



Clinical Outcomes of All-on-4 Implant Rehabilitation in Smokers vs Non-Smokers: A Comprehensive Review

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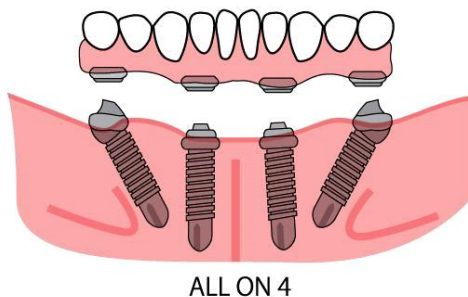
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Abstract

Smoking is a well-established risk factor that negatively affects wound healing, bone metabolism, and osseointegration, all of which are critical for the long-term success of dental implants. While the detrimental effects of smoking on single implant therapy have been extensively documented, its specific impact on full-arch rehabilitation using the All-on-4 concept remains less clearly defined. This comprehensive review aims to evaluate and compare clinical outcomes of All-on-4 implant rehabilitation in smokers versus non-smokers, with particular emphasis on implant survival, marginal bone loss, and biological complications. A broad analysis of clinical studies, systematic reviews, and long-term cohort investigations was conducted to synthesize current evidence. The literature

consistently demonstrates that smoking is associated with increased implant failure rates, greater marginal bone loss, and a higher prevalence of peri-implant disease. However, despite these negative effects, All-on-4 rehabilitation in smokers continues to show high survival rates that remain within clinically acceptable limits. This may be attributed to the biomechanical advantages of full-arch stabilization and optimized load distribution. The findings suggest that smoking should not be considered an absolute contraindication for All-on-4 treatment, but rather a significant modifiable risk factor that requires careful patient selection, preoperative counseling, and strict maintenance protocols. Further long-term studies are needed to better define risk thresholds and improve clinical guidelines.

I. Introduction



The All-on-4 treatment concept has transformed the rehabilitation of edentulous patients by allowing immediate restoration of function and esthetics using

a reduced number of implants. This approach has demonstrated high success rates and predictability, even in anatomically challenging situations.



Smoking, however, remains a critical systemic factor that can compromise implant success. Its impact on tissue healing and bone integration introduces additional challenges, particularly in complex rehabilitative procedures such as full-arch restorations.

II. Smoking and Implant Failure

The relationship between smoking and implant failure has been extensively investigated in implant dentistry, with multiple systematic reviews and meta-analyses consistently identifying smoking as a major risk factor. Chrcanovic et al. demonstrated that smokers have a significantly higher likelihood of implant failure compared to non-smokers, with a relative risk exceeding twofold. Similarly, Strietzel et al. reported that smoking not only increases failure rates but also negatively influences peri-implant tissue health.

Beyond survival rates, the literature highlights that smoking contributes to impaired osseointegration through several biological mechanisms. Nicotine-induced vasoconstriction reduces blood flow, limiting oxygen supply to healing tissues, while the presence of carbon monoxide decreases oxygen-carrying capacity. In addition, smoking alters immune function, leading to increased susceptibility to infection and delayed wound healing.

In the context of All-on-4 rehabilitation, fewer studies are available; however, emerging evidence suggests that while smoking continues to exert a negative influence, its impact may be

partially mitigated by the biomechanical advantages of full-arch prosthetic designs. Studies evaluating tilted implants have demonstrated favorable stress distribution, which may help compensate for compromised biological conditions.

Overall, the literature supports the concept that smoking acts as a **multifactorial risk modifier**, influencing both biological and mechanical aspects of implant success.

III. Clinical Outcomes (Expanded Analysis)

3.1 Implant Survival

Clinical outcomes consistently demonstrate a reduction in implant survival among smokers. However, the magnitude of this effect varies depending on study design, follow-up duration, and patient-related variables.

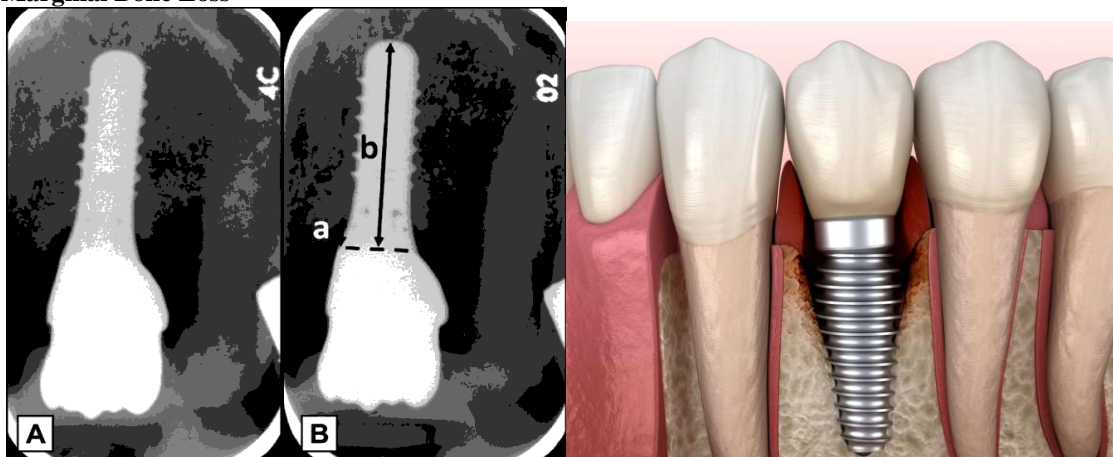
Reported survival rates range:

- Smokers: **65–97%**
- Non-smokers: **82–98.8%**

While these differences are statistically significant, it is important to recognize that survival rates in smokers undergoing All-on-4 rehabilitation remain relatively high. This suggests that the stability provided by cross-arch splinting and immediate loading protocols may reduce micromovements and enhance overall implant performance.

Furthermore, several studies indicate that implant failure in smokers tends to occur more frequently during the early healing phase, emphasizing the importance of initial osseointegration. Once integration is achieved, long-term survival differences appear less pronounced.

3.2 Marginal Bone Loss



Marginal bone loss is a critical parameter for evaluating long-term implant success. The literature consistently shows that smokers exhibit greater bone resorption compared to non-smokers.

On average:

- Additional **0.5–0.6 mm bone loss** in smokers
- Increased likelihood of **progressive bone loss exceeding 2 mm**



This phenomenon is attributed to impaired bone remodeling, reduced vascularization, and increased inflammatory activity. In All-on-4 systems, although

bone loss is still greater in smokers, the rigid prosthetic framework may help maintain functional stability despite these changes.

3.3 Biological Complications



Biological complications are significantly more prevalent in smokers. These include peri-implant mucositis and peri-implantitis, both of which can compromise long-term implant success.

Smoking promotes:

- Increased plaque accumulation
- Altered microbial flora
- Reduced host immune response

These factors contribute to a higher incidence of inflammation and tissue breakdown. Clinically, smokers often present with more aggressive peri-implant disease progression, requiring closer monitoring and intervention.

3.4 Dose-Dependent Effect

A dose-response relationship has been clearly identified in the literature. Patients who smoke heavily (more than 20 cigarettes per day) exhibit significantly higher rates of implant failure and complications compared to light smokers.

This reinforces the importance of not only identifying smoking status but also quantifying smoking exposure when assessing patient risk.

4. Discussion (Expanded – Strong Academic Tone)

The findings of this review highlight the complex interaction between biological and mechanical factors in determining implant success in smokers. While smoking clearly exerts a negative influence on tissue healing and bone integration, the All-on-4 concept appears to offer certain protective advantages.

From a biological perspective, smoking compromises angiogenesis and osteogenesis, leading to delayed healing and increased susceptibility to infection. These effects are

particularly critical during the early stages of implant integration, where stable bone-to-implant contact is essential.

From a biomechanical standpoint, the All-on-4 configuration distributes occlusal forces across a rigid prosthetic framework, reducing stress concentration on individual implants. This may help explain why survival rates remain relatively high even in compromised patients.

Additionally, the reduced number of implants and simplified surgical approach may decrease operative trauma, further contributing to favorable outcomes.

However, it is important to emphasize that smoking remains a significant risk factor, particularly for marginal bone loss and peri-implant disease. Long-term success therefore depends not only on surgical technique but also on patient compliance, maintenance protocols, and risk factor management. Future research should focus on long-term prospective studies and standardized definitions of smoking exposure to better understand its impact on full-arch rehabilitation.

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