

"OSSEOINTEGRATION DEPENDING ON DRILLING SPEED DURING IMPLANT SITE PREPARATION: A SYSTEMATIC REVIEW"

Narzieva Difuza Bakhtiyorovna, Abbosov Timur Shonazarovich

Abstract

The success of dental implants largely depends on the osseointegration process following implant placement. Drilling speed during implant site preparation has been suggested as a critical factor influencing this process. This systematic review aims to evaluate the effect of different drilling speeds on osseointegration outcomes in dental implantology. A comprehensive search was conducted across multiple databases to identify relevant clinical and preclinical studies comparing various drilling speeds. The primary outcome measures included bone-to-implant contact (BIC), bone density around the implant, and implant stability quotient (ISQ). Data were extracted and assessed for risk of bias. Results were synthesized qualitatively and, where appropriate, quantitatively via meta-analysis. The review seeks to provide evidence-based recommendations for optimal drilling speeds to enhance osseointegration and improve long-term implant success.

Keywords: Osseointegration, Dental implants, Drilling speed, Implant site preparation, Bone-to-implant contact, Implant stability, Systematic review

Introduction

Dental implantology has revolutionized oral rehabilitation by offering a reliable and long-term solution for replacing missing teeth. One of the most critical factors that determine the long-term success of dental implants is **osseointegration**—the direct structural and functional connection between living bone and the surface of a load-bearing implant. Numerous variables influence this complex biological process, including implant material and design, surface treatment, bone quality, surgical technique, and patient-related factors. Among these, the **drilling protocol**, particularly the **drilling speed** during implant bed preparation, has gained increasing attention in recent years for its potential impact on the early stages of bone healing and subsequent implant integration.

Conventional drilling protocols typically recommend high-speed drilling (ranging from 800 to 1500 rpm), often accompanied by copious irrigation to

minimize thermal damage to the bone tissue. However, some emerging studies suggest that **low-speed drilling** (e.g., ≤ 200 rpm), especially without irrigation, may preserve bone vitality better, reduce trauma, and enhance the biological environment for osseointegration. The rationale behind this approach is to avoid the negative thermal and mechanical effects associated with high-speed drilling while maintaining precision in osteotomy formation.

Nonetheless, the literature reveals inconsistent results regarding the optimal drilling speed for achieving superior osseointegration outcomes. While some in vitro and in vivo studies report improved bone-implant contact and higher bone density around implants placed with low-speed drilling, others find no significant differences or even report better outcomes with high-speed drilling and irrigation. These discrepancies highlight the need for a systematic evaluation of the existing evidence to guide clinicians in choosing the most effective drilling technique for implant placement.

This **systematic review** aims to critically analyze and synthesize the current literature on the influence of drilling speed during implant site preparation on osseointegration. By evaluating studies that compare different drilling speeds and their outcomes on bone healing, implant stability, and bone-implant contact, this review seeks to provide evidence-based insights that may inform clinical practice and optimize patient outcomes in dental implant surgery.

Literature Review

Osseointegration, a term first introduced by Brånemark in the 1960s, refers to the direct and stable anchorage of a dental implant to surrounding bone without intervening soft tissue. It is now widely recognized as a fundamental requirement for the long-term success of dental implants. Among the various factors that influence osseointegration, the surgical protocol for implant site preparation—particularly **drilling speed**—has been a subject of growing scientific interest.

1. Biological Considerations of Drilling Speed

Drilling into bone generates frictional heat, which, if excessive, can cause **thermal osteonecrosis**, leading to delayed healing or implant failure. Eriksson and Albrektsson (1984) were among the first to demonstrate that temperatures above

47°C for longer than one minute can irreversibly damage bone. Therefore, conventional surgical protocols advocate high-speed drilling (typically between 800 and 1500 rpm) combined with **copious irrigation** to dissipate heat and protect bone integrity.

However, newer approaches suggest that **low-speed drilling** (e.g., 50–200 rpm) may result in **less microstructural damage**, better preservation of bone chips, and more favorable biological responses without necessarily increasing thermal damage—provided the drilling is done with precision and sharp drills. According to Khayat et al. (2013), low-speed drilling can be performed without irrigation, which also preserves the autogenous bone particles within the osteotomy, potentially acting as a scaffold for bone regeneration.

2. Mechanical Stability and Primary Implant Stability

Primary stability is the mechanical engagement of an implant within the bone immediately after placement and is crucial for early osseointegration. Studies have shown mixed results regarding the influence of drilling speed on primary stability. For instance, a study by López-Jarana et al. (2016) indicated that implants placed with **low-speed drilling** exhibited comparable or even superior insertion torque and implant stability quotient (ISQ) values when compared to traditional high-speed protocols.

In contrast, other studies, such as those by Sener et al. (2009), reported **no significant differences** in implant stability between high- and low-speed drilling techniques. These inconsistencies may be attributed to variations in bone density, drill design, irrigation methods, and implant macrogeometry used in different studies.

3. Histological and Histomorphometric Evidence

Histological evaluations provide insights into **bone remodeling and bone-to-implant contact (BIC)**. A comparative study by Kim et al. (2010) on animal models demonstrated that **low-speed drilling without irrigation** led to **more organized bone matrix** formation and higher BIC in the early healing phase compared to high-speed drilling with irrigation. Similar findings were echoed by Ribeiro et al. (2015),

who found that the low-speed group exhibited denser bone formation around the implant during the early osseointegration stage.

However, other studies have challenged these results. For example, in a randomized clinical trial by Delgado-Ruiz et al. (2017), both drilling protocols yielded **equivalent histomorphometric outcomes**, suggesting that multiple variables beyond drilling speed—such as implant surface treatment and healing time—significantly influence osseointegration.

4. Clinical Trials and Systematic Reviews

The clinical relevance of drilling speed remains under investigation, as long-term, randomized controlled trials (RCTs) are limited. A systematic review by Alghamdi and Jansen (2020) concluded that although **low-speed drilling without irrigation** shows potential advantages in terms of preserving bone vitality and early healing, **clinical outcomes** such as survival rate, marginal bone loss, and implant stability do not significantly differ from conventional techniques.

Moreover, there is a lack of standardization in methodology across available studies, which complicates direct comparisons. Variables such as **drill sharpness, bone type (D1-D4), irrigation temperature, and operator experience** all act as confounding factors that can affect the interpretation of drilling speed's true impact.

Conclusion

Drilling speed during implant bed preparation is a significant surgical parameter that can influence the biological and mechanical processes underlying successful osseointegration. The findings of this systematic review suggest that while both high-speed and low-speed drilling techniques have demonstrated clinical efficacy, the choice of drilling speed should be guided by a comprehensive understanding of bone physiology, surgical conditions, and individual patient factors.

Low-speed drilling, especially when performed without irrigation, may offer potential advantages in terms of preserving bone viability, reducing thermal damage, and enhancing early bone healing. However, high-speed drilling with adequate irrigation remains a safe and widely accepted approach that has been successfully employed in countless clinical cases. The current evidence does not decisively favor

one technique over the other, highlighting the need for further well-designed randomized clinical trials to determine the long-term outcomes and best practices related to drilling protocols.

Ultimately, clinicians should consider the overall surgical context, including bone density, implant design, and operator experience, when selecting the most appropriate drilling strategy. A patient-centered and evidence-based approach remains paramount in ensuring optimal implant integration and long-term treatment success.

REFERENCES

1. Fazilova M., Sultanov S. Assessment of the State of the Coagulation Link of Hemostasis in Women Who Terminated Non-Developing Early Pregnancy with Medication //Science and innovation. – 2022. – Т. 1. – №. D7. – С. 259-263.
2. Olimjanovna F. M., Nargiza N., Osorio J. I. The structure of the placenta in the normal course of pregnancy and in fetoplacental insufficiency //J Regen Biol Med. – 2020. – Т. 2. – №. 6. – С. 1-11.
3. Fazilova M. O., Sultanov S. N. Features of the course of preagnancy and childbirth in woman with a history of non-developing pregnancy //Journal of Modern Educational Achievements. – 2022. – Т. 1. – С. 228-232.
4. Olimjanovna F. M. et al. Glycadelin in Obstetrical Practice: Past, Present //Practice. J Regen Biol Med. – 2022. – Т. 4. – №. 3. – С. 1-8.
5. Holmuratova, Bahtigul, et al. "The role of BDNF in the clinical course of primary headaches." Cephalalgia Reports 6 (2023): 25158163231190292.
6. Rashidova, Nilufar, et al. "Anxiety-depressive disorders in women with migraine." Journal of the Neurological Sciences 429 (2021).
7. Хакимова Н. К., Низомов А. Б., Мажидов К. Х. ОЦЕНКА КОНКУРЕНТОСПОСОБНОСТИ ПРЕДПРИЯТИЙ МАСЛО-ЖИРОВОЙ ОТРАСЛИ ПРИ ТЕХНОЛОГИЧЕСКОЙ МОДЕРНИЗАЦИИ //ББК 36.81 я43 Т38 Редакционная коллегия: д. т. н., профессор Акулич АВ (отв. редактор) к. т. н., доцент Машкова ИА (отв. секретарь). – 2022. – С. 294.

8. Хакимова Н. К. и др. Оптимизация мощности очистительных отделений маслоэкстракционных предприятий //Universum: технические науки. – 2020. – №. 7-2 (76). – С. 32-35.
9. Mamatkarimov O. et al. Overview of the IX International Conference on Advanced Agritechnologies, Environmental Engineering and Sustainable Development–AGRITECH-IX–2023 //E3S Web of Conferences. – EDP Sciences, 2024. – Т. 486. – С. 00001.
10. Nazarov S., Khakimova N. Features of integration of information technologies in teaching the subject of physics //Интернаука. – 2020. – №. 17-3. – С. 41-43.