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A study to compare the early osseointegration between photofunctionalized and nonphotofunctionalized titanium dental implant in the mandibular region – A randomized controlled trial

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Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background and Objectives: The study was done to evaluate and compare the peri-implant bone levels and soft tissue changes around photofunctionalized and non-photo functionalized dental implants at baseline (immediately after placement of implant), 4weeks,8 weeks and 4 months.

Method: This randomized, double-blinded trial evaluated UV photofunctionalization on posterior mandibular implants in 24 patients. UV-treated (n=12) or conventional (n=12) implants received 20-second UV irradiation before placement. Stability was measured by RFA at placement, 4, 8 weeks, and 4 months; marginal bone and soft tissue were also assessed.

Results: At 8 weeks and 4 months, UV implants had higher ISQ (P=0.021, P=0.004) and lower bone loss (mesial P=0.041, distal P=0.021) than controls; soft tissue showed no difference (P=1.00).

Interpretation and Conclusion: The study concludes UV photofunctionalization enhances early stability and reduces bone loss without impacting soft tissue, benefiting sites with poor bone quality.

Keywords: Implants, Osseointegration, Soft Tissue, UV Photofunctionalization, Implant Stability Quotient, Marginal Bone Loss, Soft Tissue.

Introduction

Successful osseointegration is fundamental to long-term implant stability and functional success in implant dentistry. Titanium implants have long been considered

the standard of care due to their favorable mechanical properties and biocompatibility[1]. Despite these advantages, early implant stability often declines during the healing phase due to remodeling at the bone–implant interface, potentially compromising outcomes in low-density bone or early loading scenarios[2].

Photofunctionalization, the UV treatment of titanium surfaces, has emerged as a promising method to enhance surface bioactivity by increasing hydrophilicity, removing hydrocarbons, and improving protein and cell attachment[3]. In vitro and animal studies have demonstrated increased osteoblast activity and accelerated osseointegration on UV-treated surfaces. However, clinical studies—particularly randomized controlled trials—remain scarce[4].

This study aims to provide clinical evidence by comparing early implant stability, marginal bone preservation, and soft tissue response between photofunctionalized and non-photofunctionalized titanium implants placed in the posterior mandible.

Materials and Methods

This randomized, double-blinded clinical trial included 24 systemically healthy patients requiring posterior mandibular implants. Participants were allocated to UV photofunctionalized or non-photofunctionalized implant groups. Test implants were UV-irradiated for 20 seconds before placement. Implant stability (ISQ) was measured at baseline, 4 weeks, 8 weeks, and 4 months. Marginal bone loss was assessed radiographically, soft tissue health using modified gingival index, and osseointegration by reverse torque test.

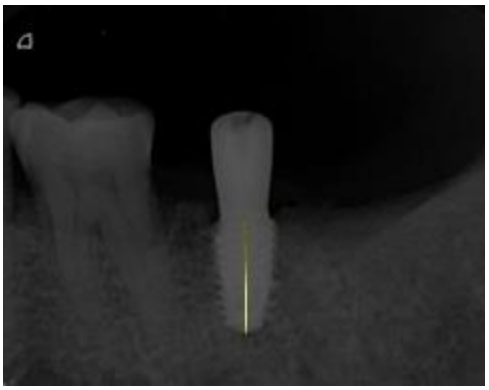

Figure 1: IOAPR

Figure 2: ISQ measurement

Figure 3: Soft tissue evaluation

Results

Data were analyzed using SPSS with significance set at $P < 0.05$. Implant stability showed no difference at baseline or 4 weeks but was significantly higher in the UV group at 8 weeks ($P = 0.021$) and 4 months ($P = 0.004$). The UV group exhibited reduced marginal bone loss. All implants resisted 30 Ncm torque, with no significant differences in soft tissue health.

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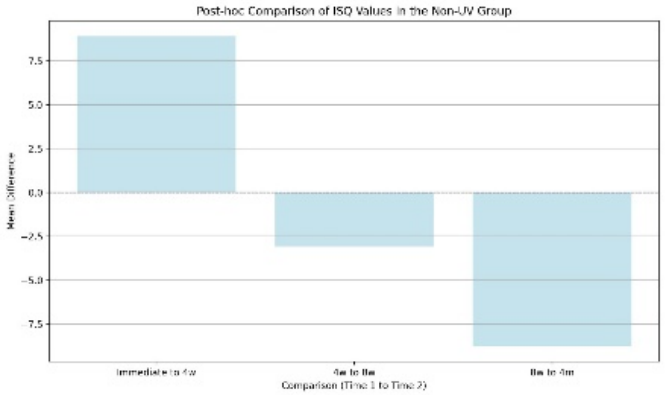
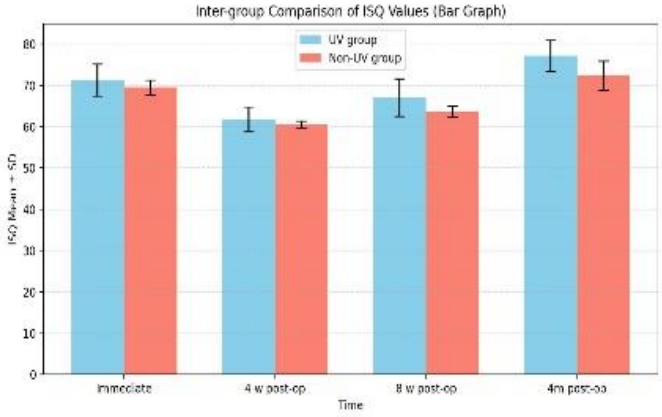
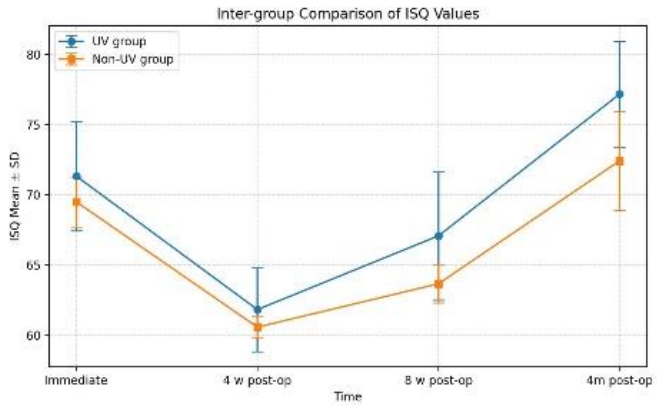


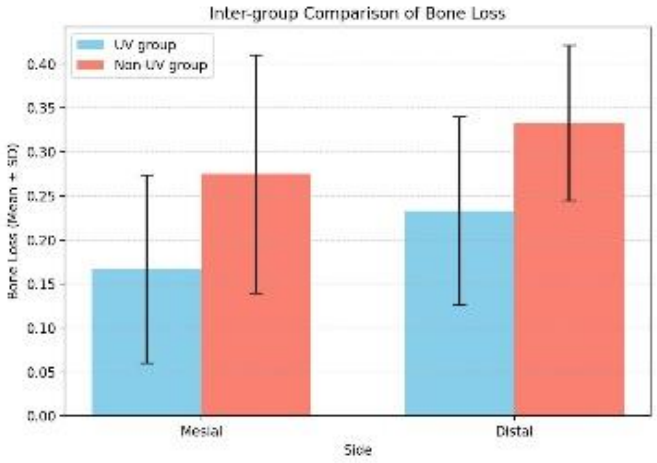
Graph 1



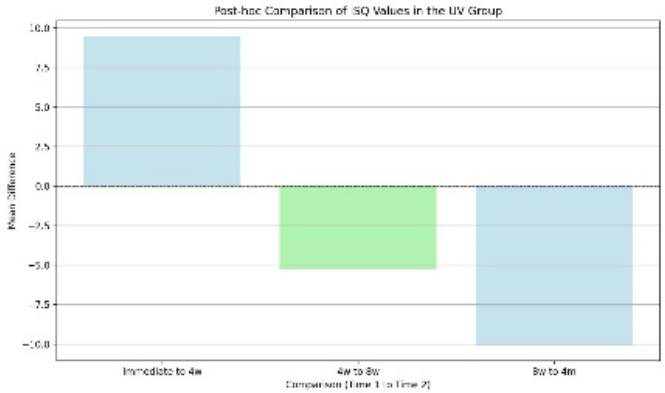
Graph 2



Graph 3



Graph 4



Graph 5

Discussion

Osseointegration is the direct structural and functional connection between living bone and a load-bearing implant. First observed in the 1950s with titanium implants in rabbit tibiae, it is clinically defined by the absence of relative movement between implant and bone and reflects a favorable biological response rather than an inherent material property[5].

Osseointegration is a multifactorial process influenced by implant characteristics, bone quality, mechanical stability, systemic conditions, and the effects of medications or adjunctive therapies.[6] Surface morphology influences cell attachment, proliferation, matrix formation, and growth factor release, beginning with a protein conditioning layer that directs cellular

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adhesion and response.[7]

Implant surfaces evolved from mechanical (machining) and morphological (sandblasting, etching) modifications to physicochemical (hydroxyapatite), biochemically active (collagen, peptides, BMPs), and finally biological surfaces (stem cell or tissue coatings).[8] Photofunctionalization rapidly enhances titanium surfaces by UV irradiation, increasing hydrophilicity and reducing hydrocarbons, which promotes cell attachment, early bone formation, and osseointegration, enabling earlier loading and improved esthetic and functional outcomes.[3] Primary stability arises from mechanical engagement; secondary stability develops through bone healing. Assessment guides loading and detects failures. Methods include invasive tests (histology, torque) and non-invasive techniques (radiography, Periotest, resonance frequency analysis).[9] RFA measures implant stability with ISQ values (0–100); modern devices provide wireless, dual-axis assessment for accurate evaluation.[10] RFA was preferred for its safe, non-contact, and reproducible assessment, avoiding the mechanical impact risks of Periotest on early osseointegration.[11] ISQ values alone do not reliably reflect bone density; trends over time better indicate osseointegration, capturing phases like the 3–5 week "stability dip."[12] The current study at 4 weeks, the UV group showed higher ISQ values than controls, indicating faster early osseointegration; 4-month evaluation aligned with clinical loading.

Marginal bone loss is influenced by immunity, hygiene, systemic and behavioral factors, and inflammation, with both bacterial and non-infectious causes.[13]

Comparison with Previous Studies Puisys et al. conducted a triple-blinded RCT demonstrating higher removal torque values in UV-treated implants across all timepoints[14] These results align with our study, showing higher ISQ and improved early marginal bone preservation in UV-treated implants.

Strengths and Limitations This study supports photofunctionalization but is limited by implant-based design, posterior mandible focus, small sample, missing one-year ISQ data, and lack of direct measures. Future larger, patient-based trials should assess compromised bone sites.

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