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CASE REPORT

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Novel technique in detecting marginal adaptation of all ceramic restoration after cementation: case report

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Abstract

Background Accurate marginal adaptation of dental restorations guarantees their long-term success and longevity. Clinical evaluation of marginal adaptation is done using different techniques utilizing conventional tools such as mirrors and probes, which are subjective and non-standardized. Precise determination of restorations marginal gap intraorally, represents a challenge, especially when conducting clinical research testing newly introduced restoration designs or materials.

Case presentation A 31-years-old female patient came to dental clinic seeking full coverage restoration for an endodontically treated upper left maxillary first premolar. After the patient received an all ceramic Bruxzir crown, the marginal adaptation and precise gap determination were evaluated intraorally utilizing digital microscope, aided with a novel custom-made microscope-holding device that facilitated standardization and handling.

Conclusions The described method aided with the novel custom-made microscope holding device proved to be an easy, time saving and precise technique in evaluating the marginal gap directly inside patient's mouth especially in clinical researches.

Keywords Adaptation, Case report, Digital, Margin, Zirconia

Background

Generally, ceramics are unique materials that can be categorized according to different perception (Mclaren and Cao 2009). One of the most commonly used perception is the microstructure-based classification which is based on the amount and type of crystalline phase, glass composition and the ratio between them. According to such classification ceramics were divided into three basic categories glass ceramics, resin matrix ceramics and polycrystalline ceramics (Mclaren and Cao 2009; Giordano 2010; Zhang and Lawn 2017).

In this study, Bruxzir solid zirconia was the material of choice as it is considered one of the newly introduced esthetic materials that combined strength and esthetics together. It is a monolithic material that is characterized by high flexural strength (1150 Mpa) and high chipping resistance especially when cemented with its recommended cementing protocol combined with resin cements. These properties allowed its use in cases where there is insufficient enough space for conventional preparation and in patients who suffer from bruxism (Reich et al. 2015; Bunek et al. 2014; Harada et al. 2016; Kwon et al. 2017).

Marginal adaptation is considered one of the most important criteria of restoration success and longevity. Inaccurate marginal adaptation increases the susceptibility to marginal leakage, cement dissolution, plaque

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accumulation and recurrent caries, destroying the tooth and its supporting periodontium and consequently causing restoration failure (Vigolo et al. 2015). Marginal adaptation is assessed by the size of the marginal gap. This gap is determined by various parameters including vertical marginal gap, horizontal marginal gap, and absolute marginal discrepancy (Suárez 2003). Several research tried to define the clinically acceptable marginal gap. Most authors agree that a marginal gap less than 120 µm is clinically acceptable for a good long-term restoration survival (Freire et al. 2019; Yu et al. 2018).

Evaluation of marginal gap is done by several techniques. In vitro methods included either destructive or non-destructive methods. The destructive in vitro methods involved the cross-sectioning technique (CST). While the non-destructive in vitro methods that are introduced in dental literature involved direct view technique, the triple scan technique, Micro CT scanning.

The in vivo methods include the traditional clinical method which depends on using a blunt end explorer but this method lacks the presence of precise values of the marginal gap. In addition to the assessment using the scoring systems employed in USPHS (United States Public Health Service), CDA-Scale (California Dental Association), FDI (World Dental Federation) and their modifications. Moreover, using the silicone replica technique that can be used clinically and in vitro (Ritter 2014) Recently, a new digital version of replica technique; *dual-scan* method was introduced. However, this technique had its limitations as it required the presence of expensive digital scanners (Baig et al. 2010; Ahmed et al. 2020) All the previous techniques couldn't give quantitative analysis of marginal fit directly intraorally. The only methods to get a quantitative measure intraorally either by using optical coherence tomography which suffered from difficulties in measuring very thick or optical-opaque materials, or by using the digital microscope (Hamza et al. 2013).

Despite the new advancements, there isn't an easy and applicable method that could detect the marginal discrepancy directly intraorally and at the same time give a quantitative and precise measurement. The present case describes a novel technique for measuring the marginal discrepancy of prepared teeth with supra gingival finish line receiving monolithic Bruxzir zirconia crown directly inside the patient mouth by using a handheld digital microscope aided by a custom-made holder.

Case presentation

A 31-years-old female patient came to dental clinic seeking full coverage restoration for an endodontically treated upper left maxillary first premolar. Her medical history revealed no contradiction to dental treatment. Clinical and radiographic examination together with preoperative photographic documentation were performed in the first appointment (Fig. 1). The clinical and radiographic examinations revealed an appropriate endodontic treatment that allowed the tooth to be restored without complications, and a defective intracoronal composite resin restoration that required replacement. The proposed treatment plan involved fiber post (fibrekleer, fiber post, pentron, USA), composite core builds up (Build-it FR, Pentron, USA) and an all ceramic (Bruxzir) crown placement (Bruxzir Shaded Blank 200, Glidewell Dental Laboratories, USA).

A primary alginate impression (Tropicalgin, Zhermack, Italy) was taken to both arches. From this impression, a study cast (GC FUJIROCK EP, GC, America) was obtained for further case examination and for diagnostic wax-up construction. After the patient approved the treatment planned, the defective composite resin restoration was removed, the post space was created, followed by post placement, cementation using dual cured resin cement (Biscem, Bisco dental, USA) and composite resin core build up (Build-it FR, Pentron, USA)). Prior to tooth preparation to receive the final extracoronal restoration, silicone guides (Elite HD + Zhermack, Italy) were made to control the tooth reduction. The tooth was prepared according to the manufacturer's instruction of the material used to allow optimum results. The preparation comprised a 1 mm occlusal and axial reduction while maintaining a deep chamfer finish line (Fig. 2).

After finalizing the preparation, secondary impression was performed using double mix single step technique with an addition silicone rubber base impression material (AFFINIS Perfect Impressions, Coltene, Germany). The impression was then carefully transferred to a dental laboratory to be scanned using ineos X5 Scanner (Dentsply, Sirona CAD/CAM, Germany). An acrylic resin crown (PMMA DISK, YAMAHACHI DENTAL, Japan) was milled using inlab MC X5 milling machine

Fig. 1 Preoperative view of the tooth to be restored

Fig. 2 Prepared left maxillary first premolar with deep chamfer finish line

Fig. 3 Final restoration after cementation

(Dentsply, Sirona CAD/CAM, Germany). For the try-in stage to serve in checking the marginal adaptation, emergence profile, contour, and occlusal interferences. MCXL5 milling machine (Dentsply, Sirona CAD/CAM, Germany) was further used to mill the final crown restoration from Bruxzir zirconia crown (Bruxzir Shaded Blank 200, Glidewell Dental Laboratories, USA). A provisional crown was placed between visits (Charm Temp Crown, Dentkist, Korea).

Once the final restoration was obtained, it was rechecked intraorally, to ensure adequate restoration morphology and satisfactory shade. This stage was performed visually and using a probe as performed in most clinical situations. There were no major adjustments needed for the restoration. Afterwards, the intaglio surface of the final restoration was cleaned by Ivoclean Cleaning paste (Ivoclar Vivadent, Leichtenstein) for 20 s then rinsed with water for 20 s and dried with light jet of air. A zirconia primer (Z-PRIME Plus, BISCO, USA) was applied to the cleaned fitting surface of the restoration, then the crown was cemented by a self-adhesive universal resin cement (Rely X Unicem Aplicap, 3 M ESPE, Germany) (Fig. 3).

Fig. 4 Hand-held Celestron digital microscope connected to the computer

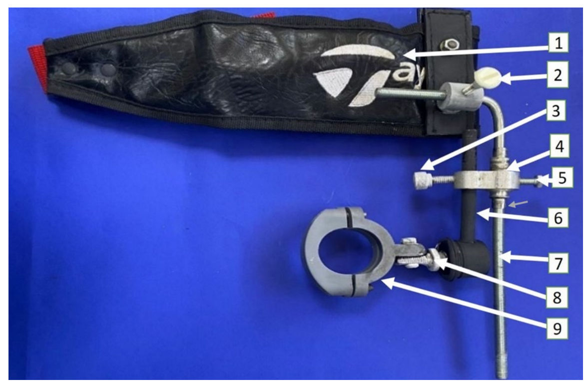

Fig. 5 Microscope Holding Device (MHD Device) Consists Of (1) Headband (2) Stabilizing Joint, (3) Fixing Joint, (4) Mounting Bar, (5) Mounting Screw (6) Vertical Positioning Arm (7) L-shaped metal support, (8) Ball and Socket Joint, (9) Microscope Locator Ring

After 6 months of cementation, a handheld digital microscope (Handheld Digital Microscope Pro, Celestron, USA) was used to examine the crown margins (Fig. 4). The microscope was fixed to the patient's head by a new device invented by the author called microscope-holding device (MHD). The MHD consisted of headband, stabilizing joint, metal arm, mounting bar, mounting screw, fixing joint, vertical positioning arm, ball, and socket joint and microscope locator ring (Fig. 5).

In order to fix the MHD to the patient's head, the headband was used. It surrounded the patient's forehead and fit it precisely with the help of an adjustable strap. The microscope locator ring, which was used to hold the microscope firmly and direct it toward the crown for marginal detection, was adjusted to its desired position with the help of the ball and socket joint part of a vertical positioning arm. Such joint allowed a 360° rotational movement (outward and inward direction) of the locater ring. The locator ring

Fig. 6 MHD positioning the microscope to detect the buccal crown margin

Fig. 7 MHD positioning the microscope to detect the palatal crown margin

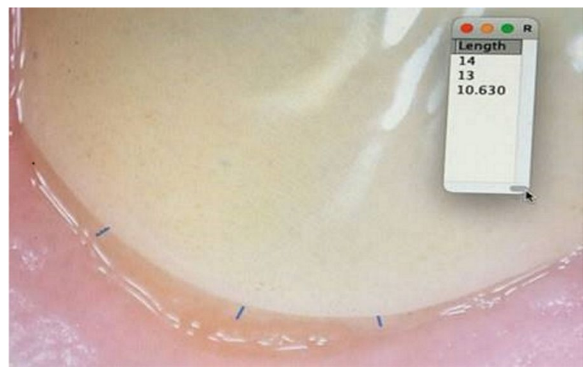

Fig. 8 Image of buccal side showing the margin analysis by the imageJ software in three points

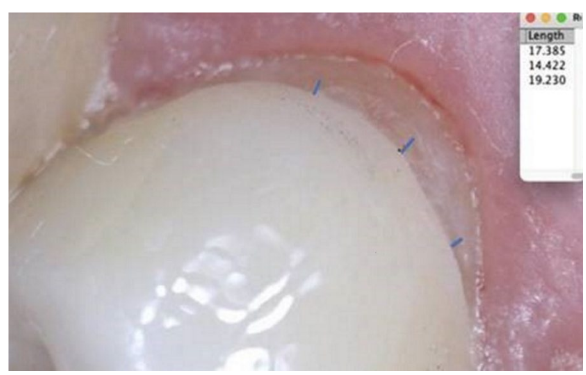

Fig. 9 Image of palatal side showing the margin analysis by the imageJ software in three points

vertical position was adjusted using the movable short vertical arm attached to the ball and socket joint. For a wider range of vertical position adjustment, the locator ring assembly (locator ring, ball and socket joint, and the short vertical arm) slide along the vertical part of the L-shaped metal support through mounting bar. As for the locator ring horizontal position, it was adjusted using the movable short horizontal part of the L-shaped metal support.

After appropriately positioning the microscope with the help of the MHD, the microscope was operated to capture the images of the buccal and palatal crown margins. The captured images were transferred to a personal computer to be analyzed using imageJ software (The National Institutes Of health and LOCI in University of Wisconsin) to measure the marginal gap (Figs. 6, 7). The marginal gap assessment was done by analyzing three points at the buccal margin and three points at the palatal margin.

The analyzed images revealed that the marginal gap were 14, 13 and 10.6 µm in the mesiobuccal, mid-buccal and distobuccal points respectively (Fig. 8) and 17.3, 14.4 and 19.2 µm in the mesiopalatal, mid-palatal and distopalatal points respectively (Fig. 9).

Discussion

This case report was conducted to introduce a new method for a precise determination of restorations marginal gap intraorally to overcome the old obstacles of limited mouth opening, lack of accessibility and the difficulty in positioning high magnification devices to assess the marginal gap intraorally.

Preshaded bruxzir solid zirconia material was used for final restoration construction as it provided high biocompatibility in addition to enhanced mechanical properties. Cementation of bruxzir zirconia crown followed three consequent steps starting with surface cleaning of zirconia fitting surface then priming followed resin cement application. This protocol enhanced bonding to the tooth and improved durability of the restoration with less technique sensitive steps (Santos et al. 2019).

The newly introduced method of intraoral marginal gap detection provided us with a precise quantitative repeatable measure. On the contrary in previous clinical researches, the most commonly used method in evaluating the marginal adaptation were the scoring systems which involved USPHS, CDA-Scale, FDI and their modifications. These methods depended on the availability of a blunt probe with ideal tip thickness ranging from 150 to 250 µm, and on the experience of the researcher and his/her tactile sensation. Unfortunately, these previously used techniques would consider the margins to be clinically satisfactory, if a harmonious continuation at the junction between the tooth and the restoration margin was detected, giving only a qualitative result and not a quantitative reliable precise data (Hansen et al. 2018).

On the other hand, the technique used in this study came in agreement with replica technique as they both obtained a quantitative results of the marginal discrepancy intraorally. However, it is in contrast with replica technique which it is time consuming, involves multiple steps, the replica material itself could be distorted or teared during the measurement procedures and it could not be used to detect marginal adaptation after cementation (Trifkovic et al. 2012).

Moreover, the benefits of using the MHD combined with digital microscope was found in testing new restorations, cement materials or techniques, determining their effect on marginal discrepancy as it might dictate or prohibit their use clinically. Inappropriate cement application or inadequate pressure during cementation might increase the hydraulic pressure exerted by the cement itself, increasing the marginal discrepancy. Dental cements flow to fill the gap that existed between the restoration and the tooth. In optimum situations, this should not be a problem. In contrast with using probe and the replica technique which are inapplicable in such cases as the cement action might affect the tactile sensation of the marginal adaptation (Ahmed et al. 2019).

This clinical report demonstrated an approach of chairside marginal gap detection that could be done intraorally and at the same time provide precise data. The MHD helped in positioning and fixing the hand-held digital microscope to detect and capture images of the crown margins intraorally.

This technique was proved fast, time saving, provided precise, and reliable immediate measurements of marginal gap by the aid of the microscope holding invented device that was introduced in this study. It helped increase the validity and accuracy of the marginal gap detection than the previously followed techniques by providing quantitative data, and by avoiding multiple steps or impression that could affect the accuracy and validity of the results. The variations in the oral environment of different patients might limit a strict standardization of different procedures.

Conclusions

The described Microscope Holding Device (MHD) technique showed accurate numerical values of intraoral marginal discrepancies of the restoration. In addition to ease and precision, which can aid in testing the reliability of restorations in clinical research.

Abbreviations

MHD	Microscope Holding Device
mm	Micrometer
USPHS	United States Public Health Service
CDA	California Dental Association
FDI	World Dental Federation

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Author contributions

SB collected the data and analysed it. Also, SB prepared and wrote the manuscript. GE and EH reviewed and edited the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Patient approved to sign the consent for study participation and the study was approved by the ethics committee of Cairo university.

Consent for publication

A written consent to publish this information was obtained from study participants.

Competing interests

The authors declare that they have no competing interests.

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