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*Case Report*

# UV Photofunctionalisation to Enhance Implant Osseointegration: A Case Report

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**Abstract**

**Background:** Ultraviolet (UV) photofunctionalization is a surface activation technique that enhances the biological activity of titanium implants by removing hydrocarbon contaminants, restoring hydrophilicity, and improving bone–implant integration. UV-C, in particular, has superior surface modification capabilities compared to UV-A and UV-B.

**Case Presentation:** A 45-year-old male patient, systemically healthy, presented with missing teeth in the right mandibular posterior region. Titanium implants were treated with UV-C light (160–280 nm) for 3 minutes in a custom photofunctionalization chamber prior to placement. The implants achieved satisfactory primary stability. Pain levels measured using a Visual Analogue Scale (VAS) were 1 at 24 hours, 1 at 3 days, and 0 at 7 days. At the 1-month review, Resonance Frequency Analysis indicated adequate implant stability, allowing placement of healing abutments. Two months following surgery, the implants were restored using screw-retained crowns. The overall treatment period was two months, resulting in healthy peri-implant soft tissues and favorable functional and esthetic outcomes.

**Discussion:** The results are consistent with literature demonstrating that UV irradiation accelerates osseointegration, enhances osteoblast activity, hydrophilicity and reduces early bacterial adhesion. Similar to previous clinical reports, early loading was achieved without complications, and postoperative discomfort was minimal.

**Conclusion:** UV photofunctionalization can shorten implant treatment timelines while maintaining excellent biological and clinical outcomes. It may be a valuable adjunct in cases where early loading is desired.

**Keywords:** UV photofunctionalization; UV-C; dental implant; osseointegration; early loading; titanium surface modification.

## 1. Introduction

Over the past decades, dental implants have emerged as a dependable and widely accepted option for tooth replacement, with long-term survival rates consistently reported to be greater than 90% in the literature.[1] These high success rates have established dental implants as the gold standard for restoring both function and aesthetics in partially and fully edentulous patients. However, while implant survival statistics are impressive, the true determinant of clinical success lies in achieving rapid and stable osseointegration, particularly in cases where early or immediate loading protocols are desired to meet patient expectations for shorter treatment times. Osseointegration, the direct structural and functional connection between living bone and the surface of a load-bearing implant, is influenced by several factors, including bone quality, surgical technique, implant design, and—crucially—the physicochemical properties of the implant surface. One often overlooked but significant factor that can compromise implant performance is the phenomenon of titanium aging. During storage, the titanium surface of dental implants gradually accumulates atmospheric hydrocarbon contaminants, a process that leads to a loss of surface hydrophilicity and a reduction in the material's biological activity.[2,3] These changes can have a negative impact on the initial interactions between the implant surface and host tissues, potentially delaying or impeding the osseointegration process.

Ultraviolet (UV) photofunctionalization is an innovative surface activation technique that involves irradiating titanium implants with UV light immediately prior to their placement in the oral cavity. This targeted irradiation process effectively removes the hydrocarbon pellicle that accumulates on the implant surface during storage, thereby restoring and even enhancing the surface's hydrophilicity by significantly increasing its surface energy. The transformation of the titanium surface from hydrophobic to superhydrophilic has been well documented.[4,5] These physicochemical modifications have profound biological implications: they facilitate rapid and robust protein adsorption from blood and surrounding tissues, which in turn promotes the attachment, proliferation, and differentiation of osteoblasts—the bone-forming cells critical to osseointegration. Enhanced osteoblast activity leads to improved bone-to-implant contact, accelerating the establishment of a strong and stable interface between the implant and the host bone.[6-8] (Figure 1) Moreover, recent studies have demonstrated that UV-treated implant surfaces not only possess superior osteoconductive properties but also exhibit reduced early bacterial attachment and biofilm formation. Importantly, this anti-biofouling effect occurs without adversely affecting bacterial viability, suggesting that UV photofunctionalization may lower the risk of peri-implant infections during the vulnerable early healing phase, thereby contributing to the long-term success of dental implants.[9,10]

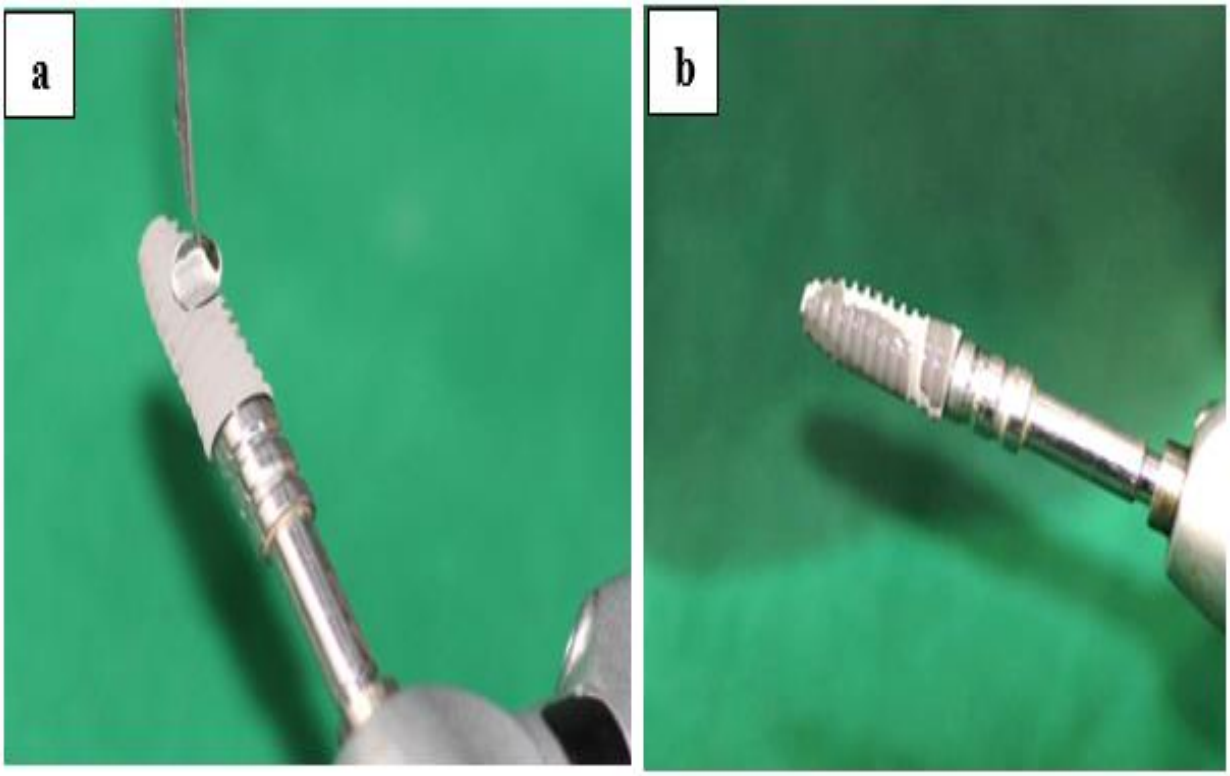


**Figure 1:** a) Before UV treatment b) After UV treatment

Hence, this case report describes the successful clinical application of UV photofunctionalized dental implants, demonstrating their ability to support early functional loading within a considerably shortened treatment period of just two months. By leveraging the enhanced biological activity and improved osseointegration associated with UV-treated surfaces, the case highlights how this technology can help clinicians meet the increasing demand for faster and more predictable implant rehabilitation, ultimately improving patient satisfaction and clinical outcomes.

## 2. Case Report

A 45-year-old male patient presented with the chief complaint of missing teeth in the right mandibular posterior region to the Outpatient section of Department of Periodontics. The patient was systemically healthy, with no relevant medical history, and provided written informed consent for implant placement.

Preoperative evaluation included clinical examination and cone-beam computed tomography (CBCT) for assessment of bone quantity, quality, and anatomical landmarks. Based on the findings, two titanium dental implants of appropriate dimensions were selected for placement in the edentulous site.

A specialized UV photofunctionalization chamber was custom-designed using a UV-C light source. The wavelength of the emitted light was confirmed using Spectrum Analysis and found to fall within the UV-C spectrum (160-280 nm).

Following local anesthesia administration, a mid-crestal incision was given, and a full-thickness mucoperiosteal flap was elevated. Osteotomy preparation was carried out using sequential drills under copious irrigation. (Figure 2)

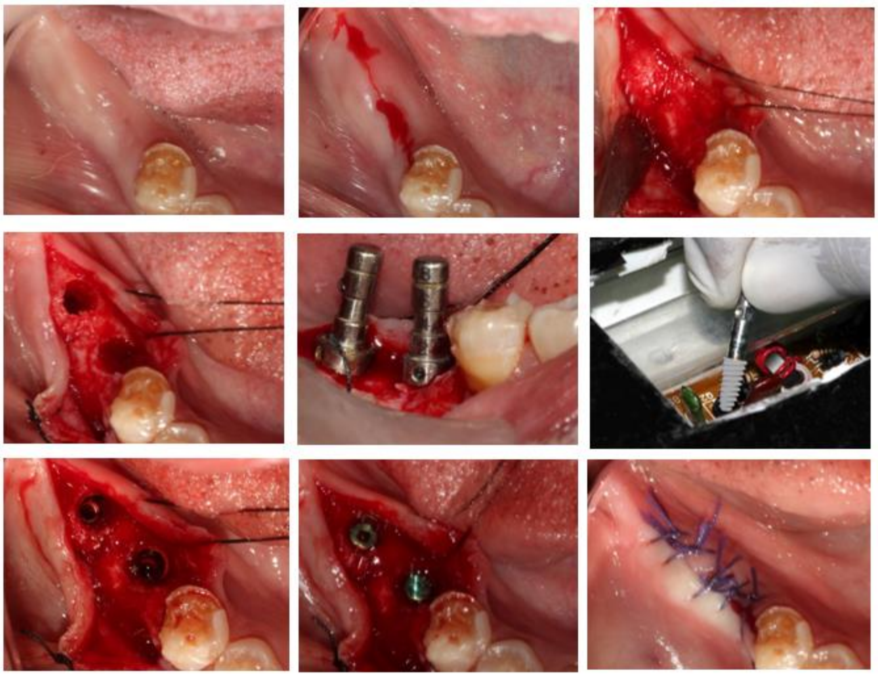

**Figure 2:** UV treated implant placement

The implants were placed inside the UV chamber and irradiated for 3 minutes immediately prior to surgery to achieve photofunctionalization. The UV-treated implants were placed in the prepared site, achieving satisfactory primary stability. The surgical site was sutured, and the patient was advised standard postoperative care instructions.

Pain levels were evaluated using a 10-point Visual Analogue Scale (VAS) at 24 hours, 3 days, and 7 days postoperatively. VAS scores were 1, 1, and 0 respectively, indicating minimal postoperative discomfort.

At 1 month, implant stability was evaluated using Resonance Frequency Analysis and found to be adequate. Healing abutments were placed at this stage.

At 2 months from placement, definitive prosthetic rehabilitation was carried out with a screw-retained crown. (Figure 3)

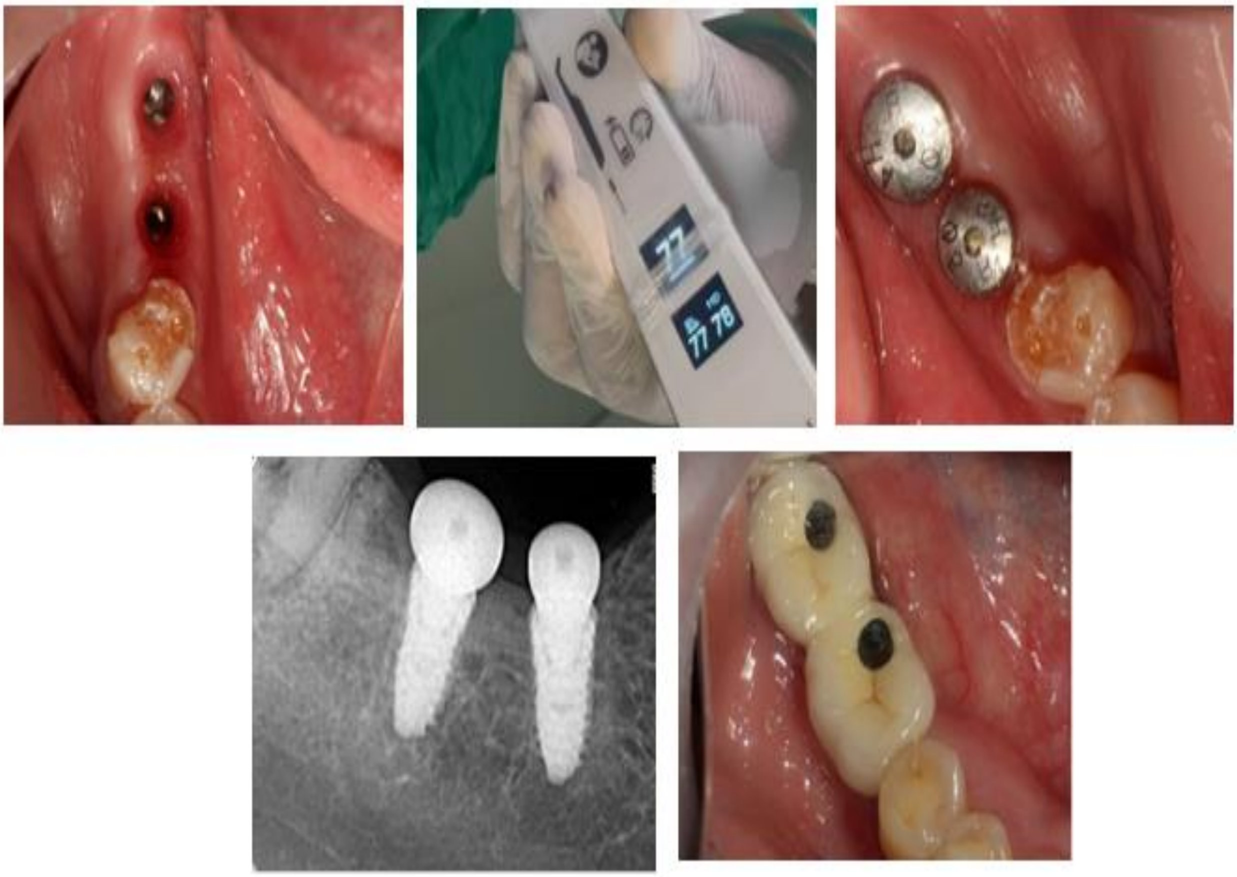


**Figure 3:** Healing abutment placed in 1 month and prosthesis delivered in 2 months

Total treatment duration was 2 months. The peri-implant soft tissues remained healthy throughout, and the patient reported satisfactory function and esthetics.

### 3. Discussion

In this case, UV photofunctionalization was applied to a titanium dental implant immediately prior to placement, resulting in satisfactory primary stability, minimal postoperative discomfort, and functional rehabilitation within two months. The success of this approach is consistent with numerous studies demonstrating the biological and clinical benefits of UV photofunctionalization on implant surfaces.

Among the UV spectrum, UV-C (160–280 nm) was specifically chosen for this case due to its superior surface modification properties compared to UV-A and UV-B. UV-C irradiation has been shown to effectively decompose hydrocarbon contaminants through a photolytic reaction, restoring surface energy and converting hydrophobic titanium to a superhydrophilic state. [2,5,7] This enhanced hydrophilicity facilitates immediate protein adsorption, promotes blood wetting of the implant surface, and accelerates the recruitment and attachment of osteoblasts, leading to faster osseointegration. [3,4,7,9]

In the present case, adequate stability was achieved within one month, allowing prosthetic rehabilitation at two months. Park et al. reported that UV photofunctionalization significantly increased early implant stability and bone-to-implant contact, even under compromised bone conditions. [7] Similarly, Flanagan emphasized that UV treatment can reverse the biological aging of titanium and restore its osteoconductive capacity within minutes. [5] Ghambaryan et al. demonstrated that immediate loading of UV-treated implants placed with guided surgery in completely edentulous mandibles yielded high survival rates and stable marginal bone levels over five years, supporting the feasibility of shortened treatment timelines. [8]

The improved biological performance observed in our case is consistent with in vitro findings by Al Qahtani et al., who showed that UV-C treatment reduced the contact angle of titanium surfaces to nearly 0°, creating a superhydrophilic condition that facilitates rapid blood spread and clot stabilization. [2] Kim et al. further confirmed that UV-treated titanium surfaces exhibit enhanced osteoblast proliferation and differentiation at the bone–implant interface, improving early osseointegration. [3]

Additionally, UV photofunctionalization has been associated with antimicrobial benefits. De Avila et al. found that UV-treated titanium surfaces exhibited significantly reduced early bacterial adhesion and biofilm formation, potentially lowering the risk of peri-implant disease during the healing phase. [1] While no signs of peri-implant inflammation were noted in our case, these antimicrobial effects may contribute to uneventful early healing.

Other studies have expanded the scope of UV treatment to different biomaterials. Kaneko et al. demonstrated that UV irradiation improved the hydrophilicity and osteoconductive capacity of hydroxyapatite, while Lopez Perez et al. showed that human mesenchymal stem cells are resistant to UV-B, supporting the biocompatibility of UV light applications in regenerative contexts. [9,10]

Overall, the present case adds to the growing body of clinical evidence that UV-C photofunctionalization enhances the biological properties of titanium implants, enabling faster osseointegration, early functional loading, and potentially reduced risk of peri-implant infection.

### 4. Conclusion

This case demonstrates that UV photofunctionalization of titanium implants can effectively enhance early osseointegration, enabling functional prosthetic rehabilitation within a shortened treatment period of two months. The choice of UV-C over UV-A and UV-B was based on its superior surface modification capabilities, including rapid hydrocarbon removal and induction of superhydrophilicity, which facilitate faster and stronger bone–implant integration. Minimal postoperative discomfort and healthy peri-implant tissues throughout the treatment further support the clinical benefits of this approach. While larger clinical studies with long-term follow-up periods are warranted, UV photofunctionalization appears to be a valuable adjunct for improving implant stability and reducing overall rehabilitation time.

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