

Review

Reliability, Accuracy, and Time Efficiency of Digital vs. Analog Bite Registration Technique

Razin Subahi^{1*}, Abdulaziz Alshekh², Rayan Alshehri², Mesfer Alzahrani², Ahmed Alfarsi², Asrar Albuqayli², Lamyaa Alzahrani², Abdulaziz Daghestani², Suhayb Jabrah², Turki Alahmari²

¹ Department of Prosthodontics, Al Thager Hospital, Jeddah, Saudi Arabia

² College of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia

Correspondence should be addressed to **Razin Subahi**, Department of Prosthodontic, Al Thager Hospital, Jeddah, Saudi Arabia. Email: dr-razin.subahi@hotmail.com

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Abstract

Prosthodontic rehabilitation hinges upon establishing an accurate and stable occlusal relationship, making accurate bite registration paramount. This process ensures optimal oral function, mastication, and speech, while also contributing to the longevity of prostheses and enhancing aesthetic outcomes. Various bite registration techniques are available, including analog methods like wax and silicone, and digital methods enabled by intraoral scanning and advanced software. The choice between these techniques depends on factors such as clinical scenarios and practitioner preferences. While both analog and digital techniques have their advantages and considerations, digital methods often offer enhanced precision, real-time visualization, and patient comfort. Reliability, accuracy, and time efficiency are crucial factors in the selection of a technique, with digital methods generally excelling in these aspects. However, the ultimate reliability of any technique is contingent on the practitioner's expertise, material quality, and adherence to best practices. In summary, the choice of bite registration technique in prosthodontics should align with patient needs, clinical context, and the practitioner's skill set.

Keywords:

prosthodontics, bite registration, digital impression, analog techniques, occlusal relationship, aesthetic outcomes, intraoral scanning

Introduction

The foundation of prosthodontic rehabilitation lies in the establishment of an accurate and stable occlusal relationship. Accurate bite registration is crucial in prosthodontics, focusing on restoring optimal oral function for activities like biting, chewing, and speaking without discomfort. It ensures occlusal stability by distributing forces evenly, preventing premature wear and TMJ issues. Enhanced masticatory efficiency aids digestion and speech clarity while promoting TMJ health. Moreover, it contributes to the longevity of prostheses by reducing complications and maintenance (1). Further, in prosthodontics, achieving aesthetic results is essential alongside restoring function. This involves addressing the appearance, shape, color, and alignment of teeth, impacting a patient's self-confidence and quality of life. Accurate bite registration is pivotal for several reasons. It ensures proper alignment, prevents misalignment or uneven tooth proportions, and aids in replicating natural tooth contours. Shade matching is facilitated for seamless integration with natural teeth. Accurate bite registration maintains facial aesthetics, prevents undesirable lip changes, and enhances patient satisfaction, boosting confidence (2). Moreover, it supports long-term aesthetic stability, vital for sustained desirable outcomes. Also, prosthesis longevity is paramount in prosthodontics, as patients expect lasting solutions. It prevents premature wear on prosthetic restorations and natural teeth by distributing occlusal forces evenly (3). This minimizes the need for early restoration or replacement. Further, it ensures the stability of prosthetic restorations, preventing movement or loosening (4). Also, accurate bite registration reduces the need for frequent adjustments and repairs. Moreover, it preserves the structural integrity of prosthetic restorations and enhances patient satisfaction (5). Financially, prosthesis longevity benefits both patients and the healthcare system by reducing expenses and inconveniences associated with frequent replacements. Achieving these goals necessitates the utilization of various bite registration techniques, which serve as a

cornerstone in the prosthodontic treatment planning process.

Methodology

This study is based on a comprehensive literature search conducted on October 5, 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the reliability, accuracy, and time efficiency of the digital vs. analog bite registration technique. There were no restrictions on date, language, participant age, or type of publication.

Discussion

Various bite registration techniques are available to prosthodontists, each offering distinct advantages and considerations. The choice of technique depends on the specific clinical scenario and the preferences of the prosthodontist (6). Firstly, interocclusal records, a cornerstone of prosthodontics, serve as essential tools for capturing the precise occlusal relationship between a patient's upper and lower dental arches during occlusion (7). Various techniques and materials are employed in their creation, each with its own unique advantages and considerations (8). Wax bite registration, for example, offers simplicity, cost-effectiveness, and immediate visual feedback, making it a straightforward choice for many cases. In contrast, silicone registration, utilizing materials like polyvinyl siloxane (PVS), provides superior stability and accuracy, resisting temperature changes and offering tear strength. On the other hand, bite registration paste is a rapid-setting option suitable for time-sensitive procedures and available in various formulations. These interocclusal records play a pivotal role in prosthodontics, facilitating the fabrication of crowns, bridges, dentures, and orthodontic appliances. Secondly, articulated models, a pivotal technique in prosthodontics, involve mounting replicas of the maxillary and

mandibular arches on an articulator, a mechanical device simulating temporomandibular joint (TMJ) movements. This technique offers several advantages, particularly in complex full-mouth rehabilitation cases (9). Firstly, it allows dynamic occlusal analysis, replicating mandibular movements and aiding in evaluating occlusion during functional activities like chewing and speaking. Secondly, articulated models facilitate comprehensive treatment planning, especially for multiple restorations or full-mouth rehabilitation, ensuring precise placement of dental implants and harmonious occlusal relationships (10). Thirdly, they enable occlusal adjustments before final restoration fabrication, reducing chairside time and enhancing patient comfort (9). Additionally, these models serve as valuable visual aids for patient education by illustrating treatment plans and enhancing patient understanding. Lastly, they allow prosthesis testing before finalizing restorations, ensuring optimal fit, function, and aesthetics. Although the use of articulated models demands specialized equipment and may be time-consuming, it is essential for achieving precision in bite registration, particularly in complex dental rehabilitation cases (10).

In the 1980s, digital impression and scanning systems made their debut in the field of dentistry. At that time, there was a prediction that a significant number of dentists in the U.S. and Europe would adopt digital scanners for impression-taking within the following decade (11). Digital impressions brought forth advantages such as exceptional precision and accuracy facilitated by high-resolution cameras and sophisticated software algorithms, speed, efficiency, the capacity to indefinitely store captured data, and the seamless transfer of digital images between dental practices and laboratories (12). Real-time visualization allows immediate feedback for both prosthodontists and patients, enhancing communication and prompt adjustments (13). Patients benefit from increased comfort, as digital registration eliminates the need for uncomfortable impression materials (**Figure 1**). Furthermore, it streamlines workflow efficiency by enabling easy sharing of digital models with dental

laboratories and specialists. Compatibility with computer-aided design and manufacturing systems facilitates precise occlusal analysis, supporting the design and fabrication of custom restorations. These technological advancements aimed to enhance patient acceptance, minimize the distortion associated with traditional impression materials, offer a 3D preview of tooth preparations, and potentially reduce costs and save time (14).



Figure 1: Positioning the intraoral scanner in the patient's mouth. (15)

Numerous studies have explored the accuracy of intraoral scanners and digital impression systems, examining their performance in various scenarios, including single-unit restorations, multi-tooth situations, quadrants, and full arch scans (16-22). Notably, a recent investigation evaluated the preferences of operators regarding digital versus conventional implant impression techniques (23). This particular in vitro study involved inexperienced students who conducted impressions on a customized model rather than live patients. Interestingly, the overall consensus among these inexperienced students was a preference for the digital impression technique. In contrast to the aforementioned analog or conventional methods, digital bite registration in prosthodontics is a cutting-edge technique that employs digital technology, intraoral scanning, and computer software to capture and analyze occlusal relationships (**Figure 1, 2**).

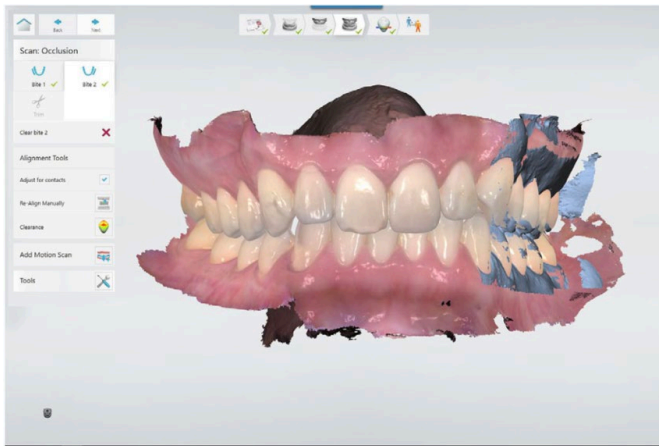


Figure 2: Static maxillomandibular relationship recorded by using an IOS. (24)

Digital records are easily archived and accessible for documentation and treatment planning. While digital bite registration requires an initial investment and training, its long-term benefits in precision, patient comfort, and workflow efficiency make it a promising standard in prosthodontics. In one clinical trial conducted by Yuzbasioglu et al., the superiority of digital impression techniques over conventional ones was established in terms of efficiency and patient preference (25). The study involved a standardized patient population with no prior experience in either technique, ensuring impartial results. However, some limitations, such as the omission of time-consuming steps in the conventional technique and the absence of real treatment conditions, need to be considered. Despite these limitations, the study supports the adoption of digital impression techniques for restorative procedures due to their efficiency and patient-friendly nature, which aligns with the broader trend of digital technology adoption in dentistry. In another study by Camcı et al., researchers focused on evaluating various bite registration methods with an emphasis on the accuracy of occlusal contact points and three-dimensional occlusal relationships (26). The study highlighted the reliability of type A silicone for bite registration and the use of the transillumination method for assessing its accuracy. It also discussed deviations between traditional and virtual bite registration methods, attributing them to the limitations of virtual registration and suggesting potential software modifications to address these issues. Additionally, the study underscored the

importance of considering three-dimensional space in bite registration and the impact of model rotations on occlusal contact points. It introduced a new evaluation technique that went beyond contact points to assess the entire occlusal relationship. However, this study acknowledged challenges in standardizing occlusal force in in-vivo studies, highlighting the need for further validation of the new technique and future research in this area. Overall, Camcı et al.'s study provided valuable insights into bite registration techniques in prosthodontics.

The reliability of bite registration techniques in prosthodontics is a critical consideration for ensuring the success of dental treatments (27). Analog techniques, such as using impression materials like wax or silicone, rely on the skill of the practitioner and the quality of materials, making their reliability contingent on precise execution. While analog methods can yield reliable results when performed meticulously, there is a potential for human error and variability. In contrast, digital bite registration techniques, facilitated by intraoral scanning and advanced software, offer inherent precision and real-time visualization, enhancing their reliability (28). Digital methods are less prone to errors and are highly reliable when used correctly with well-maintained equipment. Nevertheless, regardless of the chosen technique, reliability ultimately depends on the practitioner's expertise, the quality of materials and equipment, and adherence to best practices during the procedure. Prosthodontists must carefully select the technique that aligns best with their skills and the unique requirements of each patient.

The accuracy of bite registration techniques is a critical aspect of prosthodontic practice, influencing the success of dental treatments. Analog techniques, such as traditional bite impressions using materials like wax or silicone, have long been employed in prosthodontics. Their accuracy depends heavily on the skill of the practitioner and the quality of materials used. When executed meticulously by experienced clinicians, analog techniques can yield accurate results. However, they are susceptible to slight distortions during material settings and

potential variations in the operator's technique (26). On the other hand, digital bite registration techniques, facilitated by intraoral scanning and advanced software, have gained prominence for their precision. These digital methods provide real-time visualization of occlusal relationships, allowing for immediate adjustments and minimizing the risk of human error (29). The accuracy of digital techniques is closely tied to the technology's inherent precision, resulting in highly reliable outcomes (30). While the initial investment in digital equipment and training may be substantial, the enhanced accuracy and efficiency offered by digital bite registration techniques make them an appealing choice for prosthodontists seeking to provide the highest quality of care. Ultimately, the choice between analog and digital techniques should consider the practitioner's expertise, a patient's needs, and the specific clinical scenario.

The time efficiency of bite registration techniques is a crucial consideration in prosthodontics, as it directly impacts both the patient experience and the overall workflow of dental procedures (25). Analog bite registration techniques, such as traditional impressions with materials like wax or silicone, can be time-consuming. The process involves several steps, including preparation, impression-taking, material setting, removal, and quality control. The duration of each step may vary depending on factors such as case complexity, patient cooperation, and operator skill. In contrast, digital bite registration techniques, enabled by intraoral scanning, are typically more time-efficient (28). Intraoral scanning is swift and captures digital impressions rapidly. Real-time visualization allows immediate adjustments, eliminating waiting periods for material settings (23). Moreover, digital data can be instantly transferred, enhancing communication with dental laboratories and expediting prosthetic design and fabrication (29). While there may be an initial learning curve and equipment setup with digital techniques, their overall time efficiency can significantly improve the patient experience and streamline the prosthodontic workflow.

Comparing other aspects of analog and digital techniques in bite registration in prosthodontics

reveals distinct advantages and considerations for each approach. Analog methods lack real-time visualization, necessitating waiting for the impression material to set, while digital techniques offer immediate feedback and adjustments during scanning, enhancing communication and minimizing errors (28). Patient comfort is typically higher with digital methods, as they eliminate the use of uncomfortable impression materials. Data analysis is more efficient with digital techniques, as they are directly compatible with CAD/CAM systems, streamlining the prosthetic fabrication process. (29) Moreover, digital records are easily archived electronically, reducing storage requirements and offering secure, accessible documentation. However, digital techniques require an initial investment in equipment and software, while analog methods have lower upfront costs but may entail long-term material expenses (31). In summary, digital techniques offer precision, real-time visualization, patient comfort, efficiency, and superior data management, making them a preferred choice for prosthodontists aiming to provide high-quality care despite the initial investment.

Conclusion

In prosthodontics, diverse bite registration techniques exist. Interocclusal records, like wax, silicone, or paste, capture precise occlusal relationships, which are crucial for various treatments. Articulated models, involving mechanical articulators, support dynamic occlusal analysis, treatment planning, adjustments, patient education, and prosthesis testing, especially for complex cases. Digital impression techniques, introduced in the 1980s, provide real-time visualization, patient comfort, efficiency, and electronic archiving. Recent research demonstrates the efficiency and patient preference for digital impressions. Both analog and digital methods can yield accurate results, but digital techniques excel in minimizing errors. Time efficiency favors digital methods due to rapid data capture and streamlined workflows.

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Conflict of interest

There is no conflict of interest

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Ethical consideration

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Data availability

Data that support the findings of this study are embedded within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

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