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RESEARCH ARTICLE
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EVALUATION OF THE MARGINAL DISCREPANCY ON IMPLANT ABUTMENTS WITH CROWNS FABRICATED BY CAD/CAM TECHNOLOGY

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Abstract
This was an experimental in vitro study using CAD/CAM-fabricated implant abutments and crowns. For mandibular first molars, a total of twenty-five implant analogs measuring 4.3 mm in diameter, 10 mm in length, and 5.5 mm in height were obtained for the straight abutment. Using CAD/CAM technology, 25 first molar crowns were created on these implant abutments. Following the cementation of crowns on implant abutments, caries exploration was used to assess the marginal irregularity. Using a stereomicroscope, marginal gaps were assessed on twelve sites on the buccal, lingual, mesial, and distal surfaces. Data were gathered on data collecting sheets following evaluation. With SPSS, statistical analysis was carried out. A percentage was used to express marginal irregularity. The marginal gaps were compared using the Friedman Test. According to the findings, every specimen had a score of 0 (smooth probing, no abnormalities), meaning that there were no marginal irregularities in any of the specimens. On all surfaces, the marginal gaps ranged from 2.99 to 29.03µm. The buccal surface had the largest mean ± SD value of the marginal gap, 9.897±5.755 µm, while the distal surface had the lowest, 6.719±2.419 µm. 7.816±3.873 µm was the total Mean ±SD of the marginal gap. Between the Buccal-lingual and Buccal-Distal groups, there were observed to be significantly different marginal gaps. The area of the crown margin was responsible for varied marginal gaps, and it can be stated that the marginal gaps detected in CAD/CAM manufactured crowns on dental implant abutments were within a clinically acceptable range.

Keywords: Marginal discrepancy, Marginal gap, Marginal irregularity, CAD/CAM system, implant abutment.

INTRODUCTION

The effectiveness of dental restorations is determined by a number of factors. The three main factors are fracture resistance, aesthetic properties, and marginal fittings. One of the most crucial requirements for the long-term viability of the dental prosthesis is the marginal adaptation of the fixed prosthesis to the abutment (1). There are numerous ways to define marginal adaptation deficiencies, including "the internal gap is the perpendicular measurement from the internal surface of the casting to the axial wall of the preparation" and "the marginal gap is the distance from the internal surface of the casting to the axial wall of the preparation at the margin." Other types of marginal disagreement include underextended and overextended cast margins (2).

Marginal spaces may provide an ideal environment for the deposition of biofilm, which can lead to the development of periodontal and dental cavities in the abutment tooth as well as in neighboring teeth. Wide spaces could lead to further cement deterioration and the prosthesis coming loose from the abutment tooth (3-6). The disintegration of the cement is negatively impacted by oral fluid if the marginal gap is more than 150 µm (7). A marginal deficit facilitates the attachment of food particles and oral germs, which leads to the accumulation of plaque. This, in turn, can result in gingivitis, periodontitis, and secondary caries in the teeth that are adjacent to the abutment teeth. Adhesion and prosthesis failure follow as a result (8).

A dental crown's marginal fitness is influenced by a number of factors, including the method of fabrication, the kind of material used to create the impression, the kind of material used to make the crown, its elastic modulus, the number of crown units, the location of the abutment tooth, the setup of the tooth in preparation for receiving the crown, the kind and location of the finish line, the type and thickness of the cementing agents, the pressure used during cementation, the ratio of powder to liquid in the cement, the use of spacers, etc. (9-17). The microleakage determines how big the marginal gap is. For prostheses made using computer-aided design or computer-aided technique, a size of 90 µm or less is deemed appropriate, but 100 and 120 µm are considered clinically acceptable using conventional methods (18–20).

In dentistry, CAD/CAM technology was first used in 1985. In dentistry, this method was first used to create tooth-retained restorations such as veneers, crowns, onlays, and inlays. Afterwards, it was utilized to build a fixed partial denture to take the place of the lost tooth. These days, implant abutments are also made using it (21-22). Since CAD-CAM restorations are more exact than those made with traditional methods, the technology has been rapidly gaining traction in dentistry (23). In this investigation, we assessed the marginal disparity in CAD/CAM-fabricated implant abutment crowns.

MATERIALS AND METHOD

The Department of Prosthodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, was the site of an experimental type in vitro investigation. Implant abutments and crowns made using CAD/CAM technology served as the study samples. Samples consisted of twenty-five consecutive mandibular first permanent molar abutments.

Study Procedure

Nobel Biocare provided 25 internal connection implant analogs with a 4.3 mm diameter and 10 mm length, as well as straight snappy abutments with a 5.5 mm height and 1.5 mm collar. An implant analog was inserted into a self-cured acrylic resin (DPI-self-cure) block. Using a torque control wrench (Nobel Replace Manual Torque Wrench Surgical), abutments were attached to the implant analogs on the prepared blocks by 35Ncm screw torque in accordance with the manufacturer's advice. Using CAD/CAM technology, crowns measuring 8 mm in height and 10 mm in width were created for mandibular first molar teeth. Using glass ionomer cement (Shofu HyBond Glasionomer Cx Luting Cement) and finger pressure, the zirconium crowns were bonded over the abutment for four minutes. A sharp explorer was used to remove any excess cement once the cement had set (Figure 1 & 2).

Figure 1: Implant crown with implant abutment- laboratory analog in acrylic block before cementation

Figure 2: Cemented crown on implant abutment

Evaluation

A caries explorer was passing along the crown margin to detect any irregularity present or not (Figure 3). Scoring was done as follows-

Score-0	Smooth probing, no irregularities
Score -1	Irregularities but the probe can pass
Score- 2	marked irregularities and probe stuck

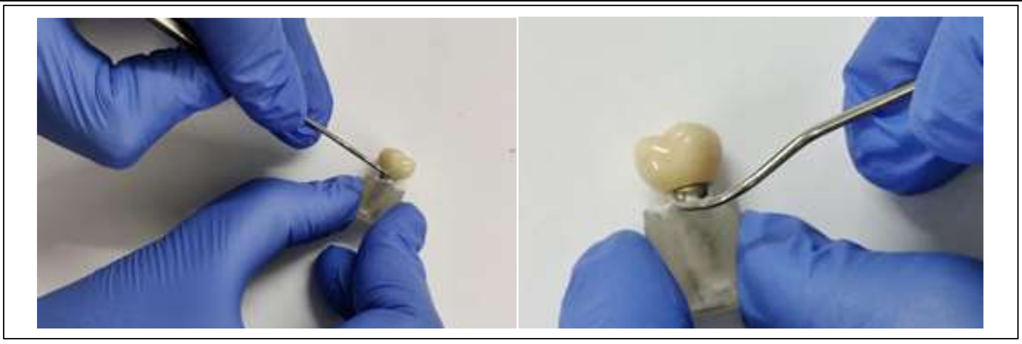

Figure 3: Evaluation of marginal irregularity with a caries explorer

An indelible marking pen was used to mark three spots on each surface along the borders, for a total of 12 points: the buccal surface (mesial, middle, distal), the mesioproximal surface (buccal, middle, lingual), the lingual surface (mesial, middle, distal), and the distoproximal surface (buccal, middle, lingual). Using a stereomicroscope to measure the absolute marginal difference of the crown margins on the implant abutment, the marginal accuracy was evaluated (Figure-3). In order to ensure that the maximum distance between the outer restoration margin and the abutment's Cavo surface angle was perpendicular to the optical axis of the microscope, the specimens were positioned in the same location on the abutment at an angle of between 90 and 120 degrees. Every measured margin of error was noted on a data collection sheet.

RESULT

The proportion of the crown's marginal irregularity score on the implant abutment is displayed in Figure 4. Score-0 (Smooth probing, no irregularities) was displayed by all specimens, meaning that 25% of the specimens had no marginal abnormality.

The buccal, lingual, mesial, and distal surfaces in Table 1 had marginal gaps ranging from 3.42-29.03µm, 3.26-15.74µm, 5.14-15.69µm, and 2.99-13.29µm, in that order. On the buccal surface, the largest mean ± SD, 9.897±5.755, marginal gap was discovered. Mean ±SD for case lingual, mesial, and distal marginal gaps were 6.961±2.871µm, 7.686±2.849 µm, and 6.719±2.419 µm, respectively. 7.816±3.873 µm was the total Mean ±SD of the marginal gap.

A nonparametric test called the Friedman test was used in Table 2 to compare the marginal gaps in the buccal, lingual, mesial, and distal regions of the margin. The test's outcome demonstrated that the computed p-value was statistically significant and less than 0.05 (.004).

The test results in Table 3 demonstrated a substantial difference in the marginal gaps between the Buccal-lingual and Buccal-Distal groups. There was no discernible variation in the marginal gap between the other comparative groups.

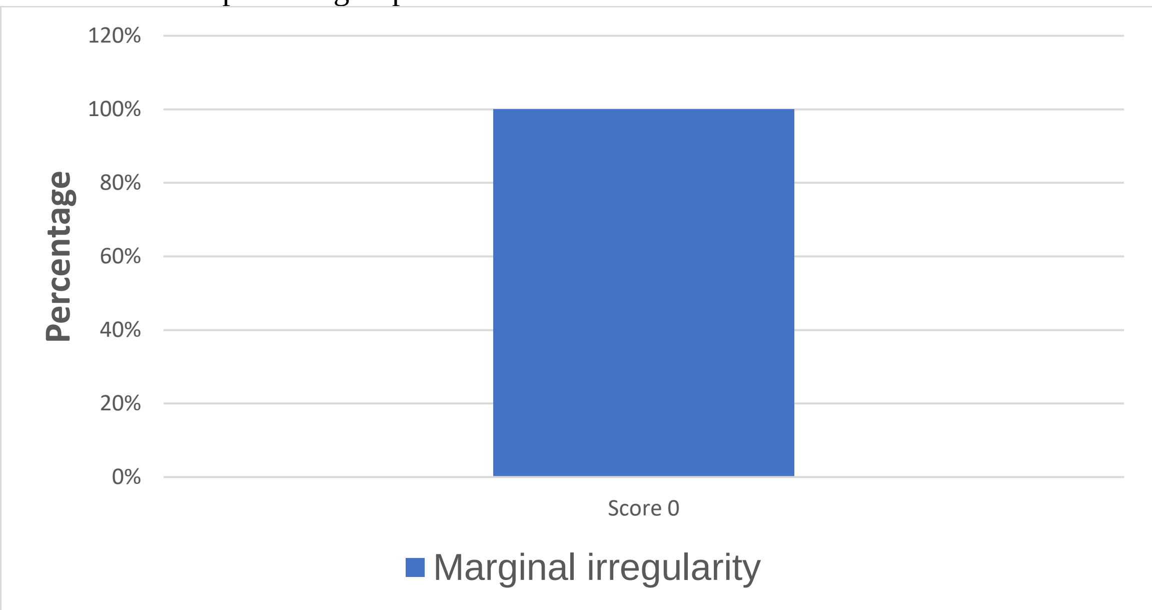

Figure-4. Percentage of marginal irregularity of CAD/CAM fabricated crown on the dental implant abutments (n=25)

Table-1 Descriptive statistics of marginal gaps (n=25)

Surface	Minimum (µm)	Maximum (µm)	Mean (µm)	Standard Deviation (µm)
Buccal	3.42	29.03	9.8979	5.75508
Lingual	3.26	15.74	6.9613	2.87140
Mesial	5.14	15.69	7.6861	2.84895
Distal	2.99	13.29	6.7197	2.41893

Total	2.99	29.03	7.8163	3.87310

Table 2 Comparison of the marginal gap between four areas by Friedman Test

Areas	Mean ± SD[a] (μm)	Mean Rank	Chi-Square value	P-value
Buccal	9.897±5.755	2.16		
Lingual	6.961±2.871	2.72	13.368	.004[b] (<0.05)
Mesial	7.686±2.848	3.16		
Distal	6.719±2.418	1.96		

n=25, in each group (dependent samples). a, standard deviation. b, statistically significant value

Table-3. Pair-wise comparison of the marginal gap between the groups by Friedman pairwise Test

Comparison groups	Mean ± SD[a] (μm)	Test Statistics	P-value
Buccal -lingual	9.897±5.755 6.961±2.871	1.000	.037[b] (<.05)
Buccal-Mesial	9.897±5.755 7.686±2.848	.440	1.000[c] (>.05)
Buccal-Distal	9.897±5.755 6.719±2.418	1.200	.006[b] (<.05)
Lingual-Mesial	6.961±2.871 7.686±2.848	.560	.751[c] (>.05)
Lingual-Distal	6.961±2.871 6.719±2.418	.200	1.000[c] (>.05)
Mesial-Distal	7.686±2.848 6.719±2.418	.760	.224[c] (>.05)

a, standard deviation
b, statistically significant value
c, statistically non-significant value

DISCUSSION

In clinical dentistry, dental implants are becoming more and more commonplace. The dental implant market is projected to grow to $13 billion globally by 2003. About 10%of dental implants have been documented to fail. The most frequent side effects of dental implants are fracture (24-25), soft tissue irritation surrounding the implant abutment, abutment screw loosening, implant fixture motion, and loss of retention and cementation failure.Food accumulation and microleakage in the prosthesis's margin, which results from the prosthesis's lack of marginal integrity to the implant abutment, are the primary reasons of cementation failure and inflammation of the soft tissue around the implant. It has been determined that a marginal gap greater than 120μm will result in the failure of fixed prosthesis such as a bridge or crown (26). The goal of the current study is to assess this crucial component—the marginal crown adaptation on implant abutment.

Here, zirconium crowns on implant abutments for mandibular first molar teeth have been created using CAD/CAM technology. After the marginal irregularity was assessed, the findings indicated that none had been discovered (Figure 4). The marginal gaps in a total of 25 specimens, which comprised 12 locations each of the buccal, lingual, mesial, and distal surfaces, were assessed using a stereomicroscope while keeping the same distance and position. At any one time, the marginal gaps ranged from 2.99 to 29.03 μm. The mean ± standard deviation of the total marginal gap was 7.8163±3.8731μm. The highest mean ± standard deviation was found in the case of the buccal surface, 9.897±5.755μm and the lowest was found in the case of distal surface, 6.719±2.418 μm.

The mean ± standard deviation of marginal gaps of other two surfaces- lingual and mesial was 6.961±2.871µm and 7.686±2.848 µm, respectively.

A small number of researchers found that the permissible marginal gap for ceramic crowns is between 1µm to 165µm in their study (27-28). Nonetheless, a small number of other writers said that restorations composed of other materials, such as porcelain bonded to metal and titanium, can have a thickness of 100–150 µm (29-30). The mean marginal gap values in this study were within a range that is considered clinically appropriate for crowns created using CAD/CAM systems. The mean marginal gap for complete ceramic crowns built using CAD/CAM was significantly smaller than the marginal gap for other crowns made using conventional methods has been reported (31)

The results of earlier investigations are likewise supported by our investigation. The current analysis yielded a minimum marginal gap of 2.99 µm and a maximum marginal gap of 29.03µm. The precision of prosthetic margins may be caused by variations in fabrication techniques. Zirconia crowns exhibited a smaller marginal gap than ceramic crowns (32). The decreased marginal gap in the current study could possibly be attributed to the zirconium type of crown material. Marginal gaps varied across different locations of the margins in our study. Table 3 & 4 displays that the buccal surface had the largest mean± standard deviation of the marginal gap, measuring 9.897±5.755µm, while the distal surface had the lowest, measuring 6.719±2.419µm. Table 3 displays the main difference between buccal and lingual surfaces as well as between buccal and distal surfaces. The marginal gaps between the surfaces varied statistically substantially. Despite the fact that the marginal gaps varied across the prosthesis, every value fell inside the range that is considered clinically acceptable.

Conventional techniques for fabricating indirect restorations, like as crowns, fixed partial dentures, and inlay, onlay, lead to various restoration problems, which eventually result in various oral health complications for the patient. To counteract the faults, numerous contemporary technologies and materials have been introduced. With the use of CAD/CAM technology, prostheses may be precisely and functionally manufactured, as well as custom-made to satisfy patient comfort and aesthetic requirements. The CAD/CAM system-made crown exhibits superior marginal precision, creating a hygienic environment around the implant abutment that facilitates appropriate cleaning and the long-term viability of the prosthesis.

CONCLUSION

Considering the study's limitations, it can be said that the marginal gap in crowns made using CAD/CAM technology on dental implant abutments was within a range that was considered clinically acceptable. The gap was in the lower range, but the area of the crown margin played a part in the various marginal gaps. The prosthetic surfaces caused a considerable difference in the marginal gaps.

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