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EVALUATION OF THE MARGINAL FIT IN FIXED PROSTHODONTICS

ПРОЦЕНКА НА МАРГИНАЛНОТО УПАСУВАЊЕ ВО ФИКСНАТА ПРОТЕТИКАТА

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Abstract

The marginal gap space is frequently responsible for prosthodontic restoration loss, due to specific demineralization process by micro-leakage and bacteria colonization. The aim of the in-vitro study was to evaluate the width of the marginal gap in porcelain fused to metal (PFM) crowns. A light-body silicone was used to measure the marginal gap between the abutment tooth and crown in order to evaluate absolute discrepancy with the replica technique (RT). Twenty PFM crowns were fabricated on premolar die marginal discrepancies ranging from 61.5 to 75.0 microns, mean vertical discrepancies ranging from 22.9 - 46.0 micron and mean horizontal discrepancies ranging from 42.0 to 58.8 micron. Based on selection of 100 microns as limit of clinical acceptability, restoration margins were presented with minimal risk for caries occurrence, and the prostheses demonstrated acceptable marginal adaptation. **Key words:** Secondary caries, abutment, marginal gap.

Апстракт

Маргиналниот простор честопати е одговорен за пропаѓање и загуба на протетската реставрација поради специфичноста на процесот на деминерализација од пропусливоста на коронката и бактериската колонизација. Целта на оваа ин-витро студија беше да се направи проценка на ширината на маргиналниот простор кај метал-керамички коронки. Маргиналниот простор се измери со реплика методата за евалуација на апсолутното растојание со употреба на течна силиконска маса. 20 метал-керамички коронки се изработија на премоларно трупче, а резултатите покажаа средни вредности на просторот 61.5-75.0 микрони, средно вертикално растојание 22.9-46.0 микрони и средно хоризонтално растојание 42.0-58.8 микрони. Според прифатените вредности во студијата на 100 микрони, маргиналните простори преставуваат минимален ризик за појава на кариес, а реставрациите се со прифатлива маргинална адаптација. **Клучни зборови:** секундарен кариес, абатмент, маргинален простор.

Introduction

In fixed prosthodontics, the evaluation of the "marginal gap" is defined as the measurement of the space or internal surface between the casting and the axial wall of the abutment tooth in the margin region[1]. The marginal gap or fit is acceptable when the crown lies or fits well in most various points on the abutment and it presents important factor for prosthetic restoration longevity and clinical success[2,3]. Deficiency in the marginal fit can sometimes cause inflammation of the tooth and the surrounding periodontal tissues as well as the appearance of secondary caries below the crown margin[4]. Dental cements serve to fill the interim space while also fixating and isolating the abutment[5]. However, even if the recommended manufacturing process is followed, the appearance of the marginal discrepancies is unavoidable. Wider marginal gaps cause cement dissolution and washing, saliva propagation, plaque accumulation and secondary caries[6]. The materials and techniques used to make dental crowns, as well as the patient's behavioral and dietary changes, all play a role in reducing or increasing caries risks[7,8].

There is a wide range of data on clinically acceptable width of the marginal gap. Some authors consider acceptable gap to be between 30μm and 200μm, while other clinical studies have found much higher values of the gaps ranging between 70μm and 647μm, but there is no defined or accepted reference value on clinically accepted marginal gap[9,10]. There are also various approaches available in the evaluation and assessment methods used for measuring the marginal gap[11,12]. The problem of determining crown fit under in vivo conditions has yet to be solved[13]. In the patient's mouth, the fit can only be evaluated by subjective methods by an experienced doctor using

visual examination, dental explorers, x-rays etc[14]. In Kerschbaum study, there were no significant differences between the visual examination and the use of the explorer,, whereas in another study radiographically margin discrepancies less than 80µm were difficult to detect[15,16]. Several other methods are presented for evaluation of the marginal gap, including the cross-sectional method (CSM), triple scan method (TSM), micro-computed tomography (MCT), optical coherence tomography (OCT), silicone replica technique (SRT) and others, each with advantages and disadvantages. Although some previous studies have examined the significance of the various assessment methods, comparing them was difficult due to the differences in the experimental condition in each study[17].

The silicone replica technique (SRT) has been widely used for evaluating of the marginal and internal fitting because of its ability to measure the condition of a dental prosthesis without causing any damage. However, due to morphological variations such as rounded margins, the location and number of the several measurement points must sometimes be predetermined.

The aim of this in-vitro study was to compare the marginal gap and fit on the abutment teeth to subjective evaluation using the direct-sight technique.

Material and methods

A light-body silicone was used to measure the marginal gap and fit between the abutment tooth and crown in order to evaluate absolute discrepancy with the silicone replica technique (SRT). It evaluates the thickness of the impression material, as a result of the cementation space of the crowns over copings. Ten anatomical premolar abutments (dies) with dimensions 6.5 mm of height, axial walls 6º tapered and chamfer finish line were made of type IV dental stone as master models (Figure 1). There was no use of die spacing. The models were then sent to the dental laboratory, where 20 porcelain fused to metal crowns (Ni-Cr-Mo alloy, Ugirex III) were fabricated on the premolars casts. They were fabricated conventionally with the wax technique, invested and casted. The investment was removed from the framework and cleaned with 110 µm aluminum oxide sandblasting. Finally the veneering porcelain was manually applied to the frameworks and sintered according to manufacturer's recommendations.

Figure 1. *Premolar stone abutment as master model*

Following that,, the light body polyvinylsiloxane addition silicone impression material (base and catalizator) was mixed with activator and used to fill the discrepancies, or the space between the crowns and abutment teeth, according to manufacturer's recommendations (Figure 2).

Figure 2. *Light body addition silicone immersion material*

The silicone impression material film was used to simulate the position and thickness of the cement layer in order to determine the width of the existing "marginal gap" (Figure 3).

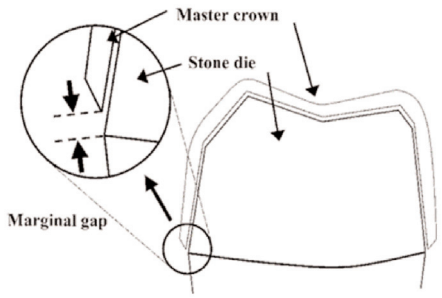

Figure 3. *Marginal gap – schematic presentation*

After the impression material had been set, it was removedfrom the die in one piece (Figure 4.) and the thickness of the layer was measured and evaluated using the direct-sight technique and a microscope at ×4.6 magnification. Each silicon impression film was cut in two

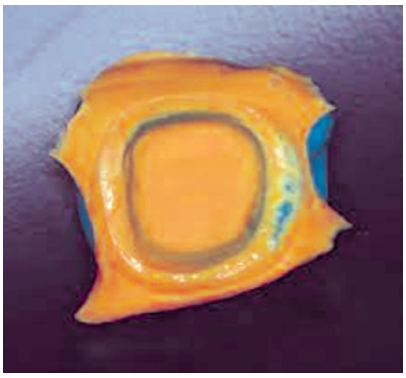

Figure 4. *Silicone impression film after setting and removing from the coping*

directions (buccolingually and mesiodistally) and evaluated at three pre-determined sites. Internal adaptation or the film thickness was measured as the distance between the inner surface of the crown and the outer surface of the prepared tooth at three location points (marginal, occlusal and axial). The fitting of the marginal surface was measured as the distance between the finish surface angle of the prepared tooth and the cervical margin of the crowns.

Results

Statistical analysis was performed using SPSS 11.0 software for Windows. The measurements of the internal fit in the marginal point in crowns revealed mean marginal discrepancies ranging between 61.5 and 75.0 μm. The results of the occlusal points measurements showed mean marginal gaps ranging from 40.9 to 45.3 μm. The results of the axial points measurements indicate vertical discrepancies ranging from 22.9 to 46.0 μm. The measurements in the occlusal points showed mean horizontal discrepancies in the range of 42.0 to 58.8 μm.

Table 1. Mean values of the marginal discrepancy in three measuring points

Measuring Points / 20 crowns	Marginal discrepancy (mean value)
marginal	68.2 μm
occlusal	43.1 μm
axial	34.4 μm

In this study, the largest gaps (mean value) were found at the marginal area 68.2 μm, the internal values showed smallest axial gap 34.4 μm, and the mean occlusal gaps 43.1 μm.

Discussion

In the field of fixed prosthodontics, the best treatment approach has traditionally consisted of a conventional impression technique for the stone casts and fabrication of a porcelain-fused-to-metal restoration. This protocol is regarded as the clinical gold standard for replicating the intraoral situation. In the modern era of digitalization, traditional dentistry and prosthesis have been questioned for their accuracy and precision, and comparative analysis is very common[18]. However, regardless of the manufacturing process, the primary goal of every prosthdontist is to achieve the smallest or acceptable marginal gap value of the restoration[19]. A well-fitting restoration needs to be accurate along its margins as well as its internal surface[20].

Various values and locations on the abutment tooth are usually defined as marginal gap (MG) and marginal discrepancy (MD). Some authors suggested using the term absolute marginal discrepancy (AMD) or the largest measurement of margin space at measurement points[21]. They consider absolute marginal discrepancy to be the most important because it considers both horizontal and vertical directions. AMD is defined as the linear distance between the finish line of the preparation and the margin of the restoration. According to some studies, the maximum opening should not exceed 100 μm, while another study reported that 100 - 200 μm is the clinically acceptable range for long-term success of dental prostheses[22]. In order to obtain accurate and correct values, the number of the measurement points in In-vitro studies must be predetermined and should not be less than 50[23]. In our study, we measured the crown/abutment gaps in our study according to the recommendations.

However, several studies for evaluation of the marginal and internal fit of the crowns using various methods and materials have been published, but there is no standardized measurement methodology and the results obtained from different techniques vary significantly. The replica technique has some limitations as well, such as possibility of tearing the elastomeric film while removing it from the abutment, or errors in cutting and sectioning that may result in higher measurement values.

A few variables control and affect the dimensional changes that occur in the interim spaces between the die and the final casting. It is usually the result of multiple errors during the clinical and laboratory stages of crown fabrication. The preparations of the tooth geometry, finish line type, impression methods, and cementation technique and cement thickness are responsible for the creation of the clinical gap space[25]. The axial gap values from our study were slightly lower than those of some previous studies[26].

When compared to the accepted parameters, the gap in chamfer area of premolar substructure in our study was in the range of 61.5 to 75.0 μm, which is slightly less than the recommended value of 100 μm, and the crowns demonstrated acceptable values of the marginal fit.

The gap space is a determining factor for the long-term integration and failure of a restoration[27,28]. It is critical for tooth and periodontal health to reduce marginal and internal fit inaccuracies. Several techniques, such as overwaxing the margin of wax pattern, removing wax from internal surface of wax pattern, die relief with the application of a die spacer, internal relief of cast restoration by sandblasting, mechanical milling, acid etching, electro-chemical milling, and so on, were presented by various authors.[29,30].

Conclusion

Within the scope of this study, the conventional method of wax pattern fabrication produced copings with good marginal and internal fit, and demonstrated a comparable and acceptable marginal, axial and occlusal fit, all of which were within the range of clinically accepted values.

Within the limitations of this study, it is possible to conclude that the SRT is an accurate and reliable technique for simulating crown gap space after the cementation. The RT is a reliable method for evaluating cement thickness at the marginal and internal gaps.

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