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Comparison of Internal and Marginal Fit of CAD/CAM Crowns Using Digital *vs.* Conventional Impressions

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ABSTRACT

The significance of evaluating the accuracy and fitness of fixed dental restorations to the prepared tooth, emphasizing the impact on the clinical success and lifespan of dental prostheses. Marginal and internal fit play crucial roles in achieving a well-fitting restoration, with marginal discrepancy referring to the vertical gap between the tooth preparation and the restoration's cervical edge, and internal discrepancy denoting the horizontal gap between the axial wall of the prepared tooth and crown Complications arising from marginal and internal discrepancies, such as plaque deposition, recurrent caries, and periodontal disease, underscore the importance of achieving precise fits in dental restorations.

Key words: Marginal discrepancy, dental prostheses, plaque deposition, periodontal disease, dental restorations

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INTRODUCTION

Discusses the transformative impact of digital impression techniques, particularly intraoral scanners (IOS), in the dental industry [1]. These advanced workflows allow for better collaboration, faster restorations, and improved treatment planning, including same-day anterior and posterior full coverage and partial-coverage restorations, veneer treatments, patient participation, and implant treatments. These digital workflows also positively influence removable prosthodontics, enabling better treatment planning, try-in, and delivery of final dentures, resulting in dentures with enhanced fit, comfort, durability, and esthetics [2]. Moreover, the integration of CAD-CAM technology in crown and bridge fabrication is reshaping dentistry, offering more accurate milling of restorative materials compared to traditional approaches [3]. Overall, this abstract underscores the growing importance of digital technologies in dentistry, particularly in fixed dental restorations and removable prosthodontics, and highlights the potential benefits they offer in terms of accuracy, convenience, and patient outcomes.

Fixed restoration

Fixed restorations play a crucial role in dental prosthodontics by restoring single teeth, groups of teeth, or filling gaps caused by missing teeth. Indirect restorations, such as inlays, on lays, veneers, crowns, and fixed partial dentures, offer numerous advantages, including increased durability, enhanced aesthetics, and improved functionality [4]. Among the fixed restorations, crowns are essential extra-coronal artificial restorations that restore the morphology, shape, and function of a natural tooth while safeguarding the remaining dental structure from future damage. Indirect restorations like crowns exhibit superior durability and aesthetics compared to chair side fillings. Dental cement is used to secure crowns in place, and they can be fabricated from various materials through an indirect method [5]. Overall, fixed restorations provide essential dental solutions that not only preserve teeth from decay but also enhance their appearance

and functionality, contributing to improved oral health and patient satisfaction.

Dental impression and impression techniques

A dental impression is a negative mold of a tooth used to create a positive replica, record, or dental restoration or prosthesis. The precision in generating the impression is vital for the successful design and longevity of both fixed and implant-retained prostheses. Incorrect impression-taking procedures or manual methods during prosthesis creation can lead to various issues, including problems with crown retention that may affect the prosthesis's Durability [6]. Dental impressions can be obtained through digital methods or traditional means. For traditional impression processes, it is crucial to use materials with suitable properties and improved attributes that allow for accurate detail replication and durability. These materials should also withstand effective cleaning processes.

Conventional impression technique

The conventional impression technique involves multiple steps in the procedure, including the fabrication of a stone cast and subsequent extra-oral digitization. However, this traditional approach raises concerns about accuracy. Documented faults in the conventional impression can lead to artifacts at the margins, compromising the restoration's marginal adaptation. To mitigate these issues, operators carefully select the appropriate tray and apply adhesive to both arches before utilizing the monophase impression technique with polyether impression material and stock trays. The interocclusal link is recorded using a polysiloxane bite registration material. The effectiveness and clinical outcomes of this traditional impression approach are then assessed [7].Inaccurate marginal fit resulting from inadequate impression-taking techniques during prosthesis fabrication can lead to various problems, such as luting agent dissolution, caries microleakage, periodontal inflammation, and hypersensitivity [8]. These issues emphasize the importance of achieving precise and accurate impressions to ensure the success and longevity of dental restorations.

Digital impression technique

The fabrication of fixed dental prosthesis traditionally involves the use of conventional impressions, which can be time-consuming for both dentists and patients. Issues may arise during the impression-making process, leading to potential errors and suboptimal prostheses. Conventional impression-making is limited by factors such as the flow and hydrophilicity of the impression material, a short working period, and patient movement during the impression-taking process [9]. However, digital impression techniques offer a more efficient and precise alternative. Intraoral scanning equipment allows for the acquisition of digital impressions, eliminating theneedfortray selection, impression cleaning, and shipping. With digital impressions, the process of pouring stone models, manual die cutting, and articulation becomes unnecessary. These digital impressions are integrated into CAD/CAM systems which enable in-office milling machines to create the final prosthesis using ceramic or composite blocks [10]. Intraoral scanners have also been developed as stand-alone devices, capturing digital impressions that can be transferred to dental laboratories for prosthesis manufacturing. While some stand-alone intraoral scanners do not allow for crown design, other systems enable dentists to mark the margins before transmitting the image to the lab. Overall, the digital impression technique revolutionizes fixed dental prosthesis fabrication, offering increased efficiency, accuracy, and patient comfort compared to traditional impression methods. The integration of digital technology in dentistry continues to enhance the dental restoration process, providing dentists and patients with more streamlined and precise solutions.

Computer Aided Device/Computer Aided Manufacturing (CAD/CAM)

The CAD/CAM process starts with the dentist taking three-dimensional images of the tooth preparation, which are then loaded into computer software. The software generates a computer-generated cast, allowing the dentist to plan the restoration digitally. This digital planning ensures a more delicate restoration, especially in the case of veneer restorations Preserving the enamel of the teeth is crucial for successful bonding of the restoration. CAD/CAM technology allows for precise preservation of enamel, which promotes better bonding compared to dentin bonding. The enamel covering must be protected during the tooth

preparation process to ensure optimal bonding results. While some dentists claim to offer a one-day process for chairside CAD/CAM services, the actual working time may be doubled compared to conventional restoration procedures [11].

Nonetheless, CAD/CAM technology significantly reduces the overall treatment time and offers the benefit of same-day restorations, enhancing the patient's convenience and experience

Advantage

Fixed restorations made using CAD/CAM technology offer the advantage of being fabricated and bonded to the tooth on the same day, providing a same-day restoration process. This is in contrast to conventional restorations, such as crowns and other classic prosthetics, which often require the use of temporaries and multiple visits to the dental office while the fixed prosthesis is being made by a dental laboratory. Finishing line, a line that separates prepared and unprepared tooth structure.

Disadvantages

Digital impression systems indeed come with their own set of disadvantages, which may affect their widespread adoption in certain clinical situation. Gingival Margin Capture: To produce an accurate digital impression, the gingival margin and approximately 0.5 mm of tooth structure apical to the margin must be exposed. This requirement can be challenging in cases with subgingival margins or difficult-to-reach areas.

Initial Cost Investment and Learning Curve: Adopting digital impression systems involves a significant initial cost for acquiring the necessary equipment. Dentists and dental staff also need to undergo training to effectively use the technology, leading to a learning curve Equipment Repair and Updates: Like any technological system, digital impression devices may require occasional repairs or updates, which can incur additional costs Restricted Opening: Some patients with limited mouth opening may find it uncomfortable or challenging to accommodate the larger wand used in digital impression systems. Furthermore, certain clinical situations still favor analog impression procedures over digital impressions. Unstable soft tissue or insufficient hard tissue can pose challenges especially when taking impressions for long-span bridges or large/full arch implant restorations. Digital impression systems also have limitations related to their scanning capabilities. The scanner's size may limit its ability to capture certain areas in the oral cavity accurately. Additionally, the presence of blood, saliva, or contamination in the oral cavity can reduce the effectiveness of digital impressions; Studies have shown that intraoral scans (IOS) using digital impression systems can be more accurate than conventional impressions for short-span fixed dental prostheses (FDPs) up to a quadrant. However, when it comes to full-arch scans, conventional impression techniques have demonstrated higher transfer accuracy. While the latest software versions of IOS scanners have shown improvements in short-span distances, conventional impression techniques still provide the lowest deviation for long-span distances [12], while digital impression systems offer numerous advantages, certain limitations and clinical scenarios may still necessitate the use of traditional analog impression procedures. Dentists must carefully evaluate each case's specific requirements to determine the most appropriate impression technique for optimal results.

Marginal fit and integrity and internal fit

The margin of a fixed dental restoration refers to the area where the crown comes into contact with the natural tooth. It is the most coronal (highest) location of undamaged tooth structure. Achieving an accurate and precise fit at the margin is essential for the success and longevity of the restoration. The space between the tooth margin and the restorative margin should ideally be between 40 and 100 nanometers (nm) to ensure a proper tooth-to-restoration adaptation. Achieving such a close fit between the restoration and the tooth margin helps prevent bacterial leakage and ensures a strong bond between the two, when the margin of the preparation is positioned below the gumline (subgingival), crown lengthening therapy may be necessary to expose the margin and allow for proper impression taking and restoration placement. Crown lengthening involves removing excess gum tissue and bone to reveal more of the tooth structure and create an appropriate margin; various types of margins can be used when fixing prepared teeth with fixed restorations. One common option is the chamfer finish line,

which is popular in complete gold restorations. The chamfer finish line design removes as little tooth structure as possible while still providing adequate space for the restoration material, resulting in a more conservative preparation, Ensuring both the marginal fit and the internal fit of fixed restorations are crucial for achieving long-lasting and well functioning dental restorations. A precise fit at the margin and within the restoration ensures proper adaptation, reduces the risk of complications, and enhances the overall success of the fixed Restoration.

Measurement methods for marginal fit

The marginal gap values of partial and full coverage restorations have been measured using a variety of approaches. Each method has its own set of benefits and drawbacks.

Cement space and marginal fit

There is a correlation between more concrete space and less seating disparity [13]. When luting an artificial crown with zinc phosphate cement, a minimum amount of seating discrepancy is required, as well as at least 40 um of cement gap. Crown seating is heavily influenced by the amount of cement available [14]. When the cement gap was increased from 10 um to 30-50 um the marginal fit of CEREC 3 CAD/CAM all-ceramic crowns improved Creating cement gap for CAD/CAM crown manufacturing is necessary to permit accurate coping adaptation to the abutments, improve excess cement outflow, and reduce the force required to adapt the crown on the abutment tooth during cementation [15]. The ideal cement space of 20–40 um for complete seating of a typical crown. The retention value of casted crowns using zinc phosphate and zinc polycarboxylate cements was higher for crowns without cement space than for crowns with cement space. A thick cement layer favors a higher concentration, which can lead to microcracks, piece maladjustment, and even marginal fractures of loose ceramic [16]. Internal adaptation, on the other hand, indicates the fracture force of the prosthetic work. As a result of the thick coating of cement, a region of force concentration is created, allowing for ideal fracture circumstances. The mean marginal discrepancies produced by crowns with a cement spacing of 70 m were greater than the clinically acceptable marginal discrepancy range of 30–120 um. One probable explanation is that the resin cement is subjected to increased intracoronal hydraulic pressure in narrower areas, which may translate to higher resistive forces during cementation, perhaps impeding a more complete crown seating. Changes in other criteria, such as tooth type, taper of tooth preparations, types of 21 materials, and CAD/CAM technologies, may also result in differing outcomes [17].

Die Spacer/ Cement Film Thickness

The die spacer utilized in crown manufacture has an impact on the indirect restoration's retention and fit indirect restoration with a die spacer of 25-40 um in thickness was reported to improve seating. The use of a die spacer of less than 30 m may result in poor seating of the repair during cementation. The potential of designing and fabricating crowns with the incorporation of virtual cement space (die spa) was established with the introduction of digital designing and fabrication of crowns. Digital designing and fabrication of crowns introduced the possibility of designing and fabricating crowns with the incorporation of virtual cement space (die spacer), consequently improving accuracy. Cements with varying degrees of deterioration in the oral environment will be used to fill the gap. Recommended using crown seating techniques that include perforations, internal relief and die spacer. It is safer to use die spacers because they promote internal relief close to the ideal and its application technique does not harm the restoration surface, as it is applied before casting. Die spacer has been shown to improve the marginal fit between the restoration and tooth preparation, decreasing the risk of cement dissolution, plaque accumulation, recurrent caries, and periodontal problems. The thickness of this die spacer affects the fracture strength of a ceramic restoration, its retention, and the marginal gap [18].

CONCLUSION

Within the limitation of this review study the following conclusion can withdraw: Conventional impression artifacts at the margins could occur from documented faults, jeopardizing the restoration's marginal adaption. The fixed restorations that were created with digital impression techniques had a better marginal fit than those made with conventional procedures. CAD/CAM allows for accurate and

aesthetically acceptable same-visit indirect fixed restorations. With the creation of very precise, accurate models and restorations. Furthermore, use of I.O.S. for digital impressions may be a viable alternative to analogical technique. The reliability of the workflow in term of marginal accuracy is enhanced by all the advantages lying into a full digital environment.

The IOS technique reduces the danger of cross-infection during fixed restoration making especially in the presence of the corona virus disease 19 (COVID-19) pandemic

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