

Biological Response of Fibroblasts to Laser-Treated Zirconia Surfaces

A Systematic Review

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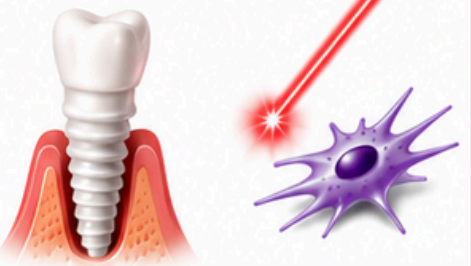
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INTRODUCTION

Laser-based surface modification may enhance the biological performance of zirconia implants and improve soft-tissue integration. Fibroblasts are essential for establishing and maintaining the peri-implant mucosal seal.



OBJECTIVE



To evaluate the effects of laser surface treatment on fibroblast behavior cultured on zirconia surfaces through a systematic review of in vitro studies

METHODS



Search Strategy

PubMed, Scopus, Web of Science, Embase, and WorldCat were searched following PRISMA guidelines



Eligibility Criteria

In vitro experimental studies investigating fibroblast responses to laser-modified zirconia surfaces



Data Extraction

Laser type, zirconia characteristics, fibroblast cell type, and biological outcomes were extracted

PRISMA FLOW DIAGRAM



LASER SYSTEMS INVESTIGATED



Er:YAG



Er,Cr:YSGG



Nd:YAG



Diode



Excimer



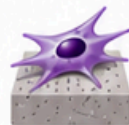
DPSS
Nd:YVO₄



Femtosecond

RESULTS

EFFECTS ON FIBROBLASTS (vs. untreated zirconia)



Enhanced adhesion ↑



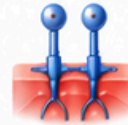
Improved spreading ↑



Increased proliferation ↑



Better cytoskeletal organization ↑



Upregulated adhesion-related protein expression ↑

ADDITIONAL EFFECTS REPORTED



Improved surface wettability



Favorable micro- and nanotopography



Antibacterial activity



Reduced inflammatory responses



Enhanced soft-tissue integration in animal models

FACTORS INFLUENCING BIOLOGICAL OUTCOMES



Laser wavelength



Energy density

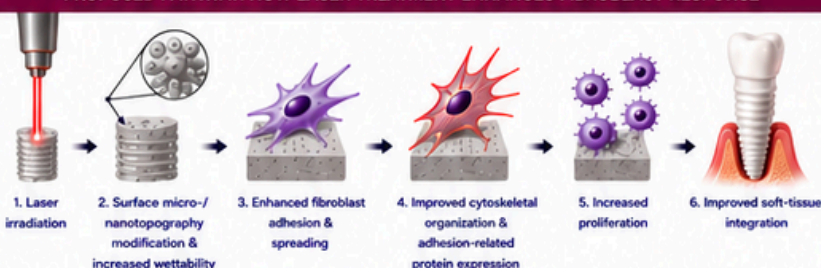


Irradiation protocol



Zirconia surface characteristics

PROPOSED PATHWAY: HOW LASER TREATMENT ENHANCES FIBROBLAST RESPONSE



Better peri-implant soft-tissue integration

CONCLUSIONS

- ✓ Laser surface modification is a safe and effective strategy for enhancing fibroblast responses on zirconia surfaces
- ✓ It may improve peri-implant soft-tissue integration.
- ✓ Biological outcomes vary depending on laser parameters and zirconia surface characteristics.
- ✓ Substantial heterogeneity among studies limits direct comparison.
- ✓ Standardized in vitro investigations and well-designed clinical studies are required to establish optimal laser protocols and confirm their clinical applicability.



TAKE-HOME MESSAGE



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DISCLAIMER:

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