

Overall, significantly reduced bacterial count was reported for antimicrobial-coated sutures compared with noncoated sutures in 3 studies,[6,26,31] whilst 2 studies did not show significant differences.[2,32] Specifically, chlorhexidine-coated sutures were reported to be effective in reducing bacterial adherence in one study[6] and not significantly different from noncoated sutures in another one.[32] Triclosan-coated sutures showed greater antimicrobial activity compared with noncoated sutures in 3 studies[6,26,31] and did not result in any significant differences in the study by Pelz et al.[2]

In addition, significantly less growth of aerobe and anaerobe species with antimicrobial-coated sutures compared with noncoated sutures was reported in one study,[26] whilst no significant difference emerged in 2 other studies.[2,32] Kruthi et al[31] reported a significant reduction in anaerobic bacteria adherence with triclosan-coated compared with noncoated sutures, with no significant difference in aerobes. Lower concentrations of aerobes and anaerobes were shown for triclosan-coated sutures compared with chlorhexidine-coated and noncoated sutures in the study by Karde et al,[6] yet no significant difference was detected between chlorhexidine-coated and noncoated sutures.

Discussion

Main findings

In terms of surgical complications, postoperative wound infections remain the second most prevalent issue. The majority of cases of surgical site infections occur in the area surrounding the incision, especially when suture material is present.[33] Given the considerable infection risk, contemporary research has focussed on preventing bacterial colonisation of medical materials by using antibacterial coatings.[2]

The purpose of this scoping review was to evaluate the antimicrobial activity of antimicrobial-coated sutures in oral surgery. A scoping review is a methodological approach to define the current boundaries of a large and recent topic and provide useful indications for future research.[34–36] The antibacterial efficacy of sutures coated with antibacterial material is a topic of clinical interest in dentistry. Accordingly, the primary purpose of this scoping review was to identify the

Table – Main characteristics of the included studies.

Author, year, and country	Study design	Sample size	Population	Intervention	Control	Type of surgery	Suture removal time	Methodology	Main results	Additional information
Karde et al 2019[6] India	Randomised controlled double-blind study	30	Age, 39.2 ± 10.76 y; sex, 13 M, 17 F; healthy patients, no smokers, no immunocompromised patients, no pregnant and/or lactating patients, no persons with any known allergies to chlorhexidine or triclosan, or no one with antibiotic use in the past 3 mo	Polyglycolic triclosan-coated suture (Megasorb T + MERIL triclosan-coated polyglycolic suture 3–0 braided); polyglycolic chlorhexidine-coated suture (Megasorb Plus MERIL Chlorhexidine-coated polyglycolic suture 3–0 braided)	Noncoated polyglycolic suture (Megasorb MERIL plain resorbable polyglycolic suture 3–0 braided)	Periodontal flap	Day 8	No. of colonies; CLSM	Triclosan- and chlorhexidine-coated sutures can be used in periodontal surgical procedure as an effective method to inhibit biofilm formation and decrease the bacterial load at the surgical site	Phase I therapy was performed for all recruited patients; postoperative warm water rinses twice daily for 1 min, for 30 d; no postoperative antibiotics
Kruthi et al 2014[31] India	Prospective double-blind study	40	Age, 18–40 y; sex, 14 M, 26 F; healthy patients, no immunocompromised patients or patients taking drugs like corticosteroids and cyclosporines	Polyglactin 910 + triclosan (Vicryl Plus 3–0, 90 cm, braided, triclosan-coated, undyed, Johnson & Johnson)	Polyglactin 910 (Vicryl 3–0 90 cm, braided, coated, undyed)	Extraction (multiple teeth), alveoloplasties, and removal of impacted teeth	Day 6	No. of colonies	Triclosan coated-sutures were effective in significantly reducing the bacterial adherence to suture material	Oral prophylaxis before undertaking the procedure; all the patients were prescribed the same antibiotics
Pelz et al 2015[2] Germany	Prospective clinical trial	17	Age, 18–43 y	Polyglactin 910 + triclosan (Vicryl Plus 4–0, 70 cm, braided, needle V-5, undyed)	Polyglactin 910 (Vicryl 4–0,70 cm, needle V-5, undyed)	Extraction (2 wisdom teeth on the same side at the same time)	Day 7	No. of colonies; morphologic analysis; in vitro susceptibility test	Vicryl Plus did not report a significant reduction in the total number of bacteria, particularly oral pathogens	–
Sala-Pérez et al 2016[26] Spain	Randomised split-mouth prospective clinical controlled double-blind study	20	Age, 18–35 y; sex, 10 M, 10 F; healthy patients, ASA I or II, no pregnant patients, no individuals with alcohol or drug abuse	Polyglecaprone 25 + triclosan (Monocryl Plus 3–0, monofilament, Ethicon)	Silk 3–0 (Suturas Aragò, Laboratorios Aragó S.A.)	Extraction (wisdom tooth)	Day 3/ day 7	No. of colonies; SEM	Monocryl Plus exhibited significant antibacterial effect in the first 3 d and some bacterial reduction after 7 d	Postoperative saline water rinses; postoperative antibiotic therapy for 7 d
Sharma et al 2017[32] India	Randomised pilot study	10	Age, 35–55 y; healthy patients, no smokers, no pregnant or lactating patients, no antibiotic use in the past 3 mo or periodontal treatment undertaken 6 mo prior to the study	Polyglactin 910 chlorhexidine-coated (Petcryl 3–0 90 cm, braided, 3/8 circle cutting)	Polyglactin 910 noncoated	Periodontal flap	Day 7	No. of colonies	No significant differences emerged in the bacterial count between antibacterial- and noncoated sutures	–

ASA, american society of anesthesiologists; CLSM = confocal laser scanning microscopy; F, female; M, male; SEM, scanning electron microscopy.

currently available studies assessing the antimicrobial activity of antimicrobial-coated sutures in oral surgery and the major limitations of the current research. For this reason, all available human clinical trials were included, regardless of study design and their reported quality. A 10-year time limit has been set in database research in order to ensure that the most recent information was selected and provided to researchers and clinicians.

There is still controversy regarding the impact of the physical and chemical characteristics of sutures on the risk of surgical site infection.[5,37] In the included studies, antimicrobial-coated sutures were almost all braided, with the exception of the polyglecaprone 25 + triclosan suture.[26] Antibacterial coatings used triclosan[2,6,26,31] and chlorhexidine.[6,32] Triclosan is a broad-spectrum antimicrobial agent active against Gram-positive and Gram-negative bacteria. Although it is most often used for antisepsis of the skin and other surfaces, incorporation of triclosan into medical devices and dentifrices has well confirmed its effective intraoral use too.[38,39] Chlorhexidine is another commonly used antimicrobial agent useful for management of oral diseases.[40] At low concentrations chlorhexidine is bacteriostatic, and at high concentrations it acts in a bactericidal manner, causing cell death by cytolysis.[6,41] Both agents, therefore, exhibit good antibacterial properties and safety,[20,42] making them suitable as antibacterial coatings for oral sutures. Yet, the results regarding their effectiveness in reducing bacteria counts are controversial.

The included studies showed remarkable methodological differences, making difficult a comparison amongst them. Two of the 5 included studies did not report details on procedures of patients' enrollment and randomisation.[2,31] Randomised trials represent the best methodological condition to make 2 groups comparable[43] and, consequently, this study design is preferred when the effect of one or more interventions is investigated. Furthermore, sample size calculation was reported in only 2 studies.[6,26] The number of patients included should be suitable for the objective to be evaluated; a low number of patients limits the generalisability of the results obtained.[44] Notably, some of the included studies did not specify sex of the enrolled participants.[2,32] This could introduce a selection bias, altering the results obtained. Indeed, sex may be considered a confounding factor, as hormonal differences may alter the results by modifications in immune response and blood flow.[18,45] In order to minimise bias, immunocompromised patients were in general excluded from these kinds of studies because immunosuppression is known to increase the risk of infections and bacterial adherence when compared to healthy participants.[31]

All patients should be treated in clean conditions through preventive and appropriate oral hygiene sessions to control the environmental setting as well as possible. Two studies reported that intervention was performed after oral prophylaxis procedures.[6,31] Furthermore, the potential mouth rinses after the surgical intervention may also impact the results. With regards to this, 2 studies specified that recruited patients were invited to perform mouth rinses after surgery with warm water[6] and saline[26] solutions. Warm saline rinses have a bacteriostatic action, promote healing, and limit the development of postextraction alveolitis.[46,47] Warm saline is preferred over chlorhexidine mouthwash because of chlorhexidine's antibacterial action[48,49] and the consequent possible influence on the number of colonies on the sutures' surface.

The possible risk factors that interfere with tissue healing and thus with bacteria growth and accumulation include smoking and alcohol use as well as drug abuse[50] and previous radiotherapy/chemotherapy.[51] Smoking impairs circulation by constricting blood vessels and reducing blood flow, affecting the outcome of surgical therapy.[52] Alcohol intake also compromises the healing of oral wounds[53]; for this reason, all patients who use alcohol should be excluded. A total of 3 studies mentioned some of the above risk factors as exclusion criteria during participants' recruitment, in particular smoking[6,32] and alcohol/drugs intake.[26]

Antibiotic therapy could act as a confounder and increase the risk for bacterial resistance phenomena. For these reasons, pre- and postoperative antibiotic therapy should not be prescribed for patients enrolled in these kind of trials[6] in order to determine the effective impact of the antibacterial coating without confounders and to avoid bacterial resistance phenomena.[26,54] Yet, Asher et al[37] reported that postsurgical antibiotic treatment had only a minor effect on bacterial accumulation on the sutures tested. Of note, no antimicrobial-coated sutures were employed in that study; thus, further studies are needed to clarify this aspect.

Types of surgery included extractions and periodontal flap surgery. According to Asher et al,[37] type of surgery seems not to significantly influence the bacterial accumulation on sutures' surface. However, Asher et al[37] considered periodontal surgery, implant surgery, guided bone regeneration, and second-stage implant surgery. Postoperative infections are more common in mandibular tooth extractions due to the difficulty of managing oral hygiene and the consequent increased bacteria adhesion.[55]

Additionally, the removal time of sutures varied from a minimum of 3 days to a maximum of 8 days. It is noteworthy that an extended suture persistence can promote bacterial growth. Typically, depending on the type of procedure, sutures are removed within 5 to 7 days, with the highest colonisation reported at 3 days.[26]

Operators were blinded with regard to the type of suture used in 3 studies.[6,26,31] Operator blinding is a fundamental procedure for preventing observer bias in clinical trials. Yet, considering that the outcome measurement is objective and is based on the measurement of bacterial counts, it is reasonable to consider the influence of this bias to be negligible.[56]

Overall, most of the studies reported a decrease in bacterial load in coated sutures compared with the noncoated ones, whilst a significant advantage was not reported by Pelz et al[2] in terms of reduction in microbial numbers. Of note, in the study by Sharma et al,[32] chlorhexidine-coated sutures showed potential in preventing microbial colonisation even if the results were not statistically significant. The contrasting results are probably due to the reduced number of patients enrolled, which did not ensure adequate statistical power; to the properties and type of suture (eg, antimicrobial agent concentration in the suture); as well as to the patient's postoperative management.

Odontogenic infections are caused by a wide variety of bacteria. Overall, a higher number of aerobic microorganisms compared to anaerobes was found. In addition, commensal species (eg, *Streptococcus* groups) were more common than pathogenic ones (eg, *Prevotella* and *Fusobacterium spp*). This could explain the relatively low incidence of infectious complications reported.[26] For the evaluation of the sutures, this aspect is pivotal considering the well-documented role anaerobic bacteria play in oral infections and inflammation.[2,29]

Limitations

Despite the rigorous methodology and the reporting according to PRISMA requirements, some limitations must be underlined. First, the great variety in the methodology of included studies made a direct comparison amongst them difficult. In addition, antimicrobial activity is a complex outcome influenced by different confounding factors that may impact results, including differences amongst participants in microbiota, inflammation status, and characteristics of sutures tested.[45]

Clinical implications and future perspectives

The reduction in bacterial adherence promoted by antimicrobial-coated agents would translate into a decrease in surgical site infection and related symptoms, including swelling, postoperative pain, and oedema, especially for high-risk patients undergoing surgical treatments. The clinical impact of antimicrobial-coated sutures has not been evaluated in the current scoping review because it was out of scope; future primary and secondary studies should address this. In addition, the properties of antimicrobial-coated sutures, such as strength, knot-holding capacity, and ease of handling,[31] as well as the precise concentration of the antibacterial agent and its drug-release profile[6] must also be further investigated.

Whilst animal and in vitro studies are fundamental to the development of clinical research, their findings may not directly translate to human outcomes.[57,58] Therefore, to ensure the relevance and applicability of the research findings to humans, these studies were excluded from the review, reflecting a cautious approach to translating preclinical results to clinical outcomes.

Implications for research

An optimal condition to explore the antimicrobial efficacy of coated sutures could be represented by the extraction in the same intervention (eg, as for orthodontic reasons) of the lower third molars in total osteomucosal inclusion and free of local infections. Furthermore, performing the extractions on the same day would minimise the confounding effect of the possible change in the oral microbiota following tooth extractions.[59,60] Sutures to be compared should be of the same diameter and type, monofilament or multifilament. Braided sutures, which retain more plaque[61] and are less easily cleanable, are preferred in clinical research to adequately test antibacterial activity. Furthermore, sutures should be ideally tested after 3 days to find a greater number of bacterial colonies and thus compare the 2 materials when the microbial colonisation is greater.[26]

Conclusions

Within the limits of this scoping review, antibacterial-coated sutures used in oral surgery showed less bacterial retention compared to noncoated sutures. However, the notable methodological variability, the available studies with small sizes, and the numerous confounding factors identified limit the generalisability and reliability of these results. Thus, high-quality randomised clinical studies with large sample sizes are required to draw firm conclusions.

Conflict of interest

None disclosed.

CRediT authorship contribution statement

Giusy Rita Maria La Rosa: Conceptualization, Formal analysis, Methodology, Software, Writing – original draft. **Simone Scapellato:** Conceptualization, Formal analysis, Investigation, Methodology, Software, Writing – original draft. **Marco Cicciù:** Data curation, Supervision, Validation, Visualization, Writing – review & editing. **Eugenio Pedullà:** Data curation, Formal analysis, Project administration, Resources, Supervision, Writing – review & editing.

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