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PROCEDIMENTOS ODONTOLÓGICOS EM PACIENTES ANTICOAGULADOS: UMA REVISÃO DE ESCOPO SOBRE O RISCO DE SANGRAMENTO

DENTAL PROCEDURES IN ANTICOAGULATED PATIENTS: A SCOPING REVIEW OF BLEEDING RISK

PROCEDIMIENTOS DENTALES EN PACIENTES ANTICOAGULADOS: UNA REVISIÓN DE ALCANCE SOBRE EL RIESGO DE SANGRADO

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Resumo

Introdução: O manejo odontológico de pacientes em uso de terapia anticoagulante requer o equilíbrio entre o risco de sangramento relacionado ao procedimento e as potenciais consequências da modificação inadequada da anticoagulação. **Objetivo:** Mapear as evidências disponíveis sobre o risco de sangramento e o manejo perioperatório de pacientes em uso de antagonistas da vitamina K (AVKs) ou anticoagulantes orais diretos (DOACs) durante procedimentos odontológicos. **Métodos:** Foi realizada uma revisão de escopo de acordo com o framework do Joanna Briggs Institute e relatada conforme o PRISMA-ScR. Foram considerados estudos clínicos primários que avaliaram procedimentos odontológicos e desfechos de sangramento em pacientes em uso de anticoagulantes orais. Artigos de revisão, estudos exclusivamente com antiagregantes plaquetários, estudos isolados com heparina, editoriais, cartas e artigos de opinião não foram considerados parte do corpus de evidências. **Resultados:** A matriz de evidências auditada compreendeu 43 estudos primários e foi predominantemente composta por estudos sobre varfarina e extração dentária. Os estudos disponíveis também avaliaram o acenocumarol e os DOACs rivaroxabana, apixabana, dabigatrana e edoxabana, bem como cirurgia periodontal e procedimentos de implante. O sangramento foi geralmente relatado como menor ou clinicamente manejável, embora sua frequência variasse de

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acordo com o procedimento, o anticoagulante, a estratégia perioperatória e a definição do desfecho. Procedimentos mais extensos, incluindo múltiplas extrações, elevação de retalho, osteotomia e manipulação óssea, foram associados a maior risco de sangramento em diversos estudos. Medidas locais, particularmente compressão, sutura, materiais hemostáticos absorvíveis e ácido tranexâmico tópico, foram frequentemente utilizadas. **Conclusão:** As evidências mapeadas apoiam principalmente o manejo individualizado de procedimentos dentoalveolares de baixo e moderado risco de sangramento, com ênfase no controle hemostático local. Os achados não devem ser generalizados para todos os procedimentos odontológicos nem interpretados como evidência a favor de uma única estratégia universal de manejo dos anticoagulantes. O manuscrito original relatava 27 estudos incluídos; esse número é mantido apenas como registro histórico, pois o registro arquivado da triagem não preservou a identificação desses estudos.

Palavras-chave: Anticoagulantes; Odontologia; Procedimentos odontológicos; Sangramento; Cirurgia oral; Anticoagulantes orais diretos.

Abstract

Background: Dental management of patients receiving anticoagulant therapy requires balancing procedure-related bleeding with the potential consequences of inappropriate modification of anticoagulation. **Objective:** To map the available evidence on bleeding risk and perioperative management of patients receiving vitamin K antagonists (VKAs) or direct oral anticoagulants (DOACs) during dental procedures. **Methods:** A scoping review was conducted according to the Joanna Briggs Institute framework and reported using PRISMA-ScR. Primary clinical studies evaluating dental procedures and bleeding outcomes in patients receiving oral anticoagulants were considered. Review articles, antiplatelet-only studies, isolated heparin studies, editorials, letters, and opinion papers were not considered part of the evidence corpus. **Results:** The audited evidence matrix comprised 43 primary studies and was dominated by studies of warfarin and tooth extraction. Available studies also evaluated acenocoumarol and the individual DOACs rivaroxaban, apixaban, dabigatran, and edoxaban, as well as periodontal surgery and implant procedures. Bleeding was generally reported as minor or clinically manageable, although bleeding frequency varied according to the procedure, anticoagulant, perioperative strategy, and outcome definition. More extensive procedures, including multiple extractions, flap elevation, osteotomy, and bone manipulation, were associated with greater bleeding risk in several studies. Local measures, particularly compression, suturing, absorbable hemostatic materials, and topical tranexamic acid, were frequently used. **Conclusions:** The mapped evidence mainly supports individualized management of low- and moderate-bleeding-risk dentoalveolar procedures, with emphasis on local hemostatic control. The findings should not be generalized to all dental procedures or interpreted as evidence for a single universal anticoagulant-management strategy. The original manuscript reported 27 included studies; this number is retained

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only as a historical record because the archived screening log did not preserve the identities of those reports.

Keywords: Anticoagulants; Dentistry; Dental procedures; Bleeding; Oral surgery; Direct oral anticoagulants.

Resumen

Antecedentes: El manejo odontológico de los pacientes que reciben tratamiento anticoagulante requiere equilibrar el riesgo de sangrado relacionado con el procedimiento con las posibles consecuencias de una modificación inadecuada de la anticoagulación. **Objetivo:** Mapear la evidencia disponible sobre el riesgo de sangrado y el manejo perioperatorio de pacientes que reciben antagonistas de la vitamina K (AVK) o anticoagulantes orales directos (ACOD) durante procedimientos odontológicos. **Métodos:** Se realizó una revisión de alcance de acuerdo con el marco metodológico del Joanna Briggs Institute y se informó conforme a las directrices PRISMA-ScR. Se consideraron estudios clínicos primarios que evaluaron procedimientos odontológicos y resultados de sangrado en pacientes tratados con anticoagulantes orales. Los artículos de revisión, los estudios exclusivamente sobre antiagregantes plaquetarios, los estudios aislados sobre heparina, los editoriales, las cartas y los artículos de opinión no fueron considerados parte del corpus de evidencia. **Resultados:** La matriz de evidencia auditada comprendió 43 estudios primarios y estuvo dominada por estudios sobre warfarina y extracción dental. Los estudios disponibles también evaluaron acenocumarol y los ACOD rivaroxabán, apixabán, dabigatrán y edoxabán, así como cirugía periodontal y procedimientos de implantes. El sangrado fue generalmente descrito como leve o clínicamente manejable, aunque su frecuencia varió según el procedimiento, el anticoagulante, la estrategia perioperatoria y la definición del desenlace. Los procedimientos más extensos, incluidas las extracciones múltiples, la elevación de colgajos, la osteotomía y la manipulación ósea, se asociaron con un mayor riesgo de sangrado en varios estudios. Las medidas locales, particularmente la compresión, la sutura, los materiales hemostáticos absorbibles y el ácido tranexámico tópico, fueron utilizadas con frecuencia. **Conclusiones:** La evidencia mapeada respalda principalmente un manejo individualizado de los procedimientos dentoalveolares con bajo y moderado riesgo de sangrado, con énfasis en el control hemostático local. Los hallazgos no deben generalizarse a todos los procedimientos odontológicos ni interpretarse como evidencia a favor de una única estrategia universal de manejo de los anticoagulantes. El manuscrito original informaba 27 estudios incluidos; este número se mantiene únicamente como registro histórico, ya que el registro archivado del proceso de selección no conservó la identificación de dichos estudios.

Palabras clave: Anticoagulantes; Odontología; Procedimientos odontológicos; Sangrado; Cirugía oral; Anticoagulantes orales directos.

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INTRODUCTION

The increasing prevalence of anticoagulant use represents an important challenge in dental practice. Anticoagulants are prescribed for the prevention and treatment of thromboembolic disorders, including atrial fibrillation, venous thromboembolism, and prosthetic heart valve-related conditions. Dental professionals therefore frequently encounter patients receiving anticoagulant therapy who require procedures with different degrees of bleeding potential (BACCI et al., 2010; MAHÉ et al., 2025).

Historically, interruption of anticoagulant therapy before dental treatment was used to reduce procedural bleeding. However, modification of anticoagulation may expose patients to thromboembolic risk, while bleeding associated with many dentoalveolar procedures can often be controlled with local measures (EVANS et al., 2002; AL-MUBARAK et al., 2007; BAJKIN et al., 2009). The clinical question is therefore not simply whether anticoagulation should be interrupted, but how bleeding risk should be assessed according to the anticoagulant, procedure, and patient context (BUCHBENDER et al., 2021a; LEE et al., 2024).

The introduction of direct oral anticoagulants (DOACs), including dabigatran, rivaroxaban, apixaban, and edoxaban, has added further complexity. These agents differ in pharmacokinetic characteristics and should not be treated as interchangeable. Perioperative decisions may also depend on the timing of the last dose, renal function, dosing regimen, and procedural bleeding potential (MAUPRIVEZ et al., 2016; IWABUCHI et al., 2022; IZZETTI et al., 2024).

This scoping review aimed to map the evidence regarding bleeding outcomes and clinical management of patients receiving oral anticoagulants during dental procedures, with particular attention to anticoagulant type, procedure complexity, modification or continuation of therapy, local hemostatic strategies, bleeding characteristics, and thromboembolic outcomes.

METHODS

Study design

This study was conducted as a scoping review following the methodological framework proposed by the Joanna Briggs Institute and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for

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Scoping Reviews (PRISMA-ScR). The purpose was to map the available primary clinical evidence rather than to estimate a pooled treatment effect.

Research question

The research question was developed using the Population–Concept–Context (PCC) framework. Population: adults receiving oral anticoagulant therapy; Concept: dental management and bleeding risk; Context: dental procedures and oral healthcare. The guiding question was: What evidence is available regarding bleeding risk and clinical management of patients receiving oral anticoagulants during dental procedures?

Eligibility criteria

Eligible studies were primary clinical investigations involving adults receiving oral anticoagulant therapy with a vitamin K antagonist or a direct oral anticoagulant and undergoing a dental or oral surgical procedure for which bleeding outcomes were evaluated. Randomized trials, prospective and retrospective observational studies, comparative studies, cohort studies, and case series were eligible. Review articles, systematic reviews, meta-analyses, guidelines, editorials, letters, opinion papers, studies involving antiplatelet therapy without an eligible anticoagulant group, and studies involving isolated heparin therapy were excluded from the evidence corpus. When a study included antiplatelet therapy together with anticoagulation, only anticoagulant-specific data were considered when these data could be separated.

Search strategy

The electronic search was conducted in PubMed/MEDLINE, Scopus, Web of Science, and SciELO using controlled vocabulary and free-text terms related to anticoagulants, dental procedures, and bleeding. The original search concept combined terms for anticoagulant therapy, dentistry/oral surgery, and bleeding/hemorrhage. Reference lists of relevant articles were also screened to identify additional primary studies.

The original manuscript did not preserve the complete database-specific search strings or the exact calendar date of the final search. These items should therefore be inserted from the archived search history before submission rather than reconstructed retrospectively.

Study selection

Titles and abstracts were screened according to the eligibility criteria, followed by full-text assessment of potentially relevant reports. Studies were classified as included primary evidence or excluded according to the predefined criteria. Where mixed populations were reported, anticoagulant-specific subgroups were extracted whenever possible.

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Data extraction

Data were extracted using a standardized matrix including author and year, country, study design, sample size, anticoagulant, clinical indication when reported, dosing or regimen, dental procedure, procedural complexity, anticoagulant continuation or interruption, timing of the last dose or INR when available, local hemostatic strategy, bleeding definition, timing and severity of bleeding, follow-up, and thromboembolic events.

Data synthesis

Data was synthesized descriptively. Because the included studies differed substantially in design, population, procedure, bleeding definitions, and follow-up, no pooled quantitative estimate was calculated. Studies were organized into VKA, DOAC, procedure-related, and local-hemostatic evidence domains.

RESULTS

Study selection and characteristics

The original manuscript reported 1,227 records identified from PubMed/MEDLINE (n=853), Scopus (n=214), Web of Science (n=132), and SciELO (n=28), followed by removal of 287 duplicates and screening of 940 records. Because the eligibility criteria were revised to exclude review articles from the evidence corpus and to separate antiplatelet-only and isolated-heparin studies, the original figure of 27 included studies was not retained automatically. The audited evidence matrix identified 43 primary clinical studies meeting the revised eligibility criteria. Thirty-four studies included VKA/warfarin exposure and 17 included DOAC exposure; these categories are not mutually exclusive because several studies evaluated both. Because the original archived screening records do not preserve the individual identities of the 27 studies reported in the original manuscript, the original PRISMA counts cannot be retrospectively converted into a verifiable 41-study flow without the archived screening history.

The audited evidence corpus comprised 43 primary studies, including 12 randomized studies and 31 non-randomized studies. The evidence was dominated by VKA/warfarin studies, while newer studies evaluated individual DOAC agents. Tooth extraction was the most frequently evaluated procedure, including single, multiple, and surgical extractions. Other procedures included periodontal surgery, flap procedures, osteotomy, bone manipulation, and dental implant placement. The original manuscript reported 27 included studies; this number is retained only as a historical record because the archived screening log did not preserve the identities of those reports.

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Vitamin K antagonists

Evidence involving VKAs was dominated by warfarin, with additional studies evaluating acenocoumarol and other coumarin derivatives. Studies compared continuation of anticoagulation with temporary interruption, dose reduction, or bridging with heparin (SACCO et al., 2007; AL-MUBARAK et al., 2007; BAJKIN et al., 2009; ERDEN et al., 2016).

Randomized studies of local tranexamic acid provide some of the clearest quantitative evidence. In Ramström et al. (1993), no bleeding requiring treatment occurred among 46 patients receiving tranexamic acid compared with 10 such events among 47 patients receiving placebo. In Sindet-Pedersen et al. (1989), bleeding occurred in 1 of 19 patients receiving tranexamic acid compared with 8 of 20 patients receiving placebo (RAMSTRÖM et al., 1993; SINDET-PEDERSEN et al., 1989).

Studies comparing continuation and interruption of VKA therapy generally did not demonstrate a consistent reduction in clinically important bleeding after interruption. Bajkin et al. (2009) reported bleeding in 8 of 109 patients (7.34%) with continued anticoagulation compared with 5 of 105 patients (4.76%) undergoing interruption and low-molecular-weight heparin bridging; all episodes were mild. Similar findings were reported in randomized and controlled studies comparing continued and interrupted warfarin therapy (EVANS et al., 2002; AL-MUBARAK et al., 2007; BAJKIN et al., 2009).

INR values varied among studies. Reported eligibility thresholds included INR values below 3.0 in some cohorts and ranges extending to approximately 4.0 in selected studies. These findings do not support a single INR threshold as a universal rule because the target range and clinical context depend on the indication for anticoagulation and the procedure being performed (BLINDER et al., 2001; SACCO et al., 2007; AL-MUBARAK et al., 2007; IWABUCHI et al., 2014).

Direct oral anticoagulants

DOAC evidence included rivaroxaban, apixaban, dabigatran, and edoxaban. These agents were considered separately when individual drug data were available (MAUPRIVEZ et al., 2016; GÓMEZ-MORENO et al., 2016; GÓMEZ-MORENO et al., 2018; IWABUCHI et al., 2022).

Mauprivez et al. (2016) evaluated 51 anticoagulated patients undergoing dental extraction without interruption of oral anticoagulation, including 31 patients receiving a DOAC and 20 receiving a VKA. The study followed patients for one

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postoperative week and used a clinical definition based on persistent oozing or marked bleeding despite local hemostatic measures (MAUPRIVEZ et al., 2016).

The EXTRACT-NOAC randomized trial included 218 patients receiving DOAC therapy. Tranexamic acid was administered to 106 patients and placebo to 112 patients. Bleeding occurred in 28 patients in the tranexamic-acid group and 32 in the placebo group; one thrombotic event occurred in the placebo group (OCKERMAN et al., 2021).

Izzetti et al. (2024) evaluated 49 patients receiving DOACs: 17 rivaroxaban, 16 apixaban, 8 edoxaban, and 8 dabigatran. Bleeding was assessed intraoperatively and during seven days of follow-up. Extraction of more than three teeth, flap elevation, and osteotomy were associated with greater bleeding (IZZETTI et al., 2024).

Kim et al. (2024) evaluated 293 patients and 414 extracted teeth. DOAC therapy was continued in 246 patients and discontinued in 47. Twelve patients experienced postoperative bleeding; the reported difference between continuation and interruption was not statistically significant (KIM et al., 2024).

Procedure-related bleeding risk

Tooth extraction was the dominant procedure across the evidence. Simple extraction generally produced limited bleeding controlled with local measures. More extensive procedures, including multiple extractions, flap elevation, osteotomy, and bone manipulation, were associated with greater bleeding potential in several studies (IWABUCHI et al., 2014; ERDEN et al., 2016; IZZETTI et al., 2024).

Implant procedures were less frequently studied than extraction. Available evidence generally reported low postoperative bleeding rates, but procedures varied in complexity. Implant placement should therefore not be interpreted as a single homogeneous bleeding-risk category (BACCI et al., 2011; CLEMM et al., 2016; GÓMEZ-MORENO et al., 2016; GÓMEZ-MORENO et al., 2018; MAHÉ et al., 2025).

Local hemostatic strategies

Local hemostatic measures included direct pressure, suturing, absorbable hemostatic materials, fibrin-based products, oxidized cellulose, and topical tranexamic acid (RAMSTRÖM et al., 1993; CARTER et al., 2003; SOARES et al., 2015; OCKERMAN et al., 2021).

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Tranexamic acid was evaluated using different protocols, including mouthwash and other topical applications; these approaches were therefore not considered interchangeable (SINDET-PEDERSEN et al., 1989; CARTER et al., 2003; SOARES et al., 2015; OCKERMAN et al., 2021).

The frequency with which a hemostatic strategy was reported was not interpreted as evidence of superiority. Differences in study design, comparator, procedure, and bleeding definition precluded ranking the available interventions.

Bleeding severity, timing, and thromboembolic outcomes

Bleeding definitions varied substantially. Most reported events were minor or clinically manageable, while major bleeding requiring hospitalization, transfusion, or substantial surgical intervention was uncommon in the available studies (BACCI et al., 2010; MAUPRIVEZ et al., 2016; BUCHBENDER et al., 2021a; MAHÉ et al., 2025).

Follow-up ranged from immediate postoperative assessment to approximately seven days or longer. In the prospective national study by Mahé et al. (2025), 62 bleeding events occurred in 50 of 523 patients; 43 were classified as clinically relevant non-major bleeding and 19 as minor events, and 90.3% occurred within seven days. No major bleeding events were reported (MAHÉ et al., 2025).

Thromboembolic outcomes were less consistently reported than bleeding outcomes. The EXTRACT-NOAC trial reported one thrombotic event in the placebo group and none in the tranexamic-acid group (OCKERMAN et al., 2021). Most other studies reported no thromboembolic events during their respective follow-up periods, but short observation periods and heterogeneous reporting limit conclusions regarding thromboembolic risk (BACCI et al., 2011; CLEMM et al., 2016; MAUPRIVEZ et al., 2016).

Quantitative characteristics of the audited evidence. Forty-three primary studies were identified in the audited evidence matrix. Twelve were randomized studies and 29 were non-randomized designs. VKA exposure, predominantly warfarin, was represented across the largest portion of the corpus, whereas DOAC evidence included rivaroxaban, apixaban, dabigatran, and edoxaban, with several studies providing drug-specific results. Tooth extraction was the dominant procedure, while multiple extraction, flap elevation, osteotomy, bone manipulation, periodontal surgery, and implant procedures were less consistently represented. Because study populations, procedure units, outcome definitions, and mixed-treatment groups differed substantially, sample sizes were not summed across studies and no pooled

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bleeding estimate was calculated (SACCO et al., 2007; MAUPRIVEZ et al., 2016; CLEMM et al., 2016; OCKERMAN et al., 2021; MAHÉ et al., 2025).

Quantitative summary of the audited evidence. The audited corpus comprised 43 primary studies: 12 randomized studies and 31 non-randomized studies. Thirty-four studies included VKA/warfarin exposure and 17 included DOAC exposure; these categories were not mutually exclusive because several studies evaluated both. Warfarin was the most frequently studied anticoagulant. DOAC evidence included rivaroxaban, apixaban, dabigatran, and edoxaban. Tooth extraction was the dominant procedure, with additional evidence from periodontal surgery, implant placement, osteotomy, flap procedures, bone manipulation, biopsy, and other dentoalveolar surgery. Because study units, populations, procedures, bleeding definitions, and follow-up periods varied substantially, sample sizes were not summed across studies and no pooled bleeding estimate was calculated. The original manuscript reported 27 included studies; this number is retained only as a historical record because the archived screening log did not preserve the identities of those reports.

DISCUSSION

This scoping review maps a heterogeneous body of primary evidence concerning dental procedures in patients receiving oral anticoagulants. The strongest body of evidence concerns warfarin and tooth extraction, whereas evidence for individual DOACs is newer and generally more heterogeneous (DEVANI; LAVERY; HOWELL, 1998; EVANS et al., 2002; IWABUCHI et al., 2014; MAUPRIVEZ et al., 2016; IWABUCHI et al., 2022; IZZETTI et al., 2024).

The findings do not support a universal rule that anticoagulation should be interrupted before dental treatment. In studies of VKA therapy, continuation was frequently associated with low rates of clinically relevant bleeding, and randomized comparisons did not consistently demonstrate a clinically meaningful reduction in bleeding after interruption. Local hemostatic measures were central to the management of postoperative bleeding (EVANS et al., 2002; AL-MUBARAK et al., 2007; BAJKIN et al., 2009; ERDEN et al., 2016).

At the same time, the evidence does not justify extending this conclusion to every dental procedure. The literature is concentrated on extractions and other dentoalveolar procedures, while more invasive surgery is less consistently represented. Bleeding risk should therefore be interpreted in relation to procedural extent, including the number of teeth involved, flap elevation, osteotomy, and bone manipulation (IWABUCHI et al., 2014; ERDEN et al., 2016; IZZETTI et al., 2024).

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VKA management also requires interpretation of the INR in context. Studies used different INR ranges and measurement schedules, and therapeutic targets depend on the underlying indication. Accordingly, the evidence should not be converted into one universal INR cutoff for every patient or procedure (BLINDER et al., 2001; SACCO et al., 2007; AL-MUBARAK et al., 2007; IWABUCHI et al., 2014).

DOACs require separate consideration. Rivaroxaban, apixaban, dabigatran, and edoxaban differ in dosing schedules and pharmacokinetic characteristics. The available studies also used different strategies regarding continuation or temporary interruption. Some protocols scheduled procedures at a low-concentration period, but the available evidence does not justify presenting a single interval, such as 12–24 hours after the last dose, as a universal rule applicable to every DOAC and every procedure (MAUPRIVEZ et al., 2016; GÓMEZ-MORENO et al., 2016; GÓMEZ-MORENO et al., 2018; IWABUCHI et al., 2022; IZZETTI et al., 2024).

Local hemostatic management appears to be a recurrent component of successful care. Compression, suturing, absorbable materials, and topical tranexamic acid were repeatedly used. However, the studies differed in how these interventions were applied and how bleeding was defined, preventing a direct hierarchy of hemostatic strategies (SINDET-PEDERSEN et al., 1989; RAMSTRÖM et al., 1993; CARTER et al., 2003; SOARES et al., 2015; OCKERMAN et al., 2021).

Patient-related factors should also be considered. Decisions in patients with particularly high bleeding or thromboembolic risk may require individualized interdisciplinary assessment rather than routine medication interruption (BACCI et al., 2010; BUCHBENDER et al., 2021a; LEE et al., 2024).

LIMITATIONS

The primary studies were heterogeneous with respect to anticoagulant regimen, procedure, bleeding definition, follow-up, and local hemostatic protocol. Several studies included mixed antithrombotic populations, requiring subgroup extraction (BUCHBENDER et al., 2021a; BUCHBENDER et al., 2021b; MAHÉ et al., 2025). The original manuscript also did not preserve the complete database-specific search strings or exact final search date, limiting exact reconstruction of the original retrieval process. As a scoping review, the objective was evidence mapping rather than formal comparative risk estimation; no pooled hierarchy of interventions was generated.

CONCLUSION

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The available primary evidence mainly concerns low- and moderate-bleeding-risk dentoalveolar procedures, particularly tooth extraction. Across these settings, postoperative bleeding was generally limited and could frequently be controlled with local hemostatic measures, while routine interruption of oral anticoagulation was not consistently associated with a clinically important reduction in bleeding (EVANS et al., 2002; AL-MUBARAK et al., 2007; BAJKIN et al., 2009; MAHÉ et al., 2025).

Management should nevertheless be individualized according to anticoagulant type, procedure complexity, patient-related risk factors, and the perioperative regimen. VKA and individual DOAC agents should not be treated as pharmacologically interchangeable, and no single INR threshold or dose-timing interval should be applied universally (BLINDER et al., 2001; MAUPRIVEZ et al., 2016; IWABUCHI et al., 2022; IZZETTI et al., 2024).

Overall, the audited evidence supports local hemostatic management and individualized anticoagulant planning for the low- and moderate-bleeding-risk dental settings most frequently studied. The available evidence does not establish a universal continuation or interruption strategy for all anticoagulants or all dental procedures.

TABLE 1. Database search strategies

Database	Core concepts	Search strategy	Final search date
PubMed/MEDLINE	Anticoagulant + dental procedure + bleeding	("anticoagulants" OR "anticoagulant therapy" OR warfarin OR "direct oral anticoagulants" OR DOAC OR rivaroxaban OR apixaban OR dabigatran OR edoxaban) AND ("dentistry" OR "dental procedures" OR "oral surgery" OR "tooth extraction" OR "dental treatment") AND (bleeding OR hemorrhage OR "clinical management")	INSERT ARCHIVED DATE

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Scopus	Same three concepts	Insert archived database-specific syntax	INSERT ARCHIVED DATE
Web of Science	Same three concepts	Insert archived database-specific syntax	INSERT ARCHIVED DATE
SciELO	Same three concepts	Insert archived database-specific syntax	INSERT ARCHIVED DATE

TABLE 2. Audited evidence matrix of included primary studies
Note: NR indicates that the value was not established from the audited source material available for this revision and should not be interpreted as zero.

Study	Design	n	Anticoagulant	Procedure	Management	Hemostatic strategy	Bleeding definition/outcome	Follow-up	Thromboembolic events
Sindet-Pedersen 1989	RCT	39	VKA	Oral surgery	Continued	Topical tranexamic acid vs placebo	Bleeding: 1/19 TXA vs 8/20 placebo	7 d	NR
Ramström 1993	RCT	93	VKA	Oral surgery	Continued	Tranexamic acid vs placebo	Bleeding requiring treatment: 0/46 vs 10/47	NR	NR
Borea 1993	RCT	30	VKA	Extractions	Continued vs reduced	Tranexamic acid/placebo	No significant difference in bleeding	7 d	NR

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Devani 1998	Controlled	65	Warfarin	Extractions	Continued vs interrupted	Local hemostasis	1 mild event in each group	NR	NR
Campbell 2000	Controlled	25 anticoagulated	Warfarin	Extraction, alveoloplasty, soft tissue	12 continued / 13 interrupted	Local hemostasis	No serious post-operative bleeding	NR	NR
Blinder et al. 2001	Controlled	249	Coumarin	543 extractions	Continued	Local hemostasis	Postoperative bleeding: 30/249 patients	NR	NR
Evans 2002	RCT	109	Warfarin	Extractions	Continued vs interrupted	Local hemostasis	Bleeding: 26% vs 14%; difference not significant	7 d	NR
Cannon & Dharmar 2003	Controlled	70	Warfarin	Minor oral surgery	Continued vs interrupted	Local hemostasis	Minor delayed bleeding events	NR	NR
Zanon 2003	Prospective	250	Warfarin	Extractions	Continued	Fibrin sponge + sutures + topical TXA	Postoperative bleeding assessed	8 d	NR
Carter et al. 2003	RCT	49; 152 extractions	Warfarin	Extractions	Continued	4.8% TXA mouthwash	2/49 (4%) postoperative	7 d	NR

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						vs autologous fibrin glue	bleeding; both in fibrin-glue group		
Carter & Goss 2003	RCT	85; 152 sites	Warfarin	Extractions	Continued	4.8% TXA for 2 vs 5 d	3 minor bleeding events	7 d	NR
Sacco 2007	Randomized	131	Warfarin/acenocoumarol	Extractions, implants, oral surgery	Reduced INR vs therapeutic INR	Local hemostasis	Mild bleeding: 15.1% vs 9.2%; no significant difference	7 d	None reported
Al-Mubarak 2007	RCT	214	Warfarin	1–5 extractions	Continued vs interrupted	Local hemostasis ± sutures	7.2% vs 6.7%; no major bleeding/CRNMB	7 d	None reported
Ferrieri 2007	Prospective	255; 334 interventions	Warfarin	Extractions, biopsy, implant and oral surgery	Continued	Atraumatic technique + local measures	5/255 (1.96 %) bleeding complications	NR	None reported
Bajkin et al. 2009	RCT	214	VKA	Simple extractions	Continued vs interruption + LMWH bridge	Collagen sponge in continued group	8/109 (7.34 %) vs 5/105 (4.76 %); all mild	NR	None reported

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Bacci 2010	Case-control	451 + 449 controls	Warfarin	Extractions	Continued	Fibrin sponge + sutures + gauze with TXA	7/451 vs 4/449; no late bleeding requiring hospitalization/transfusion	NR	NR
Duan 2010	RCT	116	Warfarin	Extractions	Continued vs interrupted	NR	6/67 vs 5/49 bleeding events	1 d	NR
Bacci 2011	Case-control	52	Warfarin	Implant placement	Continued	Sutures + gauze with TXA	2 vs 3 late bleeding events	NR	NR
Pereira 2011	Prospective	108; 215 extractions	Warfarin ± antiplatelet	Extractions	Mostly continued	Obliterative sutures/local measures	1 postoperative bleeding event reported; anticoagulant-specific data considered	NR	NR
Morimoto 2011	Observational	382; 443 extractions	Warfarin ± antiplatelet	Extractions	Continued	Local hemostasis	17 postoperative hemorrhage patients; subgro	6 d	NR

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							up-specific		
Iwabuchi 2014	Multicenter observational	496 warfarin + 2321 controls; 2817 teeth	Warfarin	Simple extractions	Continued; PT-INR <3 in study	Basic/local hemostasis; additional intervention when needed	Postoperative bleeding 7.1% of patients; clinically significant bleeding 3.6%	NR	NR
Cocero 2014	Prospective	500 extractions	Oral anticoagulants	Extractions	According to INR	Local hemostasis	Bleeding requiring reoperation assessed	NR	NR
Soares 2015	RCT	38 analyzed; 84 sites	Warfarin	Extractions	Continued	4.8% TXA vs fibrin sponge vs dry gauze	4 bleeding sites	7 d	NR
Erden 2015/2016	Controlled	36	Warfarin	Multiple extractions	Continued vs interruption + LMWH bridge	Oxidized cellulose + sutures	More bleeding with bridging	10 d	NR
Clemm 2016	Comparative	117 antithrombotic	VKA/DOAC/antiplatelet	Implant/bone graft	Variable	Local hemostasis	4/117 antithrombotic patient	NR	None reported

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							s; 0/16 DOAC		
Mauprivez 2016	Prospective cohort	51; 31 DOAC/20 VKA	DOAC/VKA	Extractions	Continued	Local hemostasis	7 bleeding episodes in 5 DOAC patients; 5 episodes in 4 VKA patients; mostly mild	7 d	None reported
Gómez-Moreno 2016	Case-control	18	Rivaroxaban	Implants	Continued	Non-absorbable sutures + TXA	1 moderate bleeding event	NR	NR
Gómez-Moreno 2018	Case-control	29	Dabigatran	Implant surgery	12 h after last dose	Local hemostasis	2 bleeding events	NR	NR
Ockerman 2021	RCT	218	DOAC	Extractions	TXA vs placebo; perioperative DOAC management per protocol	TXA mouthwash	Any bleeding: 28/106 vs 32/112	7 d	1 thrombotic event in placebo group; none in TXA group
Buchbender et al. 2021 – prospective	Prospective comparative	195	VKA/DOAC/antiplatelet	Dentoalveolar surgery	Variable	Local hemostasis	Bleeding graded by clinical severity;	NR	NR

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							associated with surgical complexity		
Buchbender et al. 2021 – retrospective	Retrospective comparative	475	VKA	Dentoalveolar surgery	Continued VKA vs heparin bridging	Local hemostasis	Bleeding: 22/170 control, 44/170 VKA, 65/135 bridging	NR	NR
Iwabuchi 2022	Multicenter prospective	233 individuals; 270 teeth	Dabigatran/rivaroxaban	Extractions	Drug-specific management	Bleeding: 1.65% dabigatran; 3.41% rivaroxaban	7 d	NR	
Japan claims 2023	Retrospective cohort	5,253	3,696 DOAC / 1,557 warfarin	Permanent tooth extraction	Real-world management	7-day bleeding: 1.9% DOAC vs 2.2% warfarin; adjusted OR 0.84	7 d	NR	
Berton et al. 2023	Cohort	112; 59 DOAC/53 VKA	DOAC/VKA	Single extraction	Continued	L-PRF	Bleeding: 15.3% DOAC vs 17% VKA; no medic	7 d	NR

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							al support		
Izzetti 2024	Prospective cohort	49; 136 extractions	17 rivaroxaban/16 apixaban/8 edoxaban/8 dabigatran	Extraction, flap, osteotomy	33 interrupted preoperatively	Local hemostasis	Bleeding assessed intraoperatively and through day 7; greater with >3 teeth, flap, osteotomy	7 d	NR
Kim 2024	Retrospective	293; 414 teeth	DOAC	Simple/surgical extraction	246 continued / 47 interrupted	Local hemostasis	12/293 patients (4.1%); 12 bleeding sites; no events in interruption group	NR	NR
Bajkin et al. 2024	Prospective observational	77 DOAC + 103 VKA + 103 controls	DOAC/VKA	Dentoalveolar surgery	NR	Local hemostasis	Bleeding: 2.9% DOAC; 4.8% VKA; 0.97% controls	NR	NR
Katz 2024	Retrospective	1,595 procedures	Oral anticoagulan	Dental/oral	Variable	Local hemostasis	Procedure-specifi	NR	NR

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			ts ± antiplatelet	procedures			c postoperative bleeding outcomes		
Lee 2024	Retrospective cohort	537	VKA/DOAC	Periodontal surgery, extraction, implant	Continuation vs interruption	Local hemostasis	35/537 (6.5%) bleeding complications	NR	NR
Mahé 2025	Prospective national observational	523; 345 DOAC/178 VKA	DOAC/VKA	Oral, periodontal, implant surgery	Variable	Local hemostatic management	62 events in 50 patients; 43 CRNMB and 19 minor; no major bleeding	Days 2, 7, 30	NR
Johansson 2025	Prospective cohort	210 final; 354 teeth; 154 DOAC/56 warfarin	DOAC/warfarin	Simple/surgical extraction	Continued	Local hemostatic agents + TXA instructions	Any bleeding 27% DOAC vs 37% warfarin; clinically relevant 3% vs 11%; no major	7 d	No major thromboembolic events reported

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							bleeding		
Kaya 2025	Prospective case-control	211 DOAC + 219 controls	Apixaban/dabigatran/edoxaban/rivaroxaban	Extractions	Continued	Local hemostasis	Five-level bleeding grading; mostly grades 0–1	7 d	NR
Higashi 2025/2026	Prospective blinded	58; 84 extractions	Rivaroxaban/dabigatran/apixaban/warfarin	Protocol-specific timing; warfarin INR 2–3	Local hemostasis	0 rivaroxaban; 2/18 dabigatran/apixaban; 2/20 warfarin; minor events	NR	None major reported	

FIGURE 1. PRISMA-ScR flow diagram. The archived search record documents 1,227 records, 287 duplicates, 940 records screened, 65 full texts assessed, 38 full-text exclusions, and 27 studies reported as included in the original manuscript. The present audit identified 43 primary studies meeting the revised eligibility criteria. Because the archived screening log does not preserve the individual identities of the original 27 included reports, the historical search counts and the audited 43-study corpus cannot be connected retrospectively in a verifiable PRISMA-ScR flow. The 43-study corpus is therefore presented as an audited evidence matrix rather than as a reconstructed numerical PRISMA flow.

PRISMA-ScR reporting note: the historical search counts are retained for transparency, while the audited evidence corpus is reported separately because the archived screening log needed to reconcile the two was not preserved.

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