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# Surface Modification for Enhancing Titanium Dental Implant Osseointegration : A Systematic Review

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## ADMINISTRATIVE INFORMATION

**Support -** Faculty of Dental Medicine, Universitas Airlangga, Surabaya, East Java, Indonesia.

**Review Stage at time of this submission -** Completed but not published.

**Conflicts of interest -** None declared.

**INPLASY registration number:** INPLASY202450006

**Amendments -** This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 02 May 2024 and was last updated on 02 May 2024.

## INTRODUCTION

**Review question / Objective** Following the Participants, Intervention, Control, and Outcomes (PICO) principle, a focused question was formulated before conducting the literature search based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (PRISMA 2020). The focused question was: What is the prospect of surface modification on titanium dental implant in enhancing its osseointegration?

**Rationale** Over the past few decades, metal implants have become the most frequently used treatment. The highlight of dental implant treatment is that this treatment maintains the structure and bone of adjacent teeth. Therefore, dental implants have become an important treatment option to replace missing teeth. Titanium is one of the most commonly used dental implant biomaterials, and this can be seen from its good mechanical properties, low density (4.5 g/cm3), and good bone contact biocompatibility. The surface properties of the implant can influence cellular and tissue responses and play an essential role in osseointegration. Thus, several types of surface modifications provide quite effective strategies in increasing protein matrix adsorption and cellular bioactivity, which can promote implant osseointegration. Several modification methods were aimed to increase the response to the tissue of Titanium dental implants. Such as surface hardening, blasting method, acid etching (SLA) techniques, laser ablation, and many more methods to improve osseointegration.

**Condition being studied** The aim of this study was to perform a systematic review of the existing literature comparing surface modifications to improve osseointegration of titanium dental implants.

## METHODS

**Search strategy** A systematic review protocol according to PRISMA 2020 was drafted. Additionally, reporting was based on the PRISMA 2020 checklist. The following databases including MEDLINE/PubMed (https://pubmed.ncbi.nlm.nih.gov), Scopus (https://www.scopus.com/), and EMBASE (https://www.embase.com/) were searched with "((((((SURFACE MODIFICATION) OR (SURFACE TREATMENT)) OR (SURFACE TRANSFORMATION)) OR (SURFACE CHANGE)) AND (((((((ETCHING) OR (BLASTING)) OR (SANDBLASTING)) OR (COATING)) OR (LASER)) OR (DEPOSITION)) OR (IMMERSION)) OR (MICROTUBE))) AND (TITANIUM DENTAL IMPLANT)) AND ((OSSEOINTEGRATION) OR (BONE INTEGRATION))" as the keyword search strategy. Manual searches were performed to supplement the completed searches. The literature search process was carried out from September 2023 until November 2023.

**Participant or population** Animals (rabbits, dogs, pigs, sheep, rats, foxhounds), patients, cell (immortalized gingival fibroblast, osteoblast cells, Rat bone cell, monocyte cell, osteoblast-like cells, osteoprogenitor cells, hMSC cell, Rat bone marrow mesenchymal stem cells (rBMSCs) and Human umbilical vein endothelial cells (HUVECs), human embryonic palatal mesenchymal cells, Human trabecular bone derived osteoblast precursor cells (HBCs), osteocyte-like cells).

**Intervention** Titanium dental implant with modification.

**Comparator** Coating, acid-etch, blast, immersion, oxidation, spray, ultraviolet light, heat treatment, anodize, laser.

**Study designs to be included** In Vivo, In vitro, and Clinical trials on patients.

**Eligibility criteria** The inclusion criteria for this study include full-text original articles that concentrate on titanium dental implants and their various surface modification methods to enhance osseointegration. However, articles in language other than English with no clear method information, doesn't discuss detailed surface modification, no clear subject or different objective, and doesn't have a clear study setting and method were excluded.

**Information sources** The following electronic databases were used as search engine: MEDLINE/PubMed (https://pubmed.ncbi.nlm.nih.gov accessed on September 28, 2023), Scopus (https://www.scopus.com accessed on September 28, 2023), and Embase (https://www.embase.com accessed on September 28, 2023).

**Main outcome(s)** To perform a systematic review of the existing literature comparing surface modifications to improve osseointegration of titanium dental implants.

**Additional outcome(s)** To answer the focused question: What is the prospect of surface modification on titanium dental implants in enhancing their osseointegration?

**Data management** The three reviewers (A.R. and N.M.) independently conducted electronic literature searches and selected the studies. Any disagreements were resolved by discussion or by consulting a second reviewer (N.H.). The reviewers (A.R. and N.M.) worked to duplicate screening, extract, and recapitulate data using a standardized form in Microsoft Excel that had been validated prior to use. Data was primarily extracted using the PICO protocol (Participants, Intervention, Controls, Outcomes). Results were tabulated in the table using predetermined data collection forms by the two investigators independently.

**Quality assessment / Risk of bias analysis** Each article was then assessed by investigators. The risk of bias assessment was conducted using a method adapted from previous systematic reviews. This assessment evaluated the description of several quality assessment criteria, including the type of titanium dental implant or titanium alloy used, surface modification method, sample preparation, randomization of samples or subjects, blind examiner, a clear test method, and complete result. The article was labeled "Y" for a given parameter if the authors reported it and "N" if the information could not be seen. Depending on how many "Y" elements were present (1-2, 3-4, or 5-6), the articles were categorized as having a high, medium, or low risk of bias.

**Strategy of data synthesis** The keyword generated a total of 2124 papers, with 1178 articles from PubMed, 936 articles from Scopus, and 10 articles from Embase. Among them, 1507 remaining articles were collected due to the process of duplicate screening as well as title and abstract reading and the number of articles assessed for eligibility at the full text are 62 articles. The reviewers read the complete texts of those articles and eventually chose 57 articles that matched the eligibility criteria.

**Subgroup analysis** Nil.

**Sensitivity analysis** Microsoft Office Excel (2021, Microsoft) was used for descriptive statistics.

**Language restriction** English.

**Country(ies) involved** Indonesia.

**Keywords** surface modifications, osseointegration, titanium dental implants.

**Contributions of each author**

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