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Effect of transmucosal abutment tightening torque on bacterial microleakage, microgap formation, and mechanical behavior at the implant–abutment interface: a systematic review

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ADMINISTRATIVE INFORMATION

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Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 26 February 2026 and was last updated on 26 February 2026.

INTRODUCTION

Review question / Objective This systematic review aims to answer the following question: In implant-supported restorations, what is the effect of manual (freehand) versus torque-controlled tightening of transmucosal abutments on bacterial microleakage, microgap formation, mechanical behavior at the implant–abutment interface, peri-implant tissue parameters, and patient-reported outcomes?

The objective of this review is to systematically evaluate the available evidence regarding the influence of abutment tightening torque on biological and mechanical outcomes at the implant–abutment interface.

Rationale Bacterial microleakage and mechanical instability at the implant–abutment interface have

been associated with peri-implant inflammation, marginal bone remodeling, and prosthetic complications. Tightening torque is a critical factor influencing preload generation and joint stability; however, the effect of manual versus torque-controlled tightening on biological and mechanical outcomes remains unclear. Although numerous in vitro studies have investigated microleakage and connection design, the specific role of abutment tightening torque has not been comprehensively synthesized, and clinical evidence is scarce. Therefore, a systematic evaluation of the available literature is necessary to clarify current evidence and identify gaps requiring further clinical investigation.

Condition being studied Dental implant therapy and stability of the implant–abutment interface. Bacterial microleakage and mechanical instability at the implant–abutment interface have been associated with peri-implant inflammation, marginal bone remodeling, and technical

complications. The present review focuses on the biological and mechanical consequences of abutment tightening torque in implant-supported restorations.

METHODS

Search strategy A comprehensive electronic search will be conducted in PubMed/MEDLINE, Embase, Web of Science, Cochrane Library, and OpenGrey from database inception to the search date. Search terms will combine controlled vocabulary (e.g., MeSH and Emtree terms) and free-text keywords related to dental implants, implant–abutment interface, abutment tightening torque, manual tightening, torque-controlled tightening, bacterial microleakage, microgap, and peri-implant outcomes. Boolean operators (AND/OR) will be used to combine search terms. A manual search of reference lists of included studies will also be performed.

Participant or population The review will include implant–abutment assemblies evaluated in vitro, animal models investigating implant-supported restorations, and patients undergoing dental implant therapy rehabilitated with transmucosal abutments or healing abutments.

Intervention Torque-controlled tightening of transmucosal abutments using calibrated mechanical torque devices according to manufacturer recommendations or predefined torque values.

Comparator Manual (freehand or finger) tightening and/or alternative torque magnitudes applied to transmucosal abutments.

Study designs to be included In vitro experimental studies, preclinical animal studies, randomized controlled clinical trials, and prospective or retrospective observational clinical studies.

Eligibility criteria Studies will be included if they evaluate the effect of transmucosal abutment tightening torque on bacterial microleakage, microgap formation, mechanical behavior at the implant–abutment interface, peri-implant tissue parameters, or patient-reported outcomes. Eligible studies must compare at least two torque conditions (e.g., manual versus torque-controlled tightening or different torque magnitudes).

Studies will be excluded if they do not report torque values, do not assess relevant biological or mechanical outcomes, apply different surgical

preparation techniques between comparison groups that could confound results, or correspond to case reports, narrative reviews, systematic reviews, meta-analyses, letters, or opinion articles.

Information sources Electronic searches will be conducted in PubMed/MEDLINE, Embase, Web of Science, Cochrane Library, and OpenGrey from database inception to the search date. No language restrictions will be applied. In addition, manual searches of the reference lists of included studies and relevant reviews will be performed to identify potentially eligible articles.

Main outcome(s) The primary outcome will be bacterial microleakage at the implant–abutment interface, assessed through qualitative or quantitative experimental models, including bacterial penetration, microbial leakage, or contamination detection methods.

Quality assessment / Risk of bias analysis Risk of bias will be assessed independently by two reviewers. The methodological quality will be evaluated according to domains applicable to each study design. For experimental in vitro studies, domains will include standardization of procedures, torque application protocol, randomization of specimens (when applicable), blinding of outcome assessment, completeness of reporting, and adequacy of statistical analysis. For animal and clinical studies, established methodological criteria appropriate to each design will be applied. Disagreements will be resolved by consensus or consultation with a third reviewer.

Strategy of data synthesis A qualitative synthesis of the findings will be performed. Due to the anticipated heterogeneity in implant systems, torque protocols, experimental models, and outcome assessment methods, a quantitative meta-analysis will only be conducted if sufficient methodological homogeneity is identified. Results will be summarized descriptively according to torque magnitude and implant–abutment connection design.

Subgroup analysis If sufficient data are available, subgroup analyses will be conducted according to implant–abutment connection design (e.g., external hexagon versus internal conical/Morse taper) and torque magnitude categories.

Sensitivity analysis Sensitivity analyses will be performed if appropriate, for example by excluding studies at higher risk of bias or studies with extreme torque values, to evaluate the robustness of the findings..

Country(ies) involved Spain.

Keywords Dental implants; implant–abutment interface; abutment tightening torque; manual tightening; torque-controlled tightening; bacterial microleakage; microgap; peri-implantitis..

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